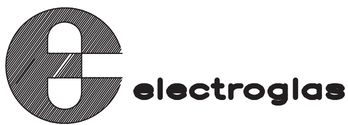

Horizon Series

MODEL 4085X

AUTOMATIC WAFER PROBER SYSTEM

TECHNICAL REFERENCE MANUAL

PN 254523−001

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CLEAN ROOM EDITIONS

Special editions of Electroglas manuals are available for Clean Room applications upon request. Clean Room manuals may be ordered by substituting the capital letter “C” for the hyphen in the part number of the Standard manual.

Example:	Standard manual	PN XXXXXX−001
	Clean Room manual	PN XXXXXXC001

Although the letter “C” replaces the hyphen on the order form, the hyphen will remain within the manual identification.

The distinction between Standard manuals and Clean Room manuals is that Standard manuals are printed on standard white bond paper and are for use under normal operating conditions. Clean Room manuals are printed on colored 30# Munising LP Clean Room stationery manufactured by Kimberly Clark Corp. or equivalent and are for use in Clean Room environments.

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SECTION 1
INTRODUCTION TO THE 4085X

1.1 GENERAL OVERVIEW

The Electroglas Horizon 4085X Automatic Wafer Prober System is a precision manufacturing machine which moves wafers through the test process quickly, accurately, and safely. It is designed to probe high−pin−count devices, performing with high accuracy in an enclosed clean environment. Probing accuracy is certified to +/− 0.25 mil, required for probing small, densely packed bond pads. *Figure 1−1* illustrates the Horizon 4085X Wafer Prober System.

The Horizon 4085X is an operational Basic Unit and includes the components listed in **Table 1−1A**. The Basic Unit can operate alone, or it may be enhanced by adding any of the optional equipment listed (**Table 1−1B**).

TABLE 1−1: HORIZON 4085X BASIC UNIT AND OPTIONS

A: BASIC UNIT	B: OPTIONS
Platen	Thermal (Hot) Chuck
Forcer Assembly	Ring Inserts
Z Drive Assembly	Clean Air Management System
Standard Chuck	Standard Machine Interface
8” Ring Carrier	Microscope
Power Control Module	Optical Character Reader
Monitor Console, Keyboard, and Joystick	Backside Bar Code Reader
Prober Vision Software	
Material Handler Module	
External Control I/O Interface	
Auto Align Module	
NonContact Edge Sensor	
Disk Based System	
Real Time Mapping	
Wafer Mapping & SECS	
Multi−Die Probing	
Ink Dot Inspection	
Probe Mark Inspection	

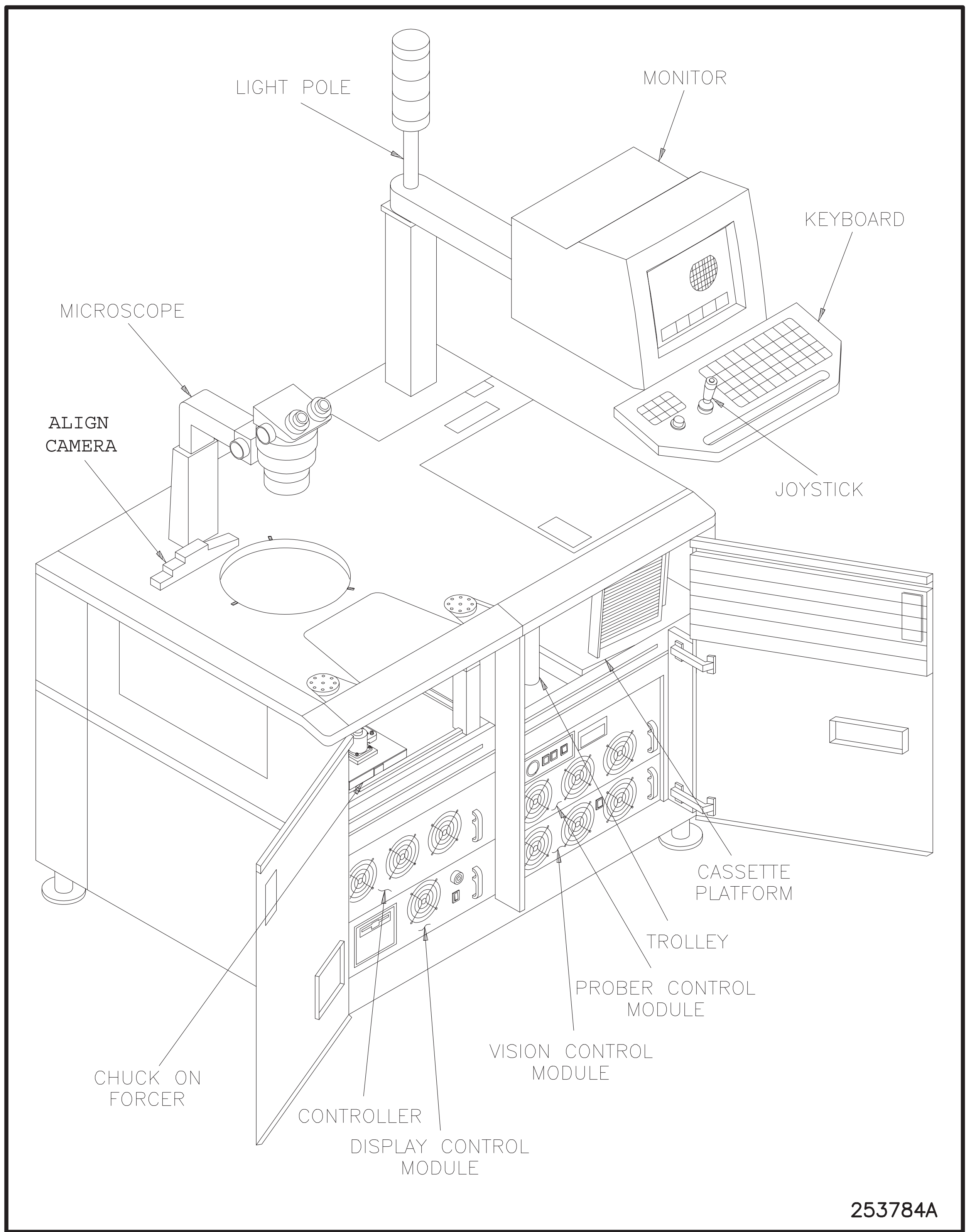

FIGURE 1−1: HORIZON 4085X WAFER PROBER

1.2 HOW TO USE THIS MANUAL

This 4085X Technical Reference Manual is intended to serve as a guide for understanding and using the Horizon 4085X Wafer Prober. It is divided into three major parts; each part is further divided into sections.

The first part is a brief introduction about the prober (Section 1), how to begin using it, including simple setup and operating instructions (Section 2) and more detailed information on each menu and submenu (Section 3).

The second part of the manual is a reference description of each of the standard major probing modules (Sections 4 through 13).

The third part discusses the clean room options and their functionalities (Section 14).

Every section will contain the following subsections:

- Overview
- How to Use this Section
- Instructions
- Summary

1.2.1 Conventions Used

This manual uses the following conventions:

< SET MODE > (< F2 >)	Key references in brackets and a different font
Section 2.2,	Section references in **bold**
Table 3−1	Table references in **bold**
Figure 12−1	Figure references in *italics*
probing area	Terms that are defined in *italics*

1.3 OPERATING SEQUENCE

The Horizon 4085X Wafer Prober performs the following operating sequence automatically:

1. A wafer is removed from a cassette by the transfer arm and transported to the prealigner, which centers the wafer and orients the flat or notch of the wafer.

2. If there is no wafer on the chucktop, the wafer is transported by the transfer arm from the prealigner to the chucktop. Otherwise, if there is a wafer on the chucktop, the wafer is transported from the prealigner to the quickloader.

3. The chuck moves the wafer to the profiler (located in the ring carrier) and the wafer surface is mapped and the diameter is measured.

4. The chuck moves under the align camera and Automatic Alignment is performed, aligning the streets of the wafer to the XY axis of the forcer.

5. Probing is then performed. The chuck:

    o moves in X and Y directions to place a die under the probes
    o moves up in the Z direction until the probes contact the pads
    o moves up further to ensure firm probe−to−pad contact

6. After the die is tested, the chuck:

    o moves down in the Z direction to remove the pads from the probes
    o moves in X and Y directions to the next die

7. Concurrently, while the first wafer is being probed, the transfer arm removes the second wafer out of the cassette and transports it to the prealigner.

8. After prealigning is performed, the transfer arm moves the wafer to the quickloader.

9. When the first wafer is completely probed, the transfer arm removes it from the chucktop and returns it to the cassette.

10. The second wafer is transported from the quickloader to the chucktop and Steps 3 through 9 are repeated until all wafers are probed.

1.4 MAJOR FEATURES

1.4.1 Prober Vision Software

The prober uses computer software (called Prober Vision Software) to receive and process instructions from you on how you want the prober to perform.

Information about the software is contained in **Section 2, Getting Started**.

1.4.2 Real Time Mapping (RTM)

The RTM (Real Time Mapping) feature provides an immediate visual map of the dies on the current wafer. As wafer probing progresses, the map can display either status or bincode for each individual die in user−selected color codes.

Information about RTM is contained in **Section 3, Tutorials**.

1.4.3 Material Handler

The Material Handler provides automatic wafer load/unload operation. It uses a single−axis linear motor system and a tower/transfer arm combination to extract wafers from and replace them into cassettes. The wafer is moved from the cassette to the prealign station, to the quickloader station, and then onto the chucktop.

Information about the Material Handler is contained in **Section 4, Material Handler**.

1.4.4 Auto Align Module

The Auto Align Module aligns the streets of the wafer to the XY axis of the forcer.

The Material Handler automatically prealigns and loads the wafer onto the Chucktop. It is then transported to the alignment area, where a previously−selected pattern on the die is placed in the viewing field of the camera. The data is then converted to digital information and placed in memory.

The wafer will move so that another die location is under the camera's view. The pattern at this location is viewed and compared to the first pattern. Based on the comparison, a theta rotational alignment is initiated to align the second pattern with the first. Following this automatic alignment, the wafer is moved through the normal sequence of probing steps.

Information about this subsystem is contained in **Section 5, Auto Align**.

1.4.5 NonContact Edge Sensor (NCES)

The NCES (Non Contact Edge Sensor) detects variations in the contour of the wafer surface.

A profile of the wafer surface is developed by sampling nine predetermined surface points. The profile is then used to establish wafer probing along the same contour, resulting in uniform probe tip contact at each probe point. It is also used to find the center of the wafer in relation to the center of the chucktop.

Information about the NCES is contained in **Section 6, NonContact Edge Sensor**.

1.4.6 X, Y, and Z Stages

The Horizon 4085X uses a linear reluctance stepper motor − an electromagnetic XY positioning system consisting of a platen and a traveling forcer. Mounted on the forcer is a Z−stage supporting a chucktop which transports the wafer for probing. The forcer operates in both the X− and Y−axis independently or simultaneously.

The forcer is supported by an air bearing and moves over the surface of the platen in steps of 0.1 mil. All support is provided by air and all drive pulses are magnetic. The system has excellent accuracy and reliability because error caused by mechanical wear of parts as in a conventional positioner is eliminated.

More information appears in **Section 7, Z Stage, Hot Chuck and Temperature Compensation.**

1.4.7 External I/O Interface

The External I/O Interface allows the Horizon 4085X prober to be operated from a host computer. Two interfaces are available; a serial RS−232C interface and a GPIB (General Purpose Interface Bus).

Once External Control is activated, software commands provide for prober setup, motion control, uploading and downloading of data, and the exchange of queries and messages. Commands are used to select parameters and modes, log coordinate information, and convey probing and inking instructions. In turn, the interface reports back to the host computer with information such as prober status and the coordinates required for mapping purposes.

Information about this subsystem is contained in **Section 8, External I/O Interface.**

1.4.8 Multi−Die Probing

Multi−Die Probing allows arrays of two, four, or eight die to be probed simultaneously. Arrays can be oriented horizontally, vertically, or diagonally.

More information appears in **Section 9, Multi−Die Probing.**

1.4.9 Wafer Mapping & SECS

The Wafer Mapping feature allows you to create wafer maps, follow a wafer map, probing only die with certain bincodes, and follow a map and ink according to stored bincodes. Wafer maps are available from a disk, SECS port, or external I/O port.

More information appears in **Section 10, Wafer Mapping & SECS.**

1.4.10 Ink Dot Inspection (IDI)

The IDI (Ink Dot Inspection) feature performs fully automatic inspection of inked die as part of the probing process or after probing, for multi−die applications. In the event the inking system malfunctions, the prober can halt probing and alert the operator to take corrective action.

More information appears in **Section 11, Ink Dot Inspection**.

1.4.11 Probe Mark Inspection (PMI)

The PMI (Probe Mark Inspection) feature enables the prober to inspect the probe marks on pads for user−selected dies on a wafer. The number of dies to inspect and the frequency of inspection may be specified. Summaries show inspection results in two formats, by wafer and by total.

More information appears in **Section 12, Probe Mark Inspection**.

1.4.12 OCR / Back Side Bar Code Reader

The OCR (Optical Character Reader) or Back Side Bar Code Reader feature identifies wafers by reading either alphanumeric character strings or bar codes laser−etched into wafers. This information is then transmitted to the prober where it is converted into ASCII data and retained in memory as the wafer ID number.

More information appears in **Section 13, OCR / Back Side Bar Code Reader.**

1.5 OPTIONAL CLEAN ROOM FEATURES

1.5.1 Clean Air Management System (CAMS)

The 4085X's CAMS (Clean Air Management System) creates a Class 1 environment within the prober for 5−, 6−, and 8−inch wafers, while the prober is located in up to Class 10,000 areas. This mini−environment eliminates the need for a clean room setup.

Information about CAMS is contained in **Section 14, Clean Room Options**.

1.5.2 Standard Machine Interface (SMIF−E™)

Used in conjunction with CAMS, the SMIF−E™ (Standard Machine Interface) provides robotics which allow 8−inch wafers to be loaded and unloaded free of exposure to the environment.

A transparent box called the *pod* encases each of the two cassettes for isolated transport between mini−environments to protect the product from sources of contamination outside of the immediate process area of each tool or cluster.

More information on this option appears in **Section 14, Clean Room Options**.

1.6 ASSEMBLIES OF THE 4085X

Assemblies and subassemblies of the 4085X include many variations and options. The descriptions below are for some of the most common assemblies and subassemblies available.

The major assemblies include the Platen/Forcer Positioning System, Chuck Assembly, Ring Carrier Assembly, Microscope Post, Material Handler Module, Monitor Console, and the major electrical assemblies.

1.6.1 Platen/Forcer Positioning

The forcer platform, suspended over the platen by compressed air at 85 psi, contains permanent single−axis magnets and mounting connections for the Chuck Assembly. When air is not applied, the magnets rest directly on the platen, holding the forcer firmly to the surface. A cable from the Power Control Module plugs into a socket on the forcer.

1.6.2 Chuck Assembly

The Chuck Assembly is mounted on the forcer and supports the wafer to be probed, vacuum−locked to the top of the chuck. The Chuck Assembly controls both the vertical Z positioning (up and down chuck travel) and the theta axes positioning (chucktop rotation in the horizontal plane) of the wafer.

Available chuck tops include a TC−2000 Thermal Chuck and a Temptronics cold thermal chuck.

1.6.3 Ring Carrier Assembly

The Ring Carrier assembly is a plate mounted on the Base Assembly above the platen and forcer on three precision alignment posts with quick−release collars for instant accessibility. The ring carrier is used to mount the adjustable probe ring insert, fixed−point probe card inserts, or test heads.

1.6.4 Microscope Arm Assembly

A Microscope Arm Assembly is normally fastened to the Ring Carrier Assembly. It provides the mounting for the optical system which permits manual or video viewing of the wafer and probe tips.

1.6.5 Monitor Console Assembly

The Monitor Console consists of two main elements − a monitor and a keyboard. Included on the keyboard is the Joystick, theta switch, and forcer release switch. More detailed information is contained in **Section 2, Getting Started.**

1.6.6 Electrical Assemblies

The electrical assemblies consist of the following components:

PCM (Prober Control Module)
PSM (Power Supply Module)
PDM (Power Distribution Module)
DCM (Display Control Module)
VM (Vision Module)

More detailed information on each of these components can be found in the Electroglas 4085X Training Manual.

CONTENTS

SECTION 2 − GETTING STARTED

The notations in the margin on this page and throughout the section indicate areas where information was changed and/or new information added in this current revision (REV A).

NOTE the Supplement located at the end of Section 2.

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SECTION 2
GETTING STARTED

2.1 OVERVIEW

Operating the 4085X begins with powering on the prober, then using the software (through menus) to give the prober instructions on how to probe for your environment.

Updated 5/96

SAMPLE ONLY

You interact with the prober by entering parameters and selecting instructions for the prober to follow. This is done by way of a menu system, which displays on the screen selections of commands and parameters to be set. You choose the selection or enter the specific parameter for your probing needs.

2.1.1 How To Use This Section

This section contains the following:

- An introduction to the prober's operating controls including the Monitor and the Joystick
- Basic information about the menus
- The locations of the power switches and how to power−up the prober
- Basic setup procedures once the prober is powered on
- An introduction to other RTM features

2.1.1.1 CONVENTIONS USED

In this manual, keys are designed as follows:

< PROG > (< F5 >)

For example, to enter this mode, press < PROG > (< F5 >) to access the Profiler Menu.

The key name contains both the name shown on the highlighted display and the associated function key located on the bottom row of the display. This will be explained in more detailed later in this section.

Additional manual conventions are located in **Section 1.2.1**.

2.2 OPERATING CONTROLS

The 4085X's operating controls consist of the following:

1. Monitor Console
2. Monitor Keyboard
3. Joystick
4. Joystick Keyboard

The Monitor Keyboard, Joystick and Joystick Keyboard were designed as one unit to provide operating ease−of−use.

2.2.1 Monitor Console and Keyboard

The Monitor Console (*Figure 2−1*) projects displays and menus, described later in this section. The keyboard is a full−function keyboard used to enter parameters and make selections.

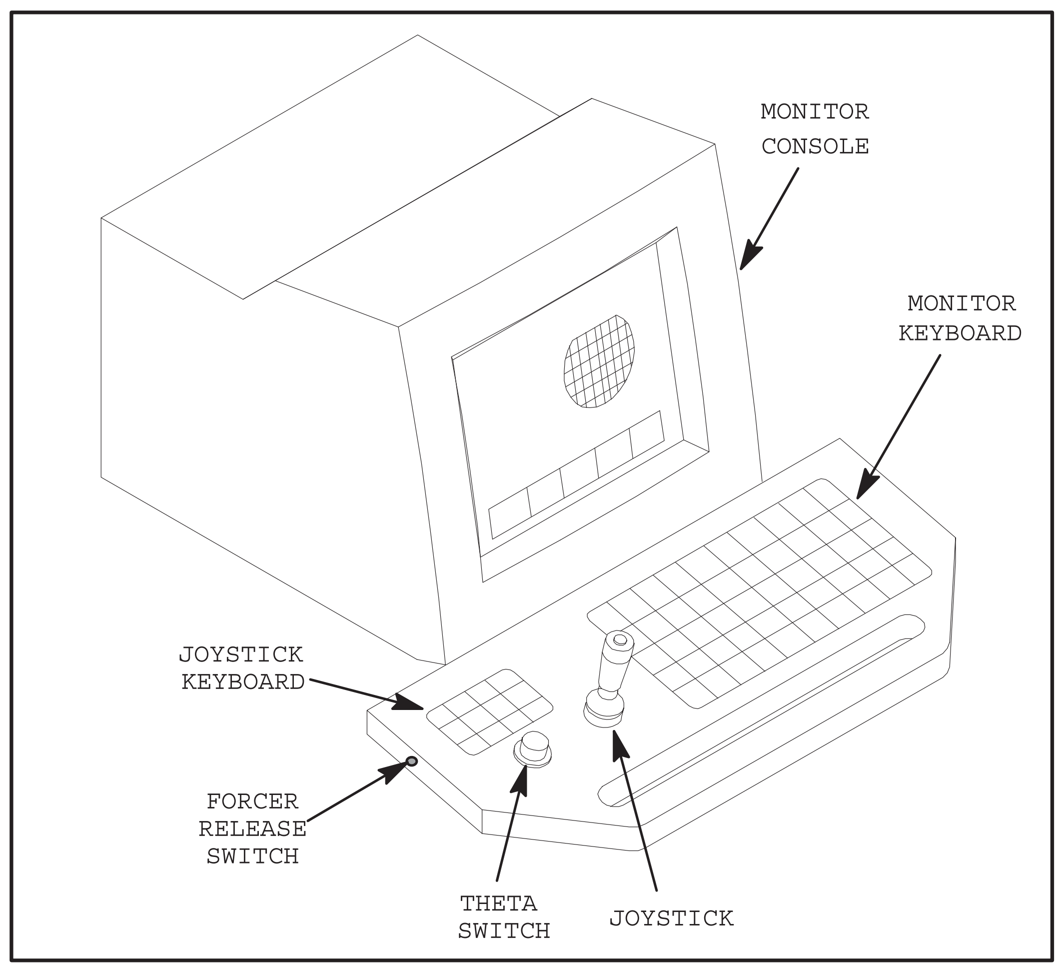


FIGURE 2−1: MONITOR CONSOLE

2.2.2 Joystick and Keyboard

The Joystick and Joystick Keyboard are located on the left side of the Monitor Keyboard (*Figure 2−1*). A theta switch and forcer release switch are also located on this side. The Joystick and Joystick Keyboard operate independently of the Monitor Keyboard.

2.2.2.1 JOYSTICK

The joystick is used to control the movement of the forcer over the platen surface. The forcer moves in an *X−axis* direction (side−to−side) and a *Y−axis* direction (front−to−back).

You operate the joystick in one of three ways (or *modes*) by rotating the handle (see *Figure 2−2, Joystick Control*, *Top View*). From the full counterclockwise position, the modes are **JOG**, **INDEX**, and **SCAN**. Twist the handle and you will hear a click.

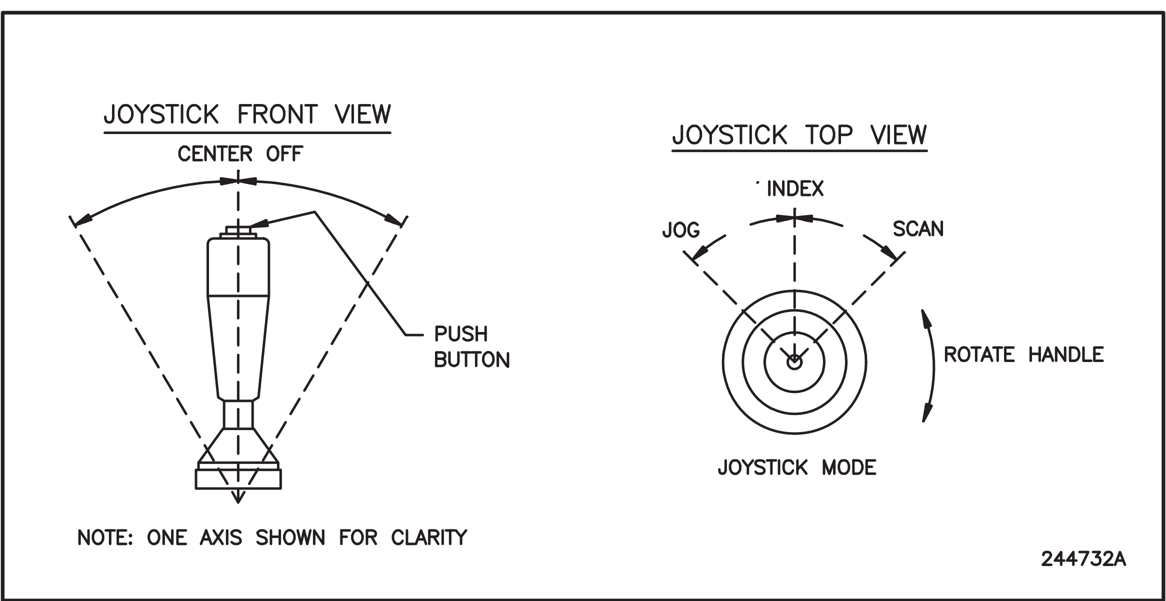


FIGURE 2−2: JOYSTICK CONTROL

After you have become familiar with the operating modes, grasp the joystick and tilt it to move the forcer. The forcer responds by traveling in the opposite direction. The red button on the top of the joystick increases the speed of the movement. In addition, the joystick can be operated with the chucktop up or down. The system automatically positions the chucktop down prior to forcer advancement.

As of Software Revision DE, joystick XY motion is disallowed following a Z slip.

JOYSTICK MODES

JOG MODE

The **JOG** mode is used to advance the forcer one step or 0.1 micro (in Metric mode) at a time. It is the slowest method of movement. It operates either in single steps or in a continuous progression.

- o To advance a single increment, tilt the joystick and return it to center in one smooth motion.
- o For continuous operation, hold the control in the tilted position.
- o In addition, the **JOG** can be speeded by simultaneously tilting the joystick and holding down the red button on the top of the handle.

INDEX MODE

The **INDEX** mode is used to advance the forcer a single die position at a time in the X and Y axes. Advances are made either as single moves or as a continuous progression.

- o Tilt the joystick to advance a single increment, and return it to the center after each move.
- o For continuous operation, press and hold down the red button concurrent with the tilt motion.

SCAN MODE

The **SCAN** mode advances the forcer in a continuous, rapid motion. It is the quickest method of movement.

- o Tilt the control to operate the scan mode. Press and hold down the red button to increase the speed of the forcer.

2.2.2.2 JOYSTICK KEYBOARD

The joystick keyboard contains special purpose keys which control various features of the prober. See **Table 2–1** for information on each of these keys. **Appendix C** contains an expanded version.

2.2.2.3 THETA SWITCH

The round, knurled, unmarked knob located below the joystick keyboard is for theta control and acts as a three–position, center–off, momentary switch.

Theta alignment regulates chucktop rotation in order to precision–align the wafer prior to the probe operation. This rotation can be controlled manually by turning the theta switch as the wafer cycles through the align scan or by system control during the Auto Align sequence.

The theta switch function provides a choice of three speeds. A single twist of the knob provides a single–step motion. A slow continuous movement is accomplished by a single twist of the knob, after which it is held momentarily. A fast continuous movement is achieved by holding the knob for a longer period.

2.2.2.4 FORCER RELEASE SWITCH

The forcer release switch releases the magnetic alignment between the platen and forcer. The push–button switch is mounted in the recess on the left side of the keyboard. You will use this switch to lock the forcer down to the platen after moving the forcer to the home position. This is discussed in the powering up procedures later in this section.

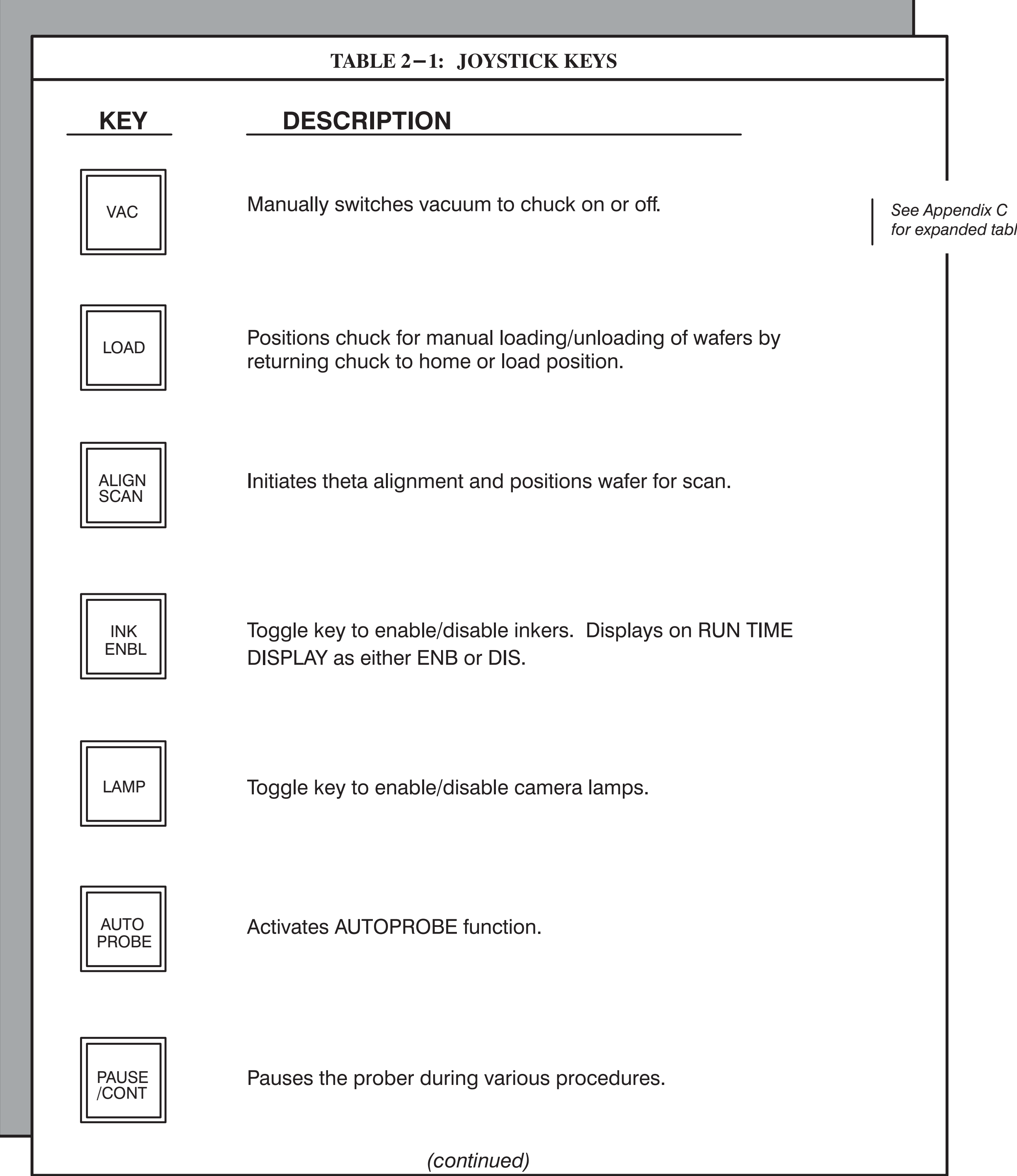


TABLE 2–1: JOYSTICK KEYS

KEY	DESCRIPTION
VAC	Manually switches vacuum to chuck on or off.
LOAD	Positions chuck for manual loading/unloading of wafers by returning chuck to home or load position.
ALIGN SCAN	Initiates theta alignment and positions wafer for scan.
INK ENBL	Toggle key to enable/disable inkers. Displays on RUN TIME DISPLAY as either ENB or DIS.
LAMP	Toggle key to enable/disable camera lamps.
AUTO PROBE	Activates AUTOPROBE function.
PAUSE /CONT	Pauses the prober during various procedures.

(continued)

See Appendix C for expanded table

TABLE 2−1: JOYSTICK KEYS (continued)

KEY	DESCRIPTION
INK TEST	Inker test button. Prompt displays, "Turn which inker on?". Enter the inker number to test.
TEST CYCLE	Initiates probe test. Screen displays "Start test" at the bottom of the screen. When completed, displays bin code number.
Z	Moves chuck to Z upper or lower position. Both positions are determined by previously set limits. This key may be pressed after a Z slip; the chuck will be lowered to 200 mils.
CAMR	Toggle key to enable/disable camera. Used as an alternating switch with Auto Align to display camera's view on monitor.

2.3 BECOMING FAMILIAR WITH REAL TIME MAPPING (RTM) SCREENS

With Real Time Mapping software, the screen is divided into three windows. The **Prober** and **Handler** windows are displayed side by side, the **Global Control** window beneath them (*Figure 2−3*).

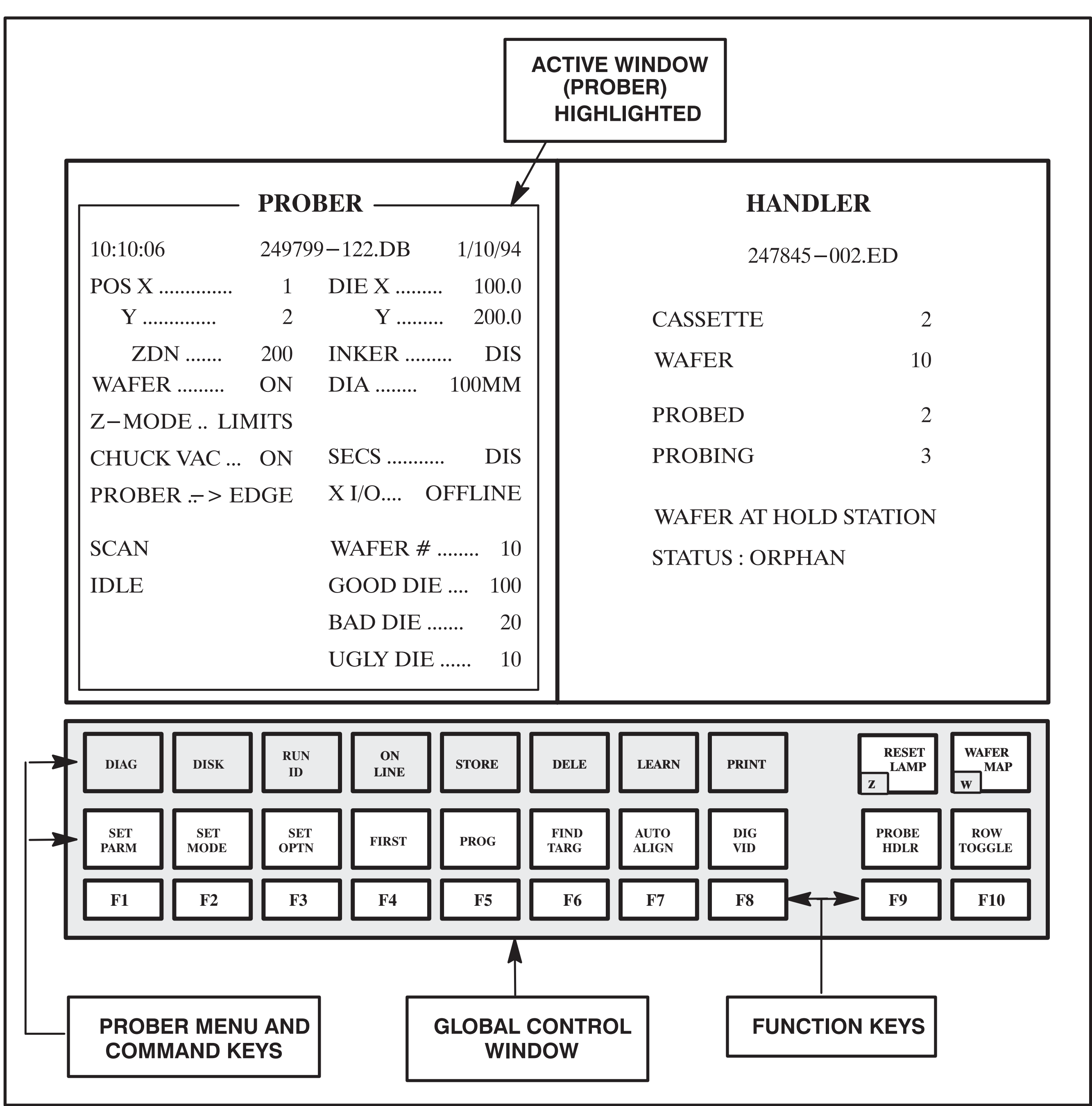


FIGURE 2−3: REAL TIME MAPPING SCREEN AREAS

A highlighted border around either window indicates the active window. In *Figure 2−3*, the **Prober** window has been selected.

2.3.1 Function Keys

Notice the boxes on the bottom portion of the screen, referred to as the Global Control window. A key number appears just below the menu name (for example, SET PARM, F1). See *Figure 2−4*.

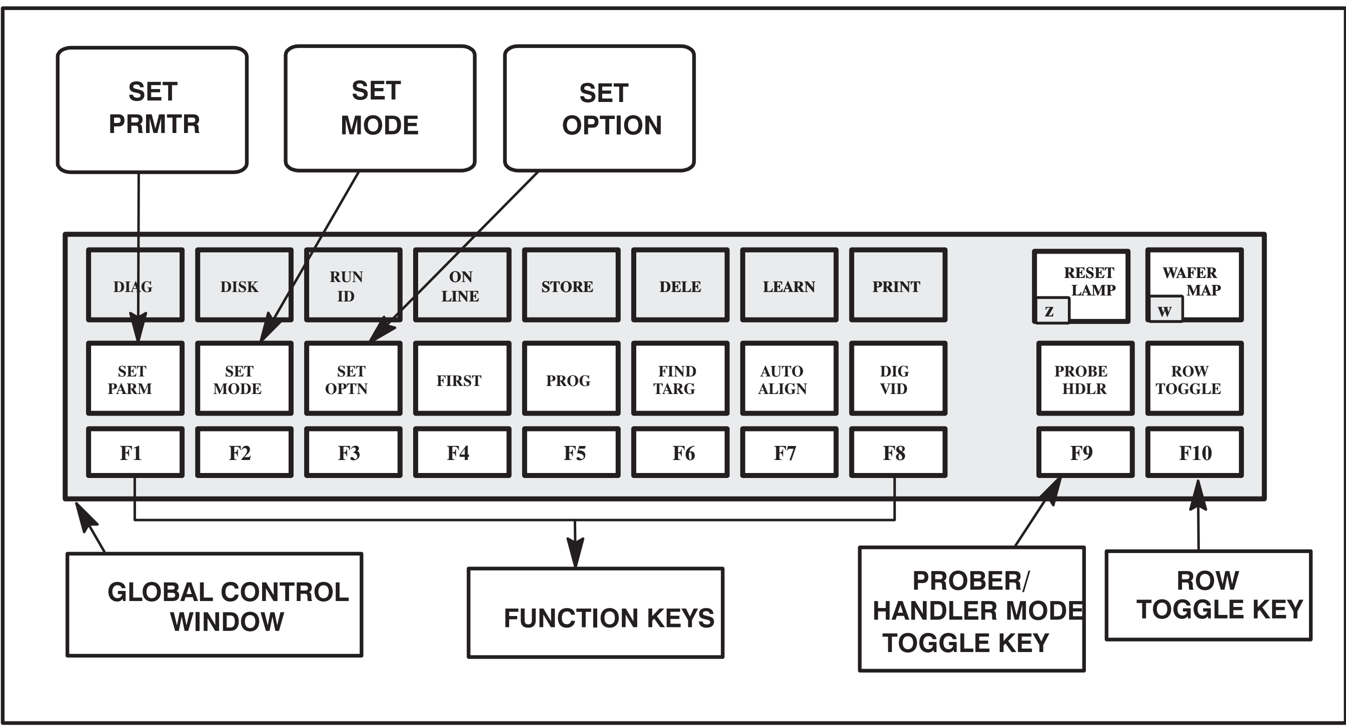


FIGURE 2−4: MENU KEY LOCATIONS

In the Global Control window, each function (< F >) key shown on the bottom row performs the operation shown in the highlighted box directly above. The < F > key images remain constant. The menus and commands above the < F > keys change depending on which mode you are in (the Prober or the Handler mode).

The < F10 > key toggles between the two rows of menus and functions. Press < F10 > and notice how the row above the function keys < F1 > to < F8 > switch from one row to the other (see *Figure 2−5*).

NOTE: A listing describing each key is located in **Appendix C**.

When you are following the instructions given in this manual, you may have to use the < F10 > key to toggle between the two rows. The instructions do not give you the row number; just the name shown on the highlighted display and the associated function key (for example, < PROG > < F5 >).

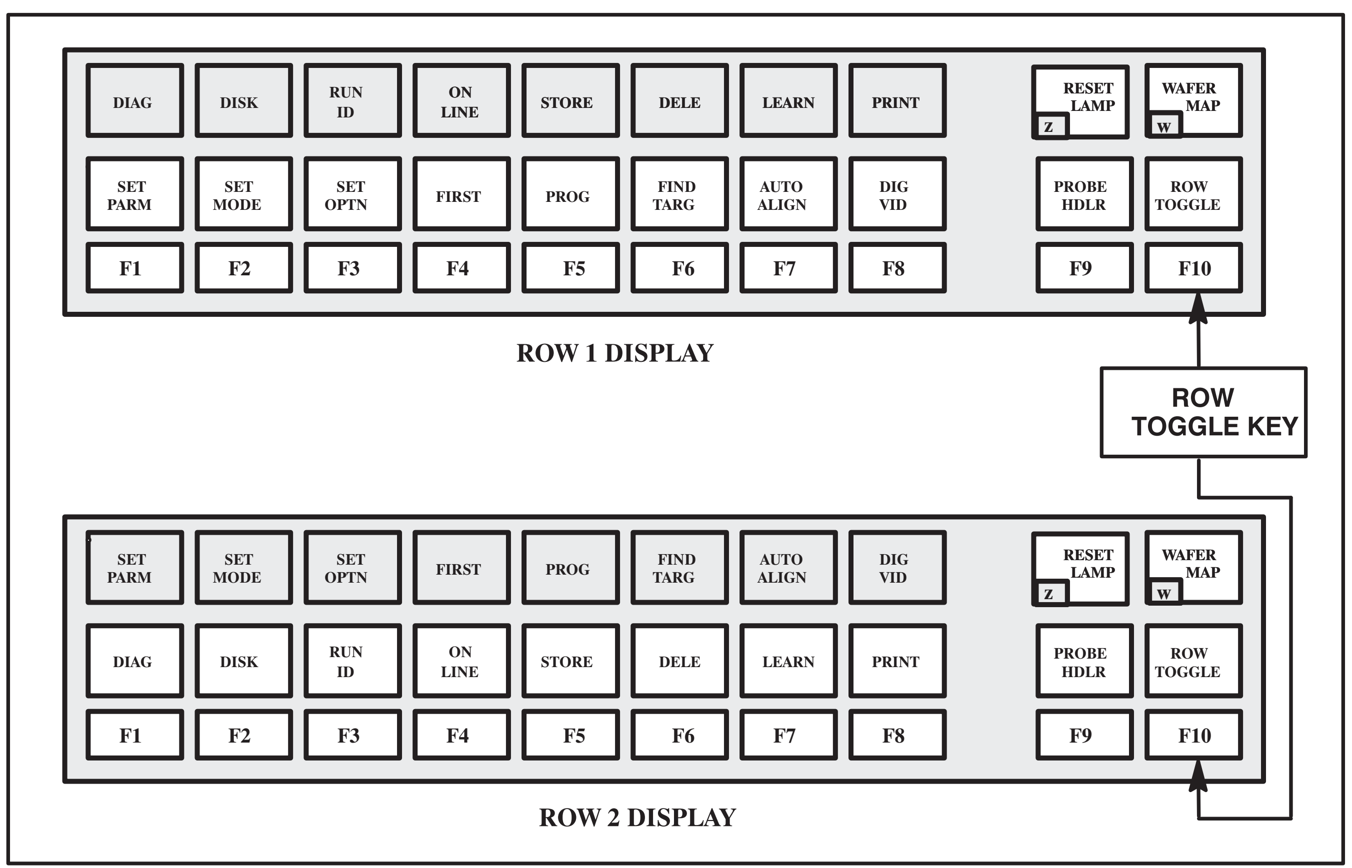


FIGURE 2–5: ROW DISPLAYS

2.3.2 Prober/Handler Status

Press the < F9 > key to toggle between the Prober and the Handler modes; the status of the Prober/Handler on the screen is updated automatically. (If proper communication with the Handler does not exist, the Handler window will be blank.)

You can access any menu or prober command from the Prober or Handler status window. Once a menu is selected (Set Option in the *Figure 2–6* example), the menu and command keys on the global control window disappear, as illustrated. Only function key < F9 > (Prober/Handler toggle key) and the toggle key < ALT >–< Z > (RESET LAMP) are accessible as shown.

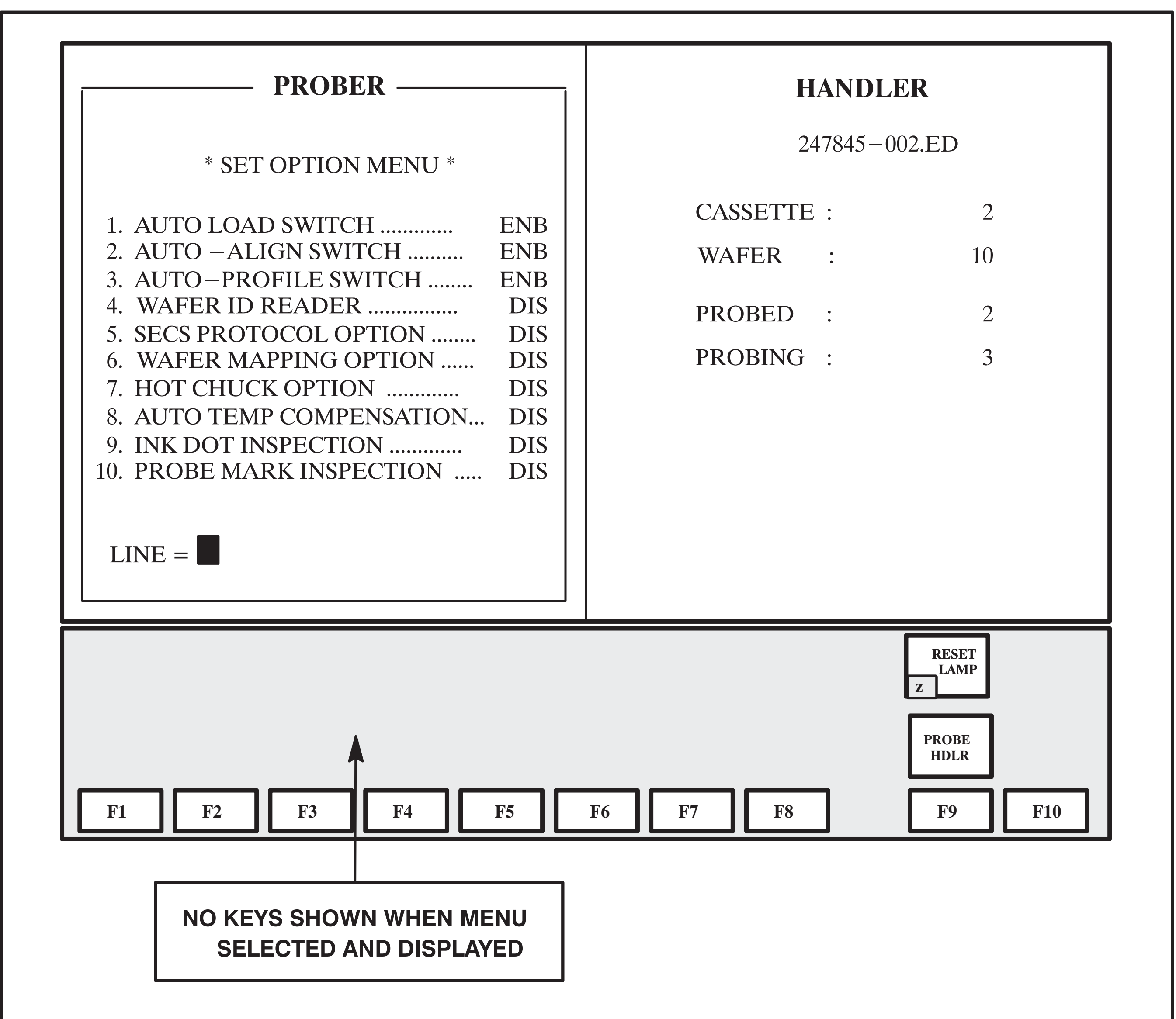


FIGURE 2−6: PROBER MODE, SET OPTION MENU SELECTED

If modes are switched with the Prober/Handler toggle key (< F9 >), the command and menu keys reappear.

2.3.3 Accessing the Menus Area

To access the menus, the machine must be in the Prober mode (the Prober window is highlighted). If the Handler window is highlighted, press the < F9 > key. The menu row must be highlighted (directly above the function (< F >) keys). If the menu row is displayed on the top row and is not highlighted, press the < F10 > key to toggle it into position.

When a menu appears on the screen, the prompt at the bottom of the menu ("LINE =") is asking which line item you wish to see or change. Some lines produce complete menus of their own.

To change a line item, type in the number of the line, followed by < ENTER >. The line will be highlighted (appear in reverse image). The prober will prompt you with a line at the bottom showing the choices available, or ask you to enter a new value if appropriate.

To exit any menu without change, press < ENTER >.

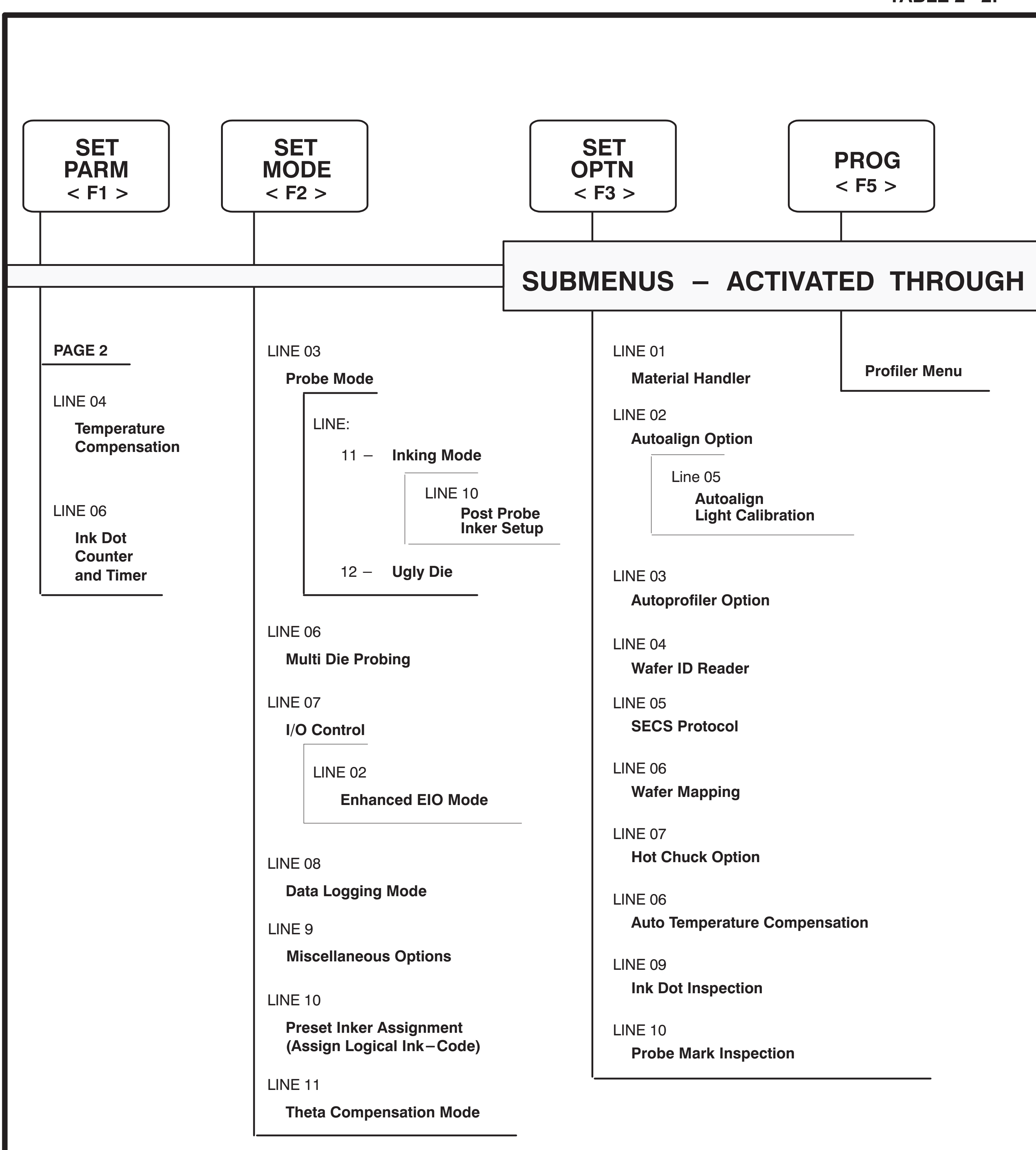
Table 2−2 is a Menu Hierarchy Chart to guide you to the location of each screen and give you an idea of the basic organization of the software.

2.3.4 The Setup Main Menus

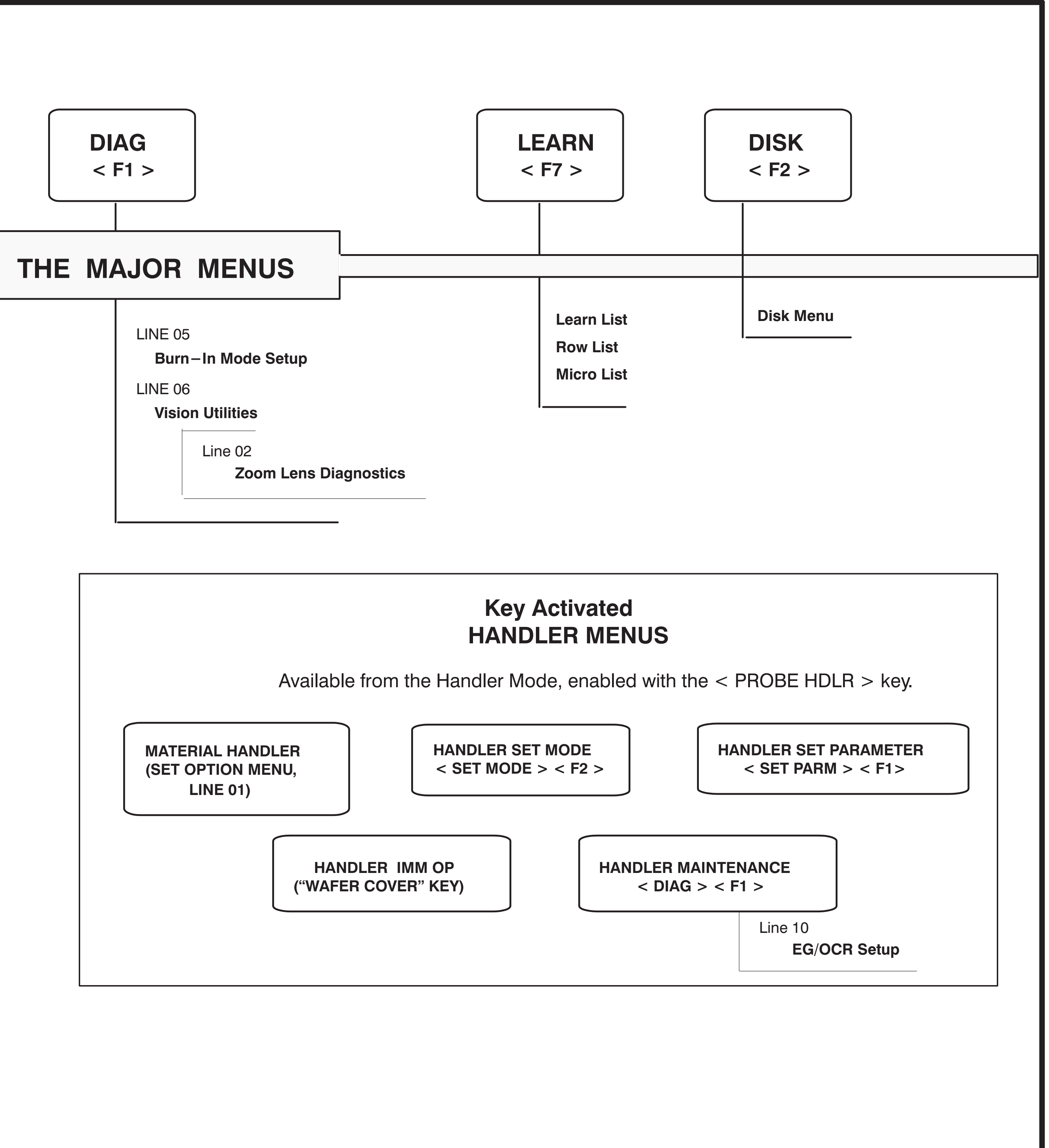
The three Setup Main Menus (*Figure 2−7)* are:

1. Set Parameter Menu (< SET PARM > < F1 >) − contains specific wafer information such as die size and wafer diameter.
2. Set Mode Menu (< SET MODE > < F2 >) − contains the selections for the prober's operating mode, such as Autoprobe Pattern and Z Traveling Mode.
3. Set Option Menu (< SET OPTN > < F3 >) − options such as Auto Align and Profiler are enabled and disabled.

TABLE 2–2:



MAJOR MENUS HIERARCHY



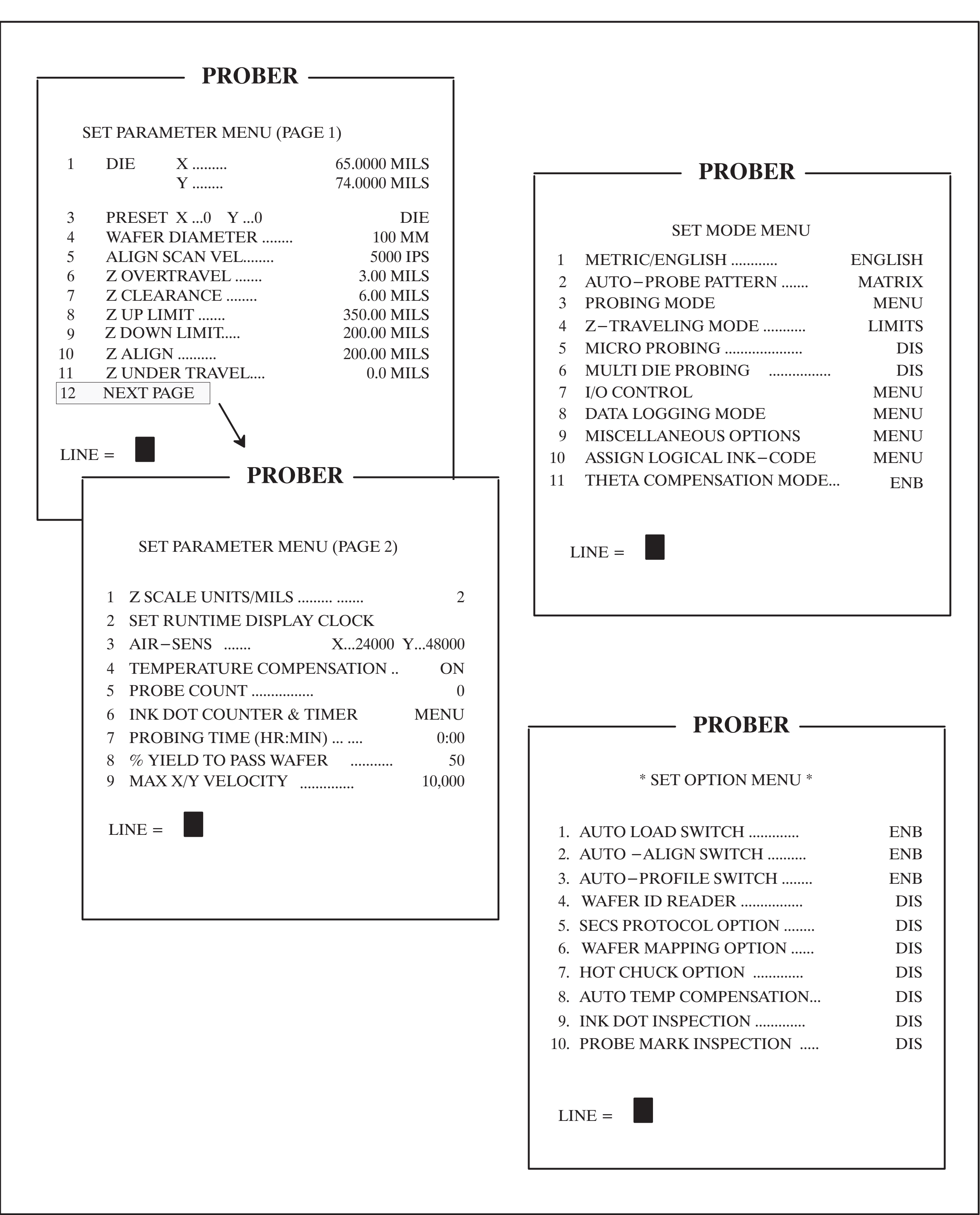


FIGURE 2−7: SETUP MAIN MENUS (IN PROBER MODE)

2.3.5 Run Time Display

The Run Time Display is shown on the screen during normal operation until the system is instructed otherwise. The entries, functions, and controls monitored by the Run Time Display are discussed in this section. A typical Run Time Display is shown in *Figure 2−8*.

Table 2−3 provides a brief description of the items displayed in the order of top to bottom, left column and right column. Additional information on the display items is located in **Appendix C**.

The routine for automatic updating of the Run Time Display during probing can be adjusted via the Run Time Display Menu. The menu and its options are described in **Section 3, TUTORIALS**, **subsection 3.4.5, Miscellaneous Options Submenu.**

PROBER

10:10:06 249799−122.DB 1/10/94
POS X .... 1 DIE X 100.0
Y .... 2 Y 200.0
ZDN .... 200 INKER .... DIS
WAFER .... ON DIA 100MM
Z−MODE .. LIMITS
CHUCK VAC ... ON SECS .... DIS
PROBER ..−> EDGE X I/O.... OFFLINE
SCAN WAFER # 10
IDLE GOOD DIE 100
BAD DIE 20
UGLY DIE 10

HANDLER

247845−002.ED
CASSETTE 2
WAFER 10
PROBED 2
PROBING 3
WAFER AT HOLD STATION
STATUS : ORPHAN

DIAG | DISK | RUN ID | ON LINE | STORE | DELE | LEARN | PRINT | RESET LAMP Z | WAFER MAP W
SET PARM | SET MODE | SET OPTN | FIRST | PROG | FIND TARG | AUTO ALIGN | DIG VID | PROBE HDLR | ROW TOGGLE
F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10

FIGURE 2−8: TYPICAL RUN TIME DISPLAY (IN PROBER WINDOW)

TABLE 2–3: RUN TIME DISPLAY ITEMS

See Appendix C for expanded table

DISPLAY ITEM	EXPLANATION
(CURRENT TIME)	In hours, minutes, and seconds, based on a 24–hour system.
POS X, Y, Z	The X and Y elements identify the current die coordinates with respect to preset die points.
WAFER	Current chuck vacuum status; ON indicates a properly mounted wafer; OFF an improperly or absent wafer.
Z MODE	Displays the current Z travel mode, which establishes the limits of the Z travel during probing (LIMITS, EDGE SENSE, OR PROFILE).
CHUCK VAC	Displays vacuum status ON or OFF.
PROBE	Displays the current auto probe pattern, which controls the probing process: EDGE (Edge Sense) MAT (Matrix) CIR (Circular) LEARN ROW XTERN (External) OFF
(JOYSTICK MODE)	Displays current Joystick mode (Jog, Index, or Scan).
(PROBER STATUS)	One of seven possible status messages will appear: ALIGN STOREREF PROBE AUTOPRB ABORTED BUSY IDLE
ID=	Displays Wafer ID number.
(SOFTWARE ID)	The prober’s software revision and part numbers display.
(UNIT OF MEASURE)	Displays the current system of measurement (either MIL or MM).
DIE X... Y...	X and Y dimensions, shown in 7–character floating–point numbers.
INKER	Displays inker status.
DIA	Displays the wafer diameter.
SECS	The status of SECS communication.
X I/O	Status (ONLINE / OFFLINE) of the interface port.
WAFER #	The number of the wafer currently being probed.
GOOD DIE BAD DIE UGLY DIE	Displays number of good die / bad die / ugly die probed up to and including the current die position.

2.4 POWER UP PROCEDURES

There are two System Power buttons located on the front of the 4085X prober. See *Figure 2−9* for the location of these buttons.

The two System Power buttons are labeled ON and OFF. To the right of the System Power buttons is the Main Power Indicator. Note that if the Main Power Indicator is lit, the system is already powered on.

To **power on** the system, press the System Power ON button. This button will light and the Display Control Module and the Monitor will automatically power on.

The Main Power Indicator will always remained lighted unless the Power Supply button (located at the back of the prober) is powered off. It is recommended that you keep the Power Supply powered on at all times and only power down by pressing the System Power OFF button.

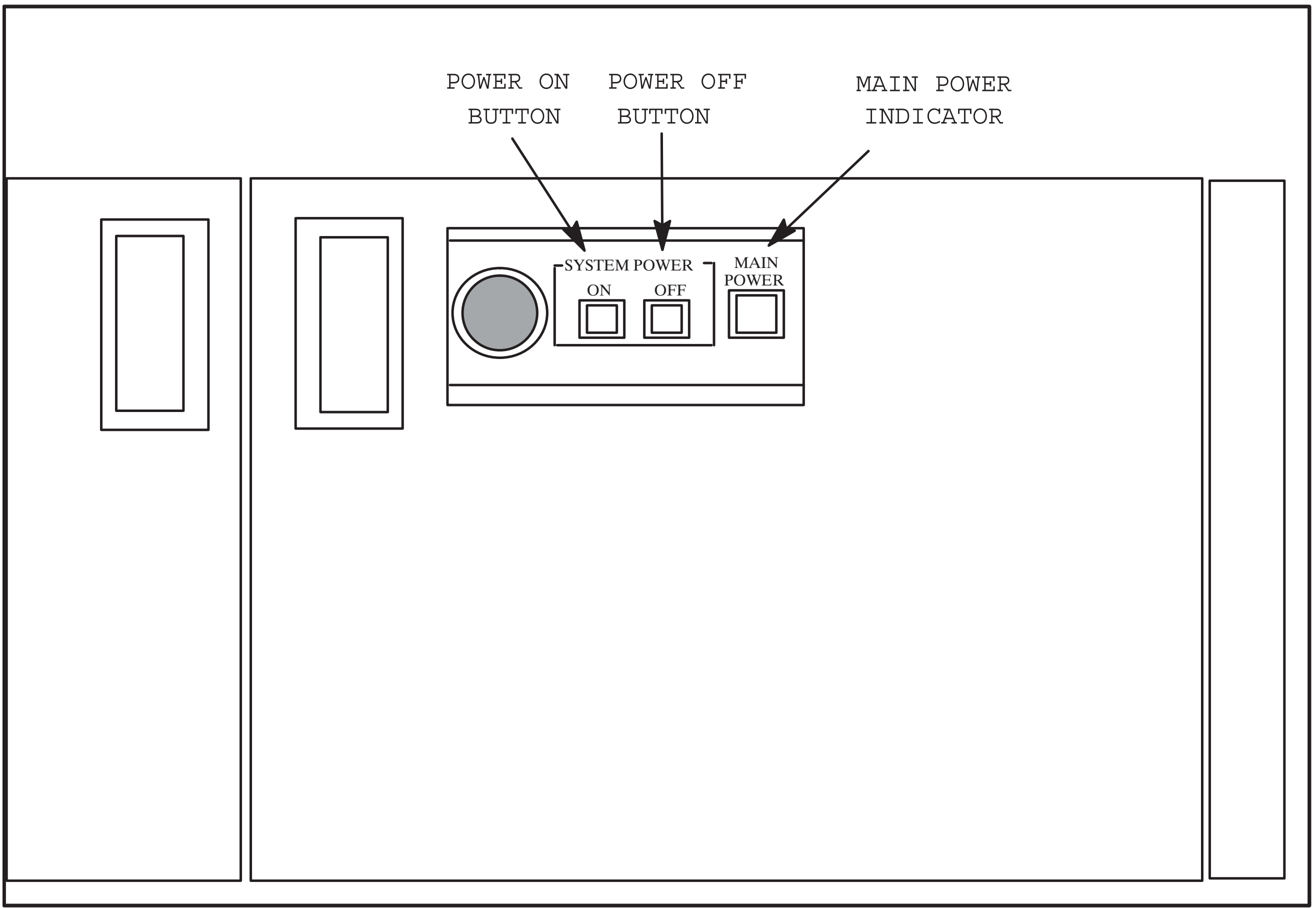


FIGURE 2−9: POWER SWITCH LOCATIONS

2.5 GENERAL SETUP PROCEDURES

After powering on the prober, the monitor displays boot up screens. After a few seconds, the forcer should be free on the platen.

The monitor will display the RTM screen with the message:

```
POWER UP SELF-TEST
```

on the right, or Handler side of the screen. The left side will show the message:

```
INITIALIZING PROBER
```

Press the < F9 > key to switch to the Handler Menu, followed by < F6 >.

If the cover is open, the message displays:

```
PLEASE CLOSE CASSETTE DRAWER...
```

Close the cassette cover and the handler initialization continues.

After a few more seconds, the Run Time Display (*Figure 2−10*) appears on the left half of the screen with the messages:

```
XY MOTOR BLANK
and
CAUTION: CHECK QUICK LOADER
```

PROBER

10:10:06	249799−122.DB	01/10/94	
POS X	1	DIE X	100.0
Y	2	Y	200.0
ZDN	200	INKER	DIS
WAFER	ON	DIA	100MM
Z−MODE ..	LIMITS		
CHUCK VAC ...	ON	SECS	DIS
PROBER .−>	EDGE	X I/O....	OFFLINE
SCAN		WAFER #	10
IDLE		GOOD DIE	100
		BAD DIE	20
		UGLY DIE	10

HANDLER

247845−002.ED

CASSETTE	2
WAFER	10
PROBED	2
PROBING	3

WAFER AT HOLD STATION

STATUS : ORPHAN

FIGURE 2−10: TYPICAL RUN TIME DISPLAY

Grasp the Z Drive motor *(Figure 2−11)* and make sure the forcer moves freely in all directions.

CAUTION

The Z Drive motor or chucktop may be hot if the prober has been running.

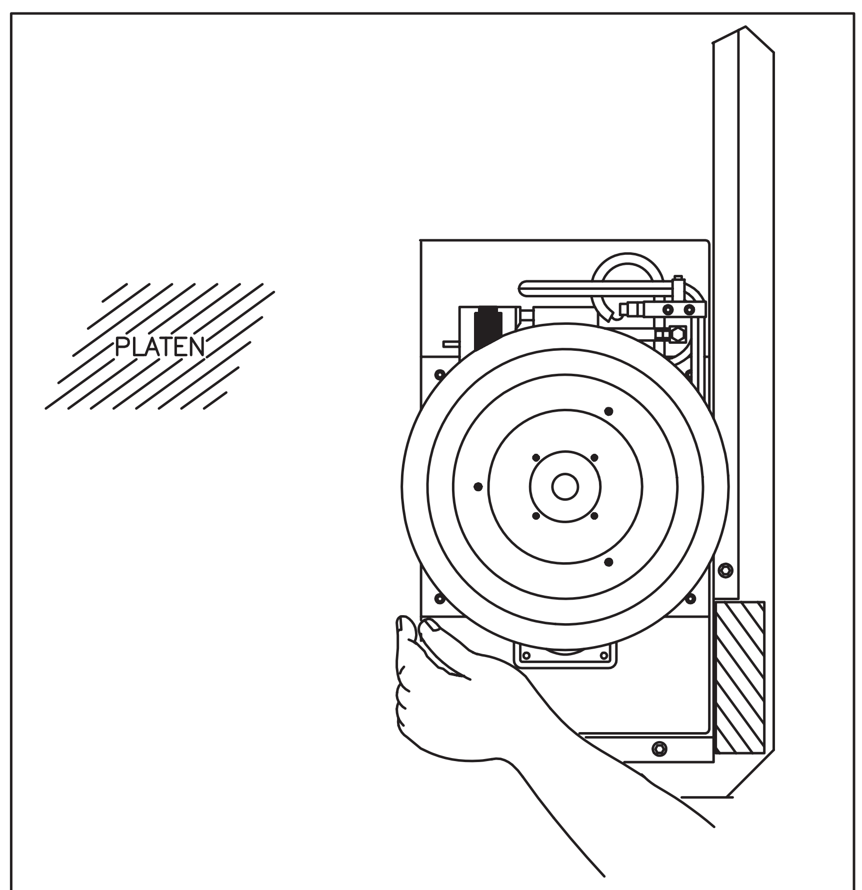


FIGURE 2−11: FORCER IN HARBOR POSITION

Taking care that you **DO NOT** grasp the encoder housing, pull the forcer to the front right corner of the platen, as shown in *Figure 2−11.* This is the Harbor or Home position.

Press the forcer release switch located on the left side of the Monitor Keyboard (*Figure 2−1*). `The XY MOTOR BLANK` message disappears from the screen; the forcer is locked down to the platen, and will not move freely.

The prober is now ready to receive more detailed instructions on how you wish to probe. These instructions will be discussed in the next section, **Section 3, Tutorials**.

2.6 INTRODUCTION TO OTHER REAL TIME MAPPING FEATURES

The Real Time Mapping feature employs the terminal video screen, color graphics, and the keyboard to provide an immediate visual map of the dies on the current wafer. As wafer probing progresses, the map can display either the probing status (such as *good* or *bad)* or the bincode for each individual die in user−selected color codes.

Real Time Wafer Map Display − A map of each wafer, containing images for each probed die, is displayed on the monitor color screen.

Bincode Table Display − A bincode table, representing an operator−selected area on the wafer map, indicates the bincode assigned to each die in that area.

Color Selection − A color palette display allows you to choose the colors representing both bincode and die status.

Run Time Wafer Map − During the probing process, displays available provide information regarding the current cassette and wafer, die probed thus far, and die currently being probed.

More detailed information about using the Mapping functions is located in **Section 3, Tutorials**.

2.7 SUMMARY

In this section, you have learned:

- How to use the prober's operating controls, including the Monitor and the Joystick.
- Basic information about RTM's screens and menus, including locations and functions of the Setup Main Menus.
- The locations of the power switches and how to power−up the prober.
- Basic setup procedures once the prober is powered on.
- An introduction to other RTM features.

SUPPLEMENT

GETTING STARTED

SECTION 2 − REV A

This supplement describes a change that applies to Section 2, Getting Started. This information will be incorporated into the section with the next revision. This information supplements the new or changed material in the manual temporarily identified by the dated bar in the margin. The margin bar is often used when updates can be made without changing pagination or section REV letter.

In the heading below, the box at the right classifies the information by the subsection to which it relates and the title of that subsection.

UPDATE:
ACTION OF < CAMR > KEY

REF: SECTION 2.2.2.2
TABLE 2.1
JOYSTICK KEYBOARD ACTION

Software Revision DF

When the < CAMR > key is pressed, the Display Control Module (DCM) software displays either the Camera or the High Frequency (HF) Microscope Video image, based on information about the present forcer location and the presence of the Video Blaster Board.

The new ProberVision software will make a check to see if the wafer is under the probe tip when the operator presses the < CAMR > key.

If the wafer is under the probe tip area, the DCM software displays the HF microscope image. Otherwise, it displays the Camera image.

To support this feature, the following DCM subsystem and PVS subsystem are needed at or above the specified revision level:

DCM (RTM)	PN 250450−001.AE
PVS	PN 249799−X2X.DF

RTM Software Revision AE

All the uppercase keys < A > through < Q > which have some functionality on the standard prober (such as the < D > key which sets `FIRST DIE` and the < O > key which triggers `FIND TARG`) are now masked out on the DCM side when the prober is in the `IDLE` state. Only the function keys dedicated to perform a particular function can be used.

When in BIOS, the DCM software outputs keys < A > – < Z > in order to enable the use of the keys to manipulate the BIOS.

RTM Software Revision AD

New Display Mode to Toggle Between Microscope and Camera Video

A new keyboard function has been added which allows the display of normal camera video on the video from an optional high frequency microscope camera. This feature is accessed by pressing the < ALT >–< D > keys which will toggle between the desired video outputs.

New Display Mode for Small Video Window or Full Screen Format

A new keyboard function has been added to allow the display of camera video in a smaller video window in the RTM display or full screen camera video. This feature is accessed by pressing the < ALT >–< T > keys which will toggle between the desired video display outputs.

New Display Adjustment Menu

A new menu for adjusting the Video Blaster display characteristics has been implemented. The operator can now change the video display characteristics and then save them as the default settings. The new menu is accessed by pressing the < ALT >–< Q > keys which will cause the following setup screen to be displayed:

```
VIDEO DISPLAY COLOR COMPONENTS
    1]    BRIGHTNESS
    2]    CONTRAST
    3]    HUE
    4]    RED
    5]    BLUE
    6]    GREEN
          DONE [Y/N]

Use arrow keys to change fields
Use [+/-] keys to change values
```

SECTION 3
TUTORIALS

3.1 OVERVIEW

The 4085X prober uses software called Prober Vision to run the prober. This software was developed to make operating the prober as simple and easy as possible. It was also developed with the idea that once initial setup was performed on the prober using the software, little or no interaction would be necessary for the prober to continue operating.

This tutorial intends to give instructions on how to use the software to accurately perform wafer probing in your environment.

3.1.1 How To Use This Section

This section contains the following information:

- A review of how to access the menus and submenus in Prober Vision
- A description and illustration of each menu and submenu
- Detailed information on each line item in each menu and submenu, including default parameters and suggested entries
- Instructions on using the special features of Real Time Mapping

3.1.1.1 CONVENTIONS USED

In this manual, keys are designed as follows:

< PROG > (< F5 >)

For example, to enter this mode, press < PROG > (< F5 >) to access the Profiler Menu.

The key name contains both the name shown on the highlighted display and the associated function key located on the bottom row of the display (*Figure 3−1*).

Additional manual conventions are located in **Section 1.2.1**.

3.2 ACCESSING MENUS AND SUBMENUS

As described in **Section 2**, to access the menus, notice the boxes on the bottom portion of the screen, referred to as the Global Control window. A key number appears just below the menu name (for example, SET PARM, < F1 >). See *Figure 3−1*.

To display the submenus available through any of the Main Menus, press the Main Menu key (in this example, < SET MODE > < F2 >). The system displays the Set Mode Menu. Enter the line number of the submenu desired (for example, enter 03 for the Probing Mode Menu).

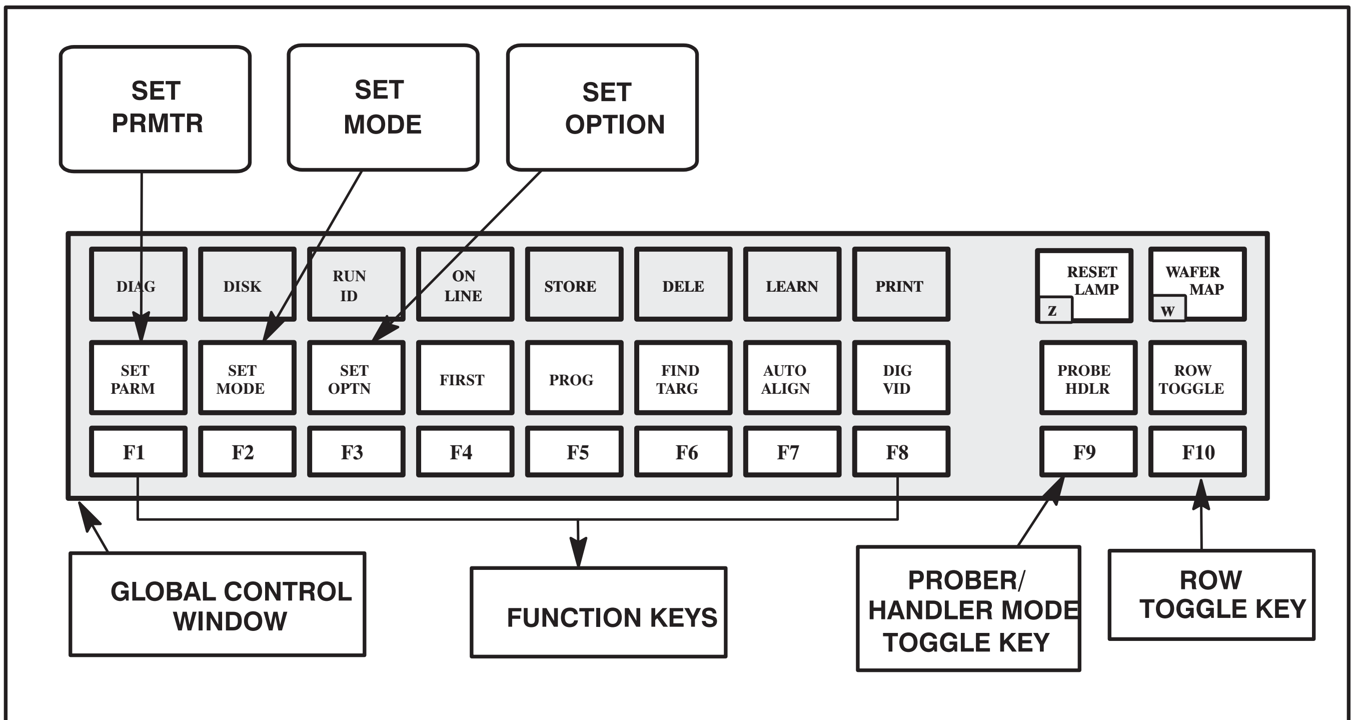


FIGURE 3−1: MENU KEY LOCATIONS

To exit the submenu, wait 30 seconds until the system returns the screen to the Main Menu, or press < ENTER > to return immediately.

REMEMBER: Press < F10 > to toggle between the two rows of menus. Press < F9 > to toggle between the Prober and the Handler modes.

The rest of this section will discuss each of the Main Menus and Submenus available in Prober Vision, and include detailed information on each parameter, including defaults and suggested entries. If the submenu or parameter is relating to a module of the 4085X that is complex, a reference to the appropriate section where extensive information is located is included.

The three Main Menus are illustrated in *Figure 3−2*.

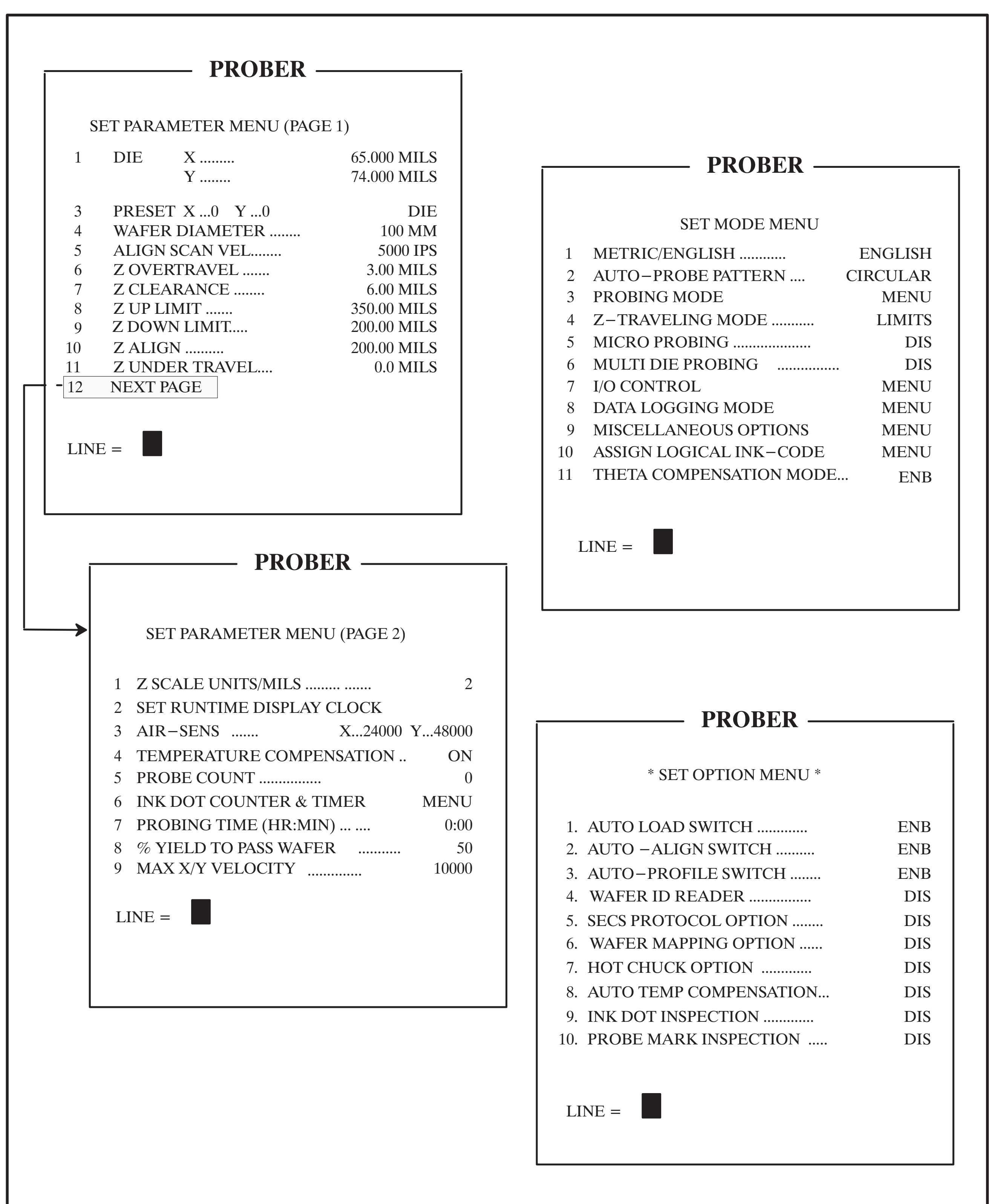


FIGURE 3−2: PROBER SETUP MENUS

See the Supplement at the end of the section for two new lines.

3.3 SET OPTION MENU

Press the < SET OPTION > (< F3 >) key to display the Set Option Menu (*Figure 3−3*), which is used to enable or disable optional features. Enter the number of the selected line, then enter < 0 > to disable the option, < 1 > to enable it.

```
PROBER
      ***  SET OPTION MENU  ***

01  AUTO-LOAD SWITCH ......... ENB
02  AUTO-ALIGN SWITCH ........ ENB
03  AUTO-PROFILE SWITCH ...... ENB
04  WAFER ID READER .......... DIS
05  SECS PROTOCOL OPTION ..... DIS
06  WAFER MAPPING OPTION ..... DIS
07  HOT CHUCK OPTION ......... DIS
08  AUTO TEMP COMPENSATION ... ENB
09  INK DOT INSPECTION  ...... DIS
10  PROBE MARK INSPECTION  ... DIS

LINE =  ■
```

FIGURE 3−3: SET OPTION MENU

NOTE

An option switch *must* be set to disable (< 0 >) when the prober is not equipped with that option. An attempt to enable an option which is not installed will produce the error message OPTION NOT INSTALLED.

Enabling any option in the Set Option Menu produces a submenu which is used to set related parameters. These submenus are not described in detail in this section. More information on each of these submenus can be found in the section referenced.

3.3.1 Set Option Menu Line Items

LINE 01: AUTO−LOAD SWITCH

Activates the Material Handler Menu described in **Section 4, MATERIAL HANDLING.**

LINE 02: AUTO−ALIGN SWITCH

Activates the Autoalign Option Menu described in **Section 5, AUTO ALIGN.**

LINE 03: AUTO−PROFILE SWITCH

Activates the Autoprofiler Option Menu described in **Section 6, NONCONTACT EDGE SENSOR.**

LINE 04: WAFER ID READER

Activates the ID Reader Menu described in **Section 13, OCR / BACK SIDE BAR CODE READER**.

LINE 05: SECS PROTOCOL OPTION

Activates the SECS Parameters Menu described in **Section 10, WAFER MAPPING AND SECS.**

LINE 06: WAFER MAPPING OPTION

Activates the Wafer Mapping Menu described in **Section 10, WAFER MAPPING AND SECS.**

LINE 07: HOT CHUCK OPTION

Activates the Hot Chuck Menu described in **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION.**

LINE 08: AUTO TEMPERATURE COMPENSATION

Enables Automatic Temperature Compensation described in **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION.**

Standard Temperature Compensation is enabled through the Set Parameter Menu (Page 2, Line 04). This activates the Standard Temperature Compensation Menu described in **Section 7.**

LINE 09: INK DOT INSPECTION

See **Section 11, INK DOT INSPECTION.**

LINE 10: PROBE MARK INSPECTION

See **Section 12, PROBE MARK INSPECTION.**

See the Supplement at the end of the section for two new lines.

3.4 SET MODE MENU

Press the < SET MODE > (< F2 >) key to display the Set Mode Menu (*Figure 3−4*), which is used for instructions related to prober execution.

```
PROBER
        ***  SET MODE MENU  ***

 01  METRIC/ENGLISH ........ ENGLISH
 02  AUTO-PROBE PATTERN ...  CIRCULAR
 03  PROBING MODE                MENU
 04  Z-TRAVELING MODE ....... LIMITS
 05  MICRO PROBING ............. DIS
 06  MULTI-DIE PROBING.......... DIS
 07  I/O CONTROL                 MENU
 08  DATA LOGGING MODE           MENU
 09  MISCELLANEOUS OPTIONS       MENU
 10  ASSIGN LOGICAL INK-CODE     MENU
 11  THETA COMPENSATION MODE . . ENB

 LINE = ■
```

FIGURE 3−4: SET MODE MENU

The Set Mode Menu also provides access to various submenus, as illustrated in *Figure 3−5*. The submenus (and the sections they are described in) are:

Probing Mode Menu	**Section 3.4.2**
I/O Control Menu	**Section 3.4.3**
Data Logging Mode Menu	**Section 3.4.4**
Miscellaneous Options Menu	**Section 3.4.5**
Assign Logical Ink−Code Menu	**Section 3.4.6**

3.4.1 Set Mode Menu Line Items

LINE 01 METRIC/ENGLISH

At the prompt, select a unit of measurement; English (< 0 >) or Metric (< 1 >).

The English system is in mils; the Metric in millimeters (mm). Switching from Metric to English and vice versa converts all the fixed XY positions (such as probe tip center and profiler) to the appropriate units, and all XY coordinates are processed in the selected unit of measure. However, setting Metric or English *must* be set before die size is entered.

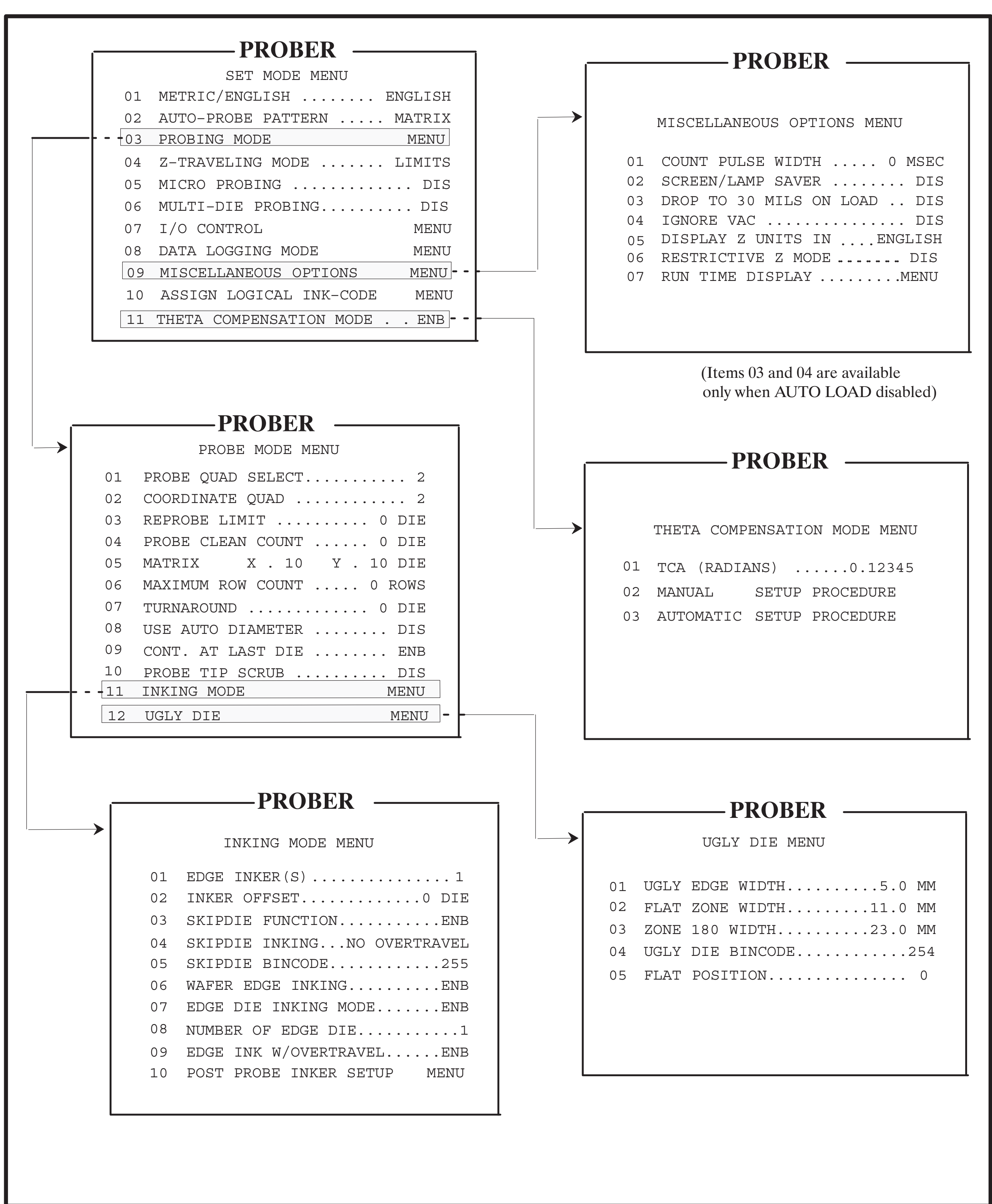


FIGURE 3–5: SET MODE MENU AND SUBMENUS

LINE 02 AUTO PROBE PATTERN

A system of patterns controls the probing process. The prober will execute the pattern automatically when Autoprobe is initiated. (The Autoprobe operation is shut off by entering < 0 >.) The available auto probe patterns are Off, Edge, Matrix, Circular, Learn, Row, Partial, and External.

STANDARD EDGE SENSE PATTERN (< 1 >)

From the starting, or First Die, the prober advances across the wafer in a serpentine pattern until the edge sensor is no longer in contact with the wafer. If delayed inking is enabled, the prober continues to step off the wafer to allow the last die to be inked.

The prober steps one or more times (as determined by the "turnaround count") and then begins stepping in the reverse X direction until the edge sensor contacts the wafer. If the edge sensor fails to contact the wafer within nine steps, the pattern is considered complete and the Pattern Complete message, if enabled, is generated. See *Figure 3−6*.

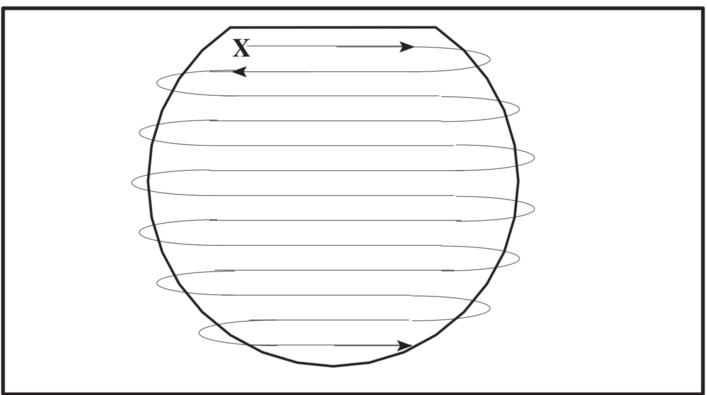


FIGURE 3−6: STANDARD EDGE SENSE PATTERN

Careful selection of the First Die and probe quadrant allows the entire wafer area to be probed. **Section 3.4.2** describes quadrant choice; *Figure 3−11 (Coordinate Quadrant Selection)* illustrates the importance of First Die point and quadrant selection to gain the greatest possible probe area. In each case, the letter "F" represents the First Die.

Edge pattern probing also depends on edge sensor configuration and placement. For example, referring to *Figure 3−14B (Wafer Edge Inking)*, illustrating inking modes described in **Section 3.4.2.1** assumes the edge sensor is positioned to make contact at the upper right corner of each die. At die 2, the sensor detects noncontact; therefore, probing is suspended at die 2 and remains in that state until contact is established again. The prober, however, continues to die 3. It then advances one row, Y travel, to die 10, reverses direction (X travel) and begins advancing. At die 11, the edge sensor makes contact and normal probing resumes.

Partial die are also probed using the Edge Sense mode. If the edge sensor is positioned center right, then die 2 will be probed. Die 3 and 4 are not probed; probing resumes at die 10. Although die 2 is a partial die, it is still probed.

MATRIX PATTERN (< 2 >)

The Matrix pattern starts at First Die. Because the pattern probes a rectangular matrix within the wafer, delayed inking is not allowed. First, the prober advances in the X direction for the number of columns selected. Next, the prober changes rows, reversing the X direction. This is repeated until all rows have been probed in a serpentine fashion.

The size of the matrix is determined by the values entered in Line 05 of the Probe Mode Menu (see **Section 3.4.2**). For example, a matrix selection of X=10, Y=10 probes an area 10 die along the X axis and 10 die along the Y axis. Travel starts at the First Die point and advances in the direction determined by probe quadrant selection. See *Figure 3−7*.

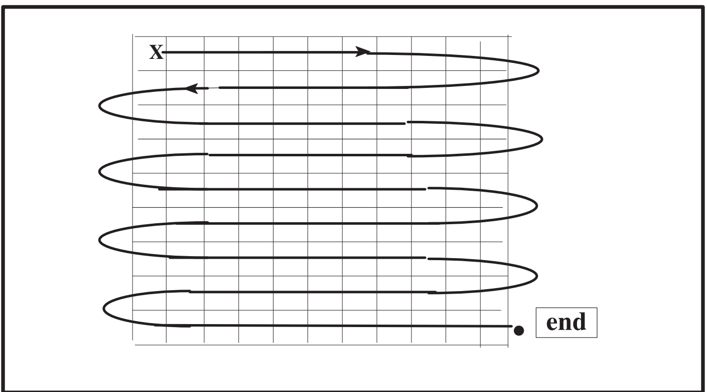


FIGURE 3−7: MATRIX PATTERN

CIRCULAR PATTERN (< 3 >)

Circular is the same as Edge−Sense − they are both serpentine. The difference is, the Circular mode uses the Noncontact Edge Sensor to turn around. Also, the row length varies with the row position to conform to the serpentine pattern and to prevent probing off the wafer. Only whole die are indexed. See *Figure 3−8*.

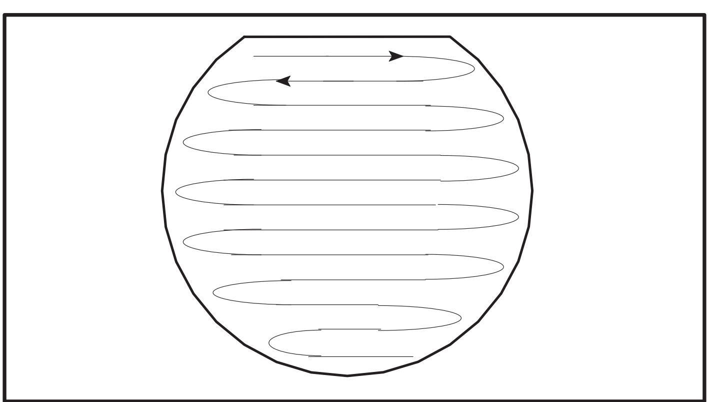


FIGURE 3−8: CIRCULAR PATTERN

A circular pattern is computed based upon:

1. X and Y die size
2. Wafer diameter
3. Wafer center

The Circular pattern is based on the Wafer Diameter entry in Line 04 of Set Parameter Menu (see **Section 3.5**). The probe direction of travel is determined by probe quadrant selection. It is important to select a First Die (whole die site) on the perimeter of the wafer diameter. Otherwise, die behind the First Die will not get probed. Note that partial die are not probed.

In order to calculate wafer center, the chuck center and NCES position need to be accurate. Also, the Profile with Find Center parameter must be set to enable (see **Section 6.2.1, Enabling and Setting the Profiler**, for more information).

LEARN PATTERN (< 4 >)

This is a non−sequential pattern used to probe selected die points. Use a coordinate list for this pattern. This list can be developed in the following ways:

- By the operator using the keyboard in the Learn List editor (see **Section 3.6, Learn, Row, and Micro Menu**)
- By the host computer using the Add, Delete, and Clear functions (see **Section 8**, **EXTERNAL I/O CONTROL INTERFACE**).

Although the coordinates are established with respect to the preset value at the First Die position, the operator must always position the First Die location, whether it is to be probed or not. The First Die location will not be probed unless it is referenced while in the learn list, which contains a maximum of up to 5015 coordinate values. This list can be used as a list of die to be tested *or* a list of die to be skipped (if skipdie is enabled).

The Learn Pattern and skip die inking cannot be used simultaneously (they both use the same list data for two different purposes).

ROW/COLUMN PATTERN (< 5 >)

The probed die points are those entered in the Row List of the Learn, Row, and Micro Menu (**Section 3.6**). Rows are probed in the order in which they appear in the list.

Up to 418 rows or columns can be selected for probing. Row probing can be paused and continued at a different row, as long as the new position is inside a stored row. Unlike the learn pattern, this probe pattern can be used with the skipdie function.

PARTIAL MODE (< 8 >)

The wafer must have at least 50% of its original area to ensure an adequate holding vacuum and reasonable alignment. Partial wafer probing requires a Noncontact Edge Sensor (NCES, or profiler) to find a perimeter of any possible shape of a broken wafer. Profiler setup for partial profiling is discussed in **Section 6, NONCONTACT EDGE SENSOR.**

Additional information on probing of partial wafers is located in **Appendix B, Procedures.**

EXTERNAL MODE (< 10 >)

This selection disables standard probe pattern indexing and normal probe function, preparing the system for External probe instruction. The system must be controlled by the host computer with External I/O parameters properly set. (The reprobe limit feature cannot be used when the probe mode is set to external.) TS (Test Start) and TC (Test Complete) signals are not generated in this mode. Additional information on External I/O is located in **Section 8**.

LINE 03 PROBING MODE

The Probe Mode submenu is used to tailor probe operation to specific requirements. The menu parameters are described in **Section 3.4.2 (Probe Mode Menu**).

LINE 04 Z TRAVELING MODE

The Z traveling mode controls the manner in which the Z chuck top rise and fall is stopped.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 05 MICRO PROBING

Use this line to enable (< 1 >) or disable (< 0 >) the microprobing feature. When enabled, microprobing is performed on every die that is reached by the regular probe modes, using a built−in micro list (not cleared at power−up) that holds up to 126 micro sites. The units for microdie definition and stepping are 0.1 mil. Micro motion and coordinates are defined using these step sizes. Micro sites only have to be entered on one die (although they can cross a die boundary).

The micro list stores X and Y microdie coordinates relative to the microdie origin, as well as the site number. The *site number* is used by the tester to reference a particular microdie point, as identified by the coordinates. See *Figure 3−9*.

The microdie coordinate system is fixed; X increases to the right of the die, Y increases toward the top of the die. This is the same as the machine coordinate system of the platen. The origin is set as the top left corner of the whole die site used when the microdie store mode is entered from the Micro Site List. See **Section 3.6, Learn, Row, and Micro Menu.**

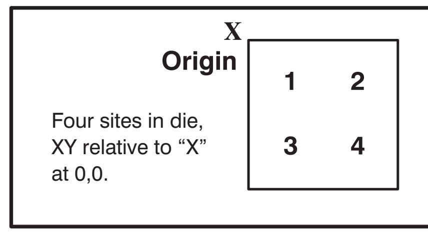


FIGURE 3−9: MICROPROBING SITES

Probing proceeds from the lowest to the highest site number used. When probing is finished, the chuck will step to the next macro (standard) site as defined by the current Autoprobe mode. Inside this macro site, the probes will contact the site defined by the lowest site number in the list. If the macro probe mode is also exhausted, the wafer will be considered completely probed and will be unloaded.

LINE 06 MULTI−DIE PROBING

Select this line to produce the Multi−Probe Parameters Menu, used to set up the prober to simultaneously probe arrays of two, four, or eight die. Multi−Die Probing is described in **Section 9, MULTI−DIE PROBING.**

LINE 07 I/O CONTROL

The I/O control menu is used to select settings involving the external I/O interface parameters and controls. It also provides access to the External I/O Menu. Its line items are identified in **Section 3.4.3, I/O Control Menu**.

LINE 08 DATA LOGGING MODE

The Data Logging Mode Menu is a parameter list used to define the types of logging data which is available to control wafer count. It is described in **Section 3.4.4, Data Logging Mode Menu**.

LINE 09 MISCELLANEOUS OPTIONS

Line items for this menu are described in **Section 3.4.5, Miscellaneous Options Menu**.

LINE 10 ASSIGN LOGICAL INK−CODE

Line 10 accesses the Inker Assignment Menu, used to assign any of the four inkers to the 256 bin codes. It is explained in **Section 3.4.6, Assign Logical Ink−Code Menu**.

LINE 11 THETA COMPENSATION MODE

This line displays the Theta Compensation Menu, used to test fixtures and probe cards without having to align the probe tips to the prober's XY platen. Details of this feature are given in **Section 5, AUTO ALIGN**.

3.4.2 Probe Mode Menu

The Probe Mode Menu *(Figure 3−10),* accessed by Line 03 of the Set Mode Menu, is a submenu of parameters related to different aspects of the probing process.

```
PROBER
SET MODE MENU

01  METRIC/ENGLISH ........ ENGLISH
02  AUTO-PROBE PATTERN ....CIRCULAR
03  PROBING MODE               MENU
04  Z-TRAVELING MODE ....... LIMITS
05  MICRO PROBING ............. DIS
06  MULTI DIE PROBING.......... DIS
07  I/O CONTROL                MENU
08  DATA LOGGING MODE          MENU
09  MISCELLANEOUS OPTIONS      MENU
10  ASSIGN LOGICAL INK-CODE    MENU
11  THETA COMPENSATION MODE . . ENB
```

```
PROBER
PROBE MODE MENU

01  PROBE QUAD SELECT......... 2
02  COORDINATE QUAD .......... 2
03  REPROBE LIMIT ............ 0 DIE
04  PROBE CLEAN COUNT ........ 0 DIE
06  MAXIMUM ROW COUNT ........ 0 ROWS
07  TURNAROUND ............... 0 DIE
08  USE AUTO DIAMETER ........ DIS
09  CONT. AT LAST DIE ........ ENB
10  PROBE TIP SCRUB .......... DIS
11  INKING MODE                MENU
12  UGLY DIE                   MENU

LINE = █
```

FIGURE 3−10: SET MODE AND PROBE MODE MENUS

LINE 01 PROBE QUAD(RANT) SELECT

Choose from the four quadrant selections (*Figure 3−11*) to establish the wafer's direction of travel during the probe operation. The key input < 1 > through < 4 > corresponds to the quadrant number.

If, for example, Quadrant 1 is selected, the wafer increments from the First Die point in the direction indicated in *Figure 3−11.* Initially, the wafer travels left along the X axis. At the probe pattern limit, two separate actions occur: the wafer increments a single die position along the Y axis, and wafer travel reverses direction along the X axis. This is the view through the microscope or probe card; it shows the *wafer* movement, not the *forcer* movement. This sequence continues until the entire pattern is probed.

Ideally, the First Die point should be in the selected quadrant (see *Figure 3−11)*. Correct selections guarantee the most efficient probe pattern.

LINE 02 COORDINATE QUAD(RANT)

Choose from the four quadrant selections to establish a reference quadrant for the Coordinate System and establish a positive direction for the X and Y coordinates, as indicated by the arrows in *Figure 3−11*. Again, input < 1 > through < 4 > corresponds to the quadrant number. Normally, the same value used for Line 01 (Probe Quad) is used for the Coordinate Quad. (This is only used for those testers that require a specific coordinate system for XY data.)

LINE 03 REPROBE LIMIT

The numeric value entered for the reprobe limit determines the number of consecutive bad die probed before a reprobe is initiated. This consecutive counter is reset on each wafer. If the limit is not reached at the end of the wafer, the count is restarted on the first testable die of the next wafer.

With the reprobe initiated, the last known good die location is probed again. If the die again probes good, the probe will continue at the next possible unprobed die position. An indication of a bad die will abort the probe and display the error message `ABORT, BAD DIE`. If only bad die have been probed, the probe will abort with the error message `NO GOOD DIE` and no attempt will be made to reprobe. Probing stops.

If probing is aborted due to a reprobe failure such as exceeding reprobe count limit, the last bad die is moved under the probe tips and a message is displayed:

```
ABORT, BAD DIE. TO CONTINUE,
INDEX TO NEXT DIE AND PRESS PAUSE
```

To continue probing, put the Joystick in the Index mode and move to the correct next die (untested) in the pattern and press < PAUSE >.

Reprobe selection is prompted by a flashing cursor. Entry for this line must be a positive whole value (no decimal point). Confirm the entry by checking the value on Line 03 of the display. A zero (< 0 >) input disables this feature. (Reprobe Limit cannot be used when the probe mode is set to External.)

QUADRANT 2

n,n X Y

F

QUADRANT 1

X n,n Y

F

"F" indicates coordinate (XY) preset

QUADRANT 3

F

Y n,n X

QUADRANT 4

F

Y X n,n

n,n = the preset XY value set in the Set Parameter Menu

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Probing begins on the top and moves from the top to the bottom, left to right. The coordinates of the die increase moving to the left for X and increase moving up for Y.

FIGURE 3–11: COORDINATE QUADRANT SELECTION

LINE 04 PROBE CLEAN COUNT

This option establishes a cleaning interval for the probe tip. Cleaning can be selected to occur after probing a set number of either dies or wafers. A simple XY clean or an XYZ scrub motion will be done depending on the setting for Line 10, PROBE TIP SCRUB.

Enter a positive whole numeric value (no decimal point) for the count. This value sets the frequency with which the probe tip cleaning occurs. Enter < 0 > to disable the cleaning interval feature.

Next, a prompt displays asking for the cleaning per wafer interval. The interval is selected by pressing either < Y > or yes or < ENTER > for no. Press < ENTER > to automatically set cleaning to a die interval.

LINE 05 MATRIX X... Y...

This option establishes the limits of the Matrix probe pattern, described in **Section 3.4.1, Set Mode Menu Line Items**. The area of the pattern is determined by the values entered for X and Y, which represent the number of die along the respective axes.

Because X and Y represent die points, entries must be whole values. (Negative values cause the wafer to increment in the direction opposite to that indicated by quadrant selection.)

LINE 06 MAXIMUM ROW COUNT

This option establishes a limit for the number of rows probed during the Autoprobe sequence. It is especially useful for small die. The maximum row count works only with the Circular probe pattern, described in **Section 3.4.1.**

Enter a positive, whole number (no decimal point) to establish the maximum count. A zero (< 0 >) entry disables this feature. In either case, press < ENTER > to complete this entry.

The maximum row count is particularly helpful in confining the probe to the wafer area bounded by the flat. This is done by setting the wafer flat at 0° or 180° and carefully selecting the number of rows that should be probed, starting from the First Die towards the flat (don't count the last partial row), as shown in *Figure 3–12.*

LINE 07 TURNAROUND

Turnaround is used with the Edge or Circular pattern selection, described in **Section 3.4.1.** In the Circular mode, turnaround is not used unless edge die inking is enabled. With Edge mode, the pattern probes the wafer from edge to edge. Each time the edge is sensed, the probe is advanced two additional die positions beyond the edge. There, the wafer reverses the X direction of travel and increments the Y axis one position.

This turnaround die position can be extended by selecting a value of < 0 > through < 8 >. The entered value represents the additional die positions the probe advances before turnaround occurs. A value of < 0 > will not extend the turnaround.

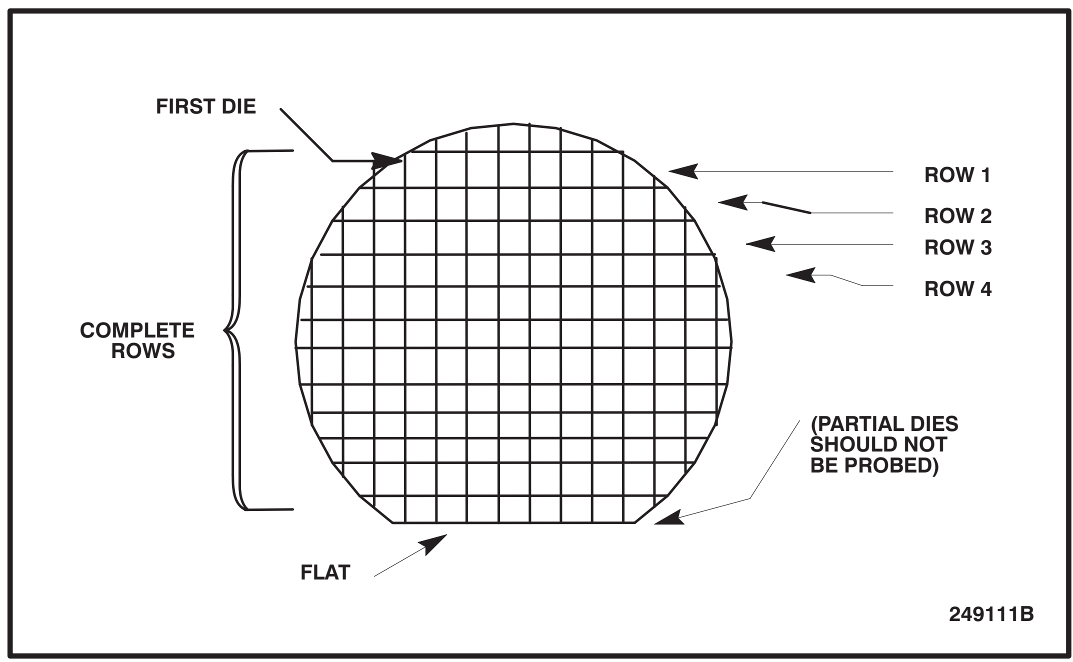


FIGURE 3–12: MAXIMUM ROW COUNT IN WAFERS WITH PARTIAL DIE

LINE 08 USE AUTO DIAMETER

Input < 1 > enables this function which causes the wafer diameter to be calculated as part of the Autoprobe function. In addition, two other options must be enabled: AUTO–PROFILE switch (Set Option Menu, Line 03), and, from the Autoprofiler Option Menu which is triggered by this selection, PROFILE FIND CENTER (Line 01). This feature is highly recommended for small die, ugly die, or the center reference feature.

Input < 0 > disables this function. In this state, the system will recognize the wafer diameter as the value entered on Line 04 of the Set Parameter Menu (**Section 3.5.1**).

LINE 09 CONTINUE AT LAST DIE

Enabled, this function allows continued probing at the die where probing has been paused. This feature works in any probe mode except `OFF` and `EXTRN`. Input < 0 > to disable; < 1 > to enable.

LINE 10 PROBE TIP SCRUB

When enabled, after the probe clean position and probe clean count are set, every time the probe array is cleaned on the cleaning pad, a 1–mil octagonal motion occurs. This motion causes each probe tip to be scrubbed from eight different directions. Different locations on the cleaning pad are used when cleaning and scrubbing to ensure that the pad wears evenly.

Probe Clean Position is set through the Profiler Menu (see **Section 3.9**). The Probe Clean Count is set through the Probe Mode Menu, Line 04 (described earlier in this section). If the probe clean position has not been set, probing will halt before the tips are scrubbed, and an error message on the screen will inform:

CLEAN POSITION HAS NOT BEEN SET

3.4.2.1 INKING MODE SUBMENU

Select Line 11 of the Probe Mode Menu to display the Inking Mode Menu (*Figure 3−13*), which is used for the skipdie function and wafer edge inking.

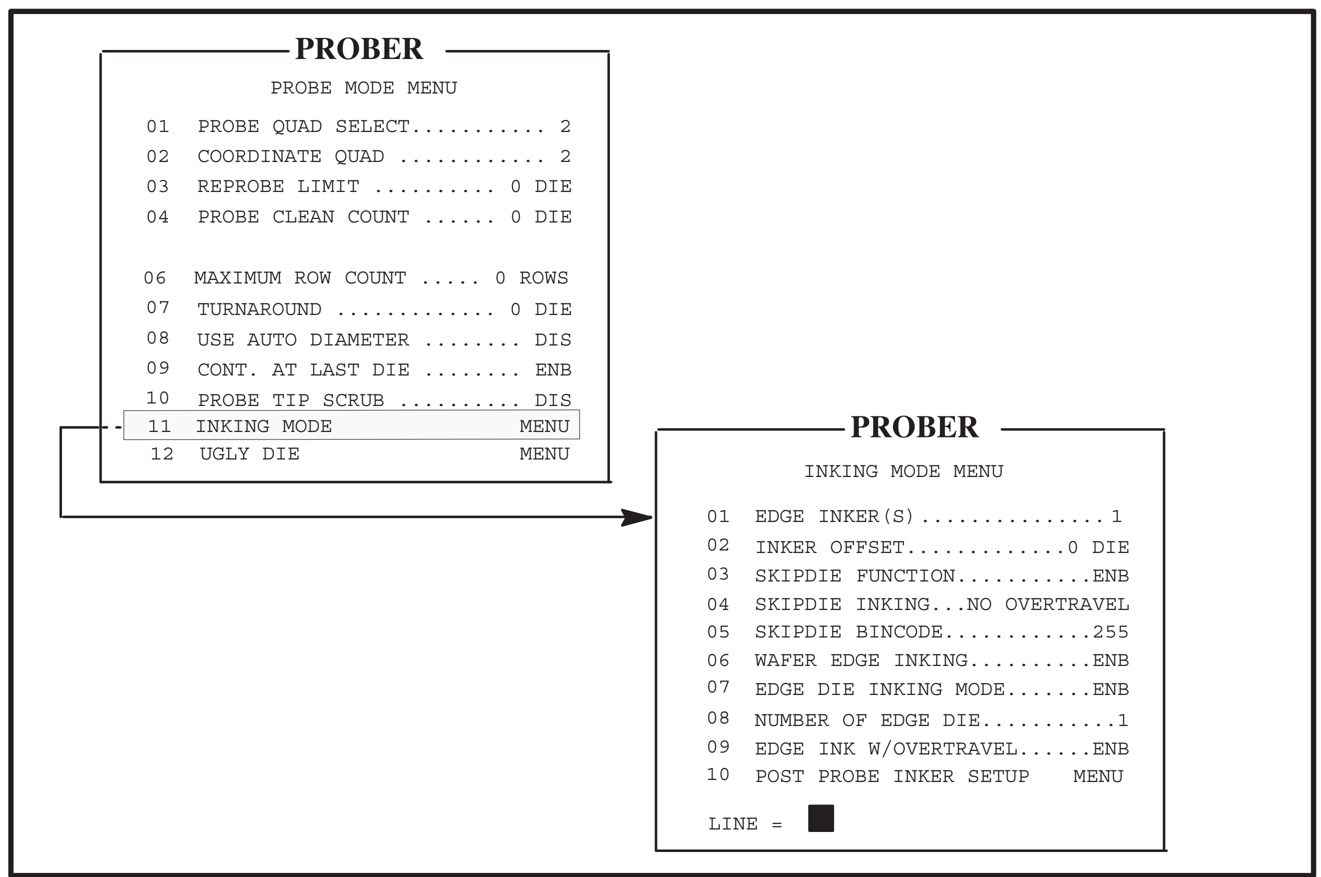


FIGURE 3−13: PROBE MODE AND INKING MODE MENUS

Edge die inking is available in the Follow, Edit, and Edit−Save mapping modes; it scans the Wafer Map, prior to probing, and creates a list of physical row ends relative to the First Die location. In the Circular, Edge Sense, and Partial wafer probing modes, edge die is calculated mathematically real−time as they occur.

Edge die inking needs to know where the edge begins on a wafer. Once the die at each extremity of the row are known, and once the physical edge of the wafer is known, a determination can be made of the locations of all the edge die. An edge die is defined as die residing next to the first and last whole die on a row. If the Number Of Edge Die parameter (Line 08) is set to 2, the prober will ink the two locations before and after the whole die on the row.

When using a Wafer Map, two edge die inking modes are possible. Each of these modes will go from the wafer map's row end to some maximum edge die location.

Fixed die mode inks a fixed number of die from the ends of wafer rows. Radial die mode uses the wafer diameter and wafer location information known to the prober to determine the maximum edge die location (for edge die only).

If the Noncontact Edge Sensor is available, the location and diameter of the wafer as determined by the NCES is used. Otherwise, the prober uses Semi−Spec wafer diameters and depends on the accuracy of wafer placement. The effectiveness of edge die inking is decreased when performed without a NCES.

Following is a description of the line items on the Inking Mode Menu.

LINE 01 EDGE INKER(S)

This feature allows you to set any combination of inkers 1−4 as edge die inkers. The default value is inker 1. When this line is accessed, a prompt will appear:

```
ACTIVE INKER(S) = 1,2,4
ADD INKER (0 = RESET, 1-4)  =
```

To add an inker, enter the inker number. Or, < 0 > resets to `NONE`. To subtract an inker from the list, first reset to `NONE` and then enter only the desired inkers.

LINE 02 INKER OFFSET

This option establishes either in−line or offset die inking.

The offset is a deliberate delay in the inking operation while the wafer is advanced either one or two die positions and is valid only for the edge or circular patterns. The inkers are placed either one or two die positions to the left and right of the probe location.

Ink−code “0” actuates in−line inking for all inkers. Inkers are not offset for this entry which is valid for all probe patterns.

Ink−code “1” actuates in−line inking of inkers 1 and 2, and a delay of one die position, in one direction only, for inkers 3 (right) and 4 (left).

Ink−code “2” delays actuation of inkers 1 and 2 by one die position and delays inkers 3 and 4 by two die positions. (Directions are 1 and 3, right; 2 and 4, left.)

The delay for inkers is also selectable as delay−by−1 or delay−by 2 (discrete mode). The delay selected will apply to all four inkers (no mixing or individual assignments).

When setting the inker offset/delay, a prompt gives the choice between the standard delayed inking scheme or the new parallel delayed inking scheme. There is no change to the menu display when the offset delayed inking scheme is selected. When parallel delay−by−1 inking is selected, the menu display reads:

```
02   INKER OFFSET     ...(PAR)..1
```

With the parallel delayed inking scheme in use, the inkers are all assigned the same delay value selected, with inkers 1 and 3 firing when the chuck is moving in one direction, and inkers 2 and 4 firing when the chuck is moving in the opposite direction.

Inkers 1 and 2 are fired, depending on chuck direction, when either inker 1 or 2 is requested to fire; inkers 3 and 4 are fired, depending on chuck direction, when either inker 3 or 4 is requested to fire.

Delayed inking may be used with all inkers having the same die offset (as opposed to standard delayed inking in which inkers have a staggered offset).

LINE 03 − SKIPDIE FUNCTION

The prober can be instructed to skip selected die points. The skipped die points are those stored in the memory stack through the Learn List, either by keyboard entry or with the < STORE > key. Up to 5023 different die points can be stored and skipped. The skipdie function is valid for four of the auto probe patterns − Edge, Matrix, Row Mode, or Circular. It is never enabled in connection with the Learn pattern; they are mutually exclusive since the Learn pattern uses the same list as a list to probe.

Skipdie inking is allowed with delayed inking (Line 09). Inker 1 is used with delay 0 and 1, and inkers 1 and 2 with delay 2.

When the skipdie function is enabled, the prober asks if inking should be done with or without overtravel. If overtravel is used, the system indicates this on the menu with `INK+`.

When the NCES is used to regulate Z stage travel, inking is done with zero overtravel to avoid contact with the probe tips. With an edge sensor, an overtravel of 1.5 mils is used. If the Z travel mode is set to Limits, inking is done at the Z Upper Limit.

Input < 1 > enables the skipdie function; < 0 > disables it. Disabled, it does not affect the probe operation.

If the skipdie function is enabled, Lines 04 and 05 become viewable.

LINE 04 − SKIPDIE INKING

This item prompts for three choices for controlling skipdie inking:

< 0 > allows the prober to move to the skipdie; however, no inking is done.
< 1 > causes skipdie inking with overtravel.
< 2 > causes skipdie inking without overtravel.

LINE 05 − SKIPDIE BINCODE

This item allows entry of a bincode to be associated with the skipdie function for Wafer Mapping purposes. This bincode must be mutually exclusive from the ugly die bincode which is displayed at the bottom of the screen when an entry is made in this line. The default skipdie bincode is 254; the default ugly die bincode is 255.

If the same bincode is selected, an error message `IDENTICAL BIN CODES,` is displayed and a new bincode can be entered.

LINE 06 − WAFER EDGE INKING

Input < 0 > to disable or < 1 > to enable the wafer edge inking for Edge or Circular probe modes.

The Edge and Circular probe modes do not share a common turnaround reference die. Edge mode turnaround starts two die positions after noncontact is detected. This point can be illustrated using the previous setup example and *Figure 3−14B.* Die 4 marks the turnaround die. In the circular mode, one partial die is inked in each direction. Die 2 marks the turnaround die. The turnaround die can be altered by setting the Turnaround parameter (Line 08 of this menu).

When the wafer edge inking function is disabled, partial die along the wafer edge are not inked *(Figure 3−14A).*

If Wafer Edge Inking is enabled, Lines 07, 08 and 09 become viewable.

LINE 07 EDGE DIE INKING MODE

This line will appear only if the probe mode is in Wafer Map Follow or Edit modes. It prompts for a choice between two edge die inking modes:

- Fixed is a fixed number of edge die beginning just after the end of the row in the Wafer Map and ending after the fixed count is exhausted.
- Radial allows inking of die from just after the end of the Wafer Map row to the physical edge of the wafer, plus whatever is set in Line 08, described next.

Edge die are partial die located on either end of a row.

LINE 08 NUMBER OF EDGE DIE

The number entered in this line determines, for the Fixed selection in Line 07, how many die are inked of the fixed number of edge die specified. If Radial has been selected in Line 07, the number set in Line 08 will be added to the inked die as specified.

If the probe mode is not Follow or Edit, then edge die inking proceeds as before; edge die inking will occur during probing and not during mapping (following or editing an existing map). In this case, the number of edge die is equal to the Line 08 setting. Turnaround will be set to Number of Edge Die minus 1. For example, if Line 08 is set to 5, Turnaround will automatically be set to 4.

The number of die locations specified on Line 08 will be inked as edge die regardless of whether or not the die center is on the wafer or 50% of the area is on the wafer.

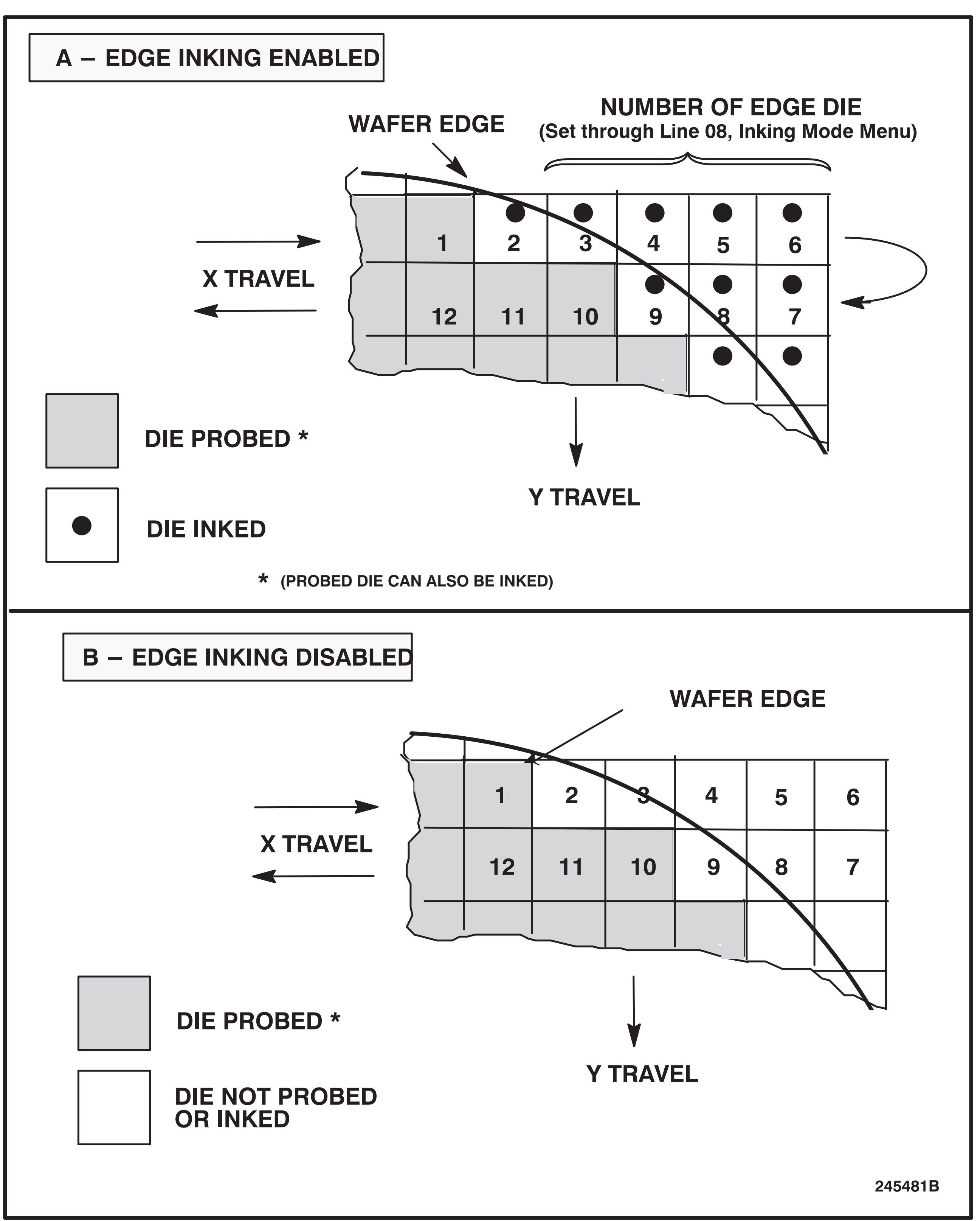


FIGURE 3–14: WAFER EDGE INKING

LINE 09 EDGE INK W/OVERTRAVEL

This item allows edge die inking to be enabled or disabled. If enabled, it includes overtravel.

LINE 10 POST PROBE INKER SETUP

Selection of this line displays the Post Probe Inker Setup Menu. Details are discussed in **Section 9, MULTI−DIE PROBING,** and also in the **Electroglas Inkers Installation and Operation Manual, DOC 246730.**

3.4.2.2 UGLY DIE SUBMENU

Line 12 of the Probe Mode Menu displays the Ugly Die Menu (*Figure 3−15*) which is used for the skipdie function and wafer edge inking.

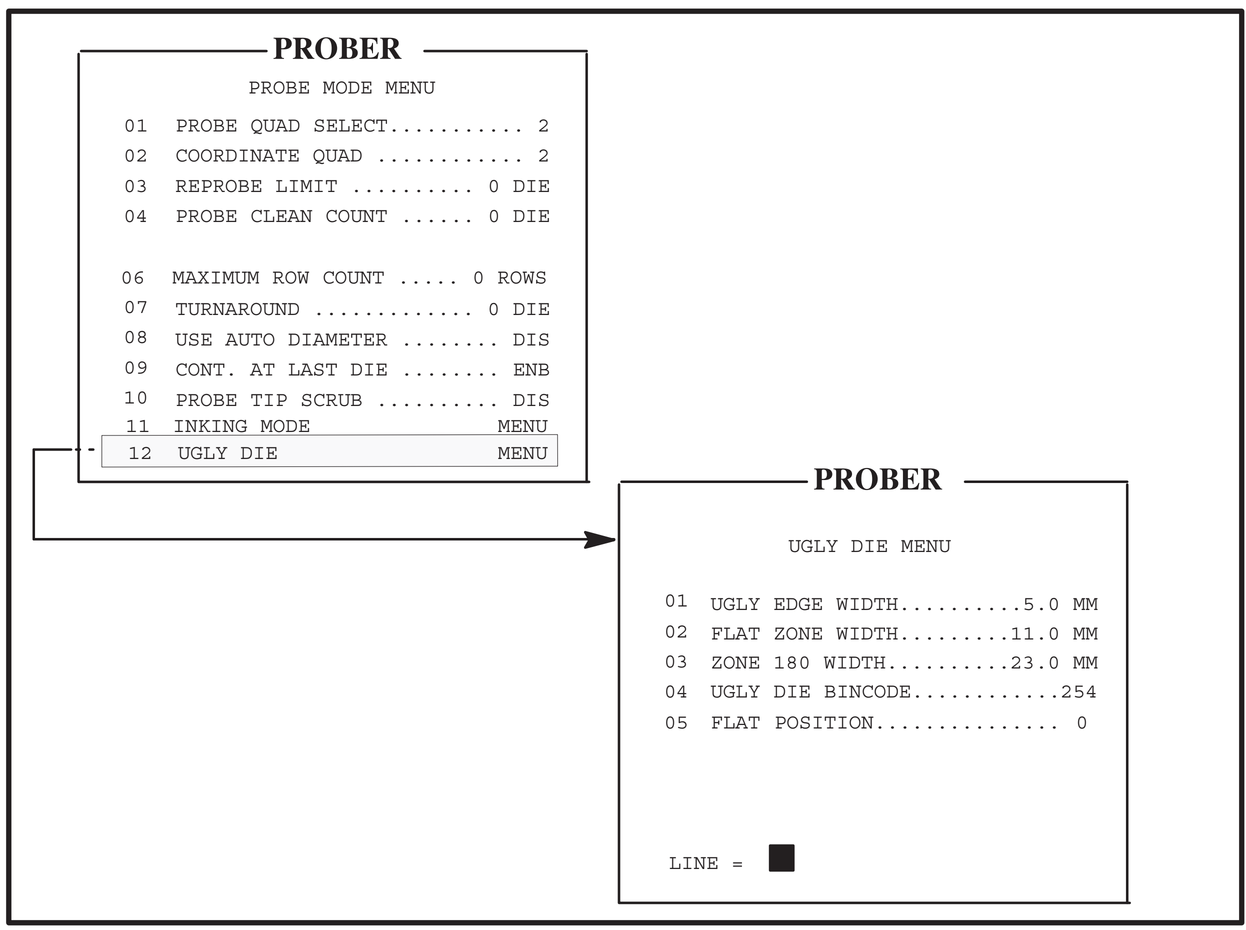


FIGURE 3−15: PROBE MODE AND UGLY DIE MENUS

Low yields found in the outermost circular band of some wafers waste valuable tester time. Some of these dies test good while on the wafer, but fail in tests done after packaging. The coatings used by some manufacturers look discolored within this low yield band, suggesting the term ugly die. A solution to the ugly die problem is to ink these die without testing them, causing them to be discarded. Ugly die probing allows you to define a band, measured inward from the wafer edge. Any die which is wholly or partly within the band is considered an ugly die and inked without testing. Interior die are probed and tested in the usual manner.

The designated band generally follows the circumference of the wafer except for two separately defined regions: those adjacent to the primary flat or notch of the wafer, and the region 180 degrees from the flat or notch (see *Figure 3−16*). The flat region is bound by the flat on the edge of the wafer and the parallel ugly die band width more toward the center.

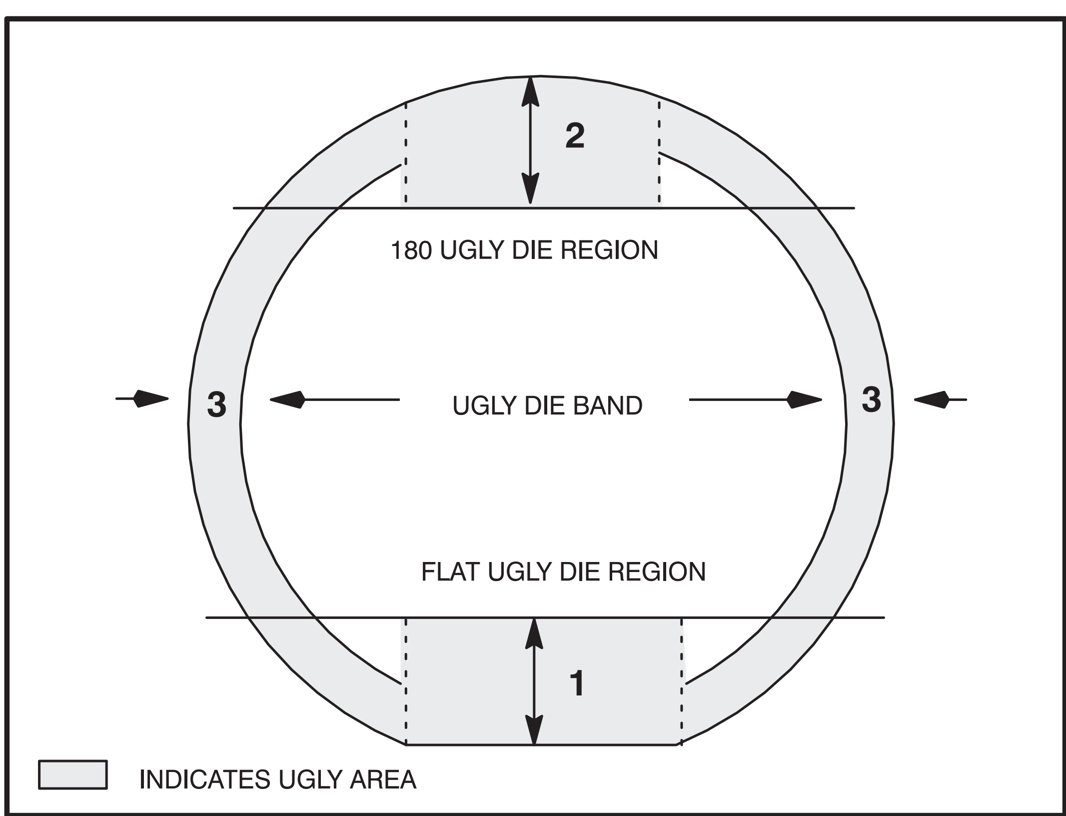


FIGURE 3−16: LOW YIELD (UGLY DIE) REGIONS ON WAFER

The 180−degree ugly die region is bound by the circumference of the edge of the wafer and the ugly die band width parallel to the flat and measured in toward the center from the extreme circumferential point. The width of the ugly die region may be set in 0.1 mm increments from 0.0 to the full radius of the wafer.

In the same manner as good and bad die, a count is kept of the ugly die, displayed on the Run Time Display, and reported in the wafer and cassette logs. Ugly die are included in wafer maps with an ugly die bincode of 0 to 255 that you select. The default value is 254. Ugly die reports are available through External I/O.

Ugly die probing can be enabled with any probe mode except Off or External. Since precise location information is required, ugly die probing requires a Noncontact Edge Sensor to accurately locate the wafer on the chucktop and determine the true wafer diameter. `USE AUTO DIAMETER`, `PROFILE WITH FIND CENTER`, and `AUTO-PROFILE` should be enabled.

If inaccuracy is allowable for the location of the ugly die bands, the NCES does not have to be used. Ugly die probing is possible without the NCES but highly discouraged.

All ugly die zones are set by measuring the wafer and entering the results in the first three items of this menu.The fourth item, bincode, is put into a Wafer Map if Wafer Mapping is enabled.

LINE 01 UGLY EDGE WIDTH

The ugly die width is a defined circumference measured from the edge of the wafer toward the center. Any die which falls on the defined boundary line or outside it toward the edge will be called ugly.

This item has a dual function as input to the edge width and as the enabling variable for ugly die inking. Any edge width greater than 0.0 enables ugly die inking. The default value of 0.0 disables ugly die inking. The ugly edge width is determined by measuring the ugly band width from the wafer's perimeter to the beginning of the good die. Measurement is to the nearest 0.1 millimeter.

LINE 02 FLAT ZONE WIDTH

The circular ugly die band is interrupted in two places. A separately settable ugly die band, Flat Zone Width, is measured parallel to the primary flat of the wafer. For notched wafers, the distance is measured from the imaginary perimeter point on the outside of the notch (see *Figure 3−16).*

LINE 03 ZONE 180 WIDTH

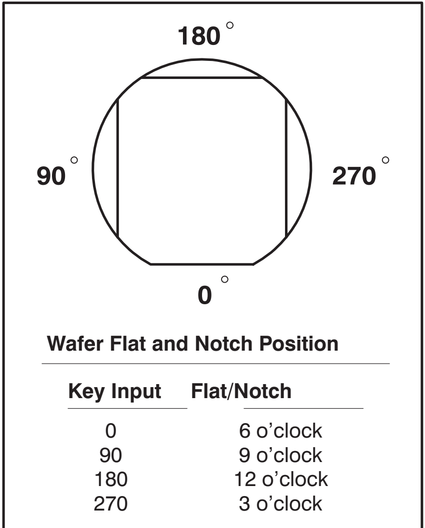
This zone is another separately settable ugly die zone that is set parallel to but 180 degrees from the primary flat.

LINE 04 UGLY DIE BINCODE

This item assigns a bincode from 0 to 255 to those die determined to be ugly die during normal probing modes. The default ugly die bincode is 254. Setting good die as a function of bincode, particularly involving ugly or skipdie bincodes, is discussed under **Section 3.4.6, Preset Inker Assignment**.

LINE 05 FLAT POSITION

The concept of the flat position is illustrated in *Figure 3−17*. Normally, this position is set through the Handler Set Parameter Menu. When using the ugly die feature on a prober with the Material Handler disabled, the flat position can be set using this line when Ugly Die is enabled. Otherwise, Line 05 is not visible on the displayed menu.



Key Input	Flat/Notch
0	6 o'clock
90	9 o'clock
180	12 o'clock
270	3 o'clock

FIGURE 3−17: WAFER FLAT/NOTCH POSITION

Both flat and notch selections relate to the wafer position on the chucktop. The selection is entered in degrees with respect to a reference point and determines how the wafer will be positioned when transferred to the chuck.

As shown in *Figure 3−17*, with the front of the prober as the reference point, a key input of < 0 > (zero or 0°/360°) places the flat at 6 o'clock. Inputs of 90°, 180°, and 270° position the flat/notch at 9 o'clock, 12 o'clock, and 3 o'clock.

3.4.3 I/O Control Menu

The I/O Control submenu *(Figure 3−18)* is accessed through Line 07 of the Set Mode Menu; its parameters are related to interfacing with External I/O.

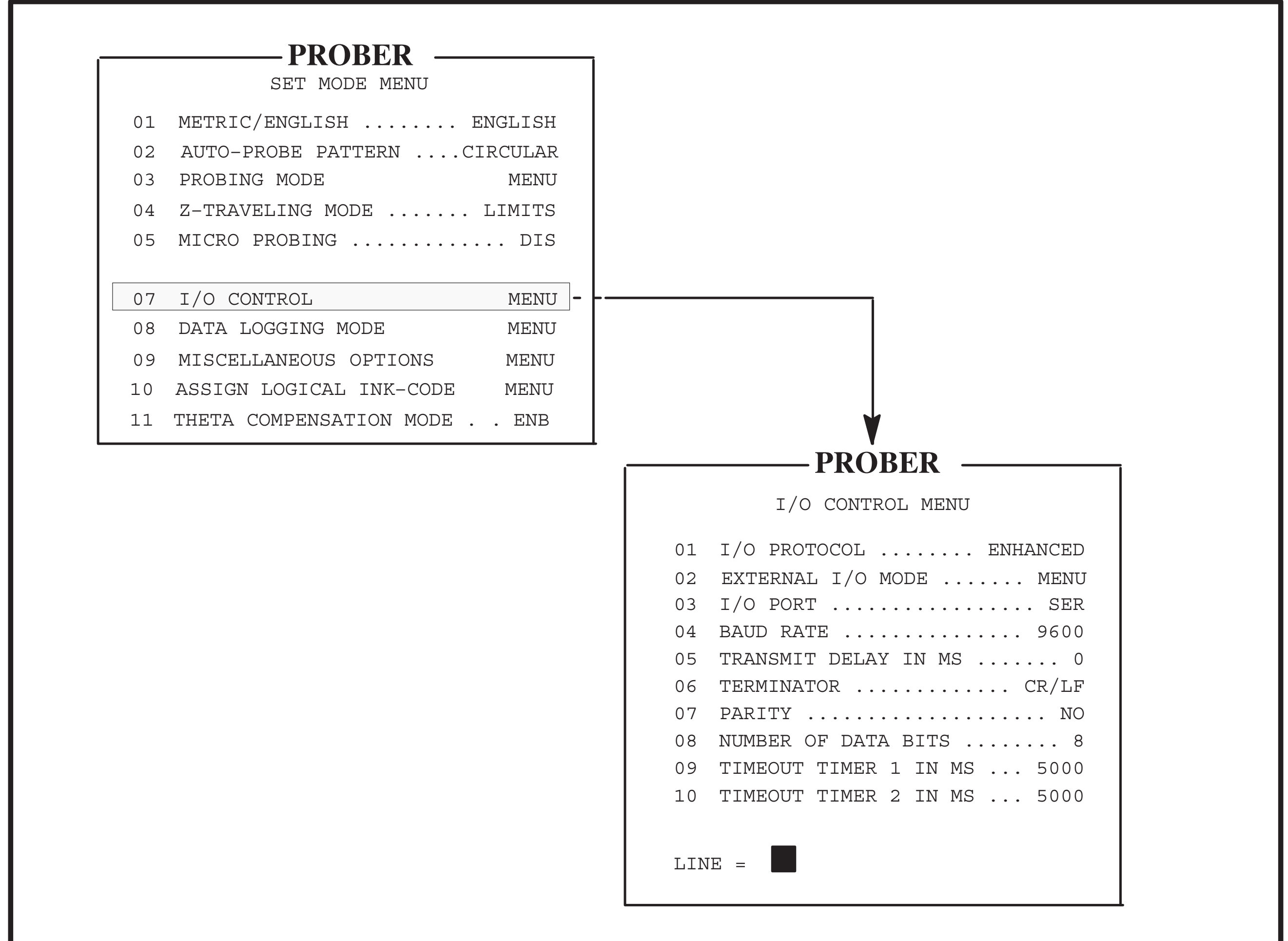


FIGURE 3−18: SET MODE AND I/O CONTROL MENUS

The menu displayed varies according to a variety of settings within its own lines. The menu line items are described briefly in **Table 3−1;** they are explained fully in **Section 8, EXTERNAL CONTROL I/O INTERFACE**.

TABLE 3–1: I/O CONTROL MENU FUNCTIONS

Line		Function
01 I/O PROTOCOL		Select from four protocols: 1. Standard I/O 2. Enhanced I/O 3. RDP I/O 4. BOCS
02 EXTERNAL I/0 MODE		Displays External I/O Menu, which lists command–related messages and is used to determine if each message is to be issued for the successful execution of a command. See **Section 8** for more information.
03 I/O PORT	(SER) (GPIB-SP) (GPIB-PP)	< 0 > shuts off I/O Interface < 1 > selects serial RS–232 interface port < 2 > selects GPIB serial poll mode < 3 > selects GPIB parallel poll mode Explanations of remaining menu lines are identified by the “code” of the Line 03 selection(s) to which each applies. Lines with the same numbers alternate according to other menu items selected.
04 BAUD RATE	(SER)	Establishes serial interface (RS–232) baud rate.
04 PARALLEL POLL ADD	(GPIB–PP)	Selects any address from 1 to 8.
05 TRANSMIT DELAY	(SER)	Sets or disables an intercharacter delay between transmitted characters on RS–232.
05 GPIB ADDRESS	(GPIB–SP & PP)	Selects any address 1 through 31.
06 TERMINATOR	(All three)	Establishes the terminator for commands and messages between the host computer and the prober.
07 PARITY	(SER)	Used to determine the characteristics of the parity check.
07 GPIB-SRQ	(GPIB–SP)	Enables/disables the GPIB SRQ function in enhanced protocol.
08 NUMBER OF DATA BITS	(SER)	Establishes the code group for each character transmission.
09 TIMEOUT TIMER 1 10 TIMEOUT TIMER 2	(All three)	Controls data received from/transmitted to the prober.

3.4.4 Data Logging Mode Menu

The Data Logging Mode Menu *(Figure 3–19)* is a submenu accessed through Line 08 of the Set Mode Menu. It is used for generating logs and error messages, entering the starting wafer number and selecting printer formats.

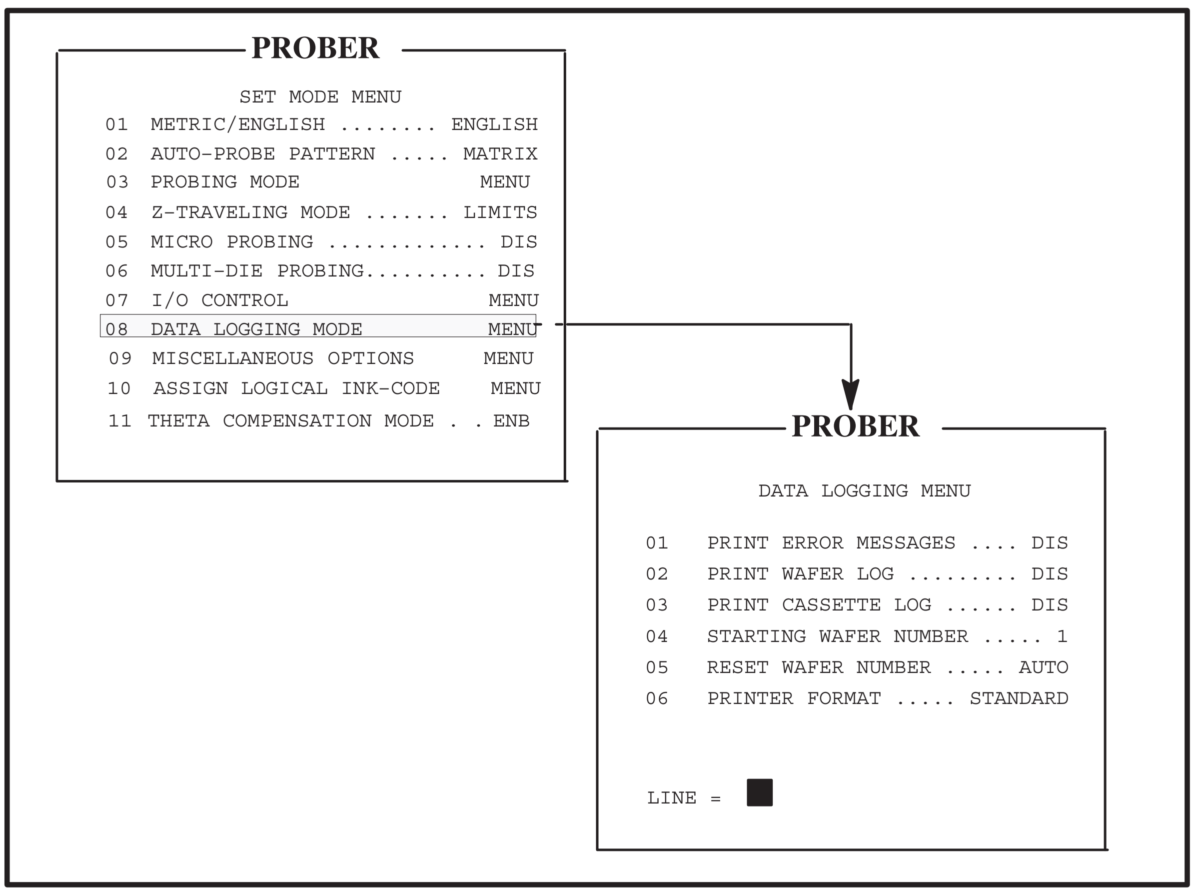


FIGURE 3–19: SET MODE AND DATA LOGGING MENUS

NOTE
Lines 01, 02, and 03 interface with an optional printer and should be left disabled for units not equipped with a printer.

LINE 01 PRINT ERROR MESSAGES

LINE 02 PRINT WAFER LOG

LINE 03 PRINT CASSETTE LOG

Input < 0 > to disable or < 1 > to enable the selected function and prevent/allow the printing of the messages or data.

LINE 04 STARTING WAFER NUMBER

Establish a starting wafer number, the first value for the wafer count sequence. If assigned a positive value, the count will increment by one for each subsequent wafer. If assigned a negative value, the count will decrease by one for each subsequent wafer. This entry is valid only if the Reset Wafer Number parameter (Line 05) is in Auto mode.

LINE 05 RESET WAFER NUMBER

Select or disable the Reset Wafer Number feature.

Input < 1 > to enable the Auto mode. The wafer number will then be automatically reset to the starting wafer number each time a wafer cassette is completed. The starting wafer number is the value entered for Line 04 of this menu.

Input < 2 > to enable the Manual mode. With Manual enabled, you must use the < RUN ID > key to establish the starting wafer number (see **Section 3.7, Log ID).**

Input < 0 > to disable both Auto and Manual modes. When this feature is disabled, the wafer number stays fixed instead of incrementing.

LINE 06 PRINTER FORMAT

Five printer formats are available for wafer and cassette logs.

Input < 1 > selects standard format, input < 2 >, the short form. Both standard and short forms print a header and the number of good and bad die. The standard form also prints the number of die tested and the number of die in each bin. The total number of die reported probed shown on the log is the same as the tester summary total. (No data is printed for a bin with zero die in it.)

In addition, three unique formats are available using the settings `SPEC1, 80 COL`, and `MAP EDIT.`

The `SPEC1` format is wafer–oriented and only uses test results for bins 0, 1, and 3. All other bins are ignored. The wafer log prints one line which gives the wafer number, ID number, and the current count for the three bins. The cassette log prints header information including device type, lot number, start, end, elapsed time, and number of wafers. This is followed by a list of each wafer with its ID and bin count for each of the three bins, ending with a total count for each bin.

The 80 COL format allows the use of a standard serial 80−column printer instead of the current 20−column printer shipped with the prober. When this format is selected the printer must be set for Auto Line Feed.

The format selection MAP EDIT prints results of reprobed bins on disk−based prober systems. It provides both Edit and Edit−Save strip printer results which detail bin results assigned for reprobe. It also provides enhanced summary printouts for applications where multi−pass testing is done.

Input < 0 > disables the printer format option.

3.4.5 Miscellaneous Options Submenu

The Miscellaneous Options Menu *(Figure 3−20)* is accessed through Line 09 of the Set Mode Menu. Items 01 and 02 are always accessible; items 03 and 04 appear only when AUTO LOAD SWITCH (the Material Handler) is disabled (see **Section 3.3, Set Option Menu**).

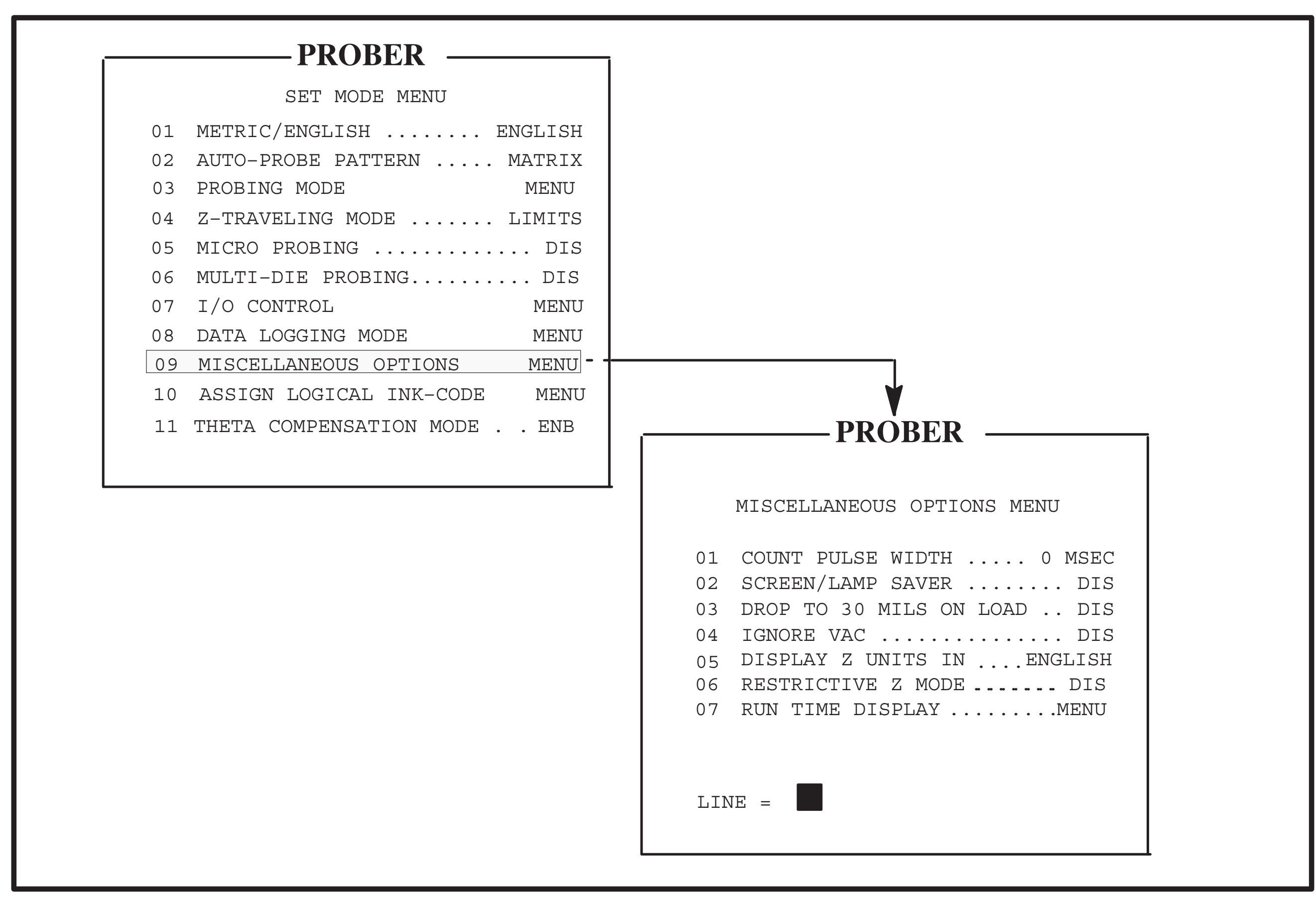


FIGURE 3−20: SET MODE AND MISCELLANEOUS OPTIONS MENU

LINE 01 − COUNT PULSE WIDTH

The prober issues a pulse on the TTL tester interface whenever a test start signal is issued for a new die during probing. The range is 0−50 msecs. The signal is disabled at initialization or by setting it to < 0 >. This has no effect on the test start message from the serial or GPIB interface.

LINE 02 − SCREEN/LAMP SAVER

This line enables/disables a feature which switches off the screen, microscope light, and camera light when no key, joystick, or theta knob has been used for four minutes. Once the screen/lamp has been switched off, when a key is pressed, the screen comes on automatically. Pressing a key may trigger some action, to restore the screen display, press < ENTER >.

LINE 03 − DROP TO 30 MILS ON LOAD

When Material Handling (AUTO LOAD) is disabled, the 30−mil chuck drop can be selected through this line item. Input < 1 > to enable the drop at 30 mils; < 0 > to disable or leave the chuck at 200 mils when the chuck returns to unload. This allows wafers to be removed with tweezers.

When this line is enabled, in the manual load operation the chuck will separate from the wafer very slowly to allow any residual vacuum to bleed off when moving to expose the vacuum pins. This prevents wafer popping during unloading.

LINE 04 − IGNORE VAC

When enabled, this option allows the partial or broken wafers to be Auto Aligned and probed. The prober will not verify that a wafer is on the chuck before performing Auto Align, and it will probe even when chuck vacuum is not sensed.

LINE 05 − DISPLAY Z UNITS IN...

Selecting Line 05 allows Z−related values to be entered into the prober system and displayed as metric values instead of English values.

When the Z metric display is used in step−motor travel, all the Z−related values are displayed with a single digit to the right of the decimal as "###.# um," where "um" denotes micrometers. Any Z value entered from the keyboard will be rounded to the nearest Z motor step (for example, 0.5 mil on a half mil chuck, or 12.7 um).

LINE 06 − RESTRICTIVE Z MODE

(For special applications.)

LINE 07 − RUN TIME DISPLAY

This line provides flexibility for the routine automatic updating of the Run Time Display during probing.

Five items on the Run Time Display can be updated while probing is taking place:

Good, Bad, and Ugly die counts
X, Y Position
Z Position
<– / –> probing direction indicator
The Time

The highest priority is given to displaying the die counts; next is the X, Y, and Z positions. The lowest priority is assigned to the probing direction and time.

Select Line 07 to display the Run Time Display Menu (*Figure 3–21)*, which provides the following options for Line 01, Probing Update Mode:

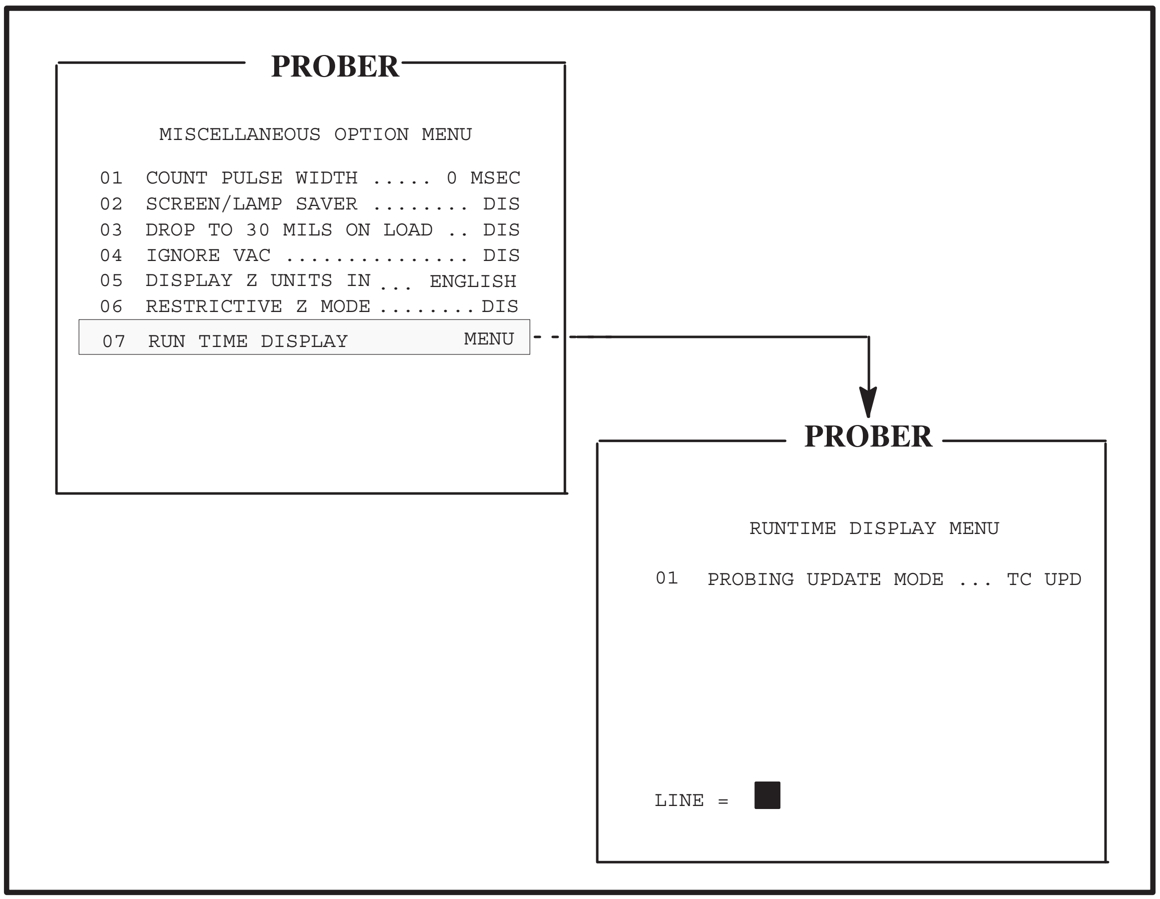


FIGURE 3–21: MISCELLANEOUS OPTIONS AND RUN TIME DISPLAY MENUS

< 3 > – OFF

This mode disables the updating of the five items during probing. In their place, diamonds will be displayed (*Figure 3–22)*.

This provides the fastest operation of the prober for short moves and short test times. In this mode, the prober will never be in the situation of updating the display when it could have been moving or responding to the tester's `TEST COMPLETE`.

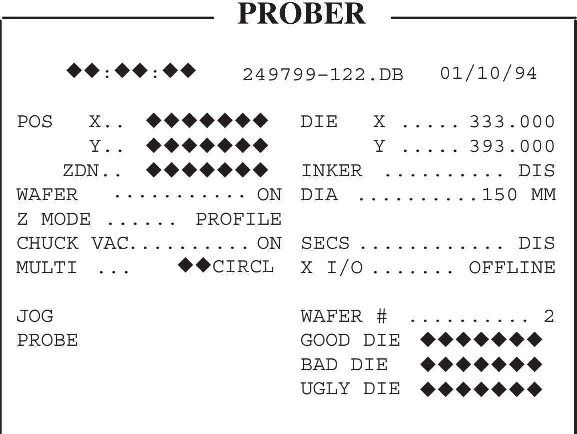


FIGURE 3–22: RUN TIME DISPLAY WITH PROBING UPDATE MODE OFF

< 1 > – NO TC UPDATE

In this mode, the prober will update a single field during each XY motion and the settling time for Z motion, but will not update any fields while waiting for a Test Complete.

In this mode it is possible that XY motion could complete, or that the Z settle time could expire before the field update is finished. Therefore, there may be situations where a little more dead time is created by the prober than was absolutely necessary due to a field update not finishing quickly enough.

< 2 > – TC UPDATE (DEFAULT)

This mode will use the time that the prober spends waiting for a Test Complete to update each of the fields until they all are current.

Each time the prober checks for a Test Complete and there is not one present, the prober will update a single field. After the update, the prober will again check for the Test Complete. This cycle continues until either the Test Complete arrives or all of the fields have been made current on the screen.

In this mode, it is possible that additional dead time can be created by the prober during motion as in the No TC Update mode above, as well as dead time due to starting a field update just before the Test Complete comes in from the tester. In this case, the prober will not respond to the Test Complete until the field update has finished.

NOTE

In both the No TC Update and TC Update modes, there can be fields which are displayed but which are not current. This is because the prober did not have time to make the updates. Only in the Off mode will asterisks be displayed to show the user that the field is not being updated.

The worst case of dead time will occur on those occasions when the prober decides to do an update and immediately after making the decision, the XY motor stops, or the Z settle time expires, or the Test Complete arrives. This means the entire time spent on the update is additional dead time.

The worst case dead time is calculated by estimating that it takes approximately one (1) msec to transmit one (1) character at 9600 baud and that the largest updates require 11 characters or 11 msec to update. **Table 3−2** compares the options.

TABLE 3−2:

COMPARISON OF RUN TIME DISPLAY UPDATE OPTIONS

NUMBER OF FIELDS UPDATED PER DIE TEST CYCLE

Z Travel Mode \ Update Mode	OFF	NO TC UPDATES	TC UPDATES
Limits or Edge Sense	No field updates	1−2 updates depending on size of XY move. **Max deadtime:** **SD = 22 msec** **MD = 33 msec**	1+ updates depending on size of XY move and test time. **Max deadtime:** **SD = 33 msec** **MD = 44 msec**
Profile	No field updates	Maximum of 1 update. **Max deadtime:** **SD = 11 msec** **MD = 22 msec**	1+ updates depending on test time **Max deadtime:** **SD = 22 msec** **MD = 33 msec**

SD = Single Die **MD = Multi−Die**

Multi−Die Probing can cause both the good and bad die counts to be updated in one screen update, causing a longer update time.

3.4.6 Preset Inker Assignment Menu (Assign Logical Ink−Code)

The Preset Inker Assignment Menu (*Figure 3−23*) is accessed through Line 10 of the Set Mode Menu.

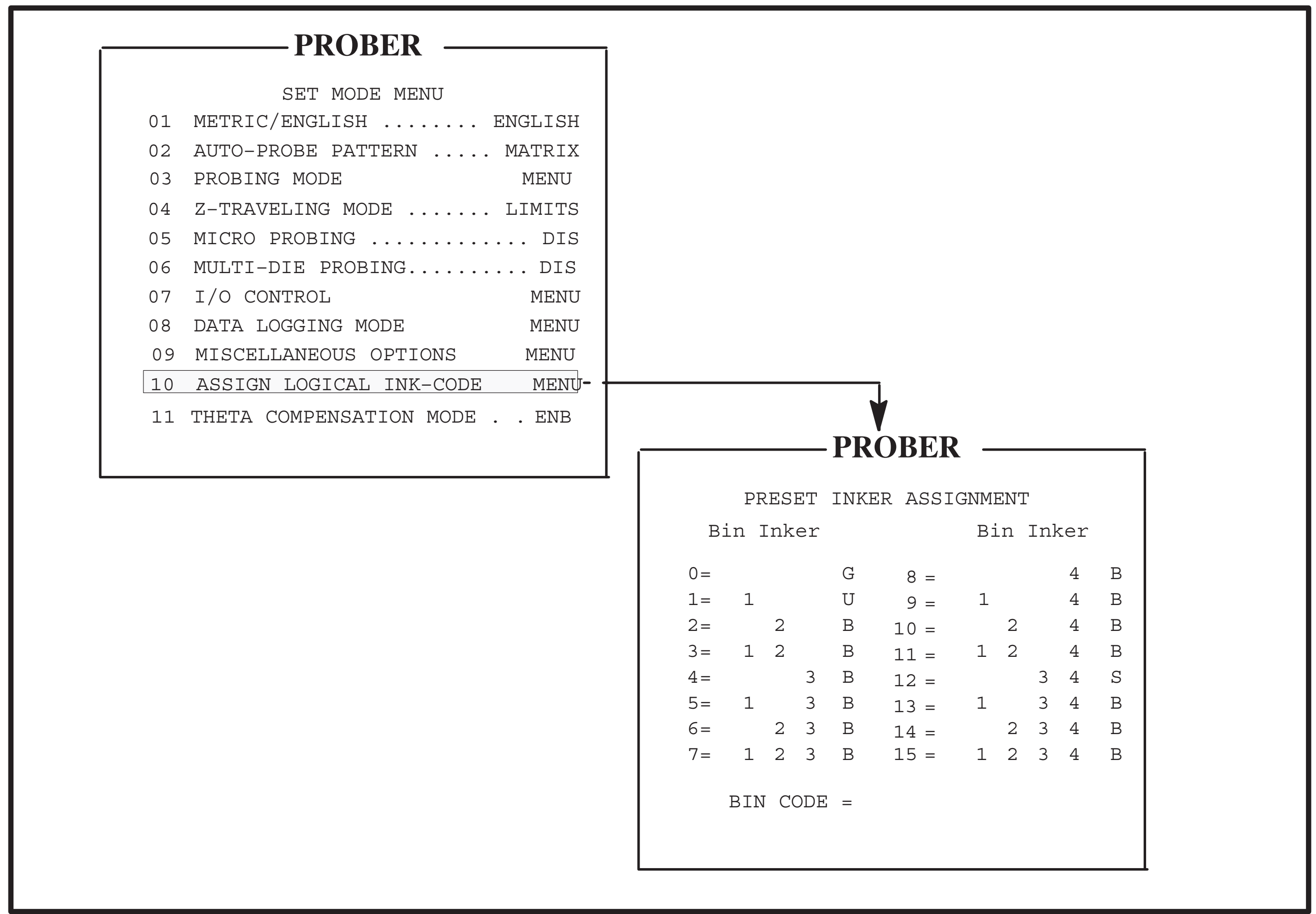


FIGURE 3−23: SET MODE AND ASSIGN LOGICAL INK−CODE MENUS

Except for setting the ugly or skipdie bincodes, all action involving bincodes 0 through 15 is performed through this menu. Bincodes are assigned by the tester to signify a test result and are sent as part of the Test Complete message.

Bin codes are expressed in decimal equivalents. The bin assignment capability is 255 bins. Because bincodes 16−255 use the same inker assignment as bincode 15, it is not necessary to show all 255 (256, including 0) in the Preset Inker Assignment Menu. The tester TTL interface supports bins 0−31 only, since it is limited to five reject lines.

When the Preset Inker Assignment Menu is activated, a prompt (`BIN CODE=`) asks for the selection of a bin code for inker assignment. Enter a value between 0 and 15, and then press < ENTER > to complete the bin code selection and display the inker prompt.

The next prompt is `FIRES INKER(S) =`. Enter a zero (< 0 >) value, or any combination of values between 1 and 4 to assign inkers to the bin code selected. A zero entry assigns No Inking to the bin code and should be assigned to each bin code for which no inker is to be fired. Press < ENTER > to complete inker assignment and display the bin code prompt in preparation for the next entry. Make subsequent entries the same way.

If the ugly or skipdie bincodes are between 0 and 15 inclusive, `U` or `S` is displayed.

Figure 3−23 shows typical entries of default inker assignments. Any inker assignment can be given to any bincode. Duplications are accepted; for example, all the bincodes could be assigned the same inker if desired. The menu in *Figure 3−23* displays an ugly die bincode of 1 and skipdie bincode of 13 (indicating both features are enabled). Assume < 7 > is entered in reply to the `BIN CODE =` prompt. A second prompt appears:

```
BIN CODE = 7
FIRES INKER(S)=
```

If the inker assignment is to remain as is, press < ENTER >. Otherwise, enter any new inker code, for example, 134. Next, the prompt:

```
BIN CODE= 7
GOOD=1  BAD=0
ASSIGNMENT=
```

If the good/bad assignment is to remain, press < ENTER >. Otherwise, choose between the good and bad, as prompted. It is acceptable to assign inkers to good die. Also, die labeled bad are inked only if specifically ordered. Die will be inked based on inker assignment, not good or bad state.

To reassign the skipdie or ugly die bincodes, go to their menus, explained in **Sections 3.4.2.1** and **3.4.2.2**.

The symbols `G` and `B` indicate good and bad. It is necessary to move the ugly or skipdie bincodes to some other bincode prior to reassignment of their bincodes. For example, if bincode 4 is classified as `U` and you want to change the assignment to `G`, you must move `U` to some other bincode, say 11, before the prober allows you to change bincode 4 to `G`. If ugly die inking or skipdie inking are not enabled, only the `G` and `B` are displayed.

3.5 SET PARAMETER MENU

Press the < SET PARM > (< F1 >) key to access the Set Parameter Menu *(Figure 3−24)* which is used to enter values related to wafer characteristics.

Added 6/96

Entering < −99 > in the Set Parameter Menu resets the machine parameters to their default values (including I/O but *not* machine dependent variables). It disables all options, and clears all set and calculated values.

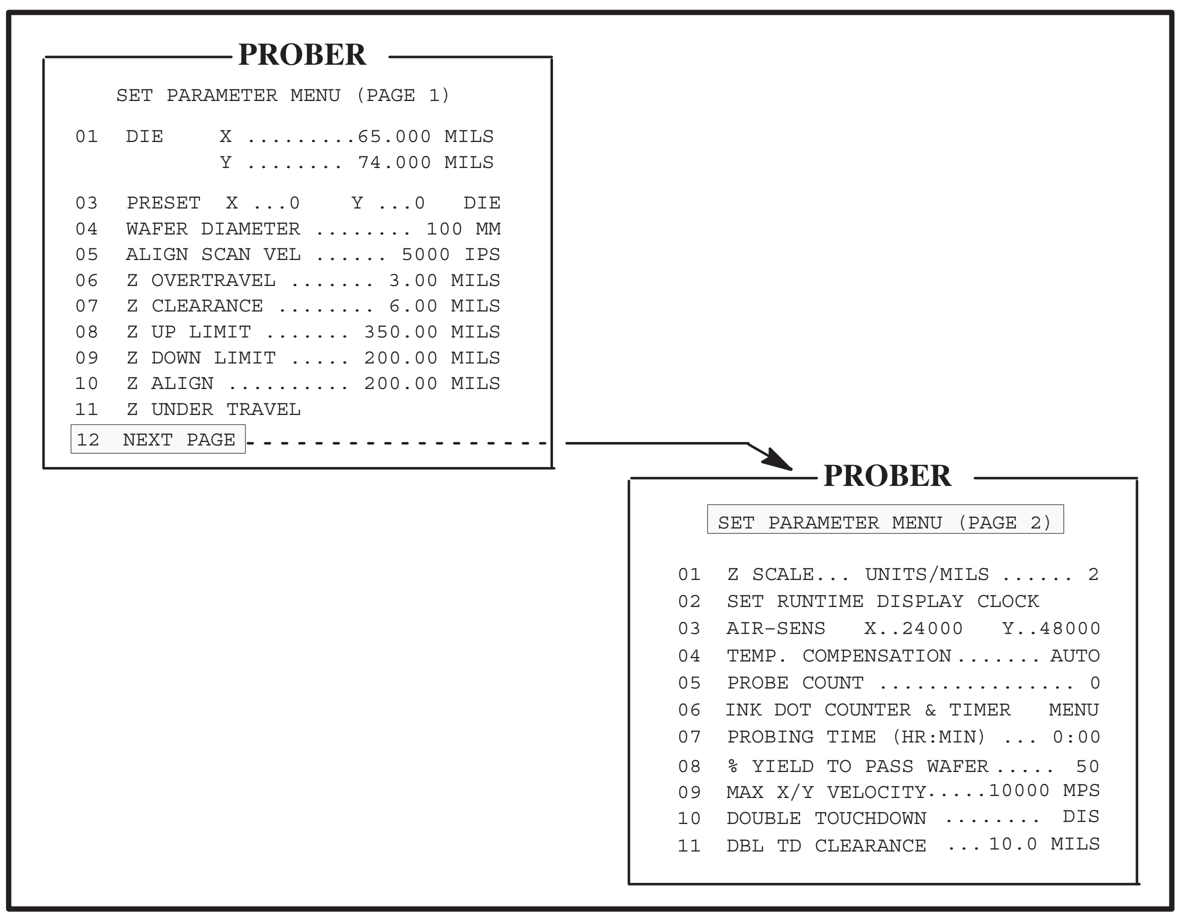


FIGURE 3−24: SET PARAMETER MENU (PAGES 1 AND 2)

NOTE

Most of the entries in this menu require a unit of measure. Therefore, confirm the measurement system displayed in the following line items:

Set Mode Menu Line 01 `METRIC/ENGLISH`
Line 09 `MISCELLANEOUS OPTIONS (Menu)`
Line 05 `DISPLAY Z UNITS IN...`

Set Parameter Menu (Page 2) Line 01 `Z SCALE (UNITS/MILS)`

3.5.1 Set Parameter Menu Line Items (Page 1)

LINE 01 (PAGE 1) DIE X...

LINE 02 (PAGE 1) DIE Y...

Die size is displayed as a function of the significant digits with a floating−point decimal. Seven characters, including the decimal, match the approximately six figures of significance.

NOTE:

As of Software REV DE, die sizes of less than .1 mils can be entered and used.

AFTER you set the Metric/English parameter (**Section 3.4.1),** enter die size dimensions to establish X and Y probe increments. The joystick Index mode advances the same increments.

Enter positive values for X and Y dimensions. The system recognizes mil entries to six digits to the right of the decimal for stepping purposes. Confirm entries by checking the values for Lines 01 and 02 on the screen; seven characters, including a floating decimal point, will be shown.

LINE 03 (PAGE 1) PRESET X... Y... DIE

This line allows you to set the starting name you wish assigned to the First Die, and subsequently, all other die.

Establish the starting coordinate of the First Die as the First Die point, which is activated by pressing the < FIRST > (< F4 >). All other die points are referenced with respect to the First Die. If, for example, die point X=0, Y=0 is selected as the preset value, die points X=10, Y=0 and X=−10, Y=0 are located along the X axis. Both are 10 die from the preset but in opposite directions.

The same physical die are probed but the coordinates assigned to those die can be reassigned by using a non−zero preset value. Any coordinate pair can be assigned. This affects the reported die coordinates only − not the order of probe. In *Figure 3−25,* the same wafer is illustrated, but with different coordinates assigned.

Because X and Y represent a die point, they must be entered as whole values (no decimal). Confirm entries by checking Line 03 on the screen.

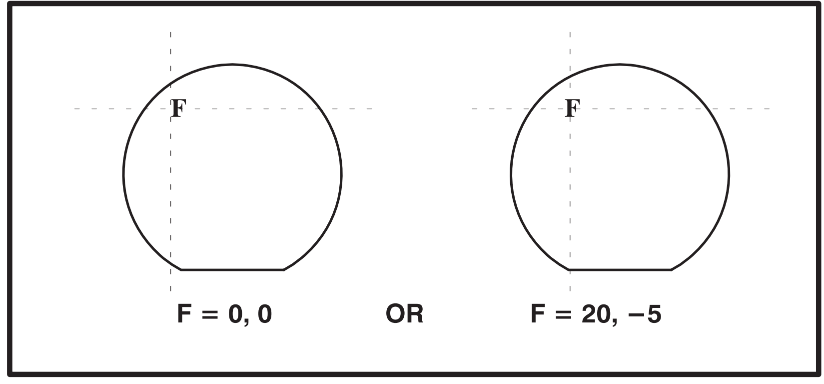


FIGURE 3−25: DIE COORDINATE ASSIGNMENT

LINE 04 (PAGE 1) WAFER DIAMETER

The wafer diameter is used by the system to compute several operation reference points. Diameter entry must be a positive value less than or equal to 200 mm. Attempts to enter a value greater than 200 mm default the system to the 200 mm limit.

NOTE

Wafer diameter is a millimeter entry. Remember, the system does not convert the entry. The operator must enter a millimeter value; however, it is not necessary to be in the Metric mode (Line 01, Set Mode Menu − **Section 3.5.1**) during imput.

LINE 05 (PAGE 1) ALIGN SCAN VEL

Establishes alignment scan rate of travel. The value entered determines the speed the wafer travels during manual alignment. It does not affect the Auto Align speed. Entry must be a positive value between 52 (mils per second − MPS) and 10,000 (MPS).

LINE 06 (PAGE 1) Z OVERTRAVEL

The Z overtravel parameter sets the distance the Z stage will continue traveling upward after contact with the wafer is made; it is used to ensure good pad−to−probe contact.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 07 (PAGE 1) Z CLEARANCE

The Z clearance parameter sets the distance the Z stage will continue traveling downward after contact with the wafer is lost. It is used to guarantee a certain distance between the probes and the wafer when the Z stage is Down and XY motion is taking place.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 08 (PAGE 1) Z UP LIMIT

The Z Upper Limit is used both as a safety limit the stage cannot exceed, and as the Z Upper Limit when the Z Travel Mode is Limit−to−Limit. The Up Limit cannot be set lower than the Down Limit.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 09 (PAGE 1) Z DOWN LIMIT

This setting establishes the maximum downward travel of the wafer chuck.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 10 (PAGE 1) Z ALIGN

The align height parameter sets the height at which Auto Align is performed, setting the Z position relative to the camera lens in order to bring the wafer into good focus on the video screen.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 11 (PAGE 1) Z UNDER TRAVEL

This feature moves the chuck down the number of mils specified after completing the chuck Up movement (including Z overtravel). The motion produces a probe tip scrub effect for each contact.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 12 (PAGE 1) NEXT PAGE

Displays the second page of this parameter list (*Figure 3−24*, line items discussed next).

3.5.2 Set Parameter Menu Line Items (Page 2)

LINE 01 (PAGE 2) Z SCALE UNITS/MILS

Establishes a unit of measure for Z−drive chuck travel.

See **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION**, for more information.

LINE 02 (PAGE 2) SET RUN TIME DISPLAY CLOCK

Selecting Line 02 activates the prompts which first requests the numerical month; the day (limit varies according to the month); the year, in four digits; and the time.

The current time is entered on the basis of the 24−hour clock system, followed by minutes (0−59). Incorrect entry results in a beep and a repeated prompt until reasonable data is entered. Seconds are automatically set to 0.

LINE O3 (PAGE 2) AIR−SENS X... Y...

Establishes X and Y coordinates at the point the chucktop is centered beneath the Noncontact Edge Sensor. Enter coordinates in response to a prompt, but only if you can accurately determine that the coordinates represent the point described above. (The setting X−24000/Y−48000 is a common pair, close enough for the NCES to calculate the actual position.)

The values are automatically updated during the profiling of the bare chuck and setting probe tip center (see **Section 6.2.3, The Profiler Menu**).

LINE 04 (PAGE 2) TEMPERATURE COMPENSATION

Enables the Temperature Compensation feature, recommended for XY motion of a thermal chuck when wafers are five inches or larger in diameter. When the feature is enabled, the Temperature Compensation Menu appears; it is used to change Temperature Compensation parameters which adjust XY motion for heat−induced changes in wafer size.

The menu is described in **Section 7, Z STAGE, HOT CHUCK AND TEMPERATURE COMPENSATION.**

LINE 05 (PAGE 2) PROBE COUNT

Sets a counter which counts the number of probe card touchdowns. It can be set to any value at any time. This is often used to aid in probe card maintenance by tracking usage. The count always increments from its starting value (+ or − number).

LINE 06 (PAGE 2) INK DOT COUNTER AND TIMER MENU

Selection of this line displays the Ink Dot Counter and Timer Menu. Details are discussed in **Section 3.5.3.**

LINE 07 (PAGE 2) PROBING TIME (HR:MIN)

This line displays probing uptime, an indication of how much of the working time actual probing is occurring.

Whenever the prober begins probing, a timer is started. When the prober finishes probing, the timer is stopped, and the elapsed time is added to the time accumulator. The timer then automatically resets. Time is not accumulated when the prober is idle.

To reset the accumulated time to zero, select this line item. A prompt displays, `RESET PROBING UP TIME?` Input `< Y >` for yes or press < ENTER > for no.

LINE 08 (PAGE 2) % YIELD TO PASS WAFER

This line allows you to enter the percentage of a wafer (0 to 100) that must pass testing before it can be accepted as a valid wafer. The formula used to calculate percentage is:

$$\frac{\textbf{Good Die}}{\textbf{Total of Good Die + Bad Die}} \quad \textbf{X 100\% = \% yield to pass}$$

If the wafer fails to meet the percentage specified, at the end of the probe cycle the prober will beep and display the error message PROBE STOPPED DUE TO POOR YIELD. The prober will pause until some operation intervention is performed (from I/O or the operator).

LINE 09 (PAGE 2) MAX X/Y VELOCITY

This controls the speed of the forcer movements in X and Y. The range is from 52 to 10000 mps; the default is 10000.

LINE 10 DOUBLE TOUCHDOWN

LINE 11 DBL TD CLEARANCE

This feature causes the probe tips to touch down on the pads twice on each die before issuing a TS (Test Start) message to the tester. This provides better probe−to−pad contact; by raising the Z stage to contact the wafer with the probe tips twice for each die before testing, the probe tips will break through the oxidation on the pads better, thereby increasing product yield.

When this feature is enabled, for each die on the wafer to be tested, the prober will move the forcer to the die position, then raise the Z stage to the Z Up position in order to make contact between the probe tips and the probe pads. Upon reaching the Z Up position, the prober will then lower the Z stage the user−specified double touchdown clearance (Line 11), then raise the Z stage back up to the Z Up position. At this point, the prober sends the TS message to the tester.

Both the parameters can be set through this menu or via External I/O Interface.

3.5.3 Inker Dot Counter and Timer Submenu

The Inker Dot Counter and Timer Menu *(Figure 3−26)* is accessed through Line 06 of the Set Parameters Menu (Page 2).

During startup and various prober operations, this function checks to see whether the ink dot count limit or the time limit, to the nearest minute, has been exceeded. If exceeded, one of two warning messages is displayed on the monitor indicating by inker number that one or more of the inkers requires servicing.

Three prober functions will cause a warning message if servicing is necessary: INK TEST, TEST CYCLE, and AUTO PROBE.

INK TEST signals after selecting the inker, TEST CYCLE after completing the prober test if INK ENBL is on. AUTO PROBE gives indication just before entering the Auto probe mode.

If the limit is exceeded while in the Auto probe mode, the current wafer is completed before the prober becomes inoperable. Prober operation cannot proceed until the inkers are serviced and reset.

The displays on the Inker Dot Counter and Timer Menu are explained next.

The inker **DOT COUNT**, the total number of times an inker has been used, is read only and is reset at the same time as the inker timer.

The **TIME ELAPSED** and **TIME LEFT** displays indicate the timing information for each of the inkers. If an inker is disabled, the dot count and time information are not displayed (*Figure 3−26B*).

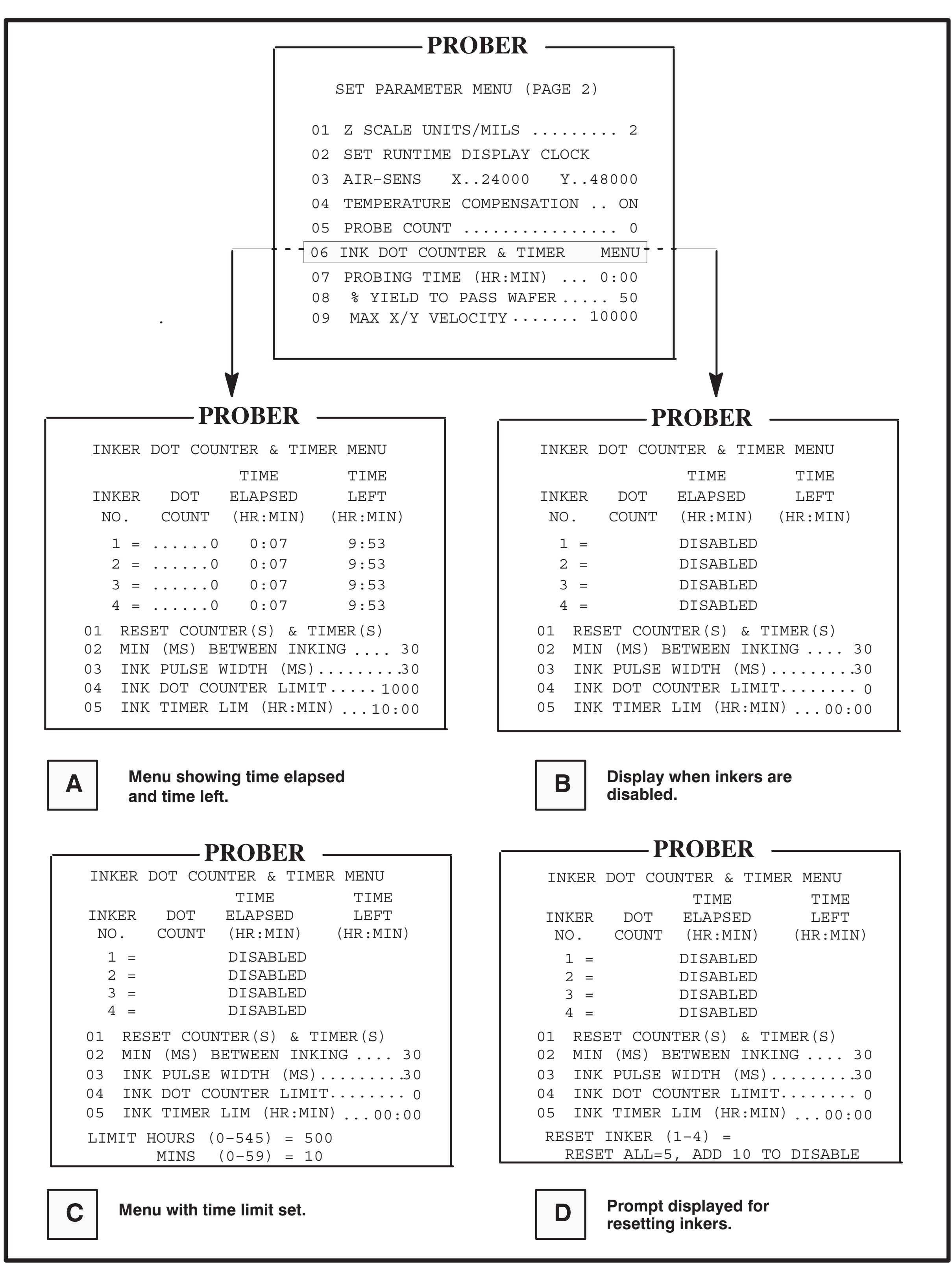


FIGURE 3–26: INK DOT COUNTER AND TIMER MENU AND VARIATIONS

Figure 3−26C shows the setting of the time limit. The maximum time that can be set is 545 hours, 59 minutes (22 days, 17 hrs, 59 mins). The time limit applies to all four inkers.

Once the limits are set, one or all the inkers can be set or reset.

Line 01, RESET COUNTERS & TIMERS, displays the prompt shown in *Figure 3−26D*. Entering < 5 > resets all four inkers; entering < 1 > − < 4 > resets the individual inkers. If an inker needs to be disconnected from its timer after setting, add 10.

For example, if inker 3's timer is to be disabled, enter < 13 > (3 + 10). If all inkers timers are to be disabled, enter < 15 >.

Line 02, MIN (MS) BETWEEN INKING (which may also be set from the Post Probe Inker Setup Menu) is the minimum time between inker activations. The range is 0 to 999, and the default is 30.

Line 03, INK PULSE WIDTH, sets the length of time the inkers are to be activated, a range of from 5 to 30 (default) milliseconds. This must be set correctly for the type of inker installed. Some inkers can respond faster than others. If Pulse Width is set too fast, inking will be unpredictable.

To set or reset an inker, both Lines 04 and 05, the INK DOT COUNTER LIMIT and the INK TIMER LIM, must be *non*−zero. If either of the two items is zero, the other is automatically linked and reset to zero.

3.6 LEARN, ROW, AND MICRO MENU

Press the < LEARN > (< F7 >) key to display the Learn, Row, and Micro Menu, a full−screen list editor, used to enter specific die points and microdie coordinates and site numbers in memory.

The basic menu (*Figure 3−27A)* offers three lists with two choices for each: a particular list can be entered, or the entire list can be cleared (*Figure 3−27B*). Details are given in the next section.

The stored data is used with probing patterns based on the order of die point or row entry. The instrument may be instructed to probe only the stored data or to skip over the stored data during probe operation (see **Section 3.4.2.1, Inking Mode**).

The maximum size of the learn list is 5K of elements and is stored at the end of the battery−backed RAM. A Cyclic Redundancy Code (CRC) check is performed during power−up and prior to storing the learn list. Short lists (less than 1K of elements) are preserved over power cycles. If the CRC check on a long list (over 1K) is valid, it is preserved; otherwise the learn list is considered empty.

PROBER

```
LEARN LIST

LIST  NUM    X          Y

CHUCK POS  ....-4    ....-1

FIRST DIE NOT SET
ALIGN FIRST DIE WITH PROBE ARRAY
JOYSTCK=XY Z=UP/DN D=ALIGNED
```

A Prompt to set first die, if not already set.

PROBER

```
LEARN LIST

LIST  NUM    X          Y

CHUCK POS  ....-4    ....-1

FIRST DIE SET
```

B Screen display for successful setting of first die.

PROBER

```
LEARN LIST

LIST  NUM    X          Y

CHUCK POS  .....0    .....0

VERIFY CORRECT FIRST DIE
  1=YES  0=NO       ENTER=EXIT
CHOICE =
```

C First die has already been set; prompt requests verification.

PROBER

```
LEARN LIST
ADD TO END OF LIST
LIST  NUM     X          Y
        1  .....1     ....11
        2  .....2     ....22
        3  .....3     ....33
        4  .....4     ....44
        5  .....5     ....55
        6

CHUCK POS  .....0     .....0
CURSOR: USE ARROW KEYS   Q=GOTO
KEYBOARD TYPE VALUE, ENTER=EXIT
JOYSTICK=INDEX TO DIE & L=STORE
```

D Learn List – set up for action.

PROBER

```
ROW LIST
ADD TO END OF LIST
NUM LOCATION    1ST DIE LAST DIE
 2 ROW.....2     ....10  .....0
 3 ROW.....3     ....-2  ....12
 4 ROW.....4     ....12  ....-2
 5 ROW.....5     ....-4  ....14
 6
           X          Y
CHUCK POS  .....0    .....0

CURSOR: USE ARROW KEYS       Q=GOTO
KEYBOARD  ROW>0  COL=0     ENTER=EXIT
JOYSTICK=INDEX TO 1ST DIE & L=STORE
```

E Row List – set up for action.

PROBER

```
MICRO SITE LIST
ADD TO END OF LIST
LIST  NUM     X          Y
        1  ..1517     ..-173
        2  ..2181     ..-421
        3  ..2189     ..-517
        4  ..1805     ..-493
        5  ..1869     ...243
        6

CHUCK POS  ..1877     ...587
CURSOR: USE ARROW KEYS   Q=GOTO
KEYBOARD TYPE VALUE, ENTER=EXIT
JOYSTICK=INDEX TO DIE & L=STORE
```

F Micro Site List – set up for action.

FIGURE 3–27: LEARN, ROW, AND MICRO MENU PROMPTS

3.6.1 List Line Items and Alternatives

When the Learn, Row, and Micro Menu is accessed, the prompt “Choice=” appears toward the bottom of the screen (*Figure 3−27C*). There are six different lines that may be selected.

- The Learn List will be used to illustrate manipulation of all lists since there are only minor differences between them.
- The Row List differs in input structure since a begin and end die need to be entered to create a row or column.
- The Micro List differs only in the magnitude of the entered numbers since they are in machine unit increments (0.0001 in.). The other two lists display the X and Y offset from the First Die in die units.

Values are entered either from the keyboard or by moving to the required die by joystick and pressing < STORE > < F5 >. The joystick, while in the Learn and Row Lists, will only move the chuck in the Index mode even if the Joystick switch is in the Jog or Scan modes.

In the Micro List, the Index mode is suppressed; Jog and Scan are available to make it easier to move slowly across a die.

Z travel up and down is allowed when entering die positions into a Learn, Row, or Micro list, making it possible to determine where the pads line up with the probe tips.

3.6.1.1 KEY COMMANDS

When the List Editor is accessed with the < LEARN > key, the alphabet printed on the edge of the key caps on the keyboard is used to achieve the desired action. When a particular list has been selected, the cursor position is marked by a reverse video input box.

The cursor is controlled by an inverted “T” arrangement consisting of the < B >, < X >, < F >, and < G > keys:

< X > moves the cursor toward the left
< G > moves the cursor toward the right
< B > moves the cursor upwards
< F > moves the cursor downwards

Other key action:		
	< FIRST > (< D >)	Sets the First Die
	< RUN ID > (< I >)	Inserts
	< DELETE > (< P >)	Deletes
	< DIG VID > (< Q >)	Performs GOTO (a means of rapidly going to a particular list element)
	< STORE > (< L >)	Enters List elements

In addition, the numeric pad and the input editing keys (< CE >, backspace) and < ENTER > are also active.

3.6.1.2 LIST FORMAT

Each list, when newly entered, displays from top to bottom the list ID, the list header, the chuck position, and either of two messages in the dialog area.

If the First Die is not set, the dialog area prompts to set First Die (*Figure 3−27A*). After First Die has been set, the prober beeps, and the screen displays the message: `FIRST DIE SET` for two seconds (*Figure 3−27B*).

If First Die is already set, the chuck automatically moves under the probe array, and a prompt requests verification of First Die *(Figure 3−27C*). If the correct die isn't under the probe array, press the < 0 > key to enable the First Die alignment procedure.

Once First Die is set, the list automatically sets up for the action Add To End Of List. See *Figures 3−27D, −27E,* and *−27F* for examples of each of the three lists.

3.6.1.3 DISPLAYS AND ACTION

There are four possible actions: Add, Modify, Insert, And Delete. Insert and Delete are only possible from the Modify action. *Figures 3−28A, −28B,* and *−28C* show the three possible Add displays.

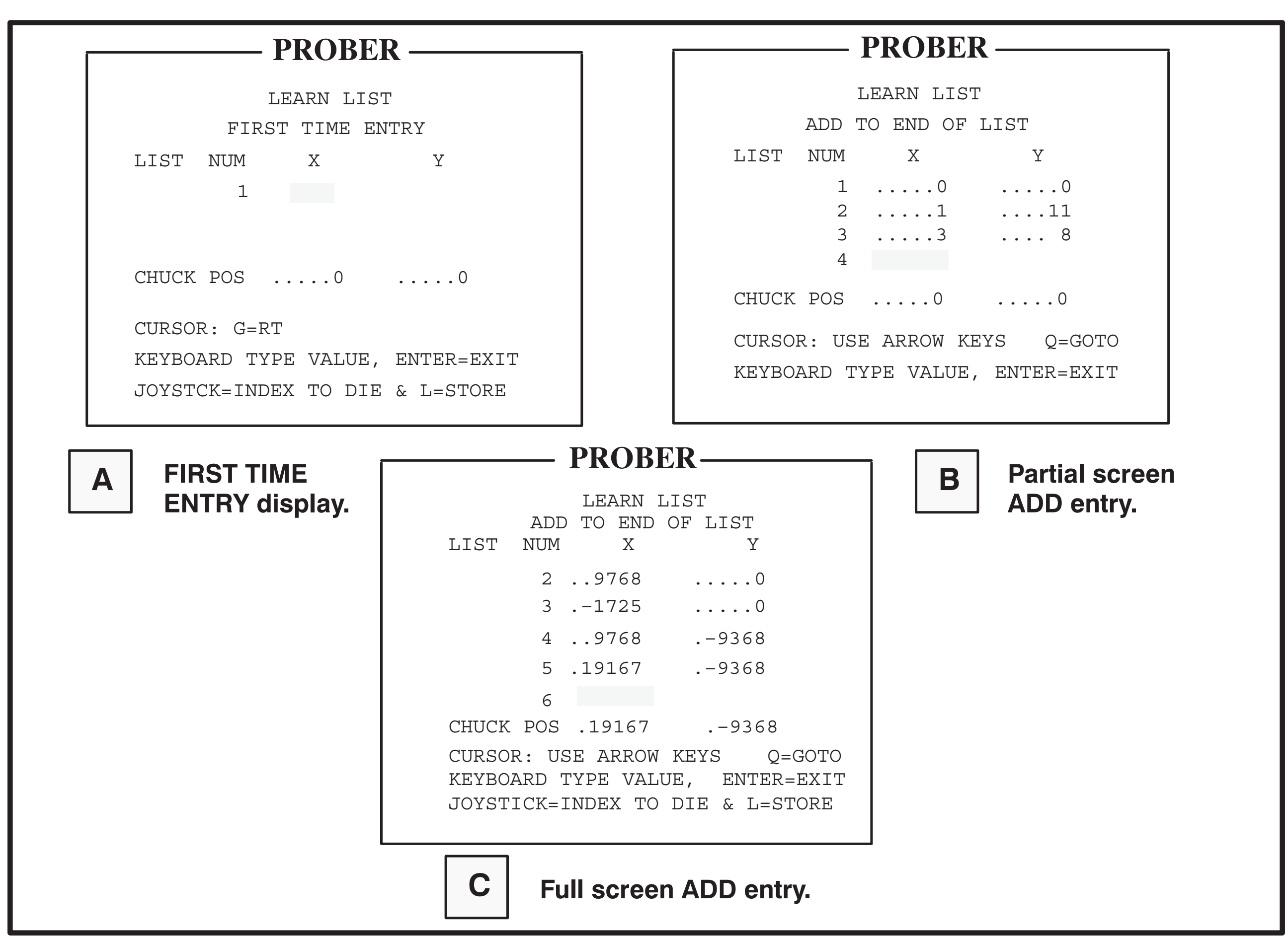


FIGURE 3−28: FIRST TIME ENTRY AND ADD DISPLAYS (LEARN LISTS)

Figure 3–28A shows a First Time Entry display. *Figure 3–28B* shows a partial screen Add entry, and *Figure 3–28C* shows a full screen Add entry. Note that the list scrolls when more than a partial screen of list members is available. Either enter the value or move the desired die under the probe array by joystick and press < STORE > to enter list elements. After the values are typed in, the cursor will automatically advance to the next field. Note that joystick entry is only allowable when the cursor is in the leftmost field.

The Row List entry is slightly more complicated. *Figures 3–29A, –29B, –29C,* and *–29D* show the sequence to enter the First Die in the row or column and the last die in the row or column by joystick. Keyboard entry differs in that the row or column is entered, then the row or column location, then the First Die position, followed by the last die position.

Press GOTO (< Q >) to display a prompt asking for the list position to go to (*Figure 3–30A*). After the desired position is entered (*Figure 3–30B*), the cursor will move to that position (*Figure 3–30C*) and the action changes to Modify. *Figure 3–30D* shows a typical Modify Learn List display. In this mode, list entries are made the same as in Add, but the cursor is not automatically advanced to the next field.

While in Modify, the other two actions, Insert and Delete, are accomplished by pressing the < I > and < P > keys. *Figure 3–30E* shows the Insert display. Entry is made the same way as Add. *Figure 3–30F* displays Delete. A prompt gives you a chance to change your mind; once deleted, the entry is destroyed.

To leave any of the lists, return to the end of the list and press the < ENTER > key.

```
PROBER
          ROW LIST

  NUM LOCATION  1ST DIE LAST DIE

              X           Y
CHUCK POS  .....0    .....0

VERIFY CORRECT FIRST DIE
1=YES  0=NO       ENTER=EXIT
CHOICE =
```

A **VERIFY FIRST DIE display.**

```
PROBER
          ROW LIST
       FIRST TIME ENTRY
  NUM LOCATION  1ST DIE LAST DIE
   1

              X           Y
CHUCK POS  .....0    .....0

CURSOR: USE ARROW KEYS
KEYBOARD  ROW>0 COL=0  ENTER=EXIT
JOYSTICK=INDEX TO 1ST DIE & L=STORE
```

B **FIRST TIME ENTRY display.**

```
PROBER
          ROW LIST
       ADD TO END OF LIST
  NUM LOCATION  1ST DIE LAST DIE
   1  ROW.....0   .....0   .....7
   2
              X           Y
CHUCK POS  .....7    .....0

CURSOR: USE ARROW KEYS       Q=GOTO
KEYBOARD  ROW>0 COL=0     ENTER=EXIT
JOYSTICK=INDEX TO 1ST DIE & L=STORE
```

C **ADD display.**
Move to a die, press < STORE >.

```
PROBER
          ROW LIST
       MODIFY LIST VALUES
  NUM LOCATION  1ST DIE LAST DIE
   1  ROW.....0   .....0   .....7
   2  ROW.....4   .....1   .....9
   3  ROW.....6   ....-2   .....6
   4  ROW
              X           Y
CHUCK POS  .....0    .....0

GOTO:
  ENTER LIST POS: 1
    END OF LIST = 4
```

D **MODIFY display.**
Press < Q >to select row to modify.

FIGURE 3–29: ROW/COLUMN LIST ENTRY SEQUENCE

```
PROBER
           LEARN LIST
        ADD TO END OF LIST
LIST   NUM      X          Y
         6   .....6     ....66
         7   .....7     ....77
         8   .....8     ....88
         9   .....9     ....99
        10   ....10     ..1010
        11   ....11     ..1111
        12
CHUCK POS   .....3    .....5

GOTO:
   ENTER LIST POS:
      END OF LIST =  12
```

A Prompt for list position.

```
PROBER
           LEARN LIST
        ADD TO END OF LIST
LIST   NUM      X          Y
         6   .....6     ....66
         7   .....7     ....77
         8   .....8     ....88
         9   .....9     ....99
        10   ....10     ..1010
        11   ....11     ..1111
        12
CHUCK POS   .....0    .....0

GOTO:
   ENTER LIST POS:  1
      END OF LIST =  12
```

B Position is entered.

```
PROBER
           LEARN LIST
       MODIFY LIST VALUES
LIST   NUM      X          Y
         1   .....1     ....11
         2   .....2     ....22
         3   .....3     ....33
         4   .....4     ....44
         5   .....5     ....55
         6   .....6     ....66
         7   .....7     ....77
CHUCK POS   .....0    .....0

CURSOR: USE ARROW KEYS   Q=GOTO
KEYBOARD TYPE VALUE,I=INS P=DEL
JOYSTICK=INDEX TO DIE & L=STORE
```

C Cursor moves to that position.

```
PROBER
           LEARN LIST
       MODIFY LIST VALUES
LIST   NUM      X          Y
         3   .....3     ....33
         4   .....4     ....44
         5   .....5     ....55
         6   .....6     ....66
         7   .....7     ....77
         8

CHUCK POS   .....0    .....0
CURSOR: USE ARROW KEYS    Q=GOTO
KEYBOARD TYPE VALUE, I=INS P=DEL
JOYSTICK=INDEX TO DIE THEN STORE
```

D Typical MODIFY display.

```
PROBER
           LEARN LIST
       INSERT WITHIN LIST
LIST   NUM      X          Y
         6   .....6     ....66
         7   .....7     ....77
         8
         9   .....9     ....99
        10   ....10     ..1010
        11   ....11     ..1111
        12
CHUCK POS   .....0    .....0
CURSOR: USE ARROW KEYS
KEYBOARD TYPE VALUE, ENTER=EXIT
JOYSTICK=INDEX TO DIE & L=STORE
```

E INSERT display.

```
PROBER
           LEARN LIST
       DELETE LIST ENTRY
LIST   NUM      X          Y
         6   .....6     ....66
         7   .....7     ....77
         8   .....8     ....88
         9   .....9     ....99
        10   ....10     ..1010
        11   ....11     ..1111
        12
CHUCK POS   .....0    .....8

ARE YOU SURE?
  ENTRY WILL BE DESTROYED
   TYPE  Y=YES    ENTER=NO
```

F DELETE display.

FIGURE 3–30: LEARN LIST DISPLAYS

3.7 LOG ID

The Log ID is used to clear printer log data and assign lot identification to products not using OCR or Backside Bar Code Reader. Press < RUN ID > (< F3 >) to display the first line of the instruction sequence.

Log ID inputs are entered prior to probe operation. You can also access this sequence manually during the probe process; press < PAUSE/CONT > to halt the prober, then press the < RUN ID > key. After exiting this display, press < PAUSE/CONT > again to resume the normal probe sequence.

For each of the following four items, the response to the prompt triggers the next line.

1. **CLEAR ALL LOG DATA** (maintain or clear the present log):.

   To maintain the current logged data, press < ENTER >.

   To clear log data, press < Y > (yes). This only affects totals on printouts, clearing die totals and percentages, but not wafer number, device type, or lot number. These are altered by the next three items.

2. **SET THE CURRENT WAFER NUMBER**

   This is the value that appears on the Run Time Display. The number will increment one count for each wafer probed. Two responses are possible:

   o Press < ENTER > to use the existing value, if there is one, as the initial wafer number, or

   o Enter a positive numeric value for the initial wafer number, and then press < ENTER > to complete the input.

   This new number will be incremented when a wafer is loaded to the chucktop.

3. **ASSIGN A NAME FOR THE DEVICE TYPE**

   This item is used in place of the Optical Character Recognition (OCR).

   o Press < ENTER > to retain the existing device type name, if there is one, or

   o Enter a new name of up to 10 characters. The name can include any combination of alpha, numeric, or special characters.

NOTE

Do *not* enter a space – to do so will cause Wafer Mapping to fail.

Press < ENTER > to complete the input.

4. ASSIGN A LOT IDENTIFICATION NUMBER

This item also is used in place of the OCR.

- o Press < ENTER > to retain the present lot identification number, if one exists, or
- o Assign a new lot identification number, up to 10 characters long. This string can include any combination of the alpha, numeric, or special characters.

NOTE

Do *not* enter a space – to do so will cause Wafer Mapping to fail.

Press < ENTER > to complete the input, exit the Log ID sequence, and return the system to the Run Time Display.

3.8 PRINT LOG

Print Log is contains printing instructions relating to the Wafer Log and Cassette Log for systems with external printers.

Current log data can be requested and printed at any time. Press < PAUSE/CONT >, then press < PRINT > (< F8 >) to interrupt probing and display the first question.

Generally, print instructions are entered to provide the current status of a particular wafer and/or the cassette. (See **Section 3.8.1, Print Log Summaries,** for more information.)

This feature operates as a separate entity independent of enabled/disabled status of the print parameters described in **Section 3.4.4, Data Logging Mode Menu.**

Press < PRINT > to display the first instruction.

1. PRINT THE WAFER LOG

- o Press < Y > (yes) to print the current Wafer Log. This includes die totals, percentages, device type, wafer number, lot number, the date, and starting time, or
- o Press < ENTER > to bypass the printout option. Either reply displays the next instruction.

2. PRINT THE CASSETTE LOG

- o Press < Y > to print the current Cassette Log. The data type is identical to the Wafer Log printout, except that totals and percentages are based on current cassette totals, or
- o Press < ENTER > to bypass the Cassette Log printout option. Either response returns the system to the Run Time Display.

3.8.1 Print Log Summaries

Instructions to print wafer and/or cassette log summaries are initiated from either of two sources. The instruction sequence (**Section 3.8 − Print Log**) halts the normal probe sequence and prints accumulated log subtotals. Enabled, the print parameters (**Section 3.4.4 − Data Logging Mode Menu**) print end−of−wafer and/or end−of−cassette summaries.

The type of log data supplied for any of the summary conditions is the same. Totals and percentages vary according to summary function. Each summary is identified by the summary heading Wafer Log or Cassette Log.

3.8.1.1 WAFER LOG SUMMARY

The Wafer Log Summary sends 20 columns of data per line to the external printer. The three lines following the heading (reading bottom to top on the printout) are the wafer number, device type, and lot number.

Remember, the wafer number represents the current wafer in relation to some value assigned as the initial wafer number. Each time a wafer is probed, the wafer number is incremented by one. Wafer numbers are not tied to slot numbers.

The next five lines print good die total and percentage, and bad die total and percentage, for any used bincode from 0 to 15. Wherever good and bad die counts are reported, the ugly die count is also reported if ugly die inking is enabled. The total number of die reported probed on the printout is the same as the tester summary total. (No data is printed for a bin with zero die in it.)

All percentage calculation printouts are based on the individual bin total and total die. When the option `INK DIES NOT REPROBED` is enabled (Line 08, Wafer Mapping Menu, Page 1, **Section 10, WAFER MAPPING AND SECS**), only die bins assigned for reprobe are printed.

The final two lines, appearing at the top of the printout, give a probe starting and ending time which parallel the Run Time Display clock. The starting time is the beginning of the probe sequence, the ending time is at the end of the probe sequence/print.

The ending time is not calculated until the last line is printed; yet *probing* actually ended before the printing started. Printing takes approximately four to six seconds.

3.8.1.2 CASSETTE LOG SUMMARY

Cassette Log data is printed in a modified format. Following the heading are the Device and Lot Number Identification.

3.8.2 Print Error Messages

In addition to the Wafer and Cassette Log, a number of system−related error messages can also be printed if the `PRINT ERROR MESSAGES` parameter is enabled (**Section 3.4.4, Data Logging Mode Menu**).

3.9 PROFILER MENU

The Profiler Menu (*Figure 3−31*), accessed by pressing < PROG > (< F5 >), sets characteristics such as Z reference height, probe tip cleaning height, probe tip reference center and activates the Noncontact Edge Sensor after it has been enabled.

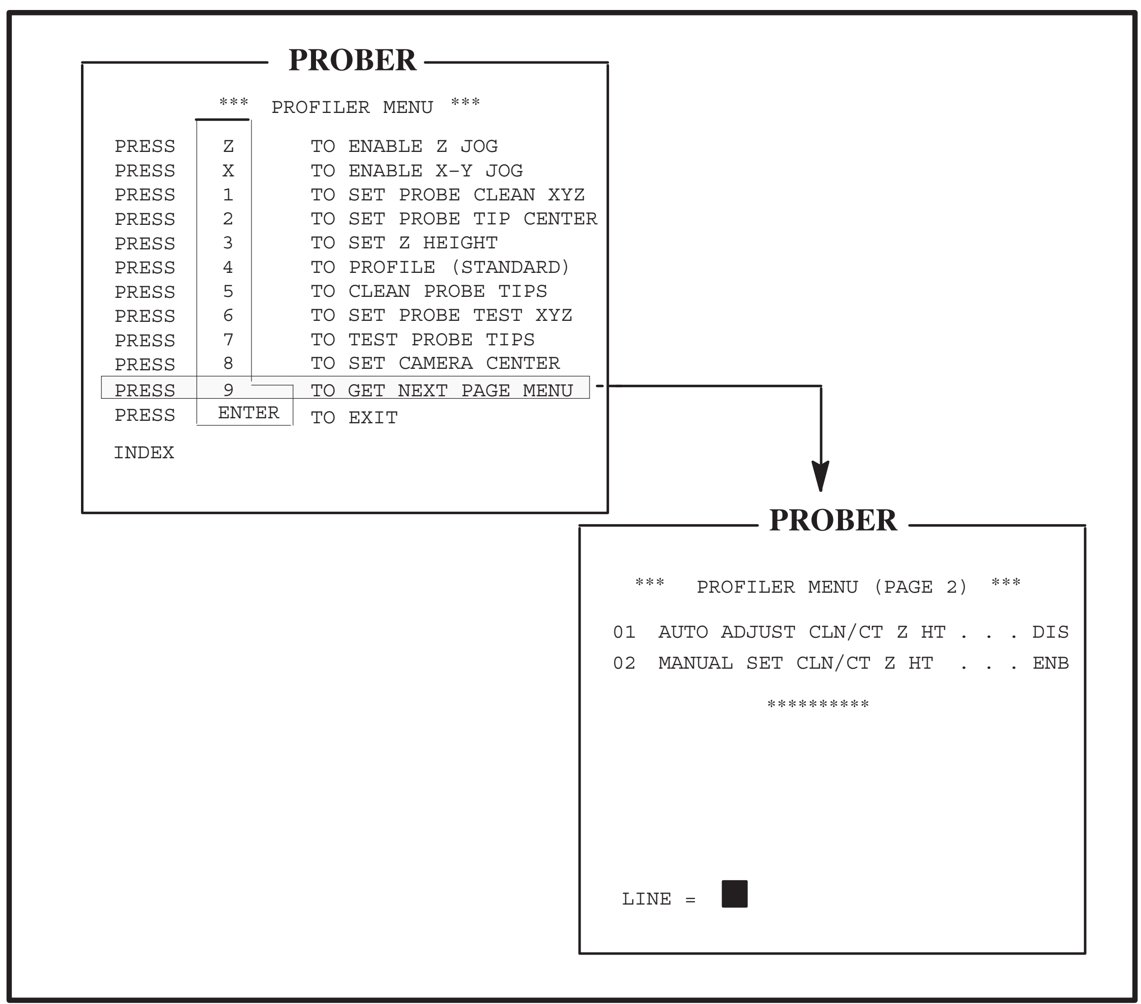


FIGURE 3−31: THE PROFILER MENU

In contrast to other menus, the Profiler Menu is used to initiate some action rather than to enter data or choose an option. < ENTER > is used only to exit the menu.

The Profiler Menu line items are explained fully in **Section 6, NONCONTACT EDGE SENSOR**.

Following is a brief explanation of the Profiler Menu line items:

TABLE 3–3: PROFILER MENU ACTIONS

Menu Item	Initiates Action	Result of action / comments
PRESS Z TO ENABLE Z JOG	Enables joystick control of Z chucktop travel.	Moves in .5 mil increments (.25 mil for the 1/4 mil Z stage).
PRESS X TO ENABLE X-Y JOG	Resumes normal XY joystick control after Z Jog is enabled.	The current joystick mode is displayed on the screen.
PRESS 1 TO SET PROBE CLEAN XYZ	To set cleaning height: position probe tip over cleaner plate; enable Z Jog; bring tip in contact with the plate. Press <1> to set.	Retains X, Y, Z coordinates in memory for future probe cleaning. **NOTE:** Setting Z height after the clean position clears the clean position. A display message informs you each time the clean position is cleared or stored.
PRESS 2 TO SET PROBE TIP CENTER	Stores center reference. Use joystick to align probe tip with center of chucktop. Press < 2 > to set.	The center reference is used during align scan and for circular probe pattern computations.
PRESS 3 TO SET Z HEIGHT	Use joystick to move wafer under the probe tip. Raise wafer until it contacts probe tip. Press < 3 > to set height.	The Z height is established to initialize a profile correction factor. **NOTE:** Whenever the probe Z height is set, the probe tip clean and probe tip test positions must be reset. A display message informs you each time the clean or test positions are cleared or stored.
PRESS 4 TO PROFILE (STANDARD)	Advances the wafer under the NCES and executes the profile sequence.	
PRESS 5 TO CLEAN PROBE TIPS	Moves the cleaner under the probes, cleans the tips, and returns the motor to the starting position.	

TABLE 3–3: PROFILER MENU ACTION (continued)

Menu Item	Initiates Action	Result of action / comments
PRESS 6 TO SET PROBE TEST XYZ	To set the XYZ position of the test area: position probe tip over cleaner plate; enable Z Jog; bring tip in contact with the plate. Press < 6 >.	The continuity test for the probe tips allows the tester to bring an electrically–conductive area in contact with the probe tips in order to run a special test program. **NOTE:** Setting Z height after the test position clears the test position. A message displays informing you each time the test position is cleared or stored.
PRESS 7 TO TEST PROBE TIPS	Enables the user to start the continuity test manually.	You must press < 6 > first.
PRESS 8 TO SET CAMERA CENTER		Used with Teach Die Corner function.
PRESS 9 TO GET NEXT PAGE MENU		Displays Page 2 of Profiler Menu.
PRESS ENTER TO EXIT		Returns to Run Time Display.
PAGE 2		
01 AUTO ADJUST CLN/ CT Z HT	Enables automatic adjustment of probe tip clean and continuity test heights.	Whenever probe tip Z height is set to new height, prober will automatically adjust cleaning and continuity test heights to same setting.
02 MANUAL SET CLN/ CT Z HT	When enabled, disables settings of probe tip clean and continuity test heights.	Items representing keys < 1 > and < 6 > will be deleted from the Profiler Menu display.

3.10 DISK MENU

The Disk Menu (*Figure 3−32*) is accessed by pressing the < DISK > (< F2 >) key.

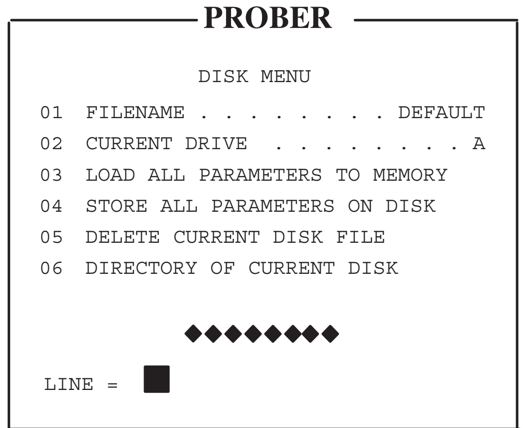


FIGURE 3−32: DISK MENU

3.10.1 Disk Menu Line Items

LINE 01 FILENAME

Legal file names are from one to eight letters or numbers long. Some examples are:

File Name	Comment
MYFILE	OK
TESTFILE17	Bad − more than eight characters
X	OK

LINE 02 CURRENT DRIVE

When this menu line is accessed, the operator is prompted to enter the letter of the disk drive to be used for subsequent disk operations.

NOTE

Currently, only drives A, B, or C may be specified.

Drive A is used to start the system from power up and will always be the initial drive displayed thereafter. Drive A is also the logical drive to hold prober setup files. Typically, there is room for more than 50 different setup files on the system disk, depending on the setup file size and information stored.

The second drive letter designation will be a B or C, depending on the Disk Assembly.

LINE 03 LOAD ALL PARAMETERS TO MEMORY

Accessing Line 03 causes the prober to immediately load from disk and store in the prober's memory the data from the drive currently specified. If Auto Align data was stored in the file, Auto Align will be initialized and loaded with the video image(s). A message displays at the bottom of the screen indicating what data is being loaded (for example, parameters, learn List, Row List, Micro List). Note that if there was no data *stored* for the Learn and Row Lists and for Auto Align video, whatever is currently in the prober memory for these items will *not* be destroyed.

Following the loading of a parameter file, the prober reinitializes the RS−232 port, the SECS port, and all Z−related values as well as all optional devices (those enabled/disabled in the Set Option Menu). Any device enabled but not installed is disabled, except printer options.

LINE 04 STORE ALL PARAMETERS ON DISK

When Line 04 is accessed, the prober immediately stores the data in the prober's memory to the disk and file currently specified. Parameters are always stored. The Learn, Row, and Micro lists are stored only if they are not empty. The alignment reference target data is stored only if it has been set up; if not, no data will be stored for it.

Ink Dot Inspection and Probe Mark Inspection information and data will also be stored if they have been set up and training is complete. Also, the status of the OCR option (Enabled/Disabled) and the type of OCR (EG−OCR/OCR/Backside Bar Code Reader) is saved.

LINE 05 DELETE CURRENT DISK FILE

Deletes file according to file name and drive specified.

If Line 05 is accessed, the file specified by the current drive and file name will be deleted. The operator is given a warning:

```
ARE YOU SURE (Y/ENTER)?
```

NOTE

Electroglas recommends that diskettes always be write−protected, and that *ONLY* trained and qualified personnel store or delete files.

LINE 06 DIRECTORY OF CURRENT DISK

Line 06 displays a list of the files stored on the selected diskette (*Figure 3−33*). Only prober parameter files are displayed; the various system files are not shown to avoid possible confusion, nor are Wafer Maps displayed.

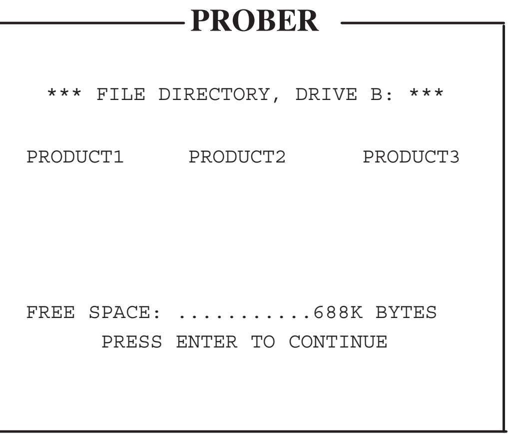


FIGURE 3−33: DIRECTORY OF FILES

Attempting a directory of an unformatted disk will result in a display of the message:

#12 − READING PROBLEM

If you try a directory of a double−density DOS−formatted disk, you will see the message:

#22 − WRONG DISK FORMAT.

However, a directory of a DOS high density formatted diskette triggers the READING PROBLEM message instead of WRONG DISK FORMAT (as with double−density diskettes).

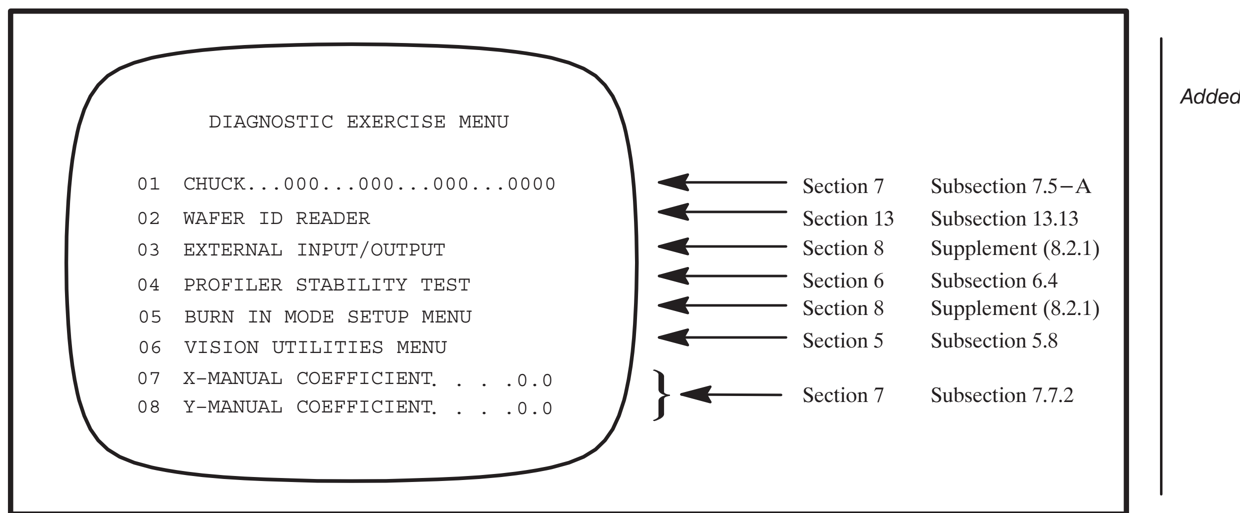
To see a directory of maps, access the Set Option Menu (press the < SET OPTION > key) and select Line 06 to display the Wafer Mapping Menu. Select Line 05 (described in **Section 10, WAFER MAPPING AND SECS**).

3.10 (A) DIAGNOSTICS

Added 6/96

A set of simple exercise and test functions is activated by the < DIAG > key which produces an eight−item menu (*Figure 3−33−A*).

Included on the illustration are references to sections and subsections where more information about the features may be found.



Added 6/96

FIGURE 3−33−A DIAGNOSTIC EXERCISE MENU

3.11 MACHINE DEPENDENT VARIABLES

A set of machine−dependent variables (MDVs) in battery−backed RAM is retained with the particular prober. These are not overwritten by download of setup files generated on another (or the same) prober.

On the present EPROM and disk system, the first 32K bytes of memory are battery backed. A 6 Kbyte section of this battery backed RAM will be reserved exclusively for the MDVs.

In order to ensure the integrity and validity of the data contained in the non−volatile memory, a Cyclic Redundancy Code (CRC) is generated on the MDV segment. The CRC is checked on power−up. If message #306 (MDV BAD CRC, DEFAULT INIT REQD) is displayed, you must press a key to continue.

The external I/O command set includes two new commands: **UV** and **DV.** These commands allow the user to upload and download the whole MDV block, respectively. The format for the data transfer is the same as the standard block transfer method now in use.

It is intended that these commands be used to back up the MDVs in case the data becomes corrupted. Whenever a CRC check indicates corrupted data, the prober automatically defaults all of the MDV data region. The operator has no control over this process, though he/she is notified (message 306) and must acknowledge the prompt. If the operator has backed up the MDV data with the **UV** command prior to this event, the **DV** command can be used to restore the correct values.

Prior to executing the **UV** command, the CRC is verified. If the CRC check indicates corrupted data, the MDV region is defaulted prior to the upload. The **DV** command stores the received data in a buffer prior to writing it out to the MDV RAM. A CRC check is performed on this buffer.

If the CRC check indicates valid data, the buffer is written out to MDV RAM. If the CRC check indicates corrupted data, message #307 (BAD MDV DOWNLOAD, NO CHANGE) is displayed, **MF** is returned to external I/O, and no update occurs.

In previous Prober Vision software (REV DA and before), the MDVs were not identified as belonging to a special group. They were stored in battery–backed RAM; some could be stored on disk files and external I/O uploadable files. This means that if such a file from another machine were downloaded, the particular machine's dependent variables would have been overwritten.

MDV VARIABLE	PARAMETER ACCESS
1. ALIGN ACCURACY MDVs:	
Align Qualification	Auto Align Options Menu –99 #01
Align Line Correction	Auto Align Options Menu –99 #02
Orthogonality	Auto Align Options Menu –99 #03
Settle Size	Auto Align Options Menu –97 #01
Settle Times	Auto Align Options Menu –97 #02
Theta Unload Steps	Auto Align Options Menu –97 #03
Micro Settle	Auto Align Options Menu –97 #05
2. OTHER MDVs	
Camera Position	Set in Profiler Menu, #08
Camera Z height	Set in Profiler Menu, <F6>
Home Position	(Currently not changeable by operator)
X, Y Camera Scale	(Currently not changeable by operator)
Zoom Focus Offset	Zoom Lens Diagnostics #05
3. MDVs which were formerly stored in the .PRM file:	
Wafer Loading Position	Material Handler Menu #02
Wafer Unloading Position	Material Handler Menu #02
Platen Coefficients	Temperature Compensation Menu #10 and #02
X, Y Location of NCES	Profiler Menu #02 (after edge profiled)
Z Scale (Z Stage Gear Ratio)	Set Parm Menu, Page 2, #01

Camera Z height is the Z height when the bare chuck is in focus under the camera. The "Z ALIGN" displayed on the Set Parameter Menu (Page 1) is the Z align height for the current (or last) wafer.

The MDV Camera Z height is set in the Profiler Menu by placing the bare chucktop in focus under the camera and then pressing < F6 >. When Camera Z height is set, message #312 is displayed: "MDV CAMERA Z SET". It can also be set in the Profiler Menu by focusing the camera on a loaded wafer which has been profiled and then pressing < F6 > – provided that the bare chuck has also been profiled. If this is done, message #313, "Z ALIGN SET", and message #312 are displayed.

3.12 SPECIAL RTM FEATURES

Some of the special features of the Real Time Mapping function include:

Real Time Wafer Map Display

A map of each wafer, containing images for each probed die, is displayed on the monitor in color.

Bincode Table Display

A bincode table, representing an operator−selected area on the wafer map, indicates the bincode assigned to each die in that area.

Color Selection

A color palette display allows you to choose the colors representing both bincode and die status.

Run Time Wafer Map

During the probing process, displays available provide information regarding the current cassette and wafer, die probed thus far, and die currently being probed.

NOTE

Electroglas strongly recommends against changing the CONFIG.SYS or AUTOEXEC.BAT files on the C drive. Modifications to these files could cause the Real Time Map/Display Control Module to malfunction.

3.12.1 Real Time Wafer Map Applications

With the window showing the prober run time display, press the toggle keys < ALT > − < W > to display the wafer map window on the right.

If a previous map exists, it will be drawn (*Figure 3−34*).

NOTE

If the Auto Probe Pattern is set to Edge or Partial, the wafer diameter circle outline on the map screen is not displayed. The map shows only whole die.

If there is no previous map in the system, the map window will be blank (*Figure 3−35*).

If a previous map is shown, press the < AUTO PROBE > key on the Joystick Keyboard to clear the window. The system will return to the standard Run Time Display and a new map will be generated while a new wafer is probed or a previous wafer reprobed.

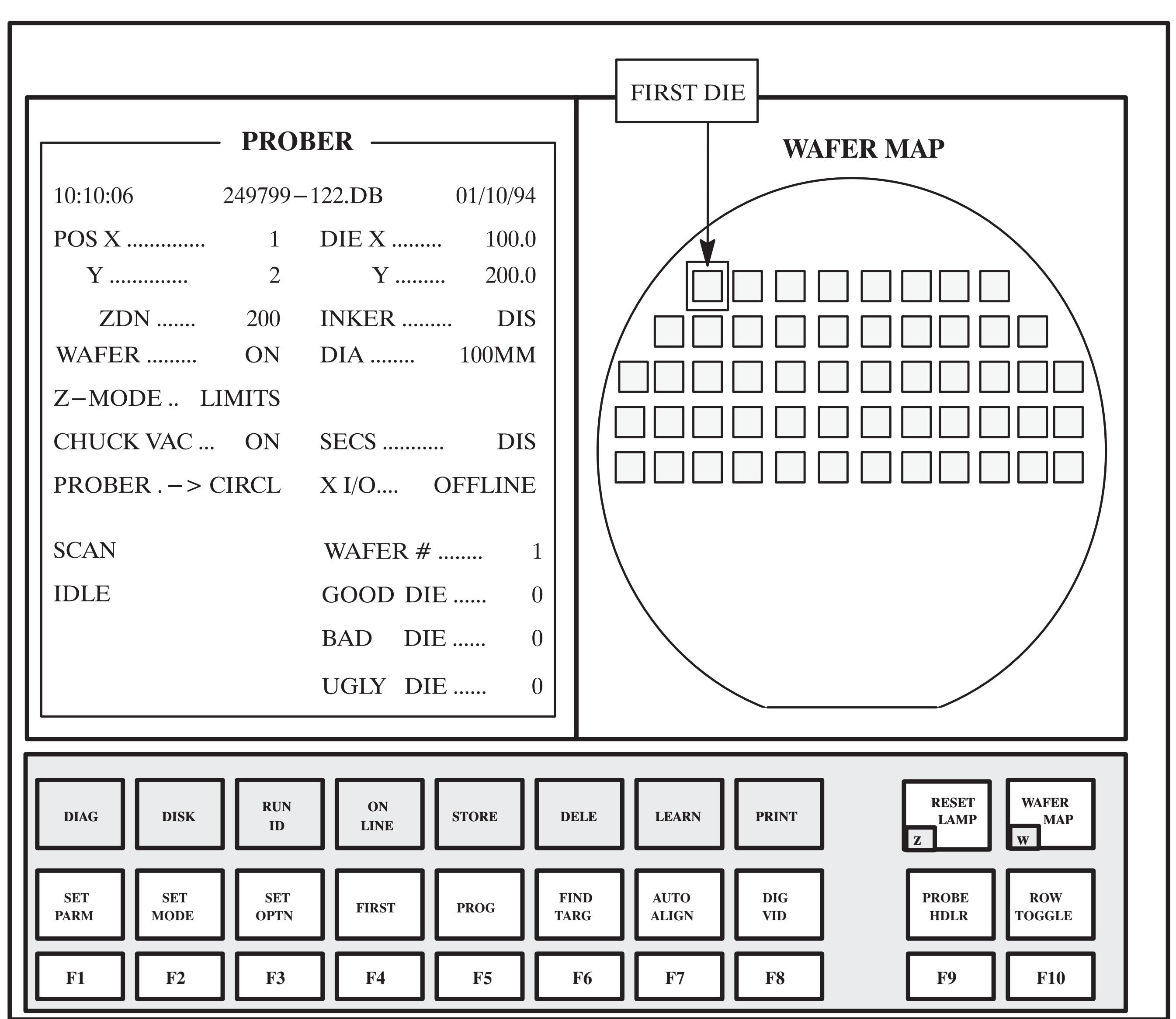
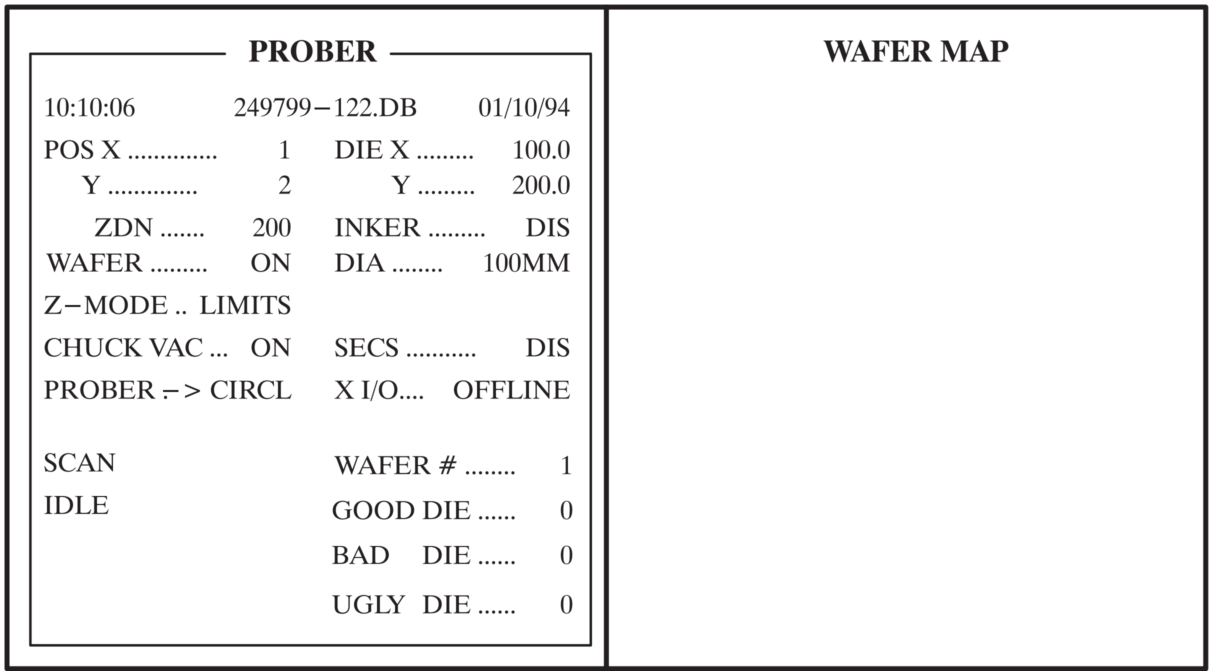


FIGURE 3−34: WINDOW SHOWING PREVIOUS WAFER MAP



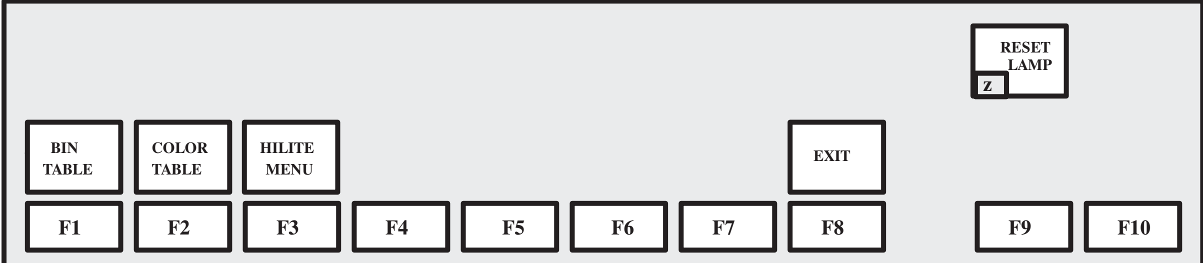


FIGURE 3−35: BLANK WAFER MAP WINDOW

Several functions use the wafer map to classify each die on the map by status and/or by bincode. These are activated by function keys < BIN TABLE > (< F1 >), < COLOR TABLE > (< F2 >), and < HILITE MENU > (< F3 >), as shown in *Figure 3−35*. To activate those functions for use on a previous (existing) map as shown in *Figure 3−34*, press the < ALT > − < W > keys.

3.12.1.1 BIN TABLE FUNCTION

Press < BIN TABLE > (< F1 >) and a frame appears superimposed on the wafer map (*Figure 3−36*). It is seven die square and its purpose is to provide a micro view of a section of the map.

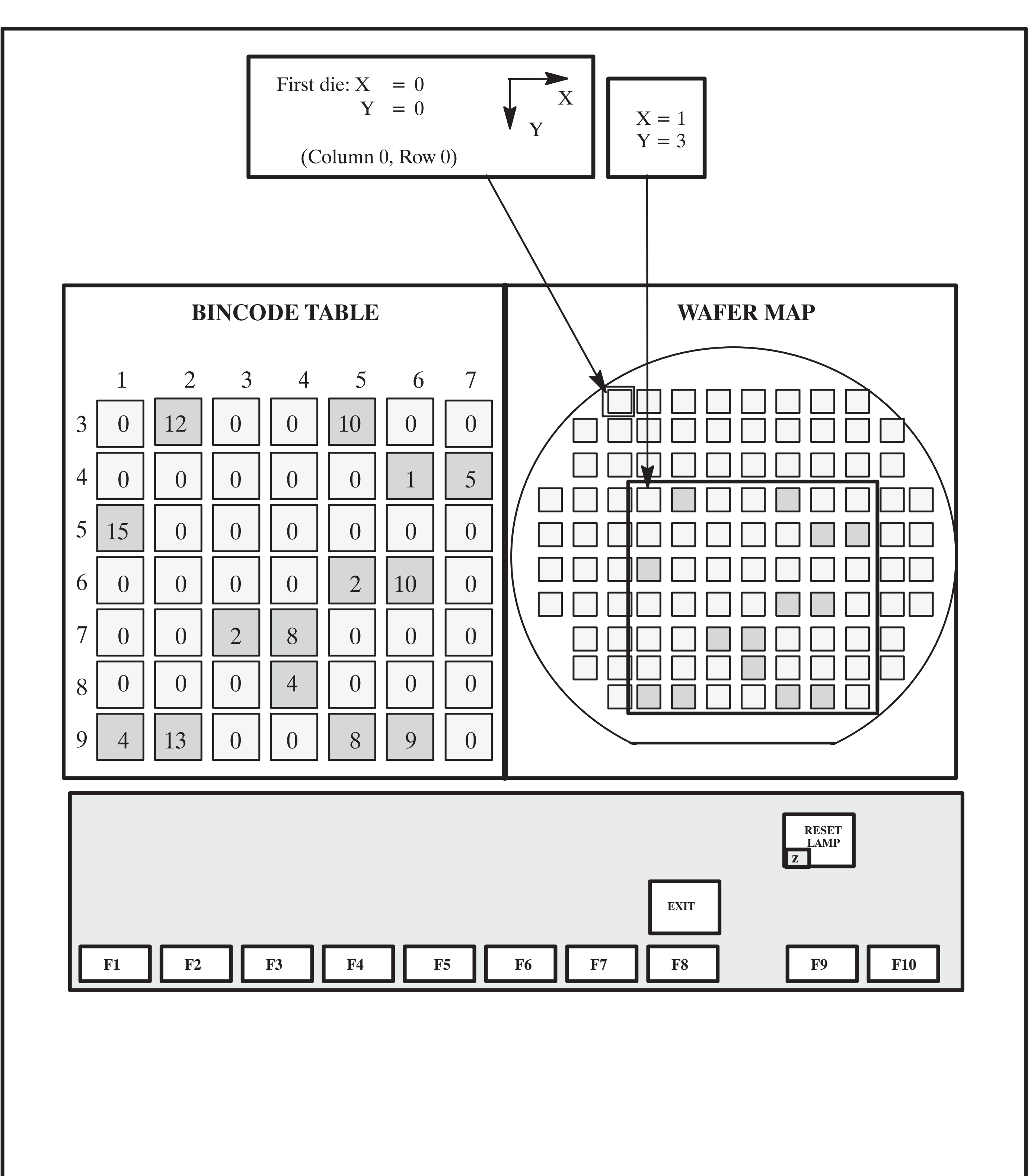


FIGURE 3−36: BINCODE TABLE ASSOCIATED WITH WAFER MAP

Use the arrow keys to move the frame around the map. In addition, you can move the frame seven die at a time; for *vertical* movement, use the < PG UP > and < PG DOWN > keys; for *horizontal*, < CONTROL > with the < PG UP > and < PG DOWN > keys.

The bincode table on the left in *Figure 3−36* is a color−coded closeup of the die images contained within the square frame. The bincode table will display codes for up to 49 die. The colors used to identify each die's bincode are selected by the operator, as described in **Section 3.11.1.2, Color Selection.**

The vertical column and horizontal row of numbers displayed on the bincode table in *Figure 3−36* represent the dies' position relative to the corner (first) reference die position, according to the direction established in the Probe Mode Menu Line 02, COORDINATE QUAD. Note that the reference die is 0/0 in this example.

Press < EXIT > (< F8 >) to the bincode table and returns to the wafer map screen *(Figure 3−35*).

3.12.1.2 COLOR SELECTION

To access the color table, access the Blank Wafer Map Window (*Figure 3−35*) and press < COLOR TABLE > (< F2 >). A window on the left displays, allowing you to select colors to be used for the die status and bincode tables *(Figure 3−37*). When the colors are applied, the wafer map will be updated to display the selected colors for the active table. The two tables are displayed simultaneously. A red box around a table indicates that the table is currently active and relates to the colors on the wafer map currently showing.

The top table consist of four boxes representing the die status colors which identify good die, bad die, ugly die, and skip die.

The lower table consists of the set of numbered boxes which provide the means for selecting the individual bincode color for each bincode number and classification (type, or bincode assignment from the prober setup), from bincode 0 to bincode 15. All bin codes greater than 15 are assigned the same color as 15.

The 16−color palette on the bottom displays the colors available for selection. The colors in the two tables need not correspond; that is, the *good* die status color in the top display is not necessarily the color that will appear in the lower table for a bin type of *good*.

The field selector and color selector arrows are moved by means of the four arrow keys:

- The **up** and **down** arrow keys move the field selector arrow vertically in each table to select the die status and bincode fields to which colors are to be assigned from the 16 palettes. The arrow automatically moves from the bottom of one column to the top of the next within the selected table.

- The **left** and **right** arrow keys move the lower arrow horizontally on the 16 color palettes. The color of the field denoted by the current position of the field selector arrow will be changed immediately as the arrow is moved across the color palette.

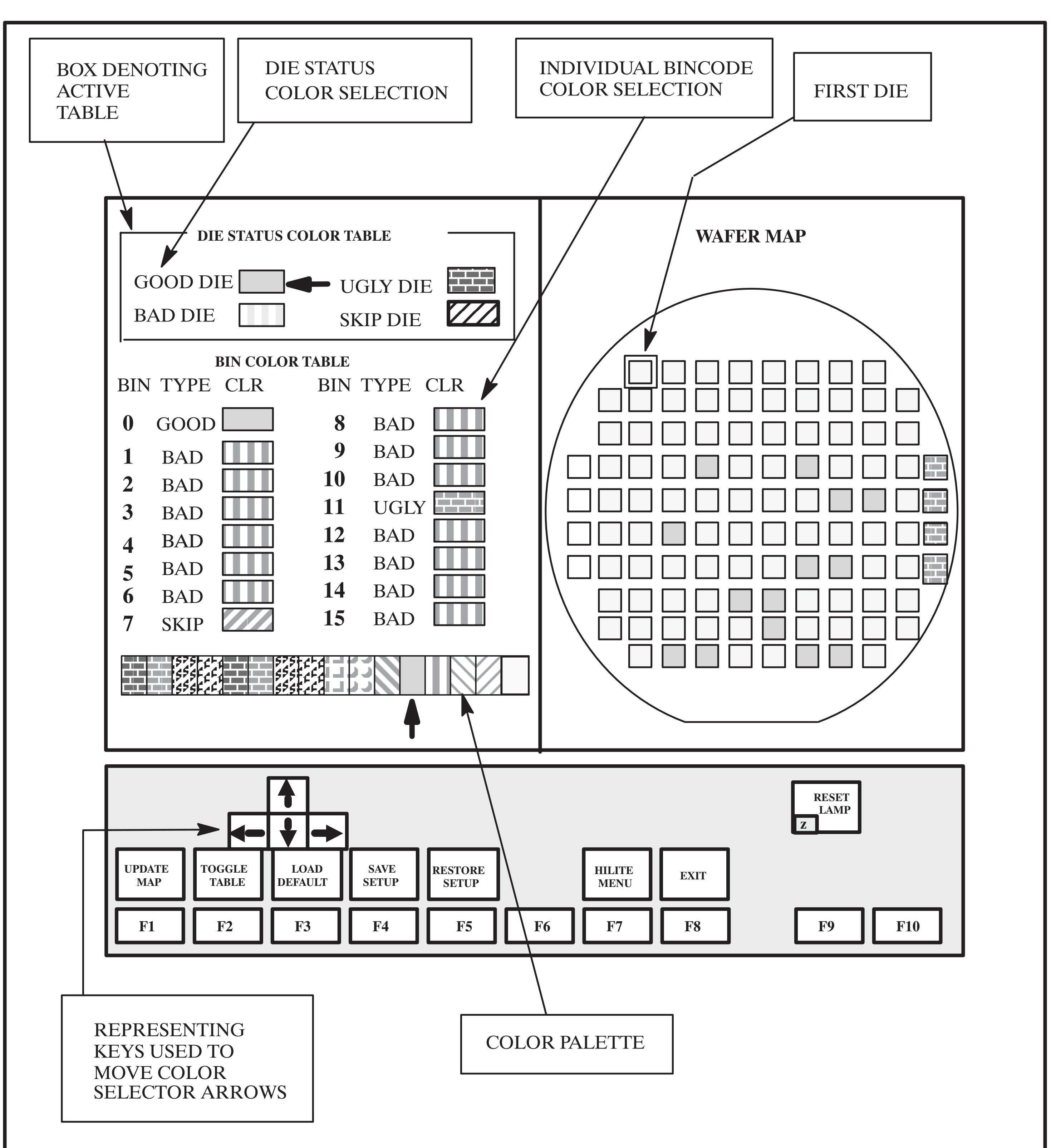


FIGURE 3−37: BINCODE COLOR ASSIGNMENT

- Press < UPDATE MAP > (< F1 >) to apply all selected color settings to the wafer map.
- Press < TOGGLE TABLE > (< F2 >) to change the wafer map display and move the red box to either die status color or individual bincode color.
- Press < LOAD DEFAULT > (< F3 >) to change the color setting including die status and individual bin code colors to the default color set by the system software:

Good Die =	Green	Ugly Die =	Blue	Bin 0 =	Green
Bad Die =	Red	Skip Die =	Purple	All others =	Red

- Press < SAVE SETUP > (< F4 >) to save the color setup to the file on the disk.
- Press < RESTORE SETUP > (< F5 >) to restore the last color assignment saved and redraw the map from the saved color setup file.
- Press < HILITE MENU > (< F7 >) to direct to the Hilite Bincode function, described next.

3.12.1.3 HILITE BINCODE FUNCTION

Move the bincode selection arrow to the desired bincode and press < F7 > to update the wafer map display *(Figure 3−38)*.

- Press < TOGGLE TABLE > (< F2 >) to change the wafer map display and move the red box to either Die Status Color Table or Bin Color Table.
- Press < TOGGLE HILITE > (< F6 >) and all bincodes not previously selected by < F6 > fade to gray background and the highlighted bincode is marked with a square to its left; its color code will not change. The highlight state can be left during probing by exiting the menu.
- Press < COLOR TABLE > (< F7 >) to return to the color table selection.
- Press < EXIT > (< F8 >) to exit the highlight bincode function and return to the color table selection.

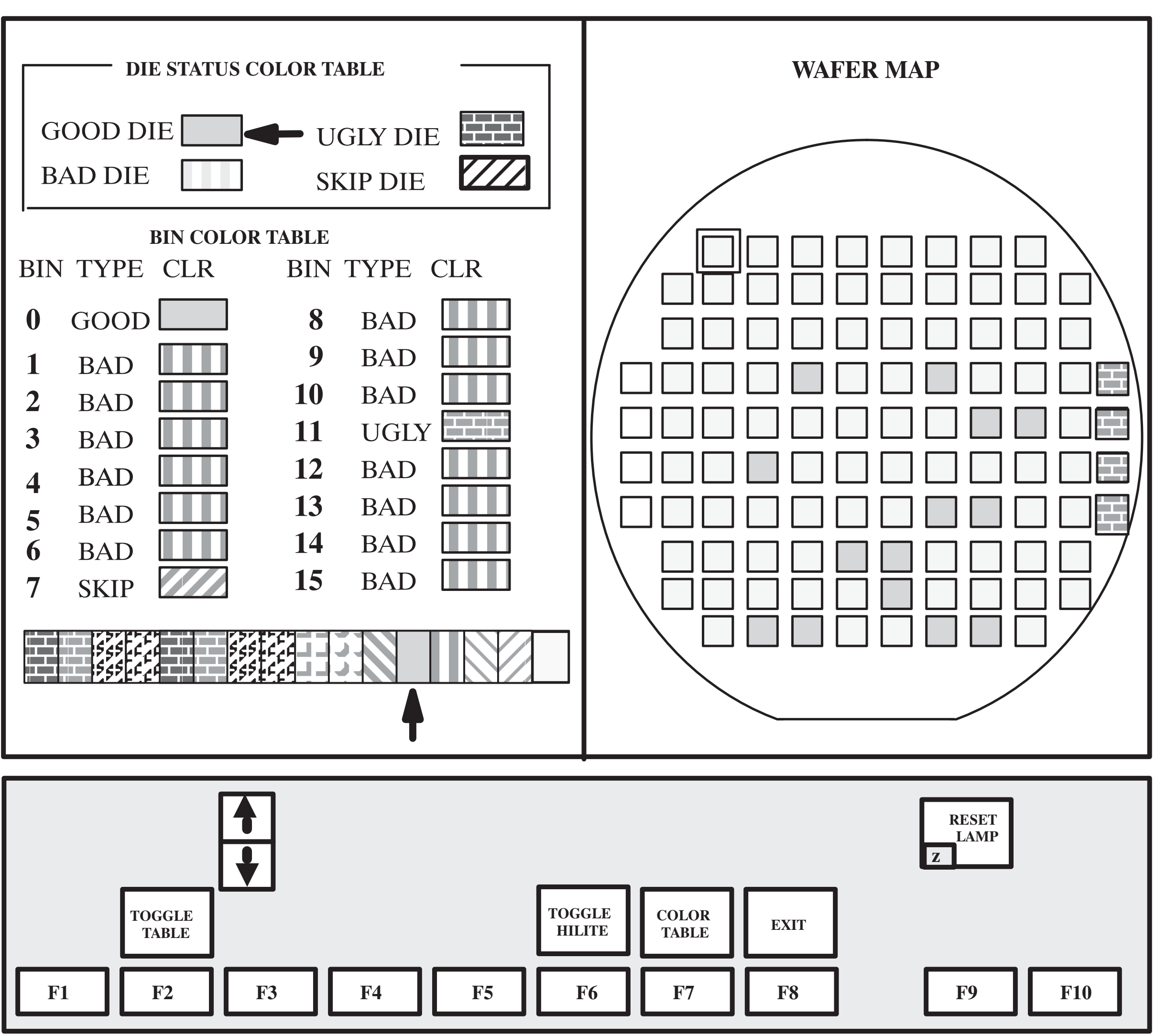


FIGURE 3−38: HILITE MENU

3.12.2 Run Time Wafer Map Function

During the auto probing operation, the Main Menu keys are not available, but you can press < F9 > to access Handler Menus. The wafer map data is updated without interruption. The Main Menu keys will be displayed again if < PAUSE/CONT > is pressed to stop probing or when probing is finished.

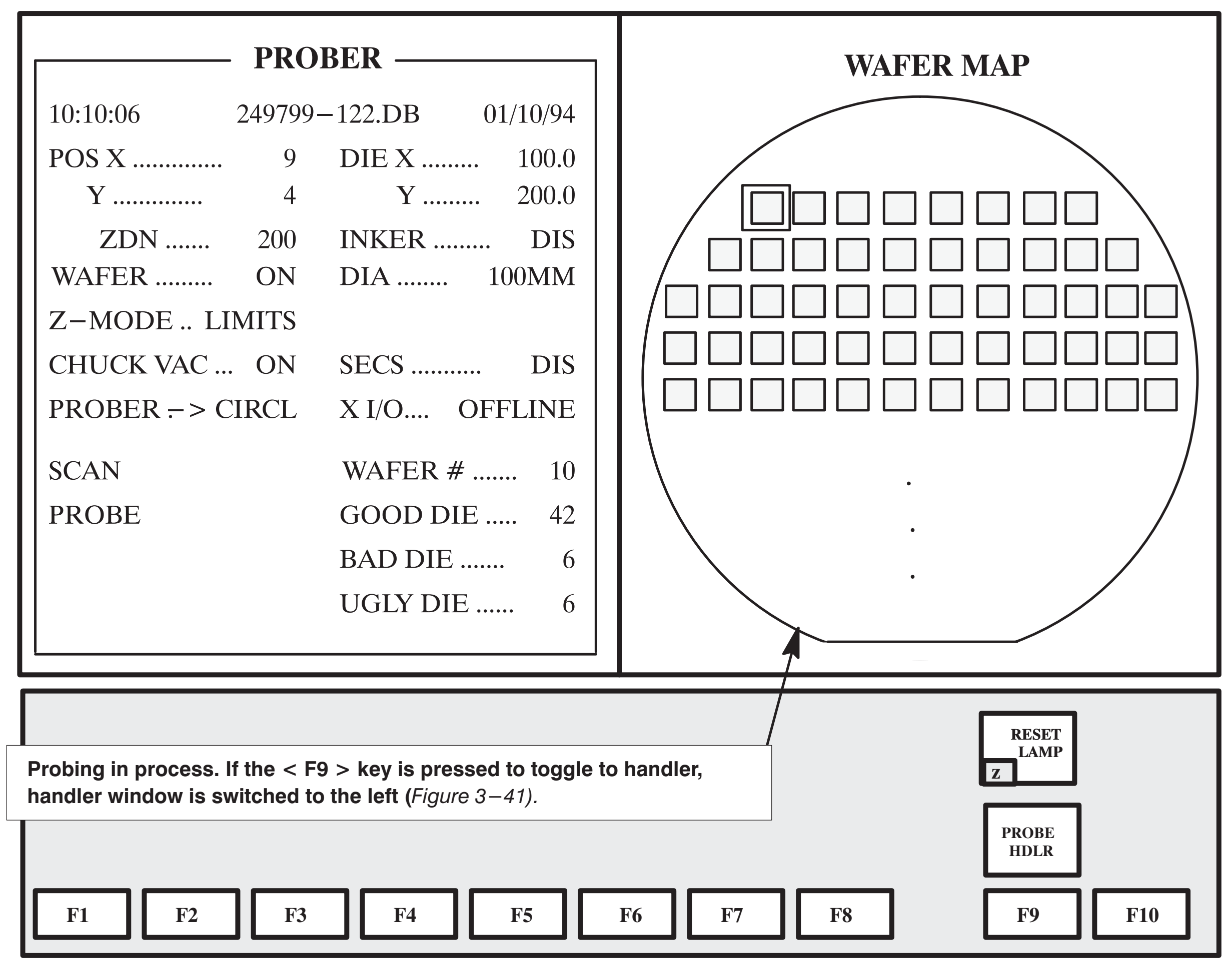


FIGURE 3−39: PROBER RUN TIME WAFER MAP DISPLAY

If the < F9 > key is pressed from the Prober Run Time Wafer Map Display (*Figure 3−39*) while probing, the Handler display is switched to the left side (*Figure 3−40*). Press < F9 > again to return to the Prober mode at any time.

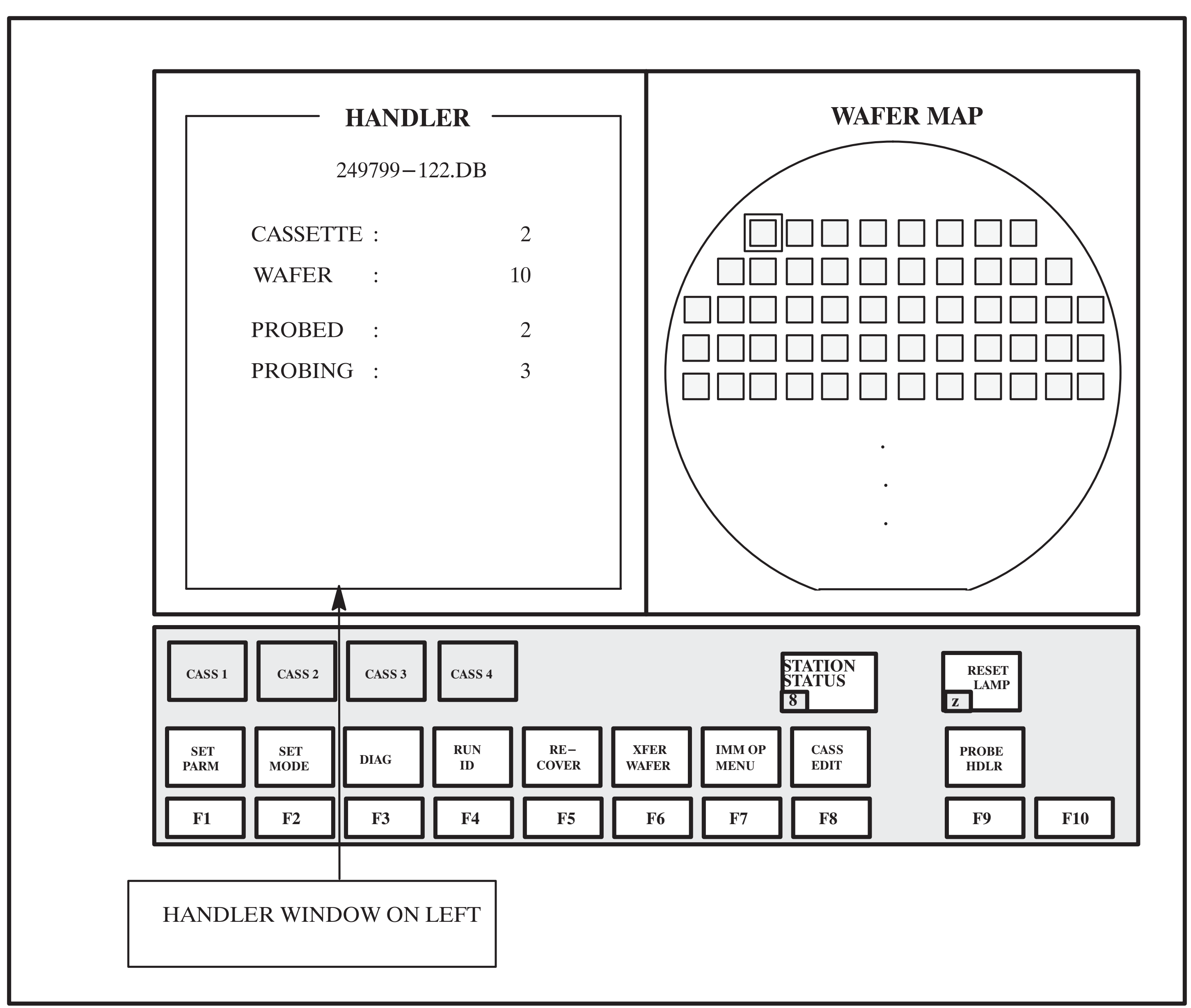


FIGURE 3−40: HANDLER DISPLAY WHILE PROBING

3.13 SUMMARY

In this section, you have learned:

- How to access the menus and submenus in Prober Vision
- Detailed information on each line item in each menu and submenu, including default parameters and suggested entries
- Instructions on using the special features of Real Time Mapping

SUPPLEMENT

OPERATING INSTRUCTIONS

SECTION 3 – REV B

The following information includes an addition that applies to Section 3, Tutorials. It will be incorporated into the section with the next revision.

In the heading below, the box at the left identifies the type of information (NEW, in this case) and the subject; the box at the right classifies the information by the major subsection to which it relates and the title of that subsection.

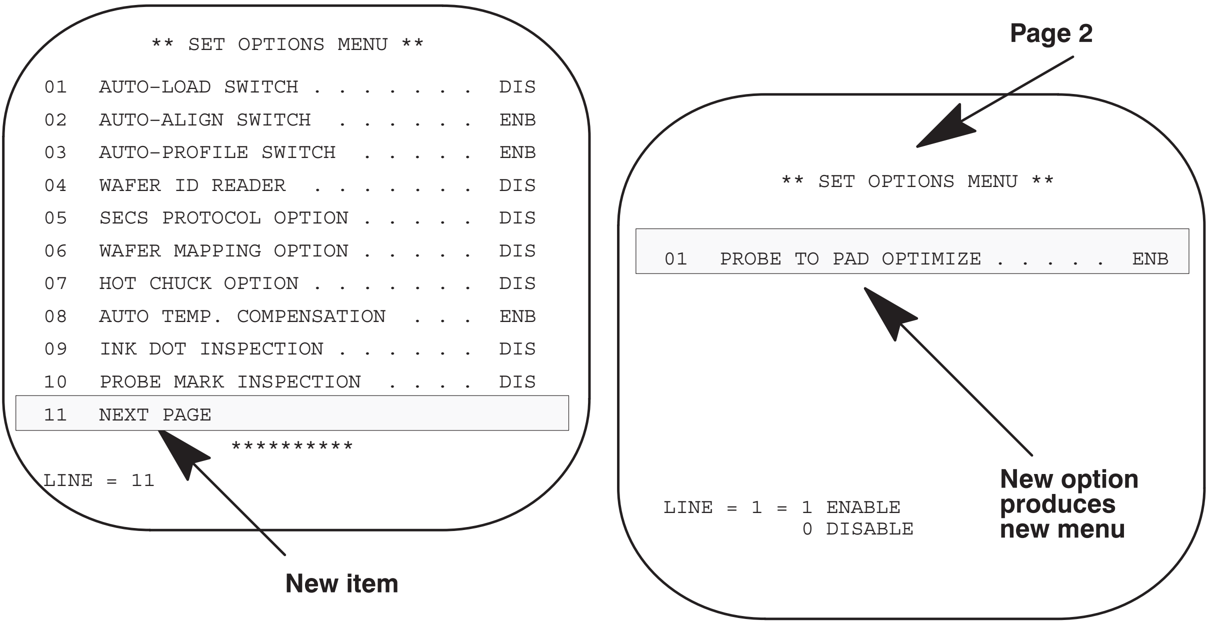
ADDITION
NEW PAGE, NEW LINE

REF: SECTION 3.3
SET OPTION MENU

Software Revision DF

A new page with a new option has been added to the Set Options Menu. A new Line 11 on the original menu now reads "NEXT PAGE", when the prober verifies functional support for the new Probe to Pad Optimization (PTPO) option.

Line 01 on the second page enables PTPO. When this line, PROBE TO PAD OPTIMIZE, is enabled, the PTPO Setup Menu will be displayed, as illustrated below.



Information about PTPO is contained in the supplement following Section 5, AUTO ALIGN.

ProberVision Software Revision DF

LIGHT POLE FEATURE

INTRODUCTION

The lamp pole light previously available on RTM probers did not sufficiently indicate the current status. The use of the lights (Green, Amber, Blue) has been redefined to serve as indicators of the current task of the prober.

GENERAL DESCRIPTION

Each of the three color lights (GREEN, AMBER, and BLUE) are now activated or deactivated depending upon the current operation and status of the prober. The basic rules are:

1. BLUE (blinking) − indicates that an unrecovered error has occurred or that all wafers have been processed.

   When BLUE (blinking) is shown with another light, this indicates that some operation has failed and the alarm sounds.

2. BLUE (solid) − indicates that an unrecovered error had occurred and a < PAUSE > key has been pressed. When BLUE turns solid, the alarm is turned off.

3. AMBER (solid) − is shown when the prober is in `PROFILE` or `AUTOALIGN` mode.

4. AMBER (solid) + BLUE (blink) − appearing together indicate that `PROFILE` or `ALIGNMENT` has failed. The alarm sounds.

5. AMBER (solid) + BLUE (solid) − appearing together indicate that `PROFILE` or `ALIGNMENT`, or material handler, has failed and the < PAUSE > key was pressed. The alarm is turned off.

6. GREEN (solid) − is shown when the prober is in `PROBING` mode. The alarm is turned off.

7. GREEN (blinking) − indicates that the probing is in the `PAUSE` state. The alarm is turned off as an exception.

8. GREEN (solid) + BLUE (blinking) − shown together indicate that an unrecovered error occurred during probing. The alarm is turned on.

9. GREEN (solid) + BLUE (solid) − shown together indicate that an unrecovered error has occurred during probing and the < PAUSE > key was pressed. The alarm is turned off.

10. BLUE (blinking) + AMBER (blinking) − shown together indicate that an unrecovered error has occurred in the Material Handler. The alarm is turned on.

11. No Light − No light is shown when the prober goes to an `IDLE` state after a successful probing.

12. < ALT−Z > operates the same way as previously, forcing all lights to be turned off.

Refer to the light transition State Diagram on the next page.

NOTE: A **"PA"** (pause/continue command from external I/O) works similarly to the < PAUSE > key except that it does *not* silence the alarm. (The **"SA"** command silences the alarm).

MENU SETUP

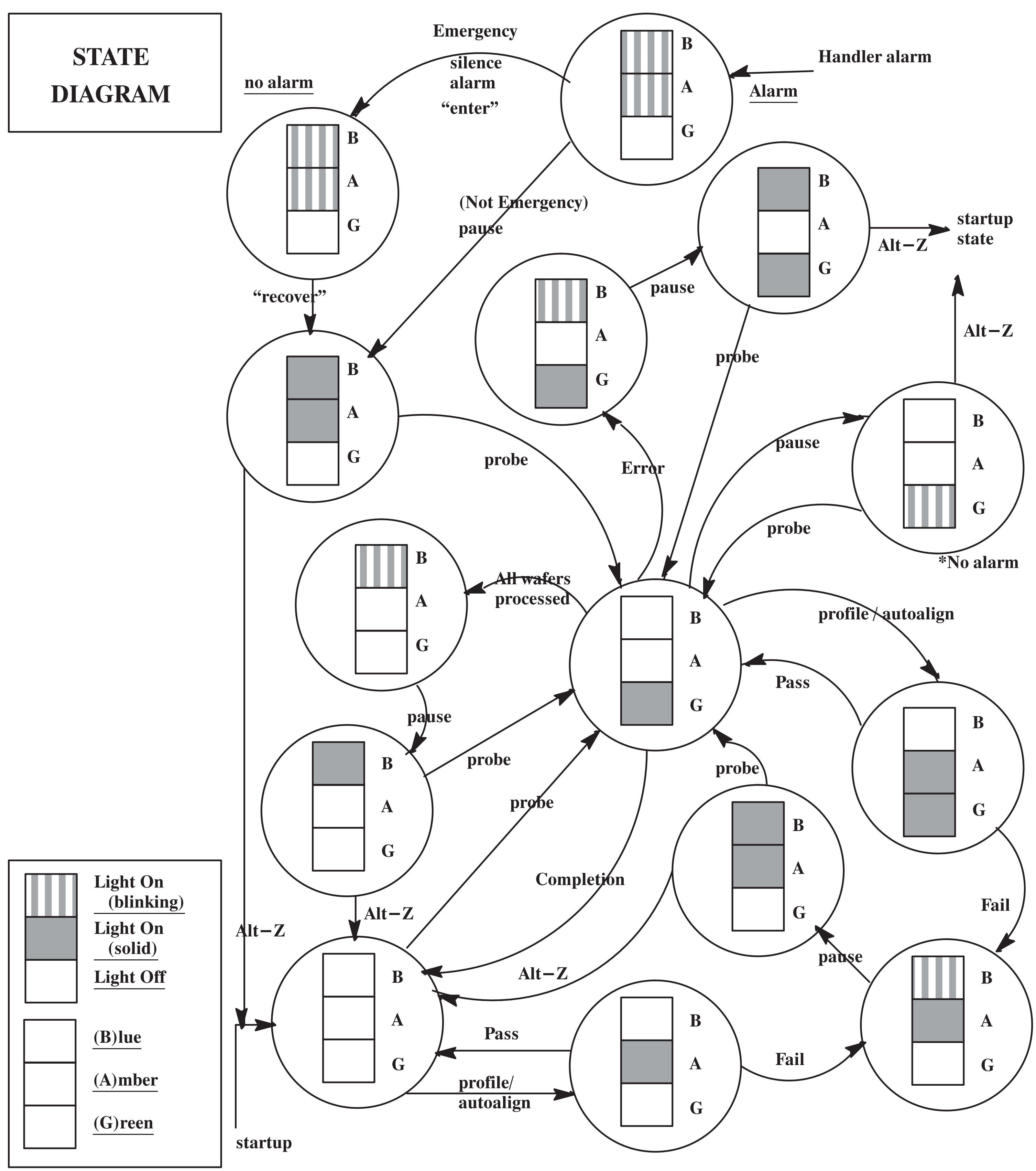
To select the lamp light light feature, enable the `LIGHT ENHANCED MODE:`

1. Select the Set Mode Menu.

2 Select the Miscellaneous Options submenu.

3 Enable the `LIGHT ENHANCED MODE`. (The default is `DISabled`.)

NOTE: The **"SA"** command is not compatible with the new enhanced lamp pole commands with regards to stopping the alarm. The alarm can only be stopped by using the proper lamp command or the **"CE"** command.


STATE
DIAGRAM
Emergency
silence
alarm
"enter"
no alarm
Handler alarm
Alarm
B
A
G
(Not Emergency)
pause
"recover"
pause
startup
state
Alt−Z
probe
Error
pause
probe
*No alarm
All wafers
processed
profile / autoalign
Pass
pause
probe
probe
probe
Completion
Fail
Light On
(blinking)
Light On
(solid)
Light Off
(B)lue
(A)mber
(G)reen
Alt−Z
Alt−Z
Alt−Z
pause
Pass
Fail
profile/
autoalign
startup

SECTION 4 – MATERIAL HANDLER

The notations in the margin on this page and throughout the section indicate areas where information was changed and/or new information added in this current revision (REV B).

NOTE the Supplement located at the end of Section 4.

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SECTION 4
MATERIAL HANDLER

4.1 OVERVIEW

The Material Handler is a random−access unit which accommodates wafers of 5, 6 and 8 inches in diameter (*Figure 4−1*). The handler may be loaded with up to two cassettes of same size wafers (5−, 6−, or 8−inch) for a total capacity of 50 for a particular run.

The Material Handler uses the same Electroglas linear motor used in the base unit. A basic difference is that the linear motor in the Handler operates only in the Y−axis. The forcer, or mobile portion, carries a transfer arm which provides X−axis movement via a coordinated Y−axis and theta movement. Two stepper motors power the Z−axis and theta positioning.

Controlled by software commands, the forcer moves the wafer through successive stages to the chucktop, where it is placed for testing, a process called *pipelining*.

A slow lift feature for all wafer sizes causes the chuck to separate from the wafer very slowly. This allows any residual vacuum to bleed off when moving to expose the vacuum pins, preventing wafer popping during the unload operation. This feature also applies to the manual unload operation.

4.1.1 How To Use This Section

This section contains the following information about the Material Handler:

- Descriptions of major assemblies
- How to position the cassette on the platform
- Material Handler operating procedures, including setting up and enabling the Handler
- Menus relating to the Material Handler
- Wafer loading and unloading procedures, including for SMIF−E™ equipped machines
- Wafer processing procedures
- How to access the Single Wafer Handling Station in a standard machine, and the Correlation Tray in a SMIF−E™ equipped machine
- Using the Material Handler Maintenance Menu to run diagnostics and tests

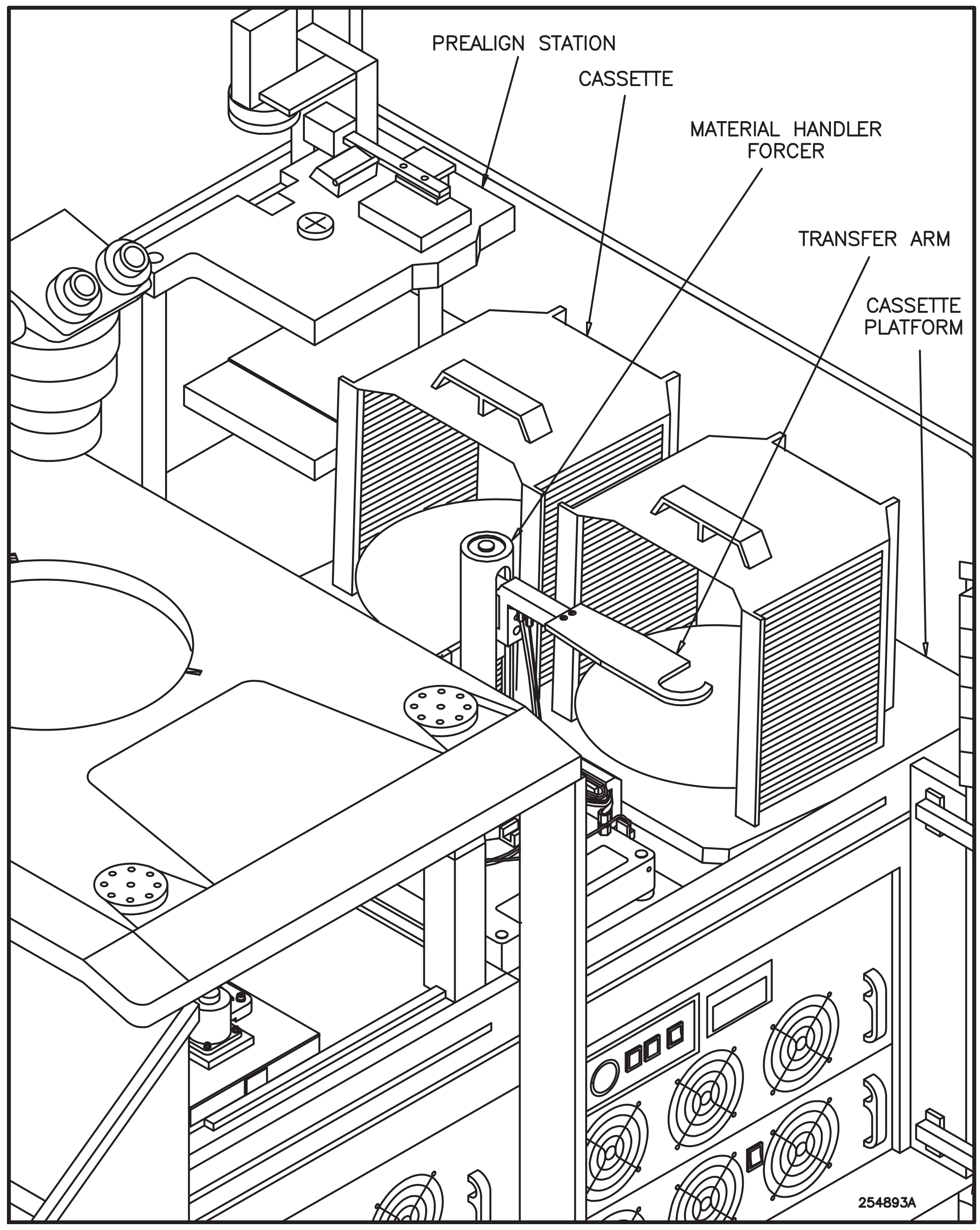


FIGURE 4−1: 4085X RANDOM ACCESS MATERIAL HANDLER

4.2 MAJOR ASSEMBLIES

In the following descriptions of major assemblies, references to directions and locations of items relate to a position in front of the prober with the Material Handler on the right, as shown in *Figure 4−1*.

CAUTION

Keep hands off the Forcer/Platen surfaces, Transfer Arm, Cassette Platform and other moving parts during operation or maintenance to prevent equipment damage and/or personal injuries.

4.2.1 Platen/Base

The platen for the Material Handler is similar to the prober platen but has distinct differences because of the Y−axis−only operation. The platen is aligned to the plane of the base casting.

4.2.2 Forcer/Transfer Arm Assembly

The Forcer/Transfer Arm Assembly (*Figure 4−2*) travels back and forth in the Y−axis along the narrow platen. X−axis motion is achieved by a simultaneous motion of Y−axis travel and rotation of the transfer arm. X−axis motion is restricted to the length of the arm. Theta (rotational) motion of the transfer arm is provided by a stepper motor mounted on the forcer base.

A Soft Torque feature allows non−centered wafers (up to .250 inches offset) to be inserted into cassette slots without an error occurring. The Material Handler will modify the wafer entry path to accommodate the offset of the wafer to the transfer arm center.

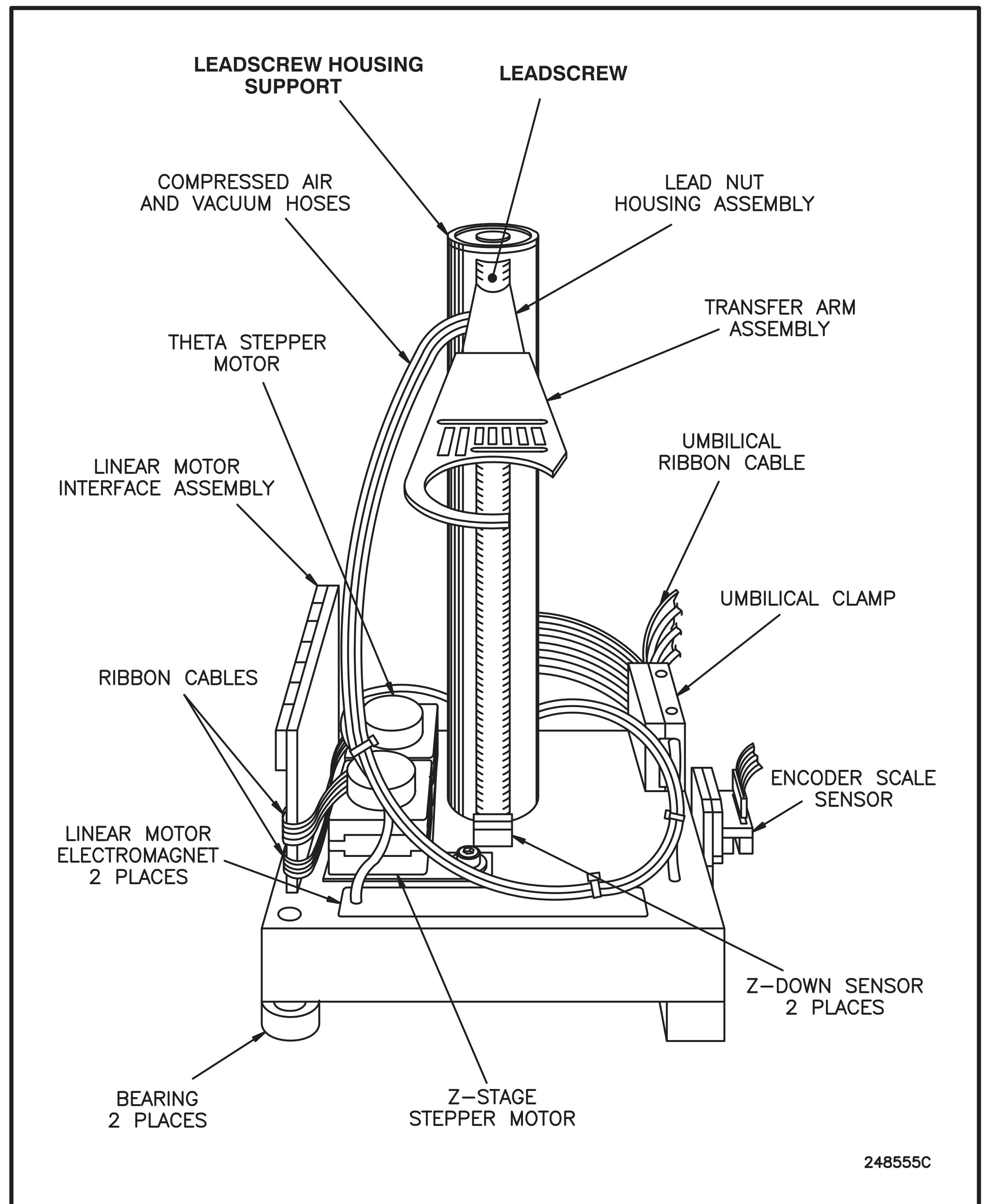


FIGURE 4–2: TRANSFER ARM ASSEMBLY

4.2.3 Cassette Platform

The cassette platform is located under the prealign plate (*Figure 4−1*). Cassette positions are numbered from front to back (*Figure 4−3*).

To align the cassettes on the left, each 5− and 6−inch position has two dowel−pinned positions which fit a crossbar on the bottom of the cassette. A front orientation stop block is stepped to accommodate each of the two sizes.

To position all sizes of cassettes in place, brackets with spring loaded plungers contact the front inside openings of each cassette for lateral alignment. Tapered blocks on the cassette plate allow initial positioning of each cassette at their narrow end for correct alignment with the crossbar on the bottom of each cassette.

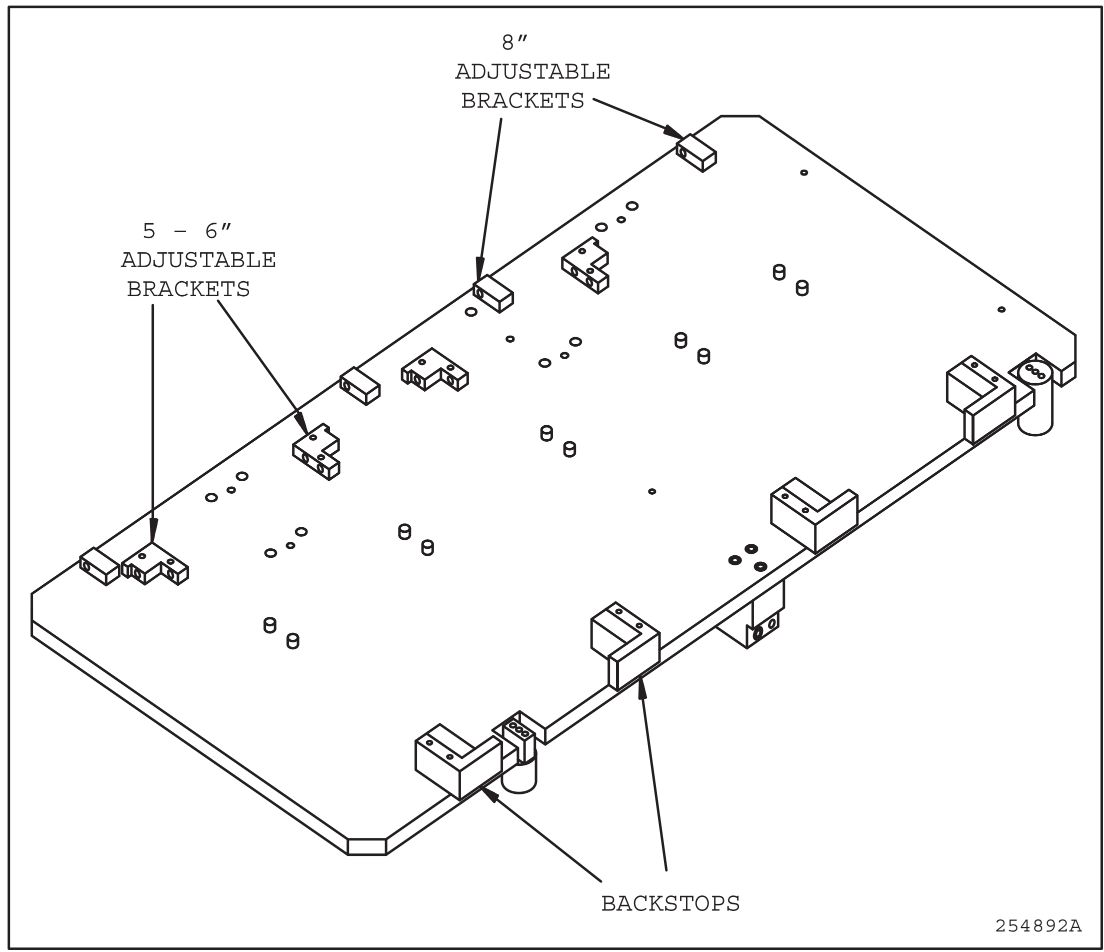


FIGURE 4−3: CASSETTE PLATFORM

4.2.4 Prealign Station

The prealign station is located at the rear of the Material Handler area (*Figure 4−1*). The wafer brought to the station by the forcer's transfer arm is deposited at the front of the station and blown gently by an air jet to the rear. It is stopped by a raised crescent, sized to the diameter of the wafer, which centers it over the prealign spindle where it is held in place by vacuum.

4.2.5 Single Wafer Handling Station

Modified 6/96

The Single Wafer Handling (or Hold) Station (SWHS − formally known as the correlation tray) is located under the prealign station (*Figure 4−4*). It is equipped with three wafer size sensors and a latch. The Material Handler controls the latch to prevent the tray from being opened during wafer transfers. It also has a sensor to detect if the tray is opened or closed.

You can insert special test wafers using this station without violating the clean environment. It can also be used as a repository for orphan wafers. Wafers are loaded or unloaded by the operator with tweezers or a vacuum wand. Wafers will also be maneuvered internally with the transfer arm by vacuum attachment from the bottom of the wafers.

On a standard machine (non−SMIF−E™), the correlation wafer is loaded from the sliding tray on the right side, probed, and returned to the station.

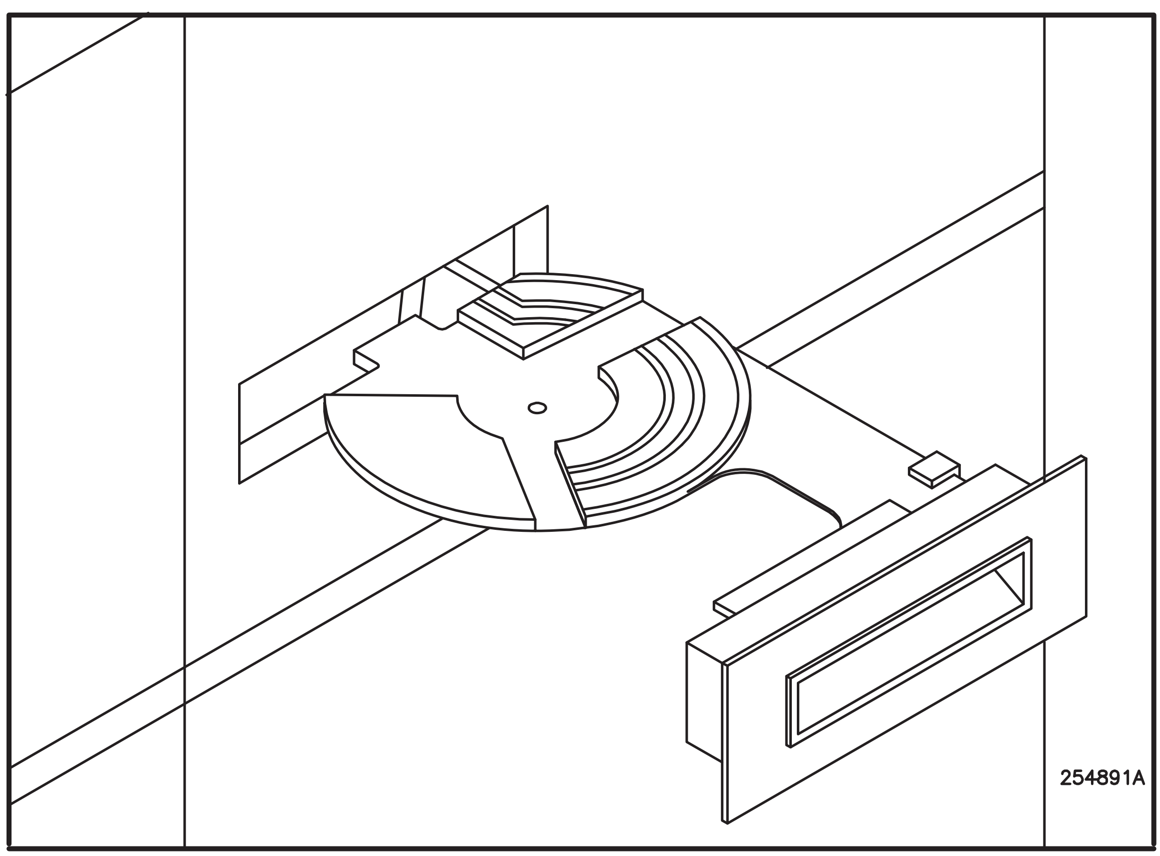


FIGURE 4−4: SINGLE WAFER HANDLING STATION

4.2.6 Quickloader Station

The quickloader station is the transition point between the Material Handler and the prober. The handler forcer carries the wafer to the station on the end of its transfer arm and places it on the station's loader arm (*Figure 4−1*).

4.3 CASSETTE POSITIONING

To position a cassette on the platform*, tilt the cassette toward its back with the insertion slots facing slightly upward and lower the cassette to engage the recesses in the platform (5−6 inch) or the tapered corner blocks (8 inch).

When seated in the guides, roll the cassette towards the horizontal position, engaging the dowel pins for the crossbar and the spring−loaded plungers for the inside front edges of each cassette.

As of Main and RTM Software REV HF, the handler checks for the presence of the cassette before inserting a wafer into the cassette or removing a wafer from the cassette. An emergency stop will be handled if the cassette is not present.

Added 6/96

* For TYPE 3, see **Appendix A, Customer Special**

4.4 SETTING UP AND ENABLING THE HANDLER

NOTE: As of Main and RTM Software REV H the option "−99" was added to the Material Handler Diagnostic Menu for enabling or disalbing the RTM handler screen upon fiirst time power−up of the handler, As of REV HJ, a wafer on the quickloader must be removed prior to power−up to avoid an Emergency Stop error following the initialization process.

Added 6/96

To set up the Material Handler:

1. Turn on the power for both units. Both cooling fans will start and the video screen will illuminate. The unit immediately goes into self−test. In case of power failure, all setup data and cassette slot status is saved automatically. As of Main and RTM Software REV HF, the handler will display "WAFER SENSOR IS OUT OF TOLERANCE" and allow you to adjust the air sensor if the air is low after power−up.

   Added 6/96

2. Press the < PROBE HDLR > (< F9 >) key to transfer operation from the prober to the handler. A message on the monitor screen will declare: "POWER UP SELF−TEST." If the self−test is successful, you will be prompted to press any key to initialize. (If the self−test fails, a flashing message will appear just below the previous one, "SELF−TEST FAILED." The system will need to be restarted after the indicated failure is repaired.)

See the Supplement at the end of the section for information about the defaulting of prober−handler variables

To enable the Material Handler:

The Handler is enabled from the Set Option Menu, accessed with the < SET OPTION > (< F3 >) key. This may be done after the handler is properly initialized.

1. If the machine is in Handler Mode, toggle the < PROBE HDLR > key to transfer operation from the Handler to the Prober mode.

2. From the Prober Mode, press the < SET OPTION > (< F3 >) key to produce the Set Option Menu. Select < 1 > for Line 01, AUTO−LOAD SWITCH. Press < 1 > to select enable. The Material Handler Menu appears (*Figure 4−5*).

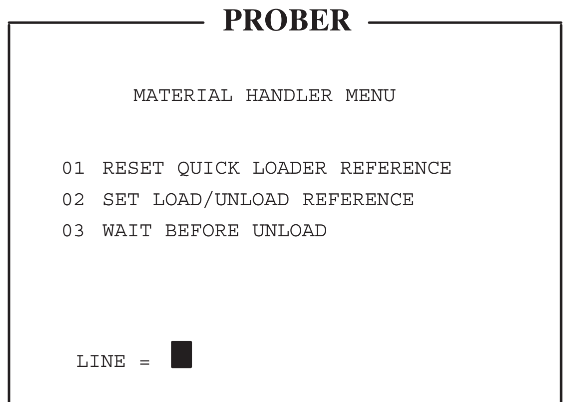


FIGURE 4−5: MATERIAL HANDLER MENU

3. Select the settings desired from the Material Handler Menu, the Set Mode Menu and the Set Parameter Menu which are discussed next.

4.4.1 Menus Relating to the Material Handler

4.4.1.1 MATERIAL HANDLER MENU *(Figure 4−5)*

LINE 01 − RESET QUICK LOADER REFERENCE

When this line is selected, the tip of the transfer arm is placed under the quickloader and raises until contact is sensed, measuring the height of the quickloader.

LINE 02 − SET LOAD/UNLOAD REFERENCE

The chuck moves to the current load/unload position. Two lines at the bottom of the screen give instructions for setting the new load/unload position:

```
MOVE CHUCK AND PRESS PAUSE TO SET
LOAD REF
PRESS "ENTER" TO EXIT
```

The chuck may then be moved with the joystick to the desired position for wafer loading. If the < PAUSE/CONT > key is pressed, the prober will beep to confirm that the new load/unload position is stored. If the position is more than 0.3 inches from the default load position, error message #120 will caution:

```
X OR Y OUT OF LOAD TOLERANCE
```

A load position more than 0.3 inches from default presents a serious risk; if the message appears, move the chuck and set the load reference again. If there is a problem, consult an Electroglas Field Service Representative.

LINE 03 – WAIT BEFORE UNLOAD

Allows you to perform an inspection after probing. The chuck will go to the Home position after probing and wait for the operator to continue by pressing the < AUTO PROBE > key, showing the following message at the bottom of the Run Time Display:

```
      > > >  UNLOAD WAIT  < < <
PRESS "AUTO-PROBE" TO CONTINUE
```

4.4.1.2 SET MODE MENU LINE ITEMS *(Figure 4–6)*

```
HANDLER

      HANDLER SET MODE MENU

1   ID READER TYPE . . . .   OFF
2   PREALIGN TO . . . . .   FLAT
3   STOP ON PREALIGN FAIL    ENB
4   ID READ FAIL RECOVERY UNLOAD
5   REAL TIME WAFER SENSE    AIR
6   KEEP WAFER ON PREALIGN   ENB

LINE = █
```

FIGURE 4–6: HANDLER SET MODE MENU

LINE 01 – ID READER TYPE

This line item is used to enable the Optical Character Reader (OCR) system, a Bar Code Reader, or the Back Side Bar Code Reader. The following prompts will appear:

ID POSITION: This is the position of the start of the ID field relative to the wafer flat in degrees (clockwise). Generally, this will be zero.

ID READER RETRIES: This is the number of attempts the handler will make to read the ID in addition to the original attempt and one extra attempt. For example, a value of "2" will result in the handler attempting to read the ID up to four times Each retry takes up to 32 seconds.

Once the OCR is enabled, the values mentioned above can be reset directly through the Set Parameter Menu. Both OCR and the Back Side Bar Code Reader are discussed in **Section 13 (OCR / BACK SIDE BAR CODE READER**).

On successive reads, the handler will maintain the image of both the most successful ID read and the latest ID read. If the latest read contains more readable characters than the most successful read, the latest read will become the most successful.

LINE 02 – PREALIGN TO...

This line item determines whether the wafer is to be prealigned to the flat or a notch. As of Main and RTM Software REV HF, if "NOTCH" is selected, the Prealign Subsystem and Fail Assist Menus will display options to "ALIGN TO NOTCH".

Added 6/96

LINE 03 – STOP ON PREALIGN FAIL

Enables/disables the option for handling prealign wafer failure.

LINE 04 – ID READ FAIL RECOVERY

Enables/disables the option for handling wafer ID read failures. This feature is explained in **Section 13 (OCR / BACK SIDE BAR CODE READER**).

LINE 05 – REAL TIME WAFER SENSE

Allows a choice of three options:

0	=	OFF	Disables real time wafer sense, as in earlier software revisions
1	=	AIR	Uses the transfer arm air sensor
2	=	VAC	Uses the transfer arm vacuum

To avoid the improper vacuum sense after the pneumatic module is modified, the Material Handler software ensures that the vacuum solenoid (SV9) is turned off before the air solenoid (SV4) is activated.

In addition, if the vacuum solenoid is not activated, the system will always show no wafer sensed under normal conditions, but will show the real vacuum sensor status in the Diagnostic Menu.

LINE 06 – KEEP WAFER ON PREALIGN

See the Supplement at the end of the section for information about the two new lines on the Handler Set Mode Menu

Allows the handler to respond faster to the prober during normal operation. When this line is Disabled, wafers are not continually placed on the prealign station, but the quick loader is kept full.

4.4.1.3 SET PARAMETER MENU LINE ITEMS *(Figure 4–7)*

LINE 01 – PROBE INTERVAL

The number entered in this line refers to the selected interval between wafers probed. For example, if the value is 5, then wafers 1, 6, 11, 16, and so on will be probed.

LINE 02 – INSPECT INTERVAL

Similar, determines the intervals between wafers to be inspected during probing. An “I” will appear beside the wafer number in the display for the cassette. (Removal for inspection is discussed in **Section 4.6.2, Removing/Inserting Wafers.)**

Updated 6/96

FIGURE 4–7

HANDLER SET PARAMETER MENU

```
                 HANDLER
    HANDLER SET PARAMETER MENU

01  PROBE INTERVAL . .   1-99
02  INSPECT INTERVAL .   1-99 (OR OFF)
03  FLAT POSITION  . .   0-359 DEG.
04  ID POSITION  . . .   0-359 DEG.
05  (UNUSED LINE)
06  ID READER RETRIES   1-99
07  UNREADABLE CHAR....  ◆
08  ID LOCATION X ...... xxx MILS

LINE = █
```

LINE 03 – FLAT POSITION

Sets the wafer flat according to the following table:

6 o'clock	=	0 degrees	12 o'clock	=	180 degrees
9 o'clock	=	90 degrees	3 o'clock	=	270 degrees

LINES 04 and 06 (*ID POSITION* and *READER RETRIES*)

These two line items are explained previously, under Set Mode Menu. Press < ENTER > to exit the menus and return the screen to the status display.

Parameters loaded from the prober system host computer to the handler from the prober system overwrite any operator–entered data from a handler menu. If the prober system sends data to the handler while the operator is accessing a handler menu, a message is displayed advising the operator to check current settings upon exit from the menu (*Figure 4–7A*).

Any data entered by the operator at this time will not be accepted. If the prober sends data while a Material Handler Menu is displayed, the handler data in the menu will not reflect the new data sent by the prober. If new setup commands are sent by the external host to the prober for the handler and the operator is busy changing one of the handler menus, the External I/O commands have priority.

See the Supplement at the end of the section for information about new lines 07 and 08.

```
                 HANDLER

  PARAMETERS HAVE BEEN UPDATED
       BY THE HOST SYSTEM
  PLEASE RE-VERIFY YOUR SETTINGS


   PRESS "ENTER" TO CONTINUE
```

FIGURE 4–7A:

PARAMETER UPDATE SCREEN

4.5 WAFER LOADING

The Material Handler on the 4085X detects the presence of SMIF−E™ arms and provides for manual or SMIF−E™ loading accordingly. As of Main and RTM Software REV HJ, for the SMIF machine, a message is displayed asking you to remove the wafer from the transfer arm before initialization.

Added 6/96

4.5.1 Standard Loading/Unloading

For a standard machine, the handler can deal with up to one or two top−loaded cassettes of 5−, 6−, or 8−inch wafers. It recognizes that the centers of the different−sized cassettes will be in different locations on the Material Handler baseplate.

Manual loading on a non−SMIF−E™ machine also is available as the default load position when the Material Handler is disabled. If the Material Handler is enabled, this position can be used by manually bringing the forcer to this position with the joystick and placing a wafer on the chuck for manual inspection.

An alternate method of starting the **LOAD/UNLOAD** operation is available from the keyboard (*Figure 4−8A*). Keys < 3 > and < 4 > are labeled `START CASS1` and `START CASS2` respectively. (These keys display only on the SMIF−E™ machines.)

The normal cassette (containing wafers to be processed using normal operation and loaded during the **DOOR OPEN** state) can only be removed or placed while the door is opened by pressing the < F6 > key, which is labeled either `LD/UL CASS` or `XFER WAFER`, depending on the handler state.

In the **DOOR OPEN** mode, the display will show `XFER WAFER` for the < F6 > key to indicate that the key may be pressed to begin transferring wafers.

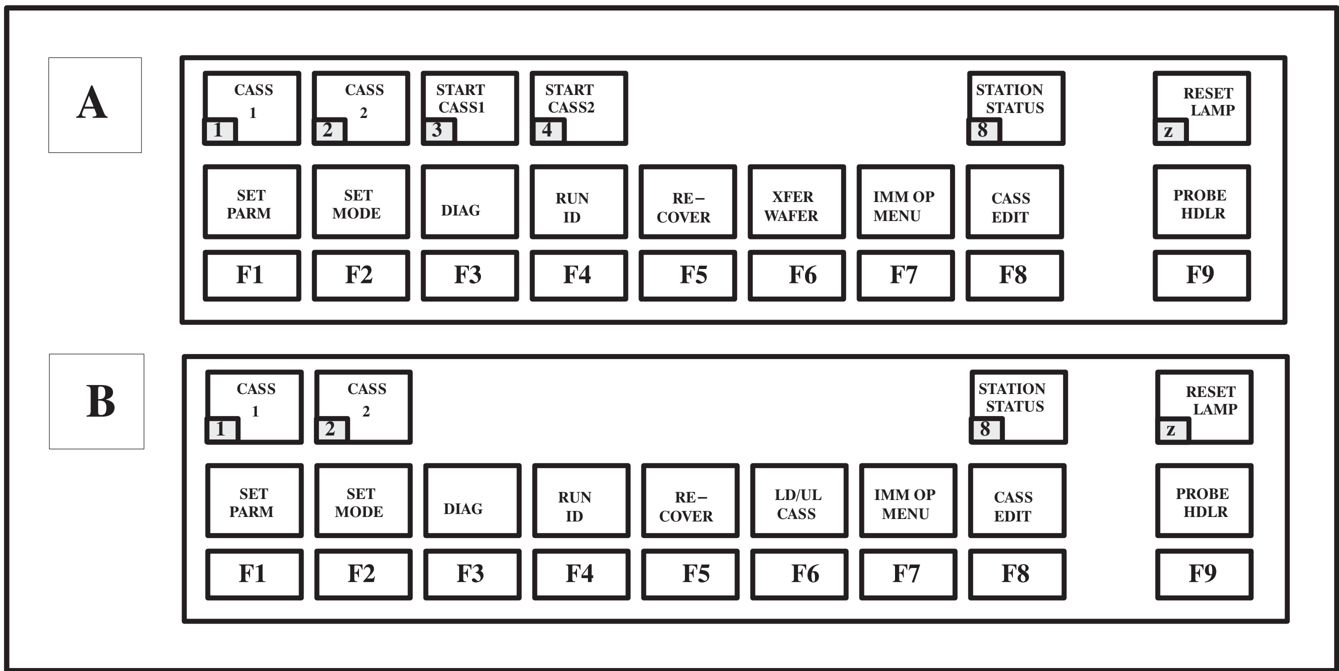


FIGURE 4−8: SPECIAL SMIF LOAD/UNLOAD KEYS

While in the **DOOR CLOSED** state, the display for the < F6 > key will be changed to `LD/UL CASS` (*Figure 4−8B).*

A submenu accessed from either Cassette Status Menu (keys < 1 > and < 2 > − `CASS 1` and `CASS 2`) is available to display the ID for each slot. In addition, key < 8 > `(STATION STATUS)` can be used to show the station information for the chucktop, quickloader, correlation tray, and prealign. The information shown includes the source and ID of the wafer on the station, if a wafer is present. As of Main and RTM Software REV HF, the handler's Cassette−ID Status has two pages to display the whole wafer ID string for each cassette.

Added 6/96

4.5.2 Loading/Unloading on SMIF−E™ Equipped Machines

The handler system for cassette loading and unloading has been modified slightly for the SMIF−E™ 4085X, in order to ensure that wafers are handled in a clean, safe environment.

If the pipeline process is on, the handler will keep a wafer on the quickloader only; not on the prealign station. This is a safety measure which also saves the time which would be required to remove the wafer from the prealign station while **CASS2** is being unloaded/loaded by the SMIF−E™ Arm.

If SMIF−E™ Arms are detected, the handler will use them for the automatic loading and unloading of cassettes; no provisions are made for manual loading. The feature is limited to 8−inch wafers. During the loading of a cassette by means of a SMIF−E™ Arm, the handler will be in a pause state and will continue when loading/unloading is complete.

The SMIF−E™ **LOAD** and **UNLOAD** operation can be started by pressing either the keys on the console keyboard or the buttons on the SMIF−E™ Arms.

4.5.2.1 "LD/UL CASS" HANDLER RUN TIME DISPLAY

In the **LD/UL CASS** mode, a flashing line under `PROBLEMS` on the Run Time Display shows the status of the cassettes/arms (*Figure 4−9).* **Table 4−1** defines the status designations.

4.5.2.2 NORMAL CASSETTE LOAD/UNLOAD

Normal cassette, as defined earlier, is one which contains wafers to be processed in normal operation, loaded during the **DOOR OPEN** state. Its counterpart is a "Hold Cassette," defined in **Section 4.6.3.1.**

During the **LD/UL CASS** state, the handler Run Time Display shows the arm status as described in **Table 4−1** to indicate the allowance of **LOAD** or **UNLOAD** for each cassette.

The corresponding ▶LOAD◀ or ▶UNLOAD◀ button will be lit on the SMIF−E™ Arm, and you can press the button or the < START CASS1 > or < START CASS 2 > key to initiate the **LOAD** or **UNLOAD** operation.

As soon as the **UNLOAD** operation is initiated and the cassette is removed from the handler platform, the control buttons on the arm are disabled. When the cassette is returned to the pod, the arm status on the Run Time Display is switched from `UNLOADING` to `UNLOADED`.

TABLE 4–1:

LD/UL CASS RUN TIME DISPLAY STATUS MESSAGES

Status	Description
NOT FOUND	The four input lines from the SMIF–E™ Arm are inactive (LOGIC LOW) and the Handler concludes the arm is not existing
READY NO CASS. INSTALLED NO POD	The M/H and the SMIF–E™ Arm are ready to have a cassette loading, but there is no pod on the port plate.
NEED POD CASS. INSTALLED, COMPLETED NO POD	A cassette is installed on the platform and all wafers in this cassette have been processed, the SMIF–E™ Arm is ready but no pod is in place.
LOCKED CASS. INSTALLED NOT COMPLETED	A cassette is installed on the M/H platform, but the Handler has not processed all of the wafers. The SMIF–E™ Arm is in READY state regardless of pod in place.
MANUAL	The Maintenance Control Panel is connected to the SMIF–E™ Arm and is set to **MANUAL** mode.
OK LOAD NO CASS. INSTALLED POD IN	There is no cassette on the platform, the pod is in place and the SMIF–E™ Arm is ready to perform the **LOAD** operation and the ◗LOAD◖ button is lit.
OK UNLOAD CASS. INSTALLED, COMPLETED POD IN	A cassette containing processed wafers is on the platform, and the SMIF–E™ Arm is ready to perform the **UNLOAD** operation and the ◗UNLOAD◖ button is lit.
UNLOADING	A cassette unload is in progress and the ◗UNLOAD◖ button is flashing until the operation is finished.
LOADING	A cassette loading is in progress and the ◗LOAD◖ button is flashing until the operation is finished.
LOADED	A cassette was just placed on the platform and the SMIF–E™ Arm is in the **HOME** position.
UNLOADED	A cassette was just removed from the platform and returned into the pod on the arm port plate. The status of the cassette will remain and the ◗LOAD◖, ◗UNLOAD◖“ buttons are disabled, until the pod is removed from the port plate.
ERROR	An unexpected status was received from the input lines.

```
PROBER
10:10:06        249799-122.DB         01/10/94
POS X ............1   DIE X ........100.0
     Y ..........2..     Y ........200.0
    ZDN .......200   INKER ......... DIS
WAFER .........  ON   DIA ........  100MM
Z-MODE ..     LIMITS
CHUCK VAC ...    ON   SECS ...........DIS
PROBER .    -> CIRCL  X I/O....    OFFLINE
SCAN                  WAFER # ........ 10
IDLE                  GOOD DIE ....   100
                      BAD DIE .......  20
                      UGLY DIE ......  10
```

```
HANDLER
              249799.122.DB
CASSETTE    :          1           *2
WAFER       :         25            3
PROBED      :         25            2
PROBLEMS    :          0            0
ARM STATUS:     OK UNLOAD      LOCKED

CURRENT CASSETTE IN PROCESS = 1
```

FIGURE 4−9: MODIFIED HANDLER RUN TIME DISPLAY

The handler will not enable the ▶LOAD◀ button for the next cassette loading until the pod which contains the unloaded cassette is removed from the port plate.

The cassette containing any unprocessed wafer or unmapped slot is not allowed to **UNLOAD** if the door is opened via the < LD/UL CASS > key. To unload an incomplete cassette, press the < RECOVER > key and follow the instructions on the screen.

You can press the ▶LOAD◀ button on the SMIF−E™ Arm and the < F6 > (< XFER WAFER >) key on the keyboard consecutively, after a new pod is put on the port plate for loading. The handler will not start to process the cassette until it is placed on the platform and the SMIF−E™ Arm is returned to **HOME** position.

4.5.3 Cassette Status

Load one or two cassettes on the platforms*, as shown in *Figure 4−3* (*CASSETTE PLATFORMS*). The monitor will display the status of each cassette present. In the cassette status display (*Figure 4−10*), information given for each cassette number is WAFERS (total in cassette); PROBED (total); and PROBLEMS (total number).

```
HANDLER
Cassette:       1   2
Wafers   :     17  25
Probed   :     16  24
Problems:       1   1

Wafer at Hold Station
Status:  Immediate Probe Done
              (or "Orphan")

Wafer Available for Inspection
Cassette 2    Slot 8
```

FIGURE 4−10: CASSETTE STATUS DISPLAY

4.5.3.1 STATUS BY SLOT

A cassette mapping system monitors each cassette slot. When a wafer is removed from a cassette slot, the slot status is updated at the moment the transfer arm contacts the wafer and vacuum is applied.

The status of the wafers in any cassette can be displayed at any time by pressing the number key for the cassette desired. Status will be shown for all wafers in that cassette in two columns, SLOT and STATUS. The status messages are:

(blank)	(unmapped)	PROCESS	(wafer in process)
UNPROBED	(but mapped)	SKIP	(wafer not processed)
PROBED		PA FAIL	(prealign fail)
ID FAIL	(ID reader fail)	LOST	(wafer not accounted for)
AA FAIL	(Auto Align fail)	EMPTY	(the system has mapped the slot but finds no wafer)
PRO FAIL	(profile fail)		

When the wafer has been processed and probed but needs to be inspected, an "I" will appear beside the wafer number. *Figure 4−11* shows a typical display.

If a wafer is not completely probed, its unload status shows one of two designations:

1. If unloaded through external I/O, the status is UNPROBED.
2. If unloaded normally, the status is SKIP. This will keep the wafer from being reprobed immediately. Operator intervention through the single wafer handling station can re−establish the UNPROBED status if desired.

* *TYPE 3,* see **Appendix A, Customer Special.**

```
                    HANDLER
                  Cassette 1
Slot   Status                Slot   Status
  1    Probed                 14    Probed
  2    Probed                 15    Probed
  3    AA Fail                16 I  Probed
  4    Empty                  17    Probed
  5    Empty                  18    Empty
  6    Empty                  19    Empty
  7    Empty                  20    Probed
  8    Empty                  21 I  Probed
  9    Empty                  22    Probed
 10    Probed                 23    Probed
 11    Probed                 24    Probed
 12 I  Probed                 25    Probed
 13    Probed

        Press "Y": ID, "ENTER": Exit
```

FIGURE 4−11: CASSETTE MAP

4.5.3.2 EDIT CASSETTE FEATURE

Any cassette slot may have its status changed when:

1. The handler is idle (transfer arm is in the Home position and the cassette drawer is open).
2. The cassette to be edited is installed.
3. The slot does not have a PROCESS status.

Slot status may be SKIP, UNPROBED, or PROBED. If the slot has been mapped, the status will update immediately. If the slot has yet to be mapped, the slot will acquire the edited status when it is mapped.

To edit a cassette, press the < CASS EDIT > key. (As of Main/RTM Software REV HF, if the cassette cover is closed, the handler will display a message "CASS COVER NOT OPEN".) You will be prompted for the number of the cassette to be edited. When the cassette has been selected, a change−of−status screen will appear (*Figure 4−12*).

Added 6/96

HANDLER

```
                 Cassette 1
Slot  Status              Slot  Status
  1   PROBED               14    EMPTY
  2   PROBED               15    EMPTY
  3   PROBED               16    EMPTY
  4   EMPTY                17    EMPTY
  5   EMPTY                18    EMPTY
  6   EMPTY                19    EMPTY
  7   EMPTY                20    EMPTY
  8   EMPTY                21    EMPTY
  9   EMPTY                22    EMPTY
 10   EMPTY                23    EMPTY
 11   EMPTY                24    EMPTY
 12   EMPTY                25    EMPTY
 13   EMPTY

 EDIT SLOT (1-25): █
```

FIGURE 4−12: CASSETTE EDIT SCREEN

When the slot has been selected, the bottom line prompt will change to "1 = SKIP, 2 = PROBED, 3 = UNPROBED." After the status changed, the bottom line prompt will return to the slot selection again. As of Main/RTM Software REV DB, an enhancement allows you to view the current cassette status while doing cassette status editing. Press < ENTER > to exit the screen.

Added 6/96

The PROCESS slot can be edited only if the wafer in this slot no longer exists on either the chucktop, quick loader, or prealigner. The LOST slot can be edited too, if a wafer is inserted manually; the operator also can insert a wafer from the single wafer handling station. The slot status will be changed according to your input.

4.5.4 Other Loading Information

4.5.4.1 RECOVERY PROCESS

The system offers a choice to abort unloading the wafer from the chucktop while in the "recovery" process. The message has been changed to:

`UNLOAD WAFER FROM PROBER OR PRESS "Y" TO ABORT.`

4.5.4.2 ATTEMPTING AUTO−LOAD WITH COMMUNICATIONS DOWN

If you attempt to enable auto−load when prober−handler communication is not working, the message `"MH COMMUNICATION FAILURE"` followed by `"OPTION NOT ENABLED"` will appear and the auto−load state will be `"DIS"` (disabled).

4.5.4.3 TIMEOUT DURING LOADING

If, during wafer loading, you press < PAUSE/CONT > and causing a timeout, the chuck (and the wafer) move away from the load area and the quickloader is raised.

4.5.4.4 CORRECTING LOAD PROBLEMS

Certain Material Handler conditions may prevent a wafer from being loaded until the condition is corrected. The conditions and the corresponding messages displayed are:

`"HANDLER COVER IS UNLATCHED"` (msg# 95)

`"HANDLER DIAGNOSTICS IN PROGRESS"` (msg# 99)

`"*EMERGENCY HANDLER STOP"` (msg# 119 − XIO alarm)

If any of these conditions are detected at the beginning of a wafer load that is *not* part of autoprobing, the load aborts and the message is displayed.

If any of these conditions are detected at the beginning of a wafer load which *is* part of autoprobing, the message is flashed continually until the condition is corrected or the load is paused. This may be done with the < PAUSE/CONT > key.

If one of the above handler conditions is caused *after the load has started,* then one of the above messages will appear but will not flash. The load problem must be cleared by the operator or the load may be aborted by use of the < PAUSE/CONT > key.

Added 6/96

NOTE:	See the supplement at the end of the section for more information about the Emergency Stop routine, as well as two new error conditions.

4.6 PROCESSING WAFERS

CAUTION

Keep hands off the Forcer/Platen surfaces, Transfer Arm, Cassette Platform and other moving parts during operation or maintenance to prevent equipment damage and/or personal injuries.

The process of moving wafers from the cassette to the various stations en route to the chucktop is called *pipelining*. Because of the volume of software operations needed to move wafers through the pipeline, many occurring simultaneously, an occasional delay will occur. As of ProberVision Software REV DB, you may require the prober to include placing a wafer on the prealign station as part of the pipeline.

Added 6/96

To begin the pipelining process:

1. Press < XFER WAFER >. The platform will move down and you will be prompted to close the cover.

   If required, the handler will then search for the next available wafer. The handler forcer will move the wafer to the prealign station. Following the mode and parameters selected, the machine will continue to process the loaded wafers.

   If the transfer arm contains a wafer destined for the single wafer handling station when it is already occupied, the arm will move to the single wafer handling station and wait. The beeper will sound continuously until you remove the wafer from the station, and when it is clear, the transfer arm will deposit its wafer.

2. To open the cover at any time, press < LD/UL CASS >. The cover may be opened after the forcer has completed its current process. After the cover has been opened, the cassette platform tilts back automatically. You may select the next cassette to process, using the appropriate key < 1 > or < 2 >, while the cover is open.

   You also may remove a completed cassette while another cassette is being probed*. (Do *not* lift slightly or remove any other cassette that is on the platform when removing a completed cassette.)

   Press < XFER WAFER > again and close the cover if there are cassettes being probed. Or, if only one cassette was installed and probed, wait to close the cover until another cassette of wafers has been installed.

* *TYPE 3,* see **Appendix A, Customer Special.**

3. Use the following procedure if processing of any cassette is interrupted and you wish to resume:

   A) Ensure that the handler is toggled to Handler mode, using the < PROBE HDLR > key. After the cassette is replaced in its previous location (it is important to replace it in its *original* location on the platform), press < RECOVER >. The screen will prompt: “CASSETTE (number) CHANGED (Y/ENTER)?”

   B) To answer yes, press the < Y > key.

   If more than one cassette is partially processed and has been removed and replaced, the monitor will display the prompt by number for each cassette.

Added 6/96

As of Main/RTM Software REV HD, Handler State information will be shown on the RUN TIME DISPLAY ninth line in the following format:

```
PROCESSING STATE                    COVER STATE
```

The processing states are:

```
WAFER-XFER
MAPPING
RECOVER
IDLE
```

The cover states are:

```
COVER OPEN
COVER CLOSED
```

4.6.1 Accessing the Single Wafer Handling Station

Added 6/96

To access the single wafer handling station, press the < IMM OP MENU > key, and the Handler Immediate Operation Menu will appear (*Figure 4−13*). As of Main/RTM Software REV HF, a submenu added into each of the first three items prompts for choices of destination or source.

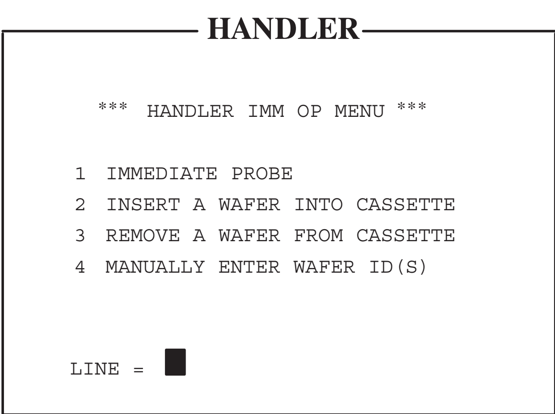


FIGURE 4−13: HANDLER IMMEDIATE OPERATION MENU

If you select Line 1, a prompt will ask for the wafer ID. Press the key(s) to identify the wafer, open the handling station drawer, then press < ENTER >. A prompt will ask you to place the wafer on the station and close the handling station drawer. If wafers are present on the prealign or quickload station, they will be removed to make way for the “immediate” wafer.

To insert a wafer (Line 2), press the < 2 > key and < ENTER > to see the display illustrated in *Figure 4−14*.

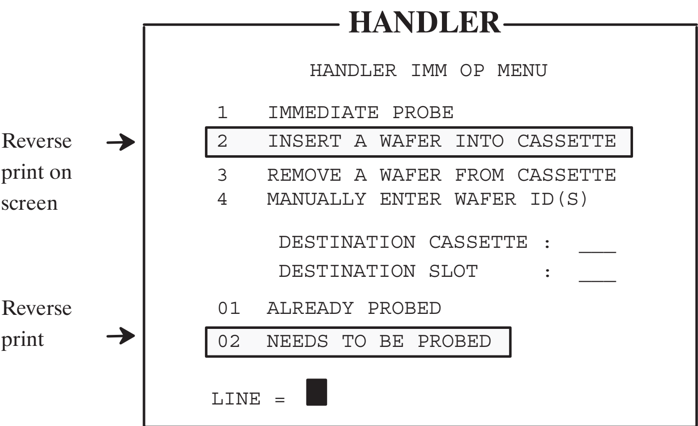


FIGURE 4−14: SCREEN DISPLAY FOR LINE 2 (INSERT A WAFER)

After you have identified and entered the “destination cassette” (1−2) and “slot” (1−25), a message will tell whether or not the cassette or slot is available. If it is not, the message will appear, "DESTINATION NOT AVAILABLE."

In the *Figure 4−14* example, Line 2 shows that the status of the current wafer is "NEEDS TO BE PROBED." This triggers the message:

```
DISPOSITION : 2
PUT WAFER ON STATION, THEN
PLEASE PRESS "ENTER"...
```

To remove a wafer while in the menu, press < 3 >. To manually enter wafer IDs, press < 4 >. The handler will display either "NONE" or place the available wafer on the single wafer handling station and ask for the ID, as in:

“ID __________” (either all blank or with partial data if it has read any)

Fill in the missing data; a prompt will then ask: "CONTINUE?"

Answer by pressing the < Y > and < ENTER > keys.

If the prober or handler detects a malfunction, input error, or other problem, an error message will be displayed on the screen in either handler or prober mode.

4.6.2 Removing/Inserting Specific Wafers

To remove a specific wafer for inspection or another reason, use the following procedure:

1. Press the < IMM OP MENU > key. From the Handler Immediate Operation Menu, select Line 3, REMOVE A WAFER FROM CASSETTE. Enter the cassette and slot number of the wafer to be inspected.

2. Remove the wafer from the single wafer handling station.

3. To re−insert the wafer, press the < WAFER COVER > key, and select Line 2, INSERT A WAFER INTO CASSETTE. Place the wafer on the handling station and close it. Enter the cassette and slot number.

4. As prompted, select the correct status (1 − `ALREADY PROBED`, or 2 − `NEEDS TO BE PROBED`). Press < ENTER > twice. The wafer will be returned to its slot.

See the Supplement at the end of the section for more information about removing and inserting specific wafers.

When removing a wafer from the system via the single wafer handling station, the wafer ID is displayed when available. When inserting a wafer into the system using the station as the entry point, you have the option of adding the wafer ID if `ALREADY PROBED` is selected.

4.6.3 Correlation Tray (SMIF−E™ Machines)

The correlation tray in SMIF−E™ equipped probers is in a fixed position with wafer introduction through one slot in a cassette. Because the 4085X has no hold station and the correlation tray is not accessible on the SMIF−E™ model (which also does not include the wafer inspection function), the processes of correlation wafer insert, immediate probe, and orphan wafer transfer have been modified.

To handle the processing of these intervention wafers, a different Immediate Operation Menu is provided *(Figure 4−15).* To access this menu, press the < IMM OP MENU > (< F7 >) key. This menu is accessible from either the **LD/UL CASS** or **XFER WAFER** state, but only items 5 and 6 are available from the **LD/UL CASS** mode.

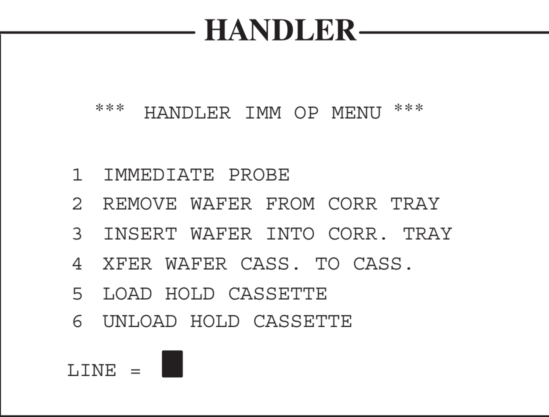


FIGURE 4−15: HANDLER IMMEDIATE OPERATION MENU (SMIF)

4.6.3.1 "HOLD CASSETTE" DEFINED

In the absence of a hold station on the 4085X machine, the source and destination of a wafer to be processed will be a cassette. This can be a "normal" cassette which is loaded while in **LD/UL** mode, or a cassette which is loaded from the Immediate Operation Menu, Line 5, LOAD HOLD CASSETTE. The latter cassette is called a "Hold Cassette".

After the Hold Cassette is placed on the platform, the status of all slots is designated as `EMPTY`, until a wafer is transferred into each slot. The status of the wafers in the Hold Cassette is different from the status of the "normal" cassette.

The messages for the Hold Cassette are:

CORR WF: The wafer in the slot is a correlation wafer which was removed from the correlation tray.

ORPHAN: The wafer is an orphan wafer from any station.

IMM RDY: The wafer is specified by the operator to be probed immediately and is awaiting processing.

IMM PROC: The "immediate probe" wafer is out of the cassette and in process. It may be on the chuck, quick loader, or prealign station. The Hold Cassette containing the `IMM PROC` wafer cannot be unloaded.

IMM DONE: The wafer was probed and returned to the original slot.

4.6.3.2 IMMEDIATE OPERATION MENU (SMIF−E™) LINE ITEMS

For menu items 1, 2, and 3, you will be asked to follow the instructions on the screen to load a new Hold Cassette if there is no cassette installed on the platform, or to specify a currently loaded cassette.) The line items are explained below.

LINE 1: IMMEDIATE PROBE

The processing of a wafer to be probed immediately is the same as that on the 3001X machine, except that the wafer is transferred from a cassette instead of the correlation tray. After immediate wafer processing has been completed, the wafer is returned to its original slot.

LINE 2: REMOVE WAFER FROM CORRELATION TRAY

When a wafer is removed from the correlation tray into the Hold Cassette, it keeps its original status − for example, `CORR WAFER` or `ORPHAN`. If the wafer is transferred to a "normal" cassette, the status will be `PROBED`. (As of Main and RTM Software REV HJ, the system allows you to repeat the immediate probe operation through the Correlation Tray without removing and then re−inserting the wafer.

Added 6/96

LINE 3: INSERT WAFER INTO CORRELATION TRAY

A wafer is removed either from the "normal" cassette or the Hold Cassette into the correlation tray as a correlation wafer.

LINE 4: TRANSFER WAFER CASSETTE TO CASSETTE

A wafer is transferred from one cassette to another.

LINE 5: LOAD HOLD CASSETTE

To load a Hold Cassette, press < F5 >, then < ENTER > . A message will display telling whether or not any cassette is installed on the platform. If a cassette is present, the handler will display the type of cassette.

LINE 6: UNLOAD HOLD CASSETTE

This item allows the operator to unload only the Hold Cassette. If the cassette requested by the operator is not a Hold Cassette or is not present, a message displays stating that the cassette is unavailable.

Before cassette loading/unloading, the Material Handler will finish its current task of transferring the wafer, or terminate the mapping task if mapping is in progress. If the cassette to be processed is cassette−2 and the system is a SMIF−E™ model, the wafer on the prealign will be returned to the device where it belongs.

4.6.3.3 ORPHAN WAFERS

When an `ORPHAN` wafer is unloaded from the chuck or from any other station, it will be placed into the next available slot of the Hold Cassette. If the Hold Cassette is not currently loaded on the handler platform, the wafer will be transferred to the correlation tray if it is not occupied.

If neither of these options is available, a warning message will appear and the beeper will sound continuously until the operator can clear it. Meanwhile, the process of unloading from the chuck will be terminated as an emergency stop occurs.

4.7 MAINTENANCE MENU

The Material Handler uses a set of diagnostic programs and procedures to test operation of specific functions.

When operating diagnostic programs with wafers in the system to test wafer transfer functions, use only wafers that are expendable.

The diagnostics have been designed to allow the technician full control and flexibility. In the absence of built−in safeguards, take special care to note the position of the various components − especially the transfer arm − before any motion takes place, to avoid damage to the machine.

For safety purposes, please keep hands off all moving parts during operation and maintenance.

In Main and RTM Software REV H, the option “−99”, (similar to −99 in the Set Parameters Menu), was added to the Material Handler Diagnostic Menu for enabling or disabling the RTM handler screen upon first time power−up of the handler, or when the battery back−up RAM becomes corrupted or unusable.

Added 6/96

When the < DIAG > key is pressed, software and hardware revision levels for the Material Handler Subsystem will be displayed (*Figure 4−16*).

```
HANDLER
 * HANDLER SYSTEM HW/SW STATUS *
    REVISION      HW       SW
 MAIN SYSTEM..... 00       EC
 SYSTEM I/O...... 00
 LINEAR MOTOR.... 01       D
 TRANSFER ARM.... 00       B
 PREALIGN........ 00       B

 PRESS "Y"        TO EXIT
       "ENTER"    TO CONTINUE
```

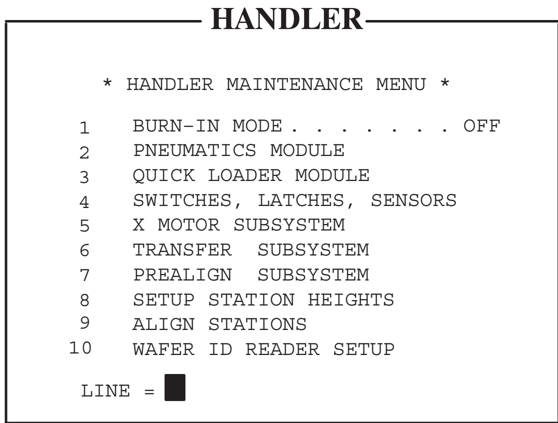
FIGURE 4−16: STATUS DISPLAY SHOWING REVISION LEVELS

Similarly, for each individual diagnostic menu, the hardware and software levels will be displayed under the menu name. For example:

```
** PREALIGN SUBSYSTEM **
 HW REV. 00   SW REV. B
```

When < ENTER > is pressed from the Handler System Status Menu, the Handler Maintenance Menu will appear (*Figure 4−17*).

To access the individual corresponding programs, press the numbered key and < ENTER >. To exit each menu, press < ENTER >. Each program and menu is described in the following pages.



```
HANDLER
   * HANDLER MAINTENANCE MENU *

 1   BURN-IN MODE . . . . . . . OFF
 2   PNEUMATICS MODULE
 3   QUICK LOADER MODULE
 4   SWITCHES, LATCHES, SENSORS
 5   X MOTOR SUBSYSTEM
 6   TRANSFER  SUBSYSTEM
 7   PREALIGN  SUBSYSTEM
 8   SETUP STATION HEIGHTS
 9   ALIGN STATIONS
10   WAFER ID READER SETUP

 LINE = █
```

FIGURE 4−17: HANDLER MAINTENANCE MENU

4.7.1 Handler Maintenance Menu Line Items

LINE 1 – BURN–IN MODE

The burn–in mode is used to cycle the handler for testing purposes.

When Burn–In is enabled, the operation of the machine is identical to normal probing modes except that when the last wafer is processed, the system will remap the cassettes and reprocess the wafers rather than stop and display the "ALL WAFERS PROCESSED" message.

When Line 1 is selected, the prompt reads:

```
TOGGLE BURN IN MODE (Y/ENTER)?
```

Line 1 will indicate the current status ("ON" or "OFF"). Press < Y > to toggle the status; press < ENTER > to leave the status unchanged and return to the Maintenance Menu.

LINE 2 – PNEUMATICS MODULE

This program is used to manually control all the air and vacuum solenoids in the handler system, and also show the current status of three sensors. The Pneumatic Module Menu is shown in *Figure 4–18*, with the submenu of explanation.

Watching the screen for confirmation, press each key (1 to 9, A to E) to toggle each associated servovalve or pressure switch on/off. Because the system is air–operated, you should be able to hear each servovalve as it activates.

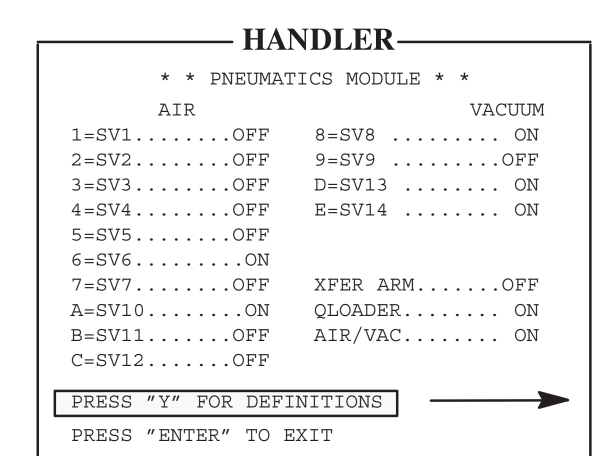
The status of the three sensors is constantly displayed:

TRANSFER ARM AND QUICKLOADER

The status display indicates whether a wafer is on the transfer arm/quickloader arm. The vacuum must be on for the sensors to function properly (SV9 for the transfer arm; SV14 for the quickloader arm).

AIR/VAC

Indicates the condition of the air/vacuum supplies. If either drops below minimum requirements, the status will change from on to off.



DEFINITIONS

The definitions obtained by pressing < Y > in the Pneumatics Module Menu identify the solenoids.

Press < ENTER > to return to the Pneumatics Menu.

HANDLER

```
* * PNEUMATICS MODULE * *

SV1    =   CASSETTE PLATFORM
SV2    =   CASSETTE DRAWER LATCH
SV3    =   PREALIGN SPINDLE AIR
SV4    =   TRANSFER ARM AIR
SV5    =   HOLD STATION CRESCENT
SV6    =   PREALIGN CRESCENT
SV7    =   HOLD STATION AIR
SV8    =   PREALIGN SPINDLE VAC
SV9    =   TRANSFER ARM VAC
SV10   =   X-MOTOR AIR BEARING
SV11   =   SPARE
SV12   =   WAFER SENSOR AIR
SV13   =   HOLD STATION VAC
SV14   =   QUICK LOADER VAC

PRESS "ENTER" TO CONTINUE
```

FIGURE 4–18: PNEUMATICS MENU AND SUBMENU

LINE 3 – QUICKLOADER MODULE

This menu (*Figure 4–19*) exercises the quickloader arm. Press the key shown in the menu to cause the following action:

< BS >	(Backspace) and < . > raise/lower the arm by steps.
< 1 >	raises the arm to the Up limit,
< 2 >	lowers it to the Down limit.
< 3 >	toggles the vacuum.

The Up/Down sensor status indicates whether the quickloader is in the raised or lowered position. (Both sensors may show off if the arm has been single–stepped to some intermediate point, but they should never both show on which would indicate a sensor failure.)

The Vacuum sensor indicates the presence of a wafer on the quickloader arm. (The quickloader vacuum must be on for this sensor to function properly.)

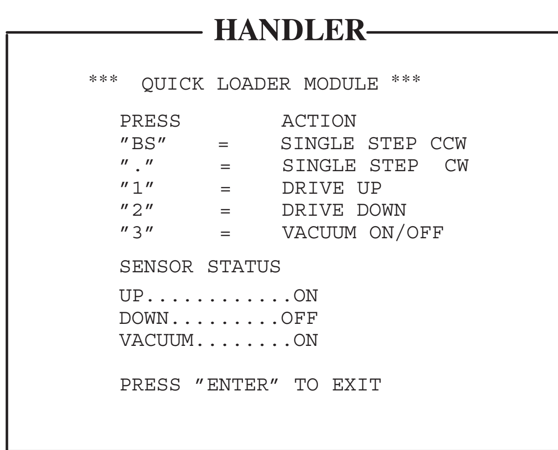


FIGURE 4–19: QUICKLOADER DIAGNOSTIC MENU

LINE 4 − SWITCHES, LATCHES, SENSORS

The Switches, Latches, Sensors Menu (*Figure 4−20)* exercises and monitors various controls not covered elsewhere. As a component is physically actuated, read its condition on the screen.

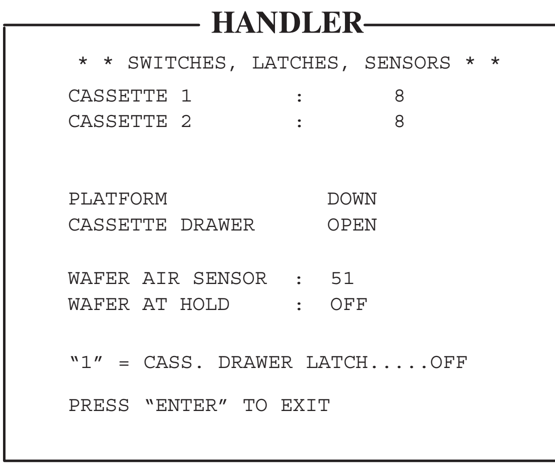


FIGURE 4−20: SWITCHES, LATCHES, SENSORS MENU

The first two lines give the condition of the 8 cassette−presence sensors; each relates to a cassette size and position. The air sensor valve indicates the operation of the pressure transducer and analog−to−digital electronics.

Other controls:

PLATFORM AND CASSETTE DRAWER

Shows current position of cassette platform/drawer. If neither Up nor Down (Open/Closed) is displayed, the platform/drawer is stuck at an intermediate position or a sensor has failed. If both are displayed, there is a sensor failure.

See the Supplement at the end of the section for information about adjusting air sensor values.

WAFER AIR SENSOR

The number displayed (0 to 255) indicates the condition of the transducer for the transfer arm wafer presence sensor. This number should be 160 if the sensor air is on and no wafer is present; or 255 if the sensor air is on and a wafer is on the transfer arm. If the air is off, the number displayed should be 60 regardless of wafer presence.

WAFER AT HOLD

Current status of wafer−presence sensor; wafer on or off. Should confirm visual check.

CASS. DRAWER LATCH

Press < 1 > to toggle the latch on/off. This feature is used to check the drawer open/closed sensors as well as the latch itself.

LINE 5 – X MOTOR SUBSYSTEM

Exercises the motor providing linear motion for the wafer transfer tower (*Figure 4–21*).

HANDLER

```
* * X-MOTOR SUBSYSTEM * *
HW REV. 01      SW REV. F


"1"  =  INITIALIZE MOTOR
"2"  =  MOVE  MOTOR .......   9496
"3"  =  AIR BEARING .......ON


        ! ! WARNING ! !
TRANSFER ARM MAY NOT BE IN A
SAFE POSITION. PLEASE TAKE
CARE WHEN REQUESTING X MOVES.

PRESS "ENTER" TO EXIT
```

FIGURE 4–21: X–MOTOR SUBSYSTEM MENU

< 1 > sends the motor to the Home position.

< 2 > displays the linear motor position which is constantly updating, even when the motor is blanked.

Both moves initiated by keys < 1 > and < 2 > will be attempted regardless of the transfer arm position. A number entered causes the motor to move. Positive numbers move the motor toward the front of the machine, negative numbers, towards the rear. A number too large will produce the message:

```
SORRY, MOVE IS OUT OF RANGE
```

After the move has been completed, the current distance from the Home position in mils is displayed.

< 3 > causes the air bearing supply solenoid to be toggled on/off.

If the air bearing is off and < 1 > is pressed, the air bearing will be turned on before the motor initializes. However, the display will not indicate this until initialization is complete. If < 2 > is pressed with the air bearing off, a message will inform:

```
SORRY, AIR BEARING IS OFF
```

LINE 6 − TRANSFER SUBSYSTEM

Exercises the transfer arm (*Figure 4−22*).

```
                HANDLER
       ***  TRANSFER SUBSYSTEM  ***
          HW REV.00 SW REV. C
      "1" =  INITIALIZE THETA
      "2" =  INITIALIZE Z
      "3" =  MOVE  THETA
      "4" =  MOVE  Z
      "5" =  VACUUM .....OFF
      "6" =  AIR.........OFF
      "7" =  SENSE AIR...OFF

      THETA QUADRANT    4
      Z REAR SENSOR.....BOTTOM
      Z FRNT SENSOR.....UP
      VACUUM SENSOR ....OFF
      WAFER SENSOR......48

       PRESS "ENTER" TO EXIT
```

FIGURE 4−22: TRANSFER SUBSYSTEM MENU

In the moves triggered by keys < 1 >, < 2 >, < 3 >, and < 4 >, the moves will be attempted regardless of impediments or obstacles which may be in the path of the arm.

< 1 > rotates the arm to Home, parallel to the X rail and pointing to the front.

< 2 > lowers the arm to Home. Theta must be 0 or 12000 to allow one of the Z down sensors to be found. If the arm is obstructed, the motor will stall but continue trying to lower the arm.

< 3 > generates the message:

```
MAX RANGE = 0 to 18000
RELATIVE MOVE IN STEPS:
```

Number entry rotates the arm − positive, counterclockwise; negative, clockwise. A number too large will produce the message:

```
SORRY, MOVE IS OUT OF RANGE
```

The current position of the arm is displayed.

< 4 > generates the message:

```
MAX RANGE = 0 TO 9595
RELATIVE MOVE IN MILS:
```

Entry of a positive number raises the arm, negative lowers it; an oversize number will produce the "MOVE OUT OF RANGE" message.

< 5 >, < 6 >, and < 7 > toggle the transfer arm vacuum, air supply, and wafer sense air supply solenoids, respectively, on/off.

The sensor diagnostics indicate...

THETA QUADRANT

... which of the four possible quadrants the transfer arm is in currently. If position displayed is contrary to actual position, adjustment is needed or a sensor has failed.

Z REAR SENSOR
Z FRNT SENSOR

... that the arm is fully down (Bottom) and pointing at the front of the machine, or not fully down (Up) or is rotated so that the sensor is not found.

VACUUM SENSOR

... the presence of a wafer on the transfer arm using the vacuum sensor. The vacuum solenoid must be on (key < 5 >) for the sensor to function properly.

WAFER SENSOR

... the presence of a wafer on the transfer arm using the profiling air sensor. If the wafer air sense is off (key < 6 >), this number should be 60 regardless of the presence of a wafer. If the sense is on, this number should be 160 with no wafer, or 255 with a wafer on the arm.

LINE 7 − PREALIGN SUBSYSTEM

See the Supplement at the end of the section for information about the CCD Prealign Subsystem Menu.

This program exercises the prealign station and is especially useful when changing the machine from one size wafer to another (*Figure 4−23*).This menu also appears automatically when a prealign failure occurs and is acknowledged, if the prealign fail option has been enabled on the handler Set Mode Menu.

Keys < BS > (Backspace) and < . > rotate the prealign spindle counterclockwise and clockwise, respectively, one motor step (0.5 degrees).

HANDLER

```
  ***  PREALIGN SUBSYSTEM  ***
      HW REV.00 SW REV.

"BS"  =   SINGLE STEP CCW
"."   =   SINGLE STEP CW
"1"   =   SPINDLE ROTATE
"2"   =   ALIGN TO MAJOR FLAT    N-F
"3"   =   ALIGN TO MINOR FLAT    N-F
"4"   =   SPINGLE AIR...........OFF
"5"   =   SPINDLE VACUUM .......OFF
"6"   =   CENTERING SEGMENT ... OUT

WAFER PRESENT SENSOR........ON
FLAT FIND     SENSOR........OFF

PRESS "ENTER" TO EXIT
```

FIGURE 4−23: PREALIGN SUBSYSTEM MENU

< 1 > produces the message:

```
RELATIVE MOVE IN STEPS:
```

which prompts for a number. Positive numbers rotate the prealign spindle clockwise, negative numbers, counterclockwise.

< 2 > causes the system to attempt to find the major (or only) flat, key < 3 >, the minor flat (or notch). In each event, if there is no wafer on the spindle, a message appears:

```
PLACE WAFER ON SPINDLE, THEN
PRESS "ENTER" TO CONTINUE
```

The spindle vacuum will be turned on, if not already so. The centering segment moves in, and then back out after a short delay. The spindle will then rotate and search for the flat. If successful, the command line reports the status as "OK;" otherwise, "N-F" (Not Found).

Spindle solenoids are toggled on/off by keys < 4 > (air supply), < 5 > (vacuum supply), and < 6 > (centering segment).

The status of two sensors is shown on the menu and should confirm visual observation. The wafer present sensor indicates whether there is (on) or is not (off) a wafer at the prealign station. The flat find sensor indicates whether the flat is at the sensor (on – no wafer seen) or not (off – wafer seen).

LINE 8 – SET STATION HEIGHTS

In the Set Station Heights Menu (*Figure 4–24*), select one of three available station heights. The system will display the submenu illustrated.

< 1 >, < 2 > or < 3 > followed by < ENTER > moves the forcer to the location indicated and rotates its transfer arm into position.

LINE 9 – STATION ALIGNMENT

Some diagnostic functions presented in transfer arm and linear motor menus are also available in the Station Alignment Menu (*Figure 4–25*). The combinations of control functions of both the transfer arm and linear motor allows the platforms and stations to be aligned effectively without swapping menus.

In the balance of the menu, the numbered lines indicate keys which, pressed and followed by < ENTER >, move the forcer to the location indicated.

< 1 > initializes the X motor at the Home (rear) position.

< 2 > moves the transfer arm to the prealign spindle at the right height. The prealign platform can now be positioned to center it properly relative to the arm.

< 3 > moves the transfer arm to the cassette platform at each position of cassette allowing the platform to be positioned for centering relative to the arm.

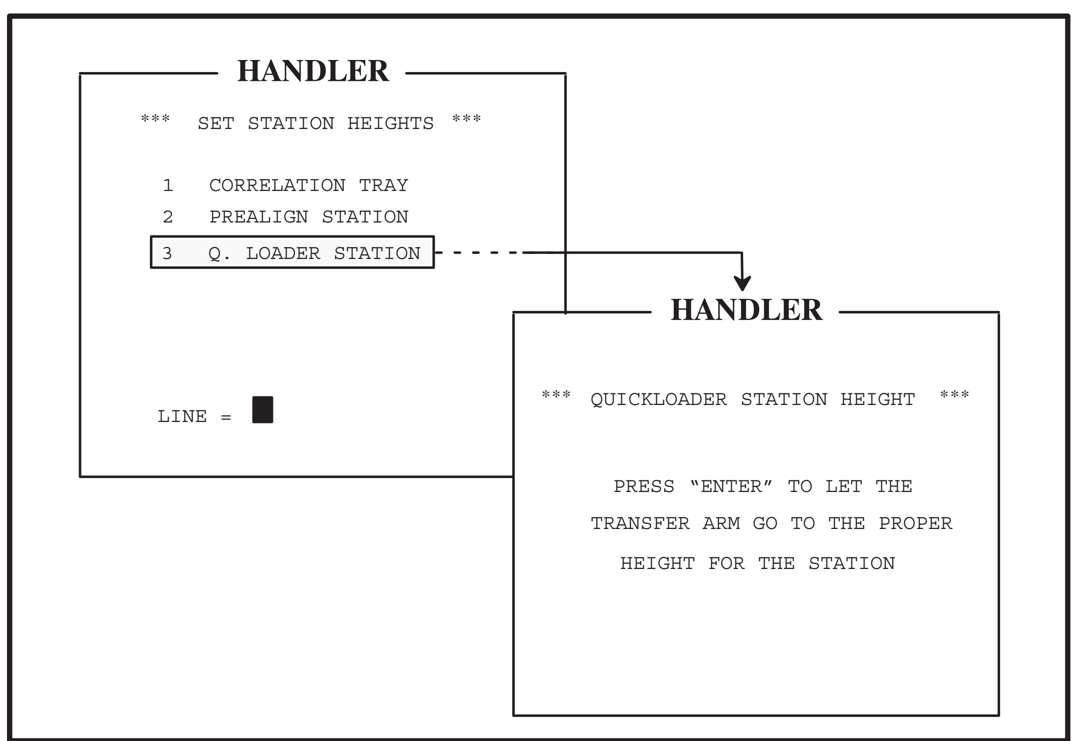


FIGURE 4–24: SET STATION HEIGHTS MENU AND SUBMENU

< 4 > rotates the transfer arm to the Home position, then moves the arm in Z until the bottom sensor is found.

< 5 > rotates the transfer arm from 0 to 6000 (which points it toward the right side of the machine) or from 6000 to 0 (pointing it towards the front), depending on the initial position. When < ENTER > is pressed again, the arm will rotate to 0 if not already there, and return the Maintenance Menu display.

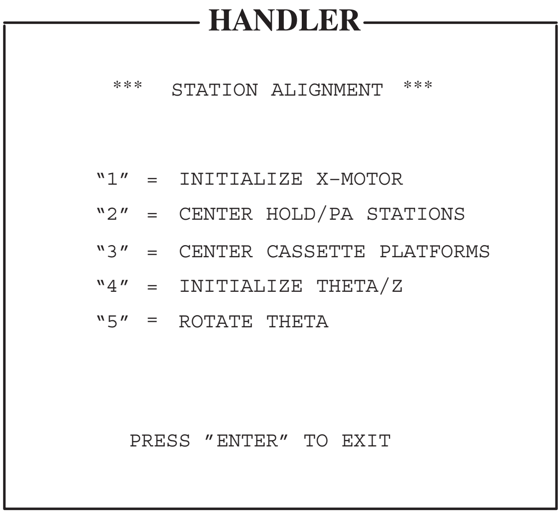


FIGURE 4–25: STATION ALIGNMENT MENU

LINE 10 − OCR READER SETUP

This display, illustrated in *Figure 4−26*, addresses non−EG OCR systems. The last line shows the wafer ID number after the OCR has read it.

If EG/OCR has been enabled through the Handler Set Mode Menu, this line will produce the EG/OCR Setup Menu. The setup procedure for the EG OCR system is given in **Section 13, OCR / BACK SIDE BAR CODE READER.**

HANDLER

```
 ***   OCR READER SETUP ***

ID POSITION...............0

PRESS "<-" AND "." TO ROTATE
PRESS "RUN-ID" TO READ
PRESS "ENTER" TO EXIT

ID =
```

FIGURE 4−26:   OCR READER SETUP MENU

4.8 SUMMARY

In this section, you have learned:

- Descriptions of major assemblies
- How to position the cassette on the platform
- Material Handler operating procedures, including setting up and enabling the Handler
- Menus relating to the Material Handler
- Wafer loading and unloading procedures, including for SMIF−E™ equipped machines
- Wafer processing procedures
- How to access the Single Wafer Handling Station in a standard machine, and the Correlation Tray in the SMIF−E™ equipped machine
- Using the Material Handler Maintenance Menu to run diagnostics and tests

THIS IS A “WORKING COPY” OF CHANGES AND ADDITIONS, INCLUDING ALL THE ITEMS WHICH WILL BE ADDED TO THE SECTION BY EITHER MARGIN BAR OR SUPPLEMENT. THE INTENT IS TO HAVE A REFERENCE OF ALL NEW MATERIAL INCORPORATED IN THIS PARTICULAR GIG. WHERE POSSIBLE, THE SMALLER ITEMS WILL BE ADDED DIRECTLY TO THE MANUAL WITH MARGIN BAR REFERENCES, A FINAL SUPPLEMENT WILL BE CREATED, AND A PRINTOUT OF THIS “WORKING COPY” WILL BE RED–LINED WITH NOTATIONS ABOUT THE DISPOSITION OF EACH ITEM.

CHANGES ARE CLONED FROM 2000 SERIES SUPPLEMENT 11/95; THIS SUPPLEMENT ORGANIZED 6/96.

SUPPLEMENT

MATERIAL HANDLER

SECTION 4 – REV B

This supplement describes additions and changes that apply to Section 4, Material Handler. This information will be incorporated into the section with the next revision. This information supplements the new or changed material in the manual temporarily identified by the dated bar in the margin. The margin bar is often used when updates can be made without changing pagination or section REV letter.

In the heading below, the box at the right classifies the information by the subsection to which it relates and the title of that subsection.

EXPANDED INFORMATION	**REF:** SECTION 4.2.5 SINGLE WAFER HANDLING STATION

Main and RTM Software REV HD
(Material Handler)

The Single Wafer Hold (or Handling) Station (SWHS – formally known as the correlation tray) is equipped with three wafer size sensors and a latch. The MH controls the latch to prevent the tray from being opened during wafer transfers. It also has a sensor to detect if the tray is opened or closed.

UPDATE CHECK FOR PRESENCE	**REF:** SECTION 4.3 CASSETTE POSITIONING

Main and RTM Software REV HF
(Material Handler)

The handler now checks for the presence of the cassette before inserting a wafer into the cassette or removing a wafer from the cassette. An emergency stop will be handled if the cassette is not present.

UPDATE LOW AIR ON POWER−UP

REF: SECTION 4.4 SETTING UP AND ENABLING THE HANDLER

Main and RTM Software REV HF
(Material Handler)

The handler now displays "WAFER SENSOR IS OUT OF TOLERANCE" and allows the operator to adjust the air sensor if the air is low after power−up.

UPDATE RTM LIMITATION

Main and RTM Software REV HJ
(Material Handler)

A wafer on the quickloader must be removed prior to power−up to avoid an Emergency Stop error following the initialization process.

UPDATE DEFAULTING OF VARIABLES

ProberVision Software, REV DA

The defaulting of global prober−handler variables (wafer unload reason, pipelining state, etc.) is only done on prober power−up. This avoids the unloaded wafer status from being changed to UNPROBED after a **DS** command.

Prober−handler communication initialization and transfer of the setup block to the handler occurs only at the following times.

a) Power "ON" with autoload enabled (read from battery−backed ram or default file)

b) Autoload enabled via menu or XIO.

c) Setup downloaded with autoload set to enabled (via XIO or disk file load).

UPDATE
“NOTCH” MESSAGE

REF: SECTION 4.4.1.2
SET MODE MENU LINE ITEMS

Main and RTM Software REV HF
(Material Handler)

If `“NOTCH”` is selected, the Prealign Subsystem and Fail Assist Menus will display options to `“ALIGN TO NOTCH”`.

ENHANCEMENT
VACUUM SENSE IMPROVEMENT

Main and RTM Software REV HB
(Material Handler)

Three new options have been added for real time wafer sense in the Handler Set Mode Menu Line 07:

0 = `“OFF”`	Disables real time wafer sense, as in prior software
1 = `“AIR”`	Utilizes the transfer arm air sensor
2 = `“VAC”`	Utilizes the transfer arm vacuum

To avoid the improper vacuum sense after the pneumatic module is modified, the M/H software has been corrected to ensure that the vacuum solenoid (SV9) is turned off before the air solenoid (SV4) is activated.

In addition, if the vacuum solenoid is not activated, the system will always show no wafer sensed under normal conditions, but will show the real vacuum sensor status in the Diagnostic Menu.

ENHANCEMENT
PROMPT FIELD FOR WAFER SIZE

Main and RTM Software REV HD
(Material Handler)

A new prompt field `“SETUP FOR WAFER SIZE .... N INCH”` has been added to the F2 screen of the Handler Set Mode Menu. This field must be set to the correct size *prior to* entering the OCR Setup Menu. This becomes the “current size”.

All other prealign and OCR parameters may now be set. You will not be allowed to change size if the TRANSFER or READ_ID task is running.

A new prompt field `“STOP BETWEEN CASSETTES”` has also been added. This field has three possible settings that are examined every time a cassette has completed processing. The settings are:

0 = `DISABLED`
1 = `STOP ONLY IF DIFF SIZE` *(if next cassette is different size)*
2 = `ALWAYS STOP`

UPDATE
NEW LINE 07

REF: SECTION 4.4.1.3
SET PARAMETER MENU LINE ITEMS

Main and RTM Software REV HD
(Material Handler)

A Line 07, "UNREADABLE CHAR ......" has been added to the Handler Set Parameter Menu because it becomes unaccessable from the prober side on the 3001X or 4085X.

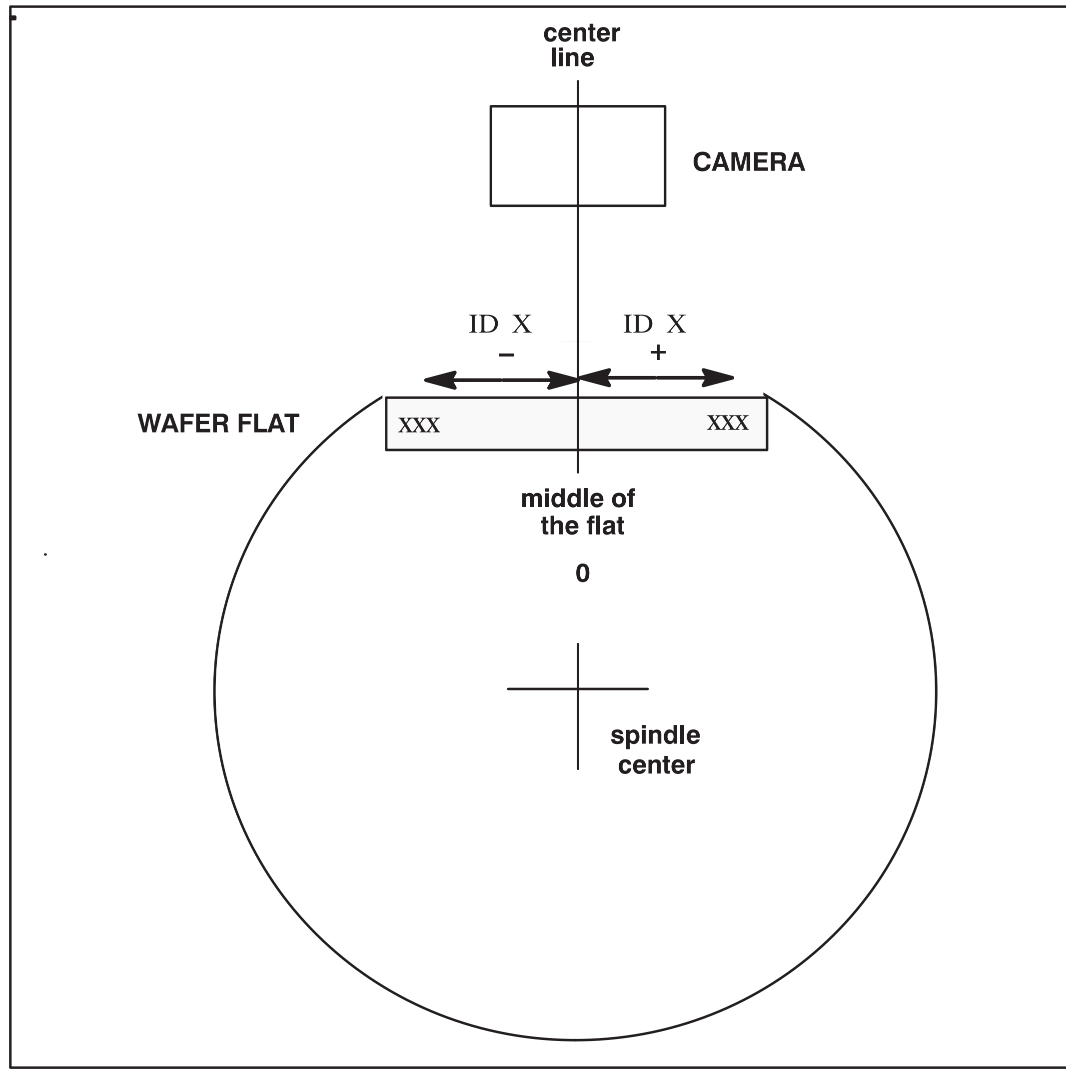
UPDATE
NEW LINE 08

Main and RTM Software REV HF
(Material Handler)

In order to handle different wafer sizes with ID position located at non−middle position and the camera mounted at 0 degree location in an AWS machine, a new item has been added to the Set Parameter Menu:

`08  ID LOCATION X  ...... xxx MILS` (default 0 mils)

The concept is illustrated below.



The "ID LOCATION X" is the linear distance from the center of the flat to the center of the ID string. The range of ID location X is:

−1000 to 1000 mils for a 6−inch wafer
− 750 to 750 mils for a 5−inch wafer

If the "ID LOCATION X" is not "0", an extra motion will be involved before the wafer can be placed to the camera read position. It is suggested that if the distance of the ID string away from the flat mid−point is within 450 mils, there is no need to set "ID LOCATION X".

UPDATE NEW MESSAGE	**REF:** SECTION 4.5 WAFER LOADING

Main and RTM Software REV HJ
(Material Handler)

For the SMIF machine, a message is displayed asking the operator to remove the wafer from the transfer arm before initialization.

UPDATE ID DISPLAY	**REF:** SECTION 4.5.1 STANDARD LOADING/UNLOADING

Main and RTM Software REV HF
(Material Handler)

The handler's Cassette−ID Status now has two pages to display the whole wafer ID string for each cassette.

UPDATE PIPELINING OPTION

ProberVision Software, REV DB

A new feature allows the user to require the 4085X prober to include placing a wafer on the prealign station as part of the pipeline.

UPDATE NEW MESSAGE	**REF:** SECTION 4.5.3.2 EDIT CASSETTE FEATURE

Main and RTM Software REV HF
(Material Handler)

If the cassette cover is closed when the < CASS EDIT > key (< F8 >) is pressed, the handler will display a message `"CASS COVER NOT OPEN"`.

Main and RTM Software REV DB
(Material Handler)

An enhancement was made to allow the operator to view the current cassette status while doing cassette status editing.

UPDATE
EMERGENCY STOP IMPROVEMENTS

REF: SECTION 4.5.4
OTHER LOADING INFORMATION

Main and RTM Software REV H
(Material Handler)

When an Emergency Stop occurs, the first press of the < ENTER > key will silence the alarm. Further presses of the < ENTER > key will operate as presently defined for Emergency Stop conditions. When an Emergency Stop occurs, the system will require the operator to remove any wafer detected on the transfer arm.

If the operator signals that the Emergency Stop has been cleared and a wafer is still detected, the system will issue a warning and not exit the Emergency Stop state. When the wafer detected on the transfer arm has been completely removed, the system will do the restart procedure.

If available, the appropriate wafer ID will be displayed as part of the Emergency Stop screen. This will aid the operator in locating the wafer after it has been removed from the system.

Two new emerg;ency stop error conditions have been added:

☞ MOTOR POSITION ERROR WHILE WAFER ON ARM:

The linear motor, transfer arm, theta motor, and transfer arm Z−motor will halt when any one x−,y−,z−axis reports an error. The transfer arm vacuum solenoid is polled to see if a wafer is present on the arm. If no wafer is detected, the system will attempt to initialize the motors without operator intervention. If a wafer is detected on the transfer arm, an Emergency Stop occurs.

☞ WAFER LOST IN TRANSIT:

This Emergency Stop occurs when the system detects a change in the state of the transfer arm vacuum sensor while transporting a wafer between stations. If a change is sensed, the linear motor,transfer arm theta motor, and Z−motor will halt. After the Emergency Stop has been acknowledged by the operator, (alarm is silenced by first press of the < ENTER > key), the linear motor will be blanked and the torque removed from the transfer arm theta motor. This allows the operator to manipulate and position the tower assembly for further processing of wafers.

ADDITION PROCESSING STATE INFORMATION	REF: SECTION 4.6 PROCESSING WAFERS

Main and RTM Software REV HD
(Material Handler)

SPAR 1418
This SPAR has added Handler State information on the RUN TIME DISPLAY ninth line in the following format:

```
PROCESSING STATE                    COVER STATE
```

The processing states are: `WAFER–XFER`
`MAPPING`
`RECOVER`
`IDLE`

The cover states are: `COVER OPEN`
`COVER CLOSED`

ADDITION IMMEDIATE OPERATION MENU SUBMENU	REF: SECTION 4.6.1 ACCESSING THE SINGLE WAFER HANDLING STATION

Main and RTM Software REV HF
(Material Handler)

A submenu has been added into each of the first three items of the 4085X handler's Immediate Operation Menu for a selection involving the cassette 1, cassette 2, and correlation tray. Prompts for these items clearly specify choices for destination or source.

EXPANDED INFORMATION	REF: SECTION 4.6.2 REMOVING/INSERTING SPECIFIC WAFERS

Main and RTM Software REV HD
(Material Handler)

The tray of the Single Wafer Hold (or Handling) Station cannot be opened until you request an `INSERT...` or `REMOVE...` operation from the Immediate Operations Menu (items 3 and 2 respectively).

When `REMOVE` is selected, the system opens the latch to allow the wafer to be removed and then waits for the tray to be closed. When the tray is closed, the sensors will be checked to verify that the wafer had indeed been removed. If the tray is empty, the latch will be engaged.

When `INSERT` is selected, the system will open the latch to allow a wafer to be inserted, wait for the tray to be closed, and then read the wafer size sensors. The appropriate wafer size will be highlighted (5, 6, or 8−inch). When you verify the wafer size, the latch is closed. If no wafer is present, you will be prompted to insert again.

ENHANCEMENT ABILITY TO REPEAT OPERATION	**REF:** SECTION 4.6.3.2 IMMEDIATE OPERATION MENU (SMIF) LINE ITEMS

Main and RTM Software REV HJ
(Material Handler)

The system now allows you to repeat the immediate probe operation through the Correlation Tray without removing and then re−inserting the wafer.

ENHANCEMENT ENABLING/DISABLING RTM HANDLER SCREEN	**REF:** SECTION 4.7 MAINTENANCE MENU

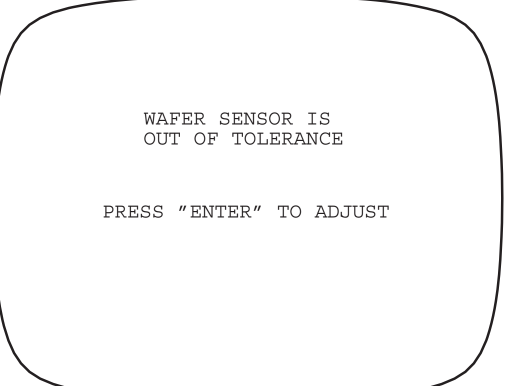
Main and RTM Software REV H
(Material Handler)

The option "−99", (similar to −99 in the Set Parameters Menu), was added to the Material Handler Diagnostic Menu for enabling or disabling the RTM handler screen upon first time power−up of the handler, or when the battery back−up RAM becomes corrupted or unusable. A future revision may incorporate a jumper on the material handler main system PCB to set the RTM display.

ENHANCEMENT ADJUSTING AIR SENSOR VALUES	**REF:** SECTION 4.7.1 HANDLER MAINTENANCE MENU LINE ITEMS LINE 4 − SWITCHES, LATCHES, SENSORS WAFER AIR SENSOR

Main and RTM Software REV D
(Material Handler)

If the wafer air sensor values are not within range, the system will cycle the Air Sensor System three (3) times. If the air sensor values are still out of range, the system will beep continuously while displaying the following:



When you press the < ENTER > key, the prober system will stop beeping and display the following screen:

```
  ** WAFER SENSOR ADJUSTMENT **

"0" = SENSE AIR SOLENOID ....OFF

WITH AIR SOLENOID .....OFF
SET SENSOR TO .........60

WITH AIR SOLENOID .....ON
SET SENSOR TO .........160

WAFER SENSOR VALUE = xxx

     PRESS "ENTER" TO EXIT
```

The wafer sensor value displayed, represented in the above screen by "xxx", is a scaled value read from the sensor that is updated five times per second. The pressure regulator should be adjusted so that the wafer sensor value is set within +2 or −2 of 160 when the air solenoid is "ON" or within +2 or −2 of 60 when the air solenoid is "OFF".

NOTE: On previous systems, when trying to map the quickloader, an emergency stop occurred if the sensor value was out of range. The emergency stop is now replaced by the above screens to allow adjustments prior to re−mapping the quickloader.

The wafer sensor value must be within range before the Air Sensor Adjustment cycle will exit. Press < 0 > on the monitor keyboard to toggle the sense air solenoid on or off. Press < ENTER > to clear the screen and resume handler operation.

ENHANCEMENT	REF: SECTION 4.7.1
CHANGES IN CCD PREALIGN SUBSYSTEM MENU	HANDLER MAINTENANCE MENU LINE ITEMS LINE 7 – PREALIGN SUBSYSTEM

Main and RTM Software REV HD
(Material Handler)

Selection “7” from the Handler Maintenance Menu activates the CCD Prealign Subsystem Menu.

```
               ** CCD PREALIGN SUBSYSTEM **
 HW REV. xx                    SW REV. xxxxxxxx
 COMM OK                          VAC ON   WAFER OK
                                    0          1
 BRIGHTNESS                        132        134
 CCD_CHUCKANGLE                    600        900
 CCD_SPINDLE                      1000        687

 1  ROTATE                          7  TOGGLE DEV
 2  RESET A13                       8  PREALIGN
 3  CALIBRATE                       9  SET CCD–CK
 4  LAMP ON–OFF                    10  SET CCD–SP
 5  SPINDLE VAC                    11  SET LAMP
 6  PIXEL SCAN                     12  BURN IN

 OPTION
```

Active Camera

The display fields `BRIGHTNESS`, `CCD_CHUCKANGLE`, and `CCD_SPINDLE` have two columns of values. These columns are located under “0” (for the 8” CCD camera) or “1” (for the 5” and 6” CCD camera). Either the “0” or the “1” will be highlighted and this represents the “active camera” with regards to reading and setting parameters.

To toggle the “active camera”, choose option 7. The `BRIGHTNESS` field will indicate the lamp brightness value currently in use for prealign. When the lamp is calibrated, its value is automatically reflected in this field. Upon entry to this screen, the active camera will correspond “current size” for setup.

Adjusting Camera Location Offsets

The prealign angular coordinate system is identical with that of the chuck except that it is rotated CW 180 degrees.

There is a `CCD_CHUCKANGLE` for each camera. It measures the angle (CW) between prealign angle 0 and the center line of the CCD array. The default angle for camera 0 is 600 (60.0 degrees) and the default angle for camera 1 is 900 (90.0 degrees).

These angles are adjustable to compensate for manufacturing and assembly discrepancies. To tell if these parameters need adjusting, prealign a wafer to angle 0 and then load it on the chuck. Inspect the resulting flat or notch position in relation to the actual chuck angle 0. Adjust the `CCD_CHUCKANGLE` parameter for the difference observed.

To adjust this angle, first highlight the appropriate "active camera", then select option 9. Enter the new angle in tenths of a degree.

The `CCD_SPINDLE` parameter (option 10) is a distance measured in tenths of a millimeter. It represents the distance from the center of the prealign spindle to the center of the CCD array. The default distance for camera 0 is 1000 (100.0mm) and the default distance for camera 1 is 687 (68.7mm).

Rotating the Spindle

Selection 1 `(ROTATE)` will rotate the spindle the number of steps specified. The spindle motor is operated in one−half step mode here, and there are 4800 steps per revolution. In all other areas not associated with prealign, the motor is operated in full−step mode: 600 step/rev. Moves are relative: positive value = CW rotation and a negative value = CCW rotation.

Reset A13

Selection 2 will send a remote reset command to the A13 prealign processor board. `"OK"` or `"FAIL"` will appear, depending on the results.

Calibrate

Selection 3 will calibrate the lamp for the "active camera" highlighted. The A13 processor will vary light intensities until the CCD output is in the middle range of the ADC. The new value calculated will be updated in the brightness display field.

There should be *no* wafer on the prealign spindle when performing calibration. `"OK"` or `"FAIL"` will appear depending on the results.

Lamp ON−OFF

Selection 4 will prompt you to turn the lamp OFF (0) or ON (1). This operation will take place on the "active camera". The prior state of the lamp does not matter; the end result will always be what you select. The lamp will be turned up to the current brightness level.

Spindle Vacuum

Selection 5 `(SPINDLE VAC)` is a toggle for the prealign spindle vacuum. A display field in the upper right hand corner of the screen indicates the current state of the spindle vacuum: `"VAC ON"` or `"VAC OFF"`. Right next to this is another display field indicating whether or not a wafer is present: `"WAFER OK"` or `"NO WAFER"`.

Pixel Scan

Selection 6 will return the pixel number of the first pixel illuminated above its threshold value. This of course operates only on the active CCD array ("active camera"). The lamp must be turned on before running `PIXEL SCAN`. The range of valid return values is 0 − 3455. A return value of 9999 indicates that all pixels are blocked (not illuminated).

Toggle Device

Selection 7 (TOGGLE DEV) will toggle the “active camera”. The current active camera can be determined by the camera number highlighted.

Prealign Wafer

Selection 8 (PREALIGN) will prealign a wafer. The resulting message will be displayed on line 14. Possible messages are:

SUCCESS (Wafer centered to specified tolerance and flat/notch positioned to specified angle)

COULD NOT FIND FLAT/NOTCH

PROBLEM WITH CCD ARRAY

UNCORRECTABLE SPINDLE OFFSET

ILLEGAL WAFER SIZE

NO WAFER BEFORE PREALIGN

NO WAFER AFTER PREALIGN

FLAT FIND SIZE ERROR

TOO MANY FLATS FOUND

WAFER CENTER COMPUTE ERROR

ERROR COMMUNICATING TO A13

UNKNOWN ERROR

Set CCD_CHUCKANGLE

For option 9 (SET CCD-CK), see Section **5.3.1.2, Adjusting Camera Location Offsets.**

Set CCD_SPINDLE

For option 10 (SET CCD-SP), also see Section **5.3.1.2**, as noted above.

Set Lamp

Selection 11 prompts you for a new brightness value for the “active camera”. The amount you enter will overwrite the value determined by automatic calibration, until the next calibration takes place.

Burn In

This selection (12) will run a prealign burn−in test for 20000 cycles, or until the < ENTER > key is pressed. It creates centering errors from 0 to 5mm and repeats this cycle starting at different angles (10 degree increments).

THE ASYST SMIF INX 2200 INDEXER
for the 4085X AWS Prober

Main and RTM Software REV HJ
(Material Handler)

The following information provides instructions on how to set up, manipulate, and otherwise work with a 4085X AWS Prober equipped with the Asyst SMIF INX 2200 Indexer. The Indexer Firmware requires REV P or above.

Indexer Components

The cassette platform has been removed and one SMIF−Indexer model INX 2200 has been located at the cassette 1 position. This Indexer allows the loading and unloading of a cassette enclosed in a standard Asyst Pod.

NOTE: Only 200 mm SEMI cassettes or EMPAC U−68 cassette (200 mm cassette except that the C4 dimension is 153.5 mm) are supported.

The Indexer power supply is located between the Indexer and the prealign platform.

Indexer Communications

Indexer RS−232 ports

Two Indexer RS−232 ports are of interest.

- AUX 1: ASCII commands, used for MH −Indexer runtime communication and for Procomm REV. 2.0 typed in commands or test script "INDXTEST.ASP". Accessed by taking off side access plate. 9600 baud + NULL modem
- HOST EQUIP: SECS II (CTS line low) and SAM (CTS line high). Also used by ISIM diagnostic program. Port accessed from back of prober

MH Software System Type Determination

The MH communicates with the Indexer through Duart 1B (J39) on the MH comm board to the Indexer's AUX1 channel. The Indexer limits the speed to 9600 baud.

On MH powerup, the MH tries to initialize the Indexer over this channel. If it gets a good response, the MH configures itself as an Indexer type machine and an additional status line "INDEXER:" will appear on the RUN TIME screen.

NOTE: If this status line does not appear and the machine is equipped with an Indexer, *then there is a communication problem; do not attempt to operate the MH.*

For the detailed ASCII commands, refer to the SMIF−Indexer Manual, A Serial Text Interface for the Asyst SMIF−Indexer.

General Operation

Wafer Size Determination (EMPAC U−68 cassette)

The original 4085 cassette size sensors have been eliminated by the introduction of the SMIF−Indexer. The wafer size for Indexer type machines will be determined by using the two prealign CCD cameras. The size deterimination is performed once per cassette, before the first wafer is prealigned. Wafers originating from the Single Wafer Load Station (Correlation Tray) have their size determined by the wafer size sensors in that station.

Prealign CCD Lamp Calibration

Both prealign CCD lamps (lamp 0 for 8" and lamp 1 for 6") are calibrated before mapping the first wafer in each cassette. The frequency of calibration is once per cassette.

Software Calibration

Two MDVs have been added to the diagnostic menu −98 selection − **First Slot Offset** and **Cas1 X Offset,** both adjustable by +−100mils.

The First Slot Offset:

Transfer Arm Z−Axis Offset Bottom of wafer in first slot with the top of the transfer arm @ 3250 mils.

This position varies depending on the type of pod liner:

Plastic Liner Default = 0, Metallic liner Default = −45

The Cas1 X Offset:

Transfer Arm X−Axis (Linear Motor) Offset of X−Axis Center Cass 1 position with the actual center of the wafer in a cassette in a pod on the indexer. Default = 0.

NOTE: The CASS 8 MAP OFFSET, for Indexer machines only, applies to both normal 8" cassettes and EMPAK U−68 cassettes containing 6" wafers. If both cassette models are used, this single offset must be set so that it works with both types. The default value is 15 mils.

NOTE: Also refer to "4085X Material Handler Software" PN 248317−001.HE Release Notes for information on setting other MDVs.

Determine Transfer Arm Z−Axis First Slot Offset

1. Load Pod to Stage

   With the pod loaded with the intended cassette and pod liner and with a wafer in slot one, load the pod on the prober and lower the cassette to the stage position. Use the RUN TIME menu key < 3 > "LD/UL CASS 1".

2. Diagnostic SMIF−Indexer Menu Item 12

   In this menu, use item 12 to automatically set the first slot offset. The Z−axis initially moves to 3050 mils, like mapping the cassette, then the Z−axis gradually moves up to sense the wafer. At the position the wafer is sensed (NewZ), the FIRST SLOT OFFSET is determined by NewZ + 10 mils offset − 3250 mils. The 10 mils offset is the distance from the wafer that the Z−axis will stop when the wafer is sensed.

Cassette Load/Unload Operations

Cassettes (200 mm or EMPAC U−68) can only be introduced to the prober by being enclosed in a standard Asyst POD.

There are two states of the cassette cover in the present MH system. While in "COVER OPEN" state, no MH actions can take place and you are allowed to freely add or remove a pod on the Indexer. If a Pod is introduced, then "OK TO LOAD" will appear and the MH will respond to the < 3 > key (LD/UL CASS 1). If the < 3 > key is pressed, then the MH will lock the pod and lower the cassette to the stage position where the MH can access it and then display "LOADED".

After the cassette is in the "LOADED" state, you can press the key < F6 > (CASS COVER), to enter the "COVER CLOSED" state; then the handler will begin mapping the new cassette.

During normal probing, if all wafers are processed (displayed in prober window), then you can press the < F6 > key to open the cover. If all wafers have been processed, then "OK TO UNLOAD" will be displayed. While "OK TO UNLOAD" is displayed, the MH will respond to the < 3 > key (LD/UL CASS 1) by raising the cassette back into the pod (home position), unlocking the pod and displaying "OK TO REMOVE". "OK TO REMOVE" will remain on the screen until the pod is removed. When the pod is removed, the MH will go to the "READY" state.

If in the "COVER OPEN" state with some wafers still in process (that is, out of the cassette), then "LOCKED" will be displayed and the cassette will not be allowed to unload (key < 3 >, LD/UL CASS1). To unload an incomplete cassette, you can press the key < F5 > (RECOVER) to return wafers to the cassette.

The possible indexer status on the runtime screen while in "COVER OPEN" state and applicable meanings are listed below:

1. READY:
The system is ready to receive a pod.

2. OK TO LOAD:
The pod is in place and the Indexer is ready to perform the LOAD operation.

3. LOADED:
A newly introduced cassette has been lowered to the stage position and is ready to be accessed by the MH transfer arm.

4. OK TO UNLOAD:
A cassette containing processed wafers is ready to be unloaded (returned to the pod).

5. OK TO REMOVE:
A cassette has returned to the pod(home position) and the pod is unlocked and ready to be removed from the Indexer.

6. LOCKED:

A cassette is in the stage position, but the MH has not processed all of the wafers.

7. ERROR:

Indexer error has occurred.

Following is the MH RUN TIME display:

```
              *SMF01-0H3.HF

CASSETTE :           1
WAFER    :          25
PROBED   :          25
PROBLEMS :           0
INDEXER  :     OK TO UNLOAD


[IDLE]          [COVER OPEN]
```

The cassette loaded by the Indexer will be designated Cassette 1. The key < 3 > (LD/UL CASS1) is used for cassette loading and unloading.

Cross−Slotted Wafer Detection

When a new cassette is loaded and lowered to the stage position, the MH queries the Indexer as to the status of the wafers in the cassette. If any are cross−slotted, the MH will display an option "CONTINUE THE SAME POD Y/N". If < Y > is selected, the material handler will enter the "LOADED" state and will allow the cassette to be processed. If < N > is selected, the material handler will unload the cassette and you must remove the pod.

When there are wafer mapping errors, the wafer map will be displayed showing the location of 'C'ross−Slotted wafers, 'F'ull slots, 'E'mpty slots, and 'U'nknown slots.

NOTE: If, after an attempt to load the cassette, there are 'U'nknown slots, an indexer error exists.

Cassette Not Present

If you attempt to load a Pod with no cassette, you will receive the message: INDEXER: ERROR / CASSETTE NOT PRESENT. In order to continue, you must go to the SMIF−Indexer Subsystem Menu and do command "5", RESET ALARM. The keystroke sequence is:

< DIAG > < Y > (LINE) < 13 > (OPTION) < 5 >

Diagnostic Menu

The following Indexer diagnostic menu provides some Indexer operation functions and a way to setup the reference position between the Handler and Indexer.

```
          ** SMIF-INDEXER SUBSYSTEM **

POD:
SLOT SENSOR POS:
WAF SENSOR POS:

1 SELF TEST                     7 MOVE ABS
2 HOME                          8 POD (UN)LOCK
3 STAGE                         9 RESEAT
4 MAP                          10 MOVE TO SLOT
5 RESET ALARM                  11 READ ABS. POS
6 MOVE REL.                    12 SET 1ST SLOT


OPTION=
```

The display field `POD` shows the current status of the pod (such as `PRESENT` and `(UN)LOCKED`.

The field `SLOT SENSOR POS` is the distance (in mils) between the slot sensor and the wafer access position.

The `WAF SENSOR POS` is the distance (in mils) between the wafer sensor and the wafer access position.

Errors are detected on all commands issued and the appropriate `SUCCESS` or `FAILURE` message will be displayed.

An explanation of the numbered menu items follows:

1 SELF TEST: Performs an Indexer internal self test.

2 HOME: Commands the Indexer elevator to home position. "HOME" is absolute position 0, and the cassette is inside the pod.

3 STAGE: Commands the Indexer elevator to stage (open) position.

4 MAP: Scans cassette and generates a cassette map. Slots can be 'F'ull, 'E'mpty, 'C'ross−slotted, or 'U'nknown. ('U'nknown slots are Indexer Malfunction)

5 RESET ALARM: Indexer Software Reset. Also clears MH error condition.

6 MOVE REL.: Moves elevator a relative distance in mils. Move distance can be +/−.

7 MOVE ABS: Moves elevator to specified absolute position (0 – 10600 mils; 0 is all the way up, 10600 is all the way down).

8 POD (UN)LOCK: Toggles pod lock. If already locked then unlocks. If unlocked, then locks. (Only works in Home position).

9 RESEAT: Runs the Indexer's wafer seater operation.

10 MOVE TO SLOT: Position specified slot in the wafer access position.

11 READ ABS POS: Reads Indexer's current absolute position.

12 SET 1ST SLOT: Commands the arm to sense the first slot wafer and set the first slot offset.

SUPPLEMENT

MATERIAL HANDLER

SECTION 4 – REV B

This supplement describes additions and changes that apply to Section 4, Material Handler. This information will be incorporated into the section with the next revision. This information supplements the new or changed material in the manual temporarily identified by the dated bar in the margin. The margin bar is often used when updates can be made without changing pagination or section REV letter.

In the heading for the respective changes, the box at the right classifies the information by the subsection to which it relates and the title of that subsection.

UPDATE:	DEFAULTING OF VARIABLES	REF: SECTION 4.4	Page Supp 4–3
NEW:	NEW LINES, SET MODE MENU	REF: SECTION 4.4.1.2	Page Supp 4–4
NEW:	NEW LINES, SET PARAMETER MENU	REF: SECTION 4.4.1.3	Page Supp 4–4
UPDATE:	EMERGENCY STOP IMPROVEMENTS	REF: SECTION 4.5.4	Page Supp 4–6
EXPANDED INFORMATION:	REMOVING/INSERTING SPECIFIC WAFERS	REF: SECTION 4.6.2	Page Supp 4–7
ENHANCEMENT:	ADJUSTING AIR SENSOR VALUES	REF: SECTION 4.7.1	Page Supp 4–7
NEW:	CCD PREALIGN SUBSYSTEM MENU	REF: SECTION 4.7.1	Page Supp 4–9
THE ASYST SMIF INK 2000 INDEXER, FOR THE 4085X AWS PROBER			Page Supp 4–12

UPDATE	REF: SECTION 4.4
DEFAULTING OF VARIABLES	SETTING UP AND ENABLING THE HANDLER

ProberVision Software, REV DA

The defaulting of global prober−handler variables (wafer unload reason, pipelining state, etc.) is only done on prober power−up. This avoids the unloaded wafer status from being changed to UNPROBED after a **DS** command.

Prober−handler communication initialization and transfer of the setup block to the handler occurs only at the following times.

a) Power "ON" with autoload enabled (read from battery−backed ram or default file)

b) Autoload enabled via menu or XIO.

c) Setup downloaded with autoload set to enabled (via XIO or disk file load).

UPDATE	REF: SECTION 4.4.1.2
NEW MENU LINES	SET MODE MENU LINE ITEMS

Main and RTM Software REV HD
(Material Handler)

A new prompt field "SETUP FOR WAFER SIZE .... N INCH" has been added to the F2 screen of the Handler Set Mode Menu. This field must be set to the correct size *prior to* entering the OCR Setup Menu. This becomes the "current size".

All other prealign and OCR parameters may now be set. You will not be allowed to change size if the TRANSFER or READ_ID task is running.

A new prompt field "STOP BETWEEN CASSETTES" has also been added. This field has three possible settings that are examined every time a cassette has completed processing. The settings are:

0 = DISABLED
1 = STOP ONLY IF DIFF SIZE (*if next cassette is different size)*
2 = ALWAYS STOP

UPDATE
NEW LINE 07

REF: SECTION 4.4.1.3
SET PARAMETER MENU LINE ITEMS

Main and RTM Software REV HD
(Material Handler)

A Line 07, "UNREADABLE CHAR ......" has been added to the Handler Set Parameter Menu because it becomes unaccessable from the prober side.

Select this line to indicate which ASCII character is to be used by the OCR to indicate an undecipherable character. When the prober receives this character, it asks the OCR to reread the wafer ID. For the Cognex OCR Reader, a diamond – "◆" – appears at the bottom of the RUN TIME DISPLAY as part of the ID string, to show that a particular character has not been read; for example:

ID = 12345 A◆CD

UPDATE
NEW LINE 08

Main and RTM Software REV HF
(Material Handler)

In order to handle different wafer sizes with ID position located at non–middle position and the camera mounted at 0 degree location in an AWS machine, a new item has been added to the Set Parameter Menu:

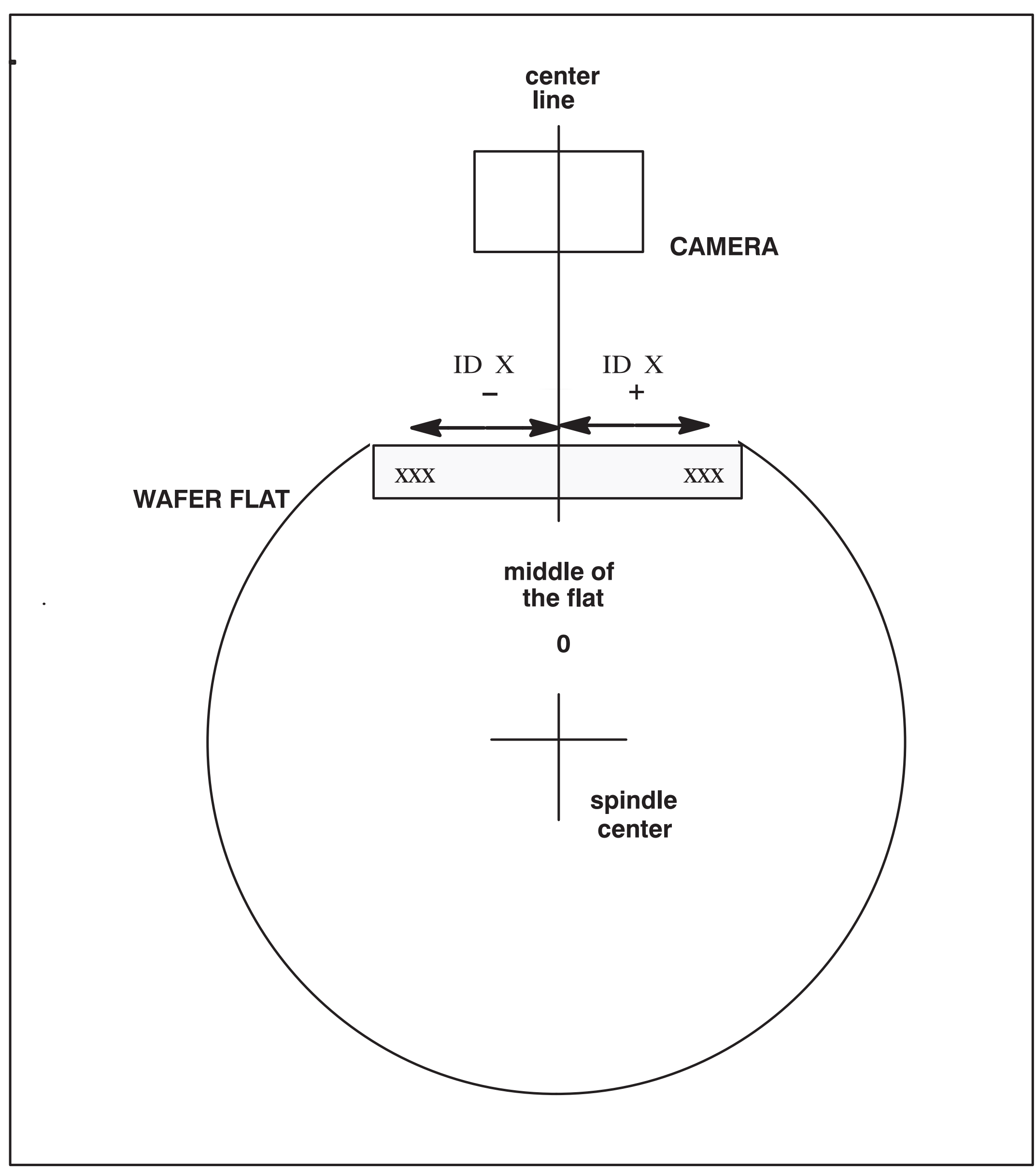
08 ID LOCATION X ...... xxx MILS (default 0 mils)

The concept is illustrated on the next page.

The "ID LOCATION X" is the linear distance from the center of the flat to the center of the ID string. The range of ID location X is:

–1000 to 1000 mils for a 6–inch wafer
– 750 to 750 mils for a 5–inch wafer

If the "ID LOCATION X" is not "0", an extra motion will be involved before the wafer can be placed to the camera read position. It is suggested that if the distance of the ID string away from the flat mid–point is within 450 mils, there is no need to set "ID LOCATION X".



ID LOCATION X DIAGRAM

Main and RTM Software REV H
(Material Handler)

When an Emergency Stop occurs, the first press of the < ENTER > key will silence the alarm. Further presses of the < ENTER > key will operate as presently defined for Emergency Stop conditions. When an Emergency Stop occurs, the system will require the operator to remove any wafer detected on the transfer arm.

If the operator signals that the Emergency Stop has been cleared and a wafer is still detected, the system will issue a warning and not exit the Emergency Stop state. When the wafer detected on the transfer arm has been completely removed, the system will do the restart procedure.

If available, the appropriate wafer ID will be displayed as part of the Emergency Stop screen. This will aid the operator in locating the wafer after it has been removed from the system.

Two new emergency stop error conditions have been added:

☞ MOTOR POSITION ERROR WHILE WAFER ON ARM:

The linear motor, transfer arm, theta motor, and transfer arm Z−motor will halt when any one x−,y−,z−axis reports an error. The transfer arm vacuum solenoid is polled to see if a wafer is present on the arm. If no wafer is detected, the system will attempt to initialize the motors without operator intervention. If a wafer is detected on the transfer arm, an Emergency Stop occurs.

☞ WAFER LOST IN TRANSIT:

This Emergency Stop occurs when the system detects a change in the state of the transfer arm vacuum sensor while transporting a wafer between stations. If a change is sensed, the linear motor,transfer arm theta motor, and Z−motor will halt. After the Emergency Stop has been acknowledged by the operator, (alarm is silenced by first press of the < ENTER > key), the linear motor will be blanked and the torque removed from the transfer arm theta motor. This allows the operator to manipulate and position the tower assembly for further processing of wafers.

EXPANDED INFORMATION	REF: SECTION 4.6.2 REMOVING/INSERTING SPECIFIC WAFERS

Main and RTM Software REV HD
(Material Handler)

The tray of the Single Wafer Hold (or Handling) Station cannot be opened until you request an `INSERT...` or `REMOVE...` operation from the Immediate Operations Menu (items 3 and 2 respectively).

When `REMOVE` is selected, the system opens the latch to allow the wafer to be removed and then waits for the tray to be closed. When the tray is closed, the sensors will be checked to verify that the wafer had indeed been removed. If the tray is empty, the latch will be engaged.

When `INSERT` is selected, the system will open the latch to allow a wafer to be inserted, wait for the tray to be closed, and then read the wafer size sensors. The appropriate wafer size will be highlighted (5, 6, or 8−inch). When you verify the wafer size, the latch is closed. If no wafer is present, you will be prompted to insert again.

ENHANCEMENT ADJUSTING AIR SENSOR VALUES	**REF:** SECTION 4.7.1 HANDLER MAINTENANCE MENU LINE ITEMS LINE 4 − SWITCHES, LATCHES, SENSORS

Main and RTM Software REV D
(Material Handler)

If the wafer air sensor values are not within range, the system will cycle the Air Sensor System three (3) times. If the air sensor values are still out of range, the system will beep continuously while displaying the following:

```
WAFER SENSOR IS
OUT OF TOLERANCE

PRESS "ENTER" TO ADJUST
```

When you press the < ENTER > key, the prober system will stop beeping and display the following screen:

```
  ** WAFER SENSOR ADJUSTMENT **

"0" = SENSE AIR SOLENOID ....OFF

WITH AIR SOLENOID .....OFF
SET SENSOR TO .........60

WITH AIR SOLENOID .....ON
SET SENSOR TO .........160

WAFER SENSOR VALUE = xxx

     PRESS "ENTER" TO EXIT
```

The wafer sensor value displayed, represented in the above screen by “xxx”, is a scaled value read from the sensor that is updated five times per second. The pressure regulator should be adjusted so that the wafer sensor value is set within +2 or −2 of 160 when the air solenoid is “ON” or within +2 or −2 of 60 when the air solenoid is “OFF”.

NOTE: On previous systems, when trying to map the quickloader, an emergency stop occurred if the sensor value was out of range. The emergency stop is now replaced by the above screens to allow adjustments prior to re−mapping the quickloader.

The wafer sensor value must be within range before the Air Sensor Adjustment cycle will exit. Press < 0 > on the monitor keyboard to toggle the sense air solenoid on or off. Press < ENTER > to clear the screen and resume handler operation.

NEW CCD PREALIGN SUBSYSTEM MENU	**REF:** SECTION 4.7.1 HANDLER MAINTENANCE MENU LINE ITEMS LINE 7 – PREALIGN SUBSYSTEM

Main and RTM Software REV HD
(Material Handler)

On CCD probing systems, selection “7” from the Handler Maintenance Menu activates the CCD Prealign Subsystem Menu.

```
          ** CCD PREALIGN SUBSYSTEM **
 HW REV. xx                SW REV. xxxxxxxx
COMM OK                        VAC ON   WAFER OK
                                 0         1
BRIGHTNESS                      132       134
CCD_CHUCKANGLE                  600       900
CCD_SPINDLE                    1000       687

 1  ROTATE                       7  TOGGLE DEV
 2  RESET A13                    8  PREALIGN
 3  CALIBRATE                    9  SET CCD-CK
 4  LAMP ON-OFF                  10  SET CCD-SP
 5  SPINDLE VAC                  11  SET LAMP
 6  PIXEL SCAN                   12  BURN IN

 OPTION
```

Active Camera

The display fields `BRIGHTNESS, CCD_CHUCKANGLE,` and `CCD_SPINDLE` have two columns of values. These columns are located under “0” (for the 8” CCD camera) or “1” (for the 5” and 6” CCD camera). Either the “0” or the “1” will be highlighted and this represents the “active camera” with regards to reading and setting parameters.

To toggle the “active camera”, choose option 7. The `BRIGHTNESS` field will indicate the lamp brightness value currently in use for prealign. When the lamp is calibrated, its value is automatically reflected in this field. Upon entry to this screen, the active camera will correspond “current size” for setup.

Adjusting Camera Location Offsets

The prealign angular coordinate system is identical with that of the chuck except that it is rotated CW 180 degrees.

There is a `CCD_CHUCKANGLE` for each camera. It measures the angle (CW) between prealign angle 0 and the center line of the CCD array. The default angle for camera 0 is 600 (60.0 degrees) and the default angle for camera 1 is 900 (90.0 degrees).

These angles are adjustable to compensate for manufacturing and assembly discrepancies. To tell if these parameters need adjusting, prealign a wafer to angle 0 and then load it on the chuck. Inspect the resulting flat or notch position in relation to the actual chuck angle 0. Adjust the `CCD_CHUCKANGLE` parameter for the difference observed.

To adjust this angle, first highlight the appropriate "active camera", then select option 9. Enter the new angle in tenths of a degree.

The `CCD_SPINDLE` parameter (option 10) is a distance measured in tenths of a millimeter. It represents the distance from the center of the prealign spindle to the center of the CCD array. The default distance for camera 0 is 1000 (100.0mm) and the default distance for camera 1 is 687 (68.7mm).

Rotating the Spindle

Selection 1 `(ROTATE)` will rotate the spindle the number of steps specified. The spindle motor is operated in one−half step mode here, and there are 4800 steps per revolution. In all other areas not associated with prealign, the motor is operated in full−step mode: 600 step/rev. Moves are relative: positive value = CW rotation and a negative value = CCW rotation.

Reset A13

Selection 2 will send a remote reset command to the A13 prealign processor board. `"OK"` or `"FAIL"` will appear, depending on the results.

Calibrate

Selection 3 will calibrate the lamp for the "active camera" highlighted. The A13 processor will vary light intensities until the CCD output is in the middle range of the ADC. The new value calculated will be updated in the brightness display field.

There should be *no* wafer on the prealign spindle when performing calibration. `"OK"` or `"FAIL"` will appear depending on the results.

Lamp ON−OFF

Selection 4 will prompt you to turn the lamp OFF (0) or ON (1). This operation will take place on the "active camera". The prior state of the lamp does not matter; the end result will always be what you select. The lamp will be turned up to the current brightness level.

Spindle Vacuum

Selection 5 `(SPINDLE VAC)` is a toggle for the prealign spindle vacuum. A display field in the upper right hand corner of the screen indicates the current state of the spindle vacuum: `"VAC ON"` or `"VAC OFF"`. Right next to this is another display field indicating whether or not a wafer is present: `"WAFER OK"` or `"NO WAFER"`.

Pixel Scan

Selection 6 will return the pixel number of the first pixel illuminated above its threshold value. This of course operates only on the active CCD array ("active camera"). The lamp must be turned on before running `PIXEL SCAN`. The range of valid return values is 0 − 3455. A return value of 9999 indicates that all pixels are blocked (not illuminated).

Toggle Device

Selection 7 (TOGGLE DEV) will toggle the "active camera". The current active camera can be determined by the camera number highlighted.

Prealign Wafer

Selection 8 (PREALIGN) will prealign a wafer. The resulting message will be displayed on line 14. Possible messages are:

SUCCESS (Wafer centered to specified tolerance and flat/notch positioned to specified angle)

COULD NOT FIND FLAT/NOTCH

PROBLEM WITH CCD ARRAY

UNCORRECTABLE SPINDLE OFFSET

ILLEGAL WAFER SIZE

NO WAFER BEFORE PREALIGN

NO WAFER AFTER PREALIGN

FLAT FIND SIZE ERROR

TOO MANY FLATS FOUND

WAFER CENTER COMPUTE ERROR

ERROR COMMUNICATING TO A13

UNKNOWN ERROR

Set CCD_CHUCKANGLE

For option 9 (SET CCD-CK), see Section **5.3.1.2, Adjusting Camera Location Offsets.**

Set CCD_SPINDLE

For option 10 (SET CCD-SP), also see Section **5.3.1.2**, as noted above.

Set Lamp

Selection 11 prompts you for a new brightness value for the "active camera". The amount you enter will overwrite the value determined by automatic calibration, until the next calibration takes place.

Burn In

This selection (12) will run a prealign burn−in test for 20000 cycles, or until the < ENTER > key is pressed. It creates centering errors from 0 to 5mm and repeats this cycle starting at different angles (10 degree increments).

THE ASYST SMIF INX 2200 INDEXER
for the 4085X AWS Prober

Main and RTM Software REV HJ
(Material Handler)

The following information provides instructions on how to set up, manipulate, and otherwise work with a 4085X AWS Prober equipped with the Asyst SMIF INX 2200 Indexer. The Indexer Firmware requires REV P or above.

Indexer Components

The cassette platform has been removed and one SMIF−Indexer model INX 2200 has been located at the cassette 1 position. This Indexer allows the loading and unloading of a cassette enclosed in a standard Asyst Pod.

NOTE: Only 200 mm SEMI cassettes or EMPAC U−68 cassette (200 mm cassette except that the C4 dimension is 153.5 mm) are supported.

The Indexer power supply is located between the Indexer and the prealign platform.

Indexer Communications

Indexer RS−232 ports

Two Indexer RS−232 ports are of interest.

- AUX 1: ASCII commands, used for MH −Indexer runtime communication and for Procomm REV. 2.0 typed in commands or test script “INDXTEST.ASP”. Accessed by taking off side access plate. 9600 baud + NULL modem
- HOST EQUIP: SECS II (CTS line low) and SAM (CTS line high). Also used by ISIM diagnostic program. Port accessed from back of prober

MH Software System Type Determination

The MH communicates with the Indexer through Duart 1B (J39) on the MH comm board to the Indexer’s AUX1 channel. The Indexer limits the speed to 9600 baud.

On MH powerup, the MH tries to initialize the Indexer over this channel. If it gets a good response, the MH configures itself as an Indexer type machine and an additional status line “INDEXER:” will appear on the RUN TIME screen.

NOTE: If this status line does not appear and the machine is equipped with an Indexer, *then there is a communication problem; do not attempt to operate the MH.*

For the detailed ASCII commands, refer to the SMIF−Indexer Manual, A Serial Text Interface for the Asyst SMIF−Indexer.

General Operation

Wafer Size Determination (EMPAC U−68 cassette)

The original 4085 cassette size sensors have been eliminated by the introduction of the SMIF−Indexer. The wafer size for Indexer type machines will be determined by using the two prealign CCD cameras. The size deterimination is performed once per cassette, before the first wafer is prealigned. Wafers originating from the Single Wafer Load Station (Correlation Tray) have their size determined by the wafer size sensors in that station.

Prealign CCD Lamp Calibration

Both prealign CCD lamps (lamp 0 for 8" and lamp 1 for 6") are calibrated before mapping the first wafer in each cassette. The frequency of calibration is once per cassette.

Software Calibration

Two MDVs have been added to the diagnostic menu −98 selection − **First Slot Offset** and **Cas1 X Offset,** both adjustable by +−100mils.

The First Slot Offset:

Transfer Arm Z−Axis Offset Bottom of wafer in first slot with the top of the transfer arm @ 3250 mils.

This position varies depending on the type of pod liner:

Plastic Liner Default = 0, Metallic liner Default = −45

The Cas1 X Offset:

Transfer Arm X−Axis (Linear Motor) Offset of X−Axis Center Cass 1 position with the actual center of the wafer in a cassette in a pod on the indexer. Default = 0.

NOTE: The CASS 8 MAP OFFSET, for Indexer machines only, applies to both normal 8" cassettes and EMPAK U−68 cassettes containing 6" wafers. If both cassette models are used, this single offset must be set so that it works with both types. The default value is 15 mils.

NOTE: Also refer to "4085X Material Handler Software" PN 248317−001.HE Release Notes for information on setting other MDVs.

Determine Transfer Arm Z−Axis First Slot Offset

1. Load Pod to Stage

   With the pod loaded with the intended cassette and pod liner and with a wafer in slot one, load the pod on the prober and lower the cassette to the stage position. Use the RUN TIME menu key < 3 > "LD/UL CASS 1".

2. Diagnostic SMIF−Indexer Menu Item 12

   In this menu, use item 12 to automatically set the first slot offset. The Z−axis initially moves to 3050 mils, like mapping the cassette, then the Z−axis gradually moves up to sense the wafer. At the position the wafer is sensed (NewZ), the FIRST SLOT OFFSET is determined by NewZ + 10 mils offset − 3250 mils. The 10 mils offset is the distance from the wafer that the Z−axis will stop when the wafer is sensed.

Cassette Load/Unload Operations

Cassettes (200 mm or EMPAC U−68) can only be introduced to the prober by being enclosed in a standard Asyst POD.

There are two states of the cassette cover in the present MH system. While in "COVER OPEN" state, no MH actions can take place and you are allowed to freely add or remove a pod on the Indexer. If a Pod is introduced, then "OK TO LOAD" will appear and the MH will respond to the < 3 > key (LD/UL CASS 1). If the < 3 > key is pressed, then the MH will lock the pod and lower the cassette to the stage position where the MH can access it and then display "LOADED".

After the cassette is in the "LOADED" state, you can press the key < F6 > (CASS COVER), to enter the "COVER CLOSED" state; then the handler will begin mapping the new cassette.

During normal probing, if all wafers are processed (displayed in prober window), then you can press the < F6 > key to open the cover. If all wafers have been processed, then "OK TO UNLOAD" will be displayed. While "OK TO UNLOAD" is displayed, the MH will respond to the < 3 > key (LD/UL CASS 1) by raising the cassette back into the pod (home position), unlocking the pod and displaying "OK TO REMOVE". "OK TO REMOVE" will remain on the screen until the pod is removed. When the pod is removed, the MH will go to the "READY" state.

If in the "COVER OPEN" state with some wafers still in process (that is, out of the cassette), then "LOCKED" will be displayed and the cassette will not be allowed to unload (key < 3 >, LD/UL CASS1). To unload an incomplete cassette, you can press the key < F5 > (RECOVER) to return wafers to the cassette.

The possible indexer status on the runtime screen while in "COVER OPEN" state and applicable meanings are listed below:

1. **READY:**
   The system is ready to receive a pod.

2. **OK TO LOAD:**
   The pod is in place and the Indexer is ready to perform the LOAD operation.

3. **LOADED:**
   A newly introduced cassette has been lowered to the stage position and is ready to be accessed by the MH transfer arm.

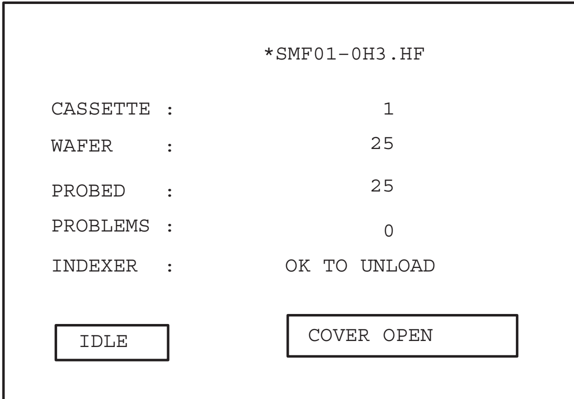
4. **OK TO UNLOAD:**
   A cassette containing processed wafers is ready to be unloaded (returned to the pod).

5. **OK TO REMOVE:**
   A cassette has returned to the pod (home position) and the pod is unlocked and ready to be removed from the Indexer.

6. **LOCKED:**
   A cassette is in the stage position, but the MH has not processed all of the wafers.

7. **ERROR:**
   Indexer error has occurred.

Following is the MH RUN TIME display:



The cassette loaded by the Indexer will be designated Cassette 1. The key < 3 > (LD/UL CASS1) is used for cassette loading and unloading.

Cross−Slotted Wafer Detection

When a new cassette is loaded and lowered to the stage position, the MH queries the Indexer as to the status of the wafers in the cassette. If any are cross−slotted, the MH will display an option "CONTINUE THE SAME POD Y/N". If < Y > is selected, the material handler will enter the "LOADED" state and will allow the cassette to be processed. If < N > is selected, the material handler will unload the cassette and you must remove the pod.

When there are wafer mapping errors, the wafer map will be displayed showing the location of 'C'ross−Slotted wafers, 'F'ull slots, 'E'mpty slots, and 'U'nknown slots.

NOTE: If, after an attempt to load the cassette, there are 'U'nknown slots, an indexer error exists.

Cassette Not Present

If you attempt to load a Pod with no cassette, you will receive the message: INDEXER: ERROR / CASSETTE NOT PRESENT. In order to continue, you must go to the SMIF−Indexer Subsystem Menu and do command "5", RESET ALARM. The keystroke sequence is:

< DIAG > < Y > (LINE) < 13 > (OPTION) < 5 >

Diagnostic Menu

The following Indexer diagnostic menu provides some Indexer operation functions and a way to setup the reference position between the Handler and Indexer.

```
        ** SMIF-INDEXER SUBSYSTEM **
POD:
SLOT SENSOR POS:
WAF SENSOR POS:

1 SELF TEST                       7 MOVE ABS
2 HOME                            8 POD (UN)LOCK
3 STAGE                           9 RESEAT
4 MAP                            10 MOVE TO SLOT
5 RESET ALARM                    11 READ ABS. POS
6 MOVE REL.                      12 SET 1ST SLOT

OPTION=
```

The display field `POD` shows the current status of the pod (such as `PRESENT` and `(UN)LOCKED`.

The field `SLOT SENSOR POS` is the distance (in mils) between the slot sensor and the wafer access position.

The `WAF SENSOR POS` is the distance (in mils) between the wafer sensor and the wafer access position.

Errors are detected on all commands issued and the appropriate `SUCCESS` or `FAILURE` message will be displayed.

An explanation of the numbered menu items follows:

1 SELF TEST: Performs an Indexer internal self test.

2 HOME: Commands the Indexer elevator to home position. "HOME" is absolute position 0, and the cassette is inside the pod.

3 STAGE: Commands the Indexer elevator to stage (open) position.

4 MAP: Scans cassette and generates a cassette map. Slots can be 'F'ull, 'E'mpty, 'C'ross−slotted, or 'U'nknown. ('U'nknown slots are Indexer Malfunction)

5 RESET ALARM: Indexer Software Reset. Also clears MH error condition.

6 MOVE REL.: Moves elevator a relative distance in mils. Move distance can be +/−.

7 MOVE ABS: Moves elevator to specified absolute position (0 − 10600 mils; 0 is all the way up, 10600 is all the way down).

8 POD (UN)LOCK: Toggles pod lock. If already locked then unlocks. If unlocked, then locks. (Only works in Home position).

9 RESEAT: Runs the Indexer's wafer seater operation.

10 MOVE TO SLOT: Position specified slot in the wafer access position.

11 READ ABS POS: Reads Indexer's current absolute position.

12 SET 1ST SLOT: Commands the arm to sense the first slot wafer and set the first slot offset.

SECTION 5 – AUTO ALIGN

CONTENTS

The notations in the margin on this page and throughout the section indicate areas where information was changed and/or new information added in this current revision (REV A).

NOTE the Supplement located at the end of Section 5.

Updated 5/96

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SECTION 5
AUTO ALIGN

5.1 OVERVIEW

The Auto Alignment feature uses the prober and a vision processor to align the streets of the wafer to the XY axis of the forcer. It then uses theta alignment to ensure that the die are placed correctly under the probe tips for accurate probing.

5.1.1 How To Use This Section

This section contains the following information about Auto Align:

- An overview of the components
- A description of the process
- Initialization and setup procedures, including setting a reference target
- Operating instructions for Auto Align, Teach Die Corner and Self−Teach Auto Align
- Operating instructions for the Vision Utility and Theta Compensation features
- Troubleshooting tips for alignment, camera and video

5.2 COMPONENTS OF AUTO ALIGN

The Auto Align function uses the Vision Module (Cognex 2000) vision processor to compare a live video image with a previously stored image.

A camera and optics assembly transmit the wafer image to the vision processor. The optics package includes a specially designed Cohu CCD (Charge Coupled Device) camera with an optics assembly mounted flush with the prober's ring carrier (to avoid mechanical contention with any test heads).

For the Cognex Vision Module, there is a specific power−up sequence as well as a definite initialization process.

Added 6/96

The Cognex must be powered up for at least two minutes prior to attempting to initialize this option via the prober Set Option Menu. However, if the Cognex box contains Revision D or later firmware, the boot sequence of the Vision Module will be cut to about 20 seconds.

SUPPLEMENT

AUTO ALIGN

SECTION 5 − REV B

The following information includes additions and changes that apply to Section 5, Auto Align. They will be incorporated into the section with the next revision. This information supplements the new or changed material in the manual temporarily identified by the dated bar in the margin. The margin bar is often used when updates can be made without changing pagination or section REV letter.

Each item in the Supplement contains a heading for identification. The box at the left identifies the type of information (such as NEW or CHANGE) and the subject; the box at the right classifies the information by the single or major subsection to which it relates and the title of that subsection. Information is given in section numerical order.

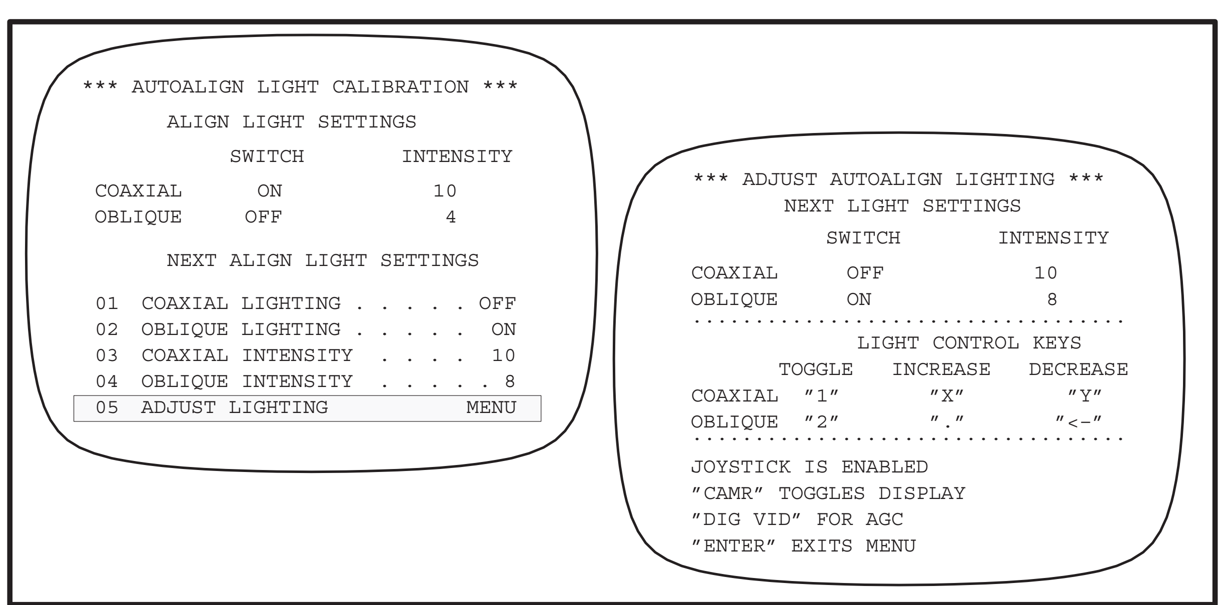
Software Revision DB

NEW FEATURE
ADJUST AUTOALIGN LIGHTING

REF: 5.5.1
AUTO ALIGN OPTION MENU LINE ITEMS
LINE 05 − LIGHT CALIBRATION

With this new feature, you can change the current align light settings. This makes it easier to adjust the align lighting without retraining the target.

On the Autoalign Light Calibration Menu, illustrated below, the intensities displayed under the heading "ALIGN LIGHT SETTINGS" are the current light values.



AUTOALIGN LIGHT CALIBRATION MENU AND ADJUST AUTOALIGN LIGHTING SCREEN

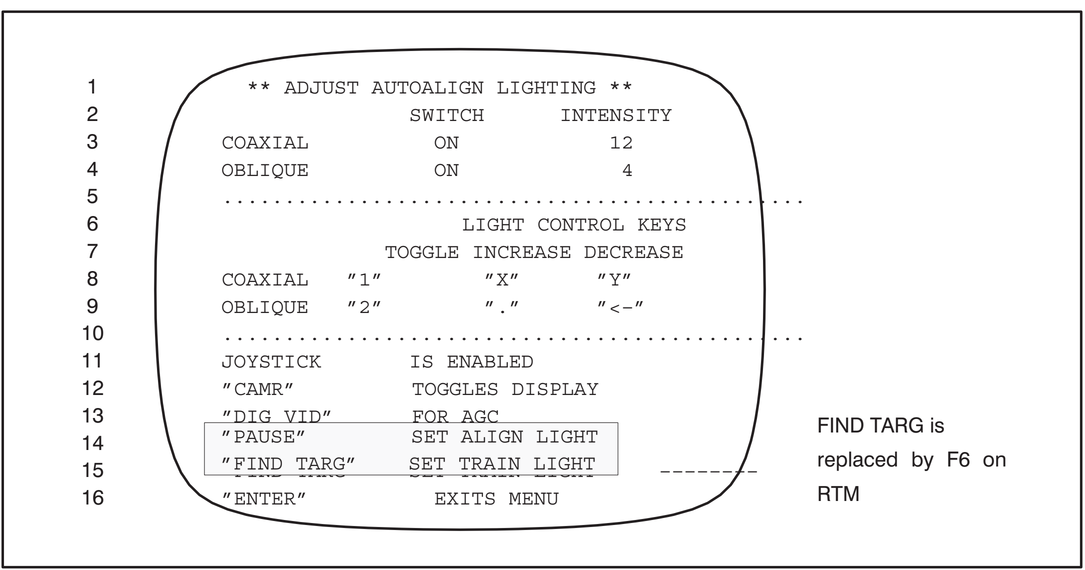
The values displayed for Lines 01−04 are for the next align train (FIND TARG function). The eighth line of the display reads “NEXT TRAIN LIGHT SETTINGS”.

The new Adjust Autoalign Lighting screen, illustrated next, prompts for the following new action keys:

The 14th line will read “PAUSE“ SET ALIGN LIGHT; this will cause the current light settings to become the settings used for the next align.

The 15th line will read “FIND TARG” SET TRAIN LIGHT; this key will cause the current light settings to become the settings used for the next align train (FIND TARG) function.

Restriction: Patterns trained using oblique lighting will most likely *not* be portable to another prober equipped with different camera optics.



NEW ADJUST AUTOALIGN LIGHTING SCREEN

Software Revision DF

NEW FEATURE
PATTERN PORTABILITY

REF: 5.5.1
AUTO ALIGN OPTION MENU LINE ITEMS
(New Line 12)

The Pattern Portability Mode provides Pattern Portability checking prior to certain operations. It is enabled via a new Line 12 of the Autoalign Option Menu or through external I/O (**SM119Pp / ?SM119Pp**). When this mode is enabled, PROFILE WITH FIND CENTER and PROFILE BEFORE ALIGN are automatically enabled.

In the Pattern Portability mode, before a FIND TARGET, ALIGN, or AUTO−PROBE function is started, a check is made to ensure that the required setup has been done. If any of the setup locations (NCES, camera, probe tip center, wafer center under NCES) has not been set correctly, the current function is aborted and an error message displayed.

Depending on the required setup, the message may be: SETUP REQUIRED: NCES, CAMERA, PROBE CENTER, PROF WAFER.

When the FIND TARGET, ALIGN, or AUTOPROBE function is started (from keyboard or external I/O), with Pattern Portability Mode enabled, the profile options “PROFILE BEFORE ALIGN” and “PROFILE WITH FIND CENTER” will be automatically enabled.

The “correct” setup requires a manual setup of camera, probe−tip center, and NCES in the Profiler Menu using the bare chuck and profiling the wafer with FIND CENTER enabled. These items can be set up with pattern portability either enabled or disabled; their correctness is only checked when pattern portability is enabled.

Pattern Portability may cause problems in moving to First Die on probers without a profiler. Since Pattern Portability relies on knowing where wafer center is on the chuck, profiling with FIND CENTER must be done. If the wafer has not been profiled with FIND CENTER, the pattern portability vector method will not be used to start align search and to locate First Die. (In this case, the pre−Rev DB method of using absolute pattern location is used instead.)

ENHANCEMENTS: THETA COMPENSATION	**REF:** 5.9 THETA COMPENSATION

Setup files from DB and earlier software which had Theta Compensation enabled can now be read in by DF software and properly processed. The older files are read in and prober memory is updated to be compatible with DF’s requirements.

The Theta Compensation (TCA) Angle in REVs DD and later is still the negative from DB and earlier software. REV DF and later software makes all necessary changes needed to load in DB and earlier setup files. However, setup files using Theta Compensation made with DD and later software cannot be successfully loaded and processed by DB and earlier software.

Also, the prober software now ensures that Z is down during the automatic moves in the Auto Theta Compensation setup procedure when verifying the theta compensation angle.

NEW FEATURE PROBE TO PAD OPTIMIZATION	**REF:** 5.10 (new) PROBE TO PAD OPTIMIZATION (Current sections beginning with 5.10 will be renumbered)

PROBE TO PAD OPTIMIZATION

Probe to Pad Optimization (PTPO) provides a semi−automatic setup of First Die position and optimization, ensuring accurate probe to pad alignment. It is designed to help align the probe to the pad in terms of wafer angle and positioning offset. This allows the best alignment to be achieved which gives the maximum margin between the probe mark and the passivation border. The optimization algorithm is used to provide the best alignment. The Probe Mark Inspection (PMI) results from the Vision Module provide the information for the algorithm to work correctly.

With the use of this feature, it is no longer necessary to use the Theta Compensation (thetacomp) option to manually align the wafer to the probe card angle. The PTPO algorithm will calculate the probe card angle and use the X−FINE alignment to accurately align the wafer to the probe card angle automatically, employing the probe mark inspection results.

PRODUCT INSTALLATION AND SETUP

Appropriate setup procedures must be performed and parameters set prior to using this feature. Incorrect setup or training procedures will lead to incorrect PTPO calculations, with erroneous results. Refer to the **"Achieving the Best Results from Probe Mark Inspection Parameters Settings"**, in the supplement following Section 16, PROBE MARK INSPECTION.

The accuracy of the PTPO calculation depends on the accurate results of the probe mark inspection. A single scratched pad or a dirty pad might ruin the whole inspection result and make the PTPO calculation fail. Look at the inspection result on each pad and check the PTPO calculation results prior to commanding a PTPO correction.

The prober can handle a probe card angle up to +/− 3 degrees or +/− 0.0525 radians. The minimum size of pads is 2.5 X 2.5 mil.

Prior to doing the PMI/PTPO operation, try to put all the probe marks inside the pads or slightly touching the edge of the pad. This will permit the best results to be achieved the first time. In some cases, two touchdowns and two PTPOs may be required for optimum results.

New Probe to Pad Optimization (PTPO) Setup Menu

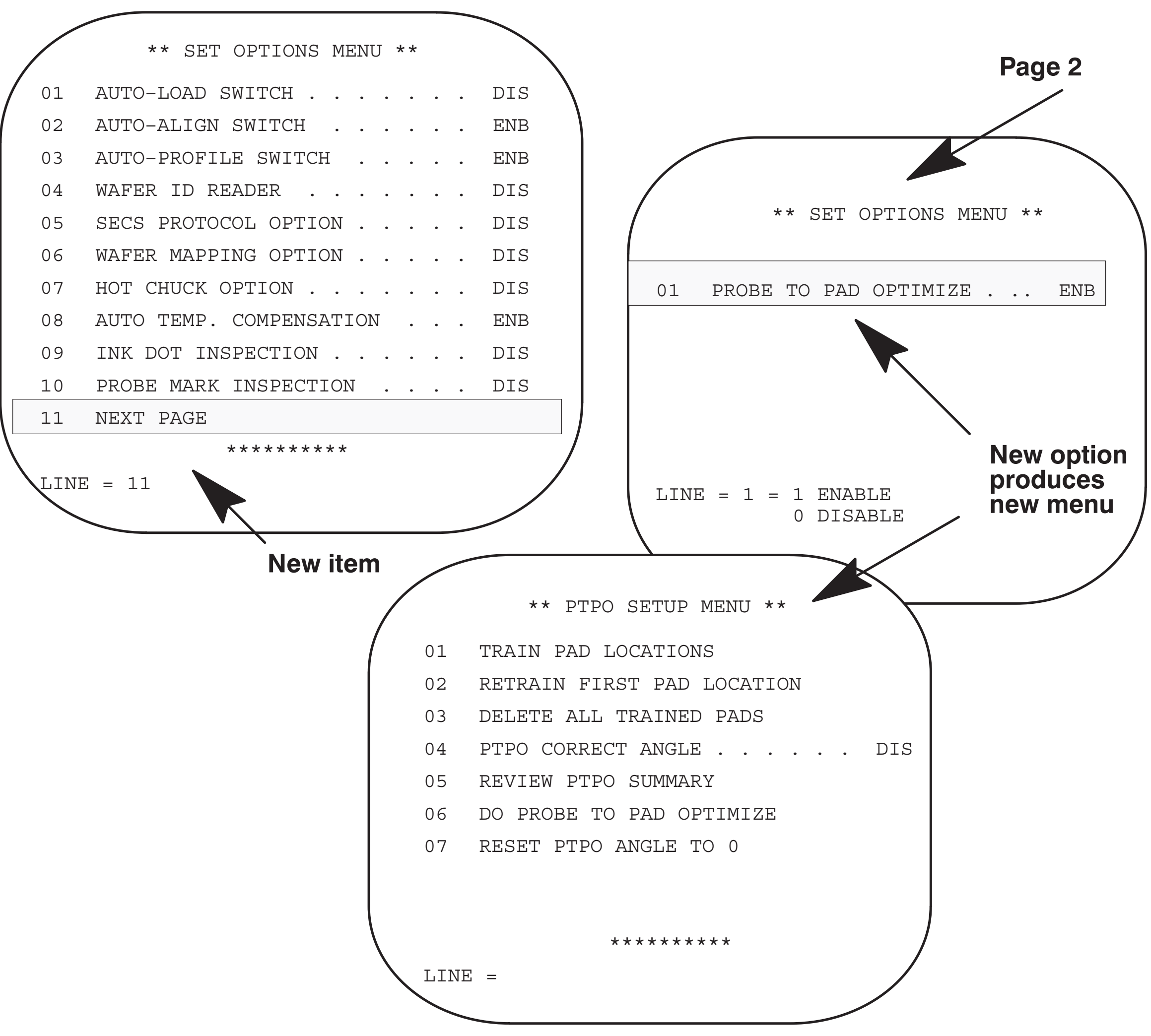
A new option has been added to the prober Set Options Menu. A new item, `"NEXT PAGE"`, Line 11 on the original menu, appears when the prober verifies functional support for the new options.

Line 01 on the second page enables PTPO. When this line, `PROBE TO PAD OPTIMIZE`, is enabled, the PTPO Setup Menu will be displayed, as illustrated below.

Line items 01 to 03 on the PTPO Setup Menu function in the same manner as their counterparts in the Probe Mark Inspection Menu. Line items 04 through 07 are described below.

Line 04 PTPO CORRECT ANGLE

When disabled, the PTPO calculation doesn't take into account the angle offset between probe card and wafer. To do PTPO in this case, ensure that the probe card is indeed parallel to the platen X/Y axis. In most cases, *this option should be enabled!*



Line 05 REVIEW PTPO SUMMARY

This option provides all the correction data from the PMI/PTPO calculation. If there is no solution to the last inspection result, all data will be 0 and a message “PTPO FAIL, CAN’T OPTIMIZE . . . .” will display on the screen.

The angle is in a unit of radians. It is then consistent with the thetacomp angle. 1 degree = 0.0175 radian.

The PTPO total angle is the sum of all the previous correction angles. This angle is battery−backed up and can only be removed via the RESET PTPO ANGLE TO 0 option.

```
******** PTPO SUMMARY ********

LAST DIE INSPECTED      X = ... 0

                        Y = ... 0

X OFFSET (IN .1 MIL)    ....    -4.879
Y OFFSET (IN .1 MIL)    ....    3.005
ANGLE OFFSET (RADIAN)   ....    0.01799
PTPO TOTAL ANGLE (RADIAN) .     0.03

"ENTER" TO EXIT
```

Line 06 DO PROBE TO PAD OPTIMIZE

This option is one of the means used to invoke the PMI/PTPO calculation. The operation involves a probe mark inspection on current die followed by a PTPO calculation. After the PTPO calculation, the result summary will display on the screen with a prompt "DO PTPO CORRECTION (Y/ENTER)?" Select < Y > to invoke the PTPO correction procedures. If you REVIEW PTPO SUMMARY after performing the PTPO correction, X and Y offset values will be zero.

Line 07 RESET PTPO ANGLE TO 0

When the probe card is changed and you wish to do the PTPO over again, this option provides a mechanism to reset the PTPO angle inside the system. This operation begins by clearing all the PTPO offset data including the PTPO angle, followed by an auto alignment at 0 degrees, and then returns to the previous First Die position.

OPERATIONAL SETUP OF PTPO

Following is the procedure used to set up PTPO after the system is powered up:

1. Set probe tip center and camera center.

   These two positions *must* be set accurately. In the Profile Menu < F5 >, selections 2 and 8 set up the probe tip center and camera center. See the respective Technical Reference Manual for your model, the section on the **Noncontact Edge Sensor,** for the procedures to set these positions.

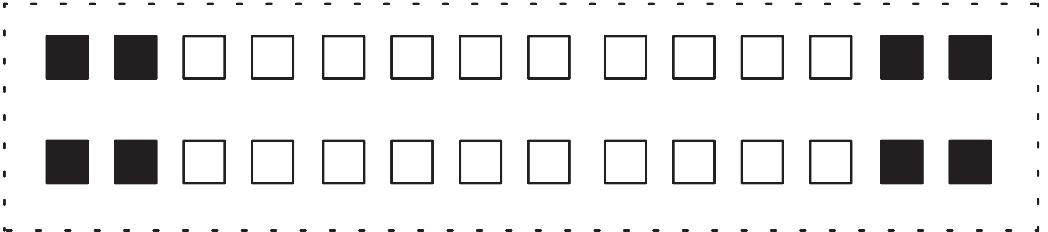
2. Load the wafer.
3. Profile the wafer by selecting Profile Menu item number 4.
4. Enable Auto Align and turn on XFINE (selection 2 in AUTO ALIGN MODE).
5. Press < FIND TARGET > to train the alignment target.
6. Select < SET OPTION > (< F3 >) and select Line 11 (NEXT PAGE), and then select Line 01 to enable PTPO and access the PTPO Setup Menu.
7. From the PTPO Setup Menu, select Line 04 to enable PTPO CORRECT ANGLE.
8. Use the microscope to align the probe tip to the pad of the First Die manually.
9. Do a touchdown to generate the probe marks.
10. Press < FIRST > to set the First Die.
11. Re−autoalign the wafer at 0 degrees (Theta Compensation should be disabled).
12. Select < SET OPTION > (< F3 >) and select Line 10 − PROBE MARK INSPECTION.

13. Set the PMI specifications and other inspection thresholds such as lighting, as instructed in the Technical Reference Manuals, the sections on **Probe Mark Inspection,** and in this document, **Line 02 Specifications** on Page 27.

NOTE: PMI Specification Menu Line item 08 (RESULT DISPLAY FORMAT...xxx) must be set to 2 = LNGH or 5 = GRAP_LNG for PTPO to work properly.

14. Select < SET OPTION > (< F3 >) and Line 10 (PROBE MARK INSPECTION). Select Line 04 (TRAIN PAD LOCATIONS) to train the pads of the First Die. In order to get the correct probe card angle, the pads in the four corners of the probe card and the pads next to them must be trained.

    For a typical probe card which has two rows of pins, the pads shown solid black should be trained:

    However, since most probe cards are not perfect, some pins might generate scrapes which are closer to the edge of the passivation borders than others. Doing the touchdown before training helps to determine which pins are really in the danger zone and should be trained.

    Remember that PTPO only does the optimization from what it can see. You should train 15 pads if that many are available. Training an optimum number of pads leads to more accurate calculation and achieves better results.

    Press < FIRST > / < F4 > to set FIRST DIE.

15. The system displays, "DO PTPO ANALYSIS? (Y/ENTER)." Select < Y > to invoke the Probe Mark Inspection (PMI) and Probe to Pad Optimize (PTPO) calculation.

16. After the PTPO calculation, the correction data (offset and angle) will display on the screen. If it is not possible to bring all of the marks inside the pads, the error message "PTPO FAIL, CAN'T OPTIMIZE ..." will be displayed.

    Otherwise, the system asks "DO PTPO CORRECTION? (Y/ENTER)". Check the PTPO result and press < Y > to do the PTPO correction.

    The correction procedure involves an auto alignment which aligns the wafer to the correction angle from the PTPO calculation. After alignment, correction offsets (X and Y) will be applied to the positioning of the First Die.

17. Index to a new evaluation position and make a new set of marks.

18. Select the < SET OPTIONS > key and choose the "NEXT PAGE" line item. On that menu, enable Line 01 (PROBE TO PAD OPTIMIZATION... ENB). On the resulting menu, choose line item 06 (DO PROBE TO PAD OPTIMIZATION) and enter < Y > when prompted.

19. Check the displayed offsets and determine if they are satisfactory.

    If they are satisfactory, exit all menus and operate as normal. If they are not satisfactory, repeat the optimization process by selecting < Y > (YES) when the system prompts to do corrections.

    In most cases, one PTPO correction should be sufficient to bring all the probe marks to the best location inside the pads. However, if after the first PTPO correction there are still some positioning offsets which are significant (more than 0.1 mil), a second PTPO and possibly a third may be performed to correct those positioning offsets on subsequent die.

CHANGING THE PROBE CARD

1. Remove the wafer.
2. Install the probe card.
3. Set the probe tip center. The prober displays, "`RESET PTPO ANGLE (Y/ENTER)`"; answer Yes (< Y >).
4. Load a wafer.
5. Profile the wafer.
6. Align the wafer.
7. Use the microscope to align the pads of the First Die to the probe tips manually.
8. Do a touchdown to generate the probe marks.
9. Press < FIRST > to set the First Die.
10. The system displays, "`DO A PTPO ANALYSIS (Y/ENTER)`".
11.. Press < Y > to invoke the PMI/PTPO analysis.
12. Check the PTPO result and press < Y > to do the PTPO correction.
13. If a second PTPO correction is considered necessary, index to the next die and repeat steps 8 to 12.

    If the correction is sufficient, then reset the first die position, press < ENTER > to ignore the correction prompt, and then operate as normal.

INVOCATION OF PTPO

Four operations invoke the PTPO operation.

Set First Die

Whenever you set First Die from the keyboard, if the following conditions are matched, a PMI/PTPO analysis will be prompted by the system, as illustrated on the next page.

- The PTPO option is enabled
- The inspection pads are trained

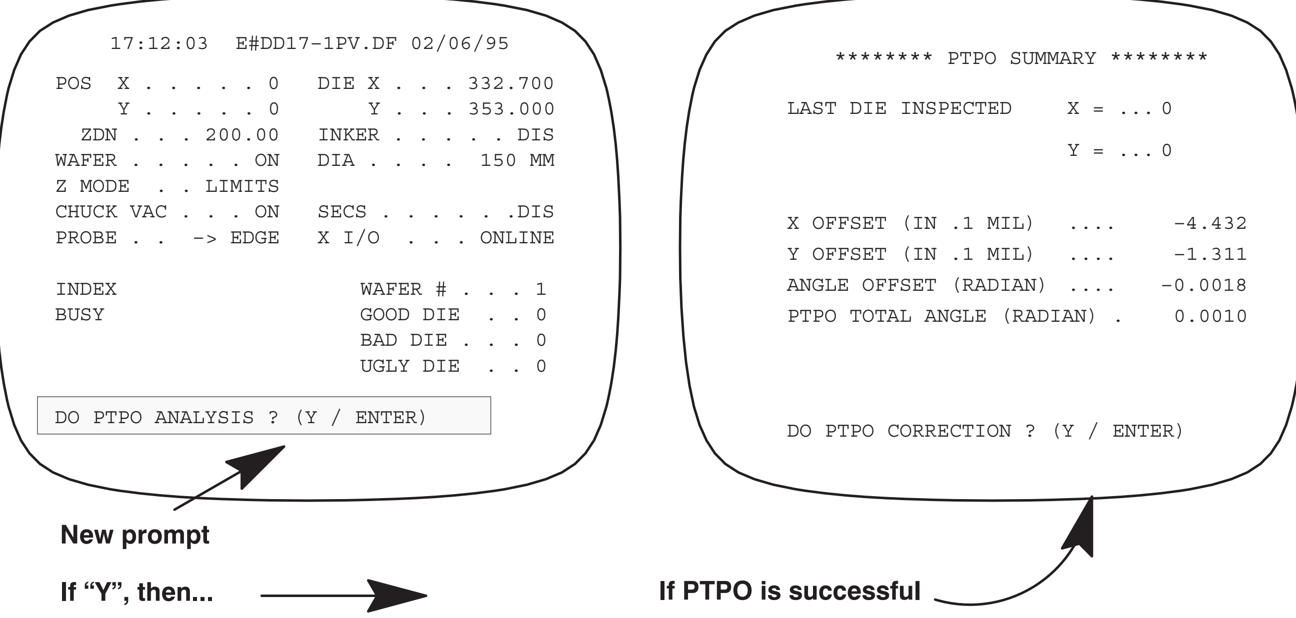
If you select "Y" to proceed with the PMI/PTPO analysis, the following conditions will be verified:

- Is the align mode X−FINE mode ?
- Is the wafer aligned ?
- Is the first pad location still valid ?

If these three conditions are matched, the system will move the current die under the camera and perform an automatic probe mark inspection of all the trained pads.

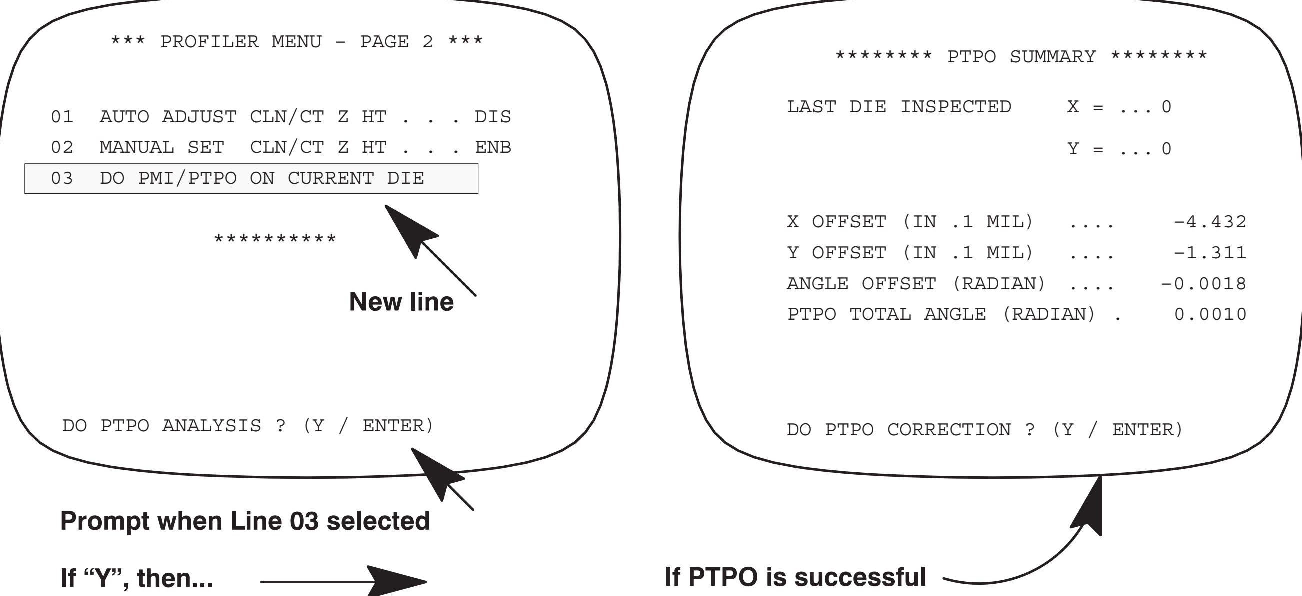
After the probe marks are inspected, the inspection results are collected and fed into the algorithm to do the optimization. The correction data will then display on the screen and the prober will prompt "DO A PTPO CORRECTION (Y/ENTER)?"

Select < Y > to invoke the correction procedures as described in the **Introduction**.



Do PMI/PTPO on Current Die

Press < PROG > to access the Profiler Menu; go to the second page and select Line 03: "DO PMI/PTPO ON CURRENT DIE" to invoke the same operation as setting the First Die, as illustrated below.



At the End of Manual Inspection

At the end of probe mark manual inspection, the prober will prompt "DO PMI/PTPO ANALYSIS (Y/ENTER)?". Select < Y > to invoke the same operation as setting the First Die.

PTPO ANGLE AND RESET THE PTPO ANGLE

How the PTPO Correction Angle Works

The PTPO correction angle works the same way as the thetacomp angle. This angle will be used to compensate all of the relative die movement.

The PTPO angle is not a Machine Dependent Variable (MDV); it can only work on the current probe card setup. It is battery backed−up so that when powered down the system will not lose it. This angle is accumulated each time a PTPO correction is performed.

Reset the PTPO Correction Angle

To reset the PTPO correction angle, you can either select Line 07 (RESET PTPO ANGLE TO 0) in the PTPO Menu or when you set the probe tip center.

5.2.1 Vision Module Processor

The Vision Module is a powerful gray−scale analyzer used to compare a live video image with a previously stored image (called a *reference target*). The process is called *pattern recognition*.

The Vision Module resolves an image into parts as small as .15625 mils, and assigns each part a gray value between 0 and 63 (0 would be black and 63 would be white). This high resolution and gray scale improves Auto Alignment.

Because the Vision Module is software−dominated, it performs several sophisticated functions, including Auto Align, Optical Character Recognition (OCR), Ink Dot Inspection (IDI), and Probe Mark Inspection (PMI). (Only Auto Align is discussed in this section; the other functions are discussed in separate sections of this manual.)

The Vision Module also drives a motorized zoom lens for PMI, and controls all the lamps for each of its vision tasks. It can also perform Self−Teach Auto Align, a function which automatically selects reference targets, relieving the operator of this task.

5.2.1.1 CORRELATION PROCESS

To perform Auto Alignment, the Vision Module relies primarily upon a blob comparison algorithm that matches the pixel values of one image with the values of another image. The matching of pixel values is called *correlation*.

In this correlation process, each of the pixels of one image is matched against that same pixel location of a second image. If the gray value is identical, a pixel match is perceived, and that location is said to correlate. The greater the number of locations which correlate, the greater the overall correlation score for those two images. If the score is high enough, then the images are said to correlate.

5.2.1.2 BEST MATCH

Correlation scores alone can be misleading, however. A uniform patch of gray may correlate well with another uniform patch of gray, yet there is no value in this correlation −− the wafer cannot be positionally corrected if there is no location information present in the image.

One method used to solve this problem is called *best match*. This algorithm looks specifically at transitional pixels − those spots where the image changes from light to dark or vice versa. If the transitions in one image match the pixel locations of the transitions in a second image, then a match has been detected. Since a field of gray has no transitional pixels, no score can be developed for this algorithm, and the reference target would be unacceptable.

Through the use of pixel correlation and best match algorithms, the Vision Module can compare one image with a second image, and determine whether they match. If the live image matches the image stored into the Vision Module memory, it will be recognized and alignment is performed.

5.2.2 Cohu CCD Camera

The Cohu CCD (charged coupled device) camera has been designed and built especially for Electroglas by Cohu, Inc *(Figure 5−1)*. The camera is small, has high resolution and clarity, is very repeatable in performance, and has a long lifespan.

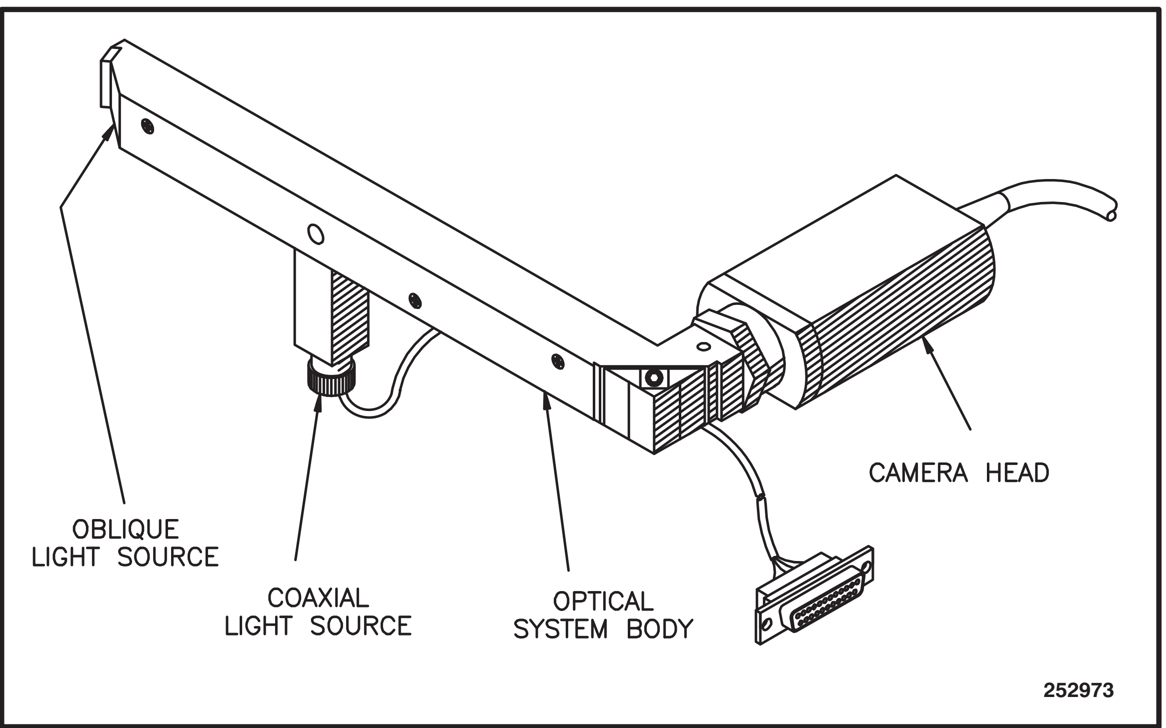


FIGURE 5−1: COHU CAMERA

Updated 6/96

The CCD array in the Cohu "sees" a portion of the wafer and feeds live video to the Vision Module. The Vision system digitizes the video for comparison with an image previously stored manually.

If the live image matches the stored image, the prober uses location information from the Vision processor to adjust the target pattern to the optical center. The prober then indexes and again has the Vision system search for the pattern. Correction is made to bring the target back to optical center. When the prober can index and the target doesn't leave optical center, wafer alignment is complete. If the images don't match, the prober moves another portion of the wafer under the camera repeatedly, until a matching pattern is found.

The camera optics provide an appropriate resolution for alignment or for Probe Mark Inspection. For Auto Align the resolution is set at .15625 mils per pixel, so that the target box covers an area of 128 x 128. The actual resolution is set by both the optics and the electronics; it can be incorrect and require adjustment by the technician during a normal PM procedure.

5.2.3 Lighting Sources

Proper lighting is critical for the creation of a good video signal to the video processor. Two light sources are provided: oblique and coaxial. Each type is engineered to maximize the video return for particular wafer surface characteristics such as refractive coatings.

- **Oblique** lighting uses four lamps to direct light from all sides at an angle to the wafer surface and to bounce a certain percentage at an angle back to the camera optics. The light is caught by a mirror and sent through the optics body to the camera.

- o A single **coaxial** lamp sends its light straight down at the surface which reflects the light back along that same axis. A beamsplitter passes 70% of the light onward to the same mirror used for oblique light return. This mirror sends the light to the wafer, which reflects the light back to the mirror, and back through the beamsplitter to the camera.

With the Vision Module and RTM software, lighting is controlled by menu input.

More information on setting the lighting is located in **Section 5.5.1.5, Light Calibration**.

5.3 THE AUTO ALIGN PROCESS

Automatic alignment involves both the prober main system and the Vision Module. The prober, which is in control, performs the theta corrections while the Vision Module, a slave device, performs the pattern recognition.

To start the Auto Align process, you select a reference target to be stored in the Vision Module's memory as digitized video. A wafer is prealigned, loaded onto the chucktop and transported to the alignment area beneath the camera. A live video image is delivered to the Vision Module along with a message to search or compare the new video image with the one stored in memory.

The target search score is displayed on the screen during the alignment process. The search score ranges between 0 and 100; the higher the score, the greater the similarity between the displayed target and the trained target.

The incoming video is digitized, and the Vision Module searches the area of the wafer in view for the pattern that best matches the stored reference target. A correlation (or "Q" for quality) value is created to indicate how much the new image looks like the stored image. This Q value is sent to the prober and the prober determines whether this number is high enough to indicate a good matching pattern.

If the pattern does not match well enough, the prober orders the forcer to move, and places another section of the wafer under the camera. The Vision Module searches again for a similar pattern; if it fails to find it, the prober presents another wafer section to the camera.

This process continues with the prober following a pre−calculated, overlapping spiral movement with the Vision Module searching each new area until a similar pattern is found. If it is still not found (as would happen should a lamp burn out or a different wafer product type be loaded accidentally), the prober stops and displays the `ALIGN FAIL` message on the monitor screen.

Assuming, however, that an appropriate pattern appears beneath the camera, the Vision Module identifies this pattern as similar to the one stored in memory. It then tells the prober where this target is compared with exact optical center so that the probe tips can accurately probe the wafer. The position deviation, measured in units of mils, is displayed in brackets to the right of the target search score during the alignment; the position deviation is the deviation between the actual found target and its predicted position.

The prober uses the location data to correct its X, Y and theta position and brings the new target image to the center of the picture seen by the Vision Module.

Auto Align is complete when the target search score and position deviation satisfy the following criteria:

search score > Q threshold (default = 50)
−.079 < X deviation < .079
−.079 < Y deviation < .079

The Q threshold values (low = 25, normal/default = 50, high = 75) are described in **Section 5.5.1, Autoalign Option Menu Line Items**.

5.4 INITIALIZATION AND SETUP

Before operating the Auto Align function, you must select and store a reference target.

5.4.1 The Reference Target

The reference target is chosen by you or by the system if the Self−Teach option is installed. The Vision Module stores the reference target into memory so that it can recognize the target for wafer alignment. It is important to select the reference target carefully. While Auto Align accepts almost any reference, some result in better alignment than others.

NOTE
The target area is only that area within the box on the monitor screen; the rest of the image on the screen is not stored.

5.4.1.1 GUIDELINES FOR SELECTING GOOD REFERENCE TARGETS

The reference target should have good contrast and include features that are clear and unique on that die, yet the pattern should be repeatable from one die to the next since the vision system will be lining up the same image from die to die. Gray is acceptable because of the Vision Module's gray scale capability. (Note that what is a good image to the eye is not always a good image to the VM.)

Information added 6/96

The following guidelines can improve alignment accuracy while reducing search time:

1. *Balance Black and White Pixels.* Choose a reference with about the same amount of strongly contrasted black and white pixels. In general, if more than 70% of one is present, the reference will not be the best. Adjust the digitized video picture to improve the balance.
2. *Provide Information in Both Directions.* The reference must contain both vertical and horizontal edges (longer edges in the Y axis), but vertical predominating. The edge of a street, if clearly defined, is excellent as a vertical line. Side edges of pads are also good. (Do not be concerned if the pads show probe marks; they will not significantly decrease the target Q value.)

   Information added 6/96
3. *Provide a Unique Pattern.* The accuracy of the Auto Align program depends on the number of edges in the reference target. If there are more unique and repeatable edges, the accuracy of the coordinates will increase. If a more common stored reference is repeated in the search area, the system may select another similar pattern.

4. *Avoid Thin Lines of Black and White and Diagonal Lines.* If narrow lines are of very fine structure, they will not be repeatable. Because of processing effects, very thin lines can either be lost or can blend with other fine lines nearby. Look at the video image at different locations to determine the reliability of the digitized line. (A common mistake is to use printed letters like a logo as a target. It is easy for you to find but not the best target for alignment.)

Information added June, 1996

5. *Include Large and Small Features.* Large features in the reference (pads, for example) will enable the system to locate the correct position faster. Smaller features, such as metal lines, will help locate with increased accuracy.

5.4.1.2 Q VALUE AS TARGET SELECTION CRITERION

Since the threshold value for all subsequent targets is set by a formula based on correlation Q values, it would seem that the Q values should be used to help determine a good reference target. However, Q values evaluate only repeatability and uniqueness. While these characteristics are important, other values must be considered.

Vertical data in the target is particularly important for the alignment process because the baseline for target comparison in the align mode is in the vertical axis. Any target−to−target deviation in alignment would be most easily seen when a vertical feature appears to move left or right; thus, vertical data is critical to alignment accuracy.

The Q values do not attempt to calculate the amount or usability of vertical data present in the target. The Q values are essential for the process of pattern recognition, but they have little bearing on alignment.

5.4.1.3 SEARCH AREA AND PATTERN

There is a difference between the **search area** and **search pattern;** the **search area** is a section of the wafer visible to the vision processor during the search algorithm; the **search pattern** is a sequential prober−controlled pattern used when the processor cannot find a match within the search area it can see.

Search Area

The search area is a 160 X 160 pixel area searched by the system in an effort to match a pattern in that area with the stored reference. A match will be found only if the center of the match lies within the search area. The Vision Module can electronically mask this area to three smaller search area sizes.

The sizes available for selection are given in **Table 5−1**, shown at the right:

TABLE 5−1: SEARCH AREAS AND SIZES

SEARCH AREA	SIZE
160 X 160 pixels	50 X 50 mils
128 X 128 pixels	40 X 40 mils
64 X 64 pixels	20 X 20 mils
32 X 32 pixels	10 X 10 mils

Search Pattern

Upon receiving a no−match statement from the Vision Module, the prober automatically moves the wafer beneath the camera optics to expose a new section for the Vision Module's search. The pattern the prober uses to expose the wafer to the Vision Module's examination is the search pattern. This pattern covers up to 40 overlapping positions. Eventually the target falls within the search area and the prober discontinues the search pattern.

The search size is a maximum of 450 X 450 mils but was made die−size dependent; this prevents the problem of straying onto the next die, thus locking onto the wrong target, or causing the search to stumble onto a test die.

5.4.1.4 SELECTING AND STORING A REFERENCE TARGET

NOTE

Whenever the forcer release switch is pressed during the Find Target sequence, < F6 > (< FIND TARG >) may be pressed again. The forcer release switch is located on the left side of the Monitor Keyboard.

1. Press < FIND TARG > (< F6 >).

   The Vision Module is told to delete any previous reference targets, and communication is reestablished between the prober and the Vision Module. Search area and pattern size information is downloaded to the Vision Module (see **Section 5.3.1.3, Search Area and Pattern**). The wafer location placed within the camera's FOV (Field of View) is determined by the value entered for die size (Lines 01 and 02, Set Parameter Menu).

2. Observe the FOV displayed on the screen.

   The prober sends the forcer beneath the camera, positioning the wafer so that the camera optical center is just right of the approximate center of the wafer.

3. Use the joystick to position a good target pattern within the box, following the guidelines given in **Section 5.3.1.1, Guidelines for Selecting Good Reference Targets**.

4. Press the < PAUSE/CONT > key on the Joystick keyboard to store the selected reference target.

5. After the Find Target sequence is complete, the system asks if you wish to use `SECOND REF (Y/ENTER)?` You may either use the Second Reference option or the Find Edge Mode. The importance of these options is discussed immediately following this section.

NOTE

If you are having mask shift or partial stepping problems, or would like another option besides the Second Reference or the Find Edge Mode, it is recommended that you use the Center Reference feature, Line 10 of the Autoalign Option Menu. See **Section 5.4.1.10, Line 10 − Center Reference,** for more information.

6. The prober then tells the Vision Module to load the target into memory. The Vision Module receives and digitizes all incoming video from the camera, but only stores the data that is within the target box on the screen (the box is generated by the Vision Module as a video overlay to help you).

Once the target data is stored, Auto Align is performed using that target. If the alignment is successful, the target will be stored again into memory, overwriting the old reference (this is done so that the target reference in memory is straight or lined up with the platen grid). If the alignment was not successful, the target is dumped and the message `REFERENCE NOT STORED` displays. Press < CAMR > to view the results of the failed tests. See **Section 5.3.2, Testing the Reference Target's Accuracy**, for more information.

Added June, 1996

As of Vision Module software REV DE, the Vision software version and options can be displayed after the "FIND TARG" procedure. Press the < CAMR > key to see a message similar to:

```
Copyright (c) 1994 by Electroglas, Vision DE:  Align IDI OCR PMI
```

which indicates software version **DE** with installed options IDI, OCR, and PMI.

5.4.1.5 SECOND REFERENCE

The second reference ensures that the prober will go to the proper First Die (First Die offset was already calculated when you pressed the < FIRST > (< F4 >) key at initial product setup).

Added June, 1996

The second reference must be a unique feature located on the right hand side of the wafer and should look very different from the first reference or any normal die. Test die work well, as they give a unique pattern that cannot be found in any of the adjacent die. Die intersections on stepped wafers also are ideal.

If you do not have test die, you may mark the wafer to use as a second reference. The mark on the wafer should be at least 1 mil across and the same size and in the same place on every wafer. If it is a featureless mark (a dot) it must be at least 4 mils across and no greater than 10 mils across. The mark should have good contrast from the background so that the prober can see it. If possible, the mark should be done during the metal mask for the best contrast.

To store a second reference, at the `SECOND REF (Y/ENTER)?` prompt press < Y >. Follow the same steps as outlined in **Section 5.3.1.4, Selecting and Storing a Reference Target**, beginning with Step 1.

If you cannot store a second reference, the Find Edge mode may be used.

5.4.1.6 USING FIND EDGE MODE

If you press < ENTER > at the prompt `SECOND REF (Y/ENTER)?`, you will see a second message: `FIND EDGE (Y/ENTER)?` If you press < Y >, the system will find the edge die. The First Die is then set normally.

The Find Edge mode can be selected as an alternative to a second reference when no partial die are printed on the wafer. If you have wafers in which the die do not go all the way to the edge and the top of the wafer, or if there is a blank area between the die and the edge of the wafer, use the

Find Edge mode. The prober determines where the edge of the wafer is by indexing across the wafer until the prober no longer sees a die.

If the Find Edge mode fails while training the reference wafer, the system asks if you would like to try finding the edge again. If you enter yes, the search begins from the reference target, to ensure a correct First Die selection on subsequent wafers.

5.4.1.7 USING FIRST DIE REASONABLENESS

If the second reference or Find Edge mode are not selected, the system automatically defaults to this method.

When you place the first wafer onto the chuck either manually or with the Material Handler to store your reference target, the prober will remember the exact forcer location where the reference was stored. When a new wafer is placed onto the chucktop the prober will move to that location to begin searching for the reference.

The reference target of the new wafer should already appear on the monitor and cross hairs should immediately lock onto the reference target as the prober moves the target into the window at the center of the monitor.

If the reference target does not appear on the monitor and the prober has to search to find it, this indicates that the Material Handler is not properly adjusted; the reliability of getting to the correct First Die is directly related to the repeatability of the Material Handler.

If the reference does not appear on the monitor and the prober has to search to find it, this indicates that the Material Handling Module may not be properly adjusted. The reliability of getting to the correct first die is directly related to:

Modified June, 1996

1. The quality and repeatability of the target;
2. The use of the second reference;
3. The accuracy of the Material Handler in loading the wafer correctly; and
4. The camera center position.

The most critical adjustment is the centering crescent on the belt track and the centering ring on the air track, which ensures that the wafer will be perfectly centered on the prealign spindle. Refer to Section **4**, **MATERIAL HANDLING**, for more information on this module.

5.4.2 Testing the Reference Target's Accuracy

Before the alignment process is taken over by the prober, the accuracy of the reference target selection can be tested. Three specific reference target qualification tests are available:

1. Contrast test
2. Confusing target test
3. Positional sensitivity test

5.4.2.1 CONTRAST TEST

The contrast tests measures the standard deviation of the gray scale selected by < FIND TARG >. There are 64 brightness or gray levels with 3.0 as the minimum allowable contrast requirement for a reference target. If a problem causing the message, `REFERENCE NOT STORED` is due to low contrast, an error is displayed as follows:

```
POOR LOW CONTRAST 1.2 (<=3.0)
PLEASE ADJUST LIGHT, Z, OR SELECT ANOTHER TARGET
```

Press < CAMR > to review the error message on the video overlay. To correct, increase the light, adjust the Z, or select another reference target with higher contrast.

5.4.2.2 CONFUSING TARGET TEST

During the reference target selection process, the Vision Module searches for the reference target in whole image or fullness. If another target is found with a target search score above 70, the confusing target test will reject the target and display the error:

```
TARGET IS CONFUSING!  SELECT ANOTHER TARGET.
```

The outline, search score, and position deviation of all confusing targets are displayed by blinking on the screen. Correct by selecting another less confusing reference target.

5.4.2.3 POSITIONAL SENSITIVITY TEST

The positional sensitivity measures the drop or difference in search scores around the immediate neighborhood of the reference target. A target with a high positional sensitivity (6 or above) in both the X and Y directions should be selected.

If the positional sensitivity value for X and/or Y is small (below 6), then the respective X and/or Y direction has very little positional information and the reference target is not good. Slight changes in directional rotation will not be detected. One of the following messages will display:

```
WARNING: NOT ENOUGH POSITIONAL INFORMATION IN X

WARNING: NOT ENOUGH POSITIONAL INFORMATION IN Y

WARNING: NOT ENOUGH POSITIONAL INFORMATION IN X AND Y
```

Press < CAMR > to review the sensitivity message and, if necessary, press < Z > to raise the Z stage to view the image. To correct, select a reference target with enough variation in positional information.

5.4.2.4 OTHER TARGET TESTS

A manual way of checking the accuracy of the alignment is to position the vertical cross hair on the edge of a street and scan the wafer up and down to see if the street drifts away from the cross hair. A good target should be accurate within a tenth mil, require no correction, and align in 10 to 12 seconds.

If you notice theta alignment problems, check your target for vertical edges. If you see First Die placement problems, look for both vertical and horizontal edges. If the align time is excessive, verify large features in the target and check camera scaling.

If each alignment starts by rotating the wafer strangely before trying to align it, then your Find Target sequence was performed with a wafer placed on the chuck top by hand, and the system is duplicating the correction required for that first wafer.

5.4.3 Alignment Completion

When the reference target and live image match, the prober indexes the forcer exactly one whole die in the Y axis, and brings the next die under the camera optical center. Assuming the die size has been entered correctly and since the wafer is not aligned perfectly, the target should appear above or below optical center.

The Vision Module, again told to search, identifies the target and tells the prober the extent of displacement of the target relative to optical center. The prober calculates the angle of rotation using the die size and the displacement value, and orders the chuck to rotate accordingly to correct the theta error.

When this is accomplished, the Vision Module again searches and verifies that the target now appears at optical center. If it does not appear at optical center, the prober corrects the theta error based on the new information from the Vision Module.

The prober moves the forcer in the X axis, 80% of the wafer radius rounded off to the nearest die size. The search and correct process resumes between the Vision Module and the prober until the target pattern is identified at optical center.

The forcer is commanded to move again in the Y axis past the center to the opposite side of the wafer (80% of the radius again). The search and correct routine resumes, completing automatic wafer alignment.

5.4.4 Adjusting the Reference Target for a New Camera Location

As of Prober Vision Software Revision REV DB, it is possible to align the correct First Die after downloading a reference pattern that was trained on a different prober. The problem of a camera location changing is overcome by storing the saved target position as an offset from the wafer center rather than using an absolute target position. Wafer center is measured by profiling the wafer with the Find Center option enabled. Therefore, in order to use this enhancement, it is *highly* recommended that the wafer be profiled before an align is attempted.

After a pattern file from a different prober is downloaded, Auto Align will adjust its search location to account for the new camera position. The correct reference die will be placed under the camera and used for alignment.

If First Die is not set after downloading the pattern file and aligning to the reference target, the First Die position is calculated using a vector from the alignment reference die to the First Die.

The prober will only be able to place the First Die under the probe tip center to an accuracy which may be off by as much as the sum of the setup errors in Probe Tip Center and Camera Center on both probers.

For die probing, First Die should be reset after aligning the first wafer associated with the downloaded pattern file.

Restriction: Pattern shift ("mask shift") between the trained wafer and the current wafer will cause the alignment search position to be off by the amount of the shift.

5.5 OPERATING AUTO ALIGN

To operate Auto Align:

1. Press < SET OPTION > (< F3 >) to display the Set Option Menu.

2. Select Line 02, AUTO−ALIGN SWITCH.

The Autoalign Option Menu displays (*Figure 5−2*).

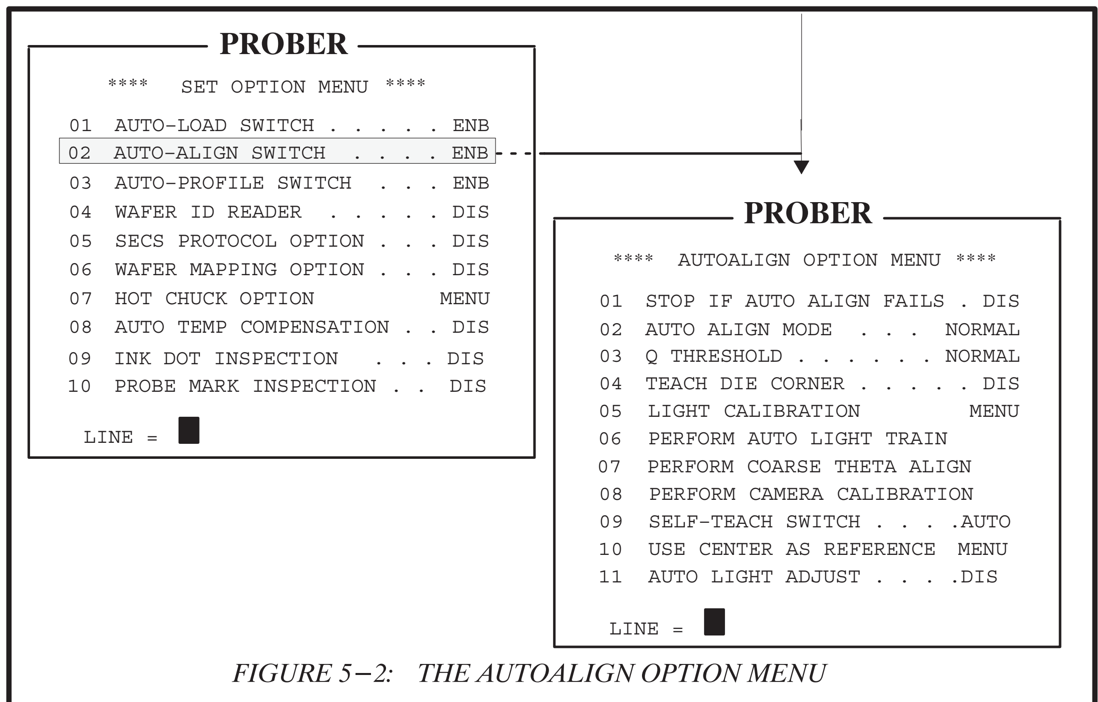


FIGURE 5−2: THE AUTOALIGN OPTION MENU

5.5.1 Autoalign Option Menu Line Items

LINE 01 – STOP IF AUTO ALIGN FAILS

This option enables/disables a stop program.

With this feature disabled (< 0 >), alignment–related failures will not halt operation. Wafers failing to align will not be probed; they will be transported directly to unload.

With this feature enabled (< 1 >), operation will halt if the Auto Align fails and an alarm message will appear on the screen and the audio alarm will sound.

LINE 02 – AUTO ALIGN MODE

Choose an alignment mode or accuracy:

0 for NORMAL – This mode requires the tolerance to be +/– .50 pixels, more than enough resolution for normal production. NORMAL is the fastest alignment mode.

1 for FINE – FINE is similar to NORMAL, except the tolerance is +/– .25 pixels. This mode may require one or more search and correct routines by the prober before it reaches this distance from optical center.

2 for XFINE – XFINE also has a tolerance of +/– .25 pixels, but also incorporates an optional theta shake and some theta compensation. **NOTE**: The Theta Compensation feature (**Section 5.7**) **cannot** be used with the XFINE alignment mode.

3 for 2 PT/2 REF – used when the wafer has two different die patterns on the two halves of the wafer (same tolerance as NORMAL).

4 for 2 PT/1 REF – for two–point alignment of a wafer with a single die pattern (same tolerance as NORMAL).

As of ProberVision software REV DA, the decreased search time for the alignment target, after resetting "FIRST" die, is available to all alignment modes, not just `XFINE`.

Added 6/96

For special procedures used on wafers qualified by alignment selections 3 and 4, see **Section 5.4.4, Find Target Exceptions**.

LINE 03 – Q THRESHOLD

The Vision Module allows you to adjust the Q (quality) value threshold. Again, the Q value is a measure of the quality of the pattern match between the new image to the stored image.

The Q value threshold appears on Line 03 of the Autoalign Option Menu (*Figure 5–3*). The prompt asks for a selection of:

```
0 = Normal
1 = Low
2 = High
```

The Q value threshold is the minimum Q value for acceptance as a match (having the same pattern). An acquired image that matches the stored reference with a Q value at or above the Q value threshold would be accepted as a match with the stored reference. Otherwise, the acquired image is rejected as not being a match. The Q value threshold for the first reference is selectable (High, Normal, Low). The Q value threshold for the second reference is fixed at Normal.

Normal − The Normal Q value threshold setting has been shown to work well with the majority of the applications. It is the recommended setting.

Low − The Low Q value threshold setting should only be used when poor wafer images (for example, poor contrast, excessive pattern variation) lead to undesirable frequency of failure to align. A Low Q value threshold gives a lower level of confidence that the correct target is located even at the end of a successful alignment.

High − The higher the Q value threshold, the more resemblance a new image must bear with the stored reference before it is considered a match. A High Q value threshold gives a higher level of confidence that the correct target reference is located at the end of a successful alignment. However, the alignment performance is more sensitive to wafer image degradation. Wafers that otherwise would align well with the Normal Q setting could possibly fail to align with the High Q setting. The High Q value threshold setting should only be used on wafers that present good images (for example, good contrast, distinctive features, highly repeatable patterns from die to die).

LINE 04 − TEACH DIE CORNER

This line is used to enable/disable the Teach Die Corner feature which allows the host to access such information as target and camera offsets. The feature is described in **Section 5.5**, **Teach Die Corner Feature**.

LINE 05 − LIGHT CALIBRATION

The camera light calibration can be adjusted during Auto Align procedures by using the Autoalign Light Calibration screen. This menu and the control screen associated with it *(Figure 5−3*) control the lighting for the next training sequence. The light settings chosen will not be in effect until the next training sequence is completed.

If the desired settings are known, they can be entered directly into the Autoalign Light Calibration Menu. If the settings are not known, select Line `05 ADJUST LIGHTING` which accesses the Adjust Autoalign Lighting screen.

Added June, 1996

When the Adjust Lighting screen is entered, the chuck moves to the align target found during the last align. If no align was done since a download of pattern (disk or XIO), camera center will be used

The last reference die trained will be moved under the camera with the current light settings. If no die has been trained, default values will be used for the light settings, and the center of the wafer will be placed under the camera.

There are fifteen discrete light levels. Press < CAMR > to toggle between the menu and the camera video display to observe lighting. When in the video display, the keys defined by the Adjust Autoalign Lighting screen are still active so changes in lighting can be seen immediately.

While making changes, do not press < ENTER > after pressing an active key; the < ENTER > key returns the display to the Autoalign Light Calibration Menu.

As of ProberVision System Software REV DB, you are able to change the current align light settings. This makes it easier to adjust the align lighting without retraining the target. For details, see the supplement at the end of the section.

Added June, 1996

LINE 06 – PERFORM AUTO LIGHT TRAIN

This line is used to select the best light type. This line item is described in **Section 5.7.4.1**, **Camera Light Type Selection**.

LINE 07 – COARSE THETA ALIGN

This feature is used to automatically perform coarse theta alignment. This line item is described in **Section 5.7.4.2**, **Perform Coarse Theta Align**.

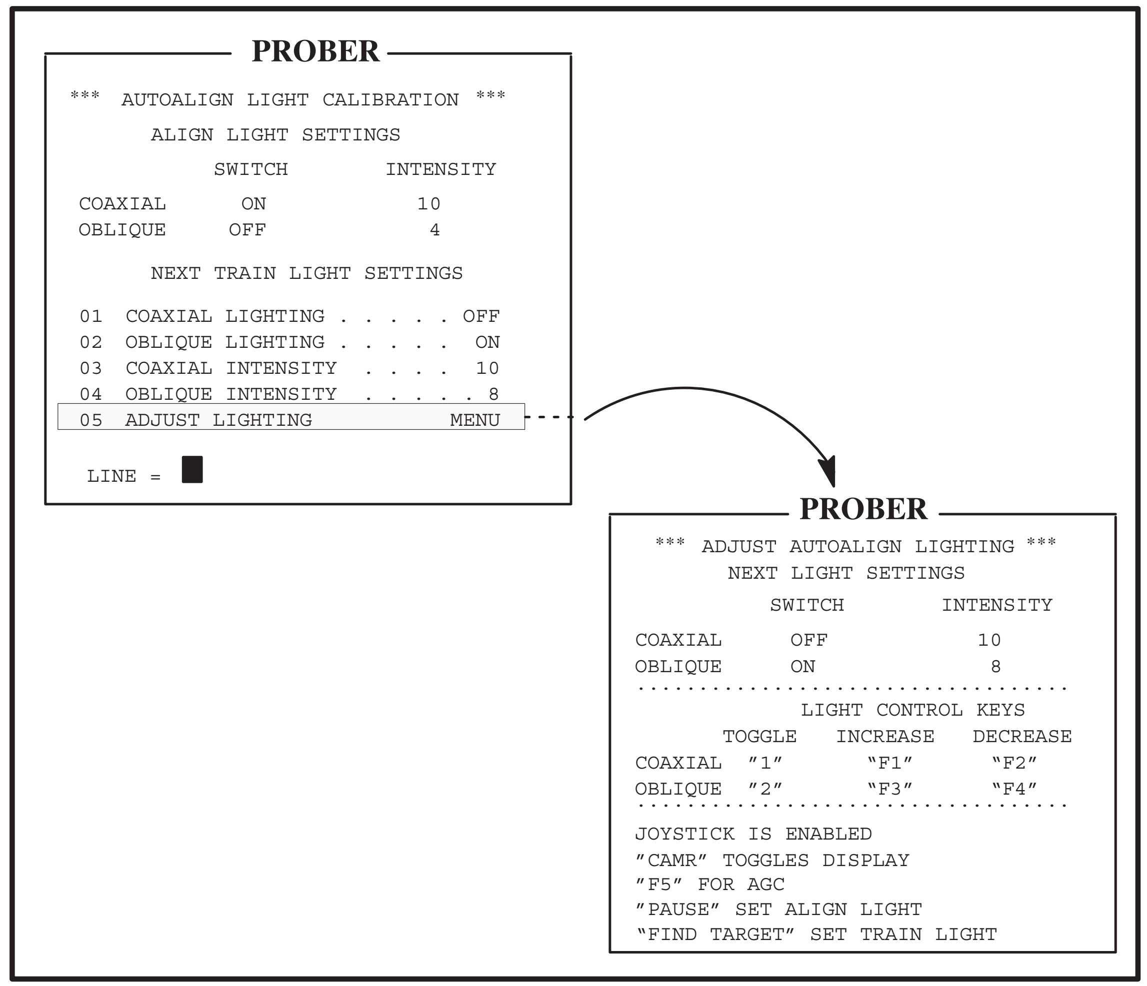


FIGURE 5–3: AUTOALIGN LIGHT CALIBRATION MENU AND ADJUST AUTOALIGN LIGHTING SCREEN

LINE 08 − PERFORM CAMERA CALIBRATION

Camera calibration determines the relationship of forcer steps in mils to camera resolution units in pixels. The system automatically performs the camera calibration procedures when the vision module is powered on. See **Section 5.6.4.3, Camera Calibration Procedures,** for more information.

LINE 09 − SELF−TEACH SWITCH

This option enables or disables the Self−Teach Auto Align feature. See **Section 5.6**, **Self−Teach Auto Align**, for more information on this feature.

LINE 10 − CENTER REFERENCE

Selecting Line 10 from the Autoalign Option Menu produces the Center Reference Menu (*Figure 5−4*). This feature is used to ensure that the First Die position selection is correct. This is especially useful for mask shift problems, inconsistent loading to the chuck top, inaccurate wafer diameter measurement, and off−line inking applications.

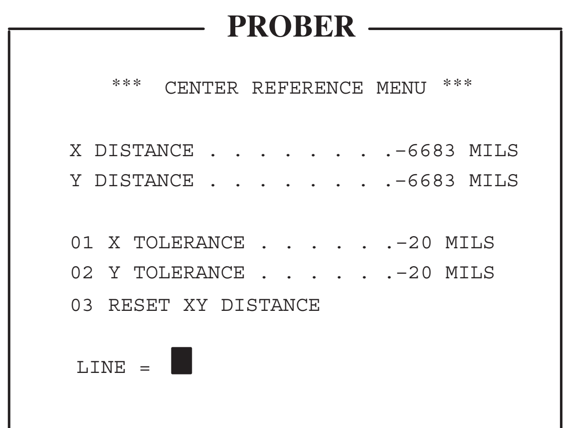


FIGURE 5−4: CENTER REFERENCE MENU

First Die is the die under the probes when you press < FIRST > (< F4 >). Usually, it is the first whole die in one of four corners of the wafer. When First Die is set, the distance between First Die and the center of the wafer is calculated and stored. Center reference allows the user to define an X and Y tolerance distance in which First Die position may vary.

When a new wafer is loaded onto the chuck and aligned by the prober, the prober moves to the predetermined First Die location for this wafer. This First Die offset was already calculated when you pressed < FIRST > (< F4 >) at initial product setup. With the Center Reference feature enabled, the prober calculates the distance from the wafer center to the First Die for each wafer loaded. If this distance falls within the calculated range, plus or minus the user set tolerances, the First Die selected for this wafer is considered valid. If the distance falls outside of this range, probing will be aborted and the display will show the error message:

```
ABORT: FIRST DIE OUT OF RANGE
```

If the alarm messages are enabled from the Enhanced I/O Mode Menu, the code `A256` is automatically transferred to the host to indicate an error has occurred. Operator intervention is then needed to correct the problem before probing can continue.

When using the Center Reference feature, it is recommended that the profiler's find center option be enabled (Autoprofiler Option Menu, Line `01` − see **Section 6**, **NONCONTACT EDGE SENSOR**, subsection **6.2.1**, **Enabling and Setting the Profiler**). Without this feature, the prober does not know the actual wafer center position and the integrity of center reference is greatly compromised.

The line items of the Center Reference Menu are:

LINE 01 − X TOLERANCE

The current X tolerance is displayed. Set the X tolerance for the First Die shift (the range is −32768 to 32767 mils).

LINE 02 − Y TOLERANCE

The current Y tolerance is displayed. Select this line item to set the Y tolerance for the First Die shift.

LINE 03 − RESET XY DISTANCE

Reset the XY distance from the center reference by selecting this line item. This distance is recalculated the next time the < FIRST > (< F4 >) key is pressed.

Set the acceptable X and Y tolerances for First Die shift (the range is −32768 to 32767 mils) using lines 01 and 02 of the Center Reference Menu. Finally, select line 03 to reset the XY distance from the center reference. This distance is recalculated the next time the < FIRST > key is pressed.

This allows the operator to set First Die manually without an error being reported. This is required on the initial First Die setting and all other resets of First Die.

Press < FIRST > (< F4 >) again without resetting the XY distance again (Line `03`) to verify that the die under the probe tips fall within the acceptable criteria to be a legal First Die. This means that if the die under the probes is not within the legal range for the calculated First Die, the error message,

```
ERROR - INCORRECT FIRST DIE
```

is displayed on the monitor. If the die selected is a legal First Die (within the tolerance range), the current die position is used as the First Die position; however, center reference data is not calculated again.

LINE 11 − AUTO LIGHT ADJUST

The purpose of the Auto Light Adjust feature is to provide pattern portability between probers with different align lamp characteristics. This feature compensates for differences in align lamps between the prober used for pattern training and the prober where alignment is performed.

This feature is to be used only for patterns which were stored by Prober Vision Software Revison DB (or later). With targets stored by older software, the intensity optimization will not be attempted even if the new option is enabled.

The type of auto light adjust will depend on the original lamp values used for the target. Light train will use whichever downloaded lamp intensity is higher as the only lamp type to optimize. If both downloaded lamp intensities are the same, the "both" mode of light train will be done; that is, both lamps will be varied at equal intensities until the optimal intensities are found.

Enabled, Auto Light Adjust will cause the Auto Light Train function to be invoked just before the first acquire image of the Align function. However, this will happen only if this is the first align performed after a download of alignment pattern via external I/O (the **DP** command) or from disk. Auto Light Adjust will not be done on any aligns after a successful target training until another alignment pattern is downloaded.

In summary, Auto Light Train will not be done as part of alignment under any of these circumstances:

1. Auto Light Adjust option disabled.
2. Auto Light Adjust already done on the downloaded pattern.
3. Pattern downloaded was stored by prober software earlier than REV DB.
4. Align light manually set from the Adjust Autoalign Lighting screen.
5. Align light optimized and saved as part of Perform Auto Light Train (Line 06 of the Autoalign Option Menu).
6. Find Target procedures performed after pattern download.

The new lamp values which are determined by the Vision Module will become the lamp intensities for the current and future alignments until a new pattern is downloaded or a new reference pattern is trained. These values also appear as the align light settings of the Autoalign Light Calibration menu.

If the auto light adjust fails, the XIO alarm message 311, `"FAILED TO SET LIGHT INTENSITY"` will be displayed, the alignment function will fail, and the previous (downloaded) intensity values will be in effect again. If this occurs during autoprobe, autoprobing will be aborted.

The default lamp intensities will be changed from `"COAXUAL, OBLIQUE = 7"` to `"COAXIAL = 7, OBLIQUE = 0"`. This is to discourage users from training their targets with both lamps on. These defaults will be invoked when the total setup is defaulted using −99 from the Set Parameter Menu or via the **SP−99** XIO command.

It is highly recommended that you train wafers using only one lamp at an intensity determined by the Auto Light Train function (Line 06 of the Autoalign Option Menu). Use the Auto Light Train function to optimize the Coaxual or Oblique lamp intensity; then train the alignment target using the optimized lamp intensity.

After the selected lamp is optimized in the end of the Perform Auto Light Train function, the 15th line shows the lamp and optimized value. A message will read "SAVE AS ALIGN VALUE? (Y/ENTER)". If you press < Y >, the optimized value will become the current align light setting (the non−selected lamp will be turned off).

After < Y > or < ENTER > is pressed, the message will read "SAVE FOR ALIGN TRAIN? (Y/ENTER)". If you press < Y >, the optimized value will become the align light setting to be used for the next align training function. (The non−selected lamp will be turned off for the next align training.)

Automatic light optimization will not be done on the alignment of a downloaded pattern if the light is already optimized by performing an auto light train and saving as "align value" (Line 06 of the Auto Align Option Menu).

Added June, 1996

See the Supplement at the end of the section for information on the new Line 12 − Pattern Portability

5.5.2 Parameters from Other Menus

The Auto Align process is also influenced by parameters set through menus other than the Autoalign Option Menu.

Z ALIGN (Set Parameter Menu, Page 1, Line 10)

Z ALIGN sets the chuck height during the alignment process, and therefore determines the distance between the wafer surface and the optics module lens. The value entered must be between the Z lower and upper limits (200 to 400 mils). Z ALIGN values may be set to improve mechanical focus in the absence of a technician. Z ALIGN should always be lower than the probes or probe damage can occur.

DIE X... Y (Set Parameter Menu, Page 1, Lines 01/02)

Values entered for the die size determine the position of the chuck at the beginning of the FIND TARGET procedure.

IGNORE VAC (Miscellaneous Options Menu, Line 04)

Partial wafers may be aligned by enabling the option IGNORE VAC in the Miscellaneous Options Menu (a submenu accessed from Line 11 of the Set Mode Menu). The prober will not verify that a wafer is on the chuck before Auto Align. (This line only appears when the Auto−Load Option is disabled − Line 01 in the Set Option Menu).

Probing of partial wafers is discussed in **Appendix B.**

5.5.3 Functional Keys

Five Monitor and Joystick keys are functional when the Auto Align System is enabled (**Table 5−2**).

TABLE 5−2: AUTO ALIGN RELATED KEYS

Key	Function
Monitor Keyboard	
< F6 > (<FIND TARG >)	Initiates the pattern selection process to select the target to be stored by the Vision Module. The chuck travels to the alignment area, where a specific wafer location is placed under the camera's field of view.
< F7 > (< AUTO ALIGN >)	Initiates Auto Align sequence, provided a reference target has been stored.
< F8 > (< DIG VID >)	Causes an auto adjustment of gain for the Vision Module.
Joystick Keyboard	
< PAUSE/CONT >	Used with < FIND TARG >key when a reference target has been selected.
< CAMR >	Switches monitor between menus and camera image. Also, displays target qualification tests after storing a reference target.

The < AUTO ALIGN > (< F7 >) key command can be initiated any time the prober is idle. For example, pressing the < PAUSE/CONT > key during the probe operation halts that process. You can then press < AUTO ALIGN > (< F7 >) to begin the alignment sequence.

NOTES

When using the < PAUSE/CONT > key to abort the alignment process, note that:

Added June, 1996

1. It may take several presses of the < PAUSE/CONT > key to actually abort the alignment. (The Vision Module can only be interrupted at certain places in the alignment process.)
2. When the alignment process is aborted by using the < PAUSE/CONT > key, the prober will no longer profile the wafer via the NCES.

The < CAMR > key in effect enables or disables the camera video to the monitor. While the camera is automatically enabled during < FIND TARG > and < AUTO ALIGN > key functions, this key can be used independently to project an image on the screen. The key also can be used during the find target procedure to allow access to the screen displays.

5.5.4 Find Target Exceptions

Special steps are required for the find target procedure when align accuracy options 3 and 4 have been selected for Line 02 (Auto Align Mode) of the Autoalign Option Menu.

> **NOTE**
>
> Whenever the forcer release switch is pressed during the Find Target sequence, < F6 > (< FIND TARG >) may be pressed again. The forcer release switch is located on the left side of the Monitor Keyboard.

Option 3 (2 Point/2 References)

This alignment procedure was designed for wafers with non−repetitive patterns with different die sizes. (Access is described in **Section 5.4.1.2, Auto Align Mode.**)

1. Theta align the wafer.
2. Press < FIND TARG > (< F6 >) and select a reference pattern − preferably on the lower part of the wafer.
3. Press < PAUSE/CONT > to store this pattern.

   Two references are required; you will be prompted to JOG TO 2ND REF AND PRESS PAUSE. The second reference should be near the top of the wafer. This target does not have to be on the same vertical axis at the first target, but it must be different from the first target.

   Added June, 1996
4. Press < CAMR > to switch from data to video.

If the procedure is successful, REF STORED displays.

Option 4 (2 Point/1 Reference)

The procedure for wafers with a single die pattern (again, access described in **Section 5.4.1.2**) is identical to the 2 POINT/2 REF except for the following:

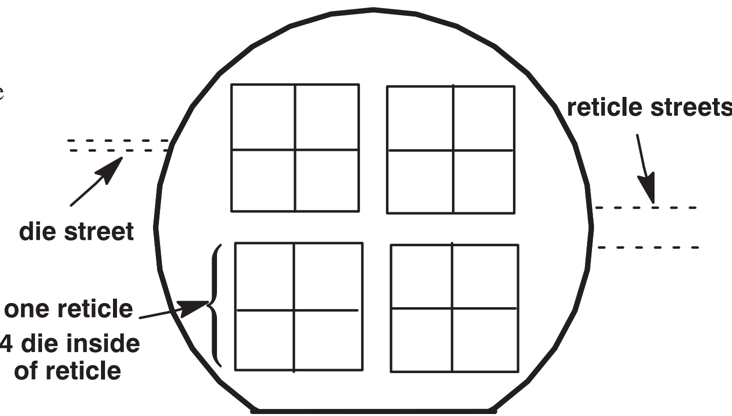
Disregard Step 1; there is no need to theta align the wafer.

In Step 3, select the same second reference die pattern as the First Die pattern and make sure that it is on the same vertical (Y axis) column as the first reference pattern.

The location of the second reference pattern in the cross hair reference box on the monitor is not critical and may be off as much as 30 pixels (10 mils).

Added
June. 1996

This pattern is good for wafers where the streets are not even across the wafer. This is often true for reticle stepped wafers where the distance die–to–die is different than from reticle–to–reticle.



5.6 TEACH DIE CORNER FEATURE

The Teach Die Corner feature is enabled from Line `04` of the Autoalign Option Menu. The feature allows the host to access such information as target and camera offsets via external I/O commands `?B, ?N` (this feature does not improve alignment; it is only useful when used with these I/O commands). When it is enabled, the following sequence takes place.

After you have found and stored the first target pattern (< FIND TARG > to position the wafer to locate a target, < PAUSE/CONT > key to store it), a message appears on the screen:

```
TO TEACH DIE, JOG TO UPPER LEFT
CORNER AND PRESS PAUSE
```

Align the upper left corner of the target die with the upper left corner of the alignment target window. This is accomplished in three steps:

1. Press < CAMR >.
2. Jog to the upper left corner of the die.
3. Press < PAUSE/CONT >.

After this is done, the alignment procedure returns to its normal format. The center of the window aligned with the upper left corner of the target die is the actual value desired, but since there is no cross hair in the Vision Module, the target window corner is used with an offset added to find the center.

This feature also requires that you:

– Enable the PROFILE WITH FIND CENTER option so that during profiling of the wafer it stores the edge positions. These are the X and Y positions in machine coordinates of the three edge points found by the profiler during the FIND CENTER operation. The option is enabled through Line `01` of the Autoprofiler Option Menu.

– Set and store the camera position through the Profiler Menu. The steps are:

1. Set die size to 1mm.
2. Press < PROG > (< F5 >) to display the Profiler Menu, then move the chucktop under the camera.

3. Turn the camera on and align the center of the chucktop to the upper left corner of the target window. Find the tangent point of the left side of the innermost vacuum groove.

4. Press < FIRST > (< F4 >).

5. Find the tangent point of the right side of the innermost vacuum groove. Return to the Run Time Display and note the X location. Divide this number in half and move the chuck to the calculated X center position.

6. Return to the Profiler Menu and press < 8 > to store the motor position. An audible signal will confirm that it is stored.

This parameter is used to calculate the offset between the probe tip position and the camera position (just stored). The upper left corner of the target window is used. The center is calculated by adding 10 mil offsets in both X and Y. The target window is 20 by 20 mils; therefore, half this number arrives at the center.

NOTE

This camera position is different than the one used when the <FIND TARG> key is pressed to set up the alignment target.

– Set the Z Align Height. Normally set through the Set Parameter Menu, it can also be set automatically through the Profiler Menu:

1. Press < PROG > (< F5 >) to enter the Profiler Menu.

2. Move the chuck, loaded with a wafer, to the camera and turn the camera on.

3. Press < Z > to enable Z Jog. Using the joystick, Z jog the wafer until it is in focus. Do not jog up to probe height or probe damage can occur.

4. Press < FIND TARG > (< F6 >) to store Z align at the current Z position. The prober will beep to indicate action completed.

5.7 SELF–TEACH AUTO ALIGN FEATURE

With the standard Auto Align option, the reference pattern selection may be difficult and confusing. Self–Teach Auto Align, a standard vision–based feature, relieves the operator of this task by automatically performing the reference target selection.

The Self–Teach Auto Align function is enabled from Line 09 of the Autoalign Option Menu (*Figure 5–5*).

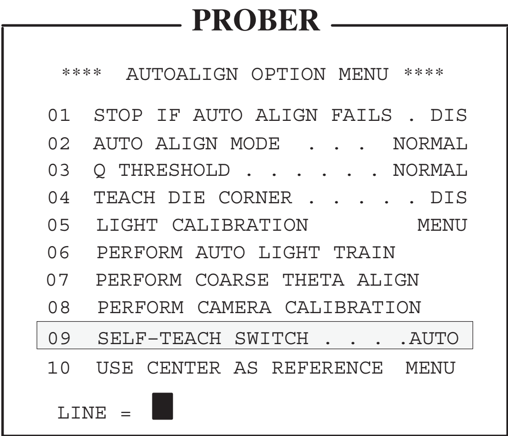


FIGURE 5−5: ENABLING THE SELF−TEACH FEATURE

Self−Teach guides the prober to select reference target candidates for evaluation. Each candidate is then compared against stringent alignment criteria, including contrast, XY data quality, and uniqueness. The candidates that meet these requirements are then measured on accuracy and repeatability attributes.

The internal target selection of Self−Teach is a hierarchical strategy composed of the following steps (or level of functionality):

Level 1. Selects regions (field of view) from the whole die.
Level 2. Selects (up to six) candidates from a region.
Level 3. Evaluates candidates' uniqueness and repeatability:

Level (1) Local Robustness and Uniqueness:

The candidate has to be both unique and repeatable in its own field of view; otherwise it is disqualified for further consideration.

Level (2) Whole Die Uniqueness:

The candidate has to be **unique in the whole die.** Self−Teach actually searches for all the candidates in the whole die area. If any other area also passes the Q threshold for a candidate, then that candidate will be disqualified for further consideration. This thorough test assures that alignment will never find the wrong target, provided the target selected by Self−Teach was used in the alignment process.

Added June, 1996

The uniqueness checking range for large dies (larger than 220 mils in X or 230 mils in Y) is a smaller range: 220 mils in the X direction and 230 mils in the Y direction (rather than the whole die). With the prealigner's accuracy, it is not necessary to check beyond 220 mils. This has two benefits:

1) Faster Self−Teach since uniqueness was checked at a smaller range.
2) Self−Teach can be applied to multi−die probing. (Multi−die would never pass the uniqueness checking for the whole multi−die range).

Level (3) Repeatability

Four neighbor dies are checked for repeatability; the candidate with the highest average Q value is chosen by Self−Teach. If the highest score is already much higher than the Q threshold, Self−Teach will select the superior target for alignment; otherwise, the steps in Level 2−3 are repeated until a superior target is found. If no superior target is found after evaluating all the regions, the target with the highest score from all regions will be selected.

5.7.1 Q Threshold Used in Target Selection

The Q threshold is applied in both uniqueness and repeatability checking as shown in **Table 5−3**:

TABLE 5−3: Q THRESHOLD CHECKING

Q Threshold	Uniqueness Check	Repeatability Check
High (70)	Fewer wrong targets Disqualify fewer candidates−>speed−up	Try more regions if repeatability is < Q
Normal (50)	More wrong targets Disqualify more candidates−> try more regions	Any candidate with repeatability over 50 will stop trying the next region.

Before Self−Teach, an operator could change the Q−threshold to HIGH, to disqualify fewer candidates (fewer wrong targets will be found), and to make it more selective in repeatability checking. It is recommended that the Q−threshold be set to HIGH for Self−Teach and Alignment.

Figure 5−6 shows the three selection levels (1, 2, 3).

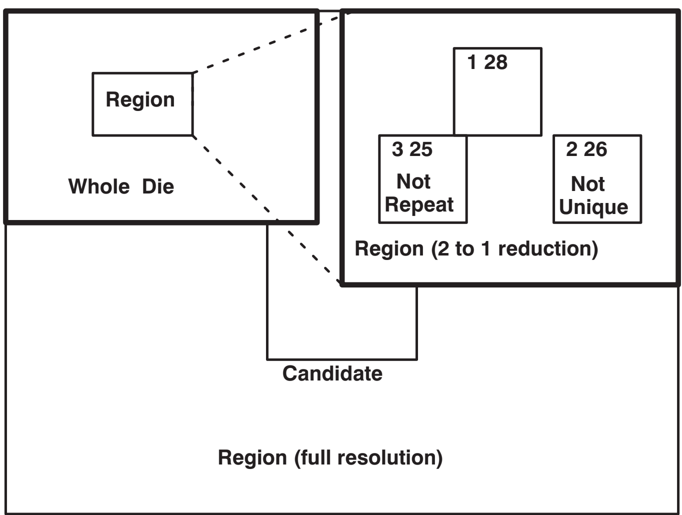


FIGURE 5−6: INTERNAL STAA TARGET LEVELS

The upper left window shows the whole die image, the upper right window shows the region image, and the background is the candidate being evaluated. The candidate number and position score are shown in the region window.

The first candidate that satisfies all the selection criteria is used as a reference pattern for wafer alignment.

5.7.2 Self−Teach with XFINE, 2PT2, and 2PT1

Self−teach currently does not support XFINE, 2PT2, and 2PT1 alignment in an integrated mode. However, Self−Teach can still be used to select targets for any alignment mode.

A potential workaround is to remember the target selected using Self−Teach and retain that target position after switching to the desired alignment mode: XFINE, 2PT2, or 2PT1. For example, you can use SEMI Self−Teach to select the best target from a field of view. The Self−Teach selected targets always contain the best features for highly accurate alignment.

5.7.3 Wafer Requirements

It is important that the wafer used for reference target selection meet the criteria discussed in **Section 5.3.1.1**, **Guidelines for Selecting Good Reference Targets**.

NOTE
If a second reference is required, the manual Auto Alignment Option (or Self−Teach disabled) should be used.

5.7.4 Initial Setup Procedures

The following initial setup procedures are required before using the Self−Teach Auto Align function:

1. Enter the correct die size of the device (Set Parameter Menu, Page 1, Lines `01/02`).
2. Load the wafer onto the chuck.
3. Set the camera center to the wafer center position.
4. Camera light *type* selection is required in order to achieve best results; for more information on light types, see **Section 5.1.3**, **Lighting Sources**. Once the type has been achieved, the system automatically selects the best light *intensity*. To select the light type, see the next section, **5.6.4.1**.

5.7.4.1 Camera Light Type Selection

To select the camera light type, from the Autoalign Option Menu select Line `06 PERFORM AUTO LIGHT TRAIN` (*Figure 5−7*).

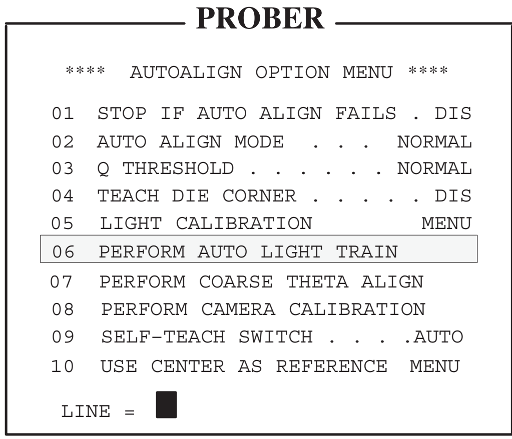


FIGURE 5−7: SELECTING PERFORM AUTO LIGHT TRAIN

Select one of the following light types (explained in **Section 5.1.3, Lighting Sources**):

0 = **Oblique −** the system adjusts the *oblique* light type and determines the intensity to use for this type to achieve the best contrast.

1 = **Coaxial −** the system adjusts the *coaxial* light type in the same manner.

2 = **Both −** the system adjusts *both* and determines the equal intensity of the two types to achieve the best contrast.

3 = **Auto −** the system scans *both* and determines which is the best light type and intensity to use to achieve the best contrast.

After your selection is made, the system displays the light type selected and allows you to confirm and save your selection.

Added June, 1996

As of ProberVision software REV DA and Vision Module software REV DE, a message informs of any change. Near the end of the `FIND TARG` procedure, with Self−Teach set to AUTO or SEMI, if the align lamp intensity has been changed, the screen will switch to text display and a message will inform the operator of the lamp chosen and the new intensity:

`SELECTED LIGHT IS [lamp] [xxxx]`

The “xxxx” is replaced by the actual intensity value. This message will appear for two seconds prior to the display of the message:

`2ND REF? (Y/ENTER)`

5.7.4.2 Perform Coarse Theta Align

To perform coarse theta alignment, from the Autoalign Option Menu select Line `07, PERFORM COARSE THETA ALIGN` (*Figure 5−8*).

This feature is used to automatically perform coarse theta alignment. The joystick is enabled, allowing you to position the die streets crossing to near center of field of view. Once you press

PROBER

```
 ****  AUTOALIGN OPTION MENU ****

01  STOP IF AUTO ALIGN FAILS . DIS
02  AUTO ALIGN MODE   . . .  NORMAL
03  Q THRESHOLD . . . . . . NORMAL
04  TEACH DIE CORNER . . . . . DIS
05  LIGHT CALIBRATION          MENU
06  PERFORM AUTO LIGHT TRAIN
07  PERFORM COARSE THETA ALIGN
08  PERFORM CAMERA CALIBRATION
09  SELF-TEACH SWITCH . . . .AUTO
10  USE CENTER AS REFERENCE  MENU

 LINE = █
```

FIGURE 5−8:
SELECTING PERFORM COARSE THETA ALIGN

< PAUSE/CONT > the prober commands the Vision Module to perform a coarse theta alignment. If the theta alignment is successful, the display will show the message:

`THE WAFER IS COARSE ALIGNED`

If it is not, you will see the message

`PLEASE SET LIGHT INTENSITY. COARSE THETA ALIGNMENT FAILED`

5.7.4.3 Camera Calibration Procedures

To perform camera calibration procedures, select Line `08 PERFORM CAMERA CALIBRATION` (*Figure 5−9*).

Camera calibration determines the relationship of forcer steps in mils to camera resolution units in pixels. When the Vision Module is powered on, after selecting the final target, the system automatically performs the camera calibration procedures and computes the scale factors between camera and motion system. **The more accurate the scale factor, the faster and more accurate the alignment. It is highly recommended to run the camera calibration** after the following operations:

1) Change Z height
2) Change wafers with different thickness
3) Adjust camera

PROBER

```
 ****  AUTOALIGN OPTION MENU ****

01  STOP IF AUTO ALIGN FAILS . DIS
02  AUTO ALIGN MODE   . . .  NORMAL
03  Q THRESHOLD . . . . . . NORMAL
04  TEACH DIE CORNER . . . . . DIS
05  LIGHT CALIBRATION          MENU
06  PERFORM AUTO LIGHT TRAIN
07  PERFORM COARSE THETA ALIGN
08  PERFORM CAMERA CALIBRATION
09  SELF-TEACH SWITCH . . . .AUTO
10  USE CENTER AS REFERENCE  MENU

 LINE = █
```

FIGURE 5−9:
SELECTING PERFORM CAMERA CALIBRATION

The camera tilt angle, camera field of view size, and estimated die size will also be displayed at the end. The Auto Light calibration will be invoked automatically when there is not enough contrast.

Manual camera calibration procedures can be performed as follows:

1. With the wafer on the positioner chuck, move the prober to a position where the camera is looking at a good reference pattern near the center of the wafer.

2. Initiate the camera calibration by selecting Line `08` from the Autoalign Option Menu.

   The system automatically performs the following:

   A. The Vision Module trains a reference pattern of size 80 by 80 pixels square at the center of the Vision Module field of view.

   B. Moves this pattern to the top left position of the search area by commanding the prober to move the positioner in the X and Y directions.

   C. Searches for this pattern at this position and saves the results. The pattern must exist within specified limits of both prober's nominal scale factor.

   D. If the search is successful, moves the pattern to the second position. This is the lower left position of the search area.

   E. Searches for this pattern at this position and saves the results.

   F. If the search is successful, moves the pattern to the third position. This is the lower right position of the search area.

   G. Searches for this pattern at this position and saves the results.

   H. If the search is successful, moves the pattern to the fourth position. This is the top right position of the search area.

   I. Searches for this pattern at this position and saves the results.

   J. If all of the four positions provided search data that are within their respective search area limits, the calibration data is computed from these results. If any of the above searches are not satisfied, the calibration is aborted and another calibration must be performed with a new pattern.

The Vision Module performs the camera calibration with the selected pattern by initiating several move commands to the prober and computing the error values obtained from the search data.

A successful calibration returns the X and Y calibration data in mils/pixel and the message `CAMERA CALIBRATION IS DONE` displays. If an unsuccessful return is received, you must move the positioner with the joystick to a position where the reference window is displaying a good imaging pattern and repeat this command.

When a pattern is trained, the prober and Vision Module interactively determine the scale factors for the X and Y–axis by searching for the trained patterns at three specified positions. The results of this search data are used to compute the relationship of the motor positioner movement in mils to the vision scale in pixels.

5.7.5 Modes Of Operation

The Self–Teach Auto Align feature has three modes of operation: **Manual, Auto**, and **Semi.**

Table 5–4 defines the Self–Teach functions which are operator–assisted and those which are performed automatically for each mode of operation, and also illustrates the differences in target selection strategy for each mode.

TABLE 5–4: SELF–TEACH MODES

Function	Manual	Auto	Semi
Select Start Position to Avoid Test Die	Operator	Automatic	Operator
Coarse Theta Alignment	Operator	Automatic	Automatic
Select a Target	Operator	Automatic	Automatic
Verify Target is Unique	Operator	Automatic	Automatic
Verify Target is Repeatable	Operator	Automatic	Automatic
Selection Strategy			
Target Selection	Target Window	Whole Die	Field of View
Uniqueness Checking	Field of View	Whole Die	Whole Die
Repeatability Checking	None	4 neighbors	4 neighbors
Camera Calibration	Not Done	Automatic	Automatic

The three modes are selected by entering < 09 > (Self–Teach Switch) from the Autoalign Option Menu (*Figure 5–10*).

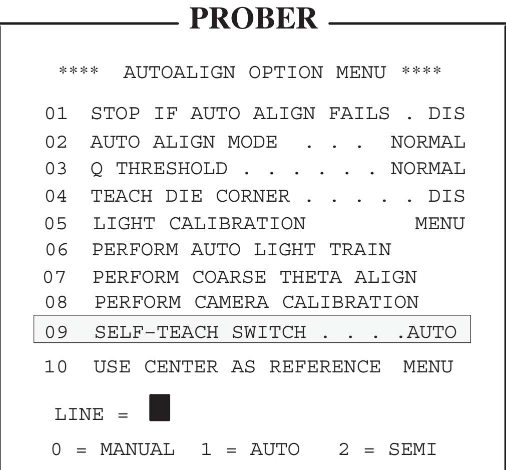


FIGURE 5−10: SELECTING SELF−TEACH OPERATING MODES

0 = MANUAL − Self−Teach Disabled

Reference pattern selection and training is manually performed using the Auto Align Option. The Self−Teach function is disabled.

1 = AUTO − Automatic

This mode requires no operator assistance. Once the automatic mode is selected, press < FIND TARGET > (< F6 >) to execute the Self−Teach Auto Align function. The system moves the chuck under the camera and starts searching for the appropriate conditions necessary to select, qualify, and train the target as the primary reference.

2 = SEMI − Semiautomatic

The SEMI mode requires limited operator assistance. This mode requires you to select the starting position so that the system will not land on a test die during target assessment or alignment.

The Semi mode asks you to provide **any** region of interest from which to select the best target (*Figure 5−11*):

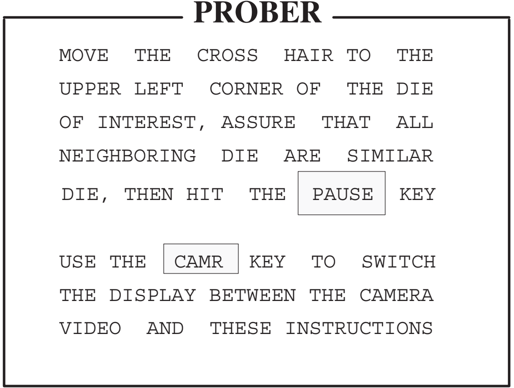


FIGURE 5−11: SEMI MODE INSTRUCTION SCREEN

As of Prober Vision software REV DA and Vision Module software REV DE, in the SEMI mode *(only)* instructions indicate that a die may be chosen even if it has a neighboring die which is different (for example, a test die). In this mode only, instead of the message:

Added June, 1996

```
MOVE THE CROSS HAIR TO THE UPPER LEFT
CORNER OF THE DIE OF INTEREST
```

you will see:

```
MOVE THE CROSS HAIR TO THE REGION OF INTEREST.
```

The prober prompts to set the starting position of the program. The joystick is enabled and the streets of interest should be positioned to the top left corner of the monitor. The system moves the chuck under the camera and starts searching for the conditions necessary to select, qualify, and train the reference pattern as the primary reference.

5.7.6 Reference Pattern Selection and Training Operation

The following is a step−by−step description of the manner in which the Self−Teach Auto Align feature selects, verifies, qualifies, and trains the reference pattern. The differences between the AUTO and SEMI modes are noted.

1. Once the operating mode (Auto or Semi) is selected, press < FIND TARG > (< F6 >) to begin.
2. The prober tests the Self−Teach Auto Align switch. If this switch is disabled, the prober waits for the operator to train a primary target. If this switch is enabled, the prober performs the Self−Teach Auto Align operations as dictated by the mode (Auto or Semi) selected.
3. The prober tests the Vision Module to see if the Self−Teach Auto Align feature is installed. If it is installed, the prober transmits the prober type ID and the device die size to the Vision Module. If this feature is not installed, the prober aborts the selection.
4. The prober tests the chuck for a wafer. If a wafer is on the chuck and the mode is Auto, the prober moves the positioner to the under the camera position. If the mode is Semi, the feature starts from the operator−selected position.
5. The prober turns on the selected camera light.
6. The prober tests the camera calibration status with the Vision Module and if the calibration has not yet been performed, the prober automatically performs the calibration procedures.

5.8 VISION UTILITIES FEATURES

To access the vision utilities features:

1. Press < DIAG > (< F1 >) to display the Diagnostics Menu.
2. Select Line 06, VISION UTILITIES MENU (*Figure 5−12*).

A description of the three line items follows.

LINE 01 ALIGN SEARCH DISPLAY

Line `01` enables/disables the displaying of the Auto Align search operation results on the monitor screen for trained personnel to evaluate. This function aids in troubleshooting align−related problems in Vision Module operations. Enter < 1 > to enable, < 0 > to disable.

LINE 02 ZOOM LENS SETUP MENU

Selecting Line `02` displays the Zoom Lens Diagnostics submenu, used for lens installation and setup. The menu is discussed in detail in **Section 12**, **PROBE MARK INSPECTION.**

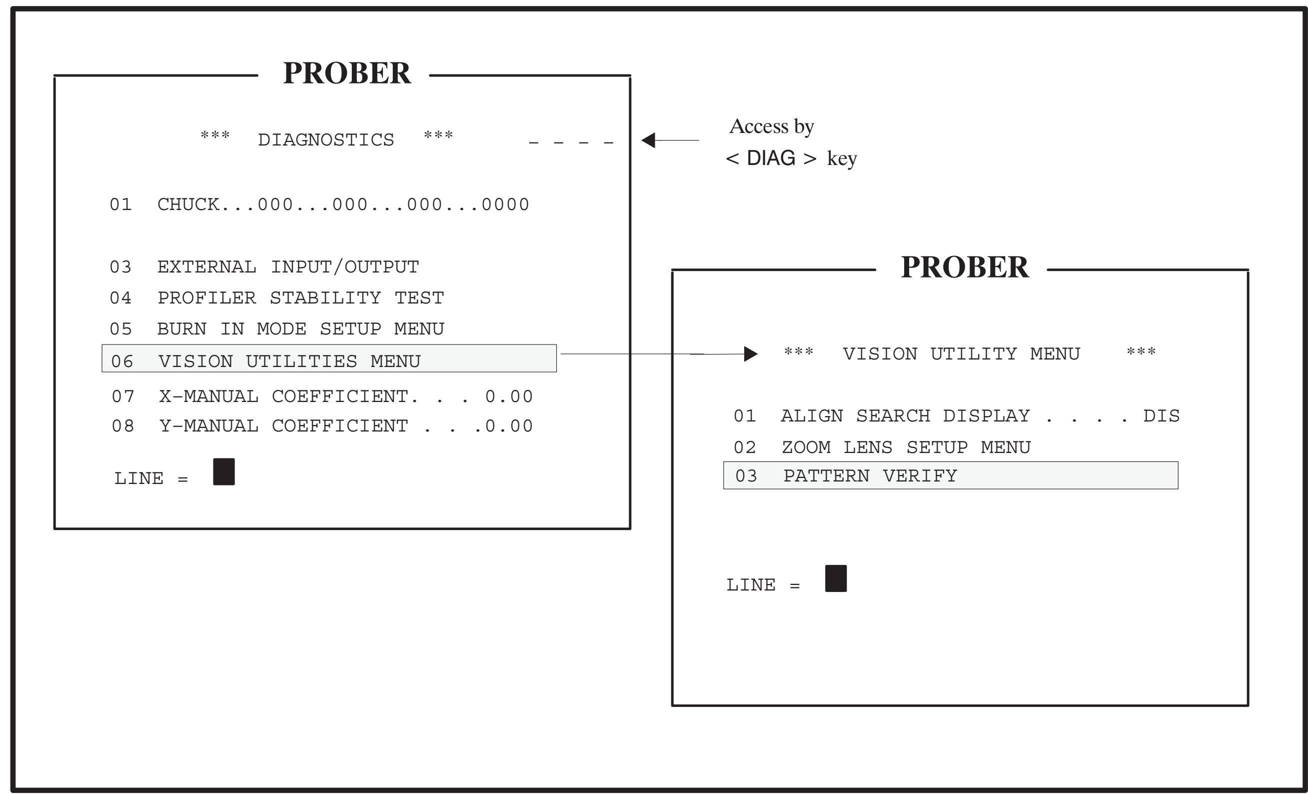


FIGURE 5−12: VISION UTILITIES MENU

LINE 03 − PATTERN VERIFY

Line 03 is used to test the acceptance or rejection of a manually selected reference pattern. It allows you to qualify the pattern within the window as a candidate for reference pattern.

The joystick is enabled, allowing you to position a unique pattern in the cross hair window. Once you press < PAUSE/CONT > the prober commands the Vision Module to perform a verification test and if the pattern is acceptable, responds back to the prober the message:

    THIS PATTERN IS ACCEPTABLE. STORE THIS PATTERN (Y/ENTER)

Store the pattern by pressing < Y >. If the pattern is unsatisfactory, the display will show the message:

    SELF-TEACH AUTO ALIGN TASK FAILED. THIS PATTERN IS NOT ACCEPTABLE

At this point you may select another pattern.

5.9 THETA COMPENSATION

See the Supplement at the end of the section for information pertaining to software upgrades

The Theta Compensation feature allows you to use test fixtures and probe cards without aligning the probe tips to the prober's XY coordinate system. Instead, you use the prober's theta drive to adjust a wafer on the chucktop until it is aligned with the probe tips.

Thereafter, all Index moves, either operator or prober initiated, will be made in the probe tip's coordinate system rather than the prober's. Jog and Scan motions will not be affected.

NOTES

- In order to enable the Theta Compensation feature, you must first disable the Ink Dot Inspection and Probe Mark Inspection features. If an attempt is made to enable theta compensation when an inspection option is enabled, the message, INSPECTION OPTIONS MUST BE OFF displays.
- The Self−Teach Auto mode cannot be used with the Theta Compensation feature. If Self−Teach Auto is enabled when you enable Theta Compen− sation, the message CAN'T USE SELF TEACH 'AUTO' MODE - USE SEMI MODE? (Y/ENTER) displays. Press < Y > to enable the Self−Teach Semi mode or < ENTER > to enable the Manual mode (Self−Teach disabled).
- The Theta Compensation feature *cannot* be used with XFINE align.

5.9.1 Theta Compensation Mode Menu

To use the Theta Compensation feature, first complete all prober setup procedures. The Theta Compensation Mode Menu is then used to enable the theta compensation mode and define the angle offset of the test head probe tips, the Theta Compensation Angle (TCA).

The Theta Compensation Menu is accessed from Line 11 of the Set Mode Menu. A typical menu display (*Figure 5−13*) is:

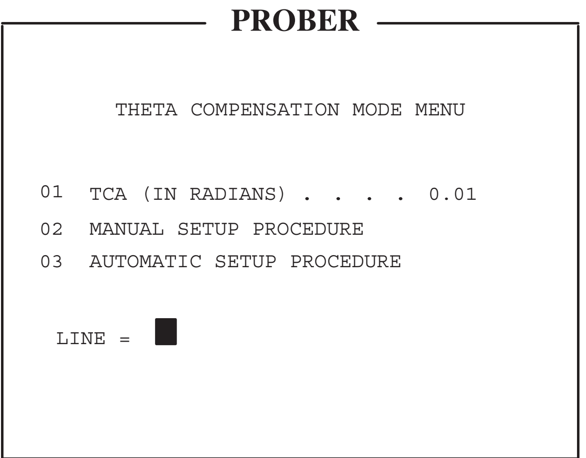


FIGURE 5−13: THETA COMPENSATION MODE MENU

LINE 01 − TCA (IN RADIANS)

Displays the current TCA value. Use this line item for direct entry of the Theta Compensation Angle, requiring that you determine the exact TCA by trial and error.

LINE 02 − MANUAL SETUP PROCEDURE

This line selects the manual setup procedure, not yet active.

LINE 03 − AUTOMATIC SETUP PROCEDURE

This line selects the procedure which prompts you through the steps required for the prober to calculate the TCA automatically. During the selection of a reference pattern for TCA calculation, the screen displays the camera video instead of the setup procedure instructions. The instructions are still available via the < CAMR > key, which toggles between the camera video and the instructions.

5.9.2 Theta Compensation Setup Procedure

The automatic theta compensation setup procedure is self−guiding. Once selected from the menu, it prompts for each step.

A wafer is loaded onto the chuck, either manually or with Material Handling. Assuming that the probe tip center has been set previously, the prober moves the wafer until its center lies directly under the probe tips. It then prompts you to align the pads to the probe tips. This alignment process is accomplished with repeated adjustments of both the chuck XY and theta positions. The tips do not have to touch the pads.

When the probe tip/pad alignment has been completed, press < FIND TARG > (< F6 >) to select a reference pattern for calculation of the TCA. The prober moves the wafer under the camera and prompts you to find a reference pattern without making any changes to theta. Once a suitable reference pattern has been selected (following guidelines given in **Section 5.3.1, The Reference Target**), press < PAUSE/CONT >, and the prober moves the wafer to various positions under the camera and locates the reference pattern at these new positions, using this information to calculate the TCA.

If the wafer is moved out of the camera's view or to a test die position, the error message `POOR TARGET SELECTION` is displayed and the automatic setup procedure is aborted. Return to this point in the procedure by again selecting Line `03` (Automatic Setup Procedure). Probe tip/pad alignment does not need to be redone since theta has not been changed. Immediately press < FIND TARG > (< F6 >) to select a better reference.

Finally, move the First Die under the probe tips and press < FIRST > (< F4 >). The prober then moves to three other die positions near the edge of the wafer to ensure the accuracy of the TCA. At each of these die positions, you are asked to verify that the probe tips and pads are aligned; if you indicate they are not, this setup procedure will repeat while you adjust the theta and chuck positions until alignment is achieved.

When all four positions are aligned, the setup procedure has been successfully completed and the system returns to the theta compensation menu.

At any time during the automatic setup procedure, you may press < PAUSE/CONT > to abort the procedure and return to the Theta Compensation Mode Menu. The only exception is when you must press < PAUSE/CONT > to indicate a reference pattern has been selected for TCA calculation.

See the Supplement at the end of the section for information about Probe to Pad Optimization

Once a satisfactory TCA has been established, all wafers processed by the prober will be aligned to the probe tips until either the TCA is reset to a new value or the theta compensation mode is disabled.

Added June, 1996

NOTE

Selecting a reference pattern for TCA calculation and a "first" die for TCA verification does *not* set the reference pattern and First Die for the auto align process. Therefore, alignment target selections must be done *after* TCA is calculated. Otherwise, the alignment target will be cleared and you will have to retrain an alignment target

5.10 TROUBLESHOOTING PROCEDURES

Most Auto Align malfunctions or problems can be traced to either camera/control, monitor/video,Vision Module, power supply or prober. Troubleshooting tables list the more common problems and solutions (**Tables 5−5** to **5−7**).

WARNING

Refer all *hardware* troubleshooting to qualified personnel. Turn power **OFF** before entering areas marked **DANGER** or **WARNING** of high or harzardous voltage.

5.10.1 CCU and Monitor Check

To determine if the Camera Control Unit and monitor are functioning correctly, perform the following:

NOTE

Barrel connectors may be used in this procedure. Note that for probers with a CRT Controller I PCB, the normal cable to the monitor has only 50 ohms impedance.

1. Remove the 75 ohm coaxial cable connecting Camera Control to the Vision Module at P1 only (video cable).
2. Remove the 75 ohm coaxial cable connecting the Vision Module to the CRT Controller PCB at P138.
3. Connect a 75 ohm coaxial cable from Camera Control to the CRT Controller PCB at P138.
4. Change switch − position to 75 ohm on back of monitor.
5. Place a wafer under the camera and light it properly.
6. If the Camera Control Unit and monitor are functioning, the image will appear on the screen.

5.10.2 Vision Module Possible Problems

1. The alignment light may not be turned on after pressing < FIND TARG> (< F6 >). This problem may be corrected by pressing the < LAMP > key twice.
2. The Vision Module may be stuck with light values selected automatically using auto light calibration. To correct the problem, execute the Semi Self−Teach mode once to invoke Auto−Light Calibration. This will reset the values.

WARNING

Refer all *hardware* troubleshooting to qualified personnel. Turn power **OFF** before entering areas marked **DANGER** or **WARNING** of high or harzardous voltage.

TABLE 5−5: TROUBLESHOOTING VIDEO

SYMPTOM	PROBABLE CAUSE	SOLUTION
No video on monitor	The cables are not connected properly, or are faulty.	Check connection of camera and monitor cable, and internal video cables.
	The Vision Module, camera or monitor is not turned "ON."	Check the components mentioned and turn on as required.
	The optics are not focused or light is not coming through the lens, optics path is blocked or beam is misadjusted.	Check the lighting and optics, adjust as required.
	Camera or monitor is faulty.	Connect the camera directly to monitor to check for proper operation.
The video is out of sync	The cables are not connected properly.	Reconnect cables.
	The monitor is not adjusted.	Adjust Horiz−Hold and/or Vert−Hold knobs on monitor.
	12V or +5V power supply is not working.	Check power supply. *TYPE 3**
	Either the camera or the monitor is faulty.	Check monitor and camera, replace as necessary.
Noise in video	Inadequate scene lighting.	Increase scene lighting.
	Improper video setup.	Check video setup.

* See **Appendix A, Customer Special**

WARNING

Refer all _hardware_ troubleshooting to qualified personnel. Turn power **OFF** before entering areas marked **DANGER** or **WARNING** of high or harzardous voltage.

TABLE 5–6: TROUBLESHOOTING COHU CAMERA

SYMPTOM	PROBABLE CAUSE	SOLUTION
No image on monitor and power is being supplied to camera	Poor cable connection.	Check power–in connection on camera rear panel.
Ghosts in picture	Improper termination of video.	Check that video cable is terminated into 75 ohms at monitor.
Picture at monitor will not lock	No sync in video.	Check video board (contact EG field service rep for assistance). *TYPE 3**
Poor contrast	Improper setting of black levels.	Check video board (contact EG field service rep for assistance). *TYPE 3**
	Improper illumination setting.	Adjust illumination setting (see **Section 5.2.3, Lighting Sources**).
Horizontal inter–ference bars	Ripple in one or more of the supply voltages.	Check video board (contact EG field service rep for assistance). *TYPE 3**
		Check cabling from Camera Control Unit to camera head.
Vertical interference	Unmatched Serial Number.	Check serial number on camera head to serial number on Camera Control Unit. (they should match). If they do not match call EG field service rep for assistance.

* See **Appendix A, Customer Special**

WARNING

Refer all *hardware* troubleshooting to qualified personnel. Turn power **OFF** before entering areas marked **DANGER** or **WARNING** of high or harzardous voltage.

TABLE 5−7: TROUBLESHOOTING AUTO ALIGN GENERAL

SYMPTOM	PROBABLE CAUSE	SOLUTION
Fan fails to switch on when power is applied to unit.	Fuse is blown.	Replace fuse. Check 12V DC on RS−232.
	The power switch is faulty.	Check switch for continuity in the closed position.
	Line current is not being supplied.	Make sure system is plugged in, and the power line supply is checked.
	The wiring has come loose.	Check the AC line, black and white, to fuse, power switch, and fans.
The power indicator does not light when power is turned on.	A +5V power supply has failed.	Check +5V supply.
	The +5V or ground wire, red or green, is "opened" or not connected firmly to switch.	Check wires.
	Bulb is burned out.	Replace bulb.
System operation is either erratic or not operational at all.	One or more of the three system power supplies is/are not adjusted or is/are faulty.	Verify voltage require−ments. Check for ripple or noise.

(continued)

WARNING

Refer all *hardware* troubleshooting to qualified personnel. Turn power **OFF** before entering areas marked **DANGER** or **WARNING** of high or harzardous voltage.

TABLE 5−7: TROUBLESHOOTING AUTO ALIGN GENERAL (continued)

SYMPTOM	PROBABLE CAUSE	SOLUTION
After Auto Align, the probes are missing the pads or are not centered in the pads.	AA optics assembly or camera is loose.	To check, with a live video image on the monitor, align the cross−hairs on a feature and pound on Ring Carrier to see if cross−hairs have shifted. If they have, tighten down optics assembly and/or camera.
After Auto Align, the probes are missing the pads or are not centered in the pads.	Chucktop fixation pin is loose between the bearings or is bent.	Adjust fixation pin bearings. Auto Align at probing height to verify if pin is bent.
After Auto Align, the prober is going to the wrong first die.	The Material Handler is not placing wafers onto the chucktop consistently, and the auto align is searching for target excessively.	Adjust the Material Handler for consistent placing of wafer onto chucktop. When camera image first appears on screen, the reference target should already be somewhere on the screen.

5.11 SUMMARY

In this section, you have learned:

- An overview of components
- A description of the process
- Initialization and setup procedures, including setting a reference target
- Operating instructions for Auto Align, Teach Die Corner and Self−Teach Auto Align
- Operating instructions for the Vision Utility and Theta Compensation features
- Troubleshooting tips

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SECTION 6
NONCONTACT EDGE SENSOR

6.1 OVERVIEW

The NCES (Noncontact Edge Sensor), also called the Profiler, measures the thickness or flatness of the wafer. This information is then used to compute a Z offset value for any particular die. Measurements are normally made at five spots; an optional enhanced profiling scheme is available, which measures the wafer at nine spots for greater accuracy.

The optional functions of the Profiler are used to improve circular probing by measuring automatically the exact wafer diameter and finding the center of the wafer in relation to the center of the chucktop.

6.1.1 How To Use This Section

This section contains the following:

- How to enable the Profiler and use the Autoprofiler Option Menu to set profiling methods
- How to access the Profiler Menu for setting profiling instructions
- Manual profiling procedures
- Auto adjust clean/continuity Z height procedures
- How to use the Profiler from External I/O
- Profiler stability test procedures
- Information regarding the Profiler's hardware

6.2 PROFILER OPERATION

6.2.1 Enabling and Setting the Profiler

To enable the Profiler:

1. Press < SET OPTION > (< F3 >) to access the Set Option Menu.
2. Select Line 03 (AUTO-PROFILE SWITCH).
3. Press < 1 > to enable.

This causes the wafer thickness measurement to take place during Autoprobing, but does not mean that the prober will use the measured data.

When the Auto−Profile switch is enabled, the Autoprofiler Option Menu *(Figure 6−1)* appears automatically.

PROBER

```
*** AUTOPROFILER OPTION MENU ***

01  PROFILE WITH FIND CENTER . . DIS
02  ENHANCED PROFILE . . . . . . DIS
03  PROFILER RETRIES . . . . . . DIS
04  USE AUTO DIAMETER . . . . . .DIS
05  PROFILE BEFORE ALIGN . . . . DIS
          **********

LINE = █
```

FIGURE 6−1: AUTOPROFILER OPTION MENU

6.2.2 Autoprofiler Option Menu Line Items

LINE 01 PROFILE WITH FIND CENTER

This is a wafer center−finding method which uses the Noncontact Edge Sensor to find the center of the wafer.

Press < 0 > to disable, < 1 > to enable Auto Profile centering. Enabled, center measurement becomes part of the auto profile sequence.

This line cannot be used if the Auto Profile option is disabled (Set Option Menu, Line 03). A blank space will appear on the menu in place of the line number and description.

LINE 02 ENHANCED PROFILE

When this feature is enabled, the Noncontact Edge Sensor will measure nine points on the wafer instead of five, ensuring greater accuracy.

LINE 03 PROFILER RETRIES

This line allows the operator to specify the number of times the Profiler will continue to try profiling the wafer after a profiling failure.

LINE 04 USE AUTO DIAMETER (for circular probing only)

Press < 1 > to enable this function, which causes the wafer diameter to be calculated as part of the "AUTO PROFILE" function. Line 01 must also be enabled.

Press < 0 > to disable the function. When auto diameter is disabled, the system will recognize the wafer diameter as the value entered on Line 04 of the Set Parameter Menu.

`USE AUTO DIAMETER` is also available from Line 08 of the Probe Mode Menu which appears when Line 03 `(PROBING MODE)` of the Set Mode Menu is selected.

NOTE

If the wafer contains solder bumps, then the Find Center and Auto Diameter profiler options, line items 01 and 04 of the Autoprofiler Option Menu, must be disabled before profiling the wafer.

LINE 05 PROFILE BEFORE ALIGN

This line controls whether the wafer will be profiled before or after alignment when the prober is working in the Autoprobe mode.

If the wafer contains solder bumps, this line must be set to Disable (wafer is aligned before profile) in order to correctly profile the wafer.

Updated 5/6/94

Enabling this line along with Line 01, Profile with Find Center, will cause the wafer to be profiled before alignment. By profiling with Find Center before alignment, the alignment target will be found without a spiral search even if the target was trained on another prober.

6.2.2.1 OTHER SETUP

Press < SET MODE > (< F2 >) to access the Set Mode Menu; select Line 04 `(Z TRAVELING MODE)`; press < 2 > to set to `PROFILE.`

When the `AUTO PROBE PATTERN` is set to `PTIAL` for the probing of partial wafers (Set Mode Menu, Line 02), the Profiler setup is done in exactly the same way as for circular probe mode. In particular, profile the chucktop with `PROFILE WITH FIND CENTER` enabled. Set the chucktop probe tip center. If Z−travel is set to `PROFILE` (Set Mode Menu, Line 04)`,` the probe tip Z−height needs to be set too.

CAUTION

Since finding of the wafer perimeter is done by profiling the Z−height, the probe tip cleaner may hit the probe card. This can be avoided by detaching the cleaner bracket assembly.

6.2.3 The Profiler Menu

The Profiler Menu, accessed by pressing < PROG > (< F5 >), is used to further set up the Profiler, the continuity tester, and the probe tip cleaner. In contrast to other menus, items on this menu initiate some action, rather than receive data or allow selection of an option. Therefore, do *not* press < ENTER > after an item is selected. Pressing < ENTER > will return the Run Time Display to the screen, instead of allowing you to continue activity from the Profiler Menu.

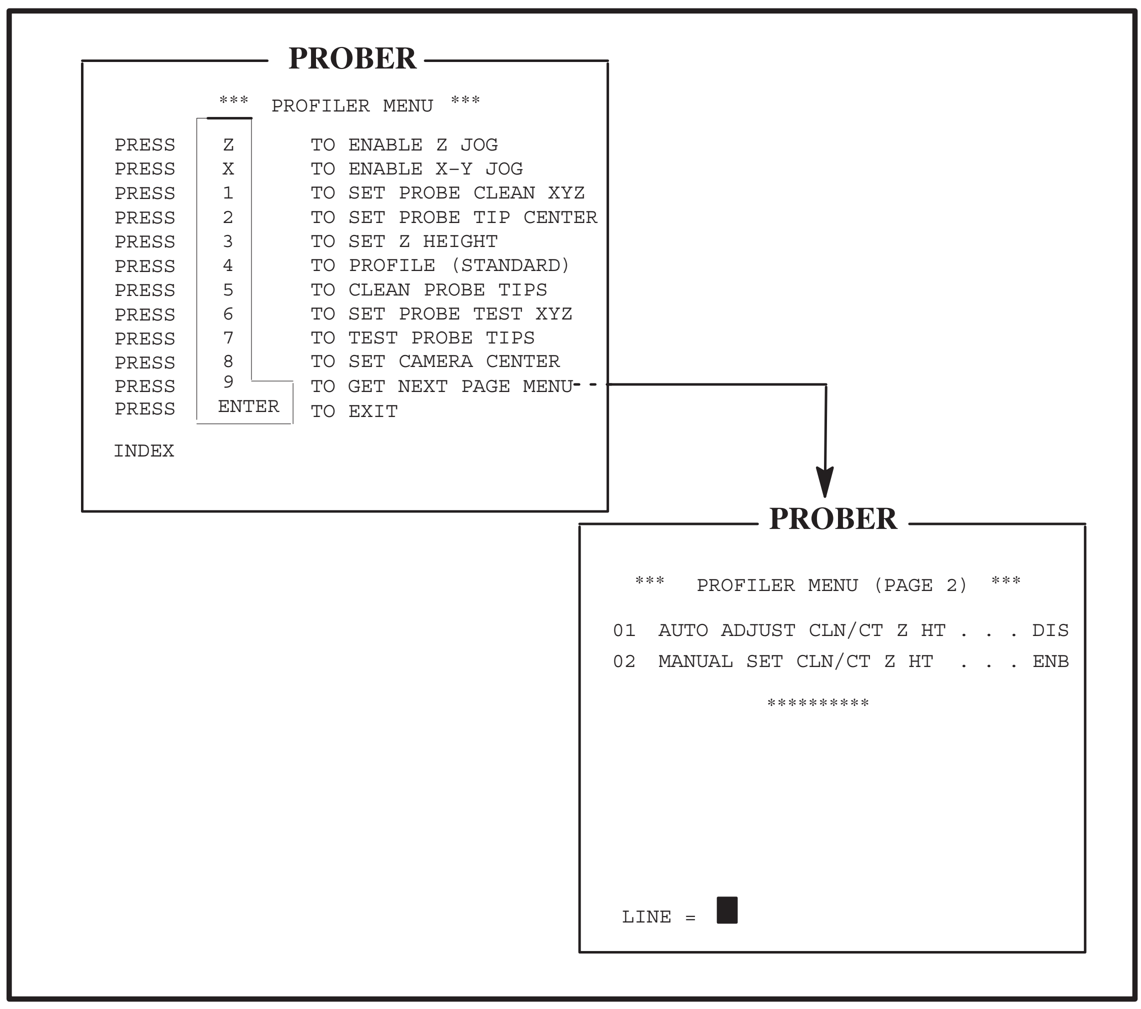

FIGURE 6–2: THE PROFILER MENU

TABLE 6−1: PROFILER MENU ACTION

Menu Item	Initiates Action	Result of action / comments
PRESS Z TO ENABLE Z JOG	Enables joystick control of Z (chucktop travel).	Moves in .5 mil increments (.25 mil for the 1/4 mil Z stage).
PRESS X TO ENABLE X-Y JOG	Resumes normal X−Y joystick control after "Z JOG" enable.	The current Joystick mode is displayed on the screen.
PRESS 1 TO SET PROBE CLEAN XYZ	To set cleaning height: position probe tip over cleaner plate; enable "Z JOG;" bring tip in contact with the plate. Press <1> to set.	Retains X, Y, Z coordinates in memory for future probe cleaning. **NOTE:** Setting Z height after the clean position clears the clean position. A display message informs the operator each time the clean position is cleared or stored.
PRESS 2 TO SET PROBE TIP CENTER	Stores center reference. Use joystick to align probe tip with center of chucktop. Press < 2 >to set.	The center reference is used during align scan and for circular probe pattern computations.
PRESS 3 TO SET Z HEIGHT	Use joystick to move wafer under the probe tip. Raise wafer until it contacts probe tip. Press <3> to set height.	The Z height is established to initialize a profile correction factor. **NOTE:** Whenever the probe Z height is set, the probe tip clean and probe tip test positions must be reset. A display message informs the operator each time the clean or test positions are cleared or stored.
PRESS 4 TO PROFILE (STANDARD)	Advances the wafer under the NCES and executes the profile sequence.	See **Section 6.2.3 (Manual Profiling).**
PRESS 5 TO CLEAN PROBE TIPS	Moves the cleaner under the probes, cleans the tips, and returns the motor to the starting position.	

TABLE 6–1: PROFILER MENU ACTION (continued)

Menu Item	Initiates Action	Result of action / comments
PRESS 6 TO SET PROBE TEST XYZ	To set the X–Y–Z position of the test area: position probe tip over cleaner plate; enable "Z JOG;" bring tip in contact with the plate. Press <6>.	The continuity test for the probe tips allows the tester to bring an electrically–conductive area in contact with the probe tips in order to run a special test program. **NOTE:** Setting Z height after the test position clears the test position. A message displays informing the operator each time the test position is cleared or stored.
PRESS 7 TO TEST PROBE TIPS	Enables the user to start the continuity test manually.	You must press < 6 > first.
PRESS 8 TO SET CAMERA CENTER		Used with Teach Die Corner function. See Section **5, AUTO ALIGN.**
PRESS 9 TO GET NEXT PAGE MENU		Displays Page 2 of Profiler Menu.
PRESS ENTER TO EXIT		Returns to Run Time Display.
PAGE 2		
01 AUTO ADJUST CLN/ CT Z HT	Enables automatic adjustment of probe tip clean and continuity test heights.	Whenever probe tip Z height is set to new height, prober will automatically adjust cleaning and continuity test heights to same setting.
02 MANUAL SET CLN/ CT Z HT	When enabled, disables settings of probe tip clean and continuity test heights.	Items representing keys < 1 >and < 6 > will be deleted from the Profiler Menu display.

6.2.3.1 PROFILER MENU LINE ITEMS

Following is an explanation of the line items on the Profiler Menu. Also see *Figure 6−2* and **Table 6−1.**

PRESS Z TO ENABLE Z JOG

PRESS X TO ENABLE X−Y JOG

The < Z > and < X > keys control the operation of the Joystick.

When you enter the Profiler Menu, the Joystick operates as usual, allowing XY motion. Pressing < Z > on the Joystick Keyboard allows you to use the Joystick to move the Z stage up and down in .5 mil increments (.25 mil for the 1/4 mil Z stage). The height of the Z stage is displayed on the screen as it moves. Pressing the red button on the top of the Joystick makes the Z stage move faster.

Joystick control of Z up/down travel is generally not active outside the Z upper and lower limits, except as noted below. Z height is monitored by the Z position shown on the bottom line of the screen.

The Z align height which is normally set through the Set Parameter Menu can also be set automatically through this item on the Profiler Menu. Pressing < CAMR > on the Joystick Keyboard allows you to view the wafer image before setting Z align height.

To set Z align height while in the Profiler Menu, move the chuck loaded with a wafer to the camera and turn the camera and lamp on. Press < Z > on the Joystick Keyboard to enable Z jog. Using the Joystick, Z−jog the wafer until it is in focus. Press < FIND TARG > (< F6 >) to store the Z align position at the current Z position. An audible signal will confirm that the action was completed.

While still in the Profiler Menu, press < X > to return the Joystick to normal XY travel mode.

PRESS 1 TO SET PROBE CLEAN XYZ

NOTE

Setting Z height after storing the probe clean position clears the clean position. A message displays informing you each time the clean position is cleared or stored.

The < 1 > key allows you to set the height and location at which probe tip cleaning will take place. Use the Joystick to position the probe tip over the ceramic burnishing plate. To establish the height, enable the Z jog feature using the < Z > key, and jog the Z stage until the probe tips contact the cleaning plate, then press < 1 >.

The system displays the message ARE ALL PROBES WITHIN PAD?; pressing < Y > answers Yes, pressing < ENTER > answers No. If < Y > is pressed, the prober will beep to signify that the location is set. If < ENTER > is pressed, the location will not be stored

The prober retains the X,Y, and Z coordinates in memory for future probe cleaning. Frequency of cleaning is determined by values entered for probe cleaning interval (Probe Mode Menu, Line 04).

NOTE

In most cases, the correct height for probe tip cleaning will not exceed the Z Up Limit selected in the Set Parameter Menu.

When necessary, however, the Z stage can be jogged above the upper limit. From the center position, pull the Joystick backward (towards the operator) again. This will jog up 10 mil at a time. The prober will beep as long as the current position is above the upper limit. This makes it possible for probe tip cleaning to be done at up to 420 mils, the absolute upper limit.

PRESS 2 TO SET PROBE TIP CENTER

PRESS 3 TO SET Z HEIGHT

For these settings, the chuck must be under the probe tips. If it is not, error message 300 (CHUCK NOT IN PROBE AREA) is issued. The probe tip center must be set at the center of the chucktop prior to the probing sequence. The center reference is used during align scan and for circular probe pattern computation.

Use the < 2 > key to tell the prober where the probes are located. Align the center by manipulating the Joystick until the probe tip aligns with the center of the chucktop. Press < 2 > to store this center reference.

The Z height is established to initialize a profile correction factor. Use the < 3 > key to set the height of the probes. With the Joystick, move the wafer under the probe tip. Raise the wafer until it contacts the probe tip. Press < 3 > to set the height.

The < 3 > key is used only during Profiler setup. When either is pressed, the prober beeps.

NOTE

Setting Z height after storing the probe clean position clears the clean position. A message displays informing you each time the clean position is cleared or stored.

PRESS 4 TO PROFILE

Once the Profiler is enabled (Line 03, Set Option Menu), it is initialized by vacuum−locking a wafer to the chucktop. Press < 4 > to move the wafer under the air sensor and execute the profile sequence. (See **Section 6.2.3 − Manual Profiling.**)

PRESS 5 TO CLEAN PROBE TIPS

When < 5 > is pressed, the prober moves the cleaner under the probes, cleans the tips, and returns the motor to the starting position.

To distribute the wear on cleaning and continuity of pads, the software moves the contact points for the probe array on both pads slightly each time the array is cleaned or a continuity test is made. The incremental movement follows a .09−inch diameter path from the XY position set in the Profiler Menu during setup, and repeats a particular spot once in 9000 times.

To avoid missing contact with the outside probe tips during the pads' migration around the wear circle, after centering the probe array on the pad, the prober automatically moves to the four extreme positions on the wear circle diameter and asks the operator, `PROBE TIPS STILL ON PAD?` If < Y > is pressed (yes), the prober proceeds to the next extreme point. If < ENTER > is pressed (no), the prober exits the setup procedure without setting the pad position and displays the monitor message: `CENTER PROBES ON PAD, TRY AGAIN.`

PRESS 6 TO SET PROBE TEST XYZ

PRESS 7 TO TEST PROBE TIPS

NOTE
Setting Z height after storing the probe clean position clears the clean position. A message displays informing you each time the clean position is cleared or stored.

Keys < 6 > and < 7 >, with tester interface, provide a continuity test which allows the tester to bring an electrically−conductive area in contact with the probe tips and run a special test program.

Press < 6 > to teach the X−Y−Z position of this conductive area, and press <7> to start the test. The Z−Y−Z position must be taught before the test can be run. It is only necessary to re−teach the position if it has changed before any subsequent test.

When < 6 > is pressed, the system displays the message `ARE ALL PROBES WITHIN PAD?`; pressing < Y > answers Yes, pressing < ENTER > answers No. During the probe tip test an error message `CONTINUITY TEST FAILED` signals test failure.

PRESS 8 TO SET CAMERA CENTER

This feature sets the camera center for use with the Teach Die Corner function. (See **Section 5, AUTO ALIGN,** subsection **5.5, Teach Die Corner Feature.**)

PRESS 9 TO GET NEXT PAGE MENU

Accesses Page 2 of the Profiler Menu.

PRESS "ENTER" TO EXIT

Returns the Run Time Display to the monitor.

LINE 01 (Page 2) AUTO ADJUST CLN/CT Z HT

Enabling this feature causes automatic adjustment of the probe tip clean height and the continuity test height whenever a new probe tip contact height is set. (A discussion of the Auto Adjust feature follows in **Section 6.2.5**.)

LINE 02 (Page 2) MANUAL SET CLN/CT Z HT

This line allows you to disable settings of the probe tip clean height and the continuity test height from Page 1 of the Profiler Menu. Keys < 1 > and < 6 > – Set Probe Clean XYZ and Set Probe Test XYZ – will be deleted from the menu.

6.2.4 Manual Profiling

Enable the Profiler by pressing < PROG > (< F5 >). The Profiler Menu displays *(Figure 6–2)*. Press < 4 > to profile the wafer.

Once profiling is complete, the XY motor will halt. Depending on the options enabled, the wafer diameter (in mils) may be displayed on the screen. To exit the menu, press < ENTER >.

Several situations require that profiling be done manually. Among them: after a `WAFER NOT PROFILED` error occurs (see **Section 6.5 – Profiling Error Messages**); and during initial product setup. You do NOT need to profile manually when cassettes are changed.

6.2.5 Auto Adjust Clean/Continuity Z Height Feature

The Auto Adjust Clean/Continuity Z Height Feature allows the prober to automatically adjust the Z height setting for either the probe tip clean position, the continuity test position, or both, when a new probe tip Z height is set. This makes it easier to set up the prober after changing probe cards.

However, the feature *must* be used correctly to avoid such problems as failure to make contact with the continuity test block or damage to a probe card because the Z stage was raised too high. Note the **CAUTIONs** listed next.

CAUTION

1. *It is important* that the probe tip cleaning and continuity test Z heights be set *after* setting the probe tip Z height. Otherwise, when you set the new clean and continuity heights, then set a new Z height, the prober will adjust the clean and continuity heights, rather than accept them all as new values.

2. Whenever a new probe card is put on the prober, *it is important* that the new probe tip Z height be set as soon as possible to minimize the potential for probe tip/card damage.

3. *It is VERY important* to remember to reset the new positions for the cleaning block and the continuity test block whenever they are moved on the chuck as soon as possible – again, to minimize the potential for probe/tip card damage.

The default state of this feature is inactive; if the feature is not in use, the prober will operate normally.

To activate/deactivate the feature, enable/disable `AUTO ADJUST CLN/CT Z HT` from the Profiler Menu; press < PROG > (< F5 >) to access the Profiler Menu. Press < 9 > to display the second page. Select line 01 (`AUTO ADJUST CLN/CT Z HT`). Select < 1 > or < 0 > to enable/disable.

To make an accurate adjustment of the probe tip cleaning and continuity Z heights, the prober must have a known reference point. The reference point it uses is the chucktop without wafer. Therefore, the chucktop *must* be profiled before the feature can be used.

The following procedure sets up the Auto Adjust feature:

1. Enable the `AUTO ADJUST CLN/CT Z HT` feature as described above.

3. Set the probe tip Z height (with a wafer on the chuck).

4. Set the probe tip cleaning/burnishing position.

5. Set the probe tip continuity test block position.

From this point, any time the probe tip Z height is set to a new value, the prober will automatically adjust the probe tip cleaning and continuity test Z heights to the same setting as the probe tip Z height.

When setting the probe tip Z height with a wafer on the chucktop, the prober subtracts the thickness of the wafer from the set Z height and uses this value to keep the reference point as the

chucktop without wafer.

6.3 USING THE PROFILER FROM EXTERNAL I/O

Several commands allow use of the Profiler under host computer control. “PZ” takes the wafer thickness measurement. The prober will reply to the host with either “MC” (profiling completed properly) or “MF” (profiling failed).

Further information about External I/0 control is given in **Section 8 (EXTERNAL CONTROL I/O INTERFACE).**

6.4 PROFILER STABILITY TEST

A simple Profiler air sensor test function is available by pressing < DIAG > (< F1 >), which produces a four−item menu. Item 04 on the menu activates the test. The test shows the stability and repeatability of Z height and find edge over the running period.

The first profiling of a wafer or chuck top after start is used as a reference. All consecutive profilings are compared to this reference data (the five Z−heights). Any variances in consecutive Z−heights are shown on the monitor screen.

If the Find Center option is enabled, the screen will also display the highest and lowest center position measured since its start. An error message, `SENSOR NOT SEATED CORRECTLY`, will be displayed if there is a variation of more than one Z motor step from the last measurement taken, and profiling will be stopped.

To recover:

1. Attempt to reprofile (press < 4 > in Profiler Menu). If the `PROFILING FAIL` message appears,
2. Press < ENTER > to exit the Profiler Menu.
3. Press < LOAD > on the Joystick Keyboard and unload the wafer.
4. Try to set up the Profiler again using the setup procedures. If unsuccessful,
5. Check all NCES hardware. If still unsuccessful,
6. Call Electroglas Field Service for maintenance.

The test is terminated by pressing < PAUSE/CONT > on the Joystick Keyboard.

6.5 PROFILER HARDWARE

The Profiler hardware consists of the Electronics Control Module (or the box) and the pneumatic sensor (the sensor).

The sensor may be lowered into operating position or raised into the ring carrier under program control. The sensor emits a stream of air which is used to detect back pressure − how much air is being reflected or bounced back into the sensor from a surface. This detected back pressure is used to determine the thickness of the wafer under the sensor.

The detected back pressure is compared by the electronics in the box to a preset reference. The output of this comparator can be one of three states:

1. Sensor less than reference.
2. Sensor equal to reference.
3. Sensor greater than reference.

The installation procedure sets up the box so that the equal condition occurs when the wafer (or chucktop) is 8 mils below the sensor. This 8−mil distance is the reference distance. Thus, the three comparator states effectively mean:

1. Wafer more than 8 mils from sensor.
2. Wafer exactly 8 mils from sensor.
3. Wafer less than 8 mils from sensor.

The comparator output is sensed by the Profiler software. To measure wafer thickness, it brings the Z stage up until the comparator switches from the "Wafer more than 8 mils from sensor" state into either the "...exactly 8 mils" state or the "...less than 8 mils" state.

The comparator output also drives two lamps on the box, labeled HI and LO. When the LO lamp is lit, the wafer is more than 8 mils from the sensor. The HI lamp is lit when the wafer is less than 8 mils from the sensor. Both lamps are off when the wafer is exactly 8 mils from the sensor.

The Profiler interface to the 4085X consists of one digital output from the 4085X's main card cage and two inputs. The output controls the position of the air sensor: lowered and operating or raised and inoperative. The two inputs correspond to the two comparator outputs, LO and HI. During profiling, the software monitors these two lines and decodes the output into the low, equal, high, and error conditions.

6.6 SUMMARY

In this section, you have learned:

- How to enable the Profiler and use the Autoprofiler Option Menu to set profiling methods
- How to access the Profiler Menu for setting profiling instructions
- Manual profiling procedures
- Auto adjust clean/continuity Z height procedures
- How to use the Profiler from External I/O
- Profiler stability test procedures
- Information regarding the Profiler's hardware

SECTION 7
Z STAGE, HOT CHUCK & TEMP. COMPENSATION

7.1 OVERVIEW

The Horizon 4085X's probing hardware consists of a Z−stage supporting a chuck, which transports the wafer in an X, Y and Z direction to place the die to be tested under the probes. The Z Stage (including the continuity and scrubing pads), Hot Chuck, and Temperature Compensation features are discussed in this section.

WARNING

Do not touch the Hot Chuck at any time. Severe burns may result. Check the panel display on the front of the Hot Chuck and wait until the Hot Chuck is cooled to a safe temperature of 45 °C or less (approximately 45 minutes).

7.1.1 How To Use This Section

This section contains the following:

– Basic assemblies of the Programmable Z stage #6 (PZ6)

– Operating and programming instructions for the PZ6

– How to enable and adjust the Hot Chuck

– Temperature Compensation overview and instructions on how to set manual coefficients

7.2 PROGRAMMABLE Z−STAGE #6 (PZ6) OVERVIEW

The Programmable Z−Stage #6 (PZ6) is an assembly made for Z axis (up or down) motion, and the term *programmable* means that it may be directed to move from one height to another. Designed for wafers of five to eight inches, the PZ6 can push upward with up to 25 pounds of force.

The PZ6 is mounted on top of the forcer *(Figure 7−1).* The wafer is held by vacuum on the top of the chuck, which moves vertically to bring the wafer into contact with the probes. This vertical or Z motion is preprogrammed to precise levels.

The chuck is driven by a vertical screw mechanism. A stepper motor coupled by a drive belt provides the drive force and the mechanism is supported by a cylindrical air bearing. The chuck is also equipped with an optical sensor to detect the zero position of the Z stage.

A stepper motor mounted directly on the side of the chuck provides theta adjustment drive. The motor can rotate the chuck a total of +/− five (5) degrees. Coarse theta centering is provided by a photosensor, also mounted on the chuck. The chucktop is secured by four screws and is removed easily.

The chuck cable from the Prober Control Module plugs into the chuck interface circuit board on the Forcer Assembly. At the opposite end of the board are four connectors for the cables attached to the two motors and the two photosensors.

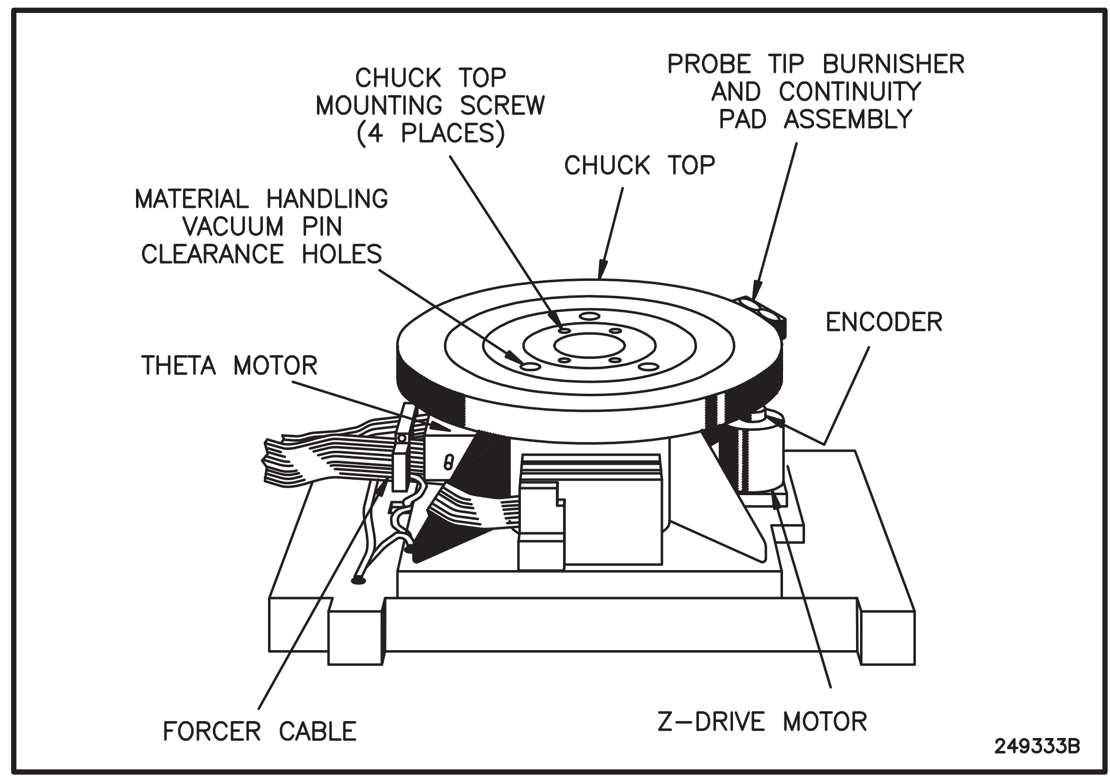

FIGURE 7−1: PZ6 PROGRAMMABLE CHUCK ON FORCER

7.2.1 Main Components

The PZ6 Assembly is comprised of four major subassemblies:

1. Chuck Housing
2. Stem and Leadnut
3. Leadscrew Assembly
4. Theta Drive Assembly

The main components are identified in two illustrations, *Figures 7−2A and 7−2B*.

7.2.1.1 CHUCK HOUSING

The chuck housing is a machined casting to which all other parts are attached and is the main component of the Z stage. The chuck housing itself rests atop the forcer, attached at four points at the base of the housing. The stem, bushing, leadscrew, and leadnut are all housed within, and the Theta Drive Assembly is mounted to the outside (*Figures 7–2A and 7–2B*).

Leveling capacity and mechanical damping are added by four rubber gaskets separating the housing from the forcer shell. The four screws that fasten the housing to the forcer are torqued individually to between 6 and 8 inch–pounds to planarize the Chuck Assembly by squeezing each rubber gasket independently.

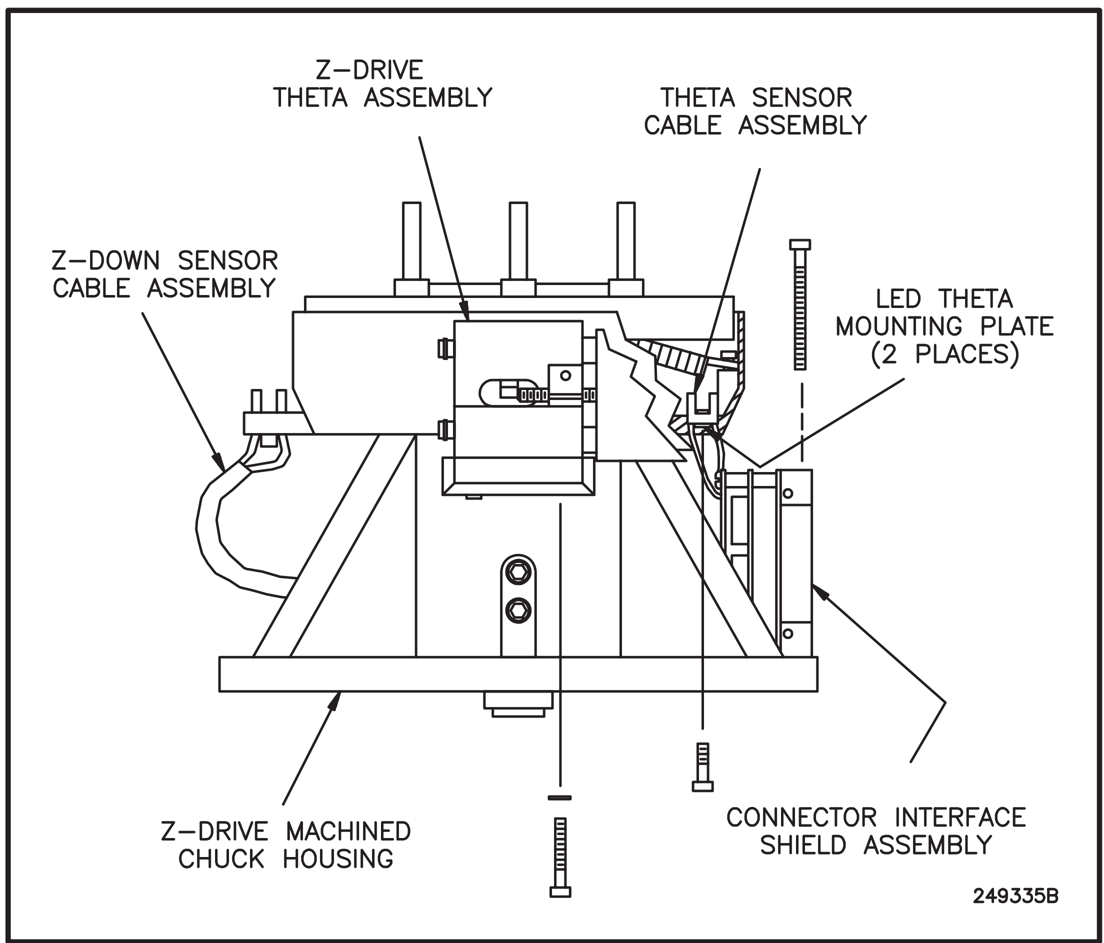

FIGURE 7–2A: ASSEMBLY DETAIL – SIDE VIEW

A machined bushing ringed with holes at the top and bottom is Installed in the center chamber of the chuck housing. Pressurized air will jet from the holes, creating a stiff frictionless jacket between the bushing's inner surface and the stem, which rides up and down inside the bushing. This bushing is press–fitted into the housing and requires no disassembly for maintenance.

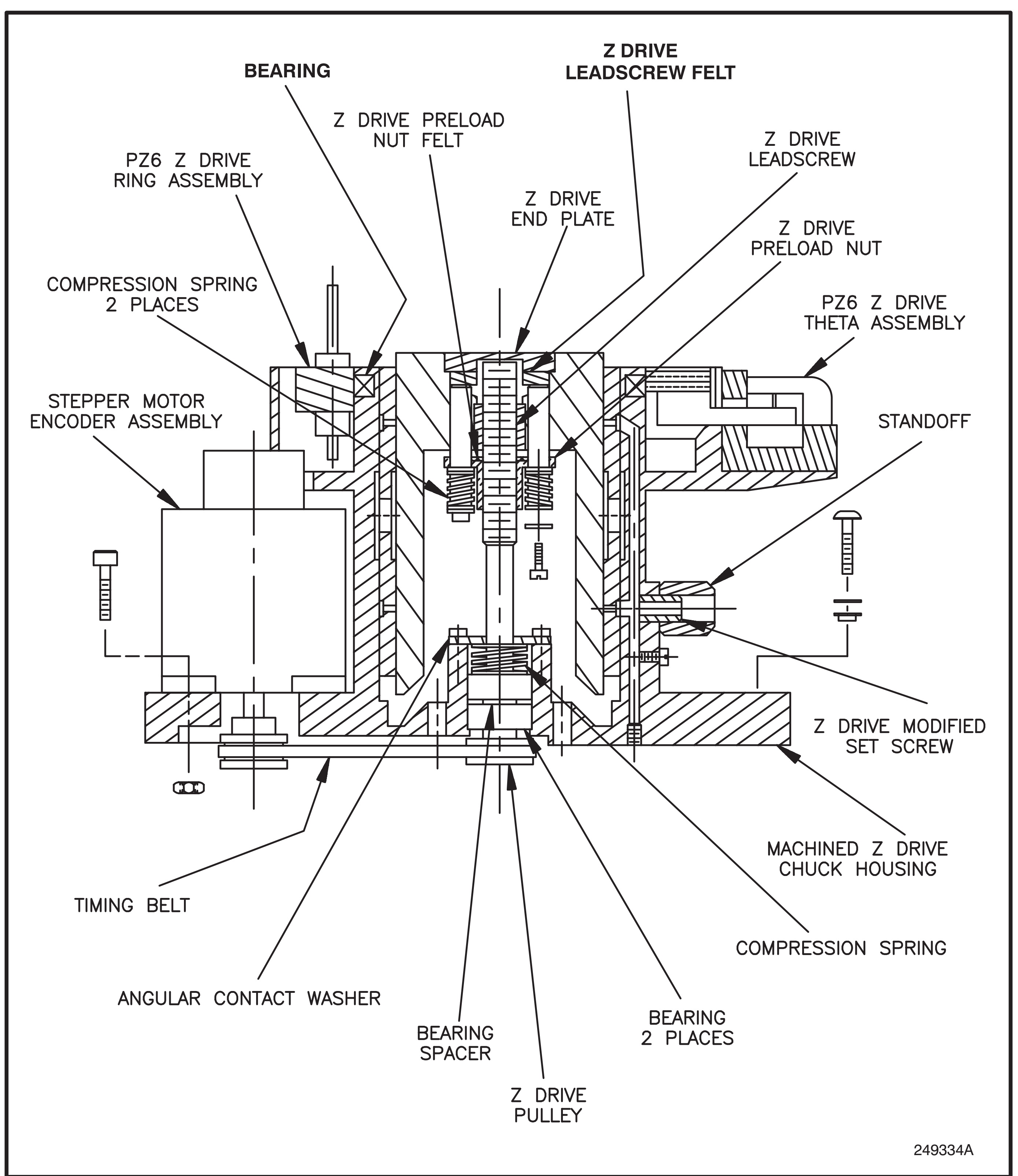

FIGURE 7−2B: ASSEMBLY DETAIL − CUTAWAY VIEW

7.2.1.2 STEM AND LEADNUT

The stem is held in the center of the bushing by air jets and rides up and down or spins within the bushing without appreciable friction. Secured inside the stem is the leadnut, which mates with the belt−driven leadscrew. As the leadscrew spins, the leadnut rides up or down, driving the stem with it. The absence of friction between the stem and its mating surface (the bushing) greatly reduces wear and lengthens the life of both stem and bushing.

The chucktop is fastened by four screws to the top of the stem and may be plated with either gold or nickel as the application dictates. The chucktop is electrically isolated from the body of the stage, allowing controlled testing of the wafer. Although the screws used to mount the chucktop are metal, they do not thread into the aluminum stem directly. Instead, non−conductive epoxy plugs are fitted into the stem, and steel helicoils within the epoxy act as threads for the screws. The vacuum pins also are isolated from the stem, bound within the insulating epoxy.

7.2.1.3 LEADSCREW ASSEMBLY

The Leadscrew is mounted vertically within the housing, supported by two ball bearing assemblies at the base of the leadscrew shaft. These bearings are sealed, and should require no preventive maintenance.

Drive for the leadscrew comes from a stepper motor attached to the outside of the housing. The motor torque is communicated to the leadscrew by a toothed fiberglass belt connected between toothed pulleys at the bottom of both the motor and leadscrew shafts. This drive belt is constructed for minimal stretch, ensuring that the positional relationship of the two shafts is tightly and repeatably controlled. Such positional accuracy and control is important, since it translates directly to the positional accuracy of the chucktop.

7.3 OPERATION OF THE PZ6

The PZ6 may be operated either manually or automatically. The automatic modes, discussed in **Section 7.3.2, Automatic Operation,** occur during autoprobing and are programmed via the menus. The manual Z mode, called *Z jog* and discussed in **Section 7.3.3, Manual Operation**, is enabled through the Profiler Menu.

7.3.1 Travel Limits

Vertical travel is limited by setting the Z Upper and Lower limits. The Upper limit is 400 mils and the Lower limit is normally 200 mils. Electrical zero (0 mils) is controlled by the electrical zero LED. It is set by an adjustable shutter at the base of the Z stage. Travel stops when the shutter (flag) interrupts the light path of a fixed LED.

Mechanical zero (the point at which the Z stage binds mechanically in downward movement) is 15−20 mils below electrical zero. This gap ensures that the Z stage does not bottom out and cause damage to the leadnut or bearings. Upward travel, controlled by the prober CPU, is predetermined for probe point contact, but never more than the maximum limit of 400 mils.

Rotational travel is controlled by theta electrical zero, the mid−point in the allowable travel range. Theta electrical zero is found using a fixed LED sensor on the chuck housing and a shutter mounted on the theta gear.

7.3.2 Automatic Operation

The Z stage is operated in the fully automatic (or programmed) mode by using the Set Parameter Menu, accessed by pressing < SET PARM > (< F1 >) **and** the Profiler Menu < PROG > (< F5 >).

During probe operations, vertical wafer travel is controlled by entering parameters or detection of the wafer by the edge sensor or Noncontact Edge Sensor. The line numbers in **Section 7.3.2.1** refer to the Set Parameter Menu (Page 1) (*Figure 7−3*):

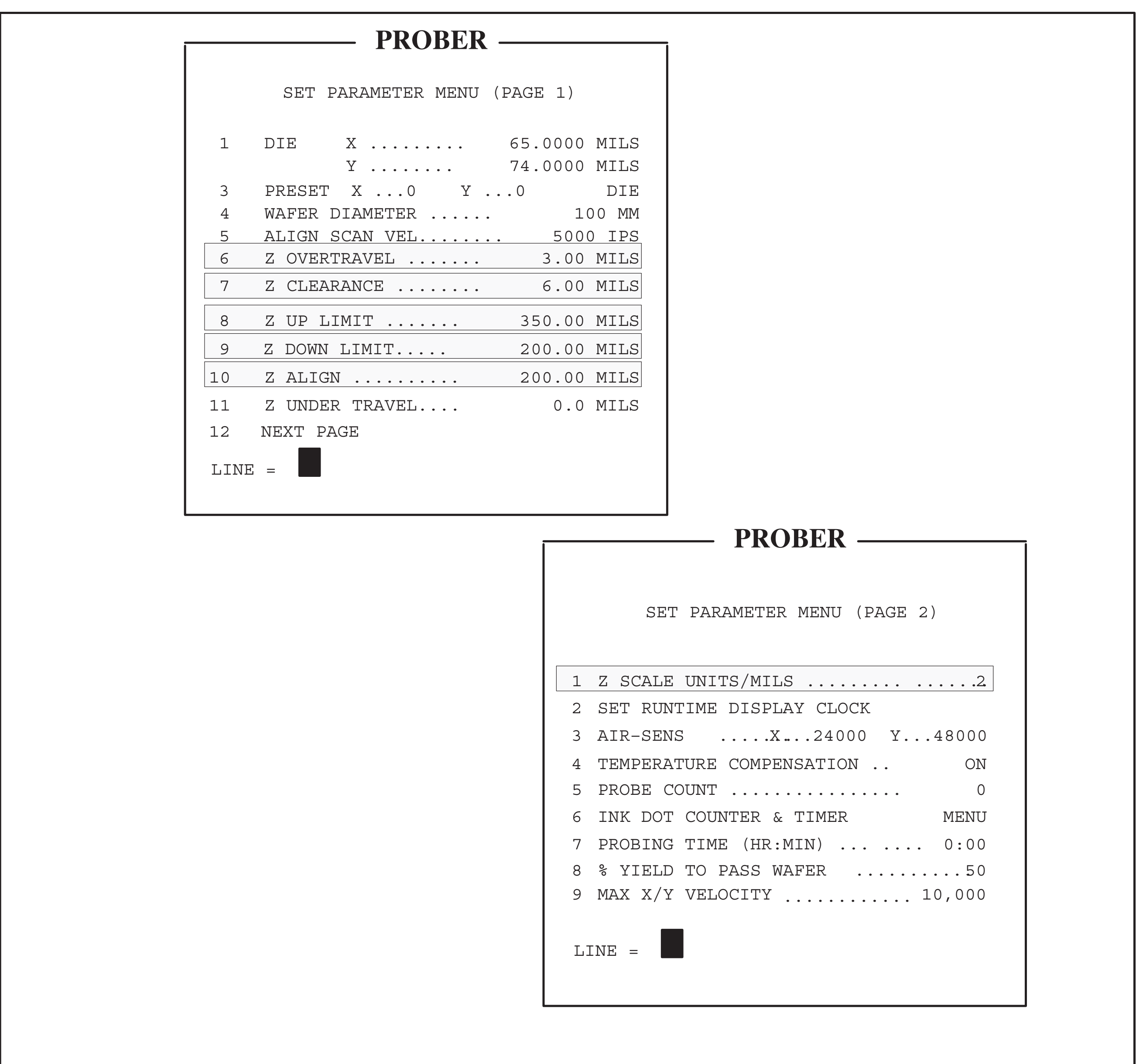

FIGURE 7−3: SET PARAMETER MENU (PAGES 1 AND 2)

7.3.2.1 SET PARAMETER MENU (Z STAGE) LINE ITEMS

LINE 06 Z OVERTRAVEL

The Z overtravel parameter sets the distance the Z stage will continue traveling upward after contact with the wafer is made; it is used to ensure good pad−to−probe contact. Wafer contact is determined either by the edge sensor or by the Noncontact Edge Sensor. See **Table 7−1.**

TABLE 7−1: Z TRAVEL MODES PARAMETERS USAGE

Not all Z−stage parameters are used in all Z travel modes. The table at the right shows which parameters are used and how they are used in any given Z travel mode.

Z Overtravel and Clearance may be set to 0 if the Z travel mode is Profile. If the Z travel mode is Edge Sense, the prober will always take at least 3 steps (1.5 mils with a 0.5 mil stage, 0.75 mils with a 0.25 mil stage).

	LIMIT	EDGE	PROF.
OVERTRAVEL	N	Y	Y
CLEARANCE	N	Y	Y
UP LIMIT	P	S	S
DOWN LIMIT	P	S	S

P = Up/Down Position
S = Safety Limit
Y = Used
N = Not Used

If an out−of−range value is entered for the Z Down Limit, the limit will automatically be set to 200 mils. If an out−of−range value is entered for the other two Z parameters, the old value that the operator was attempting to change will remain. The Z Up Limit out of range entered equals the current Z Down Limit.

Entry must be a positive value. Make sure that the height at which contact occurs plus the overtravel never exceeds the Z Upper Limit parameter. Z overtravel has no effect if the Z Travel Mode is set to Limit−to−Limit (**Section 7.3.3.3**).

The minimum amount of Z overtravel which can be used in edge sense Z mode is 1.5 mils. Even when Z overtravel is *entered* as less than 1.5 mils, overtravel will be 1.5 mils.

LINE 07 Z CLEARANCE

The Z clearance parameter sets the distance the Z stage will continue traveling downward after contact with the wafer is lost. It is used to guarantee a certain distance between the probes and the wafer when the Z stage is Down and XY motion is taking place.

Contact with the wafer is determined either by the edge sensor or the Noncontact Edge Sensor; Z clearance has no effect if the Z Travel Mode is Limit−to−Limit (Line 04, Set Mode Menu).

Entry must be a positive value. Make sure that the height at which contact is lost minus the clearance is never less than the Z down parameter (see **Table 7−1**).

LINES 08 and 09 Z UP LIMIT / Z DOWN LIMIT

The Z lower and upper limit parameters control Z axis (between 200 and 400 mils) independently of edge sensor operation. They are initialized at power−on by an electrical zero photosensor. Z

travel is confined between these limits.

LINE 10 Z ALIGN

The align height parameter sets the height at which Auto Align is performed, setting the Z position relative to the camera lens in order to bring the wafer into good focus on the monitor.

This height is usually left at 200 mils, but certain applications change the height of the ring carrier, requiring that the focus be changed. Also, thicker than normal substrates may need the align height adjusted too.

Z align height is limited to between 200 and 400 mils.

LINE 01 (PAGE 2) Z SCALE UNITS/MILS

Establishes a unit of measure for Z−drive chuck travel. The standard 1/2 mil Z drive is configured so that two steps of the drive advances the chuck top one mil. Therefore, the Z scale is set at two units/mil.

Z−related values are automatically recalculated following a change in the Z−Scale parameter set through this line. The values which follow are not to be changed unless the Z stage is changed:

1	mil	Z scale − 1
0.5	mil	Z scale − 2
0.25	mil	Z scale − 4
0.125	mil	Z scale − 8

Enter a value between one and ten as the Z−drive ratio mentioned above. The Z scale entry *must* be correct. Inaccurate entry will affect all the Z drive−related functions (Lines 06 through 10). Subsequent motion could then cause damage to the probe card and/or wafer.

If you don’t know your Z stage resolution, contact your Electroglas Field Service Representative.

7.3.2.2 PROFILER MENU (Z STAGE) LINE ITEM

LINE 03 SET Z HEIGHT

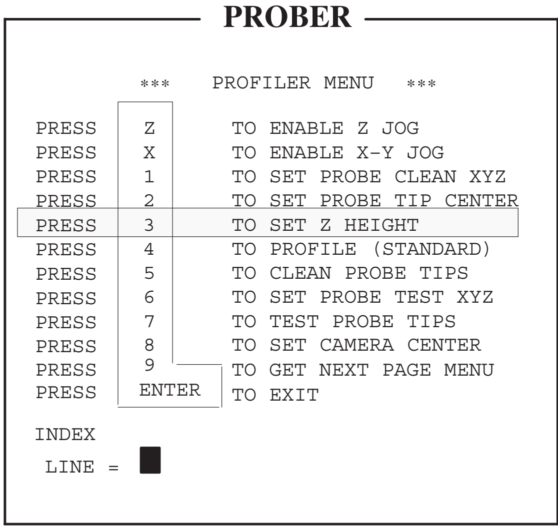

FIGURE 7−4: PROFILER MENU (SET Z HEIGHT)

The Z height is established to initialize a profile correction factor. Use the < 3 > key to set the height of the probes. With the Joystick, move the wafer under the probe tip. Raise the wafer until it contacts the probe tip. Press < 3 > to set the height.

The chuck must be under the probe tips and the probe tip center must be set at the center of the chucktop prior to the probing sequence. The center reference is used during align scan and for circular probe pattern computation.

NOTE

Setting the Z height after storing the probe clean position clears the clean position. A message displays informing you each time the clean position is cleared or stored.

7.3.3 Manual Operation

There are two ways of manually operating the PZ6:

1. Using the Joystick (Z jog)
2. Pressing the < Z > key

7.3.3.1 JOYSTICK OPERATION (Z JOG)

The most manual of the two unprogrammed modes of up/down motion is called *Z jog*. In this mode the chuck may be moved up or down one step at a time by pulling back (or pushing forward) the Joystick.

To enter this mode, press < PROG > (< F5 >) to access the Profiler Menu (*Figure 7−5*), then press < Z > on the Joystick Keyboard. The Z stage is now controlled by the Joystick. Pulling back on the Joystick will cause the chuck to rise, one step at a time. While pulling back on the Joystick, push the red button on the top of the Joystick to cause the chuck to rise more rapidly.

PROBER

```
        ***   PROFILER MENU   ***

 PRESS    Z       TO ENABLE Z JOG
 PRESS    X       TO ENABLE X-Y JOG
 PRESS    1       TO SET PROBE CLEAN XYZ
 PRESS    2       TO SET PROBE TIP CENTER
 PRESS    3       TO SET Z HEIGHT
 PRESS    4       TO PROFILE (STANDARD)
 PRESS    5       TO CLEAN PROBE TIPS
 PRESS    6       TO SET PROBE TEST XYZ
 PRESS    7       TO TEST PROBE TIPS
 PRESS    8       TO SET CAMERA CENTER
 PRESS    9       TO GET NEXT PAGE MENU
 PRESS    ENTER   TO EXIT

 INDEX
  LINE =
```

FIGURE 7−5: PROFILER MENU (ENABLE Z JOG)

The Z jog mode is limited by the Z Upper and Z Down limits entered in the Set Parameter Menu (*Figure 7−3*), although two exceptions to this rule exist:

1. The chuck may be commanded to rise above the upper limit; it will beep on each step. Movement will stop at 10 mil increments above the upper limit.

2. If travel was started from electrical zero (0.00 on the screen), then upward travel is allowed, even though this travel occurs below the Z Down setting in the Set Parameter Menu. Downward travel, however, is still locked out.

7.3.3.2 USING THE < Z > KEY

The Z stage can be manually controlled vertically (between 200 and 400 mils) with the < Z > key on the Joystick Keyboard. The < Z > key will move the chuck either to Z height (if in Profile Mode) or to the Z Upper Limit. Neither of these has to be 400 mils – and are most likely not 400 mils. The next time < Z > is pressed, the chuck will drop to the Z Down limit.

To use the < Z > key, first ensure that the Run Time Display shows on the monitor screen, and that the processor status line says either Idle or Pause. Pressing < Z > causes the chuck to move up or down, in the direction opposite from its starting position as shown on the monitor. The distance traveled depends upon two factors:

1. Whether the Z stage is within the probing area, and
2. Which Z Traveling Mode is selected.

Probing Area

The *probing area* is the area around the probes, as defined by the Probe Tip Center last entered (*Figure 7–5*, Line 02). The size of this area is variable, depending upon the prober model. 4085X probers have a probing area with a 4.00 inch radius. Normally, the probe tip scrub and shorting blocks are just outside the probing area, assuming that probe tip center was set to the center of the chuck.

Within the probing area the Z move commanded will be limited by the Z Traveling Mode selected, such as Edge Sense, and the overtravel and clearance values stored through the Set Parameter Menu. A down motion would then be far enough so that the edge sensor contacts come together, plus the clearance value. An up movement would be far enough so that the edge sensor contacts separate, plus the overtravel value.

Assuming the overtravel as three mils, and the clearance at 10 mils, the nominal full Z stroke would be about 13 mils, and would be based upon the position of the edge sensor.

Outside the probing area, the Z move commanded would be bounded by the Z Traveling Mode selected (discussed next).

Z Traveling Mode

The Z traveling mode controls the manner in which Z chuck top rise and fall is stopped. Any travel mode may be used with any probe mode. In the Edge Sense mode, the undertravel option can be applied to all die locations. In Profile mode, if the chuck is outside the probe range (more than three inches from the probe tip center), the Z stage cannot be raised manually with the < Z > key. In general, the forcer will not allow X and Y movements while the Z–stage is in the up position.

Set the Z Traveling Mode by accessing the Set Mode Menu < SET MODE > (< F2 >), Line 04 (*Figure 7–6*).

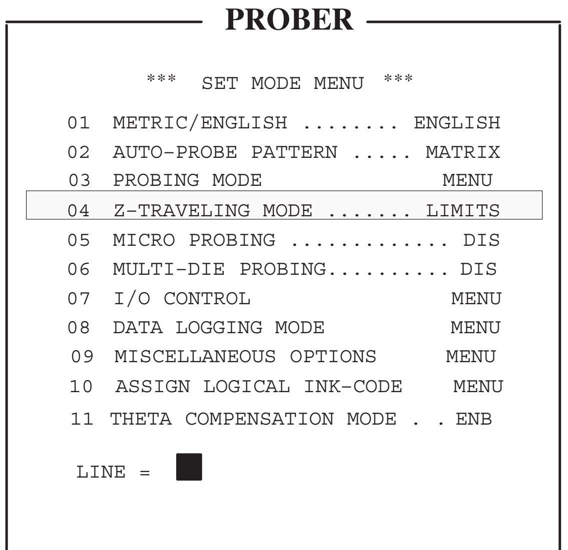

FIGURE 7–6: SET MODE MENU (Z TRAVELING MODE)

The three Z Traveling Modes are:

1. Limit
2. Edge Sense
3. Profile

<u>Limit</u>

Input < 0 > to establish the Z upper and lower limits as the range for Z chuck top travel. The limit parameters are entered on Lines 08 and 09 of the Set Parameter Menu (Page 1), and are described in **Section 7.3.2.1.**

<u>Edge Sense</u>

Input < 1 > to use the edge sensor for determining the travel range. (The edge sensor must be installed on the probe card). This selection sets the travel range between the Z clearance and wafer surface contact position and the Z overtravel. The two parameters are entered on Lines 06 and 07, respectively, of the Set Parameter Menu (Page 1), discussed in **Section 7.3.2.1**. When probing is Edge Sense mode with a wafer *not* under the probe tips, Z down movements will go to the Z down limit rather than moving down only the distance of clearance.

When the edge sensor mode is enabled, Z motion occurs as follows:

- o The stage rises until the edge sensor detects contact.
- o It then travels up the overtravel distance from that point.
- o If the stage reaches the upper limit without detecting contact, the `NO EDGE SENSE CONTACT` message is displayed and probing is aborted. This error occurs only when initial probing begins on each wafer. *During* probing, there will be 12 no contacts and wafer unloads. The prober *assumes* the wafer is finished.

- o When the stage starts down, it again monitors the edge sensor.
- o When contact is lost, the stage moves down the clearance distance and stops.
- o If the stage reaches the lower limit before contact is lost, the message CONTACT AT Z DOWN appears and probing is aborted.

Profile

Input < 2 > to use auto profile parameters to determine Z travel. This selection is based on the Z height entered through the Profiler Menu, described in **Section 7.3.2.2.**

Set to profile, this mode does not allow Z Up and Down when setting First Die until a profile of the wafer is done. This assumes a NCES exists and AUTO PROFILE has been enabled (Set Option Menu, Line 03). If the Find Target procedure is done before profiling is accomplished, then Z Up/Down will not occur when setting First Die.

This situation is worse for partial wafer probing since the normal profile, align sequence is reversed. To break this deadlock, a quick profile is taken around the first align reference location which establishes a safe working distance from the probe tips. After aligning, the prober automatically quick−profiles, and then allows the Z Up/Down necessary to set First Die.

NOTES

When the Z Traveling Mode is set to Profile, if the software determines that the current XY position is outside of the current wafer diameter, the Z will not raise.

Accurate setting of the probe tip center is also required (Profiler Menu, < 2 > key). This is the physical alignment of the center of the bare chuck with the center of the pin array.

7.4 BURNISHING ASSEMBLY

The Burnishing and Continuity Pads Assembly is an optional feature used to clean and check probe tips. The main body of the assembly is fastened to the vacuum chucktop. Seated in a hole in the main body is an adjustable Stem and Disk Assembly. When the set screw is loosened, the assembly is adjustable either up or down. The disc portion of the assembly is an encased ceramic cleaning surface.

Probe tip cleaning can be selected to occur after a set number of either probed die or wafers. To select probe tip cleaning, access the Set Mode Menu (*Figure 7−7*) by pressing
< SET MODE > (< F2 >).

PROBER

```
      ***    SET MODE MENU    ***

 1  METRIC/ENGLISH..........        ENGLISH
 2  AUTO-PROBE PATTERN..........    MATRIX
 3  PROBING MODE                      MENU
 4  Z TRAVELING MODE......          LIMITS
 5  MICRO PROBING...........           DIS
 6  MULTI DIE PROBING.......           DIS
 7  I/O CONTROL                       MENU
 8  DATA LOGGING MODE                 MENU
 9  MISCELLANEOUS OPTIONS             MENU
10  ASSIGN LOGICAL INK-CODE           MENU
11  THETA COMPENSATION MODE....        ENB

 LINE =  █
```

FIGURE 7−7: SET MODE MENU (PROBING MODE)

Input < 03 > to display the Probing Mode Menu (*Figure 7−8*).

PROBER

```
              PROBE MODE MENU

01 PROBE QUAD SELECT................. 2
02 COORDINATE QUAD..................  2
03 REPROBE LIMIT..................0 DIE
04 PROBE CLEAN COUNT...........  0 DIE

06 MAXIMUM ROW COUNT.......     0 ROWS
07 TURNAROUND.................... 0 DIE
08 USE AUTO DIAMETER.............  DIS
09 CONT. AT LAST DIE................ENB
10 PROBE TIP SCRUB..................DIS
11 INKING MODE                     MENU
12 UGLY DIE                        MENU

 LINE =
```

FIGURE 7−8: PROBE MODE MENU

Enter < 04 > for the Probe Clean Count line item.

This option establishes a cleaning interval for the probe tip. Cleaning can be selected to occur after probing a set number of either dies or wafers. A simple XY clean or an XYZ scrub motion will be done depending on the setting for Line 10 (PROBE TIP SCRUB).

The flashing cursor prompts for a positive whole numeric value (no decimal point) for the count. This value sets the frequency with which the probe tip cleaning occurs. A zero (0) entry disables the cleaning interval feature.

After the count entry, a prompt asks for the cleaning per wafer interval. The interval is selected by pressing either < Y > (yes) or < ENTER > (no). Press < ENTER > to automatically set cleaning to a die interval. Confirm the entry by checking Line 04 on the monitor.

LINE 10 PROBE TIP SCRUB

When PROBE TIP SCRUB is enabled, after the probe clean position and probe clean count are set, every time the probe array is cleaned on the cleaning pad, a 1−mil octagonal motion occurs. This motion causes each probe tip to be scrubbed from eight different directions. Different locations on the cleaning pad are used when cleaning and scrubbing to ensure that the pad wears evenly.

PROBE CLEAN POSITION is set through the Profiler Menu, third item (PRESS 1...); PROBE CLEAN COUNT, through the Probe Mode Menu, Line 04. If the probe clean position has not been set, probing will halt before the tips are scrubbed, and an error message on the screen will inform:

```
CLEAN POSITION HAS NOT BEEN SET
```

7.5 CONTINUITY TESTING

This feature allows the tester to bring an electrically conductive area in contact with the probe tips in order to run a special test program. The Continuity Assembly is shown in *Figure 7−6*.

The XYZ position of the conductive area is taught through Line 06 of the Profiler Menu (*Figure 7−9*). Line 07 of this menu is used to start the test manually.

PROBER

```
            ***    PROFILER MENU   ***

PRESS     Z        TO ENABLE Z JOG
PRESS     X        TO ENABLE X-Y JOG
PRESS     1        TO SET PROBE CLEAN XYZ
PRESS     2        TO SET PROBE TIP CENTER
PRESS     3        TO SET Z HEIGHT
PRESS     4        TO PROFILE (STANDARD)
PRESS     5        TO CLEAN PROBE TIPS
PRESS     6        TO SET PROBE TEST XYZ
PRESS     7        TO TEST PROBE TIPS
PRESS     8        TO SET CAMERA CENTER
PRESS     9        TO GET NEXT PAGE MENU
PRESS   ENTER      TO EXIT

INDEX
 LINE =  █
```

FIGURE 7−9: PROFILER MENU (SET PROBE TEST XYZ)

Keys < 6 > and < 7 >, with tester interface, provide a continuity test which allows the tester to bring an electrically−conductive area in contact with the probe tips and run a special test program.

Press < 6 > to teach the XYZ position of this conductive area, and press <7> to start the test. The Z−Y−Z position must be taught before the test can be run. It is only necessary to re−teach the position if it has changed before any subsequent test.

When < 6 > is pressed, the system displays the message `ARE ALL PROBES WITHIN PAD?`; pressing < Y > answers Yes, pressing < ENTER > answers No. During the probe tip test an error message `CONTINUITY TEST FAILED` signals test failure.

7.5 (A) DIAGNOSTIC EXERCISE AND TEST

Added 6/96

A set of simple exercise and test functions is activated through the Diagnostics Menu. To access this menu, press < DIAG > (< F1 >) and select Line 01 (`CHUCK.....0 ...0 ....0 ....0`). This feature exercises the Z stage and provides data on Z slips.

As of Software revision DE, joystick XY motion is disallowed following a Z slip

Four numbers are displayed. The first is the number of Z slips that have occurred. The second is the number of bad code reads. The third and fourth show the number of bad writes and spurious writes to the Z motor.

The third and fourth numbers will be displayed only if the Theta Z Joystick Functions II board has been modified. These numbers may be cleared by pressing the < . > key, followed immediately by the < DIAG > key, while in the RUN TIME DISPLAY.

7.6 HOT CHUCK FEATURE

The Hot Chuck has a proportional DC temperature controller. Temperature at the surface of the chucktop is integer−settable from ambient to +130 degrees C (ambient temperature may be several degrees higher in the vicinity of prober equipment).

Temperature selection is made through the local panel controls on the left front door of the 4085X or the Hot Chuck Menu (next section). The prober sets and monitors wafer temperature via the controller's RS−232 port. For proper system operation, it is recommended that the Electroglas Hot Chuck is set using the Hot Chuck Menu.

Do not touch the Hot Chuck at any time. Severe burns may result. Check the panel display on the front of the Hot Chuck and wait until the Hot Chuck is cooled to a safe temperature of 45 °C or less (approximately 45 minutes).

7.6.1 Hot Chuck Menu

All Hot Chucks are enabled through Line 07 of the Set Option Menu (activated by the < SET OPTION > < F3 > key), and a Hot Chuck Menu appears automatically *(Figure 7−10)*. The line items are:

LINE 01 − HOT CHUCK MODEL

This line prompts between the selection of the Electroglas Hot Chuck (enter < 1 >) and any other, non−Electroglas chuck (enter < 2 >), and enables it. Selection of the Electroglas Hot Chuck displays the Hot Chuck Menu in the form shown in *Figure 7−10A*; selection of the non−Electroglas chuck displays the menu in the form shown in *Figure 7−10B.*

The default model type is the Electroglas (EG) Hot Chuck. If the EG Hot Chuck is not installed, the menu will automatically reset to the non−EG menu display.

LINE 02 − SET TEMPERATURE (EG HOT CHUCK ONLY)

This is the setpoint temperature at which the EG Hot Chuck should be at any given time. This temperature also appears on the Hot Chuck controller's on the left front door of the prober.

Any time the nominal temperature is changed through the menu or External I/O Interface, the prober passes this temperature setting to the thermal chuck. When probing begins, the prober will check the thermal chuck to confirm whether the current temperature conforms to the desired value.

If these temperatures are not the same, whether over or under, the system will wait for the thermal chuck to adjust until the temperatures comply. The process is shown on the screen with the message `HOT CHUCK IS AT xx.x,` and it can be stopped by pressing
< PAUSE/CONT >.

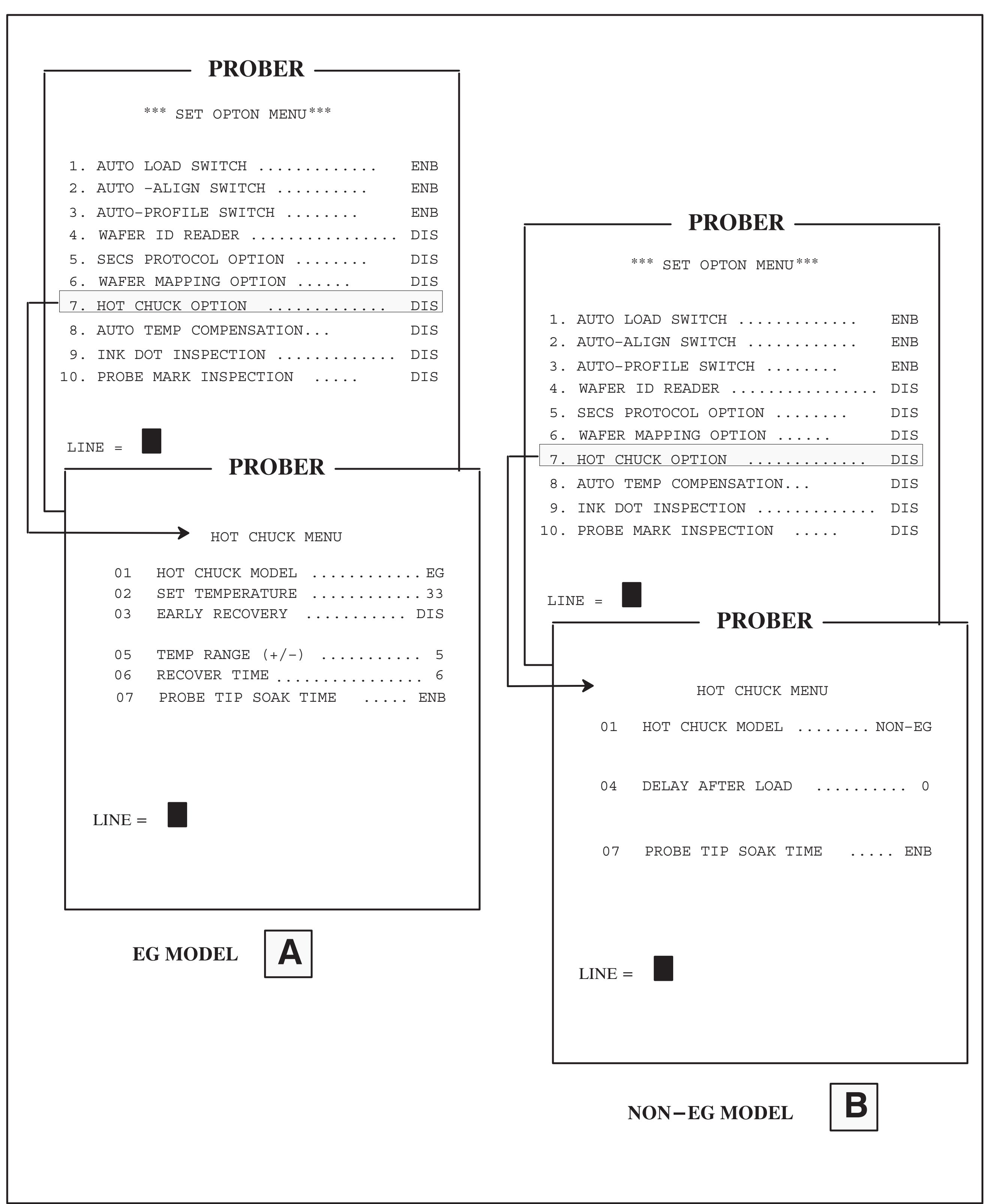

FIGURE 7−10: HOT CHUCK MENU FOR EG AND NON−EG MODEL

After probing has begun, for every forcer move that the Hot Chuck does not equal the setpoint temperature, +/− the TEMP RANGE set in Line 05, the prober waits for up to the RECOVER TIME in seconds, set in Line 06, to allow the Hot Chuck to get back within the TEMP RANGE. When the Hot Chuck is successful in returning to the allowed TEMP RANGE, the forcer moves to the next position and probing is continued.

If, however, the Hot Chuck does not return to the allowed TEMP RANGE within the RECOVER TIME allotted, the commanded move is not made, probing is paused, and error message CHUCK TEMP OFF LIMIT displays and the prober beeps to indicate that there is a problem. After correcting the problem, press < PAUSE/CONT > to continue probing the wafer from the point where probing was stopped.

LINE 03 − EARLY RECOVERY (EG HOT CHUCK ONLY)

Enabling this line speeds recovery from a temperature drop caused by a cold wafer loaded on the chuck. The system sends a message to the thermal chuck that a probed wafer is about to be unloaded; the thermal chuck overheats the chucktop to a premeasured amount so that a new, cold wafer will cool the chucktop down to its nominal temperature.

LINE 04 − DELAY AFTER LOAD

On Hot Chucks provided by vendors other than Electroglas, this line activates a time delay to allow wafers to warm up to the set temperature. The delay can be set from 0 to 30 seconds. When the delay is active, a message states the time delay in seconds.

LINE 05 − TEMP RANGE (+/−) (EG HOT CHUCK ONLY)

Select Line 05 to set the range over which the temperature can vary without causing an alarm.

Setting the temperature range to a non−zero value requires the software to have additional communication with the Hot Chuck, which can result in a noticeable throughput delay. Unless you experience frequent environmental temperature changes, this setting is not recommended.

It is recommended that if you are experiencing these environmental changes, you first experiment with setting the RECOVER TIME (Line 06) to solve probing problems before expanding the temperature range to greater than zero (0).

LINE 06 − RECOVER TIME (EG HOT CHUCK ONLY)

Sets a time length during which the prober will allow the Hot Chuck to recover to within the temperature range before sounding or displaying an alarm. This feature allows the Hot Chuck to fluctuate outside of the temperature range without error for a specified time.

The range checking and recover time features are *only* used:

1. Prior to moving the forcer
2. When the prober is probing, and
3. When the forcer is in the probe area.

Before the prober begins probing a wafer, it waits for the Hot Chuck to reach the setpoint temperature rather than a point within the allowed range.

Each of Line items 05 and 06 has a range of from 0 to 99, and the units are 1° C for TEMP RANGE and 1 second for RECOVER TIME. Both items have a default value of 0. Therefore, if no changes are made to these menu items, there will be no change in the operation of the prober.

LINE 07 – PROBE TIP SOAK TIME

Enabling this line item causes the Hot Chuck Soak Times Menu, illustrated in *Figure 7–11*, to display.

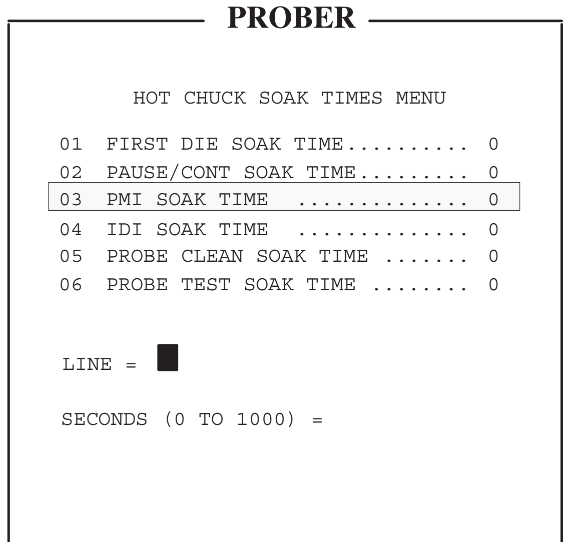

FIGURE 7–11: HOT CHUCK SOAK TIMES MENU

Hot Chuck soak time is the amount of time the prober should maintain contact between the probe tips and the wafer before sending the tester a test start (TS) message. This allows the probe tips to be at a constant temperature (thus angle and position are also constant), to ensure optimum probe tip–to–pad contact.

Each of the soak times can be set from 0 to 1000 seconds and the default is zero (0) seconds.

7.6.2 Hot Chuck Controller Unit

The Hot Chuck Controller Unit has several controls available on the thermal chuck panel (*Figure 7−12*). They are discussed, although with the different thermal modes, next.

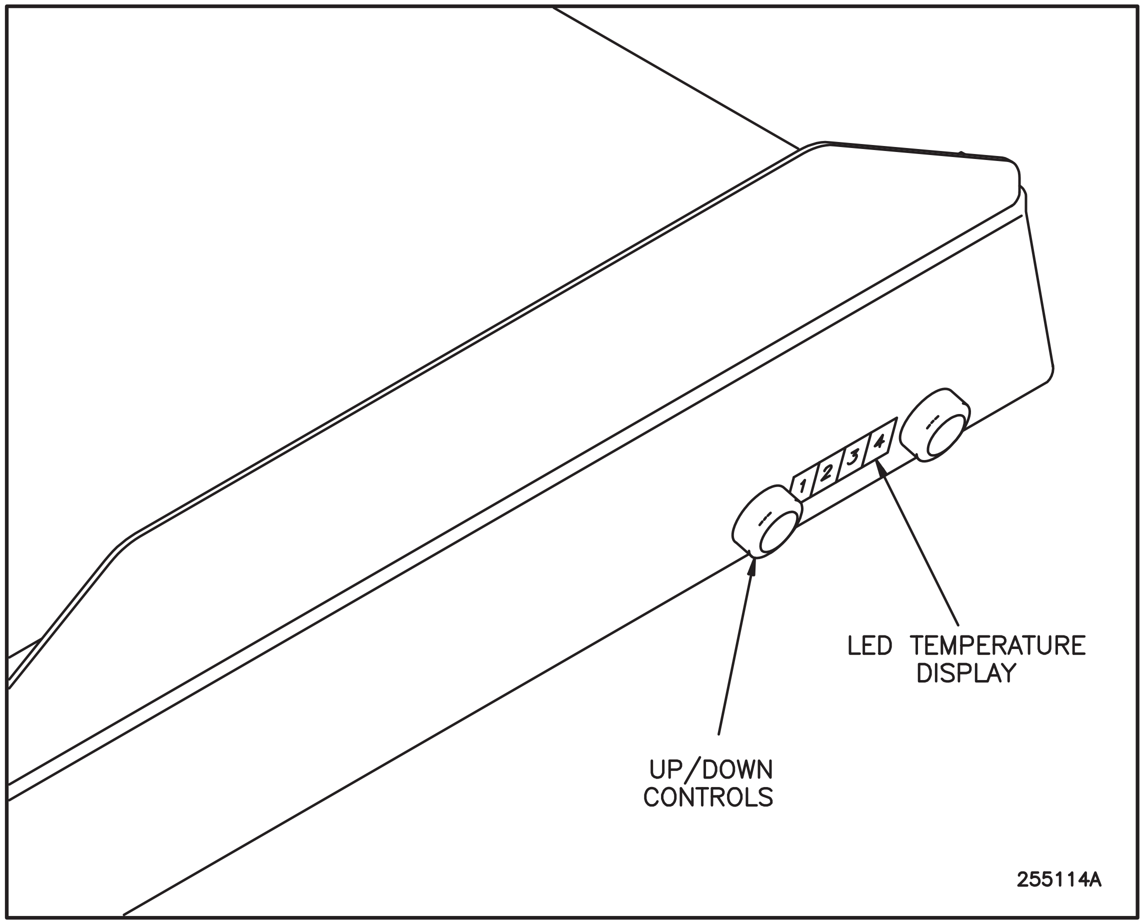

FIGURE 7−12: HOT CHUCK CONTROLLER UNIT

Upon power−on, the controller unit briefly displays its version level, and the current I/O baud rate, a numeric code, is also displayed.

The thermal modes are:

1. Factory Test Mode
2. Normal Mode
3. System Calibrate (Mode A)
4. Meter Verification (Mode B)
5. Calibration Clear Mode

7.6.2.1 TO CHANGE MODES

The Mode Switch is accessible through a hole in the front panel which can be sticker−sealed after calibration. When the Mode Switch is pressed (*Figure 7−12*), the calibrate mode will be indicated by the leftmost decimal point of the display. Press the Mode Switch again to return the mode to Normal.

If the current setpoint is a non−multiple of 5°, any attempt in Calibrate Mode to use the Up /Down Controls will revert the mode to Normal and flash the units position of the display as a reminder until any switch is pressed again. Therefore, the first step before calibrating is to select the proper setpoint while in Normal Mode.

FACTORY TEST MODE

To enter this mode, press the Up Control upon power−up and hold it for 2−3 seconds. To exit the factory test mode, turn off the power to the Hot Chuck. `HOT CHUCK PROBLEM N,` seen on the monitor, means that the Hot Chuck is in factory test mode, a mode entered into by the Hot Chuck only upon power−up and when the Up Control is pressed and held for 2−3 seconds.

It is possible that the Hot Chuck software will believe that it is in factory test mode when it is not. A temporary solution to this problem is to press the Mode Switch twice (powering the Hot Chuck on and off does not clear the condition).

NORMAL MODE

The Up/Down Controls are pressed until the desired setpoint is displayed; the display continues to show (integer) setpoint, but alternately flashes the actual sensed wafer temperature (decimal) until the two differ by less than .25° (C).

SYSTEM CALIBRATION MODE (MODE A)

This mode calibrates the temperature of the wafer surface (and the temperature meter display) to the user’s standard if different from factory standards. (See **Calibration Clear** later in this subsection.) In Calibrate Mode, each cardinal setpoint (each multiple of 5°) is independently calibratable using the Up/Down Controls. Setpoints between cardinal setpoints are calibrated automatically by the internal processor.

With an external temperature monitor on the wafer surface, adjust that temperature via the Up/Down Controls until it matches the displayed setpoint. Each depression equals approximately 1/8°.

If no response is seen, the unit is at factory limits. This usually indicates improper measurement. (See **Section 7.6.6, Specifications and Standards.**)

METER VERIFICATION CALIBRATION MODE (MODE B)

Seldom used except for test purposes, this mode displays only the decimal wafer temperature, which is the internal “meter” that has no role in temperature control except in external monitoring and limit detection. The Up/Down Controls in this mode adjust the meter offset, if ever required.

At each or any desired cardinal setpoint, press the Mode Switch for three seconds until the internal “meter” is displayed. Use the panel switches to best match it to the undisplayed setpoint integer. The decimal point at the right edge of the display is a rounding indicator representing numerals 5−9 (x .01°).

CALIBRATION CLEAR MODE

This function resets all field/QA calibration to standard benchmark values. While turning the power on, press the Mode Switch for three seconds until the unit version level display turns off. The centermost decimal point will flash once briefly.

7.6.3 Error Displays

Table 7−2 shows error indications produced by the conditions noted:

TABLE 7−2: HOT CHUCK CALIBRATION ERRORS AND CAUSES

Error	Cause
Leftmost Decimal Point	Unit has been left in Calibrate Mode.
Centermost Decimal Point	If persistent, indicates a battery or memory failure has rendered the current setpoint uncalibrated; it remains until that (nearest cardinal) setpoint is recalibrated or the Calibrate Clear function is employed; it also flashes once with each calibration change as a normal user−response.
Flashing Units Digit	(Refer to **Section 7.6.2.1, Changing Modes.**
One−Second Flicker Rate	Unit is in factory test aids mode (until power is off).

7.6.4 Early Recovery Feature

The Early Recovery feature, when I/O command−triggered, temporarily raises the temperature by a *sink value* in anticipation of a sudden load change (loss). The *sink value* is derived from the previous load change sensed by the controller after the last such command and is removed when the new load is sensed, or after 13 seconds have lapsed. The sink value is zeroed whenever a new setpoint is accepted by the unit.

7.6.5 External Controls and Baud Rate Alteration

A two−line I/O channel (RX − Receive, TX − Transmit) allows external monitoring and control in one of two modes, Static or RS−232 (300/1200 baud). If the baud rate numeric code is set to zero, static mode is asserted and the TX line follows the *at−temperature status* (1 = at−temperature), while the RX line triggers the Early Recovery feature (low−to−high transition).

The baud rate numerical code is displayed briefly at power−on. If the Down Control is pressed during power−on, it sustains the display and enables baud rate selection (0, 1, or 4) by the mode switch.

An SRQ option sends an ASCII BEL whenever the at−temperature status has changed and no other message prevails. All other messages (responses) are sent immediately upon command and optionally end with a carriage return and line feed.

The host controller should wait for each response−message. Concurrent RX/TX activity suspends any next message−character until the incoming character is fully received. If the latter requires a response, the message is reinitiated accordingly but delayed one character frame. (This discipline prevents unusual handshake loops from building due to such as unaccounted−for noise). **Table 7−3** lists the ASCII RS−232 commands and responses.

7.6.6 Specifications And Standards

Electroglas does not uphold any measurement standards above those of the customer. The thermal chuck is designed for directness and ease of calibration.

However, the following are some methods and precautions employed by Electroglas for obtaining and measuring its own benchmarked standards.

7.6.6.1 TEMPERATURE MEASUREMENT

For *bonded−sensor* measurement, a 36−gauge J−type thermocouple is epoxy−bonded to the approximate center of the silicon test wafer. The leads are stabilized near the bead and held to the surface, with the bead biased into contact, while a small doping of thermally− conductive epoxy is applied. At least one inch of the lead remains taped or epoxied down to minimize lead drain.

Larger−gauged thermocouples can seriously alter the measurement. Bonded−sensor instrumentation wafers are also commercially available (for example, non−endorsed: Marchi Associates, Redwood City, CA).

TABLE 7−3: ASCII RS−232 COMMANDS AND RESPONSES

INPUT COMMANDS:		RESPONSE:	NOTES:
D	Set Linefeed/Carriage Return mode on	Y	
E	Set Linefeed/Carriage Return mode off	Y	
F	Set SRQ mode on	Y	
G	Set SRQ mode off (default)	Y	
T	Trigger Early−Recovery (see text)	Y	
0−9	(Assembled into string value, 3−digit maximum)	none	1
:	Replace setpoint with string value (if equal)	Y/N	2
;	Verify setpoint with string value (if equal)	Y/N	1, 2
=	Send setpoint	nnn	
@	Send temperature + tenths	nnnn	
?	Send status byte (see below)	n	
(Received codes not defined/not understood):		?	
	RESERVED − FACTORY USE OR NON−STANDARD UNITS		
R	Send version level and software revision #	ann	
H	Send temperature + tenths + hundredths	nnnnh	3, 4
K	Calibrate mode A (DAC), from mode B	Y/N	4
M	Calibrate mode B (meter), from mode A	Y/N	4
N	Normal mode	Y	4
	Send signed internal values at current setpoint	snnnsnn	5
>	Up pushbutton, calibrate modes only	Y/N	
<	Dn pushbutton, calibrate modes only	Y/N	4
A−C	Set string value to 1−3	Y	
I	Select auxset number equals string (if 1−3)	Y/N	
J	Verify auxset number equals string (if equal)	Y/N	
O	Assign current setpoint to auxset number in string	Y	4
P	Send auxset number (0−3) and setpoint	annn	
L	Special, same as “T” but ignored if first “L” input after “F”	Y (either case)	

STATUS BYTE	ASCII CODE, SRQ MODE: OFF	ON
Temperature at setpoint (+/− 0.5 _ C)	@	H
Temperature < setpoint	A	I
Temperature > setpoint	B	J
Possible calibration error (battery/memory failure)	C	K
Cannot read back temperature (out of range, etc.)	D	L
Circuit failure (temperature departing setpoint)	E	M
Unit is in test mode (manually−controlled function)	F	N
Power−on delay (2−4 secs)	G	O

NOTES

1. String buffer is cleared by any understood non−numeric; it is altered by any numeric, with no response.
2. String value rejected if out of setpoint operating range.
3. Fifth digit (h) is 0 or 5, primarily used for more vernier response to calibrate−commands (meter).
4. Intended or restricted for use in calibration mode.
5. Dac and meter calibration units; s = “+” or “−”.

For *probe−sensor* measurement, a commercial handheld temperature probe is mounted into a steady fixture with its sensor head in vertical contact with the surface of the silicon test wafer.

In either method, the wafer should lie flat with chuck vacuum applied during measurement and should cover the chucktop without vacuum leaks. Each method is seen to support the measurement of the other with negligible error differences.

The *bonded−sensor* method is generally employed when finite repeatability from set−up to set−up is most important. The *probe−sensor* method is often more convenient, particularly if multiple−spot measurements are to be made. It is more difficult to get a repeatable reading within .1°.

7.6.6.2 AT−TEMPERATURE STATUS

The unit signals it is ready for use when the temperature display value is within .25° of the selected setpoint. It will again become “unready” if the error is over .5°; (see **Sections 7.6.2.1, Changing Modes (Normal Mode),** and **7.6.5, External Controls and Baud Rate Alteration**).

Note that this digital function relies on the calibrated accuracy of the display.

7.7 TEMPERATURE COMPENSATION FEATURE

Temperature compensation allows the prober to adjust XY stepping to compensate for the thermal expansion of platen and wafer, according to values for coefficients and temperature changes which have been entered through the Temperature Compensation Menu (*Figure 7−15*). It operates with or without a thermal chuck.

The Automatic Temperature Compensation feature provides a sensor in the platen which automatically shifts stepping along the die during probing to compensate for any change in temperature.

The Temperature Compensation Assembly is illustrated in *Figure 7−13*.

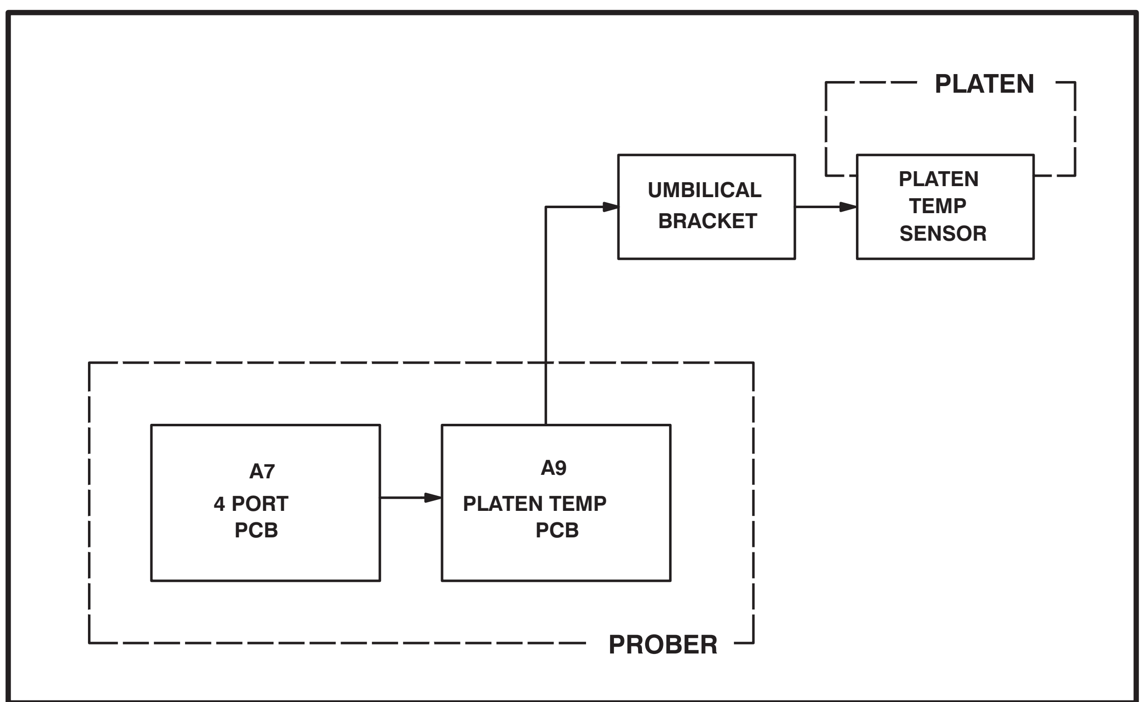

FIGURE 7−13: TEMPERATURE COMPENSATION ASSEMBLY DIAGRAM

7.7.1 Platen Expansion

The forcer−platen pair are accuracy−profiled by laser interferometry in the Electroglas factory. This process assures extreme stepping accuracy. However, the platen temperature at the time of profiling is a significant factor.

If the platen surface expands due to an increase in platen temperature, its tooth structure will expand as well. This will introduce a forcer stepping error, proportional to the expansion. For this reason, the prober measures the platen temperature and adds a compensation factor into its general temperature compensation scheme.

A thermistor is mounted to the platen and is used to provide temperature feedback to the software. This allows the motion system to compensate for changes in the platen caused by

changes in the probing environment.

7.7.2 Manual Coefficients

Two temperature compensation variables are located in the Diagnostic Menu (*Figure 7−14*):

```
PROBER

 ***  DIAGNOSTIC EXERCISE MENU   ***

01  CHUCK...000...000...000...0000
02  WAFER ID READER
03  EXTERNAL INPUT/OUTPUT
04  PROFILER STABILITY TEST
05  BURN IN MODE SETUP MENU
06  VISION UTILITIES MENU
07  X-MANUAL COEFFICIENT. . . .0.0
08  Y-MANUAL COEFFICIENT. . . .0.0

LINE =
```

FIGURE 7−14: DIAGNOSTIC EXERCISE MENU

To access this menu, press < DIAG > (< F1 >). Lines 07 and 08 of this menu allow you to correct for linear errors in the X and Y axis. This correction is done before temperature compensation. This provides a way to correct linear error in base stepping.

The X and Y manual coefficient parameters are entered in units of PPM (parts per million per inch).

7.7.3 Operation

There are two ways to operate Temperature Compensation:

1. Standard (Auto Temperature Compensation disabled)
2. Automatic (Auto Temperature Compensation enabled)

The Standard Temperature Compensation feature is discussed in **Section 7.7.4**; the Automatic Temperature Compensation feature is discussed in **Section 7.7.5**.

The differences between Standard and Automatic are shown in *Figure 7–15*. If the Automatic Temperature Compensation feature in the Set Option Menu is enabled, the Delta T's (temperature changes) are automatically calculated by the system. Otherwise, if the Auto Temperature Compensation feature is disabled (Standard), the Delta T values must be entered in the Temperature Compensation Menu.

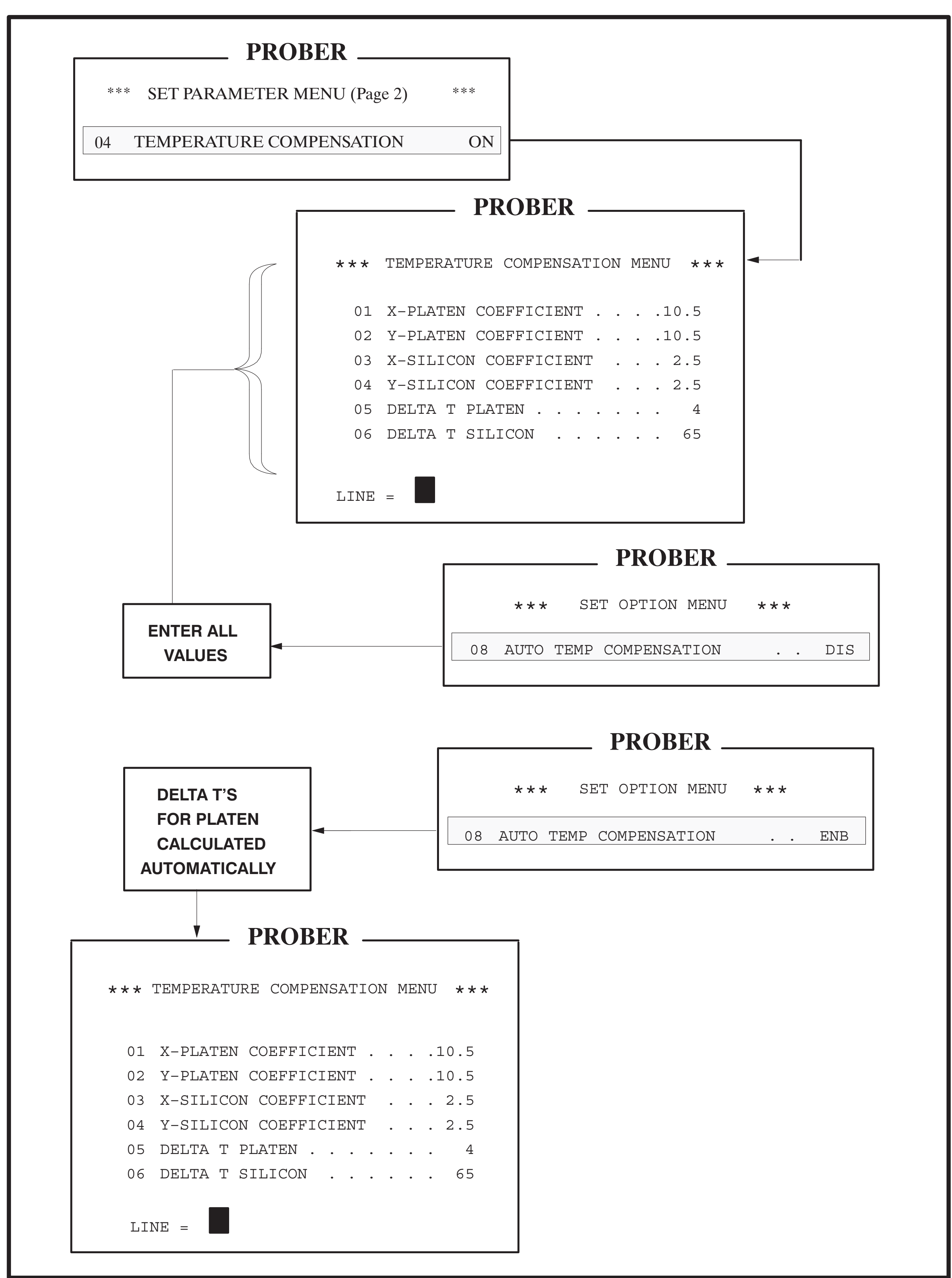

FIGURE 7−15: TEMPERATURE COMPENSATION MENU HIERARCHY

7.7.4 Standard Temperature Compensation

Standard temperature compensation is enabled through the Set Parameter Menu (page 2, Line 04, TEMPERATURE COMPENSATION) . When this function is on or Auto, the Temperature Compensation Menu is displayed (*Figure 7−16*). This menu can also be accessed through Line 08 of the Set Option Menu (*Figure 7−15*).

PROBER

```
SET PARAMETER MENU (PAGE 2)

1 Z SCALE UNITS/MILS ......... ......2
2 SET RUNTIME DISPLAY CLOCK
3 AIR-SENS   .....X...24000  Y...48000
4 TEMPERATURE COMPENSATION ..       ON
5 PROBE COUNT ...............        0
6 INK DOT COUNTER & TIMER         MENU
7 PROBING TIME (HR:MIN) ... ....  0:00
8 % YIELD TO PASS WAFER   ..........50
9 MAX X/Y VELOCITY  ...........10,000

LINE =
```

PROBER

```
TEMPERATURE COMPENSATION MENU

01 X-PLATEN COEFFICIENT . . . .10.5
02 Y-PLATEN COEFFICIENT . . . .10.5
03 X-SILICON COEFFICIENT  . . . 2.5
04 Y-SILICON COEFFICIENT  . . . 2.5
05 DELTA T PLATEN . . . . . . .   4
06 DELTA T SILICON  . . . . . .  65

LINE =
```

FIGURE 7−16: TEMPERATURE COMPENSATION MENU

The Temperature Compensation Menu is used to select expansion coefficients for platen and wafer and temperature changes (Delta T's).

NOTE

When any compensation parameter (temperature or coefficients) is changed, the probe tip center and first die positions must be set again.

LINES 01 and 02 – X/Y–PLATEN COEFFICIENT

Enter the platen expansion coefficients. Units are ppm/C; 10ths of ppm/C can also be entered. The correct value for the platen is 10.5 ppm/C.

LINES 03 and 04 – X/Y–SILICON COEFFICIENT

Enter the coefficient of expansion for the wafer in ppm/C or 10ths; 10ths are shown in *Figure 7–11.*

The default expansion coefficient for silicon is 2.5. The actual coefficient of expansion is wafer and process dependent. When seeking ideal values for a particular application, it is recommended that you begin with a range of 2.5 to 3.0. If you need further assistance or have questions, call Electroglas Technical Support.

LINE 05 – DELTA T PLATEN

In standard operation allows entry of the platen's change in temperature, a value between –50° and 110° C compared to the reference ambient of 20° C. Negative temperatures may be entered to compensate for platen contraction during low–temperature probing.

NOTE

DO NOT enter the platen temperature. Enter the platen temperature *minus 20*. This is the change from reference ambient (20°) to the platen temperature.

LINE 06 – DELTA T SILICON

In standard operation allows entry of the wafer's change in temperature. The range of entries is from –50° to 110° C. Again, enter the wafer temperature *minus 20°*.

The Delta T Silicon value, Line 06 , can be changed if a non–EG Hot Chuck is enabled. If the Hot Chuck is disabled and the operator attempts to access Line 06, an error message is displayed:

```
HOT CHUCK IS DISABLED
```

When the Hot Chuck is disabled from the Set Options Menu, the Delta T Silicon will be set to zero (0).

7.7.5 Automatic Temperature Compensation

The Automatic Compensation feature is enabled through the Set Option Menu (Line 08, AUTO TEMP COMPENSATION, *Figure 7−17*) .

When it is enabled, the Temperature Compensation Menu is automatically accessed. The menu cannot be disabled or turned off, and platen Delta T's cannot be changed. Any time the platen temperature changes more than two degrees, the prober computes a new compensation factor and compensates during probing.

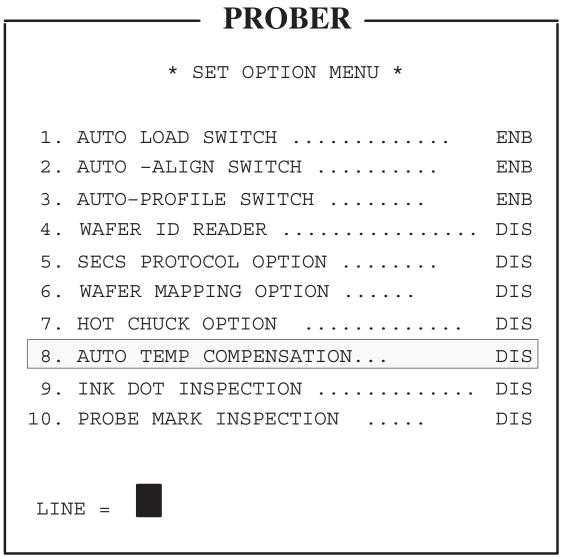

FIGURE 7−17: SET OPTION MENU

7.8 SUMMARY

In this section, you have learned:

- Basic assemblies of the Programmable Z stage #6 (PZ6)
- Operating and programming instructions for the PZ6
- How to enable and adjust the Hot Chuck
- Temperature Compensation overview and instructions on how to set manual coefficients

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SECTION 8 – EXTERNAL CONTROL I/O INTERFACE

The notations in the margin on this page and throughout the section indicate areas where information was changed and/or new information added in this current revision (REV B).

NOTE the Supplement located at the end of Section 8.

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CI	Clear Ink Dot Inspection Summary		8–42
CM	Clear Probe Mark Inspection Summary		8–42
DA	Set Date		8–42
DE	Delete Die from Learn List	AcH	8–42
DT	Delete Trained Pads		8–42
EI	Enable/Disable Inkers		8–42
FA	Add Site to Micro List		8–43
FD	Set First Die		8–43
HS	Set Hot Chuck Soak Time		8–43
MP	Move to Probe Tip Center Position		8–43
PH	Set Z Profile Height		8–43
PL	Enable/Disable Pipelining Wafers		8–44
PM	Set Probe Tip Center Position		8–44
PN	Set Probe Tip Clean Position		8–44
PO	Set Continuity Test Position		8–44
PP	Set Camera Center Position		8–44
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RF	Clear Micro List		8–45
RL	Define “Lot Number” String	AeE	8–45
RR	Clear Row/Column List	AcO	8–45
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➧ SX	Temperature Compensation Options		8–46
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WO	Wafer Map Options		8–47
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WO2	Set Wafer Map Source		8–47
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WO4	Set Map Destination Disk Drive		8–47
WO5	Enb Inking of Unreprobed Die		8–47
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WO7	Enb/Dis Map Write to Standard External I/O Port		8–47
WO8	Enb/Dis Map Write to SECS I/O Port		8–47
WO9	Select Bincodes to Reprobe		8–47

8.4.2 ACTION COMMANDS

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AA	Auto Align Wafer	AdF	8–48
AP	Abort Probing	AcM	8–48
BA	Begin Autoprobe	AcR	8–48
CB	Clear Printer Data Buffer	AeF	8–48
CE	Clear Error Buzzer and Message	AgM	8–48
CL	Load Cassette		8–49
CP	Clean Probe Tips	AgG	8–50
CT	Perform Continuity Test		8–50
CW	Clean Probes with Special Wafer		8–50
DD	Delete Product File from Disk		8–51
DM	Delete Map from Prober Disk		8–51
ET	Multiple Die Test Complete		8–51
EW	Generate EOW Pulse on Tester Interface	AgC	8–51
FC	Micro Test Complete		8–51
FM	Move Micro Coordinates		8–52
GF	Go to a Micro Site		8–52
HO	Move Motor to Home Position	AdH	8–52
➧ HW	Handle Wafer	AcS	8–52
ID	Request Prober ID and S/W REV	CD	8–55
IK	Ink Device	AgH	8–55
IN	Inspect Ink Dot		8–56
IP	Inspect Probe Mark		8–56
LA	Illuminators “ON”/“OFF”	AgF	8–56
LF	Load Product File(s) from Disk	AK	8–56
LI	Lower Retractable Inker		8–57
LM	List Maps Stored on Disk		8–57
LO	Unload Wafer / Load New Wafer	AdD	8–57
LP	Print Stored Data	AeG	8–58
➧ MA	Move Absolute		8–58
MD	Move Relative in Die Steps	AD1	8–58
ME	Display Message on CRT	AgB	8–59
MF	Move to First (Preset) Position	AdG	8–59
MM	Move Relative in Machine Steps	AdJ	8–59
MO	Move Absolute in Die Steps	AdA	8–60
MS	Request Stored Map Send		8–60
MT	Move Theta		8–60
MW	Move Wafer from Source to Destination		8–61
PA	Pause/Continue Probing	AcN	8–62
PC	Edge Profile Wafer	AgJ	8–62
PG	Put and Get Wafer		8–62
➧ PR	Probe One Wafer	AcL	8–63
PW	Prepare Specific Wafer for Loading		8–63
PZ	Profile Wafer Thickness	AgI	8–63
RI	Raise Retractable Inker		8–63
SA	Sound Alarm		8–63
SD	Set the Current Drive Specifier		8–64
SF	Store Product Files to Disk		8–64
TC	Test Complete and Bin Device	BAn	8–64
TS	Generate Test Start Pulse	AgD	8–65
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8.4.3 MESSAGES

8.4.3.1 Queries and Responses

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?B	Request Miscellaneous Position Data		8−67
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?E	Request Error Code	CA	8−69
?F	Request Micro Coordinates		8−69
?G	Request Ink Dot Inspection Data		8−70
?H	Request Absolute Motor Position		8−71
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?L	Request Multiprobe Location Code		8−72
?MD	Request Handler Device Data		8−73
?N	Request Profiler Data		8−75
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?P	Request Current XY Position	CG	8−75
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?R	Request State Variables		8−77
?RID	Read ID Command		8−77
?S	Request Status	CH	8−78
?SM15	Query for Response Setup		8−78
?SM102	Request Status Profile Before Align		8−78
?SM103	Request Status Wafer on Prealign		8−78
?SM104	Request Status Auto Light Adjust		8−78
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?SP36	Query Light Control Mode		8−79
?SP37	Query Miscellaneous OCR Setup Data		8−79
?T	Request Theta Position		8−79
?U	Request Total Probing “Up” Time		8−79
?W	Request Wafer ID	CU	8−80
?Y	Request Yield Data	CP	8−80
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8.4.3.2 Upload/Download Commands

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UQ	Upload Learn List	8−82
UF	Upload Micro List	8−82
UP	Upload PRU	8−82
UK	Upload Ink Dot Inspection Data	8−82
UB	Upload Probe Mark Inspection Data	8−82
UO	Upload Optical Character Recognition Data	8−82
DS	Download Setup Data	8−82
DR	Download Row List	8−82
DQ	Download Learn List	8−82
DF	Download Micro List	8−82
DP	Download PRU Data	8−82
DK	Download Ink Dot Inspection Data	8−82
DB	Download Probe Mark Inspection Data	8−82
DO	Download Optical Character Recognition Data	8−82

8.4.3.3 Unsolicited Messages

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PP	Pause Pending	8−91
SP	Start Probing	8−91
TC	Test Complete	8−91
TF	Test First Die	8−92
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RDP COMMANDS

When an RDP equivalent is not provided for a standard command, the application−specific RDP command "AH" may be used. This command is described in Section 8.5 (RDP Protocol).

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8.4.1 SETUP COMMANDS

8.4.1.1 Set Parameter Commands

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AbA	Set Z Scale Factor	SP12	8−19
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AcI	Set Turnaround Count	SP13	8−19
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AaE	Set Flat Orientation	SM3	8−24
AaF	Enable Notch Select	SM18	8−28
AcB	Select Probe Mode	SM4	8−24
AcE	Skipdie Enable	SM6	8−25
AcK	Edge Inking Enable	SM10	8−25
AcT	Set Probe Clean Count	SM12	8−26
AcU	Enable Auto Diameter Measurement	SM13	8−26
AcV	Enable Stop if AA Fails	SM19	8−28
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AeC	Print Cassette Log Enable	SM9	8−25
AeH	Set Coordinate Quadrant	SM11	8−26
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AfC	Assign 16 Logical Ink Codes	SM24	8−29
AgA	Select Z Travel Mode	SM5	8−25
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8.4.1.3 Miscellaneous Setup Commands

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AcP	Add Row to Row List	RC	8−44
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AgK	Set Prober Clock	TI	8−46
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RDP COMMANDS (continued)

8.4.2 ACTION COMMANDS

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AcM	Abort Probing	AP	8−48
AcN	Pause/Continue Probing	PA	8−62
AcR	Begin Autoprobe	BA	8−48
AcS	Handle Wafer	HW	8−52
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AdB	Move Z Up	ZU	8−66
AdC	Move Z Down	ZD	8−65
AdD	Unload Wafer / Load New Wafer	LO	8−57
AdE	Unload Wafer	UL	8−65
AdF	Auto Align Wafer	AA	8−48
AdG	Move to First (Preset) Position	MF	8−59
AdH	Move Motor to Home Position	HO	8−52
AdI	Move Relative in Die Steps	MD	8−58
AdJ	Move Relative in Machine Steps	MM	8−59
AdK	Move Z to Specified Height	ZM	8−66
AeF	Clear Printer Data Buffer	CB	8−48
AeG	Print Stored Data	LP	8−58
AgB	Display Message on CRT	ME	8−59
AgC	Generate EOW Pulse on Tester Interface	EW	8−51
AgD	Generate Test Start Pulse	TS	8−65
AgE	Turn Chuck Vacuum On/Off	VA	8−65
AgF	Illuminators On/Off	LA	8−56
AgG	Clean Probe Tips	CP	8−50
AgH	Ink Device	IK	8−55
AgI	Profile Wafer Thickness	PZ	8−63
AgJ	Edge Profile Wafer	PC	8−62
AgM	Clear Error Buzzer and Message	CE	8−48
AK	Load Product File(s) from Disk	LF	8−56
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	RDP command description		8−93
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8.4.4 MESSAGES

8.4.4.1 Queries and Responses

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COMMAND SET LIST by FUNCTION

Prober Function | **Command** | **Page**

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Prober Function	*Upload*	*Download*	Page
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DISK (see WAFER MAPPING / DISK)

ID READER CONTROL

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INK DOT/PROBE MARK CONTROL

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INKING CONTROL

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COMMAND SET LIST by FUNCTION (continued)

LIST MANIPULATION

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Add Site to Micro List	FA	8−43
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Clear Row/Column List	RR	8−45
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PROBER OPERATION CONTROL

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Pause/Continue Probing	PA	8−62
Probe One Wafer	PR	8−63
Send XY Coordinates with TS	WM	8−46
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PROBING PARAMETERS

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COMMAND SET LIST by FUNCTION (continued)

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Miscellaneous Position Data	?B	8–67
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Probe Mark Inspection Data	?J	8–72
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COMMAND SET LIST by FUNCTION (continued)

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Relative in Machine Steps	MM	8–59
to First (Preset) Position	MF	8–59
to Home Position	HO	8–52
Relative in Die Steps	MD	8–58

Z / THETA CONTROL

Prober Function	Command	Page
Enable Restrictive Z Mode	SM71	8–38
Enable Z Metric Display	SM68	8–38
Move Theta	MT	8–60
Move Z :		
Down	ZD	8–65
Specified Height	ZM	8–66
Z Relative to Current Position	ZR	8–66
Z Up	ZU	8–66
Select Z Travel Mode	SM5	8–25
Set: Z Clearance	SP6	8–18
Z Down Limit	SP8	8–18
Z Overtravel	SP5	8–18
Z Profile Height	PH	8–43
Z Scale Factor	SP12	8–19
Z Undertravel	SP10	8–18
Z Up Limit	SP7	8–18

MESSAGES – UNSOLICITED

Prober Function	Command	Page
Alarm Message	A	8–89
Attention	AT	8–89
Begin Cassette	BC	8–89
Continue	CO	8–89
End Cassette	EC	8–89
Message Completed	MC	8–90
Message Failed	MF	8–90
Map Received	MR	8–90
Map Transmit	MT	8–90
Pause/Continue	PA	8–90
Pattern Complete	PC	8–91
Pause Pending	PP	8–91
Start Probing	SP	8–91
Signal Test Complete	TC	8–91
Test Start	TS	8–92
When Coordinate Reporting Enabled	TSXnYn	8–92
When Microprobing Enabled (Site #)	TSSn	8–92
When Multi–Die Probing Enabled (On–Wafer Code)	TS,n	8–92
Continue After Pause	TA	8–92
Test Micro Site	TM	8–92
Test First Die	TF	8–92
Perform Continuity Test	TP	8–92
Retest or Test Cycle	TR	8–92
Ugly Die Report	UD	8–92
Wafer Begin	WB	8–92

SECTION 8
EXTERNAL CONTROL I/O INTERFACE

8.1 OVERVIEW

The External Control I/O Interface makes it possible to operate 4085X probers through a host computer. The interface is activated through the I/O Control Menu, a submenu of the Set Mode Menu. Two interfaces are selectable by the operator; a serial RS−232 interface, and a GPIB (General Purpose Interface Bus) interface.

Once External Control is activated, software commands provide for prober setup, motion control, uploading and downloading of data, and the exchange of queries and messages. Commands are used to select parameters and modes, log coordinate information, and convey prober and inker instructions. In turn, the interface reports back to the host computer such information as prober status and coordinates required for wafer mapping purposes.

Any tester communication will bring the External I/O Interface on−line. To signal readiness to the tester when the prober is in Autoprobe mode, the Test Start message is sent to the host. The prober waits for the Test Complete message, including inker bincode, from either the External I/O or tester interface before indexing to the next die.

This is the most common type of prober/tester link. The prober performs the wafer loading, aligning, profiling, stepping and unloading automatically. The tester performs electrical tests, queries various status info from the prober, and tells the prober when to move to the next die.

CAUTION

Do not use both the tester interface and External I/O to send the Test Complete command since synchronization problems can arise.

8.1.1 How To Use This Section

This section contains the following information regarding External Control I/O Interface:

- How to set External I/O parameters through the I/O Control Menu
- How to enable/disable messages through the Enhanced External I/O Mode Menu
- How to use direct External Control commands
- A description of each command and message, in alphabetical order, by category
- RDP protocol command descriptions
- Information on message strings and physical connections
- External I/O error messages and communication errors

8.2 MENUS FOR EXTERNAL CONTROL

Two menus are used to select the settings for external control. The I/O Control Menu provides the line items used for selecting protocol and setting parameters. A submenu, the Enhanced External I/O Mode Menu, mainly enables/disables the issuing of messages.

8.2.1 I/O Control Menu

The I/O Control Menu is accessed through Line 07 of the Set Mode Menu, which appears when the < SET MODE > (< F2 >) key is pressed. The format of the I/O Control Menu displayed on the screen varies according to the setting selected through Line 03; *Figure 8−1* illustrates typical displays of the three variations.

LINE 01 I/O PROTOCOL

Selection is made from four parameters:

1 – Selects standard I/O protocol.

2 – Selects enhanced I/O protocol; when selected, Line 02 (External I/O Mode Menu) appears.

3 – Selects RDP I/O protocol (used for Teradyne and other testers).

4 – Selects BOCS protocol (customer−specific; not discussed in general documentation).

LINE 02 EXTERNAL I/O MODE

If < 2 > is input for Line 01, the enhanced External I/O Mode Menu will be displayed when Line 02 is selected. This menu is discussed in **Section 8.2.2**.

The menu format varies according to the settings chosen for Lines 01 and 03.

If ENHANCED (< 2 >) is selected for Line 01, Line 02 will provide access to the External I/O Mode Menu. If any of the other three settings are selected, Line 02 will be blank.

Protocol (Line 01) was ENHANCED
I/O Port (Line 03) settings varied

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . .   ENHANCED
02  EXTERNAL I/O MODE  . . . . . MENU
03  I/O PORT  . . . . . . . . . .  SER
04  BAUD RATE  . . . . . . . .   9600
05  TRANSMIT DELAY IN MS  . . . . . 0
06  TERMINATOR . . . . . . .  . CR/LF
07  PARITY  . . . . . . . . . . .  NO
08  NUMBER OF DATA BITS . . . . .   8
09  TIMEOUT TIMER 1 IN MS . . . .5000
10  TIMEOUT TIMER 2 IN MS . . . .5000
```

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . .   ENHANCED
02  EXTERNAL I/O MODE . . . . .  MENU
03  I/O PORT  . . . . . . . . .GPIB-SP

05  GPIB ADDRESS          . . . . .  1
06  TERMINATOR . . . . . . .  . CR/LF
07  GPIB SRQ. . . . . . . . . . .  ENB

09  TIMEOUT TIMER 1 IN MS . . . .5000
10  TIMEOUT TIMER 2 IN MS . . . .5000
```

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . . .  ENHANCED
02  EXTERNAL I/O MODE . . . . .  MENU
03  I/O PORT  . . . . . . . . .GPIB-PP
04  PARALLEL POLL ADDRESS  . . . .  1
05  GPIB ADDRESS  . . . . . . . . .  1
06  TERMINATOR . . . . . . .  . CR/LF


09  TIMEOUT TIMER 1 IN MS . . . .5000
10  TIMEOUT TIMER 2 IN MS . . . .5000
```

Line 03 has three settings:

```
Serial (SER)
GPIB – Serial-Poll (GPIB-SP)
GPIB – Parallel-Poll (GPIB-PP)
```

Protocol (Line 01) was STANDARD
I/O Port (Line 03) settings varied

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . .   STANDARD

03  I/O PORT  . . . . . . . . . .  SER
04  BAUD RATE  . . . . . . . .   9600
05  TRANSMIT DELAY IN MS  . . . . . 0
```

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . .   STANDARD

03  I/O PORT  . . . . . . . . .GPIB-SP

05  GPIB ADDRESS  . . . . . . . . .  1
```

PROBER

```
          I/O CONTROL MENU

01  I/O PROTOCOL . . . . .   STANDARD

03  I/O PORT  . . . . . . . . .GPIB-SP
04  PARALLEL POLL ADDRESS . . . . .  1
05  GPIB ADDRESS . . . .  . . . . .  1
```

FIGURE 8−1: I/O CONTROL MENU − TYPICAL VARIATIONS

Since the standard I/O, RDP, and BOCS protocols define a permanent set of non−alterable parameters, an input of < 1 >, < 3 >, or < 4 > for Line 01 will block access to Line 02 and replace the line with a blank space. (However, all I/O messages in the External I/O Mode Menu can be enabled by I/O command even when standard protocol is in use.)

LINE 03 I/O PORT

Updated 5/96 See the Supplement at the end of the section for information about diagnostic testing

This menu item is used to enable and disable the external control interface, and also to select from the interfaces available when the connector is plugged into the proper jack (rear of the Power/Control Module). The selection made in this line determines the format of the balance of the menu. *Figure 8−1* illustrates the respective formats; *Figure 8−2* diagrams the interrelation between the various sections.

Added 5/96

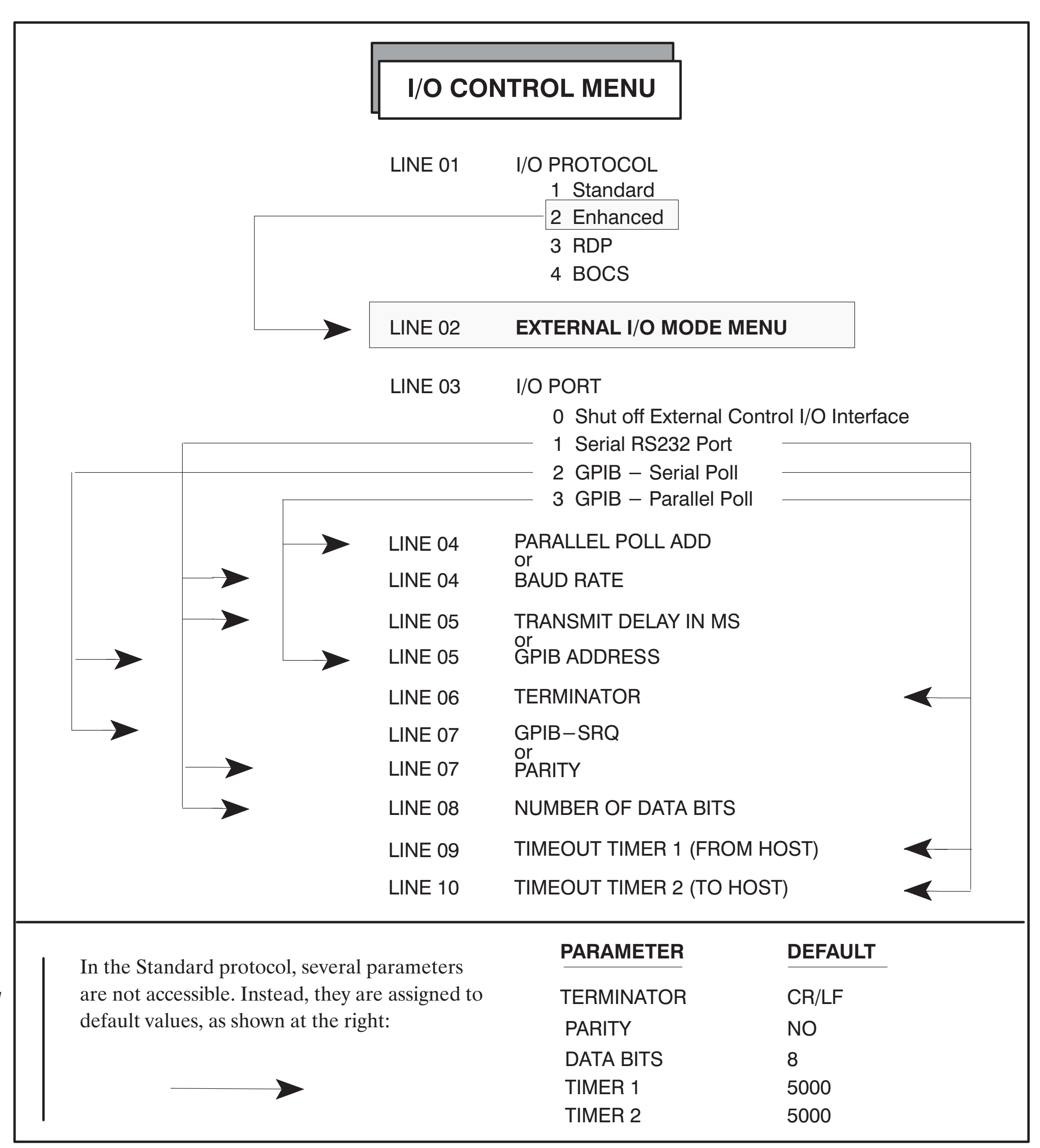


FIGURE 8−2: INTERRELATION OF I/O CONTROL MENU ITEMS

Input: 0 – Shuts off the External Control Interface.

1 – Selects the serial RS–232 interface port (SER). The baud rate (one alternate of Line 04) is entered in connection with the serial selection. The connector must be plugged into the proper jack (rear of the Power/Control Module).

2 – Selects the general purpose interface bus serial poll mode (GPIB–SP). The device address (one alternate of Line 05) operates with this interface. Any address from 1 to 31 may be selected. The connector must be plugged into the proper jack (at the rear of the Power Control Module).

3 – Selects the general purpose interface bus parallel poll mode (GPIB–PP). This allows Line 04 to be used for the selection of the parallel poll address. Line 05 is used to select the GPIB address. The connector must be plugged into the proper jack (at the rear of the Power Control Module).

In the explanations of the remaining menu lines given below, each is identified by the Line 03 selection(s) to which it applies.

LINE 04 (TWO VARIATIONS)

A – BAUD RATE (SER)

This option, which establishes the serial interface (RS–232) baud rate, is valid only if the serial interface is selected in Line 03 (input < 1 >).

B – PARALLEL POLL ADD (GPIB–PP – Input < 3 >, Line 03)

Selects the GPIB–PP address of the prober; any address from 1 to 8 may be selected.

BAUD RATE CODE

Table added 5/96

Code		Code	
1	50	9	1800
2	75	10	2400
3	110	11	3600
4	135	12	4800
5	150	13	7200
6	300	14	9600
7	600	15	19200
8	1200		

LINE 05 (TWO VARIATIONS)

A – TRANSMIT DELAY IN MS (SER – Input < 1 >, Line 03)

Sets or disables an intercharacter delay between transmitted characters on RS–232. If this delay is set to < 0 >, it works like older revisions. (Any non–zero value requires a CPU board REV B or later.)

B – GPIB ADDRESS (GPIB–SP and GPIB–PP)

The alternate variation of this line is used in connection with the GPIB interface selection (input < 2 > or < 3 >, Line 03). This is the address that the controller (tester/host) will use to route data and commands to and from the prober. Any address from 1 through 30 may be selected for the device. When the serial interface port is selected, this line is not displayed.

Updated 5/96

LINE 06 TERMINATOR (GPIB, EG Enhanced)))

The terminator sequence is the character(s) or bus signal that is used to indicate that a prober command or message string has been completely sent and no more data follows. Select from the prompt to establish the terminator for messages between the host computer and prober. The terminator sent by the prober must match the terminator sent by the host.

Updated 5/14/96

Input: 0 – to select End or Identify (EOI) – GPIB bus signal only; see note following.

1 – to select the carriage return (CR).

2 – to select the line feed (LF).

3 – to select the carriage return followed by the line feed (CR/LF).

If standard protocol is used, the terminator is fixed at <CR/LF>. RDP does *not* utilize this item.

Shown at the right are the terminator combinations that may be sent by the tester for a particular selection, as well as the terminator(s) that will be sent by the prober, in the GPIB Serial Poll.

GPIB TERMINATOR COMBINATIONS

Terminator Selection	Input (Sent by the Tester)	Output (Sent by the Prober)
CR	CR or LF	CR/EOI
LF	LF	LF/EOI
CR/LF	CR/LF	CR/LF/EOI
EOI	EOI	EOI

NOTE: The EOI signal is one of the GPIB bus management lines. The tester may assert this signal simultaneously with the last character of a command sent to the prober to terminate the command.

EOI is always asserted by the prober on output of the last byte. If EOI is set as the only terminator, it is asserted with the last character of data sent from the prober.

For example, EOI would be asserted during the time the "**C**" is sent in the message "**MC**". If a terminator character(s) is also enabled, it would be asserted during the time the final terminator character is sent. If the command "**WM1** <cr><lf>" is sent, EOI is asserted while the <lf> is being sent.

By selecting only EOI as the terminator, the total GPIB communication time can be reduced by between 7 and 50 percent, depending on the particular commands/ messages used. On the average, during probing with wafer mapping enabled, EOI would be 20% faster than CR/LF and 11% faster than CR or LF alone. This average is based on eight (8) characters (plus terminators) for the average test start message with X–Y coordinates.

LINE 07 (TWO VARIATIONS)

A – PARITY (SER – Input < 1 >, Line 03)

The parity check is based on the use of an additional bit at the end of each transmitted ch aracter. The parity bit associated with each transmitted code group is even if the total number of 1's in each code group plus parity bit is always even. The odd bit scheme sums the 1's in the

code group plus parity bit and always results in an odd number. An error message occurs if the received code group fails the parity selected.

With this method, random errors from noise or other influences are detected and indicated to the operator.

Input: 0 – Selects no parity (the code group representing each character is transmitted without the additional parity bit).

1 – Selects an odd–bit–parity check.

3 – Selects an even–bit–parity check.

5 – Selects a constant of “1” for the parity bit.

7 – Selects a constant of “0” for the parity bit.

B – GPIB–SRQ (GPIB–SP – Input < 2 >, Line 03)

This line enables/disables the GPIB SRQ (service request) function in enhanced protocol. In standard protocol, this function is automatically on and may not be disabled.

LINE 08 NUMBER OF DATA BITS (SER– Input < 1 >, Line 03)

This option establishes the code group for each character transmission by entering the number of data bits required for that particular code.

Input:

0 – Selects 8 data bits per transmitted character.

1 – Selects 7 data bits per transmitted character.

LINE 09 TIMEOUT TIMER 1 IN MS (all three options)

`TIMEOUT TIMER 1` controls data *received from* the host computer.

LINE 10 TIMEOUT TIMER 2 IN MS (all three options)

`TIMEOUT TIMER 2` controls data *transmitted to* the host computer.

Enter timer value in these line numbers to establish an allowable time lapse between characters. The timer can be set at any value between 100 and 10,000 milliseconds (ms).

If the timer times out between characters of a string, the character will not be received/transmitted and an error message will occur; if transmitting *to* the host, the prober switches offline in connection with an error message.

Disable the timer(s) by entering < –1 >.

CAUTION

If timers are disabled and the host/tester locks up, the prober will never timeout – recovery is not possible.

8.2.2 Enhanced External I/O Mode Menu

The External I/O Mode Menu (*Figure 8−3*), accessed from Line 02 of the I/O Control Menu, allows the operator to enable or disable a variety of command−related messages; this determines if a message is to be issued after the execution of a command.

The list of messages appears in **Table 8−1**, with notations comparing the two settings. For each message, enter its line number. Then follow the instructions in the prompt: enter < 0 > to disable the message, < 1 > to enable the message.

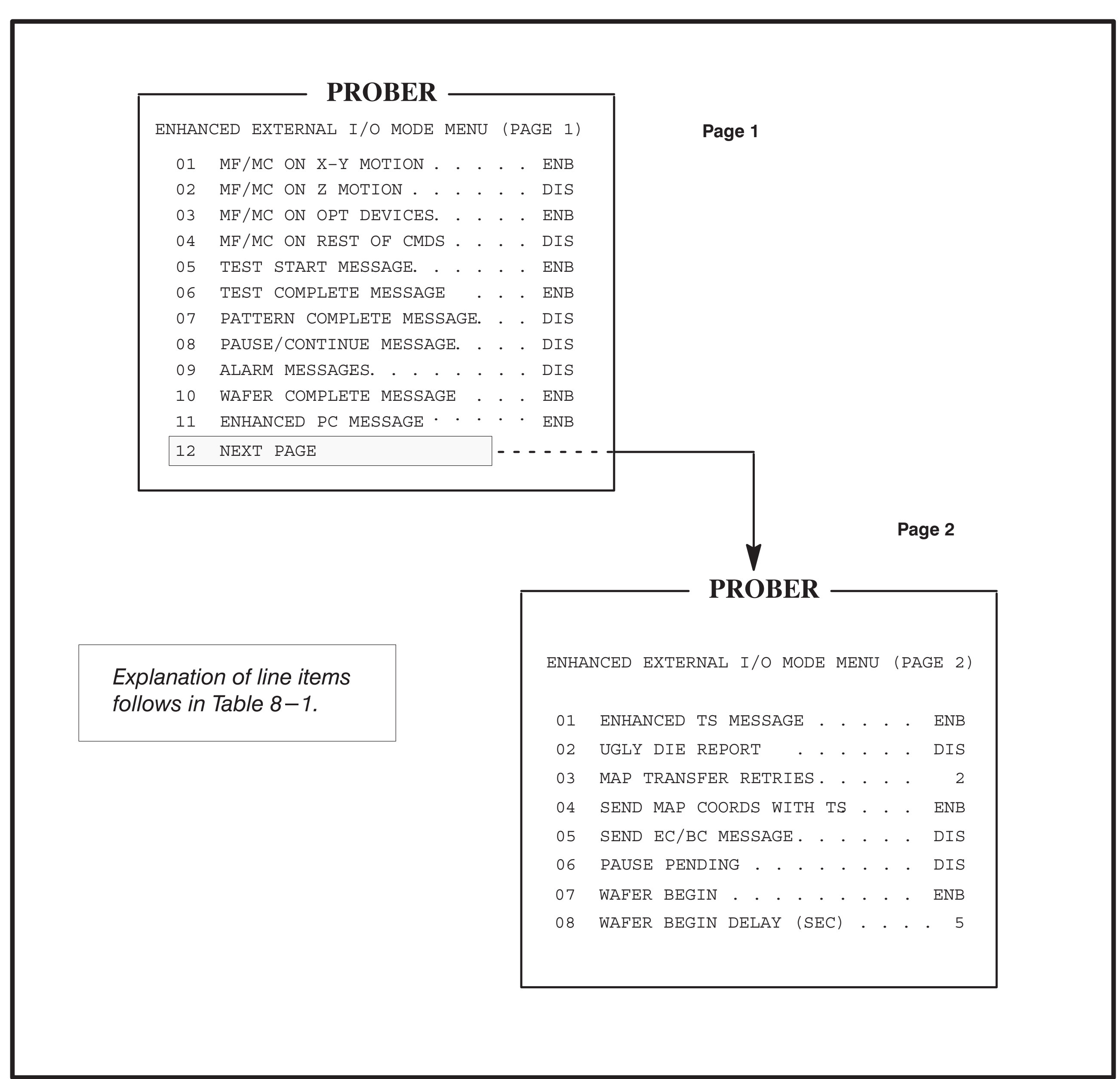


FIGURE 8−3: TYPICAL EXTERNAL I/O MODE MENU DISPLAY

TABLE 8−1: MESSAGE DISABLE/ENABLE RESULTS

EXTERNAL I/O MODE MENU (PAGE 1)

Line and Message Description	Disabled (Input < 0 >)	Enabled (Input < 1 >)
01 X−Y Motion 02 Z Motion 03 Optional Device Commands 04 Balance of Parameter Commands	Successful completion or failure of the command will not be acknowledged.	Message acknowledges successful completion (**MC**) or failure (**MF**) for each command executed. The response categories are identified in the explanation of the **MC/MF** commands in **Section 8.4.3.3 (Unsolicited Messages).**
05 Test Start	TS will not be sent to the host computer.	TS will be sent to the host computer.
06 Test Complete	TC will not be sent to the the host computer.	TC will be sent to the host computer if received over the TTL (tester) interface.
07 Probe Pattern Complete	PC will not be sent to the host computer.	PC will be sent to the host computer.
08 Probing Interrupted Via < PAUSE > Key	PA will not be sent to the host computer.	PA will be sent to the host computer.
09 Alarm Messages (Error, Warning, Information)	All alarm messages to the host computer will be repressed.	Alarm messages will be sent to the host computer as they occur (**Annn** format).
10 Wafer Complete	**PC** will not be sent to the host computer at unload.	**PC** message will be sent to the host computer at unload. (Same as 07 except 07 occurs on last die, 10 occurs when wafer is physically unloaded.)
11 Enhanced PC	Enhanced version PC is not used.	Enhanced PC version will be sent to the host computer at unload when wafer complete is enabled. It then provides information about the wafer handling system and the wafer ID. See **Section 8.4.3.3** for description of message syntax.
12 Next Page		

EXTERNAL I/O MODE MENU (PAGE 2)

Line and Message	Disabled (Input < 0 >) / Enabled (Input < 1 >)
01 Enhanced TS	Enabled, tells the tester what kind of test has been started: **TF** = Test First Die **TA** = Test Again **TS** = Regular Test Start **TM** = Test Micro Site **TR** = Retest or Test Cycle
02 Ugly Die Report	Enables/disables the sending of the message: UDX<pos>Y<pos>B<bincode> where xpos and ypos = relative location from 1st die and bincode = ugly bincode If enabled, this message is sent for every ugly die encountered during probing.
03 Map Transfer Retries	Enabled, instructs the external I/O to retry sending wafer maps from 0 to 10 times automatically. The message **MR** (Map Ready) indicates the prober is ready to send a wafer map; it is sent in order to synchronize the host with the prober for the wafer map transmission. Information about wafer mapping is contained in **Section 10** of this manual.
04 Send Map Coords with TS	When this line is enabled and a test start is sent to the tester, the prober issues the following message: TSX<Xdie>Y<Ydie> The X die and Y die positions indicate the current position relative to the first die position. The axes are the same as those selected for the coordinate axes in the Probe Mode Menu Line 02 (COORDINATE QUAD). The tester can then track die coordinates itself. Xdie and Ydie can be preceded by a “ − ” sign, but never a “ + ” − for example, TSX-14Y12.

EXTERNAL I/O MODE MENU (PAGE 2) (continued)

TABLE 8–1: MESSAGE DISABLE/ENABLE RESULTS (continued)

EXTERNAL I/O MODE MENU (PAGE 2) (continued)

Line and Message	Disabled (Input < 0 >) / Enabled (Input < 1 >)
05 Send EC/BC Message	Enables/disables **EC/BC** messages which indicate when processing of wafers from a new cassette has begun or ended. If not supported by the hardware, the error message `FEATURE NOT SUPPORTED BY HANDLER` is issued when enable is attempted. **EC** and **BC** are discussed in **Section 8.4.3.3.**
06 Pause Pending	Enables/disables `PAUSE PENDING` message; available only if the autoprobe mode is set to `EXTERN` (external) or `OFF`. It is similar to the `PAUSE/CONTINUE` message (Line 08 on Page 1 of this menu) in that it indicates when the < PAUSE > key was pressed. The differences are: (see below)

- If the < PAUSE > key is pressed, the prober sends the message **PP** to the host system (instead of the **PA** message like the normal `PAUSE/CONTINUE)`.
- The Z stage will not drop with subsequent presses of the < PAUSE > key (as it does with normal `PAUSE/CONTINUE)`.
- The prober will not go into a Pause state until the host (tester) sends a **TC** (test complete) command. At this time, the Z stage will drop as it does in the normal `PAUSE/CONTINUE` function.

The purpose of the **PP** message is to prevent the operator from pressing the < PAUSE > key twice in succession, thereby dropping the Z stage away from the probe card and causing test failures before the tester has a chance to complete the current test. Probing is continued in the same manner as the standard `PAUSE/ CONTINUE` in that the operator presses the `<PAUSE>` key to continue probing (return control to the tester).

In case the tester locks up, the `< Z >< PAUSE >` key sequence can be used to force the prober into PAUSE mode.

If `PAUSE/CONTINUE` and `PAUSE PENDING` are both enabled when `EXTRN` probe mode is used, `PAUSE PENDING` will take precedence. For example:

Tester	Operator	Prober	Comments
	press <PAUSE> key		
		PP	send message to host
		message written to CRT `(WILL PAUSE UPON TC FROM TESTER)`	
finish current test			
TCn			send test complete (bincode “n” optional)
		PA	send `PAUSE` message only if `PAUSE/- CONTINUE` is enabled, too
		drop Z stage	prober is now paused
	press < PAUSE > key		continue probing
		CO	send `CONTINUE` message only if `PAUSE/CONTINUE` is enabled, too; testing resumes

Line and Message	Disabled (Input < 0 >) / Enabled (Input < 1 >)
07 Wafer Begin	This message will be sent after the probes have contacted the wafer, but before the first **TS** (test start) message is transmitted to the tester. It notifies the tester/host that a wafer has been loaded and is about to be presented for testing. See the **WB** message in **Section 8.4.3.3.**
08 Wafer Begin Delay (Sec)	This line is used to specify a test start delay of from 0 to 10,000 seconds, the interval the prober will wait before sending the first **TS** to the tester. The optimum delay depends on the time needed by the tester to get ready before accepting the first **TS.** This delay should be long enough to allow the tester to initialize its program. While the prober is in this delay state, the prober is not locked out from External I/O nor from the use of the < PAUSE > key. This delay is *only* used with the **WB** message (Line 07). It cannot be enabled independently.

8.3 FUNCTIONS OF THE INTERFACE

Three useful functions of the External I/O Interface are:

1. Setting up the prober for a product type (such as setting die size).
2. Interacting with the tester during probing.
3. Controlling prober actions explicitly if dictated by the tester program.

8.3.1 Direct External Control

Direct External I/O Control is typically used from the external probe mode. External I/O commands can control XY motion as well as raise and lower the chuck. The X and Y coordinate references are absolute units of die size with respect to the operator−established origin. Die size (X and Y) is established through either operator control or external commands.

Before X−Y motion, the Z stage is lowered if it is in the up position. After the X−Y motion is complete, the Z stage is automatically returned to its previous position. Z axis positioning may also be controlled directly by the **ZU** (ZUp), **ZD** (ZDown), **ZM** (move to Z absolute), or **ZR** (move Z relative) commands. The host computer may establish the maximum Z up or Z down limits as well as Z overtravel, Z undertravel, and Z clearance.

8.3.2 Standard Probing Modes for Automatic Operation

A system of patterns controls the probing process. In any of the automatic probing modes, the prober is automatically indexed with a standard probe pattern. The available auto probe patterns are Off, Edge, Matrix, Circular, Learn, Row, Partial, and External.

8.3.2.1 STANDARD EDGE SENSE PATTERN

From the starting die, or First Die, the prober advances across the wafer in a serpentine pattern until the edge sensor is no longer in contact with the wafer. If delayed inking is enabled, the prober continues to step off the wafer to allow the last die to be inked.

The prober steps one or more times (as determined by the “turnaround count”) and then begins stepping in the reverse X direction until the edge sensor contacts the wafer. If the edge sensor fails to contact the wafer within nine steps, the pattern is considered complete and the Pattern Complete message, if enabled, is generated. Edge Sense mode requires a mechanical edge−sensor on the probe card fixture.

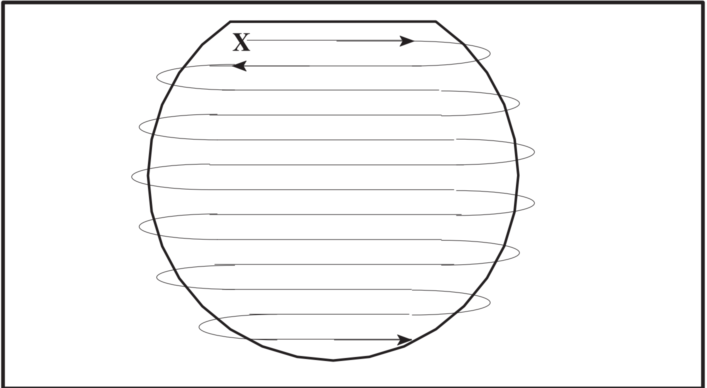


FIGURE 8–4: STANDARD EDGE SENSE PATTERN

8.3.2.2 MATRIX PATTERN

This pattern starts at first die. Because the pattern probes a rectangular matrix within the wafer, delayed inking is not allowed. First, the prober advances in a serpentine pattern for the number of columns selected. Next, the prober steps once, reversing the X direction. This is repeated until all rows have been probed. See **Section 8.4.1.1 (Set Parameter Commands)** for a description of the Set Matrix Size command **(SP3).**

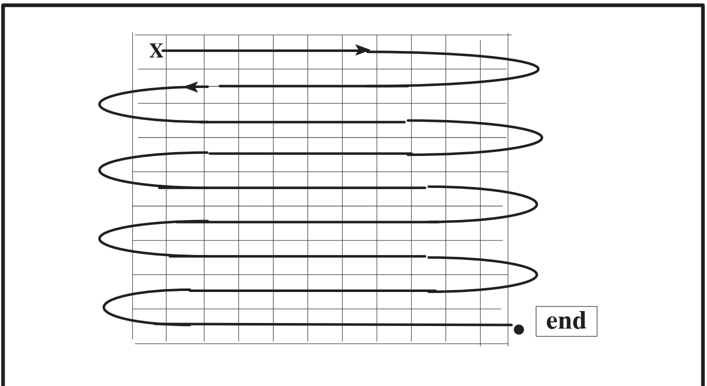


FIGURE 8–5: MATRIX PATTERN

8.3.2.3 CIRCULAR PATTERN

Circular is the same as edge–sense – they are both serpentine. The difference is, the circular mode uses the Noncontact Edge Sensor (profiler) to turn around. Also, the row length varies with the row position to conform to the serpentine pattern and to prevent probing off the wafer. Only whole die are indexed. A circular pattern is computed based upon:

1. X and Y die size
2. Chuck center position
3. Wafer diameter
4. Wafer center

See **Section 8.4.1.1 (Set Parameter Commands)** for descriptions of the Set Die Size **(SP1)** and Set Wafer Diameter **(SP4)** commands. For instructions on setting the chuck center, see **Section 6 (NONCONTACT EDGE SENSOR).**

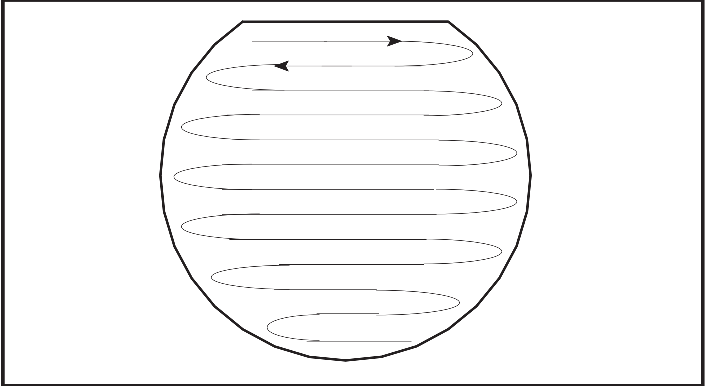


FIGURE 8−6: CIRCULAR PATTERN

8.3.2.4 LEARN PATTERN

Use a coordinate list for this pattern. This list can be developed in the following ways:

- By the operator using the keyboard in the Learn List editor.
- By the host computer using the Add, Delete, and Clear functions. (See **Section 8.4.1.3, Miscellaneous Setup Commands,** for a description of these functions.)

Although the coordinates are established with respect to the preset value at the first die position, the operator must always position the first die location, whether it is to be probed or not. The first die location will not be probed unless it is referenced while in the learn list, which contains a maximum of up to 1024 coordinate values. This list can be used as a list of die to be tested *or* a list of die to be skipped (if skipdie is enabled).

The Learn probe mode and Skipdie inking cannot be used simultaneously (they both use the same list data for two different purposes).

8.3.2.5 ROW/COLUMN PATTERN

To use the row/column probe pattern, select two similar axis points on either the X or Y axis. Next, choose a third point on the opposite axis. The prober will either go across the row or down the column to cover the distance between the two points chosen on the same axis, depending upon the third point chosen. The format to enter rows (X axis) and columns (Y axis), respectively, is as follows:

Command		Example	
(n = row or column number)			
Row:	**RCXnYnXn** **(RDP: AcPxf,y,xl)**	**RCX1Y2X36**	= sends the prober across from X=1, to X=36 in the second row (Y=2) of the die.
Column:	**RCYnXnYn** **(RDP: AcQyf,x,yl)**	**RCY2X15Y10**	= sends the prober from Y=2 to Y=10 in column 15.
The row list can store up to 415 rows.			

See the Supplement at the end of the section for information about new and modified commands

8.4 COMMAND SUMMARY

Commands are divided into several categories:

- **SETUP** commands establish the initial parameters (**Section 8.4.1).**
- **ACTION** commands maneuver the various parts of the prober (**Section 8.4.2**).
- **UPLOAD/DOWNLOAD** commands make it possible to both upload and download to or from a host or tester. The micro list, Auto Align pattern, learn list, row list, Probe Mark Inspection setup, Ink Dot Inspection setup and product setup data may be uploaded or downloaded (**Section 8.4.3.2**).
- **MESSAGES** (**Section 8.4.3**), if enabled, are sent to the tester upon completion of External I/O commands. Messages can be broken into two categories:

  QUERY AND RESPONSE MESSAGES (**Section 8.4.3.1**)

  UNSOLICITED MESSAGES (**Section 8.4.3.3**)

If the prober is offline and a command is sent to the prober, the prober will switch to an online status and attempt to execute the command. The prober will not send information to the host when it is offline. This online/offline state is toggled by pressing the < ON LINE > (< F4 >) key on the Monitor keyboard.

At the following commands, the prober reinitializes the RS−232 port, the SECS port, and all the Z−related values:

DS (Standard I/O)	DOWNLOAD SETUP DATA
DE (RDP)	SEND NEXT DATA BLOCK

In addition, at the following commands, the prober also reinitializes all optional devices (those enabled/disabled in the Set Option Menu):

DS (Standard)	DOWNLOAD SETUP DATA
SO (Standard)	SET OPTIONS
AhA (RDP)	SET OPTIONS
DE (RDP)	SEND NEXT DATA BLOCK

Any device enabled, but not installed, is disabled following the interpretation of these commands.

8.4.1 Setup Commands

See the Supplement at the end of the section for information about new and modified commands

SETUP commands include Set Parameters (**SP**) and Set Mode (**SM**) commands, as well as some miscellaneous commands. They are used before the ACTION commands to establish such parameters as:

Set Parameter Section 8.4.1.1	**Set Mode** Section 8.4.1.2	**Miscellaneous** Section 8.4.1.3
Die size Z limits Matrix dimensions Wafer diameter Coordinate preset	Coordinate type (English/Metric) Enable/disable various operational modes Quadrant and wafer orientation	Non–sequential probe (Learn List) Microprobing coordinates Row/column list

NOTE

It is important that certain commands be executed before others. Three of these instances are given here; instructions are repeated in the descriptions of the respective commands:

SM15 (ENABLE RESPONSE MESSAGES)
Should be the first command issued.

SM1 (SET ENGLISH/METRIC UNITS)
MUST be used before the die size commands (**SP1** or **SP29**).

SP12 (Z SCALE VALUE)
MUST be used before any Z stage parameters are set and before any X–Y or Z motion.

All commands and messages are described on the following pages, arranged in alphabetical order by category, as listed above.

Descriptions include equivalent RDP commands, where available. When an RDP equivalent is not provided for a standard command, the application–specific RDP command **AH** can usually be used. This command is described in **Section 8.5 (RDP Protocol)**.

8.4.1.1	SET PARAMETER COMMANDS	SETUP
FORMAT: SPn <parameter string>		n = parameter code number

COMMAND	DESCRIPTION

SP1 **SET DIE SIZE**
RDP: **AaCx,y**

Format: **SP1XnYn** n = die size
Range: 1 − 9999998

Sets a particular unit of X and Y die size in units of 0.1 mil or 1 micro.

IMPORTANT: SM1 (Set English or Metric Motion *must* be set first).

EXAMPLE: ***SP1X1234Y5678*** ➧ *Sets the X die to 123.4 mils or 1.234 millimeters (mm); the Y die to 567.8 mils (5.678 mm).*

SP2 **SET PRESET (FIRST) DIE COORDINATE**
RDP: **AcAx,y**

ALSO RE−DEFINES CURRENT DIE DURING PROBING AS TEMPORARY FIRST DIE

Format: **SP2XnYn** n = coordinates
Range: −999999 − 999999

Assigns the die coordinate values to the First Die reference.

During probing, the current die becomes temporary First Die. Any subsequent **MF** (MOVE FIRST) command will return to this die, not the original First die. After the next wafer is Auto Aligned, the original First Die will be restored.

NOTE: When using the **SP2** command, the First Die on the current wafer is temporarily relocated if the real first die is not under the probe tips at the time the command is sent. The original First Die position is restored at the next autoalign cycle.

EXAMPLE: ***SP2X50Y−50 (before A/A)*** ➧ *Sets the First Die preset X coordinate to 50, Y to −50.*

EXAMPLE: ***SP2X50Y−50 (during probe)*** ➧ *Current die becomes temporary First Die with X coordinate set to 50, Y coordinate to −50. All die index moves will now be made with reference to this new First Die position until an Auto Align occurs. Then the original First Die will be restored.*

SP3 **SET MATRIX PROBE SIZE**
RDP: **AcDx,y**

Format: **SP3XnYn** n = rows/columns
Range: 0 − 32767

Determines the number of die in X and Y that will be probed in the matrix probe mode. The X and Y parameters are the number of columns and rows to be probed relative to First Die.

F x
y

EXAMPLE: ***SP3X100Y48*** ➧ *Sets a pattern of 100 columns and 48 rows to be probed.*

SP4 **SET WAFER DIAMETER**
RDP: **AaAn**

Format: **SP4Dn** n = diameter
Range: 75 − 150

Sets the diameter of the wafer to be probed in millimeters (mm). Extreme accuracy is important only if the circular probe mode will be used and the profiler option is not installed.

EXAMPLE: ***SP4D125*** ➧ *Sets the wafer diameter to 125 mm.*

8.4.1.1 SET PARAMETER COMMANDS (continued) SETUP

SP5 **SET Z OVERTRAVEL**
RDP: **AbBn**

Format: **SP5Zn** n = overtravel parameter

CAUTION: The height at which contact occurs plus overtravel must never exceed the Z Up limit (set with **SP7**).

SP6 **SET Z CLEARANCE**
RDP: **AbCn**

Format: **SP6Zn** n = Z clearance

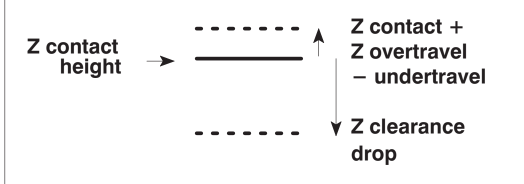
CAUTION: The height at which contact is lost minus clearance must never be less than the Z Down limit (set with **SP8**).

Range: 0 − 2000
Units: 0.1 mil

Sets the distance the Z stage will continue to travel beyond contact with the wafer as determined by the edge sensor or profiler.

Overtravel sets distance upward from contact and is used to force probes into die pads to ensure good probe−to−pad contact and low resistance.

Clearance sets the travel downward after contact with the wafer is lost. It ensures a certain distance between the probes and the wafer when the Z stage is down and XY motion is taking place.



If contact is at 275 mils and Z overtravel is at 3.0 mils, testing is actually done at 278.0 mils. When XY moves are done, the Z stage moves down to 265.0 (275.0 less 10.0 clearance, which is the factory default) before moving back up to 278.

EXAMPLE: ***SP5Z35*** ➧ *Sets the Z overtravel parameter to 3.5 mils.*

EXAMPLE: ***SP6Z100*** ➧ *Sets the Z clearance to 10.0 mils*

SP7 **SET Z UP LIMIT**
RDP: **AbDn**

Format: **SP7Zn** n = max ZUp limit

SP8 **SET Z DOWN LIMIT**
RDP: **AbEn**

Format: **SP8ZN** n = min ZDown position

Units: 0.1 mil
Range: 2000 − 4000

Sets the absolute position of the upper/lower limit of Z travel. Used as a safety limit when the edge sensor is enabled; used as the Z Up/Down position when the Z travel mode is set to Limit.

NOTE: Take care that the Up limit is not set and left lower than the down limit, and that the Down limit is not set and left higher than the Up limit.

EXAMPLE: ***SP7Z3800*** ➧ *Sets the Z Up position to an absolute height of 380.0 mils.*

EXAMPLE: ***SP8Z2000*** ➧ *Sets the Z Down position to 200.0 mils.*

SP9 **SET Z AUTO ALIGN HEIGHT**
RDP: **AbFn**

Format: **SP9Zn** n = focus height
Range: 2000 − 4000
Units: 0.1 mil

Sets the height for proper focus under the Auto Align subsystem optics. Must be less than or equal to the Z Up limit.

EXAMPLE: ***SP9Z2850*** ➧ *Sets focus height absolute to 285.0 mils.*

SP10 **SET Z UNDERTRAVEL**

Format: **SP10Zn** n = Z undertravel
Range: 0 − 2000
Units: 0.1 mil

Sets the Z Undertravel parameter which moves the chuck down the number of mils specified after completing the Z Up movement (including Z overtravel).

8.4.1.1 SET PARAMETER COMMANDS (continued) SETUP

SP11 — SELECT INKER DELAY

RDP: **AfBn**

Format: **SP11Dn** n = delay setting (0,1,2)

0 In−place inking (no delay)
1 Inkers placed 1 die step away
2 Inkers placed 2 die steps away
} Behind to the left and right of the probe location

NOTE: Delay ("offset") inking may only be used with edge, circular, and partial probe modes.

This option is often used for high density probe cards where the likelihood of inker contamination is high.

Allows inking outside probe area. Delay may be set to ink 1 or 2 die stps behind. If delay is set, inkers are activated as follows:

INKERS						
	1	n/a	Inc	Inc		
	2	n/a	Dec	Dec		
	3	n/a			Inc	Inc
	4	n/a			Dec	Dec

X−Coordinate: Inc = Increasing
Dec = Decreasing

EXAMPLE: ***SP11D2*** ➧ *Inks 2 die places behind. Inkers should be two places to the left and to the right of probe location.*

SP12 — SET Z SCALE FACTOR

RDP: **AbAn**

Format: **SP12Sn** n = Z scale value
Range: 1 − 10 (Not less than 1)

Sets the Z resolution according to the chuck option. The units are Z motor steps per mil (2 for a standard chuck with 0.5 mils per step).

Since 2 x 0.5 = 1: Z scale = $\frac{1}{\text{Z stage resolution}}$

NOTE: This command MUST be used before ANY Z stage parameters are set and before ANY XY or Z motion. Whenever the scale factor is changed, the prober recalculates all Z parameters. If these parameters are downloaded and then the Z scale is changed, the parameters will be wrong.

This value should never be changed unless you have changed your Z motor − for example, from .5 to .25 mil. ***Otherwise, severe probe damage could occur..***

EXAMPLE: ***SP12S2*** ➧ *Sets the Z scale value to 2 steps for the standard resolution of 0.5 mils.*

SP13 — SET TURNAROUND COUNT

RDP: **AcIn**
Format: **SP13Tn** n = number of steps
Range: 1 − 8

NOTE: Also affects edge die inking in edge sense and circular probe modes.

Controls the number of empty die positions that will be stepped through after contact with the edge sensor is lost and before the chuck moves to the next row and reverses the X direction. Used only in the edge sense mode to turn around, and in the circular mode with edge inking enabled.

EXAMPLE: ***SP13T4*** ➧ *Causes prober to turn around after four no−contact steps in X.*

SP14 — SET REPROBE COUNT

RDP: **AcJn**

Format: **SP14Rn** n = reprobe limit
Range: 0 − 32767

NOTE: To disable, set n = 0.

Sets the reprobe limit. After the specified number of consecutive bad die are tested, the prober positions itself to the last tested good die and re−tests it.

If the previously good die tests bad, the prober stops with an error message. If it tests good, probing resumes with the next untested die.

The counter is reset after end−of−wafer (the counter does not continue to the next wafer).

EXAMPLE: ***SP14R100*** ➧ *Sets the reprobe limit to 100.*

8.4.1.1 SET PARAMETER COMMANDS (continued) SETUP

SP15 **SET MAXIMUM ROW COUNT**
RDP: **AcCn**

Format: **SP15Mn** n = row limit
Range: 0 − 32767
NOTE: To disable, set n = 0.

Limits the number of rows probed in the circular probe mode. The circular probe mode will consider the wafer to be complete after "n" rows of die have been probed. Used to terminate probing without probing the positions located on the flat. Only useful if flat is at 0 degrees or 180 degrees orientation.

EXAMPLE: ***SP15M51*** ➧ *Terminates circular probing after 51 rows are probed.*

SP16 **SET ALIGN SCAN SPEED**
RDP: **AhBn**

Format: **SP16Vn** n = mils per second
Range: 52 − 9999

Defines the speed at which the back and forth motion of align scan takes place. Only affects manual alignment, not Auto Align.

Does not apply when the Joystick is in the Scan mode.

SP17 **SET AC LINE FREQUENCY**

(Not supported).

SP18 **SET AIR SENSOR X−Y POSITION**
RDP: **AhCx,y**

Format: **SP18XnYn** n = coordinates in tenth mil steps
Range: X0 − X115000
Y0 − Y81250
Units: 0.1 Mil / 2.5 Micron

Defines the XY coordinates of the Noncontact Edge Sensor (profiler) in 10th mil steps from the Harbor (0,0) position.

During setup, prober will measure exact location of sensor and replace the set values with the measured values.

Updated 5/96

NOTE: Should be used only during machine setup *before NCES setup is performed.* At that time, command **SP18X42,800Y150700** should be used to assign default position.

SP19 **SET TOUCHDOWN COUNTER**

Format: **SP19Cn**
Range: −999999 − 999999

Sets an initial value into the touchdown counter. The counter is incremented every time a test start is issued during probing, and is used to determine probe card wear and life expectancy. (Related to query command **?D**).

SP20 **SET INKER PULSE WIDTH**

Format: **SP20Pn** n = pulse width
Range: 5 − 30 milliseconds

Sets the width of the pulse used to fire the inkers − the length of time the inkers will be activated. If set too short, the inker will not fire correctly and bad die will not get inked.

SP21 **SET INK COUNTER LIMIT**

Format: **SP21Ln** n = counter limit
Range: −999999 − 999999

NOTE: To disable, set n = 0.

Sets a maximum limit for the number of times an inker can be used before refilling. If any inker counter exceeds this limit (see commands **SP22−SP25**), probing may not begin and a message will appear on the screen telling the operator to service the appropriate inker.

The counters are incremented every time an inker is fired during probing. If the count is exceeded in the middle of a wafer, the alarm will sound at EOW (End of Wafer).

8.4.1.1	SET PARAMETER COMMANDS (continued)	SETUP

SP22 **SET INKER 1 COUNTER**
SP23 **SET INKER 2 COUNTER**
SP24 **SET INKER 3 COUNTER**
SP25 **SET INKER 4 COUNTER**

Format: **SP22Cc**
Range: 1 – 999999

Sets the counters which monitor the respective inkers, counting the total number of times each has been used.

SP26 **RESET INKER TIME LIMIT**

Format: **SP26Rm** m = time limit
Range: 0 – 32759

Sets the maximum time an inker can be used before refilling. Must be other than "0" before inker(s) can be reset (**SP27**). For detailed discussion, see **Section 3**, **TUTORIALS.**

EXAMPLE: ***SP26R61*** ➧ *Inker timer limit becomes 1.01 (1 hour, 1 minute).*

SP27 **RESET INKER TIMERS AND COUNTERS**

Format: **SP27Rn**

Resets or disables timers and counters for inkers, either individually or as a group.

n = action code:

1 – 4	Reset timer and counter for individual inker, as specified (1, 2, 3, or 4).
5	Reset timers and counters for *all* inkers.
11–14	Disable use of timer/counter for individual inker: 11 = for inker 1 12 = for inker 2 13 = for inker 3 14 = for inker 4
15	Disable use of timer/counter for *all* inkers.

EXAMPLES: ***SP27R3*** ➧ *Resets timer/counter for Inker 3.*
SP27R15 ➧ *Disables timers/counters for all inkers.*

SP28 **RESET PROBING "UP" TIME**

Resets the accumulated probing time to 0. (See related query **?U** in **Section 8.4.3.1, Queries and Responses.)**

SP29 **SET SIX–DIGIT DIE SIZE**

Format: **SP29XnYn** n = die size
Range: 1 – 999999

Allows the host to set a die size of six significant digits to match the ability to set this value from the prober's keyboard. Allows a floating point number in which the first digit to the left of the decimal represents mils in English and millimeters in metric.

NOTE: This command differs from the SP1 command which assumes a unit measurement increment of 0.1 mils

EXAMPLES: ***SP29X345.25Y301.75*** ➧ *In English, sets the die size to X = 345.25 mils, Y = 301.75 mils.*

SP29X8.45821Y9.98221 ➧ *In Metric, sets the die size to X = 8.45821mm, Y = 9.98221 mm.*

SP30 **SET COMPENSATION PARAMETER**

(For specialized application. Check with your Field Service representative.)

8.4.1.1 SET PARAMETER COMMANDS (continued) SETUP

SP31 **LOAD Z DEFLECTION TABLE**

(For specialized application. Check with your Field Service representative.)

SP32 **SET MOTOR SPEED**

(For specialized application. Check with your Field Service representative.)

SP33 **SET % YIELD TO PASS WAFER**

Format: **SP33Yn** n = % required
Range: 0 − 100

Sets the percentage of a wafer which must pass testing before it can be accepted as a valid probed wafer. If the wafer fails to meet the specified percentage selected, the alarm will sound and an error message will be displayed. Calculated at end of wafer.

The formula used to calculate the percentage is:

$$\frac{\textbf{Good Die}}{\textbf{Total of Good Die + Bad Die}} \textbf{ X 100\% = \% yield to pass}$$

SP35 **SET OCR ILLUMINATION**

Format: SP35LbVv

b = Lamp select: "0" − main OCR lamp
"1" − auxiliary OCR lamp

v = Intensity value: 0 − 255

Allows the host to set the OCR lamp intensities. The new intensity value is not sent to the Vision Module as part of the **SP35** command, as this would cause the lamp to go on. (The lamp intensities are sent when an OCR read is commanded.)

SP36 **SET LIGHT CONTROL MODE**

Format: SP36Mm

m = Light Control Mode:

"0" − manual
"1" − auto dual lamps
"2" − auto main lamp
"3" − auto auxiliary lamp

Sets the type of light to be used for Auto Align functions.

SP37 **SET MISCELLANEOUS OCR SETUP DATA**

Format: SP37MbDdFf

b = Read Mode: "0" − conservative
"1" − aggressive

d = Display Time: "0" − 1/2 sec
"1" − 5 sec
"2" − 20 sec

f = Filter Size: 1, 3, 5, 7, 9

Sets the type of OCR read, length of time to leave ID on screen, and filter size.

8.4.1.1 SET PARAMETER COMMANDS (continued) SETUP

SP40 **ENABLE DOUBLE TOUCHDOWN**

Format: SP40Db

b = 0 Disable
b = 1 Enable

This feature also affects the operation of the **ZU** command. Upon receiving a **ZU**, the prober raises the Z stage either once or twice, depending on double touchdown being disabled or enabled.

The function of this feature is to provide better probe to pad contact. By raising the Z stage to contact the wafer with the probe tips twice for each die before issuing a TS, the probe tips are better able to break through the oxidation on the pads and thus increase product yield.

When this feature is enabled, for each die on the wafer to be tested, the prober will move the forcer to the die position, then raise the Z stage to the ZUP position. Upon reaching the ZUP position, the prober will then lower the Z stage the user−specified double touchdown clearance, then raise the Z stage back up to the ZUP position. At this point, the prober sends the **TS** to the tester.

SP41 **SET DOUBLE TOUCHDOWN CLEARANCE**

Format: SP41Zz z = the number of MILS required to break contact betw een the probe tips and pads.

Units = .1 MILS
Range = 0 to 200 MILS.

Allows the user to set the double touchdown clearance. This is only used if double touchdown is enabled.

SP−99 **RESET PARAMETERS TO DEFAULT**

Resets the machine parameters to their default values. Used to disable all options and clear all set and calculated values. This is the same as entering "−99" at the keyboard from the Set Parameter Menu.

Defaulting the total setup with SP−99 does not cause Machine Dependent Variables (MDVs) to be defaulted.

CAUTION: **This also resets all of the I/O parameters to their default setting of standard serial.**

See the supplement at the end of the section for information about existing and additional SM commands

8.4.1.2 SET MODE COMMANDS SETUP

FORMAT: SMn <mode value> n = mode code number

COMMAND	DESCRIPTION

SM1 **SET ENGLISH OR METRIC UNITS**

RDP: **AaBn**

Format: **SM1Un** n = 0 – English; n = 1 – Metric

Sets the XY unit coordinate either English or Metric. This determines whether the die size command is interpreted in units of one tenth mil (0.0001 inch) or 1 micron.

NOTE: MUST be used BEFORE the die size commands (SP1 or SP29).

EXAMPLE: ***SM1U0*** ➧ *Sets the system to English.*

SM2 **SET PROBE QUADRANT**

RDP: **AaDn**

Format: **SM2Qn** n = quadrant

Range: 1 – 4

Sets the starting quadrant (1–4) and orientation of die coordinate system (`PROBE QUAD SELECT` line on Probe Mode Menu); tells the prober the initial direction of travel.

The following table shows the X and Y motion of the forcer for each wafer quadrant.

L = Left R = Right F = Front B = Back

WAFER QUADRANT	1	2	3	4
X forcer motion moves from	L–R	R–L	R–L	L–R
Y forcer motion moves from	F–B	F–B	B–F	B–F

Back of the prober

2 1
3 4

Front of the prober

EXAMPLE: ***SM2Q2*** ➧ *Sets the starting quadrant to 2 (upper left). The X coordinates will increase to the right across the wafer, the Y, toward the front. Probing motion will begin from the top left and move to the right. (Note that the forcer motion moves in the opposite direction of the probing motion.)*

SM3 **SET FLAT ORIENTATION**

RDP: **AaEn**

Format: **SM3Fn** n = flat location

Range: 0 – 359

Units: degrees

Sets the orientation of the wafer major flat to the chucktop. Use only if Material Handler is enabled (**SO** command).

180 = 12 o'clock
90 = 9 o'clock
270 = 3 o'clock
0 = 6 o'clock

EXAMPLE: ***SM3F90*** ➧ *Orients the major flat to the 9 o'clock position.*

SM4 **SELECT PROBE MODE**

RDP: **AcBn**

Format: **SM4Pn** n = probe pattern

Range: 0 – 5, 8, 10

Selects the probe pattern to follow when in an auto–probe state. Choose External or Off for directed probing.

0 – Off	2 – Matrix	4 – Learn	8 – Partial
1 – Edge Sense	3 – Circular	5 – Row/Column	10 – External

EXAMPLE: ***SM4P2*** ➧ *Selects Matrix probe mode.*

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM5 **SELECT Z TRAVEL MODE**
RDP: **AgAn**

Format: **SM5En** n = Z travel mode

- 0 = enables LIMITS mode (limit−to−limit, Z Up, and Z Down)
- 1 = enables the edge sensor
- 2 = enables the Z stage to be guided by the profiler

Selects the type of travel used for Z motion, as limited by edge sensor, profiler, or limit−to−limit setting.

If the edge sensor is to be used, a probe card with this mechanical device must be provided.

EXAMPLE: SM5E1 ➧ *Enables the edge sensor.*

---

*ENABLE/DISABLE EXAMPLE (**SM6−SM10**):* ➧ ***SM6S1** enables the skipdie function.*

SM6 **SKIPDIE ENABLE**
RDP: **AcEb**

Format: **SM6Sn** n = “0” (disables) n = “1” (enables)

Enables/disables the skipdie function. (Not valid in Learn, External, or Off modes − see **SM4**.)

With function enabled, the learn list is used to designate dies to be skipped during testing.

SM7 **PRINT ERROR MESSAGE ENABLE**
RDP: **AeAb**

Format: **SM7En** n = “0” (disables) n = “1” (enables)

Enables/disables the printout of selected error messages on the optional log printer.

SM8 **PRINT WAFER LOG ENABLE**
RDP: **AeBb**

Format: **SM8Mn** n = “0” (disables) n = “1” (enables)

Enables/disables a wafer log printout after the completion of the probing pattern.

Used only in Autoprobe modes 1−5.

SM9 **PRINT CASSETTE LOG ENABLE**
RDP: **AeCb**

Format: **SM9Mn** n = “0” (disables) n = “1” (enables)

Enables/disables a cassette log printout after the cassette is completed.

Used only in Autoprobe modes 1−5, and 8.

SM10 **EDGE INKING ENABLE**
RDP: **AcKb**

Format: **SM10En** n = “0” (disables) n = “1” (enables)

Enables/disables wafer edge inking.

Used only with the edge, circular, and partial modes.

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

SM11 **SET COORDINATE QUADRANT**
RDP: **AeHn**

Format: **SM11Qn** n = 1−4

Allows the user to choose the sign (positive or negative) of the reported XY coordinate. That is, determines whether motion is going to be reported as positive or negative.

Does not affect actual motion, only reported coordinates. Has no relationship to the starting probe quadrant (set with **SM2).**

L = Left R = Right F = Front B = Back

COORDINATE SYSTEM	1	2	3	4
positive X moves to the	L	R	R	L
positive Y moves to the	F	F	B	B
negative X moves to the	R	L	L	R
negative Y moves to the	B	B	F	F

SM12 **SET PROBE CLEAN COUNT**
RDP: **AcTn,b**

Format: **SM12CnWb**

n = 0: disables cleaning
n = 0 − 32767: defines frequency

b = 0: counts by die
b = 1: counts by wafer

Determines the frequency of probe tip cleaning, by die or wafer. The cleaning pattern is an XY scrub motion or an octagonal scrub motion (depends on setting of **SM50;** see **SM50** to enable the octagonal XY probe scrub feature).

If cleaning by die and the count is *not* reached before the end of the wafer, the counter will continue on to the next wafer.

NOTE: Cleaning pad height must still be set by the operator before cleaning is performed.

EXAMPLE: ***SM12C5W1*** ➧ *Cleans probes every 5 wafers.*

SM13 **ENABLE AUTO DIAMETER MEASUREMENT**
RDP: **AcUb**

Format: **SM13Dn** n = “0” (disables)
n = “1” (enables)

NOTE: Does not cause an immediate measurement to occur.

Instructs the prober to measure wafer diameter during profiling, when NCES (profiler) is enabled.

This function is useless unless circular autoprobe mode is in use, but is HIGHLY recommended when using the circular mode. It overrides the diameter value entered from **SP4**.

SM14 **ENABLE CONTINUE AT LAST DIE**
RDP: **AgOb**

Format: **SM14Cn** n = “0” (disables)
n = “1” (enables)

Controls operation after the <PAUSE/CONT> key is pressed or `PAUSE` command **(PA)** is issued.

Not valid in Off or External probe modes.

NOTE: When the function is disabled and the <PAUSE/CONT> key or command is used the *third* time (to continue automatic operation), the prober moves the Z stage up and issues `TEST START` at whatever location it happens to be.

When the function is enabled, the prober memorizes the current XY position when paused and moves the chuck *back* to that location when automatic operation is resumed. The Z stage is then raised and `TEST START` issued.

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

SM15 **ENABLE RESPONSE MESSAGES**

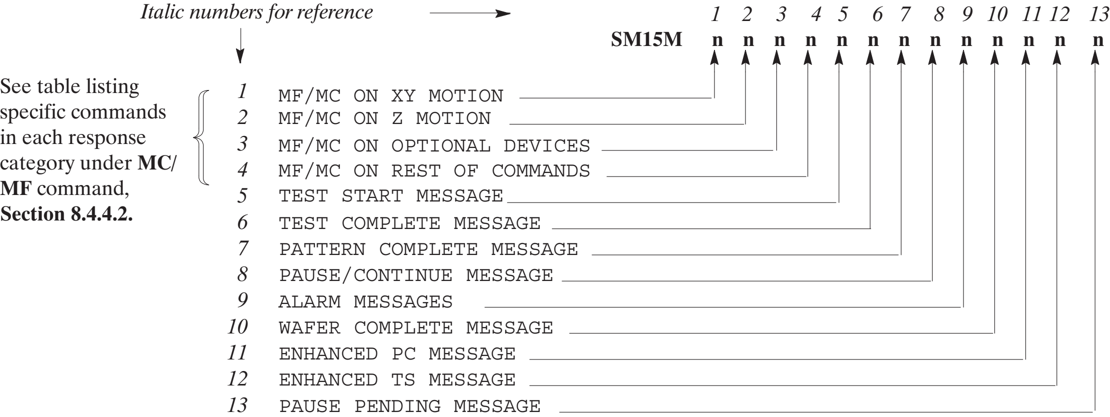
Format: **SM15Mnnnnnnnnnnnnn**

n = "0" (disables message)
n = "1" (enables message)

Enables/disables various I/O responses and unsolicited messages that the prober can originate.

Should be the FIRST command issued.

Note that the list of messages matches the items on the Enhanced External I/O Mode Menu*(Figure 8−3).*



This command's response group is "rest of commands". If the **MF/MC** message is enabled by this command, an **MC** will be sent back to the host when execution is complete. If this message is disabled by the command, no message will be returned to the host. About 95% of the I/O commands fall into one of the four categories listed.

Use of the RS232 link is assumed in the following example:

	HOST	PROBER	COMMENTS
EXAMPLE:	➧ ***SM15M0001000000000***		*o Enable "rest of commands" messages, disable all others*
		>	
		MC	*o Command complete (MC), prober ready for next command (">")*
	➧ ***SM15M0000000000000***		*o Disable "rest of commands" messages (all messages)*
		>	*o Prober ready for next command*
			*o No **MC/MF** message sent by prober*

SM16 **SET STARTING WAFER NUMBER**

RDP: **AeIn**

Format: **SM16Nn** n = first wafer number

Range: −32768 − 32767

NOTE: The absolute value of the wafer number is printed. If a negative number is used as a starting value, the printed numbers will count down. This command will operate differently depending on how the "reset wafer number" is set.

Defines the first wafer number that will be printed on a wafer cassette log, assigned to a wafer map, or displayed on screen. After each wafer is loaded, the number is incremented by one. If OCR is used instead, wafer numbers are read from each wafer, but the prober always maintains an incremental counter for each wafer loaded.

The sequence from one cassette to the next is determined by the command **SM17.**

EXAMPLES: ***SM16N50*** ➧ *(n = 50): the first wafer is number 50, the second is 51, and so on.*

SM16N−25 ➧ *(n = −25): the first wafer is 25, the second is 24, and so on.*

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM17 **RESET WAFER NUMBER**
RDP: **AeJn**

Format: **SM17Rn**

n = 0: "OFF"
n = 1: "AUTO"
n = 2: "MANUAL"

Determines the wafer numbering sequence after a starting number is set (**SM16**).

If set to manual (n=2), the start number can be changed at any time. The prober will count wafers endlessly using the starting wafer number as the first wafer number and incrementing for each subsequent wafer. If the starting number is 22 and there are 100 wafers to go, numbers will range from 22 to 122.

If OCR is used, this item is not needed since each wafer is assigned an ID based on its scribe mark.

"OFF" – The prober does not increment wafer number; it stays at the value set by the starting wafer number.

"AUTO" – The prober will count until the end of the source cassette and then reset the number to the starting wafer number (1–25, then 1–25 again). This works the same as manual except the wafer number is reset on each cassette to the start number. For example, if the starting number is 5 and there are three cassettes, then:

	Cass 1	Cass 2	Cass 3
Wafer	5–29	5–29	5–29

"MANUAL" – The operator may change the starting number and have it take effect immediately on the next wafer. For example:

	Cass 1	Cass 2	Cass 3
Wafer	5–29	30–54	55–79

SM18 **ENABLE NOTCH SELECT**
RDP: **AaFb**

Format: **SM18Nn**

n = "0" (disables)
n = "1" (enables)

Determines whether the Material Handling system will look for a notch (or a flat) in the wafer during prealignment.

SM19 **ENABLE STOP IF AUTO–ALIGN FAILS**
RDP: **AcVb**

Format: **SM19An**

n = "0" (disables)
n = "1" (enables)

Causes the prober to stop and summon the operator each time an Auto Align failure occurs.

With the function disabled, the prober unloads the wafer and fetches a new one. (Its status is updated with Align Fail.)

SM20 **ENABLE PROFILE WITH FIND CENTER**
RDP: **AcWb**

Format: **SM20Cn**

n = "0" (disables)
n = "1" (enables)

Instructs the prober to find the wafer center during profiling. Highly recommended for edge die and ugly die inking, as well as Circular Auto probe mode.

Does not cause an immediate measurement to occur.

SM21 **LOT ID NOT IDENTICAL**
RDP: **AgPn**

Format: **SM21Ln** n = 0–2

Defines the action taken when the lot ID read from a wafer does not match the value operator–entered from the Run ID Menu. Compares the first "X" number of characters with the OCR ID.

n = 0: Disables lot number comparison.
n = 1: Disables the inkers for this wafer (inkers will be re–enabled after the wafer is unloaded).
n = 2: Stops prober, summons operator.

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

SM22 **ENABLE IGNORE VACUUM**
RDP: **AgQb**

Format: **SM22Vn** n = 0 or 1

n = 0: Requires whole wafers
n = 1: Allows partial wafers

Causes the prober to ignore the vacuum back pressure measurement which reports whether or not a wafer is on the chuck. Automatically enabled for partial probe mode.

May only be enabled if the Material Handler is disabled.

SM23 **ASSIGN 16 GOOD/BAD DIE BINS**
RDP: **AeKb,b,b...b,b**

Format: **SM23Bnnnnnnnnnnnnnnnn**
(each "n" corresponds to a bin, in order from 0 to 15)
"0" bin is a bad die
"1" bin is a good die

EXAMPLE: ***SM23B0111000110000111***

Allows the host to define bincodes as good and bad die (used in accumulating the totals for reporting on the screen and printer). All bins greater than 15 are assigned the state of 15 (except skip and ugly die).

Does **not** relate to inking in any way.

Bins 0, 4, 5, 6, 9, 10, 11, 12 are bad die; the others are good.

SM24 **ASSIGN 16 LOGICAL INK CODES**
RDP: **AfCn,n,n...n,n**

Format: **SM24Innnnnnnnnnnnnnnnn**
(each "n" corresponds to a bin, in order from 0 to 15).

Defines which inkers are fired in response to any given incoming bincode. Bins are identified by ASCII characters. (Exception: RDP protocol uses numeric parameters, 1 to 15.) The table shows default settings; inkers to be fired for each bin can be re−assigned by keyboard entry.

n	(ASCII)	Fires inkers	n	(ASCII)	Fires inkers	n	(ASCII)	Fires inkers
0	0	−−−	6	6	2 and 3	11	;	1, 2, and 4
1	1	1	7	7	1, 2, and 3	12	<	3 and 4
2	2	2	8	8	4	13	=	1, 3, and 4
3	3	1 and 2	9	9	1 and 4	14	>	2, 3, and 4
4	4	3	10	:	2 and 4	15	?	1, 2, 3, and 4
5	5	1 and 3						

EXAMPLE (spaces added for clarity): ***SM24I9 0 8 1 1 1 7 0 0 0 ? : 4 0 0 >***

Bin = Bincode

Ass'gd = Assigned inker bin shown

Bin	*Ass'gd*	*Bin*	*Ass'gd*	*Bin*	*Ass'gd*	*Bin*	*Ass'gd*
0	*9*	*4*	*1*	*8*	*0*	*12*	*4*
1	*0*	*5*	*1*	*9*	*0*	*13*	*0*
2	*8*	*6*	*7*	*10*	*15 (?)*	*14*	*0*
3	*1*	*7*	*0*	*11*	*10 (:)*	*15*	*14 (>)*

SM25 **SET NUMBER OF ID READ ATTEMPTS**
RDP: **AgRn**

Format: **SM25Sn** n = 0−30

Sets the maximum number of read attempts to be made with the ID Reader before a misread occurs. Each attempt causes the ID angle to be increased, to increase the likelihood of success. The prober automatically performs two read attempts before this number is invoked.

If a correct read occurs before "n" spins have been performed, the wafer will immediately be related to the correct angle and loaded onto the chucktop.

See the Supplement at the end of the section for more information about this command

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

See the Supplement at the end of the section for more information about these commands

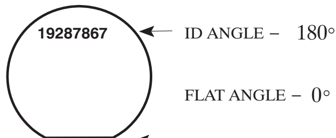
SM26 **SET ID POSITION ANGLE**

RDP: **AEn1, n2**

Format: **SM26Dn** n = 0−359 degrees

NOTE: RDP protocol has two parameters for this command:
n1 = Delay angle
n2 = ID size angle (see **SM27**)

Defines how far the prealigner will rotate the wafer (from the prealigned orientation) before beginning a read. Tells when the ID is on the wafer relative to the flat, counted clockwise. This is usually set to 0 since most OCR IDs are scribed on the flat itself.



SM27 **SET BAR CODE SIZE ANGLE**

RDP: (see **SM26**, above)

Format: **SM27Sn** n = 0−359 degrees

NOTE: For OCR, this parameter must be set to “0.”

Defines the number of degrees the prealigner will rotate the wafer back and forth under the sensor when attempting to read a bar code.

For example, if the arc of the bar code covers 30 degrees, this parameter should be set to 30 plus a safety margin of perhaps 10 degrees.

The size of the safety margin depends on how closely the delay angle brings the code to the sensor, and on the repeatability of the marking device that placed the code on the wafer.

SM28 **SET PRINTER FORMAT**

RDP: **AEb**

Format: **SM28Pn** n = 0−5

Determines the format of wafer and cassette log printouts.

- n = 0: Off – No printing will be done.
- n = 1: STANDARD – Form prints header, and numbers of good die, bad die, die tested, and die in each bin. No data is printed for a bin with zero die.
- n = 2: SHORT – Prints only header and number of good and bad die.
- n = 3: SPECIAL 1 – Uses only test results from bins 0, 1, and 3 for wafers #1 to #25.
- n = 4: 80 COLUMN – Allows choice of printer.
- n = 5: EDIT MAP – Prints MAP EDIT results of reprobed bins on disk−based systems. Provides Edit and Edit−Save strip printouts which detail bin results assigned for reprobe. Provides enhanced summary printouts for applications where multi−pass testing is done.

SM29 **ENABLE SKIPDIE INKING**

Format: **SM29In** n = 0,1,2

n = 0: disables
n = 1: enables but without Z overtravel
n = 2: enables with Z overtravel

Enables inking of die skipped by the Skipdie function. The user can select the inker.

The height at which inking takes place depends on the Z travel mode and overtravel choice.

(This feature is not available from External, Learn, or Off probe modes.)

SM30 **ENABLE 30 MIL DROP AT LOAD POSITION**

Format: **SM30Ln** n = “0” (disables)
n = “1” (enables)

Enables/disables a 30−mil chuck drop when the forcer comes Home and the Material Handler is disabled. Used when manually unloading wafer.

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

SM31 **SELECT AUTO ALIGN MODE**

Format: **SM31An** n = 0−4

Allows a choice of Auto Align accuracies. Selects only normal alignment when Auto Theta Compensation is enabled (**SM60**).

Normal mode aligns the wafer to within 1.5 pixels, Fine aligns to within 0.5 pixels.

0 = Normal alignment (uses standard PRU data)
1 = Fine alignment (uses sub−pixel PRU data)
2 = XFINE (special function for use by EG Field Service)
3 = 2 pt/2 ref (same tolerance as normal) − for wafer with two different die patterns on the two halves of the wafer
4 = 2 pt/1 ref (same tolerance as fine) − for wafer with a single die pattern

---

SM32 **SET COUNT PULSE WIDTH**

Format: **SM32Pn** n = 0−50 msec
0 = no pulse

Issues a pulse on the tester interface whenever a Test Start is issued for a new die during probing.

SM33 **SET HOT CHUCK TEMPERATURE**

Format: **SM33Hn** n = 20−130 degrees C

Sets the temperature of the remotely controlled TC−2000 Thermal Chuck.

The correct set−point temperature will be sent even if the Hot Chuck is disabled. Use **SO** to enable Hot Chuck option.

SM34 **ENABLE EARLY HOT CHUCK RECOVERY**

Format: **SM34Bn** n = "0" (disables)
n = "1" (enables)

Enables/disables the Hot Chuck early recovery feature, which minimizes soak time when a cool wafer is placed on a hot chuck by the Material Handler.

SM35 **ENABLE MICROPROBING**

Format: **SM35Bn** n = "0" (disables)
n = "1" (enables)

Enables/disables the microprobe function (inter−die test sites). Sites must be stored in the micro list to use this feature.

Other microrobing commands:

FM
GF } (Action Commands)
FC
FA (Miscellaneous Setup Command)

SM36 **ENABLE POST PROBE INKING**

Format: **SM36n** n = 0−2

0 = disable post probe inking
1 = enable post probe inking
2 = enable post probe inking and ink restart after pause.

Enables/disables Post−Probe Inking, which permits inking after Multi−Die Probing of the whole wafer, when both Multi−Die and Post Probe Inking modes are enabled.

8.4.1.2 SET MODE COMMANDS (continued) SETUP

Updated 5/14/96 per Prober Vision SW REV DA

SM37 **SET ID READER TYPE**

Format: **SM37Rn** n = 0, 1, 2,3

n = 0 selects Bar Code Reader
1 selects Non−EG OCR
2 selects EG OCR
3 selects Back Side Bar Code Reader

Selects the ID Reader type. The type chosen through this command will take precedence over any ID reader type selected through a handler menu change which has not yet been communicated to the prober.

NOTE: Since ID reader state and type are separate variables on the prober side but a single variable on the handler side, some confusion may exist. For example, if the ID reader is off on the handler, SM37R0 will not turn it **on** and set type to `BAR−CODE` (the handler menu will still say “OFF”).

The Back Side Bar Code Reader is currently only a valid option on the 4085 model. On models with intelligent handlers not supporting BSBC, the message `FEATURE NOT SUPPORTED BY HANDLER` (error code 123) will be displayed. The message will also display if BSBC is selected when **LO** is activated, **MF** is returned, and the old value of the reader type is not changed.

See the Supplement at the end of the section for more information about these two commands

SM38 **SET ID READER FAIL RECOVERY MODE**

Format: **SM38Rn** n = 0−4

Determines the action the prober will take when a wafer ID failure occurs.

n = 0: “STOP” mode:
Stops the system, leaving the wafer on the prealign, and the alarm sounds to summon the operator. The wafer is not returned to its origin. Probing is halted. The operator can retry the read by pressing the <LOAD> key, or can override this condition and load the wafer by pressing the dot (<.>) key, followed by the <LOAD> key.

n = 1: “MANUAL” mode:
Stops the system and alerts the operator. A menu appears with these six options:

1. Edit the ID (enter a new ID or fix the unread characters).
2. Retry the read (causes the prober to re−read the wafer on the prealign).
3. Set up the reader (via the ID Reader Setup Menu).
4. Unload the wafer and return it to its point of origin with the status of `ID FAIL.`
5. Ignore and continue (the wafer is loaded to the chuck as if the ID read was successful).
6. Stop and abort; the probing is stopped and the next wafer is not retrieved.

n = 2: “UNLOAD” mode:
Returns the wafer to its origin cassette with slot status updated to `ID FAIL.` No alarm sounds. A new wafer is then fetched. This continues until an ID is successfully read or no more wafers are available.

n = 3: ”IGNORE” mode:
Causes wafer to be loaded as if the read was successful. The ID assigned to the wafer is whatever the reader could read including any unreadable characters.

n = 4: ”HOLD” mode:
Keeps the wafer at the prealign station without sounding the alarm when an ID read fail is detected.

When the Hold mode is active and an ID read fail has occurred, the next XIO action command will result in the displayed message 46, `* ID READER FAIL`; **MF** will be returned to the host. The host may then command light intensity changes (**SP35L**) and re−read ID (**?RID**) if desired. The host may also cause the alarm to sound (**SA**). The ID read fail error is ignored when the prober receives the next action command.

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM39 **ENABLE WAIT BEFORE UNLOAD**

Format: **SM39Un** n = "0" (disables)
n = "1" (enables)

Sends the chuck to the Home position after probing to wait for the operator to continue. Allows manual inspection after probing. (Only works if Auto Align and Material Handler are enabled.)

NOTE: When the <AUTO PROBE> key is pressed, the wafer will be unloaded and a new wafer will be fetched, aligned, and probed.

SM40 **ENABLE SCREEN/LAMP SAVER**
SELECT RUN TIME DISPLAY UPDATE OPTIONS

Format: SM40SnRr

n = "0" disables the screen/lamp saver
n = "1" enables the screen/lamp saver

r = "0" selects the "OFF" update mode
r = "1" selects the "NO TC UPDATE" update mode
r = "2" selects the "TC UPDATE" update mode

"OFF" disables updating during probing.

"NO TC UPDATE" will not update fields while waiting for a "TEST COMPLETE."

"TC UPDATE" (default) updates selectively while waiting for a "TEST COMPLETE."

Screen/Lamp Saver:
Switches off the screen, microscope light, and camera light when no key, joystick, or theta knob has been used for four minutes. Press <ENTER> to restore CRT display.

RUN TIME DISPLAY Update:
Selects the manner in which five items on the display are to be updated. The items are:

Good, Bad, and Ugly die counts
X,Y position
Z position
<−/−> probing direction indicator
Time

SM41 **ENABLE ENHANCED PROFILE**

Format: **SM41En** n = "0" (disables)
n = "1" (enables)

Instructs the Noncontact Edge Sensor to measure nine points on the wafer instead of the ordinary five, for greater accuracy.

SM42 **SET PROFILER RETRY COUNT**

Format: **SM42Rn** n = 0−32767

Determines the number of times the Noncontact Edge Sensor is to continue to attempt to profile a wafer after a profile failure.

In the profiling operation, the Z height of the wafer center is re−read after normal profiling has been completed. If this value does not match the first Z height reading at the wafer center, the prober will raise the sensor and retry profiling the wafer until the readings match or the retry count has been reached.

EXAMPLE: ***SM42R3*** ➧ *The NCES must continue to attempt to profile 3 times, or until the profile has successfully completed.*

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM43 **ENABLE MULTI−DIE PROBING**

Format: **SM43Rn**

n = "0" (disables)
n = "1" (enables)
n = "2" (enables multi−die probing and octal or quad probe array)

Enables/disables Multi−Die Probing, which is documented in **Section 9** of this manual.

SM44 **MULTIPLE DIE ORIENTATION**

Format: **SM44Rn**

Where 0< = n < = 10, n is the location code.

Describes the probe card orientation for Multi−Die Probing; horizontal, vertical, or diagonal.

Multi−Die Probing is documented in **Section 9** of this manual.

SM45
SM46
SM47
SM48
SM49 **RESERVED**

SM50 **ENABLE XY PROBE SCRUB**

Format: **SM50Rn** n = "0" (disables)
n = "1" (enables)

Enables/disables the scrub feature; each time the probe array is cleaned on the cleaning pad, a 1−mil octagonal motion occurs. Each probe tip is thereby scrubbed from eight different directions. Each scrub is done on a different place on the pad to minimize wear.

Use **SM12** (**SET PROBE CLEAN COUNT**) to set frequency of cleaning.

SM51 **SET HOT CHUCK DELAY**

Format: **SM51Rn** (n = 0 − 30 seconds)

Allows wafers to warm up to the set temperature on hot chuck provided by vendors other than Electroglas.

EXAMPLE: ***SM51R16*** ➧ *Sets 16−second delay.*

SM52 **SELECT EDGE INKERS**

Format: **SM52In**

Provides for the setting of any combination of inkers 1−4 as the edge die inkers.

n = 0 − Deactivates all inkers

n	Activates inkers	n	Activates inkers	n	Activates inkers
1	1	6	2 and 3	11	1, 2, and 4
2	2	7	1, 2, and 3	12	3 and 4
3	1 and 2	8	4	13	1, 3, and 4
4	3	9	1 and 4	14	2, 3, and 4
5	1 and 3	10	2 and 4	15	1, 2, 3, and 4

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM53 AUTO ALIGN THRESHOLD

Format: **SM53Tn**

n = 0 – Normal
n = 1 – Low
n = 2 – High

Sets the Q (Quality) threshold when a Cognex Vision Module is in use.

The Cognex Vision Module can adjust the Q threshold which decides how much variation in target quality is acceptable between subsequent wafers. Rarely, some pattern reference is difficult to locate on certain die. By increasing or decreasing the Q threshold, these die may successfully align when the normal Q threshold would fail.

For further explanation, see **Section 5 (AUTO ALIGN).**

SM54 SET HOT CHUCK MODEL TYPE

Format: **SM54Hn**

n = 1 – EG Hot Chuck
2 – Non–EG Hot Chuck

Provides for the use of various types of Hot Chuck models.

SM55 SET UGLY DIE BAND DEPTH

Format: **SM55Un**

n = ugly die edge width in 0.1 mm

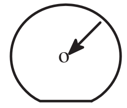
Range: From 0 to 1000 mm (radius)

Enables the ugly die function and determines the depth from the wafer's edge of the major ugly die band. All die which touch this band will be counted as ugly.

A non–zero value "n" automatically enables the function. Width is given in 0.1 increments.

EXAMPLES: ***SM55U0*** ➧ *Disables ugly die probing and sets the ugly die edge width to 0.*

SM55U25 ➧ *Sets ugly die edge width to 2.5 mm.*



SM56 SET UGLY DIE BINCODE

Format: **SM56Bn**

n = bincode

Range: Integer from 0 to 255. Default is 254.

Sets the bincode for use in ugly die inking.

Automatically sets the bincode that will be used according to the bincode–to–inker assignment table (see the **SM24** command, **ASSIGN 16 LOGICAL INK CODES**).

This bincode will also be placed into the wafer map for each ugly die processed (disk systems only).

SM57 ENABLE UGLY DIE REPORTING

Format: **SM57Un**

n = "0" (disables)
n = "1" (enables)

Reports ugly die during testing. Since ugly die are not tested, the tester would not normally receive notification of the ugly die that have been processed. This can result in a discrepancy between the prober's reported results (or a count of ink dots on a wafer) and the tester's yield reports.

Enabling ugly die reporting allows the tester to send a message for every ugly die encountered during probing.

The ugly die report consists of the string **UDXxYyBn** being transmitted for *each* ugly die processed. The "x" and "y" reports are the X and Y coordinates of the die; "n" is the bincode (from 0 to 255) assigned to the die. Note that this will be the same bincode specified by the **SM56** command. See the **UD** command, **Section 8.4.4.2.**

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM58 **SET MAP TRANSFER RETRY COUNT**

Format: **SM58Rn** n = 0 to 10

Determines how many attempts will be made to transmit a wafer map over the external I/O port before declaring a communication failure. Repeatedly re− reads the map via the described protocol. See the discussion of wafer map transfers in **Section 10 (WAFER MAPPING & SECS).**

SM59 **ENABLE TEACH DIE CORNER**

Format: **SM59Tn** n = "0" (disables)
n = "1" (enables)

Normally used only in special applications. For further explanation, see **Section 5 (AUTO ALIGN).**

Allows the host to access such information as die position and sizes. It must be enabled (and the Auto Align system must have been taught a die corner image) for the information returned by the **?B** command to be meaningful, and the `PROFILE WITH FIND CENTER` command must also be enabled.

SM60 **ENABLE AUTO THETA COMPENSATION**

Format: **SM60Tn** n = "0" (disables)
n = "1" (enables)

Allows use of probe cards without aligning the probe tips to the prober's XY coordinate system. Instead, it uses the prober's theta drive to adjust a wafer on the chucktop until it is aligned with the probe tips. The Ink Dot Inspection and Probe Mark Inspection options must be disabled (**SO** command).

If feature is disabled:
prober moves in the prober's XY coordinate system.
If feature is enabled:
the prober moves in the XY coordinate system defined by the prober−calculated TCA (theta compensation angle).

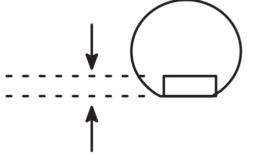
For further explanation, see **Section 5 (AUTO ALIGN).**

SM61 **SET UGLY DIE FLAT BAND DEPTH**

Format: **SM61Un** n = 0 − 1000

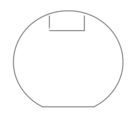
Defines the ugly die band box to be used on the flat area. The depth of the area is defined by the SEMI standard defined width of the flat, an integer in 0.1 mm increments from 0.0 to the radius of the wafer.

EXAMPLE: ***SM61U185*** ➧ *Sets ugly die flat band to 18.5 mm.*



SM62 **SET UGLY DIE 180 BAND DEPTH**

Format: **SM62Un** n = 0 − 1000



Defines the ugly die band box to be used at the edge of the wafer at 180°. The depth of the area is defined by the SEMI standard defined depth of the flat, an integer in 0.1 mm increments from 0.0 to the radius of the wafer.

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM63 SET EDGE INKING MODE

Format: **SM63En** n = "1" FIXED
n = "2" RADIAL

Selects between FIXED and RADIAL edge die inking modes when the probe mode is in wafer map follow or edit modes. (Edge die inking must be enabled to apply− **SM10**.)

- FIXED defines a fixed number of edge die beginning just after the end of the row in the wafer map and ending after the fixed count is exhausted. The number of edge die set in **SM64** determines how many die are inked.
- RADIAL defines die from just after the end of the wafer map row to the physical edge of the wafer, plus the number set in **SM64.** It takes into account the location of the die on the wafer, the die and wafer size, and the curve of the wafer, and is suitable only when a Noncontact Edge Sensor is used.

SM64 SET EDGE DIE INK COUNT

Format: **SM64En** n = 1 − 9

Determines the number of edge die to be inked in relation to **SM63.** Sets number of die steps prober will make when performing edge die inking in "fixed" mode. If "radial" mode has been selected, number will be added to inked die as specified.

SM65 ENABLE EDGE INK OVERTRAVEL

Format: **SM65En** n = "0" OFF
n = "1" ON

Determines if edge die inking will be performed with or without overtravel.

The effect of this command depends on the Z travel mode selected. If mode is Limits, no overtravel is performed and this command is meaningless. When mode is Profile, this command is fully effective. If an edge sensor is sused, this command will only be partiall effective because the Z stage must be decelerated before stopping, which requires 3 Z motor steps. Thus with a 0.5 mil Z stage, 1.5 mils of overtravel will be used even if overtravel is disabled by this command. For a 0.25 mil Z stage, 0.75 mils of overtravel will be used.

SM66 SET SKIP DIE BINCODE

Format: **SM66Sn** n = 0 − 255
(Default is 255)

Allows the user to specify a bincode to be placed into the wafer map for skipped die (die not probed due to the skipdie function). By placing skipped die bincodes into the map, the skipped die may later be offline inked along with the rest of the wafer.

Skipped die must be located in the Learn List or else they will not be inked.

SM67 ENABLE CASSETTE BEGIN/END MESSAGES

Format: **SM67Cn** n = "0" (disables)
n = "1" (enables)

Enables `BEGIN CASSETTE` (**BC**) and `END CASSETTE` (**EC**) messages. These messages (described in **Section 8.4.4.2 − Unsolicited Messages**) may be used by the tester or host to determine which cassette is currently being probed.

When this command is used to enable these messages, the prober will send a **BC** message when the first wafer is removed from a cassette. **EC** is sent when the last wafer of a cassette is returned to its origin slot.

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM68 ENABLE Z METRIC DISPLAY

Format: **SM68Zn** n = "0" (disables)
n = "1" (enables)

Allows Z−related values to be displayed on the screen as metric rather than English values.

Any Z value entered from the keyboard will be rounded to the nearest Z motor step (for example, 0.5 mil on a half mil chuck, or 12.7 um).

When Z metric display is used in step−motor travel, all Z−related values will be displayed with a single digit to the right of the decimal as "###.# um" where "um" denotes micrometers.

SM69 SET CASSETTE SLOT STATUS

Format: **SM69CmSnSt**

Sets the status of a wafer within a cassette as long as the wafer is not currently being processed. Overrides the prober's cassette mapping function.

"m"	=	Cassette Number	Ranges from 1 to the maximum cassette number (3)
"n"	=	Slot Number	Ranges from 1 to the maximum slot number (25)
"t"	=	Status Number	Values 1 (SKIP); 2 (PROBED); or 3 (UNPROBED)

SM70 SET CURRENT CASSETTE

Format: **SM70Cm**

"m" = Cassette Number

Range: From 1 to the maximum cassette number (3)

Applies only to prober systems that are using Material Handler software, PN 248317−001, REV D or later.

Selects the cassette for use by the Material Handler. The cassette number represented by "m" will be used to supply the next series of wafers for loading.

The wafers previously loaded and pending processing must be completed before the wafers of the newly selected cassette are processed.

SM71 ENABLE RESTRICTIVE Z MODE

Format: **SM71Mb** b = "0" (disables)
b = "1" (enables)

Enables/disables the restrictive Z Mode options. For special application only.

SM72 SET UNREADABLE CHARACTER

See the Supplement at the end of the section for more information about this command

Format: **SM72Du** u = ASCII character to be used (default is "*")

Determines which ASCII character is to be used by the OCR to indicate an undecipherable character.

EXAMPLE: SM72D% ➧ *Identifies "%" as the ASCII character which the ID Reader will use to indiate a character which is unreadable.*

SM73 SET SELF TEACH AUTO−ALIGN

Format: **SM73Sn** n = "0" (disables)
n = "1" (enables)

Enables/disables the Self−Teach Auto Align feature, which automates alignment reference pattern selection. The Self−Teach Auto Align feature is described in **Section 5 (AUTO ALIGN).**

8.4.1.2 SET MODE COMMANDS (continued) SETUP

SM74 SET CENTER REFERENCE

Format: **SM74Cn**

n = “0” (disables)
n = “1” (enables)

Ensures that the selection of First Die position is correct by allowing the defining of an X and Y tolerance in which First Die position may vary. Relates to commands **SM75, SM76, FD,** and **?Q.**

When using the center reference feature, it is highly recommended that the profiler’s `FIND CENTER` option be enabled (**SM20**). Center reference is explained in **Section 5 (AUTO ALIGN).**

SM75 SET DISTANCE FROM FIRST DIE TO WAFER CENTER

Format: **SM75XnYn**

Defines a unique wafer position for First Die by treating the distance as individual XY values (in mils). This command causes the prober to “recalculate” the XY distance from wafer center to First Die. This is the same calculation done by the prober when the operator presses <FIRST> and resets the XY distance.

If this command is sent after the prober has already determined the offset, the prober’s stored calculation is replaced by this one.

SM76 SET X/Y TOLERANCES

Format: **SM76XnYn**
Range: −32768 to 32767 mils

Sets the XY tolerances that are acceptable for First Die shift. (Only used in conjunction with Center Reference feature.)

SM77 RESET X/Y DISTANCE FROM CENTER REFERENCE

Format: **SM77Fn**

n = “0” − First Die position is cleared; no validation is done. A new First Die can now be stored via the <FIRST> key or **FD** command.

n = “1” − First Die position is set and cannot be changed by the <FIRST> key without causing an error. The **FD** command inherently forces this position to be set.

Resets the First Die calculation. The XY distance is recalculated the next time <FIRST> is pressed. Allows the operator to set First Die manually without causing an error. Required on the initial First Die setting and all other resets of First Die.

Pressing the <FIRST> key again without resetting the XY distance is a verification that the die under the probe tips falls within the acceptable criteria for a legal First Die.

If the die under the probes is not within the legal range for the calculated First Die, an error message is displayed. If the die selected is a legal First Die (within the tolerance range), the current die position is used as the First Die position; however, center reference data is not calculated again.

SM78 ENABLE WAFER BEGIN MESSAGE

Format: **SM78WbDn**

b = “0” (disables)
b = “1” (enables)

n = time delay for test start:
0 − 10,000 seconds

Enables the `WAFER BEGIN` message and sets the **TS** delay. The intent is to give the tester the current wafer’s ID before testing starts so it can set itself up as needed.

The **TS** time delay can only be used in conjunction with the `WAFER BEGIN` message; it is not available for other I/O messages.

EXAMPLE: ***SM78W1D15*** ➧ *Enable message; TS delay = 15 seconds.*

8.4.1.2	SET MODE COMMANDS (continued)	SETUP

Command	Description
SM79 to SM84 **RESERVED**	
SM85 **SET OFFSET OR PARALLEL DELAYED INKING** Format: **SM85Dn** n = “0” Offset inking n = “1” Parallel inking	Selects between the standard delayed offset inking or the parallel delayed inking. When parallel inking is selected, the inkers are all assigned the same delay value, with inkers 1 and 3 firing when the chuck is moving in one direction, and inkers 2 and 4 firing when the chuck is moving in the opposite direction. When either inker 1 or 2 is requested to fire, the one that fires depends upon chuck direction. Likewise, when either inker 3 or 4 is requested to fire, the chuck direction determines which inker will fire. Parallel delayed inking may be used with all inkers having the same die offset (as opposed to standard delayed inking in which inkers have a staggered offset). **NOTE:** **SM85** does *not* enable inker delay; the default is “0” − no delay (disable). **SP11** sets the inker delay.
SM86 to SM93 **RESERVED**	
SM94 **SET MANUAL CLEAN/CONTINUITY Z HEIGHT** Format: **SM94Bn** n = “0” (disables) n = “1” (enables)	Enables/disables the setting of the `CLN/CT` Z height. Allows the user to disable settings of the probe tip clean height and the continuity test height.
SM95 **AUTO ADJUST CLEAN/CONTINUITY Z HEIGHT** Format: **SM95Bn** n = “0” (disables) n = “1” (enables)	Enables/disables the automatic adjustment of the `CLN/CT` Z height. Allows the user to have the probe tip clean height and the continuity test height adjusted automatically whenever a new probe tip contact height is set. (A discussion of the Auto Adjust feature appears in **Section 6, NONCONTACT EDGE SENSOR.**)
SM96 **ALWAYS SET PPI Z HEIGHT** Format: **SM96Pn** n = “0” (disables) n = “1” (enables) (Multi−die only)	Records the XY position of the forcer as well as the Z height when the inker position is being set. If the option is disabled, Line 9 of the Post Probe Inker Setup Menu will ask for an offset down from the probing height if the Z traveling mode is autoprofile. This is only used for Multi−Die Probing.

8.4.1.2 SET MODE COMMANDS (continued) SETUP

Updated 5/14/96

SM97 SET HOT CHUCK TEMP RANGE AND RECOVER TIME

Format: **SM97TnRn**

Tn = Temperature range in degrees centigrade
Rn = Recovery time allowed, in seconds

Sets the range over which the chuck temperature can vary without causing an alarm. Also sets a time during which the hot chuck may recover to the set temperature range before an alarm condition occurs.

This allows the hot chuck to fluctuate outside of the temperature range without error for a specified time. For more details, See section 7**, Z Stage, Hot Chuck, & Temperature Compensation,** subsection **7.6.1, Hot Chuck Menu.**

Each of these items has a range from 0 to 99, and the units are 1 degree Centigrade for TEMP RANGE and 1 second for RECOVER TIME. Both of these items have a default value of 0. Therefore, if no changes are made to the menu items, there will be no apparent difference in the operation of the prober.

The range checking and recover time are only used prior to moving the forcer and only when the forcer is in the probe area. Therefore, before the prober begins probing a wafer, the prober waits for the hot chuck to reach the setpoint temperature, not just until the temperature gets into the allowed range.

SM98 SET MATERIAL HANDLER COMMUNICATIONS PARAMETERS

Format: **SM98LlBbPpDdSs**

l = the line number to set parameters for (1 through 4)

b = the baud rate.
Currently supported values are:
9 for 1200 baud
13 for 9600 baud
240 for 19200 baud
112 for 38400 baud

p = parity choice
0 = none
2 = even
1 = odd

d = number of data bits (7 or 8)

s = number of stop bits (1 or 2)

This command sets up communications parameters for any of the serial communications ports in the Material Handler. It places the information into the Handler block and sends the block to the Handler.

This is a 4085X−specific command.

SM102 PROFILE BEFORE ALIGN

Format: SM102Pb

b = 0 Disable
b = 1 Enable

Allows the operator to control the order in which the prober profiles and aligns (used in solder bump applications).

SM103 ENABLE KEEP WAFER ON PREALIGN STATION

Format: SM103Pp

p = 0 Disable
p = 1 Enable

Requires the 3001X or 4085X prober to include keeping a wafer on the prealign station as part of the pipeline.

SM104 ENABLE AUTO LIGHT ADJUST

Format: SM104Ab

b = 0 Disable
b = 1 Enable

Allows the user to compensate for differences in align lamps between the prober used for pattern training and the prober where alignment is performed.

This feature is described in Section **5, AUTO ALIGN.**

SM105 *See the Supplement at the end of the section for information about new commands* **SM105, SM110, SM111, SM115, SM116**, *and* **SM119.**

Updated 5/14/96

8.4.1.3 MISCELLANEOUS SETUP COMMANDS SETUP

COMMAND	DESCRIPTION
AD **ADD DIE TO LEARN LIST** RDP: AcGx,y Format: **ADXnYn** n = coordinate of die in the Learn List Range: −999999 to 999999	Adds the XY coordinates to the Learn List (coordinate values are die coordinates relative to First Die). Die will be probed in the Learn probe mode in the order stored in the list (or they will be skipped in another probe mode if the skipdie function is enabled). Up to 1024 coordinate points may be stored.
EXAMPLE: ADX50Y−18	*Adds the point X=50, Y=−18 to the Learn List.*
CI **CLEAR INK DOT INSPECTION SUMMARY** Format: **CIWbTb** **CM** **CLEAR PROBE MARK INSPECTION SUMMARY** Format: **CMWbTb** b = "0" − Function disabled b = "1" − All values in the summary are reset to zero	Enables the clearing of Ink Dot/Probe Mark Inspection summaries. "W" = Wafer Summary "T" = Total Summary
EXAMPLE: CMW1T0	*Clears the probe mark wafer summary but leaves the total summary unchanged.*
DA **SET DATE** Format: **DAMmDdYy** m = 1 − 12 d = 1 − 31 y = 85−99 (1985−2099)	Allows the host to set the prober's month, day, and year. Companion to **TI** (Set Prober Clock). Run Time Display is updated accordingly.
EXAMPLE: DAM3D18Y91	*March 18, 1991*
DE **DELETE DIE FROM LEARN LIST** RDP: **AcHx,y** Format: DEXnYn n = coordinate of die to delete from the Learn List Range: −999999 to 999999	Deletes die from the learn list. The learn list is searched from top to bottom for the referenced XY die coordinate, and the first occurrence is deleted. All points following the deleted coordinate point are moved up one position (so no "holes" appear in the list).
EXAMPLE: ***DEX1Y24***	*Deletes the first occurrence of the point X=1, Y=24*
DT **DELETE TRAINED PADS**	Deletes all probe mark trained pads (returning probe mark inspection to the "untrained" state).
EI **ENABLE/DISABLE INKERS** RDP: **AfAb** Format: **EIb** b = "0" (disables) b = "1" (enables)	Corresponds to <INK ENBL> key on Joystick Keyboard. If inkers are disabled, data regarding various bins will still accumulate, but wafers will not be inked unless the **IK** command is sent.

8.4.1.3 MISCELLANEOUS SETUP COMMANDS (continued) SETUP

FA **ADD SITE TO MICRO LIST**

Format: **FAXxYySn**

Range: xy = +/− 32767 XY coordinates
n = 1−126 Microsite number

Units: 0.1 mil/1 micron

Adds a die site to the micro list. Used for inter−die (parametric) testing. Adds and stores X−Y coordinates and site number. The X−Y range allows a probing area of up to 6 inches to be covered, if necessary.

Microdie may be added in any order, but they will be probed from lowest to highest site number. The **GF** command allows motion directly to a site; the **FM** command allows motion to any micro coordinate.

FD **SET FIRST DIE**

NOTE: This command changes the value of the `RESET X/Y DISTANCE` (**SM77**) but does not verify that this new die is within the X/Y tolerances set.

Sets the current motor position as the new First Die for all subsequent wafers loaded onto the chuck. This command has the same effect as pressing the <FIRST> key, even with Center Reference disabled (**SM74**).

When the center reference feature is enabled, the First Die set flag is cleared so that **FD** is always successful in setting the current motor position as the First Die position.

HS **SET HOT CHUCK SOAK TIME**

Format: **HSHbFnCnPnInBnTn**

b = Hot Chuck Soak: "0" − Disable
"1" − Enable

n = Soak Time: 0 − 1000 seconds
(default = 0 seconds)

The hot chuck soak time is the amount of time the prober should make contact with the wafer to the probe tips before sending the tester a test start (TS). This allows the probe tips to be at a constant temperature (thus angle and position are also constant), to ensure optimum tip−to−pad contact.

When the prober returns to the probing area after the associated condition, the prober waits for the specified number of seconds before issuing a test start. Each of the soak times can be set from 0 to 1000 seconds and is defaulted to 0 seconds. For more information, see section 7**, Z Stage, Hot Chuck, & Temperature Compensation.**

Fn	First Die Soak Time	**In**	IDI Soak Time
Cn	Pause/Cont Soak Time	**Bn**	Probe Clean Soak Time
Pn	PMI Soak Time	**Tn**	Probe Test Soak Time

See the Supplement at the end of the section for information about new commands **LC** *and* **LE.**

MP **MOVE TO PROBE TIP CENTER POSITION**

Moves to the previously stored position of probe tip center.

PH **SET Z PROFILE HEIGHT**

(Does not reset the continuity or cleaning pad heights, as they would be reset if the height was sent manually from the keyboard.)

Sets and stores the current Z stage height as the probe tip height (useful only when Z travel mode is set to Profile and profiler is enabled). The chuck must be under probe tips or an error message will be issued. Corresponds to key < 3 > in the Profiler Menu (accessed via the <PROG> key).

Allows the tester to determine probe/pad contact point, instead of requiring the operator to do this.

The tester must first profile the wafer with the **PZ** command, then use the **ZM** command to move the stage up a half or quarter mil at a time, depending on the Z motor resolution, performing a continuity test each time.

When tester determines that contact is made, it should issue the **PH** command to set this height as the probe tip height. This height is then used during probing as the base height to compensate for the wafer thickness and Z overtravel.

8.4.1.3 MISCELLANEOUS SETUP COMMANDS (continued) SETUP

PL **ENABLE/DISABLE PIPELINING WAFERS**

Format: **PLn** n = 0 or 1

"0" disables
"1" enables } Pipelining Switch

Refers to the process by which wafers are automatically prepared for loading; with pipelining enabled, the next two wafers are moved to the prealign station and the quickloader.

This command typically would be used at the end of a product run to turn pipelining back on after it has been turned "OFF" Some I/O commands automatically enable or disable pipelining.

PM **SET PROBE TIP CENTER POSITION**

Sets the XY position of probe tip center. Corresponds to key < 2 > from the Profiler Menu, accessed via the <PROG> key.

PN **SET PROBE TIP CLEAN POSITION**

Corresponds to key < 1 > from the Profiler Menu (<PROG> key) except that there is no confirmation requested from the operator that the probe tips will land on the cleaning pad.

PO **SET CONTINUITY TEST POSITION**

Corresponds to key < 6 > from the Profiler Menu (<PROG> key) except that there is no confirmation requested from the operator that the probe tips will land on the test pad. The current motor position as well as the current Z height are assumed to be the new continuity test position.

PP **SET CAMERA CENTER POSITION**

Sets the Auto Align camera position. Corresponds to key < 8 > from the Profiler Menu, accessed via the <PROG> key.

RC **ADD ROW TO ROW LIST/ ADD COLUMN TO ROW LIST**

RDP: **AcP / AcQ**

Format: **RCXnYnXn (AcPxf,y,x1)** – Add row to list
RCYnXnYn (AcQyf,x,y1) – Add column to list

Adds a specified row or column to the row/column list. Up to 415 rows and/or columns may be added. This is explained more fully in **Section 8.3.2.5 (Row/ Column Pattern).**

Row coordinates are stored with respect to First Die. Rows also obey settings of probe and coordinate quadrants.

RD **DEFINE "DEVICE TYPE" STRING**

RDP: **AeDs**

Format: **RDs** s = character string

NOTES: *Must* be set *before* wafer is loaded to chucktop.

Also – this is part of the ID read and is stored on the map if there is no OCR. (RD has no effect if OCR is used.)

Sets the device type to the string "s" ; used on a wafer or cassette log. This is the same as what is entered in the Run ID Menu. Up to 10 alphanumeric and special characters (only uppercase letters) are allowed as follows:

0–9	"	%	(	!
A–Z	#	&	)	
–	$	'	.	

NOTE: Do not enter a space as part of the string.

EXAMPLE: ***RDABCDE*** ➧ *Sets device type to ABCDE.*

8.4.1.3 MISCELLANEOUS SETUP COMMANDS (continued) SETUP

RF **CLEAR MICRO LIST**

Clears the microdie list. This command should be issued before adding die to the list via the FA command.

RL **DEFINE "LOT NUMBER" STRING**
RDP: AeEs

Format: **RLs** s = character string

NOTES: *Must* be set *before* wafer is loaded to chucktop.

Also − this is part of the ID read and is stored on the map if there is no OCR.

Sets the lot number to the string "s"; used on a wafer or cassette log. This is the same as what is entered in the Run ID Menu. Up to 10 alphanumeric and special characters (only uppercase letters) are allowed (see **RD** command for list).

RL has no effect if OCR is used.

NOTE: Do not enter a space as part of the string.

EXAMPLE: ***RLXY1*** ➧ *Sets the lot number to XY1.*

RR **CLEAR ROW/COLUMN LIST**
RDP: **AcO**

Deletes all entries in the row list used for the Row/Column autoprobe mode. Should be the first command sent before adding rows or columns to the list (via the **RC** command).

RS **CLEAR LEARN LIST**
RDP: **AcF**

Clears all die coordinate data stored in the learn list (used for random access probing or to designate skipped die if the skipdie function is enabled). Should be the first command sent before adding die (via the **AD** command).

SO **SET OPTIONS**
RDP: **AhAb,b,b,b**

Format: **SOnnnn[nnnnnn]** n = "0" (disables)
n = "1" (enables)

Enables/disables the major prober options (corresponds to choices in Set Option Menu).

For standard protocol, to enable Ink Dot or Probe Mark Inspection, Theta Compensation must be disabled (**SM60**).

The first 4 bits are required, the rest are optional. If omitted, the current setting is used.

The RDP protocol command includes only the first four options.

See the Supplement at the end of the section for more information about this command

Italic numbers for reference. → *1 2 3 4 5 6 7 8 9 10*

n n n n n n n n n n

```
1  MATERIAL HANDLING
2  AUTO ALIGNMENT
3  WAFER PROFILER
4  WAFER ID READER
5  SECS PROTOCOL
6  WAFER MAPPING
7  EG TC-2000 THERMAL CHUCK
8  AUTO TEMPERATURE COMPENSATION
9  INK DOT INSPECTION
10 PROBE MARK INSPECTION
```

EXAMPLE: ***SO1001011000*** ➧ *Material Handler, Wafer ID, Wafer Mapping and Thermal Chuck are enabled, Auto Align, NCES, SECS, Auto Temp Compensation, Ink Dot Inspection, and Probe Mark Inspection are disabled.*

8.4.1.3 MISCELLANEOUS SETUP COMMANDS (continued) SETUP

NOTE: When using any of the **SXn** commands to set coefficients for temperature compensation, the "FIRST" die must be set again. Also, if the **SX** command attempts to set temperature compensation values which are not changed from the previous values, an "**MC**" (successful) will be returned to the host and the *FIRST* set flag will not be cleared.

Updated 5/14/96

SX1 ENABLE TEMPERATURE COMPENSATION

Format:**SX1Bn**

n = "0" (disables)
n = "1" (enables)

Disables/enables Temperature Compensation. Expansion coefficients and temperature should be set before compensation is enabled to prevent stepping errors.

NOTE: Do not confuse with this command with Automatic Temperature Compensation.

SX2 SX3 PLATEN X/Y AXIS COEFFICIENTS OF EXPANSION

Format: **SX2Cn** (X)
SX3Cn (Y)

n = units of 1/10 ppm/C
Range: 0 − 1000

Defines the coefficients of expansion for the XY axes of the wafer.

ppm/C = parts per million per degree Celsius
(Allows entry of tenths)

EXAMPLE: ***SX2C105*** ***SX3C105*** ➧ *Sets coefficient of 10.5 ppm/C for X and Y respectively.*

SX4 SX5 WAFER X/Y AXIS COEFFICIENTS OF EXPANSION

Format: **SX4Cn** (X)
SX5Cn (Y)

n = units of 1/10 ppm/C
Range: 0 − 1000

Defines the coefficients of expansion for the XY axes of the wafer.

ppm/C = parts per million per degree Celsius
(Allows entry of tenths)

EXAMPLE: ***SX4C35*** ***SX5C35*** ➧ *Sets coefficient of 3.5 ppm/C for X and Y respectively.*

SX6 SX7 PLATEN DELTA TEMPERATURE / WAFER DELTA TEMPERATURE

Format: **SX6Tn** (Platen)
SX7Tn (Wafer)

Defines the change in temperature of the platen/wafer from the 20−degree C ambient temperature.

The temperature of the platen/wafer should not be used; instead, use the temperature minus 20 degrees.

NOTE: If the EG hot chuck is in use, the Delta T Silicon cannot be set via the **SX7Tn** command. The prober will return an **MF** and issue error message 75: `SYSTEM IS IN AUTOMATIC MODE.`

TI SET PROBER CLOCK

RDP:**AgKn,n**
Format: TIhh:mm

hh = hour, 0−23
mm = minutes, 0−59

Allows the host computer to set time−of−day clock, in hours and minutes (based on 24−hour clock). Seconds are set to 00 when this command is received.

EXAMPLE: ***TI9:15*** ➧ *The time (9:15 am) is set on the prober's Run Time Display.*

WM SEND XY COORDINATES WITH TS

Format: **WMn**

n = "0" (disables)
n = "1" (enables)

Disables/enables the current XY die coordinate reporting when the Test Start message is transmitted. The Test Start message then takes the form **TSXnYn.** When disabled, only **TS** is output. This is typically used to allow the host to create its own wafer map.

XY coordinates can be sent with all variations of the TS message (TF, TM, TA, etc.).

EXAMPLE: ***WM0*** ➧ *Disables the XY coordinate reporting.*

8.4.1.3 MISCELLANEOUS SETUP COMMANDS (continued) SETUP

WO — **WAFER MAP OPTIONS**

Format: **WOnMn** — 1st n = select (1 − 9); 2nd n = variable

Allows the tester to set up various wafer mapping parameters (see **Section 10** for details on Wafer Mapping).

SYNTAX	FUNCTION AND VARIABLE	EXPLANATION
WO1Mn	**SET WAFER MAP MODE** n = 1 − 4: 1 = Make 2 = Follow 3 = Edit 4 = Edit−Save	Defines the wafer map mode of operation.
WO2Mn	**SET WAFER MAP SOURCE** n = 1 − 3: 1 = SECS I/O port 2 = Standard External I/O port (GPIB or RS−232) 3 = Disk subsystem (with this selection, **WO3Mn** must also be set to select the drive)	Selects the source device to be used when the prober must read an existing wafer map. (Need not be set if wafer map mode is set to Make.)
WO3Mn	**SET WAFER MAP SOURCE DISK DRIVE** n = 1 − 4: 1 (Drive A) through 4 (Drive D)	Selects the drive to be used to read an existing wafer map. (Need not be set if the wafer map mode is set to Make or the source device is SECS or External I/O port.)
WO4Mn	**SET MAP DESTINATION DISK DRIVE** n = 1 − 4	Selects the drive to be used to write wafer maps. Irrelevant if the mode is Follow or if disk is not chosen as a destination device (**WO6Mb**). See **WO3Mn** for disk drive assignment.
WO5Mn	**ENABLE INKING OF UN−REPROBED DIE** n = 0 (disable) n = 1 (enable)	Determines if die that are not probed in the Edit or Save modes are inked. Irrelevant if the map mode is set to Make or Follow.

Set Map Destination Device Commands:

The map may be written to any combination of three devices (irrelevant if the map mode is set to Follow).

WO6Mn **ENABLE/DISABLE MAP WRITE TO DISK ***

WO7Mn **ENABLE/DISABLE MAP WRITE TO STANDARD EXTERNAL I/O PORT ****

WO8Mn **ENABLE/DISABLE MAP WRITE TO SECS I/O PORT**

n = 0 (disable)
n = 1 (enable)

* If disk subsystem is enabled, the individual drive must also be selected **(WO4Mn).**
** **(GPIB or RS−232)**

WO9Bn **SELECT BINCODES TO REPROBE**

n = bincode(s) 0 − 15 Determines which bincodes will be reprobed during an Edit or Edit−Save map operation.

There may be between 0 and 16 "n's" following the initial command, each defining a bincode to be reprobed. Only bins 0−15 can be explicitly reprobed. ***

EXAMPLES: **WO9Bn,n...,n** ➧ If no numbers follow the command, no die will be reprobed.
WO9B3,5,12 ➧ All die in bins 3, 5, and 12 will be reprobed. Other bins remain unchanged.

*** If bin 15 is set to be reprobed, bins 16−255 will also be reprobed.

8.4.2 ACTION COMMANDS

COMMAND	DESCRIPTION
AA **AUTO ALIGN WAFER** RDP: **AdF** **NOTES:** Auto Align must be installed. Operator must first select a target with the <FIND TARG> key and a starting die with the <FIRST> key. If First Die has not been set, the error message `FIRST DIE NOT SET (30)` will be reported. Optional format: **AAFn** n = 0 or 1 0 = Stay under camera after align 1 = Move to First Die location	Allows the host computer to start the Auto Alignment procedure when AA is enabled (**SO** command). The wafer must be on the chuck or `IGNORE VACUUM` must be enabled (**SM2**2). When alignment is complete, the forcer moves to the First Die location and the Z stage is raised according to the Z travel mode enabled at the time. An enhancement of the command **AA** allows it to accept an optional parameter for moving to First Die after a successful align. If the **AA** command is used without the parameter, the move to First Die is done after the align.
AP **ABORT PROBING** RDP: **AcM**	Stops probing immediately. Leaves the Z stage and XY motor at their current position. If microdie probing, probing stops after the last microdie site is tested.
BA **BEGIN AUTOPROBE** RDP: **AcR** Causes prober to:	Issues an autoprobe sequence; similar to pressing the <AUTO PROBE> key when the Material Handler and Auto Align are enabled (**SO** command). Do not use if probe mode is Off or External.

1. Load a wafer, if there is no wafer on the chucktop.
2. Profile the wafer, if profiling is enabled and the wafer has not been profiled.
3. Align the wafer, if it has not been aligned.
4. Move the First Die under the probe tips.
5. Raise the Z stage, issue a `TEST START` message and pulse, and probe the wafer according to the current probe pattern.
6. After the last die has been tested, the wafer will be unloaded and the cycle will be repeated starting at Step 1.

NOTES: If a wafer that *has* been probed is still on the chuck when the command is executed, the prober will enter the cycle at Step 2 and reprobe the wafer.

If Autoprobe is attempted and inspection is enabled but not ready, probing will be prevented and the following messages will be displayed:

Ink Dot Inspection – `INK DOT INSPECTION NOT TRAINED (178) or`
`UN-INKED BACKGROUND NOT TRAINED (191)`

Probe Mark Inspection – `NO PADS TRAINED! (182) or`
`RETRAIN FIRST PAD (184)`

COMMAND	DESCRIPTION
CB **CLEAR PRINTER DATA BUFFER** RDP: **AeF**	Forces the prober to delete all stored information concerning wafer and cassette logs. The device type and run/lot strings in the Run ID Menu are not affected, but all stored numeric data (total die tested, number good, etc.) is replaced with zeros.
CE **CLEAR BUZZER AND MESSAGE** RDP: **AgM**	Silences the buzzer after an error (like the <PAUSE/CONT> key) and clears any error code in the prober. Also clears messages off the screen and turns off alarm light.

8.4.2 ACTION COMMANDS (continued)

CL **LOAD CASSETTE**

Format: CLn n = 1 = enable loading
0 = disable loading

This command allows you to operate your own cassette loader.

Prober software PN 249799 REV DB (or greater) and handler software PN 248317−001 (3001X/4085X), at REV HC or greater, are required for this feature.

A possible sequence of host−initiated events for loading would be:

1. Issue Cassette Load enable command via external I/O to enable sensing of cassettes.

2. Load cassette via host's external loader (check status with **?MD0S0**).

3. Issue the Cassette Load disable command to cause the handler to re−map the cassette(s) which have been inserted (check status with **?MD**).

To accomplish this, enable the **CL** command. This causes the handler to enter the "CASSETTE LOAD" state in which the changes in cassette status are monitored. When disabled, the handler will return to its normal wafer processing state.

This feature assumes you wish to load cassettes without actually sliding the cassette cover open and closed. This can be accomplished by removing the cover and attaching a magnet to the Cover Closed Sensor; this puts the sensor in the "closed" state to allow normal wafer handling. The Cover Open Sensor must read TRUE to complete power−up initialization of the handler.

The handler will not monitor the Cover Open Sensor but will immediately move the transfer arm to the idle position, leave the cassette platform in the level non−tilted position, and enable the sensing of cassettes. In the Cassette Load state, no action commands (such as wafer transfer) are accepted. If the transition to the Cassette Load state is successful, **MC** will be returned to the host.

When the Cassette Load disable request, **CL0**, is received, the handler discontinues sensing of cassette status and begins to map any cassettes which have changed. If the handler is already in the requested state, **MC** (success) will be returned. If **CL1** comes in while the handler is mapping a cassette, the handler suspends mapping and then goes to the cassette load state. (**MC** is returned to the host.)

When **MF** is returned, the prober will display one of the following messages:

```
 98   HANDLER ERROR RECOV IN PROGRESS
 99   HANDLER DIAGNOSTICS IN PROGRESS
106   WAITING FOR HANDLER TO COMPLETE
119   * EMERGENCY HANDLER STOP
123   FEATURE NOT SUPPORTED BY HANDLER
128   OPTION NOT ENABLED
166   HANDLER HARDWARE NOT INSTALLED
268   ID READ IN PROGRESS
```

The message number is available via the **?E** request. For the XIO alarm message, 119, "A119" will also be sent to the host when this message is displayed (if "ALARM MESSAGES" is enabled).

RESTRICTIONS

1. It is the responsibility of the host to ensure that all wafers have been processed and returned to the cassette before changing the cassette. Otherwise, wafers left on handler stations are designated "orphan wafers" and the handler will attempt to put these on the hold (inspection) station.

2. The host must not attempt to load/unload when the handler is in the normal wafer processing (Cassette Load disabled) state. Otherwise, a collision with the transfer arm may occur.

3. Autoprobing should not be allowed to attempt a wafer unload during the Cassette Load state. Autoprobing may be paused (**PA** command) to prevent this.

8.4.2 ACTION COMMANDS (continued)

CP **CLEAN PROBE TIPS**
RDP: **AgG**

NOTE: If Z stage is in any position other than Up prior to clean command (Z Down or set via a Z−move command), it will be left at 200 mils.

Causes the prober to clean the probe tips. The probe clean XYZ position is set up in the Profiler Menu (<PROG> key, <1>). The position is saved temporarily and the Z stage drops to 200 mils. The enabled routine − either clean count (**SM12**) or scrub (**SM50**) − is executed.

After the probes are cleaned, the former XYZ position, is restored.

CT **PERFORM CONTINUITY TEST**

The chuck is lowered before the move and raised after the move.

When the test is complete, the tester issues a TCc command.

Causes the prober to perform a continuity test with the probe tips. The probe test XYZ position is set up in the Profiler Menu (<PROG> key, <6>). The position is saved temporarily and the Z stage drops to 200 mils. A bincode (“c”) of 0 indicates the test passed. Any non−zero bincode aborts probing with a `CONTINUITY TEST FAIL` message.

When probing in Edge Sense Mode if a wafer is not under the probe tips, Z down movements will go to the Z Down limit rather than moving down only the clearance distance. This prevents probe card damage when using the command sequence **CT MM.** During a **CT** operation, the **MM** command will use the current XY position as the move reference point rather than the previous XY position from which the **CT** command was issued.

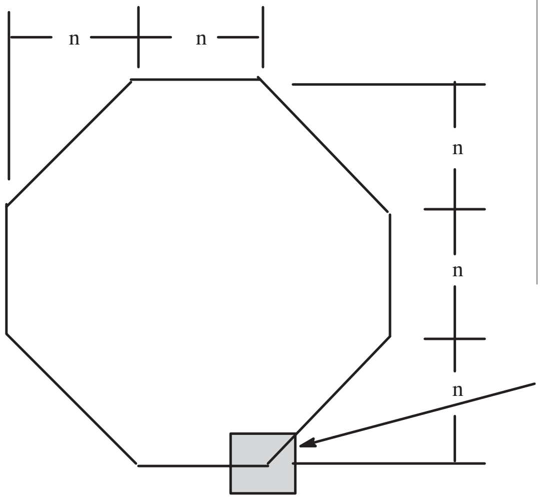
The **CT** command tells the prober to move to the preset XYZ on the continuity pad. This allows the host to determine whether or not the probe tips are functioning. This is the recommended and only supported use of the **CT** command.

The prober then sends out a **TS** (or **TP** if enhanced TS is enabled); the tester performs a continuity test and returns a **TC0** (for pass) or **TC1** (for fail − any non−zero bincode).

CW **CLEAN PROBES WITH SPECIAL WAFER**

Format: **CWOmSn**

“m” = Overdrive amount (range 0 − 10 mils)
“n” = Octagon Segment Size (range −500 to +500 mils)



Causes the prober to clean the probe tips on a specially supplied wafer. Used to move Z up by the overdrive amount and is an octagon pattern using the passed octagon segment size.

Before issuing the command, the special cleaning wafer must be loaded and placed below the probe tips. The host machine is responsible for placing the cleaning wafer under the probe tips at the required position.

Negative values can be used as octagon segment sizes to allow probe tip cleaning in the reverse direction (*counterclockwise*). Positive values allow for probe tip cleaning in the *clockwise* direction. The pattern shown at the left will be used in both directions.

8.4.2 ACTION COMMANDS (continued)

DD — DELETE PRODUCT FILE FROM DISK

Format: **DDs** s = ASCII string containing the product name

Erases the specified product file from one of the prober's disk drives. If a disk drive specifier is not used, the current setting in the Disk Menu is the default (or the specifier used with the **SD** command). A drive specifier is only needed to override the last drive setting.

EXAMPLES: ***DDA:WAFER1*** ➧ *Erase file "WAFER1" from Drive A:.*
DDWAFER1 ➧ *Erase file "WAFER1" from current drive.*

In this example, all product files called "WAFER1" are erased from Drive A: The drive specifier "A" is only necessary if the current specifier is something other than Drive A: Note that the colon is used to separate the drive letter from the file name. The file name is from 1 to 8 characters; the current default file name, as displayed in the Disk Utility Menu, is now updated to be the name of this file.

DM — DELETE MAP FROM PROBER DISK

Format: **DMcIi** c = drive letter (A – D)
i = wafer ID string (1 to 27 characters)

Deletes a map from the prober disk; identifies the drive where the map is stored and the wafer ID as returned by the **LM** action command. The prober returns **MC** after file is deleted, **MF** if file cannot be deleted.

If multiple copies exist (of the same ID), will only erase the latest copy.

ET — MULTIPLE DIE TEST COMPLETE

See the **TC** Action Command.

EW — GENERATE END OF WAFER PULSE ON TESTER I/F

RDP: **AgC**

Assumes a connection on standard I/O port and tester interface port.

Causes the 1 millisecond end of wafer pulse to be generated on the tester interface connector J403 pin 8. It does not cause the wafer to be unloaded. **EW** can be used by the host computer to cause a tester to generate a wafer summary.

FC — MICRO TEST COMPLETE

Format: **FCn**

Range: 0 to 9, ":", ";", "<", "=", ">", "?" — n = a single ASCII character from 0 to "?" (hex 30 to 3F) corresponding to bins 0 through 15

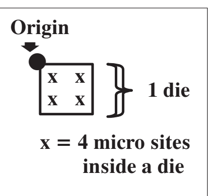
See table for **SM52** command. Use of ASCII equivalents is required.

EXAMPLES: ***FC?*** *will fire the inkers that are associated with bincode 15*
FC: *will fire the inkers that are associated with bincode 10*

Indicates to the prober that a microdie test has been completed. Only after the last microdie site has been tested for a die will the prober ink that die and increment the counters. The inker will fire based upon the binning for the last microdie site tested.

If the micro list has been exhausted, the prober will step to the first micro site in the next whole die specified by the current auto probe mode.

If the auto probe mode is also exhausted, the wafer will be unloaded.



8.4.2 ACTION COMMANDS (continued)

FM **MOVE MICRO COORDINATES**

Format: **FMXxYy**
Range: −32768 − 32767
Units: 0.1 mil/1 micron

NOTE: Both positive and negative numbers may be used. Positive X always moves the forcer to the left, positive Y towards the front of the platen.

Specifies an absolute movement to a specific micro coordinate position. The chuck moves to position XY, relative to the current microdie origin (the top left corner of the macro die).

Crossing die boundries is OK. The micro coordinates do not have to be in the micro list.

Origin
x x
x x
1 die
x = 4 micro sites inside a die

GF **GO TO MICRO SITE**

Format: **GFn** n = microsite number
Range: 1 − 126

Causes the forcer to move site "n" under the probes. If no site "n" was defined by the operator or by the `MICRO ADD` command (**FA**), the chuck will move to the site of micro origin (top left corner of original macro die).

HO **MOVE MOTOR TO HOME POSITION**

RDP: **AdH**

Moves the Z stage to a height of 200 mils and the forcer to the Home position (lower right corner of the platen). Typically used to allow an operator to manually inspect or unload a wafer.

HW **HANDLE WAFER**

RDP: **AcS**

Two other formats are supported:

HWRn / HWDnSnRn n = number

R = unload reason code (0, 3−4)
D = destination device # (0−4, 9−10)
S = destination slot # (1−25)

Performs all wafer handling functions (except probing) normally done automatically in the autoprobe cycle when Material Handling and Auto Align are enabled.

When the **HW** command is sent, the next wafer in sequence will then be profiled (if enabled) and aligned and the first die placed under the probes.

If First Die is not set when the command is issued, the prober will respond with **MF** (if **MF/MC** category is enabled) after completing the autoalign process.

Device addresses and reason codes are listed with the Handler Specifics, beginning on the following page.

The **HW** command may be used without specifying any parameters, in which case the unload reason defaults to `PROBED` when probe mode is External or Off, or `UNPROBED` for any other probe mode.

HWRn may be used to specify an unload reason and to unload the wafer back into its original location.

Added 5/14/96 per Prober Vision Software REV DB

When a load is commanded by **HW**, the prober determines the state of the handler before attempting the load by requesting a system status command (0x01). To support this, two more handler system status responses have been added to the system status request command:

```
08  00  HANDLER IS IN RECOVERY
09  00  HANDLER IS IN DIAGNOSTIC
```

Also, the system offers an additional choice to abort unloading the wafer from the chucktop while in the "recovery" process. The message is:

```
UNLOAD WAFER FROM PROBER OR PRESS "Y" TO ABORT.
```

If the handler is in the pipeline mode, unload reason 7 `(UNPROBED)` is displayed on the screen as `SKIP.` If the pipeline is turned off, then `UNPROBED` is displayed. In all cases, wafer pipelining is turned on after the new wafer is loaded.

EXAMPLES: ***HWD3S9R0*** ➧ *Unload this wafer to cassette 3, slot 9, normal unload (R0 = no failure).*

HWR3 ➧ *Unload this wafer to the cassette it came from and set the status to "AA FAIL".*

8.4.2 ACTION COMMANDS (continued)

SPECIFICS FOR RANDOM ACCESS MATERIAL HANDLER

Device Addresses

Each place in the handler where a wafer may reside is identified by a unique address. The form of addresses used in external I/O commands is **DnSn,** where **Dn** is the cassette or device number, and **Sn** is the cassette slot or a specific piece of information concerning the device. Device addresses are:

Device Addresses

−1	Immediate Probe	10	Hold Station	14	Correlation Tray 1
0	Origin	11	Quickloader	15	Correlation Tray 2
1 − 4	Cassette #1 − #4	12	Chucktop		
9	Prealigner	13	Transfer Arm		

Load and Unload refer to transfers to and from the chucktop. The slot number is 0 if a cassette is not involved. Device and slot 0 may also be used as a destination when the specific address is unknown. For example, a wafer on the chuck may be sent to the hold station and then later transferred to its origin (**D0S0**). This is useful when the origin of the wafer is unknown to the tester.

Pipelining

The handler operates in a sequential mode, always keeping wafers in the pipeline (the prealigner and quick loader).

Pipelining is the concept whereby the material handler always has the next two available wafers ready for probing. While one wafer is being tested, the next wafer is waiting on the quickloader (after the ID has been read, if applicable) and the third wafer to be probed is on the prealigner.

This queuing up of wafers ensures the fastest throughput and allows probing to continue while the handler is busy stacking up wafers to be processed. This is the normal state of the prober/handler. All prober I/O is optimized with pipelining in mind.

By disabling pipelining, the user has access to the non−sequential access feature of the Material Handler. Since the prober is now waiting for the host to tell it which wafer to pick up next, it will not be able to stack up wafers to be processed.

This process is slower, but provides the flexibility to allow the host to rearrange wafers in cassettes. This is often used to sort wafers of similar yields into one cassette, or to load wafers for probing in an order chosen by the host at test time. Use the **PG (Put and Get Wafer)** command to move wafers between slots and/or between the handler and prober. **PG** also provides an unload reason code similar to **UW (Unload Wafer to Specified Destination).**

Be aware that most commands enable pipelining after execution. To keep pipelining off, use **PG**, **UW** and **MW**.

8.4.2 ACTION COMMANDS (continued)

Other Handler Command Specifics

The commands **HW (Handle Wafer), LO (Unload Wafer and Load New Wafer)**, and **UL (Unload Wafer)** do not specify origins and destinations for wafers. These commands will always unload a wafer to its origin slot, and will always fetch the next wafer in the sequence for loading to the chucktop. When one of these commands is received, the prober will send a command to the handler to resume pipelining; pipelining is resumed regardless of the success of the load or unload of the wafer.

For tester driven operation, it is necessary to suspend this automatic pipeline operation since the tester may want to specify the next wafer in sequence for loading.

When the prober receives one of the commands **MW (Move Wafer from Source to Destination), PG (Put and Get Wafer), PW (Prepare Specific Wafer for Loading),** or **UW (Unload Wafer to Specified Destination),** it will send a command to the handler to suspend pipelining. All wafer handling then becomes the direct responsibility of the tester. In addition, it is necessary for the prober to command the handler to resume pipelining whenever the
< LOAD > or < AUTO PROBE > keys are used to cause automatic loading or unloading.

Reason Code

Several commands include a reason code letter (**Rn**) in their formats. The "n" represents the number for one of the reasons listed below:

Reason Codes

0	= normal (probed)	3	= align fail	6	= unknown wafer
1	= prealign fail	4	= profile fail	7	= unprobed (if pipelining is Off); or skip (if pipelining is On)
2	= ID read fail	5	= unprobed wafer		

Variable Defaulting

The defaulting of global prober−handler variables (wafer unload reason, pipelining state, etc.) is only done on prober power−up. This avoids the unloaded wafer status from being changed to `UNPROBED` after a **DS (Download Setup Data)** command.

Prober−handler communication initialization and transfer of the setup block to the handler occurs only at the following times:

a) Prober power on with autoload enabled (read from battery−backed RAM or default file)

b) Autoload enabled via menu or XIO

c) Setup downloaded with autoload set to enabled (via XIO or disk file load)

8.4.2 ACTION COMMANDS (continued)

ID **REQUEST PROBER ID AND S/W REVISION**
RDP: **CD**

Returns a text string identifying the prober for both standard and special applications.

Format returned: ppppp.rr.nnnnnn−vvv

ppppp identifies prober model (2001X, 2010X, 3001X, 4085X)

rr identifies revision letter(s) of the software. The first character is the major revision level and is always lowercase. The second will be either a space or alphanumeric character. A space identifies the software as a major release; an alphanumeric character identifies “minor−release” software released to fix bugs only.

nnnnnn Software part number. Common SW PN is 248899, Prober Vision SW PN is 249799.

vvv Software version number:

- 001 – EG standard PROM−based software
- 101 – EG standard disk−based software
- 021 – 68020 PROM
- 121 – 68020 disk
- 122 – 68020 RTM

EXAMPLE: ***2001X.a.248899−001*** ➧ *Indicates to the host that the prober is a 2001X, major revision level “A”, common base software (248899), EG standard PROM−based (−001).*

NOTE: If the 4085X model is unable to establish prober−to−handler communication, the ID string will report “3001X”. After communication has been established, the prober will correctly report “4085X”.

IK **INK DEVICE**
RDP: **AgHc**
Format: **IKc** c = bincode

Fires any inker(s) assigned to the bincode “c”. The table lists the standard bincode−to−inker assignment.

BINCODE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inker 1	N	X		X		X		X		X		X		X		X
Inker 2	O		X	X			X	X			X	X			X	X
Inker 3	N				X	X	X	X					X	X	X	X
Inker 4	E								X	X	X	X	X	X	X	X

} default settings

NOTES: The bincode table can be changed by Set Mode Menu Line 10 (Assign Logical Ink Code) or the **SM24** command.

This command allows the inkers to be fired through External I/O even if the Ink Option is disabled (command **EI**).

Any bin > 15 gets the inkers that were assigned to bin 15.

EXAMPLE: ***IK5*** ➧ *Fires inkers 1 and 3.*

8.4.2 ACTION COMMANDS (continued)

IN **INSPECT INK DOT**

Format: **INXnYn** n = whole die offsets

IP **INSPECT PROBE MARK**

Format: **IPXnYn** n = whole die offsets

Range: −999 to 999

To inspect the die currently under the probe tips, the displayed X and Y values (the same X and Y values returned from the **?P** command) would be used for the **IN** and **IP** commands.

> For details of the Ink Dot Inspection feature, see **Section** 11 of this manual.
>
> For details of the Probe Mark Inspection feature, see **Section** 12 of this manual.

Inspects die XY. The die to be inspected is given in X and Y whole die offsets (both positive and negative) from the 0,0 location. 0,0 is determined by the First Die position and the preset values. The die must be physically capable of being moved under the camera or else the command will fail.

The die specified is moved to the camera and inspected for:

IN – An ink dot using the trained reference dot and position
IP – Probe marks on all pad positions.

After the inspection, the chuck is returned to its original position. The wafer and total inspection summaries are updated. (Enabled failures will increment the fail counters as in inspections during probing.)

NOTE: The prober does not allow RDP communication during the inspection process; it will send the host a `NAK` message.

The current Coordinate Quadrant affects the sign of the offset values, as it does with all XY moves.

EXAMPLES: ***INX2Y−4*** ➧ *(Coordinate Quadrant 3) The die that is offset 2 die to the right (in X) and 4 die down (in Y) from 0,0 is inspected.*

INX0Y0 ➧ *(Presets 0,0) First Die (defined as the reference die, the die under the probe tips when the operator presses the <FIRST> key) is inspected.*

See the Supplement at the end of the section for information about new command **IPX.**

LA **ILLUMINATORS ON / OFF**
RDP: **AgFb**

Format: **LAn** n = 0 "OFF"
n = 1 "ON"

Allows both the microscope and the alignment camera lamps to be simultaneously turned on or off.

LF **LOAD PRODUCT FILE(S) FROM DISK**

Format: **LFs** "s" = ASCII string containing the product name (1−27 characters)

Loads a product file from disk to memory. The syntax is the same as the DD command in that the drive specifier is optional.

RDP: **AK** (See **Section 8.5, RDP Protocol**, for details)

EXAMPLES: ***LFB:WAFER1*** ➧ *Load file from disk B:.*

LFWAFER1 ➧ *Load file from current disk.*

AKB:WAFER1 ➧ *RDP equivalent command, load file from disk B:.*

In this example, all product files called "WAFER1" are loaded from Drive B:. The drive specifier "B:" is only necessary if the current specifier is something other than Drive B:. Note that the colon is used to separate the drive letter from the file name. The current file name in the Disk Utility Menu is updated to the name of this latest file load ("WAFER1"). The drive letter is also updated.

8.4.2 ACTION COMMANDS (continued)

LI — **LOWER RETRACTABLE INKER**

Lowers a special articulated inker. (Use **RI** to raise it for probing.)

LM — **LIST MAPS STORED ON DISK**

Format: **LMc** c = drive letter (A − D)

Returns a list of wafer ID strings for maps stored on the disk drive specified.

The prober responds with the ID of the first map stored and waits for a terminator character(s), if serial, from the tester to send the next ID. When all IDs have been sent, the prober waits for a terminator and then sends the **MC** message. If no maps are stored on disk, the prober responds with an immediate **MC.** (If GPIB, use normal SRQ/serial poll sequence).

The selectable terminator(s) is represented by <t> in the following example. Terminators are set in the Enhanced I/O Menu.

EXAMPLE: LMA

Prober	Tester	Comments
	LMA <t>	Request maps on drive “A”
abc12301 <t>		Prober sends 1st map ID
	<t>	Tester sends terminator (if serial)
abc12302 <t>		Prober sends second map ID
	<t>	Tester sends terminator (if serial)
MC <t>		No more map IDs left

LO — **UNLOAD WAFER AND LOAD NEW WAFER**

RDP: **AdD**

Triggers the unloading of a wafer (if any) from the chuck and loading of next wafer.

Prober moves to load/unload position where the wafer is picked up by the transfer arm to be returned to its origin slot/cassette. The operator then presses <AUTO PROBE>.

Handler wafer pipelining is turned on regardless of the success of the load or unload of the wafer.

When a load is commanded by the < LOAD > key, the external I/O **LO** or **HW** command, or during auto−probing, the prober now determines the state of the handler before attempting the load by requesting a system status command. To support this, two more handler system status responses have been added to the system status request command:

```
08 00        HANDLER IS IN RECOVERY
09 00        HANDLER IS IN DIAGNOSTIC
```

Also, the system offers an additional choice to abort unloading the wafer from the chucktop while in the “recovery” process. The message has been changed to:

```
UNLOAD WAFER FROM PROBER OR PRESS "Y" TO ABORT.
```

See the information entitled **Specifics for Random Access Material Handler** on the page following the **HW** action command.

8.4.2 ACTION COMMANDS (continued)

LP **PRINT STORED DATA**

RDP: **AeGn**

Format: **LPn**

n = "0" – cassette log
n = "1" – wafer log

Prints a wafer or cassette log; does not modify the log data. The stored data is not cleared after printing, and the current wafer number is not changed. Printer must be installed on prober beforehand.

The type of data printed depends on the setting of **SM20** (**SET PRINTER FORMAT**).

EXAMPLE: ***LPO*** ➧ *Prints out cassette log.*

Updated 5/14/96

MA **MOVE ABSOLUTE**

Format: MAXnYn n = The specified position in 0.1 mil (English) or 2.5 microns (metric). Whole numbers only (same as **MM** command).

Moves the forcer to a specified motor step (0.1 mil) position.

The range of n is from 0 to the dimension of the platen, plus an additional "virtual zone." Within the virtual zone, the prober will calculate the position, but because it is out of the platen, it cannot move the forcer to this location.

Attempts to move the forcer past the end of the platen dimensions result in error message #38, "X-Y OUT OF PLATEN."

The dimensions of the platens with which Prober Vision software operates are:

3001/4085 Standard	X 91350	Y 192750	units in 0.1 mil steps

The "virtual zone" extends the platen dimensions in both directions by 150000 0.1 mil steps.

The **MA** command always moves to the absolute destination specified, even if Theta Compensation is enabled. After an **MA** move, **?H** will always give the current location which was the destination specified in the **MA** command.

See the supplement at the end of the section for more information about MD commands

MD **MOVE RELATIVE IN DIE STEPS**

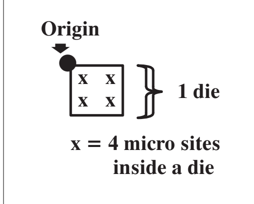
RDP: **ADIx,y**

Format: **MdXnYn** n = XY die coordinates
Range −999999 to 999999

NOTE: Both positive and negative coordinates can be used.

Causes the forcer to step X die positions in the X axis and Y die positions in the Y axis, relative to the current position in XY die coordinates. If the Z stage is up prior to motion, it will be lowered before moving and raised once XY travel is complete.

All relative moves are based on First Die and probe quadrant selected.



WARNING!

If microprobing is used, do *not* use this command to index to the next die site without returning to the micro origin. Return to the origin position of the current die before sending either **MD** or **MO** (typically done in External probe mode).

EXAMPLE: ***MDX3Y1*** ➧ *Moves forcer 3 die in the positive X direction and 1 die in the positive Y direction from the current position.*

8.4.2 ACTION COMMANDS (continued)

ME **DISPLAY MESSAGE ON CRT**
RDP: **AgB**

Format: **MEs** s = <message string>

NOTE: The display screen is 32 characters wide. Componse message carefully to avoid awkward word splits.

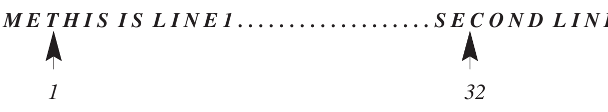
Carriage return or line feed may not be used to move the cursor to the left side of the screen or the next line. Use spaces to write on second message line.

Displays a message of up to 64 characters in two lines on the screen. Uppercase letters only. The bell character (hex 07) can be included anywhere in the message string, to provide an audible beep accompany– ing the message and to turn on the optional light pole attached to the prober. The light will go on and stay on until the operator resets the light.

EXAMPLES:

MEABCDE ➧ *Displays ABCDE on Line 1*

M E T H I S I S L I N E 1 . . . . S E C O N D L I N E *(spaces added for clarity)*



"SECOND LINE" will appear on the second line.

MF **MOVE TO FIRST (PRESET) POSITION**
RDP: **AdG**

NOTE: Do not confuse with Message Failed (**MF**) message. **MF** from the host is a command; **MF** from the prober is a message.

Moves the forcer to the predefined first die location.

If the first die location has not been set by the setup command **FD** (**SET FIRST DIE**) or <FIRST> key, no motion will occur.

First Die is reset on each Find Target operation.

MM **MOVE RELATIVE IN MACHINE STEPS**
RDP: **AdJx,y**

Format: **MMXnYn** n = specified distance, as described
Range: −999999 to 999999

Harbor position is X0,Y0.

The chuck is lowered before the move and raised after the move.

NOTE: Both positive and negative numbers may be used. Positive X always moves the forcer to the left, positive Y towards the rear of the platen.

Allows the host to move a specified distance relative to the current position in machine coordinates of 0.1 mil/2.5 microns in each axis.

If **MM** is used to step from microdie to microdie during autoprobing, the user must move the forcer back to the original point before issuing an end of test signal or command (otherwise you won't be on a whole die site).

IMPORTANT

Before using the command sequence **CT MM,** read the information given for the **CT** command earlier in this section.

8.4.2 ACTION COMMANDS (continued)

MO **MOVE IN ABSOLUTE DIE STEPS**

RDP: **AdAx,y**

Format: **MOXnYn** n = absolute die coordinate values in units of die size

Range: −999999 to 999999

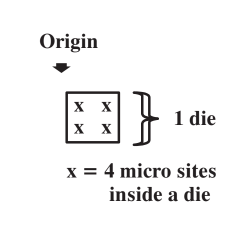
NOTE: Attempted moves to positions beyond table area will result in an `XY OUT OF PLATEN` error. All forward motion will stop once this message is reported.

Moves the forcer to absolute die coordinate XY (in whole die steps only). If the Z stage is in the up position prior to movement, it is lowered then raised once the XY movement is completed.

Obeys coordinate system set by **SM2 (SET PROBE QUADRANT).**

WARNING!

If microprobing is used, do *not* use this command to index to the next die site without returning to the micro origin. Return to the origin position of the current die before sending either **MD** or **MO** (typically done in External probe mode).



EXAMPLE: ***MOX253Y−922*** ➧ *Moves the forcer to X=253, Y=−922.*

MS **REQUEST STORED MAP SEND**

Format: **MScLi**

c = drive letter (A − D)

i = wafer ID string (1−27 characters)

Requests the prober to send a map with ID string "i" stored on disk drive "c" to external host. Map is identified as in the action command **DM** with **MC/MF** returned in the same manner. After the **MC** message is sent, the prober initiates transmission with the **MR** unsolicited message.

MT **MOVE THETA**

Format: **MTn**

Range: −7603 to 7603 n = motor steps

Allows rotation of the chuck theta. The rotation amount "n" is a relative number from current theta position. (**MT1** rotates one [1] motor step clockwise, not to step number 1.) See **?T** (**Section 8.4.3.1 − Query and Response**).

8.4.2 ACTION COMMANDS (continued)

MW **MOVE WAFER FROM SOURCE TO DESTINATION (4085X)**

Format: **MWDn $_1$ Sn$_1$Dn $_2$ Sn$_2$** n = number

Dn $_1$ = source device code (1–4, 9–11, 14–15)
Sn $_1$ = slot number (1–25)
Dn $_2$ = destination device code (0–4, 9–12, 14–15)
Sn $_2$ = slot number (1–25)

Causes wafers to be moved around inside the handler; wafer in device "Dn$_1$/ Sn$_1$ " is moved to device "Dn $_2$/ Sn $_2$." (Moves from slot to slot are not allowed.) Pipelining is automatically disabled, equivalent to sending **PL0.**

NOTE! To use this command properly, the wafer destination must be vacant. Use **?M** to verify this beforehand.

*For device addresses, see listings included in the information entitled **Specifics for Random Access Material Handler** on the page following the **HW** command.*

This command will move wafers *to* the chucktop. It cannot be used to move wafers *from* the chucktop (use **PG** command instead).

Direct moves between cassette slots are not supported. Rather, wafers must be moved from a cassette slot to another station (such as prealigner or hold station), and then to the destination cassette slot. Therefore, cassette–to–cassette moves require two **MW** commands.

EXAMPLES (spaces added for clarity):

MW D4S6 D10S0	Moves a wafer from cassette 4, slot 6 (**D4S6**) to hold station (**D10S0).**
MW D3S14 D10S0	Moves a wafer from cassette 3, slot 14 (**D3S14**) to the hold station (**D10S0).**
MW D1S6 D12S0	Moves a wafer from cassette 1, slot 6, to the chucktop.
MW D11S0 D0S0	Moves a wafer from the quick loader (**D11S0**) and returns it to its "origin." Note that device 0 (**D0S0**) may be used when the destination is not known to the host. For example, a wafer on the prealigner may be sent to the hold station and then later transferred to its "origin" without the host having to know where the wafer came from. Because the handler mapped the wafers originally, it knows the locations of those wafers at all times (assuming one was not incorrectly removed from the system).
MW D1S14 D10S0 *and* *MW D10S0 D3S1*	Shows how a wafer is moved from one cassette to another. The hold station (**D10S0**) is used as an intermediary since a wafer cannot be directly moved between slots. This wafer was moved from cassette 1, slot 14 (**D1S14**) to cassette 3, slot 1 (**D3S1**).

To move wafers from the probing area (the chucktop) to the handler and back without enabling pipelining, use the **PG** or **UW** commands. Any of the automatic handling commands (such as **HW, LO, BA**) will cause the pipeline to be filled starting with the wafer that followed the one before the MW was sent. For example, if wafers were being automatically loaded sequentially (implying pipelining was enabled) from cassette 1, and an **MW** was sent to interrupt the pipeline to load a wafer from cassette 4, cassette 1 will continue to be the current cassette when pipelining is resumed. This could be changed if the current cassette is changed (**SM70** command).

Since pipelining is disabled and the user is responsible for telling the prober which wafer to pick up, the prober will not automatically fetch the next wafer to be probed. If the user wants to re–start the automatic wafer cycling sequence of the prober, **PL1** should be sent to enable pipelining again (or send an automatic command such as **HW, LO, BA).**

8.4.2 ACTION COMMANDS (continued)

PA **PAUSE/CONTINUE PROBING**
RDP: **AcN**

Pauses probing and moves the Z stage down. When the **PA** command is entered a second time, probing resumes. Pressing <PAUSE/CONT> has the same effect. If Pause/Continue messaging is enabled, **CO** is returned when probing is resumed.

PC **EDGE PROFILE WAFER**
RDP: **AgJ**

Obsolete. Use **PZ** command instead.

PG **PUT AND GET WAFER**

Format: **PGDn $_1$ Sn$_1$ Dn $_2$ Sn$_2$ Rn** n = number

Dn $_1$ = source device code (1−4, 9−11, 14−15)
Sn $_1$ = slot number (1−25)
Dn $_2$ = destination device code (0−4, 9−11, 14−15)
Sn $_2$ = slot number
Rn = unload reason (0, 3−4)

*For device addresses and reason codes, see listings included in the information entitled **Specifics for Random Access Material Handler** on the page following the **HW** command.*

Moves a wafer from and to the chucktop. The source is the location of the new wafer; the destination applies to the wafer currently on the chucktop. All stations between the source and chucktop (that is, the prealign and quickloader stations) must be empty. Pipelining is automatically disabled.

The wafer on the chucktop is unloaded to the destination device with the status supplied by the reason code. The souce wafer is then transferred to the prealign station where it is prealigned and the ID read (if the reader is enabled and the reading has not already been done). Next, the wafer is placed onto the quickloader, where it is then transferred to the chucktop.

EXAMPLES (spaces added for clarity):

PG D4S7 D4S6R0 ➧ Unload current wafer to cassette 4, slot 6 (it has been probed − thus, **R0**). Get next wafer from cassette 4, slot 7.

PG D2S7 D0S0 R3 ➧ Moves the wafer on the chucktop back to its original location (**D0S0**) and fetches a new wafer from cassette 2, slot 7 (**D2S7).** The wafer that was on the chucktop was unloaded due to an autoalign fail **(R3).** This next wafer (from cassette 2, slot 7) is moved to the prealigner and quick loader as usual, before being loaded to the chucktop. If the ID reader is enabled, the wafer ID will be read, too. It is assumed that the prealigner and quickloader are available to receive this new wafer.

Note that the origin device (**D0S0**), may be used when the destination is not known by the host. For example, a wafer on the chucktop may be sent to the hold station and then later transferred to its “origin” without the host having to know the wafer’s original slot location. Because the handler mapped all the wafers initially, it knows the locations of all wafers at all times. This is one of the reasons why a wafer should never be manually removed from the system without the handler knowing about it.

PG D10S0 D4S2 R0 ➧ Moves the wafer on the chucktop to cassette 4, slot 2 (**D4S2**) and fetches a wafer from the hold station (**D10S0**) The reason code used specifies a normal unload (**R0**).

This command does *no*t permit moves between cassettes and slots. Use the **MW** command for these moves.

8.4.2 ACTION COMMANDS (continued)

PR **PROBE ONE WAFER**
RDP: AcL

Instructs the prober begin probing according to the current autoprobe mode. This doesn't load a wafer; it assumes a wafer is already loaded and located at First Die. In any automatic probe mode, a **TS** (Test Start) is returned; in External probe mode, an **SP** (Start probing) is returned.

ROUTINE:

The user manually (or over I/O) executes the wafer unload/load, auto alignment, and wafer profiling commands. (The command only invokes the wafer probe routine and not the entire autoprobe cycle of fetch, profile, align, and probe.) After all die are probed, the forcer is left under the probes at last die probed, and the Z stage is in the down position.

As of Vision SW REV DD, the status is of the wafer is returned as `"PROBED"`.

Added 5/14/96

*See the Supplement at the end of the section for information about the new **PT** command.*

PW **PREPARE SPECIFIC WAFER FOR LOADING**

Format: **PWDnSn**

Dn = source device code (1–4, 9–10, 14–15)
Sn = slot number (1–25)

*For device addresses, see listings included in the information entitled **Specifics for Random Access Material Handler** on the page following the **HW** command.*

Removes the wafer from the specified device; the wafer is prealigned and the ID is read (if enabled and not already read). The wafer is then transferred to the quickloader. (Pipelining is suspended.)

EXAMPLE: ***PWD3S12*** ➧ *The wafer is moved from cassette 3 slot 12 through prealigner to the quickloader.*

PZ **PROFILE WAFER THICKNESS**
RDP: **AgI**

NOTE: The profiler (NCES) must be installed.

Measures the thickness of the wafer on the chuck. This data is used during probing to calculate the Z stage contact height.

The Noncontact Edge Sensor scans the wafer and calculates the Z Up values. When operation is completed, the forcer is left beneath the air sensor and the Z stage is left at 200 mils.

If the option FIND CENTER is enabled, the NCES also scans the wafer for its diameter and center.

RI **RAISE RETRACTABLE INKER**

Raises a special articulated inker out of the probe array area so probing can be continued.

SA **SOUND ALARM**

Halts the current process and turns on the buzzer and light. The <PAUSE> key (or **CE** via External I/O) will turn off the beeping and light; the next <PAUSE> (or **PA**) will continue the process.

*See the supplement at the end of the section for more information about the **SA** command.*

8.4.2 ACTION COMMANDS (continued)

SD — SET THE CURRENT DRIVE SPECIFIER

A and B = Floppy drives (3 1/2")
C = Floppy (5 1/4")
C = Hard (RTM)
D = Hard

Sets the default drive for writing to and reading from disk. The drive specifier can be changed by explicitly including a drive letter in the **DD, LF,** and **SF** commands. Same as Line 02 in the Disk Utility Menu.

EXAMPLE: ***SDA*** ➧ *Sets the current drive to A: (the 3 1/2" drive).*

Valid drives are A to D. Note that the colon is *not* needed in this command as it is in the other disk−related commands.

SF — STORE PRODUCT FILES TO DISK

Format: **SFs** "s" = ASCII string containing the product name

Writes the contents of the prober's current setup data to one or more disk files. The syntax is the same as the **DD** command in that the drive specifier is optional.

Up to 8 separate files could be created (the same 8 addressed by the upload/download commands).

EXAMPLES: ***SFC:WAFER1*** ➧ *Save product file to drive C:.*

SFWAFER1 ➧ *Save product file to current drive.*

In this example, all product files called "WAFER1" are saved to prober drive C. The drive specifier "C" is only necessary if the current drive is something other than drive C. Note that the colon is used to separate the drive letter from the file name.

TC — TEST COMPLETE AND BIN DEVICE

RDP: **BAn1,n2,n3**
(See **Section 8.5 − RDP PROTOCOL.**)

Format: **TCn** n = bin code

Range: 0 − 255

The Bin Code/Inker reference table appears in the descriptions for the **SM24** command and the **IK** action command.

Signals the completion of testing on the current die and actuates one or more inkers, if enabled, according to the bincode−to−inker assignment table **(SM24).**

The prober will also step to the next die in the probe pattern and isssue a TS (Test Start) message and pulse (if Autoprobe pattern is not External or Off).

ET — MULTIPLE DIE TEST COMPLETE

RDP: **BA**
Specifies bincode for each die and whether or not it should be inked. See **Section 8.5.**

Signals the completion of testing on the current multiple die. This command is the equivalent of **TC** (Test Complete) for single die applications.

Allows up to eight bincodes to be sent to the prober. Each bincode is delineated by the comma and can range from 0 to 255. Even if all die are not tested, all bins must be included.

EXAMPLES: ➧ **ET2,1,0,2** Quad die probing:
die 0 = 2, die 1 = 1, die 2 = 0, die 3 = 2

➧ **ET3,15** Dual die probing:
die 0 = 3, die 1 = 15

IMPORTANT: See **Section 9** of this manual for details on Multi−Die Probing.

8.4.2 ACTION COMMANDS (continued)

TS **GENERATE TEST START PULSE**
RDP: **AgD**

Causes the prober to generate a 1 millisecond start test pulse on the tester interface. It may be used when the host computer is separate from the tester in use. (Generally used only in OFF/EXTRN modes.)

UL **UNLOAD WAFER**
RDP: **AdE**

NOTE: If Material Handling is not enabled, the forcer moves to the Home position and the Z stage is left at the Z Down limit.

See also – information entitled ***Specifics for the Random Access Handler*** *on the page following the* ***HW*** *command.*

Moves the forcer to the unload position if a wafer is on the chuck and puts the Z stage at 200 mils. If a wafer is not on the chuck, there will be no X, Y, or Z motion.

This command unloads the wafer on the chuck to its origin slot. In addition, the prober will command the handler to resume pipelining wafers, regardless of the success of the wafer load or unload.

UW **UNLOAD WAFER TO SPECIFIED DESTINATION**

Format: **UWDnSnRn**

Dn = destination device (0–4, 9–10, 14–15)
Sn = slot number (1–25)
Rn = unload reason

Causes the wafer to be unloaded from the chuck to the specified device and slot. The Handler is also instructed to cease pipelining wafers.

For device addresses and reason codes, see the information titled ***Specifics for Random Access Material Handler****, on the page following the* ***HW*** *command.*

EXAMPLE: ***UWD10S0R4*** ➧ *Wafer is unloaded to hold station because of profile failure.*

VA **TURN CHUCK VACUUM "ON"/"OFF"**
RDP: **AgEn**

Format: **VAn** n = "0" OFF
n = "1" ON

Switches the chuck vacuum on or off.

Not all XY functions test for vacuum before moving, so it is possible to drop the wafer on the platen if the vacuum is off.

In addition, any time the **VA** command is received, all profiler information is lost and the wafer must be reprofiled before a Z up or Z down is performed.

ZD **MOVE Z DOWN**
RDP: **AdC**

NOTE: Z stage is in Down position during all XY movement.

Moves the Z stage down. If the Z stage is up, it moves it down according to the current Z travel mode. If the Z stage is down when this command is received, no Z motion takes place.

The Z height the chuck reaches depends on the Z travel mode currently being used (Profile, Edge Sense, Limits).

8.4.2 ACTION COMMANDS (continued)

ZM **MOVE Z TO SPECIFIED HEIGHT**
RDP: **AdKn**

Format: **ZMn** n = desired height
Range: 2000 − Z Up Limit
Units: Depends on resolution of Z stage
(1/2, 1, 1/4, 1/8 mil)

Moves the Z stage to a hny desired height within the range of its current Z Up/Down limits.

NOTE: The height selected must be at least 2000 (200 mils) and less than or equal to the currently defined Z Up limit. (For example, if the Z Up Limit is set to 320 mils, the range must be between 2000 and 3200. If the height selected is outside this range, the Z Stage will not move.

EXAMPLE: ***ZM2570*** ➧ *Moves Z stage to 257.0 mils.*

ZR **MOVE Z RELATIVE TO CURRENT POSITION**

Format: **ZRn** n = −2000 to 2000 mils

A negative number moves the stage down.
A positive number moves the stage up.

Units: Depends on resolution of Z stage
(1/2, 1, 1/4, 1/8 mil)

Range: 2000 − Z Up Limit

Moves the Z stage to a height relative to its current position.

The most common Z stage is the 0.5 mil resolution: others are 1.0, 0.25, and 0.1 mil. This resolution is important because it specifies the minimum movement permitted for the specific Z stage.

Works with the Restrictive Z Mode option.

EXAMPLES: ***ZR25*** ➧ *Raises the Z stage an additional 2.5 mils from its current height.*

(NOTE: No leading symbol indicates "UP" direction.)

ZR−375 ➧ *Lowers the Z stage by 37.5 mils from its current height.*

If the prober is equipped with a 0.25 mil Z stage, then the prober will adjust the parameter "n" to the next suitable value.

EXAMPLES: ***ZR258*** ➧ *Raises the Z stage an additional 25.75 mils from its current height.*

ZR−399 ➧ *Lowers the Z stage40.0 mils from its current height.*

ZU **MOVE Z UP**
RDP: **AdB**

Units: 0.1 Mil

NOTE: The Z stage is in the Down position during all XY movement.

Moves the Z stage up. If the Z stage is down, it moves it up according to the current Z travel mode. If the Z stage is up when this command is received, no Z motion takes place.

The Z height the chuck reaches depends on the Z travel mode currently being used (Profile, Edge Sense, Limits).

The processing of this command has been modified to respond to the double touchdown feature. Upon receiving a **ZU,** the prober raises the Z stage either once or twice, depending on whether double touchdown is enabled or disabled.

(See related commands **SP40** and **SP41.)**

8.4.3 MESSAGES

8.4.3.1 QUERIES AND RESPONSES

COMMAND	RESPONSE

?A **REQUEST HOT CHUCK DATA**

Returns:

Format:			Response
?A0	(Temperature)	Available from EG chuck only	AT followed by ###.# series of digits
?A1	(Setpoint)		AS and setpoint as an integer
?A2	(Delay)		AD and delay as an integer (0−30 secs)
?A3	(Model ID)		AMn (n = 1 − EG hot chuck, n = 2 − non−EG hot chuck)

EXAMPLES:

?A0 ➧ *Prober returns* ***AT123.4;*** *the temperature is 123.4 Degrees.*

?A1 ➧ *Prober returns* ***AS111;*** *the setpoint is 111 Degrees.*

?A2 ➧ *Prober returns* ***AD6;*** *the time delay is 6 seconds.*

?A3 ➧ *Prober returns* ***AM1;*** *the Hot Chuck is EG.*

?B **REQUEST MISCELLANEOUS POSITION DATA**

Returns the miscellaneous XY position data used in special applications. Data is returned in 0.1 mil units.

Range: 0 − 999999

Format returned (spaces added for clarity): **AXnYn TXnYn CXnYn PXnYn**

EXAMPLE: ➧ ***AX20000Y50000*** (1) ***TX112Y100*** (2) ***CX10000Y10000*** (3) ***PX30000Y0*** (4)

1. Primary alignment target position − the position of the motor when the operator teaches the system the primary alignment target image. If primary target is not stored or Auto Align not enabled, X0Y0 will be reported.

2. Offset between Teach Die Corner and primary target position. If Teach Die Corner is not enabled, or if wafer isnot aligned, a value of X999999 and Y999999 will be returned. These values have already been offset by 10 mils due to using the corner of the target “box” as a reference.

3. Offset between camera and profiler positions. If camra position is not set, a default value of X0 and Y0 is returned. Already offset by 10 mils, as mentioned in Item 2, above.

4. Offset between probe tip center and profile position. If probe tip position is not set, a default value of X0 and Y0 will be returned. Probe tip position is set through the Profiler Menu (<PROG> key).

   If all values were at default (meaning Teach Die disabled), output would be:

   AX0Y0TX999999Y999999CX0Y0PX0Y0 (means “no information stored”)

The **?B** command is only valid when Teach Die and Auto Align are enabled and an alignment reference point is stored. Otherwise, the all−default data line shown is returned to the host.

If the **?B** command is valid, a non−zero value will be returned for the profiler−to−camera offset and profiler−to−probe offset. The camera, probe tip, and profiler positions will show non−zero default values.

8.4.3.1 QUERIES AND RESPONSES (continued)

?C **REQUEST HANDLER/ID STATUS**

Returns the current Material Handler status and the wafer ID. (See note below.)

Format returned (spaces added for clarity): **C Pn Ln Sn Rn Wi**

- **Pn**: "1" if wafer on chuck is profiled and aligned (if enabled) and completely probed; "0" if not
- **Ln**: "1" if unprocessed wafer(s) available in any cassette, the prealigner, or the quickloader; "0" if no unprocessed wafers are available
- **Sn**, **Rn**: "1" if one or more unprocessed wafers are available in any cassette; "0" if not
- **Wi**: The string "i" is the ID of the wafer on the chucktop. This ID was read by an ID reader or entered by the operator (from the <RUN ID> menu). If no ID was entered, this will be the sequential wafer number assigned by the prober.

EXAMPLES:

?C ➧ *Prober returns string* ***C P1 L0 S0 R0 W123−13*** *(spaces added for clarity)*

This says:

1. *The wafer on the chuck has been probed* ***(P1)***
2. *No more unprocessed wafers are available in the system* ***(L0)***
3. *There are no more unprocessed wafers in any cassette* ***(S0 R0)***
4. *The ID of the wafer on the chuck is* ***123−13***

?C ➧ *Prober returns string* ***C P1 L1 S1 R1 WFAA336−9*** *(spaces added for clarity)*

This says:

1. *The wafer on the chuck has been probed* ***(P1)***
2. *Some unprocessed wafers are available in the Material Handler* ***(L1)***
3. *There are unprocessed wafers in the cassettes* ***(S1 R1)***
4. *The ID of the wafer on the chuck is FAA336−9*

> The **?M** command is more suitable to the multiple cassette Material Handler units.
>
> If the **?C** command is used nevertheless, the code returned for the **Sn** and **Rn** parameters will be the same since any cassette can be a sender or receiver. Usually wafers are returned to their original cassette, so the receiver is the same as the sender.

8.4.3.1 QUERIES AND RESPONSES (continued)

?D **REQUEST CURRENT PROBE CARD TOUCHDOWN COUNTER VALUE**

Format returned: **DTn**

Returns a value representing the number of times the probe pins have made contact with the wafer.

The probe card touchdown counter value is set with the command **SP19**.

?E **REQUEST ERROR CODE**
RDP: **CA**

Format returned: **En** n = 0 to 999
Range: 0 − 999 (n = "0" − no error)

Returns a code indicating the number of the last error (can only be read once).

RDP Format returned:

Error code followed by the ASCII text of the message.
No error is indicated by the sequence STX ETX with no text between (null).

EXAMPLE: ***E12*** ➧ *Last error was* `#12 (WAFER TRANSFER ERROR).`

> **NOTE:** When low pressure or vacuum to the handler is detected, resulting in an Emergency Stop state, the messages `EMERGENCY STOP` and `LOW SYSTEM AIR/VACUUM` are displayed on the material handler monitor screen. If the host issues an I/O command requesting handler motion, an **MF** response is sent by the prober notifying of the problem. If the operator sends the query error command **?E,** the prober will respond with `283 (LOW SYSTEM AIR/VACUUM).`

?F **REQUEST MICRO COORDINATES**

Reply format: **XxYySn**
Units: 0.1 mil/1 micron

If the probes are not over a site defined in the micro list, the site number returned is 0 ("S0").

Returns the current microdie coordinates and site number.

The X and Y coordinates are given in steps from the current micro origin. The "n" is the site number corresponding to these coordinates as they exist in the microsite list.

See also Action Commands **GF** and **FC** and miscellaneous Setup Command **RF**.

QUERIES AND RESPONSES (continued)

8.4.3.1 QUERIES AND RESPONSES (continued)

?G **REQUEST INK DOT INSPECTION DATA**

Requests Ink Dot Inspection data. The transfer of inspection summary data follows the order and content of the data which can be printed. The values transferred are whole positive numbers. "FOV" refers to the camera's field of view.

Input: **?G0** **LAST INK DOT INSPECTION RESULTS**

Format returned (spaces added for clarity)**: Pb Wr H rXr Yr Ar Cr Vb En**

P	=	**P**ass Status: P0=failed, P1=passed
W	=	Dot **W**idth: ####.#
H	=	Dot **H**eight: ####.#
X	=	Drift from Reference in **X**: ####.#
Y	=	Drift from Reference in **Y**: ####.#
A	=	Weighted Dot **A**rea (% of Reference): ####
C	=	**C**entral Weighted Area (% of Reference): ####
V	=	Field of **V**iew Exceeded: V0=no, V1=yes
E	=	**E**rror: 0=none,VM error number, or −1 (not supported by Vision Module)

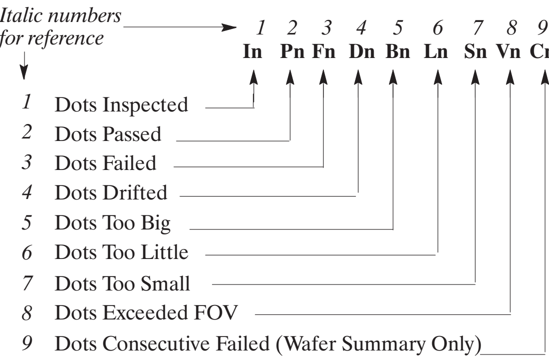
Dot dimensions and drift values given are ASCII real values. Leading zeros are not used so the #'s represent the maximum field size. Unless otherwise specified, the assumed units are mils. If the scale is Metric, the assumed units are micrometers (and one decimal place is dropped).

If a non−zero error is reported in the E (error) field, the rest of the output string contains "*"s instead of values (that is, "P*W*H*X*Y*A*C*V*").

Input: **?G1Sn** **INSPECTION SUMMARY**

S = Summary Type:
- **"S0"** = Wafer
- **"S1"** = Total

Format returned (spaces added for clarity):



Input: **?G2** **INSPECTION STATUS**

Format returned (spaces added for clarity): **Fb Rb Bb Ln**

"0" = no, "1" = yes:
- Functional (0,1) → Fb
- Reference Trained (0,1) → Rb
- Background Trained (0,1) → Bb

Parameters Loaded Status (0,1,2) → Ln
- "0" = not loaded
- "1" = loaded from disk
- "2" = loaded from external I/O

The inspection status also appears on the Ink Dot Inspection summary display.

8.4.3.1 QUERIES AND RESPONSES (continued)

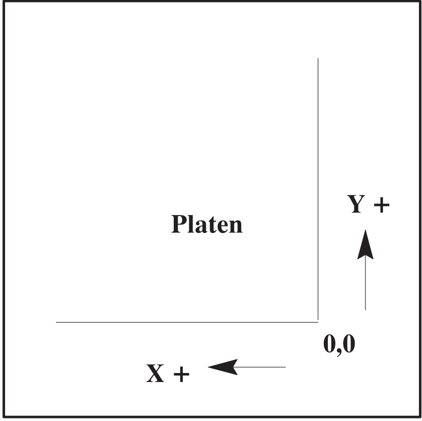
Query	Description
?H **REQUEST ABSOLUTE MOTOR POSITION** Format returned: **HXxYy** Range: −999999 to 999999	Returns the position in 0.1 mil (machine coordinate) steps from the Harbor position (0,0 lower right corner of the platen).
?I **REQUEST FIRST DIE POSITION, WAFER CENTER POSITION, AND WAFER DIAMETER** Format returned (spaces added for clarity): **IX_1Y_1 X_2Y_2 Dd** Range: −999999 to 999999	Returns the positions in 0.1 mil (machine coordinate) steps from the Harbor position (0,0 lower right corner of the platen). First Die position is for the current wafer; wafer center and diameter are for the center of the wafer or chuck. The fixed coordinate system has X increasing to the left and Y increasing towards the back of the prober.

First Die Position (first XY pair):
When the first die is under the probes and the probes are aligned to the pads, the motor is at this coordinate. If first die has not been set, **X0Y0** will be returned for this value.

Wafer Center Position (second XY pair):
If the wafer center has been measured by the profiler, this data is the value returned. If the profiler is not used or this value is not measured (because Profile with Find Center option is disabled), then chuck center position is returned. If the forcer is moved to this position, the center of the wafer (or chuck) will be beneath the probes.

Wafer Diameter (Dd)
If the Profiling and `PROFILE WITH FIND CENTER` options are enabled, the measured diameter is returned (units = mils). If disabled, the wafer diameter (Line 04, Set Parameter Menu or **SP4**) is returned (units = **MM**).

EXAMPLE: ***IX68161Y15547X77432Y38683D15O*** ➧ *First Die Location: (6816.1, 1554.7)*
Wafer Center Location: (7743.2, 3868.3)
Wafer Diameter: 150 mils



8.4.3.1 QUERIES AND RESPONSES (continued)

?J REQUEST PROBE MARK INSPECTION DATA

Requests the Probe Mark Inspection data. The transfer of inspection summary data follows the order and content of the data which can be printed. The values transferred are whole positive numbers (unsigned).

Input: **?J0 LAST PROBE MARK INSPECTION RESULTS**

Format returned (spaces added for clarity): **Pb Fb Ib Mb Ab Db En**

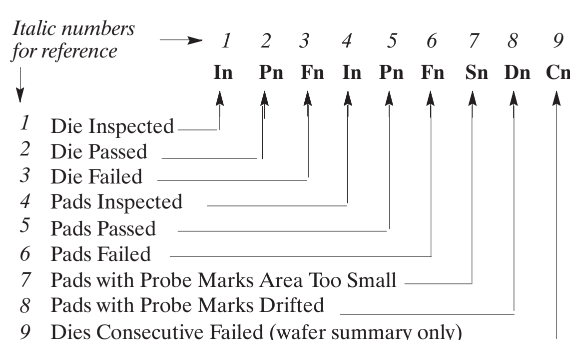
P	=	**P**assed: P0=no, P1=yes
F	=	Pad **F**ound: F0=no, F1=yes
I	=	Pad **I**nspected: I0=no, I1=yes
M	=	Probe **M**ark Found: M0=no, M1=yes
A	=	Probe Mark **A**rea Big Enough: A0=no, A1=yes
D	=	**D**rifted: D0=no, D1=yes
E	=	**E**rror: 0=none,VM error number, or −1 (not supported by Vision Module)

NOTE: If a non−zero error is reported in the E field, the rest of the output string contains "*"s instead of values (that is, **"P*F*I*M*A*D*"**)

Input: **?J1Sn INSPECTION SUMMARY**

S = Summary Type:
"0" = Wafer
"1" = Total

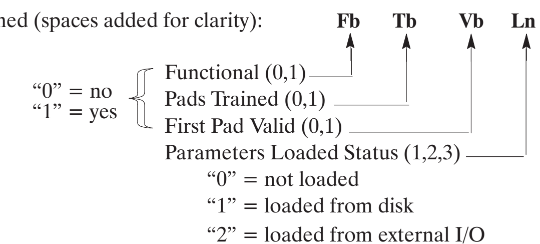
Format returned (spaces added for clarity):



Input: **?J2 INSPECTION STATUS**

The inspection status also appears on the Probe Mark Inspection summary display.

Format returned (spaces added for clarity):



?L REQUEST MULTIPROBE LOCATION CODE

Range: 0 to 10

Returns: Value corresponding to the user−selected location code ("0" returned when multi−probe is not enabled; or die array = 1 for single die probing).

Returns a numeric code describing orientation of multiple die being tested. See **Section** 9 for details on Multi−Die Probing.

8.4.3.1 QUERIES AND RESPONSES (continued)

*See the Supplement at the end of the section for more information about the **?MD** commands*

?MD REQUEST HANDLER DEVICE DATA

FORMAT: ?MDmSn
m = device code / n = slot number

The values allowed for m and n, and the format of the returned data, are:

?MDmS0 **CASSETTE MAP**

m = cassette number (1 to 4)

Format Returned: **M s_1 s_2 s_3 ...s_{25}**

The values and meanings for Slot Status are:

1 = unmapped slot
2 = slot empty, wafer in process (on prealigner, quickloader, chuck, or hold station)
3 = slot empty
4 = slot occupied by unprobed wafer
5 = slot occupied by probed wafer
6 = slot occupied by problem wafer
7 = slot occupied by wafer not scheduled for probing (skip)

Returns the cassette mapping information.

The numbers s_1 to s_{25} are "Slot Status" numbers corresponding to slots 1 to 25 of the specified cassette.

Updated 5/14/96 per Material Handler Software REV HC

If the ID read Fail Recover mode is set to IGNORE and the ID read fails, the wafer is probed and its status becomes "probed" without any indication that an ID read fail occurred. The response to **?MDmS0** will simply indicate which wafers were probed (status = 5).

The handler returns rational data to the **?MD** status request after power−up with the main cover open. If no cassettes are present, **?MD1S0** will return all "1s" (not mapped) and **?MD1S1** will return "**S1E0W**". If power−up is done with a previously mapped cassette in place, its status is preserved and available via external I/O.

If a previously mapped cassette is removed while the handler is powered down and then replaced after power−up (before closing main cover), its last status will be preserved and available, but the status will be reset to unmapped when the cover is closed. To retain the old status, use the < RECOVER > key and indicate that the cassette has not changed.

EXAMPLE: ***?MD4S0*** ➧ *REQUEST CASSETTE MAP OF CASSETTE #4*

DATA RETURNED −

M 5 5 6 5 2 2 2 4 4 3 3 3 3 3 1 1 1 1 1 1 1 1 1 1 1

Slots 1, 2, 4 contain probed wafers
Slot 3 contains a problem wafer
Slots 5, 6, 7 are empty, their wafers are in process
Slots 8, 9 contain unprobed wafers
Slots 10−14 are empty
Slots 15−25 are unmapped

?MDmSn **SLOT STATUS**

m = cassette number (1 to 4)
n = slot number (1 to 25)
Format returned: **SsEeWi**

Error Code Values:

0 = probed, no error
1 = prealign fail
2 = ID read fail
3 = align fail
4 = profiling fail
5 = lost wafer
6 = unknown wafer

Returns the status of the requested slot. In this format, "s" is the Slot Status (described above); "e" is the Error Code; and "i" is the wafer ID (no characters if ID not read).

Note that some status data is unavailable when the wafer is not present in the slot since some status data follows the wafer, not the slot of origin.

EXAMPLE: ***?MD4S21*** ➧ *REQUEST SLOT STATUS OF CASSETTE #4, SLOT 21*

DATA RETURNED: ***S6E3W456−13*** *Slot contains problem wafer, align failure; wafer ID is "456−13."*

(?M Query Variations Continued)

8.4.3.1 QUERIES AND RESPONSES (continued)

?M REQUEST HANDLER DEVICE DATA (continued)

?MD0S0 **HANDLER SYSTEM STATUS**

Format Returned: **PbMbAbBbCbDb**

P = Pipeline Status: b = 0 − Off; 1 − On
M = Main Cover Status: b = 0 − Closed; 1 − Open
A−D = Cassette 1−4 Status: b = 0 − Not Present; 1 − Present

EXAMPLE: ?MD0S0 ➧ *REQUEST HANDLER SYSTEM STATUS*

REPLY − P0M1A1B1C1D0

REPLY: Pipeline is "OFF"
Main Cover is open
Cassettes 1−3 are present
Cassette 4 is not present

?MD0S1 **HANDLER REVISION DATA**

Format Returned:
SrvcXrvcArvcPrvc

S = System
X = Processor
A = Arm Processor
P = Prealign Processor

r = Software Revision Letter
v = Software Revision Number
c = Hardware Revision Letter

EXAMPLE: ?MD0S1 ➧ *REQUEST HANDLER REVISION DATA*

REPLY − SA1BXA2CAA2BPA2A

		Soft REV	Soft Ver	Hdw REV
(S)	*System*	*A*	*1*	*B*
(X)	*Processor*	*A*	*2*	*C*
(A)	*Arm Processor*	*A*	*2*	*B*
(P)	*Prealign Processor*	*A*	*2*	*A*

?MD9S0 **PREALIGNER STATUS**

Format Returned:
WnDnSnEnIn

Wn = Wafer Present: n = 0 − Not Present; 1 − Present
Dn, Sn = Origin Cassette, Slot: n = 0−25; 0 − No Wafer
En = Error Code: see "?MDmSn" for error codes
In = Wafer ID String: n = ID string; None if ID Not Read

EXAMPLE: ?MD9S0 ➧ *REQUEST PREALIGNER STATUS*

REPLY − W1D4S16E0ICMOS−102

Wafer is present
From cassette 4, slot 16
There is no error
Wafer ID is "CMOS−102"

OTHER REQUESTS FOR STATUS − Returns data in the same format as for the prealigner status, above.

?MD10S0 **Hold Station**
?MD11S0 **Quickloader**
?MD12S0 **Chucktop**

The prober intercepts the **?MD12S0** chuck status query command, if no wafer is on the chuck. In this case, **W0D0S0E0I** is returned through external I/O.

?MD13S0 **Transfer Arm**

Updated 5/14/96 per Material Handler Software REV HC

8.4.3.1 QUERIES AND RESPONSES (continued)

?N **REQUEST PROFILER DATA**

Range: −999999 to 999999
Unit: 0.1 mil

Returns the X and Y position in machine coordinates of the three edge points relative to the flat found by the profiler during the Find Center operation.

Format returned (spaces added for clarity): **BXnYn LXnYn RXnYn**

Example: **BX1000Y25000** – 1st position (bottom right corner) *
LX5000Y65000 – 2nd position (upper left corner) *
RX15000Y5000 – 3rd position (upper right corner) *

* Assumes flat is at 0 degrees.

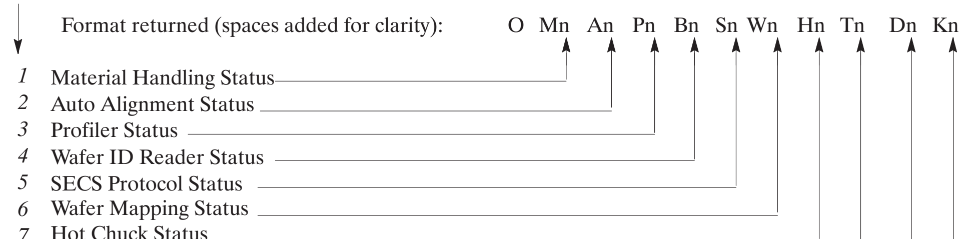
If edge profiling has not been performed, then the return is 0,0 for all three points: **BX0Y0LX0Y0RX0Y0**

?O **REQUEST CURRENT OPTION SETTINGS**
RDP: **CM**

n = “0” (disabled)
n = “1” (enabled)

Returns a message indicating the current enabled/disabled status of the system’s major options.

Italic numbers for reference.



NOTE: Only the EG model TC−2000 Thermal Chuck is supported by the Hot Chuck and Temp Comp queries. Also, the RDP protocol command indicates only the first four options.

EXAMPLE: ***OM1A1P0B0S0W1H0T0I0C0*** ➧ *Material Handling, Auto Align, and Wafer Mapping are enabled; the other options are disabled.*

?P **REQUEST CURRENT XY POSITION**
RDP: **CG**
See **Section 8.5 (RDP Protocol)** for more information about this RDP command.

Range: −999999 to 999999
Format returned: XnYn

n = X and Y absolute die coordinate position

Returns the position of the forcer in die coordinates with respect to first die. This is the same coordinate reported on the monitor. Coordinates obey coordinate quadrant settings (and preset XY coordinate of First Die).

EXAMPLES: ***X1235Y0*** ➧ *Current position is X=1235, Y=0 with respect to First Die.*
X−31Y18 ➧ *Current position is X= −31, Y = 18 with respect to First Die.*

8.4.3.1 QUERIES AND RESPONSES (continued)

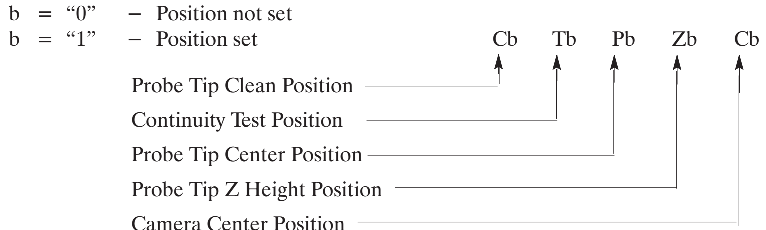
?Q0

RETURN STATUS OF SETTINGS IN PROFILER MENU

Returns the status of the settings in the Profiler Menu. This command is used to validate the proper setting of all positions before allowing the first wafer to be tested. Corresponding commands are **MP, PH, PM, PN, PO**, and **PP**.

Format returned (spaces added for clarity): **Q Cb Tb Pb Zb Cb**

b = “0” – Position not set
b = “1” – Position set



EXAMPLE: ***?Q0*** *returns* ***QC1T0P1Z1C0***

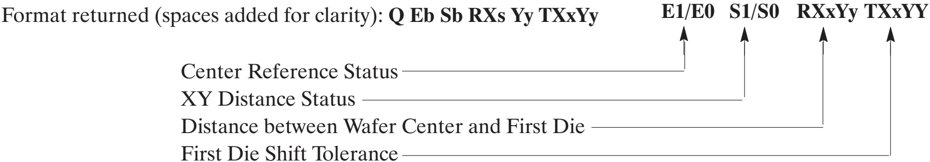
Probe tip clean position is set ***(C1)***
Continuity test position is not set ***(T0)***
Probe tip center position is set ***(P1)***
Probe tip Z height is set ***(Z1)***
Camera center position is not set ***(C0)***

?Q1

RETURN STATUS OF CENTER REFERENCE SETTINGS

Returns the status of the Center Reference settings. The Center Reference settings are made through the **FD, SM74, SM75, SM76,** and **SM77** commands.

Format returned (spaces added for clarity): **Q Eb Sb RXs Yy TXxYy**

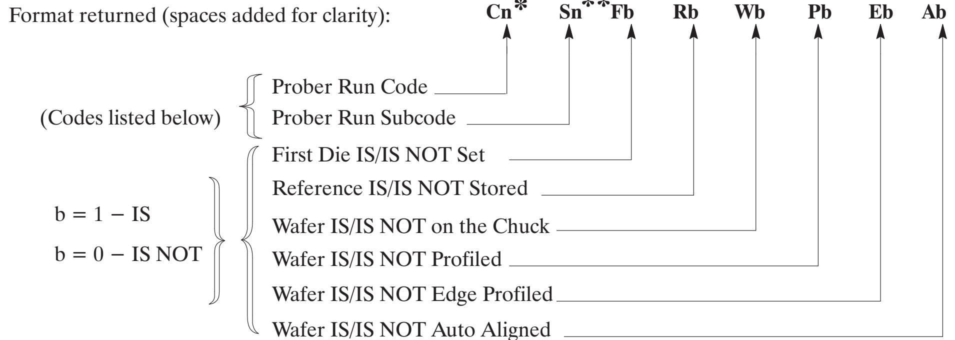


EXAMPLE: *?Q1 returns* ***QE1S1RX780Y613TX100Y85***

Center reference is enabled ***(E1)***
XY distances have been set and calculated ***(S1)***
XY distance is 78.0, 61.3 mils from wafer center to First Die
XY tolerance is 10.0, 8.5 mils from center of First Die

8.4.3.1 QUERIES AND RESPONSES (continued)

?R REQUEST STATE VARIABLES



*** Cn**

n =		
0	System is idle	
1	Prober is	... in FIND TARG procedure
2		... in ALIGN SCAN
3		... in PROBE one wafer
4		... in AUTOPROBE (load to unload, and repeat)
5		... up/down loading memory
6		... in TEST CYCLE
7		... in initializing

(negative number means function is in PAUSE).

**** Sn**

n =		
0	System is waiting for commands	
1	Prober is	... unloading
2		... loading
3		... autoaligning
4		... in ALIGN SCAN
5		... profiling
6		... prealigning (if I/O “retry prealign” is used)
7		... probing a wafer
8		... is busy (after a keypress)
9	Procedure has been aborted	
10	Prober is doing disk transfer	
11	Prober is doing XIO transfer	

?RID READ ID COMMAND

Returns: WwDdSsEeIi

Follows the format for the “?MD9S0” command:

w = wafer present — “0” − No; “1” − Yes

d = source device code

s = source slot number

e = error code *
(Example: 2 = ID Reader fail)

i = wafer ID

* These are not the prober error codes but the error codes that are listed for the **?MD** command.

Causes ID to be read on the wafer at the prealign station (even if it has already been read, successfully or not).

This command is typically used only if the ID fail mode is set to “HOLD”.

8.4.3.1 QUERIES AND RESPONSES (continued)

?S **REQUEST STATUS**

RDP: **CH**

Format returned: **SZaWnCn**

S Z (U,D) W (0,1) C (0,1)

chuck position
- U = up
- D = down

wafer/chuck
- 0 = "OFF"
- 1 = "ON"

edge sensor
- 0 = no contact
- 1 = contact

NOTE: Status of the edge sensor is returned in real time. Also, when in the profile mode, the C−status variable indicates whether or not the current probe tip position is on or off the wafer.

Returns the prober status. Also reports whether the edge sensor is in contact.

If the edge sensor is not used but Z travel mode is set to Profile, the response for the third parameter (edge sensor) indicates:

C1 = the current die under the probes (X and Y position) is within the wafer boundary

C0 = the current position under the probe tips is outside the wafer boundary

When the edge sensor is not plugged in, the return status will be "1" (contact).

EXAMPLE: ***SZUW1C0*** ➧ *Chuck is up, wafer is on the chuck, and no edge contact was sensed. Or, if the Z mode is profile, the current position is outside the boundary of the wafer.*

?SM15 **QUERY FOR RESPONSE MESSAGES**

The prober's response is :
SM15Ibbbbbbbbbbbbb
b = 1 if the response message is enabled
b = 0 if the response message is disabled.

This new command allows the user to query the prober for its response setup − that is, whether or not the prober should send messages to the host under certain conditions.

There are 13 response message groups. They are:

- MF/MC on XY motion
- MF/MC on Z motion
- MF/MC on optional devices
- MF/MC on rest of commands
- Test Start message (TS)
- Test Complete message (TC)
- Pattern Complete message (PC)
- Pause/continue message (PA/CO)
- Alarm messages (An)
- Wafer Complete (PC)
- Enhanced PC (PCLSRW)
- Enhanced TS (TF, TA, TR, TM)
- Pause Pending message (PP)

See the Supplement at the end of the section for more information about the following new commands:

?SM70
?SM105
?SM110
?SM111
?SM115
?SM116
?SM119

Command	Description	Returns	Value	Meaning
?SM102	**REQUEST STATUS PROFILE BEFORE ALIGN**	RETURNS: **SM102Pb**	b = 0	Disabled
			b = 1	Enabled
?SM103	**REQUEST STATUS WAFER ON PREALIGN OPTION**	RETURNS: **SM103Pp**	p = 0	Disabled
			p = 1	Enabled
?SM104	**REQUEST STATUS AUTO LIGHT ADJUST**	RETURNS: **SM104Ab**	b = 0	Disabled
			b = 1	Enabled

8.4.3.1 QUERIES AND RESPONSES (continued)

Query	Response
?SP35 **QUERY OCR ILLUMINATION** Format: ?SP35Lb b = Lamp select: "0" − main OCR lamp "1" − auxiliary OCR lamp	Returns: Vv v = Intensity Value: 0 − 255
?SP36 **QUERY LIGHT CONTROL MODE**	Returns: Mm m = Light Control Mode: "0" − Manual "1" − Auto Dual Lamps "2" − Auto Main Lamp "3" − Auto Auxiliary Lamp
?SP37 **QUERY MISCELLANEOUS OCR SETUP DATA** Requests read mode, display time, and filter size.	Returns: MmDdFf M = Read Mode: "0" − Conservative "1" − Aggressive d = Display Time: "0" − 1/2 sec "1" − 5 sec "2" − 20 sec f = Filter Size: 1, 3, 5, 7, 9
?SP40 **REQUEST STATUS DOUBLE TOUCHDOWN**	RETURNS **SP40Db** b = 0 Disabled b = 1 Enabled
?SP41 **REQUEST STATUS DOUBLE TOUCHDOWN CLEARANCE**	RETURNS: **SP41Zz** z = the number of MILS required to break contact between the probe tips and pads.
?T **REQUEST THETA POSITION** Range: −7603 to 7603	Returns the current theta position in motor steps. The prober's response is **Tn.** Refer to the **MT** action command.
?U **REQUEST TOTAL PROBING "UP" TIME** Range: hh = 0−23 mm = 0−59	Returns the time in integers (hours and minutes). The prober's response is Uhh:mm.

EXAMPLE: ***U14:10*** ➧ *Time is 14:10 (colon character is included).*

8.4.3.1 QUERIES AND RESPONSES (continued)

?W **REQUEST WAFER ID**

RDP: **CU**

Format: **?Wn** n = 0 to 3

Format returned:

?W0 returns the current wafer ID string (**?W** can also be used)

?W1 returns the device ID
?W2 returns the lot number
?W3 returns the wafer number

} As seen in the Run−ID Menu only

Returns the current wafer ID string. If the ID was read from the wafer, the exact data read is what is returned to the host.

If the Wafer ID Reader option is enabled (OCR or bar code), the prober returns the operator−entered device type and list number and the prober−assigned wafer number from the Run ID Menu.

The maximum length for the device ID and lot number is 10 characters each, and the maximum length of the wafer number is six digits. In this case, the retuerned wafer ID is a concatenation of the ID, lot number, and wafer number.

NOTES: The wafer number entered through the <RUN ID> key menu is the number for the *next wafer to be loaded and not the current wafer.* When the <LOAD> key is pressed, the wafer number just entered will be incremented by one (1) and assigned to this new wafer. The prober always assigns this sequential number even if OCR is used.

If the ID Reader is enabled, **?W/?W0** return that string regardless of the data in the Run ID Menu. However, **?W1, ?W2, ?W3** can still be used to read the individual fields in the Run ID Menu independent of the ID reader.

EXAMPLES: ID Reader is present, ID is "381CB−19,"
Run ID Menu has device type = A39,
Run ID Menu has lot number = 837B,
Current wafer number is 7.

→ *?W and ?W0 return **381CB−19***
*?W1 returns **A39***
*?W2 returns **837B***
*?W3 returns **7***

ID Reader is present, ID is "381CB−19,"
Run ID Menu is empty.
Current wafer number is 21.

→ *?W and ?W0 return **381CB−19***
?W1 returns nothing
?W2 returns nothing
*?W3 returns **21***

See the Supplement at the end of the section for information about new command **?X010**

?Y **REQUEST YIELD DATA**

RDP: **CP**

All variables are 4 byte integers.

Returns the yield data collected by the prober. The number of good, bad, and ugly die is returned as well as the number of die in each of the 16 bins (0−15). Good and bad die are defined via the "Assign Good Die Bins" command (SM23). The good and bad totals count all 256 bins, not just the first 16 bins.

Format returned: **GnBnUnDnDnDnDnDnDnDnDnDnDnDnDnDnDnDnDn**

Gn: = number of good die
Bn: = number of bad die
Un: = number of ugly die
Dn: = bin count for each bin, beginning with bin 0

NOTE: The RDP protocol does not include the **Un** parameter. The order of the rest of the data is the same. Note the semicolon between the bad die count and the bin 0 data.

RDP format: **n,n;n,n,n,n,n,n,n,n,n,n,n,n,n,n,n,n**

For more information about the **CP** command, see **Section 8.5 (RPD Protocol).**

?Z **REQUEST CURRENT Z HEIGHT**

RDP: **CN**

Format: **?Z0**
Format returned: **Zn** n = 0 to 4000
Units = 0.1 mil

?Z0 returns the current height of the Z stage.

?Z1 returns compensation data (no RDP). For limited application. Check with your Field Service representative. (Relates to **SP30**.)

8.4.3 MESSAGES (continued)

8.4.3.2 UPLOAD/DOWNLOAD FEATURE

See the Supplement at the end of the section for more information

Via the upload/download feature, three fields of data are transferred: length, upload/− download data, and checksum. All characters transferred are in ASCII except for the line terminators.

A memory block feature for external I/O allows for the uploading and downloading of setup data and other information. The handshake function between the prober and the tester or host computer is available over both the GPIB and serial ports.

Types Of Data Files Stored To Disk

Eight files can be transmitted over the I/O ports:

- Menu parameters setup (DEFAULT.PRM)
- Row list (DEFAULT.ROW)
- Learn list (DEFAULT.LRN)
- Micro list (DEFAULT.MIC)
- Alignment data (DEFAULT.PAC, DEFAULT.PA2, or, for View systems, .PAT)
- OCR (Optical Character Recognition) data (DEFAULT.OCR)
- IDI (Ink Dot Inspection) data (DEFAULT.IDI)
- PMI (Probe Mark Inspection) data (DEFAULT.PMI)

The name for each file is user−defined, contains one to eight characters, and has a prober−assigned extension (for example, .PRM or .ROW). These are the file names that are stored on the disk. For file transfer, no file name is used since the data is already stored in the prober's memory. Each data file type is represented by a pair of I/O commands: Upload, pertaining to data received *from* the prober; and Download, for data transmitted *to* the prober. These commands are described in **Table 8−2.**

Each field starts a new line. The upload/download data may consist of several lines; the maximum line length is 64 characters not including the terminators. "Length" is the total number of upload/download data characters sent (terminators, length, and checksum data are excluded). In **Table 8−2,** these fields are enclosed in brackets ([...])for readability; the brackets are not sent as part of the protocol.

Data File Format

Each data file is organized into blocks of 64 ASCII data characters per line. Each block is terminated by the user−defined terminator character(s) selected from the I/O Control Menu's Line 06. There may be 0, 1, or 2 terminator characters, depending on the current protocol and user selections, specifically those shown in the table below:

SERIAL	GPIB
CR (Carriage Return) only	CR and EOI
LF (Line Feed) only	LF and EOI
CR and LF	CR/LF and EOI
	EOI

Table updated 5/14/96

TABLE 8−2
UPLOAD/DOWNLOAD COMMANDS

Command	Data	Includes
UB / DB	INSPECTION − PROBE MARK	See information below.
UK / DK	INSPECTION − INK DOT	See information below.
UF / DF	MICRO LIST	Micro die list data
UO / DO	OPTICAL CHARACTER RECOGNITION (OCR)	See information below.
UP / DP	PRU	Alignment data. Initializes alignment image unit with both first and second reference data and position of first die.
UQ / DQ	LEARN LIST	Learn list data
UR / DR	ROW LIST	Row list data
US / DS	SETUP	Parameter and setup data (such as die size, wafer diameter, probe mode)
UV / DV	MACHINE−DEPENDENT VARIABLES	See information below.

Added per ProberVision Software REV DB

CAUTION

*All parameters accessed by prober menus are modified by the **DS** command, including the I/O parameters. Unless the current I/O setup matches exactly the setup you are down−loading, the communication link will fail unpredictably during or after the download.*

INSPECTION − PROBE MARK

UB UPLOAD RDP: **DDh,n1,n2**

Returns: [Length] [Probe Mark inspection data] [Checksum]

Length is up to 102 K bytes (but typically will be much less)

DB DOWNLOAD RDP: **DAh,n1**

Format: **DB** [Length] [Probe Mark Inspection data] [Checksum]

Probe Mark Inspection data are the setup parameters and the Vision Module probe mark data; these data are the same as those stored on disk. (See section **12 − PROBE MARK INSPECTION.)**

INSPECTION − INK DOT

UK UPLOAD RDP: **DDg,n1,n2**

Returns: [Length] [Ink dot inspection data] [Checksum]

Length is approximately 700 bytes

DK DOWNLOAD RDP: **DAg,n1**

Format: **DK** [Length] [Inspection Data] [Checksum]

Ink Dot Inspection data are the setup parameters and the Vision Module ink dot data; these data are the same as those stored on disk. (See section **11 − INK DOT INSPECTION.)**

OPTICAL CHARACTER RECOGNITION (OCR)

UO UPLOAD

Returns: [Length] [OCR data] [Checksum]

Length is approximately 4.5 K bytes

DO DOWNLOAD

Format: **DO** [Length] [OCR data] [Checksum]

OCR data are the parameters necessary to set up OCR − the line items of the EG/OCR Setup Menu. Individual access to items 01−07 on the menu is not provided. Upon uploading the OCR setup, the setup record should reflect the current setup in the Vision Module − no further com−munication is necessary. After the host downloads the OCR setup, the prober (or handler) sends the setup data to the Vision Module.

Table added 5/14/96 per ProberVision Software REV DB

TABLE 8−2
UPLOAD/DOWNLOAD COMMANDS (continued)

MACHINE−DEPENDENT VARIABLES

UV UPLOAD
DV DOWNLOAD

A set of Machine−Dependent Variables (MDVs) can be maintained in battery−backed RAM and retained with a particular prober. They are not overwritten by download of setup files generated on another (or the same) prober.

Two commands, **UV** and **DV,** allow the user to upload and download the whole MDV block, respectively. The format for the data transfer is the standard block transfer method. These commands back up the MDVs in case the data becomes corrupted.

To ensure the integrity and validity of the data contained in the non−volatile memory, a Cyclic Redundancy Code (CRC) is generated on the MDV segment. The CRC is checked on power−up. If message #306 `(MDV BAD CRC, DEFAULT INIT REQD)` is displayed, the operator must press a key to continue.

Prior to executing the **UV** command, the CRC is verified. The **DV** command stores the received data in a buffer prior to writing it out to the MDV RAM. A CRC check is performed on this buffer.

Whenever a CRC check indicates corrupted data, the prober automatically defaults all of the MDV data region. The user has no control over this process, though he/she is notified (message #306) and must acknowledge the prompt. If the user has backed up the MDV data with the **UV** command prior to this event, the **DV** command can be used to restore the correct values.

If the CRC check indicates valid data, the buffer is written out to MDV RAM. If the CRC check indicates corrupted data, message #307 `(BAD MDV DOWNLOAD, NO CHANGE)` is displayed, "**MF**" is returned to external I/O, and no update occurs.

MDV VARIABLE	PARAMETER ACCESS
1. ALIGN ACCURACY MDVs:	
Align Qualification	Auto Align Options Menu −99 #01
Align Line Correction	Auto Align Options Menu −99 #02
Orthogonality	Auto Align Options Menu −99 #03
Settle Size	Auto Align Options Menu −97 #01
Settle Times	Auto Align Options Menu −97 #02
Theta Unload Steps	Auto Align Options Menu −97 #03
Micro Settle	Auto Align Options Menu −97 #05
2. OTHER MDVs	
Camera Position	Set in Profiler Menu, #08
Camera Z height *	Set in Profiler Menu, FIND TARG (F6 for RTM)
Home Position	(Currently not changeable by operator)
X, Y Camera Scale	(Currently not changeable by operator)
Zoom Focus Offset	Zoom Lens Diagnostics #05
3. MDVs which were formerly stored in the .PRM file:	
Wafer Loading Position	Material Handler Menu #02
Wafer Unloading Position	Material Handler Menu #02
Platen Coefficients	Temperature Compensation Menu #10 and #02
X, Y Location of NCES	Profiler Menu #02 (after edge profiled)
Z Scale (Z Stage Gear Ratio)	Set Parm Menu, Page 2, #01

*Camera Z height is the Z height when the bare chuck is in focus under the camera.

The terminator(s) are not counted as part of the 64−byte blocks. Therefore, if the terminator is CR and LF, each block of data (except possibly the last block) will contain 66 bytes (64 plus two for the terminator). If the GPIB port is used, the EOI bus line will also be asserted during transmission of the final character in each block. (This does not increase the block length since EOI is a signal on the bus, not a character.)

The first block of data which appears in the data file is the length field which states the number of bytes to follow. The last block of data is the checksum field. The length field does not count its own block of data, the terminator character(s), or the checksum field in the total count − only the actual data in between.

The information regarding data in the length field is useful when allocating memory on the host/tester to store the file. A typical program used to read the data file could use this information to determine how many blocks it needs to read.

It is usually sufficient to store the exact data sent by the prober, including length field, terminators, and checksum, for later download. This simplifies programming since the exact data file can then be returned to the prober.

Upload From Prober

The procedure for uploading (retrieving) data from the prober is:

1. The tester sends the appropriate upload command to the prober.

2. The system responds with information in a “line” format of 64 ASCII characters. A two−byte checksum follows at the end.

The data received is an exact image of the prober’s current parameter memory area, converted to hex ASCII. No interpretation of this data is required by the host; it is intended that the uploaded data simply be re−transmitted to the prober via the corresponding download command. In the standard protocol the default terminators are always “carriage return” and “line feed.” The prober also sends the angle bracket (>) prompt followed by the terminator(s) before sending the line (RS−232 only).

In the standard or enhanced protocol, the prober will send the first block (length block), wait for the tester/host to send the defined terminator character(s), and then send the next block. This will continue until the prober has sent all blocks to the tester/host.

Table 8−3 illustrates the exchange from the prober to the host over the RS−232 port. In this example, the user−defined terminator character is represented by “(t).” Therefore, if the selected terminator is CR (carriage return) only, substitute the **CR** character for the “(t)” symbol.

If the GPIB port is used, the same sequence is followed on the prober side; however, the GPIB port does not have an equivalent character (“>”) handshake sequence. The normal GPIB handshaking (NRFD, DAV, NDAC) is automatically used to slow down transmission and regulate the flow of data.

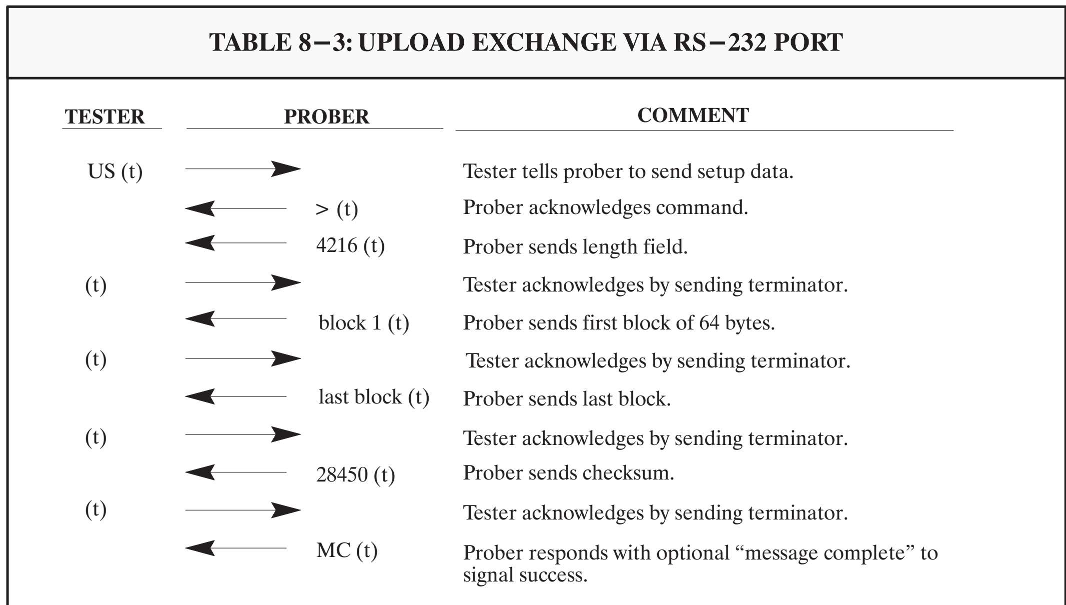


TABLE 8–3: UPLOAD EXCHANGE VIA RS–232 PORT

TESTER		PROBER	COMMENT
US (t)	→		Tester tells prober to send setup data.
	←	> (t)	Prober acknowledges command.
	←	4216 (t)	Prober sends length field.
(t)	→		Tester acknowledges by sending terminator.
	←	block 1 (t)	Prober sends first block of 64 bytes.
(t)	→		Tester acknowledges by sending terminator.
	←	last block (t)	Prober sends last block.
(t)	→		Tester acknowledges by sending terminator.
	←	28450 (t)	Prober sends checksum.
(t)	→		Tester acknowledges by sending terminator.
	←	MC (t)	Prober responds with optional “message complete” to signal success.

Instead of the terminator handshake [“(t)”] sent by the tester to the prober, the normal “SRQ/serial poll” sequence is used. If SRQ (Service ReQuest) is enabled, each line of data will be preceded by a service request. The host computer must respond to the SRQ with a serial poll and then read in the line.This sequence is completed for each block of data sent from the prober. For example:

Is the prober’s SRQ asserted?
If YES, issue SERIAL POLL:
– Read status byte (hex 40)
– Read map data
If NO, continue waiting for prober’s SRQ

This sequence of waiting for SRQ and reading the data is done for each block sent by the prober until the entire file is transferred. All communication between the tester and prober is based on the SRQ/serial poll sequence.

Download To Prober

Downloading to the prober works the same way as uploading. After the download command is sent by the tester, the prober expects a multiline data block of the exact size and format originally transmitted by the upload command (**Table 8–4**). Each line is composed of 64 ASCII data characters followed by the current terminator character.

When the RS–232 port is used with the standard or enhanced protocol, the prober cannot accept data as fast as it can be sent, and the angle bracket (”>”) prompt character is used to slow down the host transmission. After the command is sent, the host must wait for the prompt and terminator before sending the first block of data (length). Between each line of data the host must also wait for the prompt and user–defined terminators before sending the next line.

After completion, the second block can be sent. This sequence of "send data, wait for prompt, send data" is repeated for the entire data file. After the final line has been sent, the prober will verify that the checksum is correct and issue an optional **MC** or **MF** message (if enabled).

If the GPIB port is in use, the message will be sent "normally," that is, using SRQ if enabled. If downloading, the normal bus handshake lines (DAV, NRFD, NDAC) are used. The prober will assert the NRFD (Not Ready for Data) signal after each line has been received. Refer to Application Note C−005 for details of GPIB transmission.

After a successful download of Ink Dot Inspection or Probe Mark Inspection from External I/O, the "loaded" status (which appears on the inspection summary display), is set to `DISK` or `EXIO`, meaning that the inspection parameters were loaded from external I/O.

If the upload or download command does not complete successfully because the Vision Module does not support the option (IDI, PMI, or OCR), **MF** (optional) is returned and a message informs:

```
#39:  OPTION NOT INSTALLED
```

Other messages which may be seen during the upload and download of OCR are:

`#99    HANDLER DIAGNOSTICS IN PROGRESS`

`#128  OPTION NOT ENABLED` (Autoload not enabled)

`#123  FEATURE NOT SUPPORTED BY HANDLER` (Incorrect Handler PN)

`#268  ID READ IN PROGRESS`

`#269  VM COMMUNICATION ERROR` (Problem with Handler−VM communication)

TABLE 8−4: DOWNLOAD TO PROBER

TESTER	PROBER	COMMENT
DS (t)	→	Tester tells prober to get ready to receive setup data.
	← > (t)	Prober acknowledges command.
4216 (t)	→	Tester sends length field.
	← > (t)	Prober acknowledges by sending terminator.
block 1 (t)	→	Tester sends first block of 64 bytes.
	← > (t)	Prober acknowledges receiving block.
last block (t)	→	Tester sends last block.
	← > (t)	Prober acknowledges receiving block.
28450 (t)	→	Tester sends checksum.
	← MC (t)	Prober responds with optional "message complete" to signal success.

After a successful load of Ink Dot Inspection data, the Background Trained status is cleared, the Vision Module is updated, and the following message appears:

```
VERIFY INKER TO CAMERA OFFSET
AND TRAIN UN-INKED BACKGROUND
```

After a successful load of Probe Mark Inspection data from disk or from External I/O, the Loaded status is set to `DISK` or `EXIO`, the Vision Module is updated, and the following message appears:

```
VERIFY PROBE TO CAMERA OFFSET
AND CHECK FIRST PAD LOCATION
```

These messages which appear after loading Ink Dot or Probe Mark Inspection are displayed on lines 14 and 15 of the monitor screen and remain visible until a key is pressed.

Checksum Algorithm

The checksum is an unsigned 16 bit integer value which represents the sum of all data bytes modulo 65536. When the prober sends a data file to the tester, a checksum is appended to the end of the file. This checksum can be verified by the tester upon receipt of the file to validate the correctness of the data. It is usually sufficient to store the exact image of the data that the prober sent: each block of data plus the terminator and the checksum. The operation may then be reversed and the same "image" may be sent to the prober when requested.

The following procedure is used to calculate the checksum:

1. Initialize the checksum to 0.
2. Exclude the first block of data, the length block. Read a character and convert it to the decimal equivalent.

   For example, the character "2" converts to decimal 50; a "/" character would convert to its decimal equivalent of 47.
3. Add the decimal value to the checksum. For the number of bytes of data called out in the length block, repeat step 2. Do not include any carriage returns or line feeds in this process.
4. Calculate the checksum in either of the following ways:

   A. While the checksum is > 65535 subtract 65536. When the checksum is <= 655535 this becomes the file checksum and should match the checksum sent by the prober (as shown in the last block of the file).

   B. When step three is complete, perform modulus arithmetic on the accumulated checksum data. The form would be:

      (Accumulated Checksum) MOD 65536 = (Calculated Checksum)

   As in A., the calculated checksum should match the last block of the file.

8.4.3 MESSAGES

8.4.3.3 UNSOLICITED MESSAGES

Note that some messages described below are optional, meaning that they need to be explicitly enabled through the Enhanced External I/O Mode Menu (**Section 8.2.2**).

MESSAGE	DESCRIPTION
A **ALARM MESSAGE** *Optional* Format: **An**	Indicates a critical error has occurred. When ALARM MESSAGES is enabled (Line 09, Enhanced External I/O Menu), the prober will transmit **An** for any error that is shown with a leading "*" in the error list. These alarms can be sent at any time to the host/tester.

EXAMPLE: ***A17*** ➧ *MEANS NO WAFER ON CHUCK.*

MESSAGE	DESCRIPTION
AT **ATTENTION** Format: Press the < 5 > key (when the RUN TIME DISPLAY is shown on the screen). The prober must be "paused" or idle.	Issues an **AT** to the host/tester. It will be followed by the terminator character(s) defined in the I/O Control Menu. This may be used by the operator to signal completion of some task.
BC **BEGIN CASSETTE** *Optional* Format: **BCn** n = cassette number from 1 to 4 **NOTE**: As long as the **EC/BC** feature is enabled, they work as a pair. (For example, an **EC** will follow a **BC** even if all wafers fail alignment and no probing is done.) Therefore, **TS** does not have to follow the **BC.**	Issues a **BC** to signal the beginning of a new cassette when the first wafer of cassette "n" is loaded onto the chuck. The **BC** comes after the previous wafer's **PC** (Pattern Complete) and/or **EC** (End Cassette), and before the first die's **TS** (Test Start). When **EC/BC** is enabled, a **BC** will be issued when the next wafer is loaded onto the chuck. This message is enabled via the **SM67** command.
CO **CONTINUE** *Optional*	Issues a **CO** when probing is continued either by the <PAUSE/CONT> key or by External I/O (**PA** command).
EC **END CASSETTE** *Optional* Format: **ECn** n = cassette number from 1 to 4 (See **NOTE** in **BC** above.)	Indicates that processing of wafers from the current cassette has ended. The prober issues **EC** when the last wafer of cassette "n" is returned to its origin location, to indicate the end of processing for cassette "n". **EC** comes after the last wafer's **PC** (Pattern Complete) and before the next wafer's **BC** (Begin Cassette).

8.4.3.3 UNSOLICITED MESSAGES (continued)

MC or MF **MESSAGE COMPLETED OR FAILED**

Optional

MC = command completed correctly

MF = command failed

The table below identifies the commands by response category:

Issues an **MC** or **MF** message to the host/tester after certain commands are completed.

Most I/O commands fall into one of the four **MC/MF** response categories represented by Lines 01−04 of the Enhanced External I/O Mode Menu (**Table 8−1**): XY motion, Z motion, optional devices, and rest of commands.

It is highly recommended that these messages be enabled since they will result in a more robust test program.

RESPONSE CATEGORY	COMMANDS
MF/MC ON XY MOTION	FM, GF, HO, MD, MF, MM, MO, MP
MF/MC ON Z MOTION	MT, ZD, ZM, ZR, ZU
MF/MC ON OPTIONAL DEVICES	AA, BS, CP, CW, HW, LI, LO, LP, MW, PC, HS, PG, PH, PL, PO, PP, PW, PZ, RI, RP, UL, UW
MF/MC ON REST OF COMMANDS	**All commands not listed elsewhere**
ALWAYS (**always return** MC **or** MF)	DM, LM, MS
QUERIES (**do not return** MC **or** MF; **always return an answer**)	ID, ALL?
TEST START (**return only** TS**; if they fail, they return nothing**)	BA, CT, FC, PR*, ET, TC

* PR returns **SP** if sent from External Probe Mode.

MR **MAP RECEIVED**

Used only if wafer mapping and `WRITE MAP TO EXT I/O` are enabled.

Issues the **PC** message (if enabled) after the last die is tested. The prober then sends the **MR** message to the tester. This starts the transmission of the map to the tester.

For more information, see **Section 10 (WAFER MAPPING AND SECS).**

MT **MAP TRANSMIT**

Format: **MTi** i = ID read from the wafer (1−27 characters)

Used only if wafer mapping and `WRITE MAP TO EXT I/O` are enabled.

Issues the **MT** message to the tester after a wafer is loaded. If the wafer reader hardware is not in use, the prober will transmit the operator−entered run and lot numbers from the Run ID Menu and the prober−assigned sequence number in a format similar to that used by the **?W** I/O command.

For more information, see **Section 10** (**WAFER MAPPING AND SECS**).

PA **PAUSE/CONTINUE**

Optional

Issues the **PA** message after probing has been paused by the operator via the <PAUSE/CONT> key or by External I/O (**PA** command). The Z stage drops.

8.4.3.3 UNSOLICITED MESSAGES (continued)

PC **PATTERN COMPLETE**

Optional

Issues the **PC** message to the tester after the Test Complete message has been received by the prober for the last die in the pattern.

Referrring to selections in the Enhanced External I/O Mode Menu:

☞ If `PATTERN COMPLETE MESSAGE` (Line 07) is enabled, **PC** is sent after the last die in the pattern is completed but before the wafer is unloaded.

☞ If `WAFER COMPLETE MESSAGE` (Line 10) is enabled, **PC** is sent after the last die in the pattern is completed *but after* the wafer is unloaded.

☞ `ENHANCED PC MESSAGE` (Line 11) can be used with Line 10 only to provide more information (such as end of lot). The response is the same as **?C** but with a PC prefix:

PCPbLbSbRbW (see the **?C** command for details)

PP **PAUSE PENDING**

A complete description of the `PAUSE PENDING` message is given in **Table 8−1**.

Issues the **PP** message in external probe mode only when <PAUSE/CONT> is pressed. The Z stage does not drop.

This command is used to prevent the operator from taking prober control away from the tester until the tester is ready.

SP **START PROBING**

Issues the **SP** message to the tester when <AUTO PROBE> is pressed and Autoprobe mode 10 (`EXTRN`) is selected.

This command is used to tell the tester that probing can begin.

TC **TEST COMPLETE**

Format: **TCn** n = 0−31

Optional

Issues the **TC** message only in response to Test Complete signal from the tester interface (not from Standard I/O). Note that this interface only supports 32 bins.

If the signal is received on the tester interface, the bincode is accepted from the user interface and it is used for inking; it is then echoed to the host in the **TC** message.

HOST
TC SERIAL
PROBER
TESTER I/F
T
(TTL)
TC
Echoed from the tester to the host

8.4.3.3 UNSOLICITED MESSAGES (continued)

TS — TEST START

Optional

This message is sent in three forms:

- **TS** – used when coordinate reporting is disabled **(WM0)**
- **TSXnYn** – used when coordinate reporting is enabled **(WM1)**
- **TSSn** – used when microprobing is enabled Sn = site number "n"
- **TS,n** – used when Multi–Die probing is enabled n = on–wafer code

Issues the TS message after <AUTO PROBE> is pressed and the chuck has risen to contact the first die to be probed.

Each time the host sends the Test Complete (**TC**) message, the prober indexes to the next die in the pattern, raises the chuck, and transmits the Test Start message. When the last die is probed, the Pattern Complete message (**PC**) is sent (if enabled).

If the multi–die mode is enabled, this command also returns the "on–wafer" code. See **Section 9** of this manual for details on Multi–Die Probing.

NOTE: The **TS** message can be extended by enabling `ENHANCED TS MESSAGE` in the Enhanced External I/O Mode submenu. If this option is enabled, the prober will send:

- **TA** for `CONTINUE AFTER PAUSE`
- **TF** for `TEST FIRST DIE`
- **TM** for `TEST MICRO SITE`
- **TP** for perform continuity test
- **TR** for a retest or test cycle
- **TS** for `REGULAR TEST START`

EXAMPLES:

- ***TSX1Y–24*** ➧ *Coordinate reporting is enabled. Prober sends test start plus XY coordinates (1, – 24) to the tester.*
- ***TSS5*** ➧ *Test start for micro site #5.*
- ***TSX3Y18, 7*** ➧ *Coordinate reporting enabled; test start at (3, 18).*

UD — UGLY DIE REPORT

Optional

Format: **UDXnYnBn**

- **Xn** = X position
- **Yn** = Y position
- **Bn** = Ugly bincode

Issues the **UD** message for every ugly die encountered during probing if ugly die reporting is enabled.

Xn and Yn are absolute locations from First Die (same as **?P** command).

This message is enabled via the **SM57** command.

WB — WAFER BEGIN

Format: **WBIs** "s" = Wafer ID

Optional

This message is not supported in the probe modes OFF or EXTRN.

The ID shown (up to 27 characters) is for the wafer currently on the chucktop. If an ID reader is installed (OCR or barcode), the ID sent is the same as the actual wafer ID. If a reader is not installed (the ID is entered manually through the RUN–ID menu); the ID sent is in the form "D/L–N" (same as ?C command).

- D = Device type
- L = Lot Number
- N = Sequential number assigned by the prober

Issues the WB command after the probes have contacted the wafer, but before the first **TS** (Test Start) message is transmitted to the tester. It is enabled from the Enhanced External I/O Mode Menu, Page 2, Line 07.

The purpose of this message is to notify the tester/host that a wafer has been loaded and is about to be presented for testing. Based on the given wafer ID, the tester can reconfigure itself and/or modify test parameters as needed.

This is particularly useful for mixed lot testing and varying test parameters based on previous yields.

In the first example, note the use of the two delimiter characters "/" and "–" to separate the device type, lot number and sequential number:

EXAMPLES:

- ***WBIABCD/18A–87*** ➧ *(No ID reader installed) ID = ABCD18A87*
- ***WBI20A–326A–1–16*** ➧ *(ID reader installed) ID = 20A–326A–1–16*

See the Supplement at the end of the section for more information

8.5 RDP PROTOCOL

RDP is a serial protocol that drives the prober as a slave with the tester being the master. A separate I/O command set was created to support RDP. These commands are similar to the standard I/O set.

An application−specific command (called “AH”) allows the RDP protocol user to use the standard External I/O Interface commands not otherwise available. Other special commands include the upload and download data block commands, the application−specific command interpreter, and a command to load setup files from disk. The commands that follow are only those unique to RDP. Other RDP commands are listed with the standard command set.

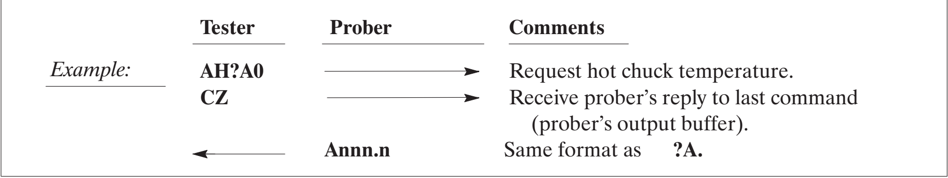
Updated 5/14/96

In the upgrade to Prober Vision REV DD, it is noted that RDP upload and download of setup are not compatible with revisions earlier than DB. Also, the Learn List RDP upload and download are not supported at this time.

AHs − HOOK TO STANDARD INTERPRETER

Allows the user to hook into the standard protocol interpreter. The string “s” should be an EG (non−RDP) command. If a command returns a message, use the RDP command **CZ** to retrieve data from the standard interpreter output buffer. (**CZ** is always used with **AH.**)

For example, the hot chuck command **?A** is not implemented in RDP protocol. Therefore, the command sequence would be:



	Tester	Prober	Comments
Example:	**AH?A0**	⟶	Request hot chuck temperature.
	CZ	⟶	Receive prober’s reply to last command (prober’s output buffer).
	⟵	**Annn.n**	Same format as **?A.**

Most standard Electroglas commands can be used with the “AH” prefix.

Updated 5/14/96

As of ProberVision software REV DB, RDP commands using the AH hook to standard EXIO commands get one command buffered. This allows testers to correctly operate with 2010X probers when using the AH command followed by the CZ command.

AKs − LOAD SETUP FILE

Valid only with the disk option. Loads file set “s” into the prober’s memory. File names are up to 8 characters long followed by a period and a 3−character extension. The prober assigns files with the extensions “.PRM” for parameter files, “.PRU” for auto align data, “.LRN” for learn lists, “.ROW” for row lists, “.MIC” for microdie site lists, and “.IDI” and “.PMI” for ink dot and probe mark inspection. A drive letter (set in the Disk Utility Menu) is optional; if omitted, the current drive setting will be used.

To load the parameter, Auto Align, and learn list files, three separate commands are needed:

AKC: −.PRM
−.PRU
−.LRN

Example: **AKC:DP999.LRN** will load the learn list file DP999 from drive C.

BA − BIN TO CATEGORY/INK (Format: BAn1,n2,n3[;n1,n2,n3])

This command causes the device to be binned according to bin "n3." Upon receipt of this command, the peripheral will index to the next device under test, and the "Test Start" flag will become true when the next device is in contact (see the **CE** command − **REQUEST TEST START** − immediately following).

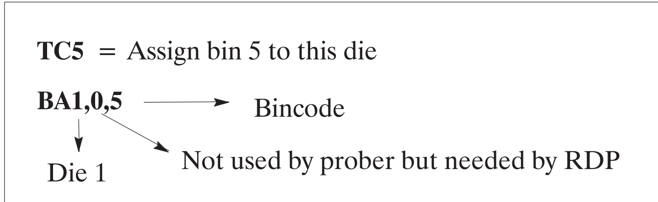
Values are:

n1 Specifies the site number for parallel testing (defaults to "1" for single testing).

n2 Value sent is ignored, but still needed as a place holder (0 is recommended).

n3 Defines the bin number for the device tested; this must be an ASCII integer in the range 0 − 255.

BA is the RDP equivalent of the standard **TC** (Test Complete). To illustrate:



For multiple die, the standard equivalent for **TC** is **ET.** The RDP equivalent stays the same, but more data is added. To illustrate:

ET5,9 = The first die gets assigned to bin 5, the second die to bin 9

BA1,0,5;2,0,9

Die 1 Die 2

Semicolon necessary to delineate die

EXAMPLES:

BA1,0,5 = Single die testing; send bincode 5.

BA1,0,5;2,0,9;3,0,0;4,0,6 − Multiple die testing (quad die probing).

To bin a single site to bin 3: **BA1,0,3**

To bin a dual probe configuration:
Site #1 as bin 2
Site #2 as bin 11 **BA1,0,2;2,0,11**

CA − REQUEST INHIBITS

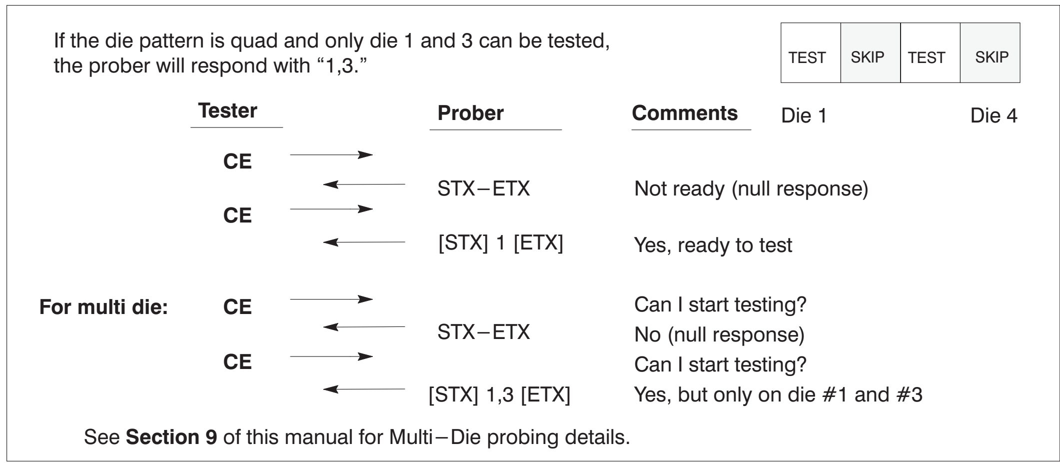
Similar to the **CO** command but it only returns an error for critical failures that result in probing being stopped. All other errors return a null (STX−ETX). Errors are also returned with an ASCII string for the message (the same message that appears on the prober's screen). The error number returned is the same as the standard **?E** command.

CE − REQUEST TEST START

Since RDP doesn't allow the prober to send messages unsolicited, the tester must ask if a TS is pending. It does this with the **CE** command.

CE allows the host to ask the prober if it can start testing. If the prober responds with NULL (STX−ETX), it cannot start. If the prober responds with "1," it can. For multi−die probing, the prober responds with multiple numbers corresponding to the sites that can be probed (similar to the "on−wafer code" of the standard Electroglas command set).

To illustrate the **CE** command:



CG – REQUEST XY POSITION

Response is **b1, b2,x,y.**

Returns the status of the "End of Wafer" (**b1**) and "End of Product" (**b2**) flags and the current XY die coordinate (x,y).

b1 is a "1" if the wafer is complete, "0" if not. **b1** must become true after the last die on the wafer is binned. (Equivalent to standard `PATTERN COMPLETE`.)

b2 is a "1" if there is no more product (the last wafer on the last cassette has been processed); **b2** must be valid when **b1** is true.

CU – REQUEST WAFER ID

Returns the ID of the wafer on the chucktop as read by the ID Reader or that was entered manually in the Run ID Menu (see the standard command **?W** or **?W0**).

CM – REQUEST OPTIONS

This is similar to the prober's standard ?O command but it only reports the first 4 bits (OMbAbPbBb).

CO – REQUEST ALL ERRORS

CO returns a single byte error code similar to the standard **?E** command. The codes are not identical since RDP restricts the code to a single, unsigned byte. Because of this restriction, most of the prober's errors cannot be uniquely identified (the range of error codes exceeds the value stored in one unsigned byte).

Error code 0 (from **?E**) is returned as a null (STX–EXT). Error code 1 is represented by the byte hex 41, code 2 by hex 42, etc. This continues until error 63 which maps to hex 7F. At error 64 (and 192 and 320) the codes start over again from hex 00 to hex 7F.

For example, see the table at the right:

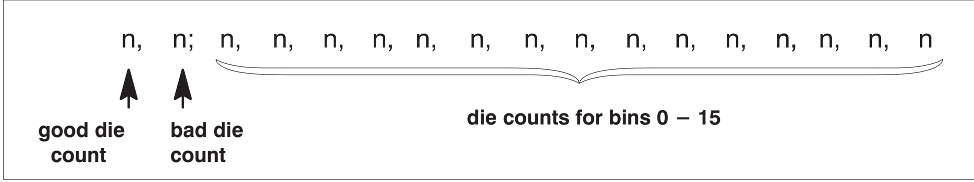
	?E	CO
no error	0	null
	1	41 hex
	2	42 hex
	.	.
	.	.
	63	7F hex
	64	0 hex
	.	.
	.	.
	191	7F hex
	192	0 hex
	.	.
	.	.
	319	7F hex
	etc.	

Obviously, this causes problems since the same error code is used to represent multiple errors. For this reason, it is recommended that **?E** command be used with the **AH** RDP command to retrieve the actual error code.

Where the **CA** command returns only an error response if the error will keep the machine from probing, the **CO** command returns the current error code whether the code is an error or a warning (learn list empty, etc.). It may be used instead of the **CA** command.

CP − REQUEST YIELD

Returns the yield data collected by the prober. The data returned is in the following form (spaces added for clarity):



Example: **13, 4; 0, 3, 6, 0 1, 0, 0, 0, 5, 2, 0, 0, 0, 0, 0**

Yield is 13 total good die, 4 total bad die.

Bin 1 = 3 Bin 4 = 1 Bin 9 = 2
Bin 2 = 6 Bin 8 = 5

CU − REQUEST WAFER ID

Same as the **CI** command.

CZ − REQUEST STANDARD MESSAGE

Returns the standard command interpreter's output message buffer. Typically used after the RDP command **AH**.

DAc,n1 − DATA BLOCK REQUEST TO RECEIVE

Requests the prober to prepare to send a data block to the tester; **c** defines the type of data to be sent, **n1** defines the block number being requested for the data type, "n2" is the peripheral's response. The selections supported by EG are:

c = b − Menu setup, including setup parameters and row, learn, and micro lists

= c − Alignment setup data

= g − Ink Dot Inspection data

= h − Probe Mark Inspection data

The **DA** command returns the number of blocks which must be transmitted to complete the transfer. Blocks are transmitted only in response to the **DB** command (explained next).

For example:

Prober		Tester	Comments
	←	DAb,0	Tester requests prober to send setup data to tester starting at block 0.
252	→		Prober says data to be sent is a total of 252 blocks. *
	←	DB	Tester asks for first block to be sent.
xx...xx	→		Repeated 252 times
	←	DB	
xx...xx	→		
	←	DC	Tester knows it's at last block so it requests checksum.
14743	→		Prober sends checksum.

* The peripheral will respond with the record count "n2," indicating how many records will be returned within that block. The number ranges from 0 to 255 with "0" indicating no records in that block and the previous block was the last block.

DB − REQUEST DATA BLOCK

RDP returns an 80−character block of data in response.

Example: The following dialogue shows parameter data being uploaded to the tester and then downloaded to the prober. In the example, only two blocks are sent; the actual number of data blocks will be much greater.

Tester	Prober	Comments
(UPLOAD FROM PROBER TO TESTER)		
DAb,0		Request upload of setup data (c = "b").
	2	Prober says it will send two blocks.
DB		Request first block.
	xx..xx	Prober sends first 80−character block.
DB		Request second block.
	xx..xx	Prober sends second block.
DC		Request checksum.
	3762	Prober sends checksum.
(DOWNLOAD FROM TESTER TO PROBER)		
DDb,0,2		Tell prober to receive two blocks of setup data.
	b,0,2	Prober echoes to confirm.
DExx..xx		Tester sends first block.
	1	Prober acknowledges receipt of block one.
DExx..xx		Tester sends second block.
	2	Prober acknowledges receipt of block two.
DC		Tester requests checksum.
	3762	Prober sends checksum.

DC – REQUEST CHECKSUM

Causes the prober to send a checksum of the entire upload or download, verifying that data was transferred without error.

DDc,n1,n2 – DATA BLOCK REQUEST TO SEND

Requests the prober to prepare to receive "n2" data blocks of type "c" (see **DA**). Actual block transfer is done via the **DE** command (following). Note that the **DD** command will echo "c,n1,n2" back to the tester. For example, sending **DDb,0,2** will cause the message "b,0,2" to be returned to the tester.

c = data type (b, c, g, or h)
n1 = starting block number *
n2 = record count (number of records to be sent) *
n2 = 0 means previous block sent was last block

** Range from 0 to 255*

Prober		Tester	Comments
	←	**DDb,0,252**	Tester asks prober to send first block of 252 total blocks of setup data ("b").
b,0,252	→		Prober acknowledges.
	←	**DExx...xx**	Data block sent.
1	→		Prober acknowledges block 1.
	←	**DExx...xx**	
2	→		Prober acknowledges block 2.
.	←	**DExx...xx**	Tester knows it's at last block so it requests checksum.
.			
.			
252	→		
	←	**DC**	Request checksum.
14743	→		Checksum data

DExx...xx – SEND NEXT DATA BLOCK

Requests the prober to add string "s" as the next block of the data block being transferred. The header precedes the actual data, and there are no spaces between **DE** and the data; for example:

DE319AF93014...

8.6 MESSAGE FORMAT, CODING, AND OTHER PROTOCOL

All message strings are coded in 7−bit ASCII. When message strings are sent by the prober, bit 8 equals 0. When message strings are received by the prober, bit 8 is ignored. Terminate message strings by the terminator defined in the I/0 Control Menu (Line 06).

When messages are sent from the prober on the GPIB port, the End or Identify (EOI) signal is always asserted. When messages are received by the prober, the messages can be terminated with the EOI signal concurrent with the last character of the message and/or with any of the three terminating characters. Use of EOI as the only terminating character is *not* recommended.

The GPIB−SRQ function is automatically on and may not be disabled in the standard protocol. It may be disabled in the enhanced protocol. Use of the SRQ line will make communications more reliable and predictable, however.

Before accessing the External I/O Mode Menu, select the Enhanced I/O Protocol (see **Section 8.2.2 − External I/O Mode**). The External I/O Mode Menu allows you to enable or disable the following messages:

- **MC** or **MF** messages for the X, Y, and Z motion commands
- **MC** or **MF** messages for the optional device commands as well as the remaining parameter commands. **MF/MC** response categories are given in **Table 8−5** below, as well as in the listings with the **MF/MC** commands.

TABLE 8−5: MF/MC RESPONSE CATEGORIES

RESPONSE CATEGORY	COMMANDS
MF/MC ON XY MOTION	FM, GF, HO, MD, MF, MM, MO, MP
MF/MC ON Z MOTION	MT, ZD, ZM, ZR, ZU
MF/MC ON OPTIONAL DEVICES	AA, BS, CP, CW, HW, LI, LO, LP, MW, PC, HS, PG, PH, PL, PO, PP, PW, PZ, RI, RP, UL, UW
MF/MC ON REST OF COMMANDS	**All commands not listed elsewhere**
ALWAYS (**always return** MC **or** MF)	DM, LM, MS
QUERIES (**do not return** MC **or** MF; **always return an answer)**	ID, ALL?
TEST START (**return only** TS**; if they fail, they return nothing)**	BA, CT, FC, PR, ET, TC

- Test Start and Test Complete messages
- Pattern Complete message
- Pause/Continue and Alarm messages

Messages sent to the prober are buffered one command at a time. Generally, messages cannot be processed as quickly as they are sent. To prevent data overrun, a simple protocol is used to signal the prober's readiness for input.

The GPIB port asserts the normal bus handshake (NDAV, NRFD, DAC) signal until the interface is ready to receive. The serial port uses the ">" character message plus the carriage return and line feed (or user−selected terminator). The host must wait for this prompt sequence before sending more data.

To send a message from the prober on the GPIB interface to the host, the prober uses the SRQ signal. In order to service this message, the host computer performs a serial poll. The host has up to 10 seconds within which to address the prober as the sender and accept the message. If this is not completed within 10 seconds, the prober issues a timeout; probing is aborted and the prober goes off−line.

The GPIB bus function DEVICE CLEAR may be used at any time to re−initialize the I/O port, which has the effect of clearing SRQ (if set) and clearing any messages that the prober is waiting to send. It does not change the prober's Offline/Online status. This should *not* be used in lieu of the standard SRQ/serial poll handshake sequence. Refer to application note C−005 for more information on the GPIB protocol.

8.7 PHYSICAL CONNECTION

8.7.1 RS−232 Signals

Serial interface signals are available at the connector marked "serial interface" on the rear panel of the Power Control Module. The connector is a female 25 pin D connector. The signals are listed in **Table 8−6**.

TABLE 8−6: SERIAL INTERFACE SIGNALS

CONNECTOR PINS	SIGNALS
2	Prober receives data on this pin
3	Prober transmits data on this pin
1	Ground

An inter−character delay between transmitted characters on RS−232 can be set or disabled through an item in the new I/O Control Menu, "`TRANSMIT DELAY IN MS`." If this delay is set to 0, it works like older revisions.

8.7.2 GPIB Signals

The GPIB interface signals are available at the connector marked GPIB on the rear panel of the Power Control Module. This interface implements the interface functions listed below (**Table 8−7**):

TABLE 8−7: GPIB INTERFACE FUNCTIONS

Function	Code
Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T5
Listener	L3
Service Request (Menu Selectable)	SR1

The host interface must implement not only the above functions but also the controller functions C1,C2,C3,C4, and C5. Select the device address, from 1 − 31, through the I/O Control Menu, Line 05 (see **Section 8.2.5**, **Line 05−B, GPIB Address**).

8.8 ERROR MESSAGES

The **?E** command returns a message in the format: En (where: n = a number from 0 − 999, the code of the last error that occurred). Any time an I/O command responds with **MF** (Motion Fail), the **?E** should be sent to return the error code. **E0** means no error.

As of Prober Vision Software REV DD, I/O error messages such as "FRAMING ERROR" are now displayed at the lower end of the RUN TIME DISPLAY for all I/O protocols (including BOCS).

Added 5/14/96

In addition to the **?E** command, alarm messages may be sent to the host computer. These messages take the form **An** (where: n = subset of numeric error codes).

An error condition on External I/O (timeout or abort) will abort probing with an appropriate error message. Messages are:

`EXTERNAL I/O ABORTED`

`EXTERNAL I/O FRAME ERROR`

`EXTERNAL I/O TIMEOUT A` Timeout occurred during receiving.

`EXTERNAL I/O TIMEOUT B` Timeout occurred during start of transmission.

`EXTERNAL I/O TIMEOUT C` Timeout occurred during transmission.

`EXTERNAL I/O TIMEOUT D` Timeout occurred during VERIFY.

NOTE: Not all timeout messages are available for all protocols.

8.9 COMMUNICATION ERRORS

In the following descriptions, **T1** and **T2** refer to the timeout timers 1 and 2 found in the I/O Control Menu on Lines 09 and 10.

These two timers are used in multiple cases; in general, **T1** is used for receive errors and **T2** is used for transmit errors.

8.9.1 Standard and Enhanced Protocol Errors

FRAMERR – Command is longer than 80 characters including the terminator (Serial or GPIB) or the parity is wrong (Serial).

TIMEOUT A – Greater than T1 milliseconds has occurred between any two characters (serial or GPIB).

Typically, the host has sent the wrong terminator to the prober.

This error will not occur until after the serial poll has been received (GPIB).

TIMEOUT B – SRQ was active for more than 60 seconds before the serial poll occurred. *This error will not occur until after the serial poll has been received (GPIB).*

Note that there is NO timeout for SRQ; the prober will assert SRQ for as long as it takes for the tester to service it. SRQ can be terminated manually by pressing <PAUSE/CONT> *or* <ON–LINE>.

Greater than T2 milliseconds has occurred between the completion of the serial poll disable command (SPD) and the prober being addressed to talk (GPIB only).

TIMEOUT C – Greater than T2 milliseconds has occurred between the sending of any two characters. *Indicates the host has quit handshaking (GPIB) or the host is holding the CTS line inactive (Serial).*

8.9.2 RDP Protocol Receive Errors

FRAMERR – Command is longer than 80 characters including the terminator. Parity, frame or overrun errors were detected.

TIMEOUT A – Greater than T1 milliseconds has occurred between the prober sending an ACK and the tester sending a STX.

8.9.3 RDP Protocol Transmit Errors

TIMEOUT B – Greater than T2 milliseconds has occurred between the prober sending an ENQ and the host responding with an ACK.

TIMEOUT D – Greater than T2 milliseconds has occurred between any two characters. *Indicates the host/tester is holding the CTS line inactive*.

TABLE 8–8: TIMER SUMMARY TABLE

TIMER1	TIMER2	SERIAL	GPIB	RDP
A		x	x	x
	B		x	x
C		x	x	
	D			x

8.10 SUMMARY

In this section, you have learned:

- How to set External I/O parameters through the I/O Control Menu
- How to enable/disable messages through the Enhanced External I/O Mode Menu
- How to use direct External Control commands
- A description of each command and message, in alphabetical order, by category
- RDP protocol command descriptions
- Information on message strings and physical connections
- IO error messages and communication errors

SUPPLEMENT

EXTERNAL CONTROL I/O INTERFACE

SECTION 8

254523−080 REV B

The following information includes additions and changes that apply to Section 8, External Control I/O Interface. It will be incorporated into the section with the next revision.

Each item in the Supplement contains a heading for identification. The heading at the left identifies the type of information (such as NEW or CHANGE) and the subject; the heading at the right classifies the information by the single or major subsection to which it relates and the title of that subsection. Information is given in section numerical order.

ADDITIONS:	**REF:** SECTION 8.2.1
(OMISSION)	I/O CONTROL MENU
	LINE 03 − I/O PORT

Testing of the I/O Port is possible through the Diagnostics Menu, illustrated on the next page. To access this menu, press < DIAG > (< F1 >) and select Line 03 `(EXTERNAL INPUT/OUTPUT)`.

A message to be sent may be defined by typing it in, and terminated by pressing < ENTER >. The message is sent each time the < PAUSE/CONT > key is pressed. Any complete command received by the prober will be displayed but not executed. Press < ENTER > twice to exit to the RUNTIME DISPLAY.

NOTES

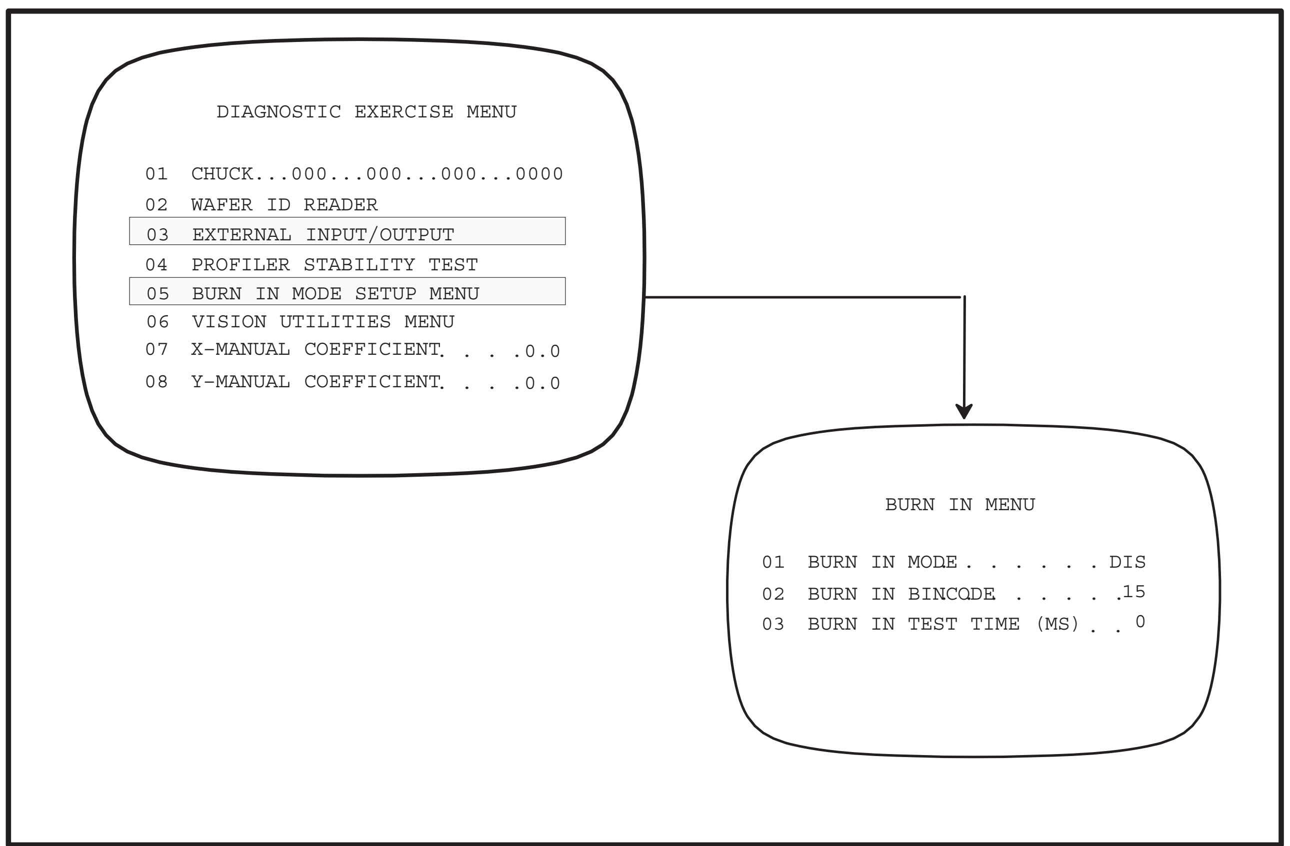
This function requires that a command from the host be properly terminated before the current receive buffer is displayed when the < X > key is pressed. This differs from the reaction to < X > when the RUN TIME DISPLAY is on the screen, when the buffer is displayed whether or not the command was terminated properly.

Here, the < X > key is used to display the most recent data received in ASCII hex. For example, if ABC is sent by the host, the prober would display:

41 42 43 0A (spaces for clarity)
A B C LF

If the < X > key is pressed a second time, the data is erased.

Messages sent by the prober are terminated by the current terminator sequence as defined in the I/O Control Menu. This exercise currently is used only when standard and enhanced protocols are selected. It does not apply to RDP or BOCS protocols since the data sent does not follow those protocols.



DIAGNOSTIC EXERCISE MENU

A burn–in feature, available through the Diagnostics Menu, allows the prober to be run continuously, until all wafers are probed, without a test time simulator plug. Through the tester interface port, the prober will loop back the TS (test start) and TC (test complete) signals.

To access the Diagnostics Menu, press < DIAG > (< F1 >) and select Line 05 (BURN IN MODE SETUP MENU). A Burn–In Menu appears. Through the line items of this menu, the bin code to be sent and the test time length can be set.

ADDITIONS:	**REF:** SECTION 8.4
NEW COMMANDS	COMMAND SUMMARY

Among other new or enhanced commands listed in this supplement are commands added to support Auto Wafer Sizing, Immediate Reader Update Mode, and Pattern Portability, to invoke PMI/PTPO analysis, provide control of the lamp pole light during IDLE, PAUSE, or ABORT states, and to change and query the state of the prober and handler’s burn–in mode. Descriptions follow.

ADDITIONS: NEW COMMANDS	**REF:** SECTION 8.4.1.2 SET MODE COMMANDS (SM)

Software Revision DD

Auto Wafer Sizing

SM105Sb – SET STOP BETWEEN CASSETTES

This command sets the value of the Stop Between Cassette (SBC) control variable:

b = 0: off
b = 1: stop only if cassette size is different
b = 2: always stop between cassettes

This command will return **MF** to the host if the handler does not support SBC for the current prober (that is, if it is a non–Auto Wafer Sizing machine). In addition, message #123, `FEATURE NOT SUPPORTED BY HANDLER,` will be displayed. If the handler supports SBC (for an AWS machine) or if **SM105S0** (disable SBC) is sent, **MC** will be returned and no message displayed.

?SM105 – QUERY STATE OF STOP BETWEEN CASSETTES

Returns **SM105Sb** where b is the current value of Stop Between Cassettes.

Immediate Reader Update Mode

For external I/O update of ID reader parameters, a new Immediate Reader Update Mode has been created in which ID Reader parameters are not saved by the prober if the handler is disabled.

This mode is called the Immediate ID Reader Update mode; it only affects the external I/O commands which change ID Reader setup (**SM 25, 26, 27, 37, 38, 72,** and **86** and the **SO** command) and only if the handler is disabled and it can only be enabled or disabled via external I/O.

The **SO0001** command no longer sends **MF**. The other ID reader commands will send **MF** if the 2010 handler is disabled but only if the new Immediate Reader Update mode is enabled. The default state, disabled, allows the prober to behave as before with respect to updating the ID Reader via external I/O; this is needed for backwards compatibility with current tester programs.

Support for RDP commands **AgR (SM25)** and **AEa (SM26, 27)** has been included in new software. Other ID Reader setup commands are hooked in by use of **AH.**

In the Immediate ID Reader Update mode, an external I/O command which attempts to change the ID Reader while the handler (auto–loading) is disabled will fail. **MF** will be returned to the host (if `"RESPONSE ON REST OF COMMANDS"` is enabled) and message #318 will be displayed:

`HANDLER NOT ENABLED`

There are two exceptions to the **MF** response.

One occurs when using the Set Option (**SO**) command with the first parameter = 0 (auto−loading disabled) and the fourth parameter (for ID Reader) either 1 or 0 (indicated here by x = don't care). **SO0xxx** will return **MC** as long as auto−align and profiler (2nd and 3rd parameters) can be set to the requested states. Message #318, however, will be displayed, followed by message #321:

```
ID READER NOT CHANGED
```

The other exception occurs when downloading a prober setup (**DS**) which disables handler−prober communication (auto−loading). In this case, the command is considered successful since the prober is set up, so an **MC** is returned to the host; however, message #318 is displayed. ID Reader parameters from the downloaded block will be discarded so that they will not overwrite the handler's setup when handler−prober communication is later enabled.

The external I/O support for setting and querying this new mode is:

SM111Ub
b = 0: disable
b = 1: enable Immediate ID Reader Update mode

?SM111
response: **SM111Ub**
b = 0: Immediate mode disabled,
b = 1: enabled

If Immediate Update is off, external I/O behaves as before; the ID setup change is saved on the prober side until the handler is enabled and **MC** is returned to the host.

A Manual ID mode has been created to allow manual ID entry during load. The default is "disabled". (This new variable is not connected to the old Wafer ID Reader variable.)

During the load wafer process, if Manual ID is enabled, the operator is prompted to `"PLEASE ENTER WAFER-ID"`; the current ID is displayed, allowing editing of the ID string. This mimics the standard method of manually entering a wafer ID during load.

The external I/O support for setting and querying this new parameter is:

SM110Mb
b = 0: disable
b = 1: enable Manual ID

?SM110
response: **SM110Mb**
b = 0: Manual ID disabled,
b = 1: enabled

Software Revision DF

SM115Bb − ENABLES / DISABLES THE PROBER'S BURN−IN MODE.

Where b = 0 disables / b = 1 enables

SM116Cc − ENABLES / DISABLES THE HANDLER'S BURN−IN MODE.

Where c = 0 disables / c = 1 enables

Different commands have been provided for changing and querying prober and handler burn−in modes because of their differences in functionality: the prober's burn−in is the test complete simulation, while the handler's burn−in is the wafer cycling.

SM119Pp − ENABLES/DISABLES PATTERN PORTABILITY MODE

Where p = 0 disables / p = 1 enables

For an explanation of Pattern Portability, see the supplement following Section 5, AUTO ALIGN.

ADDITIONS: NEW OR ENHANCED COMMANDS	**REF:** SECTION 8.4.1.3 MISCELLANEOUS SETUP COMMANDS

Software Revision DF

LCAmGnYnBn − SETS THE LAMP POLE LIGHT COLOR AND ALARM

This command sets the light to the preferred color regardless of the current light setting. In addition, the command makes it possible to turn on or off the "blinking."

"A" = Alarm
"G" = Green light
"Y" = Yellow light
"B" = Blue light

where n = 0 deactivates the light
n = 1 activates the light
n = 2 activates the light and "blink"

m = 0 deactivates the alarm
m = 1 activates the alarm

LEn − ENABLES OR DISABLES THE LIGHT ENHANCED MODE

Where b = 0 disables / b = 1 enables

SO – SET OPTIONS

A new bit has been added to this command to enable/disable PTPO:

```
SOxxxxxxxxxxx
            |______________ Enable/Disable PTPO (11th bit)
           |_______________ Enable/Disable PMI (during auto probing) (10th bit)
```

ADDITIONS: NEW COMMANDS and LIMITATION	**REF:** SECTION 8.4.2 ACTION COMMANDS

Software Revision DD

New External Control I/O Interface commands have been implemented for Auto Wafer Sizing.

?MDnS–1 will return cassette process status and cassette size for cassette n.

Returns **PbSs** where b = 1/0 (processed/not processed) and s = cassette size in inches.

?MDnWs (Query diameter of wafer in Device n, Slot s)

Returns **D###.#** where **###.#** is the wafer diameter in mm.

?SM70 (Query current cassette)

Returns **SM70Cm** where m = current cassette. (0 means no cassette set).

SA (SOUND ALARM) COMMAND

The **SA** (Sound Alarm) command causes the current process to go to the `PAUSE` state. If `"RESPONSE ON REST OF COMMANDS"` is enabled, one (and only one) **MC** or **MF** will be returned to the host in response to this command.

The external I/O is now allowed to continue the process that was `PAUSE`d.

If the prober receives the **SA** command while *not* in the `IDLE` state, the current process is halted, the alarm beeps continuously, and the prober goes to the `PAUSE` state (`"PAUSE"` is displayed on the RUN TIME DISPLAY). If the < PAUSE > key is pressed or **CE** received, the alarm is silenced but the state will remain `PAUSE`. The next < PAUSE > key or **PA** will cause the paused process to continue; the state on the RUN TIME DISPLAY will again show the current process.

If **SA** is received while the prober *is* in the `IDLE` state, the alarm sounds and the state remains `IDLE`. If **SA** is received while the prober is already in the `PAUSE` state with alarm sounding, then no change will occur; (the **SA** is considered successful).

While in the `PAUSE` state with the alarm sounding, XIO **PA** commands are ignored – the alarm must first be silenced (< PAUSE > key or **CE**) before the process can continue; this is the current behavior. The XIO sequence **SA PA**, therefore, will leave the prober in the `PAUSE` state with beeping The sequence **SA CE PA** will sound alarm, clear alarm, then continue the process.

A new command, **SAx,** turns the alarm buzzer “ON” or “OFF”.

The format is:

SAx	where	x = 1	means sound alarm
		x = 0	means turn alarm off.

SAx works *only when the prober is in an IDLE or PAUSEd state.* If **SA1** is received while a prober process is in progress, *it will not* turn the alarm “ON”; **MF** will be returned and error message #320 will display:

```
PAUSE PROCESS BEFORE CHANGING ALARM
```

If **SA1** is issued while the prober is in the `PAUSE` state, the alarm will start beeping. The `PAUSE`d process will not be allowed to continue until the alarm is turned off by a **SA0** command, a **CE** command, or by the < PAUSE > key; (the **PA** command will not work for turning off the alarm).

SA1 or **SA0** will not change the state of the current process.

Software Revision DF

IPXmYn – INVOKES THE PTPO CALCULATION

This command will automatically invoke the PTPO calculation at the end of the Probe Mark Inspection if the PTPO option is enabled.

PT – INVOKES THE PTPO CORRECTION

SA (limitation)

The **“SA”** command is not compatible with the new enhanced lamp pole commands with regards to stopping the alarm. The alarm can only be stopped by using the proper lamp command or the **“CE”** command.

ADDITIONS: NEW COMMANDS	**REF:** SECTION 8.4.3.1 QUERIES AND RESPONSES

Software Revision DD

?SM105 – QUERY STATE OF STOP BETWEEN CASSETTES

Returns **SM105Sb** where b is the current value of Stop Between Cassettes.

?SM110 − QUERIES THE MANUAL ID MODE

Returned message: **SM110Mb**

Where: b = 0: Manual ID disabled,
b = 1: Manual ID enabled

?SM111 − QUERIES THE IMMEDIATE READER UPDATE MODE

Returned message: **SM111Ub**

Where b = 0: Immediate mode disabled,
b = 1: Immediate mode enabled

Software Revision DF

?SM115 − QUERIES THE PROBER'S BURN−IN MODE STATE

Returned message: **SM115Bb**

Where b = 0 prober's burn−in mode is disabled.
b = 1 prober's burn−in mode is enabled.

?SM116 − QUERIES THE HANDLER'S BURN−IN MODE STATE

Returned message: **SM116Cc**

Where c = 0 handler's burn−in mode is disabled.
c = 1 handler's burn−in mode is enabled.

?SM119 − QUERIES THE PATTERN PORTABILITY STATE

Returned message: **SM119Pp**

Where p = 0 pattern portability is disabled.
p = 1 pattern portability is enabled.

?X010 − QUERIES THE RESULT OF PTPO CALCULATION

The response to this command is:

X010XnYnXdYdAaSs

Where:

n is the die coordinate position of the die inspected
d is the offset in 0.1 mil unit
a is the offset angle in radian
s is the status of the last PTPO calculation

s = 0 PTPO is successful; no need to do the PT correction.

In this release of software, you will receive s = 6 even if the offsets are very small. It is up to you to decide whether a correction is necessary or not by checking the returned offsets.

s = 6 PTPO is successful; need to do the PT command for PTPO correction

s = 11 PTPO is not successful; check the probe marks.

When s = 11, all offsets will be 0. If a PT command is sent, the prober will *still* perform the PTPO correction with no actual correction made.

ENHANCEMENT:
UP/DOWNLOAD FLEXIBILITY

REF: SECTION 8.4.3.2
UPLOAD/DOWNLOAD FEATURE

Software Revision DE

As of software Revision DE, an OCR file can be passed between prober models via external I/O without affecting the fielding. The only limitations are:

1. Old OCR files stored on a 2001CXE must be loaded to a 2001CXE.
2. Old OCR files stored on a 2010CXE, 3001X, or 4085X prober must be loaded to a 2010CXE, 3001X, or 4085X prober.
3. Old software (pre−Revision DE) will not correctly load a REV DE OCR file stored on a 2010CXE, 3001X, or 4085X prober.

On upload of the parameter file, with Pattern Portability Mode enabled, the profile options “PROFILE BEFORE ALIGN” and “PROFILE WITH FIND CENTER” will not be automatically enabled, and no message will appear warning that they are not enabled since they will be enabled when needed by the “FIND TARG”, “ALIGN”, and “AUTOPROBE” functions.

LIMITATION:
RDP UP/DOWNLOAD

REF: 8.5
RDP PROTOCOL

Software Revision DF

The EXIO RDP communication mode has a problem when trying to up/download the LEARN list and OCR setup files. This feature is *not* supported at this time.

SECTION 9
MULTI−DIE PROBING

9.1 OVERVIEW

Multi−Die Probing allows arrays of two, four, or eight die to be probed simultaneously. Arrays can be oriented horizontally, vertically, or (except for octal probing) diagonally. This orientation, or probe pattern, is called a *location code*.

Upon completion of profiling, Auto Aligning and other preparation, the forcer moves to the operator−selected First Die. A slight pause in prober operation occurs as the system generates an internal generic map representing the whole wafer in memory. Upon completion of the map, the forcer moves to a prober−selected First Die.

Wafers that have been probed by the Multi−Die process can be inked offline or by the post−probe method, which allows the wafer to be inked after it is probed but before it is unloaded.

When Multi−Die Probing returns both good and bad bincodes from a single test, both counters are updated on the Run Time Display.

9.1.1 How To Use This Section

This section contains the following information about Multi−Die Probing:

- Location codes and their importance for proper stepping
- The Generic Map and how it relates to Multi−Die
- The prerequisites required before using Multi−Die Probing
- Enabling Multi−Die Probing in the software
- Setup instructions for the two methods of Multi−Die inking: post−probe and offline
- How to use the wafer code method to communicate die sites to the tester
- Information on External I/O commands relating to Multi−Die Probing

9.2 LOCATION CODE

The location code determines the multiple die orientation, or pattern, used in stepping across the wafer: vertical, horizontal, or diagonal. Dual and quad die probing can be oriented in any of the three patterns; octal die probing is limited to vertical or horizontal orientations. As illustrated in *Figure 9−1,* each pattern is represented by a code value from 0 (single die) to 10 (quad or octal). Die are numbered from die0 to die7. Multiple die arrays begin with die0. The distinction between the individual die in the array is critical to Multi−Die probing.

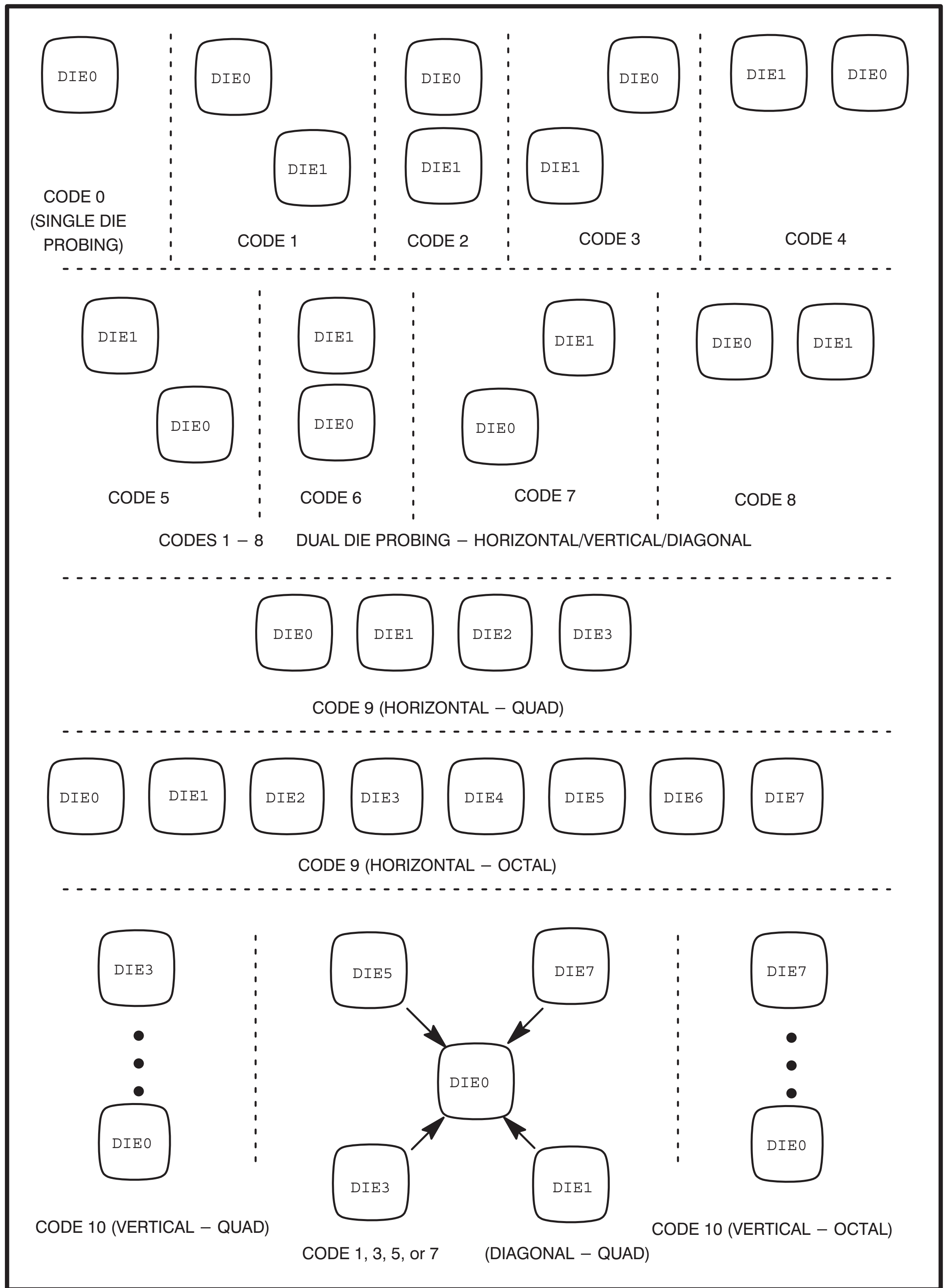


FIGURE 9–1: LOCATION CODES

Die0 is called the reference or *base die* in the probe array. This base die is used as a reference point when reporting XY die coordinates. It is used to set probe tip center, First Die, and inker position. It is also the die used by the prober to respond to a host's request for coordinate data (using the I/O command "?P), the die position reported when enhanced TS (test start) is enabled ("TSXnYn"), and the position used for indexed moves (for example, the "MO" and "MD" I/O commands).

Location codes 1, 3, 5, and 7 (diagonal orientations) are used for both dual and quad die probing. If one of these codes is selected, you are asked to choose between the dual or quad die patterns. Location codes 9 and 10 also serve a dual purpose. They define the horizontal and vertical patterns for either quad or octal arrays, depending on a menu setting. Once a location code is selected, the operator setup is identical to single die probing. No special setup is needed to accommodate the larger probe array.

9.3 GENERATION OF THE GENERIC MAP

Created in the prober's memory just prior to probing, the *generic map* is an image of the wafer based on die size and wafer diameter. The generic map is used by the prober to optimize movements across the wafer. If wafer mapping is enabled in the Set Option Menu, the map is converted to a SECS wafer map after the wafer has completed test.

The generic map is a two−dimensional array of elements containing bin data (0 to 255) and status data. Each element represents a die on the wafer. Prior to probing, the number of elements in the array are computed dividing the wafer diameter by the X and Y die sizes, adjusted to ensure an even number of elements in each.

There is a distinction between the operator selected First Die and the prober−selected First Die. The prober calculates the optimal starting point for the multiple die pattern selected. This may or may not be the same First Die selected by the operator; depending on the application, this may or may not be an issue.

If the tester depends on First Die being at a particular coordinate, then the dual First Die may be a problem. Usually, the order in which the die are tested is immaterial as long as all the die are tested. In reality, the prober will select a First Die in one of the four corners of the wafer (depending on the starting probe quadrant). This First Die position is for the reference die, die0. Since Multi−Die probing is only available in circular or row mode, other autoprobe patterns are not affected.

In the prober, the probe tip center and First Die coordinates are maintained as absolute motor steps. The element in the generic map whose coordinates correspond to X/2 and Y/2 is equated to the probe tip center. The X and Y offsets of First Die from the probe tip center are now converted to die increments and are applied to the generic map probe tip center to locate First Die in the generic map coordinates. At this point the generic map elements whose coordinates fall within the wafer diameter or row list are selected for probing. If the skipdie option is enabled, any die in the learn list are added to the generic map and labeled as skipdie.

The operator setup needn't change to accommodate the prober−selected First Die. To minimize operator interaction, select a die near the center of the wafer because once the wafer is aligned, it is automatically positioned in the approximate center of the probe array. It is efficient to leave it there and choose the closest testable die near the center for final probe−to−pad alignment, then press the < FIRST > key to set this position. This operator−selected First Die position will be stored with the target data for auto alignment. The prober−selected First Die will be chosen at run time, when the < AUTO PROBE > key is pressed.

Note that the operator−selected First Die is not necessarily the First Die to be probed. It is simply a reference to build the generic map and a link between the generic map coordinate system and the prober coordinate system.

The First Die to be probed is found by traversing the generic map array from top to bottom or bottom to top, depending on the probe quadrant chosen, and locating the first element (die) selected for probing. The prober will attempt to select a First Die position such that all die in the array will fit on the wafer (*Figure 9−2*).

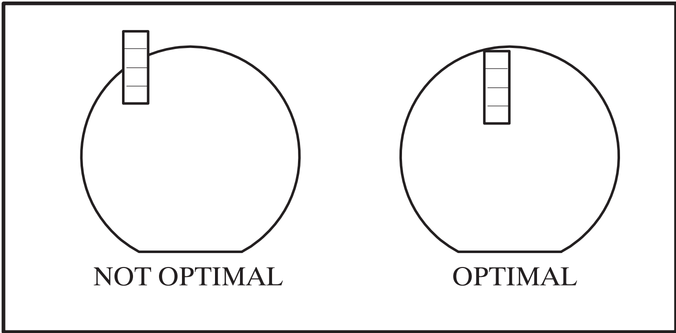


FIGURE 9−2: OPTIMAL VS. NON−OPTIMAL FIRST DIE LOCATION

9.4 MULTI−DIE PREREQUISITES

Multi−Die Probing requires that the auto−probe pattern be set to either Row or Circular in the Set Mode Menu (*Figure 9−3*). If Row mode is used, it is set up the same as it would be for single die except that the starting and ending coordinates are based on die0.

PROBER

```
SET MODE MENU

 1  METRIC/ENGLISH ...........  ENGLISH
 2  AUTO-PROBE PATTERN .......      ROW
 3  PROBING MODE                   MENU
 4  Z-TRAVELING MODE ..........  LIMITS
 5  MICRO PROBING ..................DIS
 6  MULTI DIE PROBING  ............DIS
 7  I/O CONTROL                    MENU
 8  DATA LOGGING MODE              MENU
 9  MISCELLANEOUS OPTIONS          MENU
10  ASSIGN LOGICAL INK-CODE        MENU
11  THETA COMPENSATION MODE...      ENB

  LINE =
```

FIGURE 9−3: SET MODE MENU

To maximize the prober's selection of First Die, the PROFILE WITH FIND CENTER, ENHANCED PROFILE, and USE AUTO DIAMETER options should be enabled through the Autoprofiler Option Menu (*Figure 9−4*).

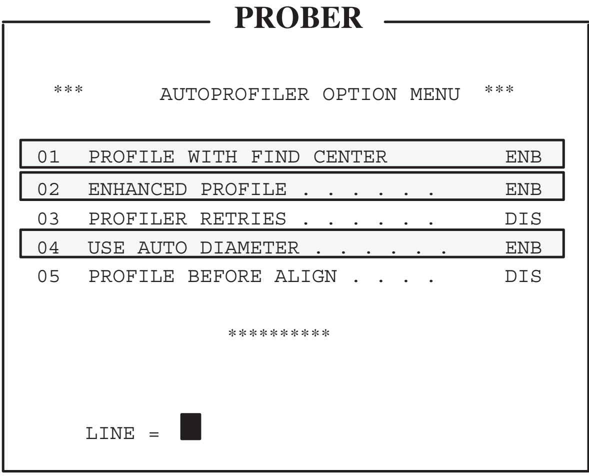


FIGURE 9−4: AUTOPROFILER OPTION MENU

Also, probe tip center should be accurately set to the innermost vacuum ring on the bare chucktop. These precautions will minimize errors in the profiler algorithm when the wafer diameter is calculated.

9.5 THE MULTI−PROBE PARAMETERS MENU

To enable Multi−Die Probing, press < SET MODE > (< F2 >) to access the Set Mode Menu (*Figure 9−5*), and then select Line 06. The Multi−Probe Parameters Menu (*Figure 9−6*) displays. Below the menu, a location display of relative array patterns is shown.

```
PROBER

SET MODE MENU

 1  METRIC/ENGLISH ...........  ENGLISH
 2  AUTO-PROBE PATTERN .......      ROW
 3  PROBING MODE                   MENU
 4  Z-TRAVELING MODE ..........  LIMITS
 5  MICRO PROBING ..................DIS
 6  MULTI DIE PROBING  .............ENB
 7  I/O CONTROL                    MENU
 8  DATA LOGGING MODE              MENU
 9  MISCELLANEOUS OPTIONS          MENU
10  ASSIGN LOGICAL INK-CODE        MENU
11  THETA COMPENSATION MODE...      ENB

  LINE =
```

FIGURE 9−5: SET MODE MENU

```
PROBER
MULTI-PROBE PARAMETERS

01   OCTAL PROBE ARRAYS . . . . . DIS
02   LOCATION CODE  . . . . . . .   0
03   INK AFTER PROBING  . . . . . DIS
04   RESTART AFTER INK PAUSE  . . DIS
05   ALWAYS SET PPI Z HEIGHT  . . DIS

     DUAL      QUAD      *
     5 6 7               *
     4 0 8      (9)      *    (10)
     3 2 1    0 * * *    0

  LINE =
```

FIGURE 9−6: MULTI−PROBE PARAMETERS MENU WITH LOCATION CODE DISPLAY

9.5.1 Multi−Probe Parameters Line Items

LINE 01 OCTAL PROBE ARRAYS

The setting of Line 01 determines the orientation to be followed − quad or octal − when code 9 or 10 is selected in Line 02, LOCATION CODE.

LINE 02 LOCATION CODE

Location codes, as discussed in **Section 9.2**, are used to describe the probe array orientation used in Multi−Die probing. Line 02 allows the user to select from 11 different array patterns.

Location codes range from 0 (single die probing) to 10 (vertical probing of four or eight die). Selecting locations 1 through 8 allows probing of two die or four at a time. Selecting locations 9 or 10 allows probing of four or eight die at a time, depending on the setting of Line 01.

If Line 01 is enabled, then codes 9 and 10 in Line 02 will define probe arrays of eight die each; code 9 horizontal, code 10 vertical. If Line 01 is disabled, codes 9 and 10 will represent horizontal and vertical probe arrays of four die each.

Diagonal probe arrays are not supported for octal configurations. Location codes 0 − 8 are invalid for octal arrays; if any of those codes is selected, the prober will probe a die array. The prober will not warn you if you select octal with an invalid code.

The 3 X 3 matrix at the left in the location code display represents the eight dual and quad die orientations available (location codes 1 − 8). The center of the matrix represents die0 reference (and also code 0 for single die probing).

Dual and quad die arrays can be probed horizontally (codes 4 and 8, as shown in *Figure 9−1*), vertically (codes 2 and 6), or diagonally (codes 1, 3, 5, and 7). If code 1, 3, 5, or 7 are selected, a message on the screen will prompt: `QUAD DIE PROBING? (Y/ENTER)`. If < Y > is selected, the display heading over the matrix will change from `DUAL` to `QUAD`.

Regardless of the setting of Line 01, only the quad pattern is displayed, showing the orientation for the horizontal (9) and vertical (10) location codes. If Line 01 shows `ENB` on the menu above, octal is assumed.

To select the appropriate location code, match the probe pattern array of the probe card to the desired orientation. For example, if probing dual die diagonal, select code 1, 3, 5, or 7, depending on the alignment of the probe card and the position of die0. To compare the orientations with the matrix, refer to *Figures 9−1* and *9−6.*

LINE 03 INK AFTER PROBING

This line item enables/disables the post−probe inking function, described in **Section 9.6.1**.

When the line is enabled, the wafer will be probed, inked, and unloaded.

When the line is disabled, the wafer will be off−loaded and *not inked*. If a wafer map was generated at probe and stored, inking can be done off line (see **Section 9.6.2, Offline Inking**). Otherwise, if a wafer map was not stored, when this line is disabled the binning data will be lost.

LINE 04 RESTART AFTER INK PAUSE

This line item allows you to determine the action taken if post−probe inking is interrupted by pressing < PAUSE >.

If the Line 04 is enabled and < PAUSE > is pressed three times (twice to pause and once to continue probing), the wafer will be *re−inked* starting at the First Die. This is useful if the inker malfunctioned or ran out of ink in the middle of the wafer and the wafer needed to be re−inked.

If the line is disabled and probing is paused and continued, inking will continue from the last die inked.

LINE 05 ALWAYS SET PPI Z HEIGHT

If this line is enabled, the Post Probe Inker (PPI) Setup Menu will always record the XY position of the forcer as well as the Z height when the inker position is being recorded. If the option is disabled, Line 9 in the Post Probe Inker Setup Menu will ask for an offset down from the probing height if the Z traveling mode is set to Autoprofile.

9.6 INKING MULTI−DIE

There are two methods of inking multiple die products:

1. Post−Probe (**Section 9.6.1**)
2. Offline (**Section 9.6.2**)

9.6.1 Post−Probe Inking (PPI)

Post−Probe Inking (PPI) is the method used to ink the wafer after it is probed, but before it is unloaded. It operates in a serpentine manner similar to circular probing, and will not ink if the inkers have been disabled. A special post−probe inker setup procedure facilitates setting the Z position of the inker(s); it is described in **Section 9.6.1.1**.

In PPI, after the wafer is probed, the chuck moves the wafer under the inker(s) at the position of the First Die to be inked (which may or may not be the First Die probed), and all die are inked.

The prober follows the internal wafer map (generated during initial probing) to ink the die based on the stored bincodes and on−wafer code for each die position. (See **Section 9.7.1** for information about on−wafer codes). Inking is done one die at a time (no multiple die inking). Edge die and skip die can be inked at this time, too, but ugly die inking is not supported. Once inking is finished, the wafer is unloaded.

This feature can also be used for single die probing if the location code in the Multi−Probe Parameters Menu is set to 0 (see **Section 9.5.1,** Line 02, Location Code).

The inker can be fired anywhere on the wafer, and then the dot is brought to the probe tips. You press a key to inform the prober that the dot is in place. PPI uses the positioning adjustments provided as an output of the Auto Align process to position each wafer under the inker.

NOTE

The offset from the probe tips to the Post Probe Inker will be calculated based on the most recent firing of the inker. Therefore, when an acceptable ink dot is produced, that ink dot must be placed under the probe tips and taught to the prober with the < 7 > key without any further firing of the inkers in order to correctly set up the Post Probe Inker. (See *Figure 9−8).*

PPI warns you about jogging the Z position above the probing height when using the Z profile mode. In addition, when a new probing height is established, the PPI height will be cleared (unless it was set as an offset from the probe tips, in which case it will be adjusted).

The probing procedure ensures that if post probe inking is to be used, there is a valid setup before probing the wafer.

9.6.1.1 POST−PROBE INKING SETUP PROCEDURE

NOTE

The PPI setup procedures will not prevent you from exceeding the probing height (in the Profile mode) or the upper limit (in any other mode) while jogging the Z position.

The operation is similar to that of the Profiler Menu in that Z motion is first stopped at the nominal upper limit, and then you are forced to restart the upward motion every 10 mils. For the entire time that the Z position is above the nominal upper limit, there is a constant beeping.

Up to four inkers can be used for post−probe inking. If more than one inker is used, all of them must be placed over the same die (a separate inker over each die is not supported). The XY position of the inker is assumed to be the center of die0.

The inker(s) used during PPI must be assigned a Z reference and should be done just after finishing the set probe tip center procedure.

To perform the PPI setup procedure:

1. Begin with a bare chucktop (no wafer).

2. Using the Joystick, move the forcer until it is under the inker(s). The bottom of the ink tube(s) should be positioned over the center of the chucktop (the center of the smallest vacuum ring). See *Figure 9−7.*

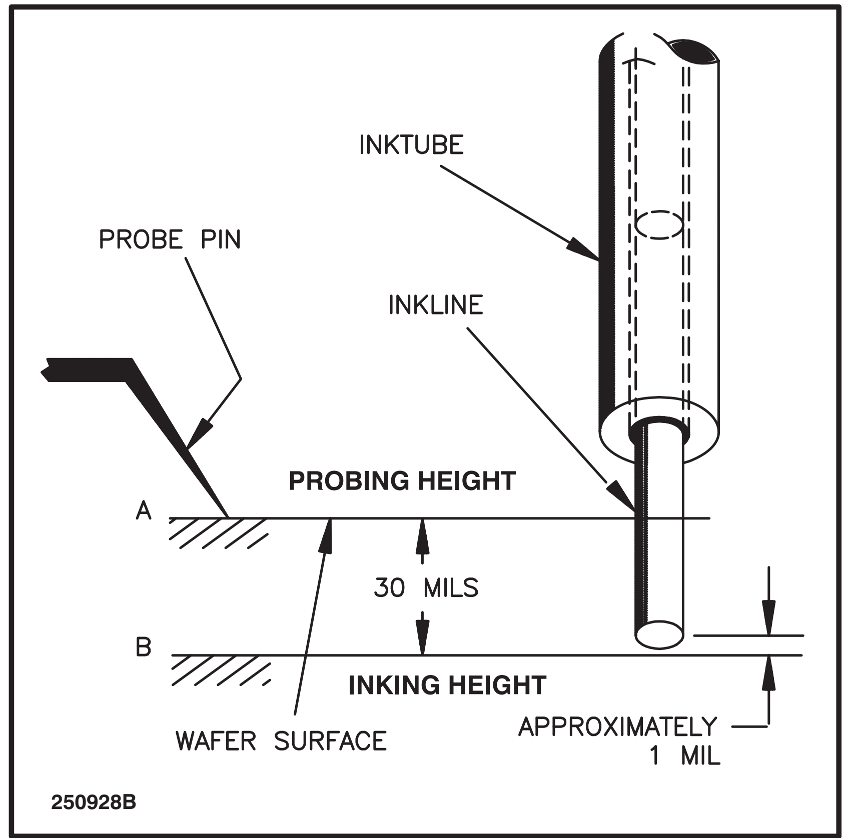


FIGURE 9−7: FRONT VIEW OF INK TUBE AND INKLINE

3. Set the inker(s) Z height, ink dot size, pulse width, and refresh time by accessing the Post−Probe Inker Setup Menu (*Figure 9−8*).

   A. Press < SET MODE > (< F2 >) to access the Set Mode Menu.

   B. Select Line 03, PROBING MODE, and press < ENTER > to display the Probe Mode Menu.

   C. Select Line 11, INKING MODE, and press < ENTER > to display the Inking Mode Menu.

   D. Select Line 10, POST PROBE INKING SETUP, and press < ENTER > to display the Post−Probe Inker Setup Menu.

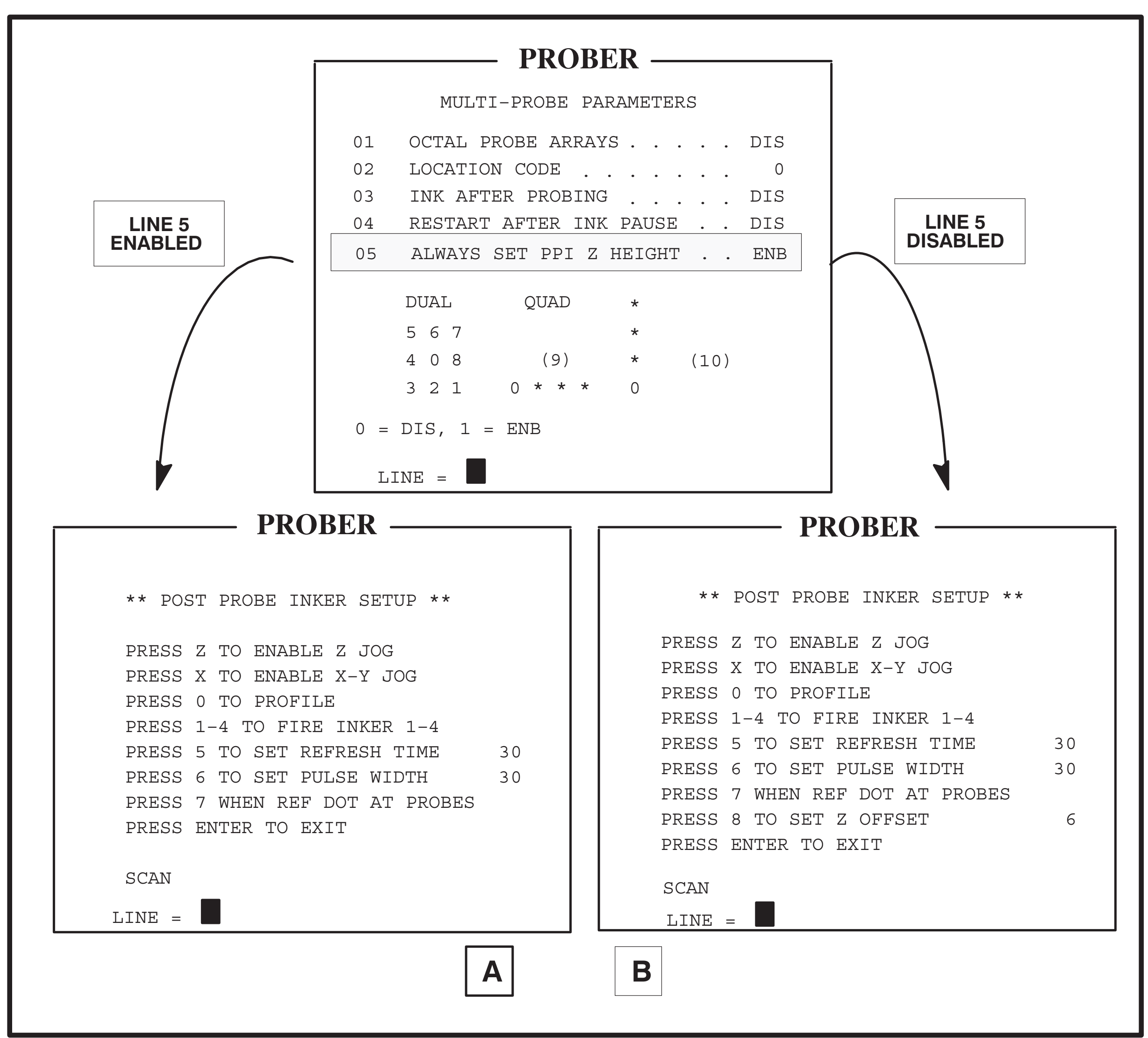


FIGURE 9–8: POST–PROBE INKER SETUP MENU

4. Set the PPI Height. A choice of two methods is available for setting the PPI inker height:

   1. Fixed Offset

   2. PPI Height Teaching

FIXED OFFSET METHOD

The PPI height is set as a fixed offset down from the probing height. This is the default method when the Z travel mode is Profile. This default can be changed by enabling the `ALWAYS SET PPI Z HEIGHT` option on Line 05 of the Multi−Probe Parameters Menu (*Figure 9−6*).

If the PPI inker height is being set as an offset down from the probe tips, the PPI Setup Menu will display the lines shown in *Figure 9−8A*.

To set the inker position in the Fixed Offset mode:

1. Place a scrap wafer on the chucktop; or, select a good wafer with test die or bare silicon area that can be used to test the position of the inker(s).
2. If the profiler is enabled, press < 0 > to profile the wafer surface.
3. Move the forcer until the wafer (or test die/bare silicon area) appears below the ink tube(s).
4. Position any arbitrary location under the inker and press the key which will fire the appropriate inker (key < 1 > to < 4 >). (Before firing the inker, the prober will move the chuck up to the appropriate inking height.) Check the ink dot for size, shape, and position.
5. If the ink dot is not acceptable, press < 8 > to re−enter the inker offset. You can also raise or lower the Z stage or adjust the ink pulse width to a value from 5 to 30 mS (key < 6 >).
6. Press < 5 > to check or change the inker refresh time (minimum time between inker activations); the range is from 0 to 999 mS.
7. Press < 6 > to check or change the pulse width to a value from 5 to 30 mS.

   Note that the inker pulse width and refresh time may also be changed from the Ink Dot Counter and Timer Menu (accessed from the Set Parameter Menu, Page 2, Line 06, INK DOT COUNTER AND TIMER).
8. Once the desired ink dot dimension and position is obtained, place that ink dot under the probe tips and press < 7 > to set the inker height. Post−probe inking will be done at this fixed Z height (the chucktop will not move).
9. Verify the Z heights of the ink tube, probe pins, and ink line extension, as shown in *Figure 9−7*. Fine tune the inker Z if needed.

PPI HEIGHT TEACHING METHOD

This method is used in the Limits or Edge Sense Z traveling modes, or when the `ALWAYS SET PPI Z HEIGHT` option on Line 05 of the Multi−Probe Parameters Menu (*Figure 9−6*) is enabled.

If the PPI inker height is to be directly taught to the prober, the PPI Setup Menu displays the lines shown in *Figure 9−8B.*

To set the inker position in the Teaching mode:

1. Position any arbitrary location under the inker.
2. Press < Z > and jog up to the desired inking height.
3. Fire the appropriate inker (press key < 1 > to < 4 >).
4. If the ink dot is not acceptable, jog to the new Z height and fire the inker again.
5. When an acceptable ink dot has been made, place that ink dot under the probe tips and press < 7 >.

NOTE

Whenever the Z stage is moved to obtain the desired ink dot size, the inker height must always be reset.

The Z stage will move down to Z−200 upon exit from the Post−Probe Inker Setup Menu; it will move to the preset inking height when the inker is fired.

Further information about post−probe inking setup and high speed inking applications is contained in the **Inker Installation and Operation Manual, Doc. No. 246730**.

9.6.2 Offline Inking

Offline inking follows a prober−generated wafer map. This map contains the XY coordinate and bincode data of each tested die. The prober follows this map, inking according to the stored bincodes.

If the Wafer Mapping feature is enabled, the internal generic map generated by the prober during testing will be converted into a SECS II wafer map. This wafer map can then be written to a disk and/or transmitted to an external host. Once this map is saved, it can be used to control an offline inking station.

The Wafer Mapping setup is discussed in **Section 10, WAFER MAPPING AND SECS**.

9.7 USING EXTERNAL CONTROL I/O INTERFACE

Three communication protocols can be used to interface the tester with the prober: standard or enhanced serial (RS−232); standard or enhanced GPIB (IEEE−488); or RDP.

The use of the parallel port/tester interface (TTL) is not recommended. The TTL port offers limited support for multiple die applications.

9.7.1 On−Wafer Code

Because the prober is stepping across multiple die sites, not all of the steps will place all of the probe tips for each die on a testable site.

If skip die are used (test die or bare silicon areas), the prober must tell the tester that these die sites are not available for testing.

Also, as the prober turns around from one row to the next, some of the probes may be hanging off the edge of the wafer. Again, the tester needs to know that not all the die on the probe array are testable. This is the function of the *on−wafer code*.

This code is appended to the test start (“TS”) command from the prober and represents the die in the probe array that are to be tested. The code is a decimal number that ranges from 0 to 255 (0−3 for dual arrays, 0−15 for quad arrays, and 0−255 for octal arrays). The on−wafer code will always be separated from “TS” by a comma.

Each testable die in the probe array is represented internally by a bit in the on−wafer code. For example (*Figure 9−9*):

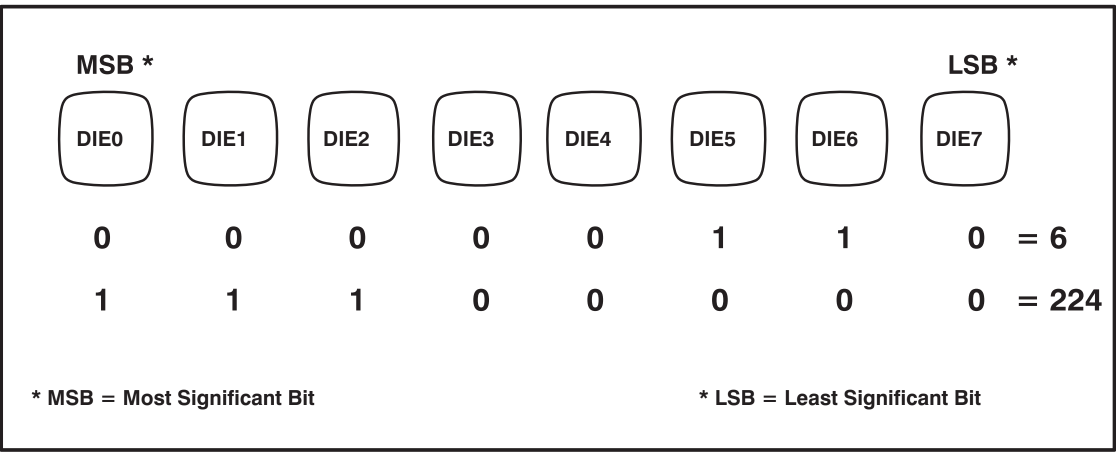


FIGURE 9−9: ON WAFER CODE EXAMPLE

In the above example, if die0, die1, and die2 are testable, then the on−wafer code is 224; the decimal would be TS,224.

Conversely, if the on−wafer code = 6, die5 and die6 are testable.

For another example, if the prober sends:

“TS,14”

this means that the on−wafer code for this position is 14 (*Figure 9−10*). If the probe array is set for quad probing and an on−wafer code of 14 is sent, then die1, die2, and die3 are testable, and die0 is not.

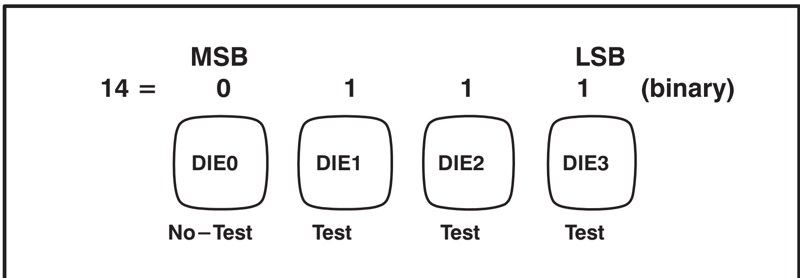


FIGURE 9−10: ON WAFER CODE EXAMPLE TS,14

In this example, the probes for die0 are either off the wafer, or they are positioned over a pre−defined skip die.

If `SEND MAP COORDINATES WITH TS` is enabled (in the Enhanced I/O Control Menu, Page 2, Line 04), the prober automatically sends the XY die coordinate with each TS as well as the on wafer code for Multi−Die probing.

For example, the prober sends:

TSX5Y3,14

Translated, the XY coordinate (X5Y3) is the position of the reference die (die0), with respect to the operator−selected First Die.

The XY coordinates of the other die in the array are not directly available; however, since the coordinate of the base die is known, once the probing orientation is selected, the coordinates of the other die in the probe array can be determined, based on probe quadrant and coordinate quadrant values.

For example, the prober sends:

TSX−3Y45,14

This indicates the following XY coordinates:

die0 (the base die)	is located at	−3, 45
die1	is located at	−3, 44
die2	is located at	−3, 43
die3	is located at	−3, 42

Depending on the application, this information may or may not be useful to the host/tester.

If wafer mapping is used for reprobe (EDIT or SAVE) and specific bincodes are designated for reprobe (EDIT or SAVE mapping modes), the appropriate on−wafer code will also be sent with each “TS.” For example, if all bins 3 and 5 are to be reprobed and a quad array is used, the prober will send “TS,10” to the tester (*Figure 9−11*):

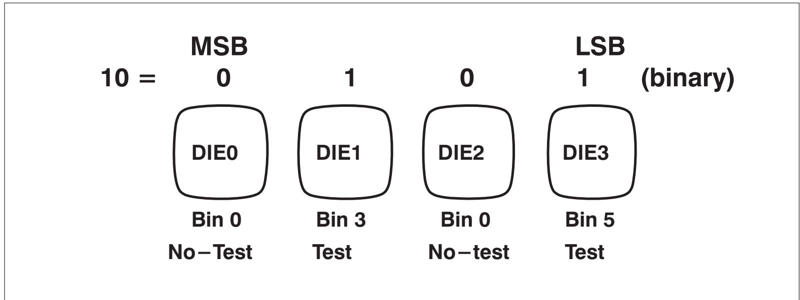


FIGURE 9−11: ON WAFER CODE EXAMPLE TS,10

9.7.2 I/O Commands Relating to Multi−Die Probing

External Control I/O Interface commands directly related to Multi−Die Probing are:

SM36 − ENABLE POST−PROBE INKING
Format: SM36In (n = 0−2)

0 = disables post probe inking
1 = enables post probe inking
2 = enables post probe inking and ink restart after pause

SM43 − ENABLE MULTI−DIE PROBING
Format: SM43Mn (n = 0−2)

0 = disables Multi−Die Probing
1 = enables Multi−Die Probing
2 = enables Multi−Die Probing and octal or quad probe array

SM44 − SET DIRECTION FOR MULTI−DIE PROBING
Format: SM44Ln

Where 0< = n < = 10, n is the location code.

ET − MULTIPLE BINNING TEST COMPLETE

The unsolicited message command “ET,” for multiple die binning, is the equivalent of the “TC” (test complete) command for single die applications. Since multiple die are being tested, multiple bincodes need to be sent by the tester to the prober for inking and wafer mapping purposes.

The “ET” command allows up to eight bincodes to be sent to the prober. Each bincode is delineated by a comma and can range from 0 to 255. **Table 9−1** shows examples.

IMPORTANT

Always supply *all* bincodes; if probing 4 die, always send 4 bins; if probing 2 die, always send 2 bins − even if some die are not tested.

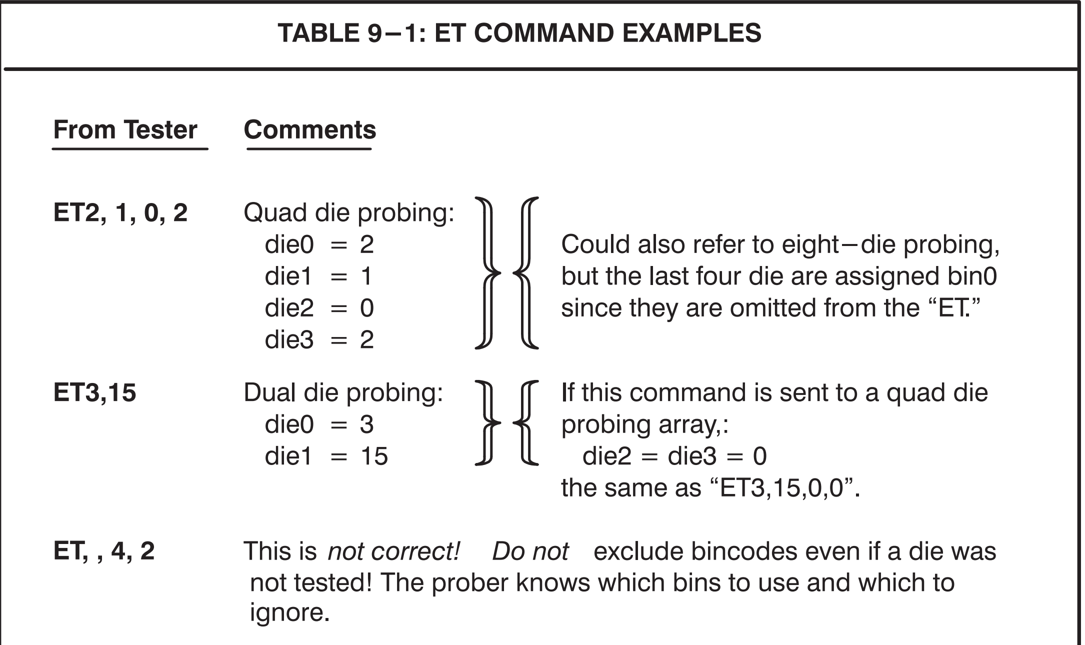


TABLE 9−1: ET COMMAND EXAMPLES

From Tester	Comments	
ET2, 1, 0, 2	Quad die probing: die0 = 2 die1 = 1 die2 = 0 die3 = 2	Could also refer to eight−die probing, but the last four die are assigned bin0 since they are omitted from the "ET."
ET3,15	Dual die probing: die0 = 3 die1 = 15	If this command is sent to a quad die probing array,: die2 = die3 = 0 the same as "ET3,15,0,0".
ET, , 4, 2	This is *not correct!* *Do not* exclude bincodes even if a die was not tested! The prober knows which bins to use and which to ignore.	

?L − REQUEST MULTI−PROBE LOCATION CODE

To query the location code, the "?L" command can be used. This command returns a value from L0 to L10, depending on the user−selected location code.

BA (RDP) − BIN TO CATEGORY / INK
Format: BAn1,n2,n3[;n1,n2,n3]

If the RDP protocol is used to communicate between the tester (typically Teradyne) and the prober, a different I/O command set is needed when the Multi−Die mode is enabled. The RDP equivalent of "ET" for multiple die is "BA". The "BA" command uses the on−wafer byte to obtain the site numbers and bincode for each die and determine whether or not it should be inked.

For Multi−Die Probing, "n1" defines the site number; "n2" is ignored by the prober; and "n3" defines the bin number for the device tested. The prober will fire the appropriate inker for the bin code assigned as defined in the Assign Logical Ink Code Menu.

For example, to bin a dual probe configuration with site #1 as bin 2 with inker #2 fired; and site #2 as bin 11 with inkers #1, #2, and #4 fired::

BA1, 0, 2; 2, 0, 11

CE (RDP) – REQUEST TEST START
Format: CE
Response: n[,n]

When the Multi–Die mode is enabled, the prober will use the on–wafer byte to return numbers indicating which sites may be tested. The range is from 1 to 8.

For example, to start sites 1, 3, and 4:

Request: **CE**
Response: **1,3,4**

9.8 MULI–DIE PROBING LIMITATIONS

IN–LINE INKING

This inking is not supported. This is the typical inking procedure for many single die applications, the normal sequence of probing a die, inking, and indexing to the next die site.

PROBING MODES

Only Circular and Row autoprobing modes are supported.

INCLUSIVE PROBING

It is not supported. In this probing mode, stepping across the wafer is modified based on the location of test die or bare silicon areas (stepped wafers) and whether or not the probe pins are allowed to hang over the edge of the wafer.

PROBE MARK INSPECTION

If Multi–Die is enabled, Line 02 of the Probe Mark Specifications Menu (`# CONSECUTIVE FAILURES`) is not available, and the unit term *die* is replaced by the unit term *cluster*. The term *cluster* also replaces *die* in the Inspection and Failure Summaries.

INK DOT INSPECTION (IDI)

IDI should only be used in the After Probing (Post–Probe) mode.

UGLY DIE INKING

This is not supported.

9.9 SUMMARY

In this section, you have learned:

Location codes and their importance for proper stepping

The Generic Map and how it relates to Multi−Die

The prerequisites required before using Multi−Die Probing

Enabling Multi−Die Probing in the software

Setup instructions for the two methods of multi−die inking: post−probe and offline

How to use the wafer code method to communicate die sites to the tester

Information on External I/O commands relating to Multi−Die Probing

SECTION 10 − WAFER MAPPING & SECS

CONTENTS

Updated 6/96

> The notations in the margin on this page and throughout the section indicate areas where information was changed and/or new information added in this current revision (REV A).
>
> **NOTE the Supplement located at the end of Section 10.**

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SECTION 10
WAFER MAPPING & SECS

10.1 OVERVIEW

The Wafer Mapping feature performs the following functions:

- Create a wafer map
- Follow a wafer map, probing only die with certain bincodes; edit an old map
- Follow a wafer map, probing only die with certain bincodes and creating a new wafer map showing the combined test results
- Follow a wafer map and ink according to the stored bincodes. This mode does not require a tester and is often used in off-line inking applications.

Wafer maps are available from three sources: Disk, SECS port, or External I/O port. The prober can simultaneously send a wafer map to any or all of the three devices. All three receive and send maps in SECS stream 12 type formats (wafer mapping message categories). The Disk and External I/O devices compose single block maps containing header and map information in a single transmission. SECS map transactions follow multiple block transmission procedures defined by the SEMI SECS standard.

In the External I/O Interface application, the host system commands index motions and logs its own test information and die XY coordinate data. The SECS wafer map format is explained further with other SECS material in **Section 10.6.2**

10.1.1 How To Use This Section

This section contains the following information about Wafer Mapping and SECS:

- How to enable the Wafer Mapping feature
- Information about the Wafer Mapping Menu and the associated parameters
- How to use the four mapping modes to run a wafer map
- Information regarding GPIB or serial wafer map transmissions
- SECS information, including communication protocols, streams and functions

10.2 THE WAFER MAPPING MENU

Wafer Mapping is enabled from the Set Option Menu. The Wafer Mapping Menu (Pages 1 and 2) displays automatically *(Figure 10−1)*.

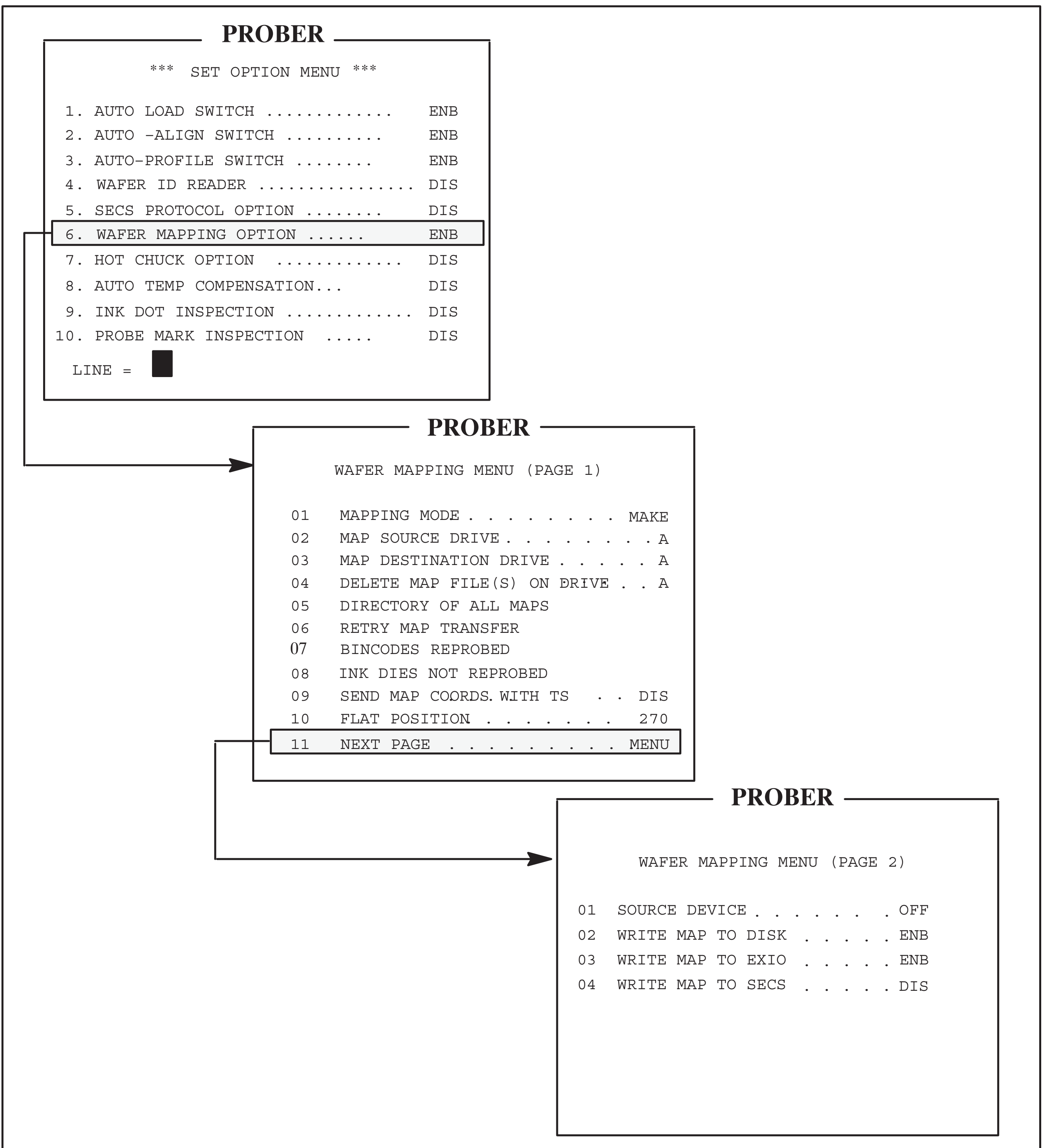


FIGURE 10−1: SET OPTION MENU, WAFER MAPPING MENUS

10.2.1 Wafer Mapping Menu Line Items

LINE 01 (PAGE 1) MAPPING MODE

Line 01 sets the mode of operation. The modes are:

- Make
- Follow
- Edit
- Edit−Save

Each of these modes is discussed next, along with instructions on how to create a wafer map in that specific mode.

MAKE MODE

In the *Make* mode, the prober will create a new wafer map to be used for later inking and/or re−testing.

Figure 10−2 illustrates the Wafer Mapping Menu in the Make mode and notes the lines that are blank in this mode.

To create a wafer map, from the Wafer Mapping Menu:

1. Line 01 − Select the *Make* option
2. Line 03 − Select the destination disk drive (if map is to be written to disk)
3. Page 2 − Select the destination device(s) (Lines 02, 03, and/or 04)

Once the menu selections have been made, set up the rest of the prober normally and begin probing. Every time a wafer is unloaded there will be a short pause while the map is written to the selected destination(s).

If the disk drive is chosen as a map destination as well as External I/O, the map will be written to disk first, then over the I/O port. If the map is not successfully written to disk (or sent over I/O), the prober will attempt to retain the map in memory until it can read it.

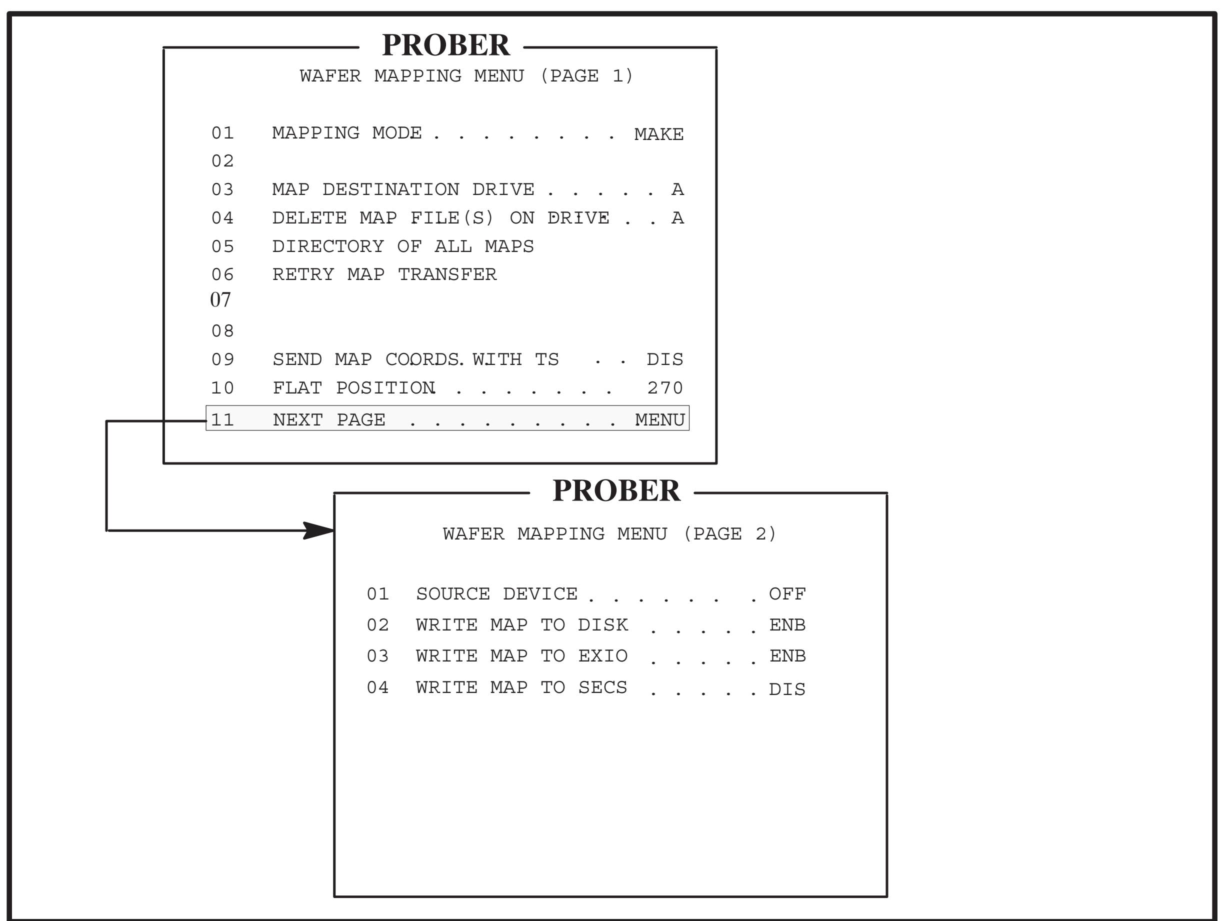


FIGURE 10−2: WAFER MAPPING MENU (MAKE MODE ONLY)

FOLLOW MODE

The *Follow* mode is used as an off−line ink station. (If Multi−Die Probing is enabled, the Follow mode cannot be used.) *Figure 10−3* illustrates the Wafer Mapping Menu in the Follow, Edit and Edit−Save modes.

1. Line 01 − Select the *Follow* option
2. Line 02 − Select the map source drive, from which maps will be read (if map is on disk)
3. Page 2, Line 01 − Select the source device

When the Follow mode is used, the prober will use the logical inker assignment found in the Preset Inker Assignment Menu (Assign Logical Ink Code). This menu is used to tell the prober which inker to fire for any given bincode as well as the individual good/bad die assignment. When inking a wafer, the prober will only move to those die that need to be inked. Since only whole die are stored in the map, enable edge die inking if partial die around the perimeter of the wafer need to be marked, too.

When the Follow mode is selected, the probing mode is automatically set to follow the map and cannot be changed while the system is in this mode.

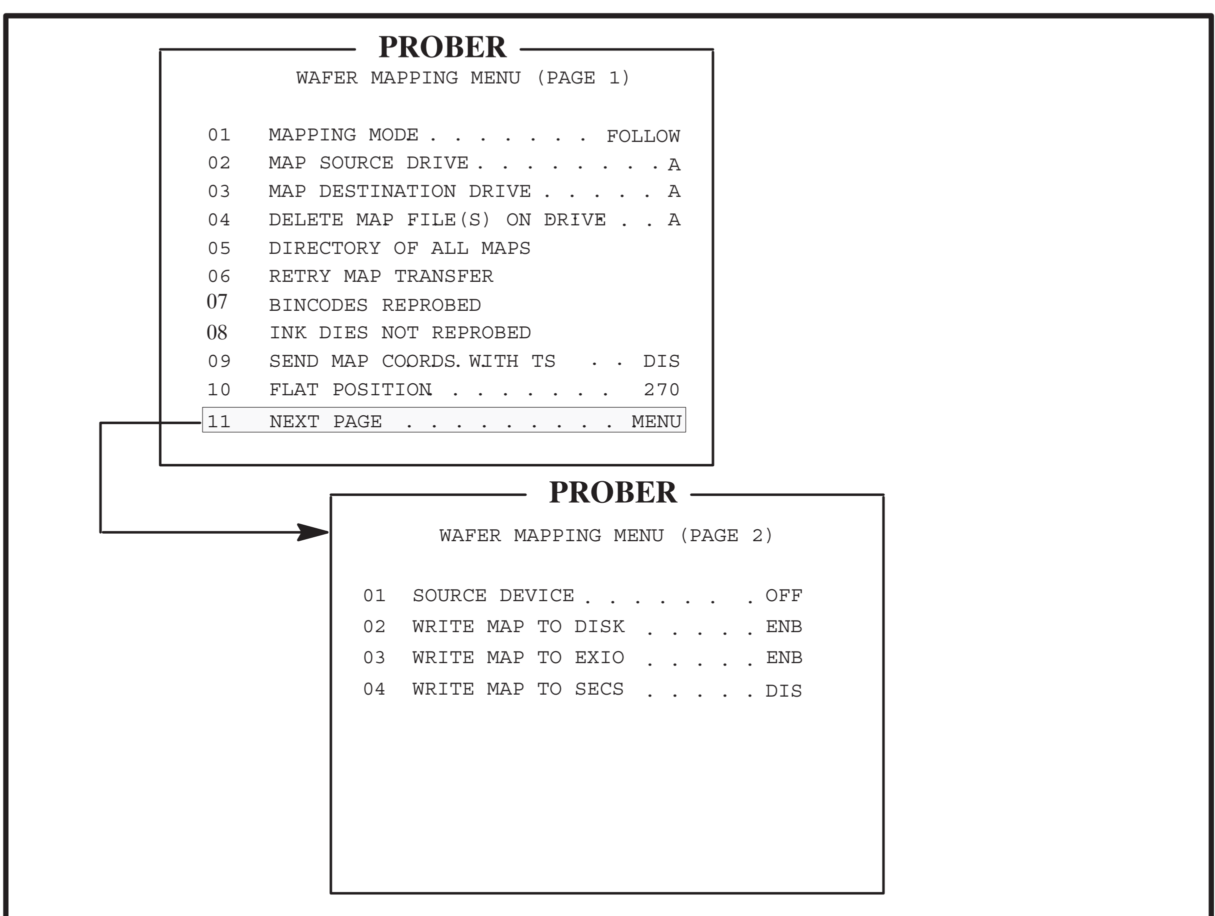


FIGURE 10−3: WAFER MAPPING MENU (FOLLOW, EDIT, AND EDIT−SAVE MODES)

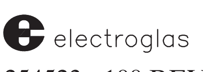
EDIT MODE

The *Edit* mode is similar to the Follow mode, with the difference that the old map file will be updated with the new results on the die re−tested on the current pass. Also, Edit may not be used for off−line inking.

When Edit is used, the dies that are reprobed have their new bincodes stored in the map in memory, replacing the original bincodes. As mentioned, wafer maps are associated with wafer ID only. For example, when in Edit mode, a wafer map is read from External I/O, modified, and, if Line 03, `Write Map to EXIO` (*Figure 10−3*) is enabled, returned via External I/O with the same wafer ID.

If originating from disk (Page 2, Line 01, Source Device = Disk), when reprobing is complete, the new wafer map is written back to disk using the same file name as the original. In this event, the original map is lost, replaced by the new map. If this is undesirable, set the Map Source Drive (Page 1, Line 02) to A and read the maps in from Drive A, and set the Map Destination Drive (Page 1, Line 03) to B or C and write the new maps to the disk in Drive B or C (or use the Edit−Save mode, discussed next).

Also, a map can be read from disk and written out to I/O if needed. The destination does not have to be the same as the source.



To set up the prober to follow a map and reprobe all dies with bincode 1 or 2, for example, select Line `07` and assign `REPROBE` for bins 1 and 2. If all the other dies are to be inked automatically, enable `INK DIES NOT REPROBED` in Line 08. The reprobed dies will be inked if enabled according to the bincode received from the tester during the reprobe.

EDIT−SAVE MODE

Edit−Save allows the making of a new output map while following an existing input map.

This mode operates the same as Edit except the original map (or previous passes of maps) is not edited. Instead, a new map is created that contains the previous results and new bincodes from the tester.

The new map can be stored on the same destination device as the original map. A simple linking notation on the directory listing indicates the existence of an Edit−Save map, explained later in this section (Line 05 −Directory of All Maps). The Edit−Save linkage notation is not stored in the wafer map itself and is not available to host computers through SECS or External I/O. It is strictly for use by the prober's disk system to determine the most recent map.

Skip and ugly die bincodes are set in the Inking and Ugly Die Menus just as they would be in normal probing. Once bincodes from 0 to 255 are assigned, these are entered into the wafer map during Make map probing whenever a skip or ugly die is detected. In the other three modes, the appropriate action will result if skipdie inking is enabled and the skipdie bincode is encountered. Similarly, if ugly die inking is enabled, the detection of the ugly die bincode causes the ugly die to be inked. The skip die and ugly die bincodes must be mutually exclusive values.

Edge die can be inked in any mapping mode. During probing, die which fall within the ugly die edge bands are not tested; however, the ugly bincode is inserted into the wafer map if the Make, Edit, or Edit−Save mapping modes are enabled. If in Edit or Edit−Save mapping mode, enable `INK DIES NOT REPROBED` (Line 08) in the Wafer Mapping Menu; make sure the bincode associated with ugly die is set to SKIP within `BINCODES REPROBED` (Line 07). Bincodes from 16−255 use the `BINCODES REPROBED` assignment of bincode 15.

Any bincode listed as `REPROBE` in the Present Reprobe Assignment Menu (accessed by Line 07) will cause a Test Start (TS) to be sent to the tester just as in regular probing. When the Test Complete (TC) and bin is received by the prober, it will edit the map with the new bincode (if Edit or Edit−Save are used) and ink according to the Preset Inker Assignment Menu (Assign Logical Ink Code). If inkers are disabled, no inking will take place, but the map will still be updated.

LINE 02 (PAGE 1) MAP SOURCE DRIVE

This line identifies the drive that contains the disk from which maps will be read during Follow, Edit, and Edit−Save operations, when the source device is Disk (Page 2, Line 01). (Not used if the map destination is set to External I/O or SECS.)

LINE 03 (PAGE 1) MAP DESTINATION DRIVE

This line identifies the drive that contains the disk where the wafer map will be stored, if Disk is selected as a destination (Page 2, Line 02). Electroglas recommends storing maps on a separate disk, other than the prober system files. This line will not appear if Line 01 is set to Follow mode.

LINE 04 (PAGE 1) DELETE MAP FILE(S) ON DRIVE . .

When this line is selected, for maps stored on disk, a prompt will ask first if the entire disk is to be deleted. If the answer is no, the screen will show the last wafer ID to be processed and a prompt asks for the desired wafer ID to delete. Press < ENTER > to delete the ID shown, or input the desired ID.

After you have given instructions to delete either all maps or a single map, a prompt queries one last time...

ARE YOU SURE (Y/N)?

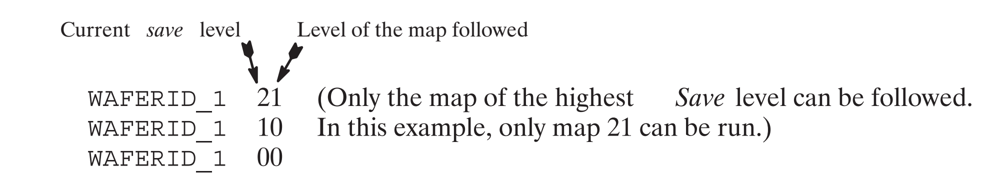
...before irretrievably deleting the map or maps from the disk. You may choose to abort the operation and answer < N > (no); then nothing is deleted. If you answer < Y > (yes) and the deletion is done, the cross reference file `WMAPXREF.LNK` is automatically updated. If all maps are deleted, the cross reference file is also deleted.

LINE 05 (PAGE 1) DIRECTORY OF ALL MAPS

See the Supplement at the end of the section for error messages.

For maps on disk, this line displays the wafer ID of all maps in the designated drive (Line 04). The disk capacity is displayed at the top of each page. Each wafer ID, up to 27 characters, is shown, followed by the Edit−Save level code.

The Edit−Save level code is a two−character code. The first character indicates the current Save level. The second shows the level of the map followed. For example, assume the following WAFERID notation in a directory display:



The topmost map is at Save level 2 (first digital character) and was created by following the map at Save level 1 (second digital character), that is, the map just below it. This map on the second line (Save level 1) was created by following the map at Save level 0, displayed just below it. The bottom line displays the original `WAFERID_1` map created – indicated by the Edit–Save code level of 00. The code is always 00 unless map mode Edit–Save was used. The prober only allows access to the newest map (highest code number).

The cross–reference file `WMAPXREF.LNK` on each map disk contains the wafer IDs and Edit–Save levels for all the maps on the disk. If the mapping mode is Make, the directory is accessed on the destination disk. If the mode is Follow, the directory is accessed via the source disk. Both Edit and Edit–Save display the source disk first, followed by the destination disk, if the source drive and destination drives are different.

For directories that run longer than a page, subsequent pages are produced by pressing any key. If `WMAPXREF.LNK` is nonexistent, the message `EMPTY WAFER MAP DIRECTORY` displays.

LINE 06 (PAGE 1) RETRY MAP TRANSFER

On disk transfers, if a destination disk becomes full, an error message is displayed. After the full disk is replaced with another blank, formatted disk and this line is selected from the Wafer Map Menu, the wafer map that is still in memory will be written to the new disk. In event of a communication breakdown in External I/O and SECS transfers, the prober will attempt to save the map in memory until it can be re–sent. This is why it is recommended to specify disk as a destination as a backup to External I/O. This option is only available from the keyboard. It is not possible to request that maps be re–sent from External I/O.

LINE 07 (PAGE 1) BINCODES REPROBED

The display activated by this line lists each of the 16 bincodes and shows whether each die with that code is to be reprobed or skipped (not used in Follow or Make mode). To change a setting, follow the prompt to select the bincode, and then choose either option. *Figure 10–4* shows typical entries and prompts. As noted earlier, bincodes from 16–255 use the `BINCODES REPROBED` assignment of bincode 15.

PROBER

```
     PRESENT REPROBE ASSIGNMENT
BIN ASSIGN               BIN ASSIGN
O  =   SKIP               8 =   REPROBE
1  =   REPROBE            9 =   REPROBE
2  =   REPROBE           10  =  REPROBE
3  =   SKIP              11  =  REPROBE
4  =   SKIP              12  =  SKIP
5  =   REPROBE           13  =  SKIP
6  =   SKIP              14  =  SKIP
7  =   REPROBE           15  =  REPROBE

BIN CODE = 5
CHOOSE:  1 = REPROBE  0 = SKIP
ASSIGNMENT =
```

FIGURE 10–4: PRESENT REPROBE ASSIGNMENT MENU

LINE 08 (PAGE 1) INK DIES NOT REPROBED

The enabling or disabling of this line determines whether the dies that are not reprobed during an Edit or Save operation will be inked according to their stored bincodes or ignored. (Not used in Follow or Make modes; also not available if Multi−Die Probing is enabled.) Bins 16−255 take on the skip/reprobe assignment of bin 15.

LINE 09 (PAGE 1) SEND MAP COORDS WITH TS

If this line is enabled, whenever a test start is sent to the tester, the prober sends a message indicating the current X and Y die positions relative to the first die position. The axes are the same as those selected for the coordinate axes in the Probe Mode Menu line `02 (COORDINATE QUAD)`, for example**, TSX5Y9.** This item typically is used when the tester wants to generate its own map. This is the same line item found in the Enhanced External I/O Mode Menu, Line 04. (See the I/O command "WM" in **Section 8, EXTERNAL CONTROL I/O INTERFACE).**

LINE 10 (PAGE 1) FLAT POSITION

Since SECS wafer maps transmit the flat orientation, among other parameters, Line 10 is used to display and set the current flat position. More importantly, this line displays the orientation of the flat when it sits on the chucktop.

This notation assists users you if you are manually loading wafers. Should the map and the prober flat orientation disagree, probing will abort, allowing the correct prober flat orientation to be set. (This same line item is found in the Autoload Option Menu, Line 01.)

LINE 11 (PAGE 1) NEXT PAGE

Press this key to produce the second page of the display (*Figure 10−5*) which contains all device combinations for receiving and sending wafer maps.

PROBER

```
WAFER MAPPING MENU (PAGE 2)

01  SOURCE DEVICE . . . . . . . OFF
02  WRITE MAP TO DISK  . . . . . ENB
03  WRITE MAP TO EXIO  . . . . . ENB
04  WRITE MAP TO SECS  . . . . . DIS
```

FIGURE 10−5: WAFER MAPPING MENU (PAGE 2)

LINE 01 (PAGE 2) SOURCE DEVICE

When a map is to be followed or edited, the prober must know where the map is coming from. If the mapping mode is Follow, Edit, or Save, the map source device must be specified in this line.

The source device selections are:

0 = OFF
1 = SECS
2 = EXIO (serial or GPIB)
3 = DISK

LINE 02 (PAGE 2) WRITE MAP TO DISK
LINE 03 (PAGE 2) WRITE MAP TO EXIO
LINE 04 (PAGE 2) WRITE MAP TO SECS

The remaining items enable/disable any or all of the three map destinations. After a map is made, edited, or edit−saved, the map is sent to those destinations enabled. If multiple destinations are selected, maps will be written to each in succession before unloading the wafer (Disk first, then External I/O, then SECS).

10.3 WAFER MAP DISK FILE NAME

If the wafer maps are written to a disk, a correlation, or cross−reference file called WMAPXREF.LNK is created in addition to the individual maps. A unique file name is calculated and assigned automatically. The file name is an internal reference irrelevant to the operation of the Wafer Mapping feature. If maps are copied from one disk to another, this file must be copied, too or the maps will be lost.

All Wafer Mapping activity uses the wafer ID as input. The WMAPXREF.LNK file contains all the wafer IDs mapped onto a given disk. The prober automatically accesses this file to find the map file name associated with the wafer ID and load the required wafer map.

On the prober, the Wafer Mapping Menu contains a directory line which will display the wafer IDs found on the disk. If a prober isn't handy, WMAPXREF.LNK can be listed on a CP/M−operated computer by setting `USER 1` and using the CP/M command `TYPE WMAPXREF.LNK.` The disk is standard MS−DOS formatted.

When Wafer Mapping is enabled, if no wafer ID device exists and the ID reader feature is disabled, the current wafer ID is defaulted to the concatenation of the device type, lot number, and wafer number. The device type and lot number are entered through the Log ID display produced by pressing the < RUN ID > key. For example, if the current wafer number is 6, the current device type set to `DRAM,` and the current lot number is LOT122, then the wafer ID assigned to the wafer map for the current wafer is:

```
DRAMLOT1226
```

If an automatic ID reader is used (OCR or bar code), the wafer ID is taken from that device − *not* the information entered through the RUN ID display.

A maximum of 255 maps can be stored on a 3 1/2” (720KB) disk, and up to 63 maps on a 5 1/4” (360KB) disk. To simplify disk utilization, it is recommended that each lot or cassette of wafers be assigned to a separate disk.

The file overhead for a map is approximately 1.2 to 1.5 bytes per die. For a typical 1000−die wafer, the map will be stored as a file of 1200−1500 bytes. Use this value to estimate the number of maps that can be stored to disk. (This overhead comes from the SECS format.)

Since the disk format is standard MS−DOS, the maximum number of maps that can be stored is only limited by disk capacity (3 1/2” 1.44 MP disk, or 65 MB hard disk).

10.4 GPIB OR SERIAL WAFER MAP TRANSMISSION (NON−SECS)

See the Supplement at the end of the section.

Wafer maps sent via the GPIB or serial port are an exact image of the map layout on the disk. The transmission protocol is similar to that used for file upload/download (the “US” and “DS” commands). To transmit a map over the GPIB or serial port, use the Standard I/O Control Menu (Line 07 of the Set Mode Menu) to set communication parameters.

The following I/O commands are used to send/receive wafer maps over the GPIB or serial port:

Command	Description
LMc	List maps stored on specified disk drive.
MScIi	Send map ID “i” from specified disk drive.
DMcIi	Delete map ID “i” from specified disk drive.
WO1Mn	Set wafer map mode.
WO2Mn	Set wafer map source.
WO3Mn	Set wafer map source disk.
WO4Mn	Set map destination disk.
WO5Mn	Enable “Ink die not reprobed”.
WO6Mn	Enable “Map write to disk”.
WO7Mn	Enable “Map write to I/O”.
WO8Mn	Enable “Map write to SECS.”
WO9Bn. . .n	Set reprobe bincodes.
SM58Rn	Set map transfer retry count.

Use “SO” to enable the Wafer Mapping feature.

The commands are described more fully in **Section 8**, **EXTERNAL CONTROL I/O INTERFACE.**

10.5 THE WAFER MAP FORM

SECS protocol and terminology is discussed in **Section 10.6** and subsections. However, some explanation at this point of wafer and data identification will provide a basis for the information to follow on using the wafer map.

10.5.1 Material ID (MID)

For purposes of mapping, a wafer (“material”) ID is defined as an identification read from the wafer itself − MID in SECS notation. Although it is possible to enter an ID into the prober via the < RUN ID > key, this information is not considered suitable for wafer identification. IDs should be read from the wafer either with an Optical Character Reader (OCR) or Backside Bar Code Reader (BSBCR). Both reader types are enabled in the Set Option Menu, Line 04.

The ID is ASCII data and may be up to 27 characters long. This ID uniquely defines this wafer with a particular map.

10.5.2 Row Data (X, Y, and Bin Information)

The prober uses the row method of storing map data. In this method, each logical row of die is described by the starting X and Y coordinate of the row, the number of die in the row, the direction of probing, and the bincodes for each die.

Since there is no unique end of file mark in a wafer map, the software must count the number of rows processed to determine when the map is complete. This number is contained in a descriptor called ROWCT, found in S12F1. Once the map processing software reads “n” rows of data, the map is complete.

Each row of die is described in a list with two items, found in S12F7: the first is the row start information (X, Y, and direction); the second is the number of bincodes and a list of actual bincode data. The SECS II code for these are *RSINF* (*Row Start Info*) and *BINLT* (*Bin List*).

Row start information is identified by six two−byte integers. The first and second are the starting X and Y coordinates of the row. The first bincode in BINLT corresponds to this die. The coordinates of the other die in the row are determined by adding or subtracting one (1) from the initial X coordinate for each successive die.

The third two−byte integer in RSINF is the direction parameter. It determines the direction of X axis travel to get from one die to the next.

The number of die in the row is contained in the length bytes of the BINLT item. The direction of travel is determined by the *sign* of the direction parameter. If the value is positive, the die were probed left to right. If the value is negative, the die were probed right to left.

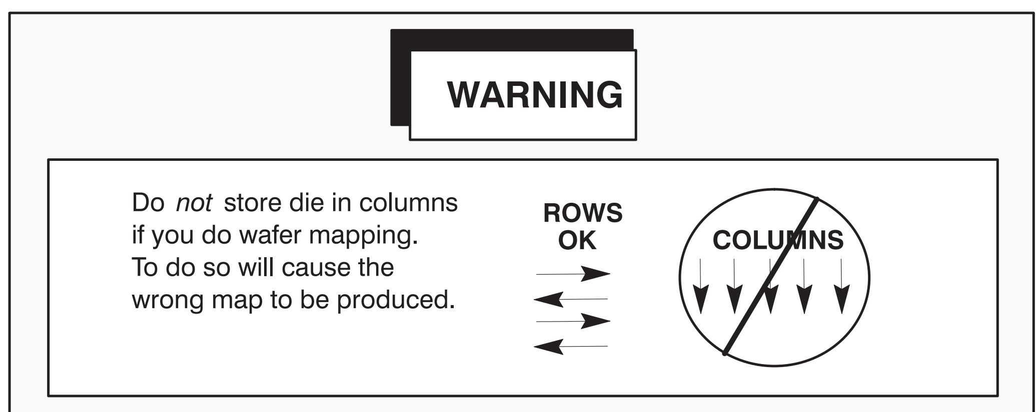
For example, assume the following data is given for RSINF:

X = 5, Y = 7, Direction = 1, Count = 3

This means that the first die in the row is at coordinate **X5,Y7**, and there are three die in the row. The die were probed from left to right (direction is +):

(x5y7) ⟶ (x5y8) ⟶ (x5y9)

Die 1 ⟶ Die 2 ⟶ Die 3



10.5.3 Wafer Maps and Probe Modes

Wafer maps can be created while the prober is in the following Probe Modes:

1. Edge Sense
2. Circular
3. Matrix
4. Learn
5. Row

Wafer maps will **not** be created if the Probe Mode is set to:

1. Off
2. Partial
3. External

Probe Modes are set in the Set Mode Menu, Line 02 (`AUTO PROBE PATTERN`).

10.5.3.1 WAFER MAPPING IN THE LEARN MODE

The Learn mode generates unusual maps due to the nature of Learn Mode probing.

In the Learn mode, the prober is taught up to 1024 specific die to probe, in the order stored in the list. Since the map format is based on rows, for mapping purposes each die is called a row, and for each die a complete RSINF and BINLT list is created. The starting X and Y values are the coordinates of the individual die and the direction parameter is always set to 1. BINLT contains one bincode, that of the die in question.

Because of this implementation, maps created by the Learn mode are very long for the number of die contained in them. Maps created during Multi−Die Probing look identical to maps created during single die probing.

10.5.4 The Coordinate Quadrant

As noted, the direction parameter in the RSINF item describes the X direction as right or left. This is because you must define the positive X and Y directions before probing. The mechanism for this definition is the coordinate quadrant parameter *(Figure 10−3)*, set through the Probe Mode Menu Line 02.

For example, selecting coordinate quadrant 2 tells the prober that positive X is to the right and positive Y is down (toward the front of the machine). As the prober moves in the positive X direction, successive die to the right are probed. In this case, a positive X direction indication in RSINF means that successive die in the row are to the right of the die defined by the starting X and Y coordinates in RSINF.

The coordinate quadrant parameter affects the way the prober reports its position. Setting the coordinate quadrant (Probe Mode Menu, Line 02) causes the prober to log XY positions and directions according to the definitions in *Figure 10−6.* In effect, the prober performs a coordinate transformation as it probes.

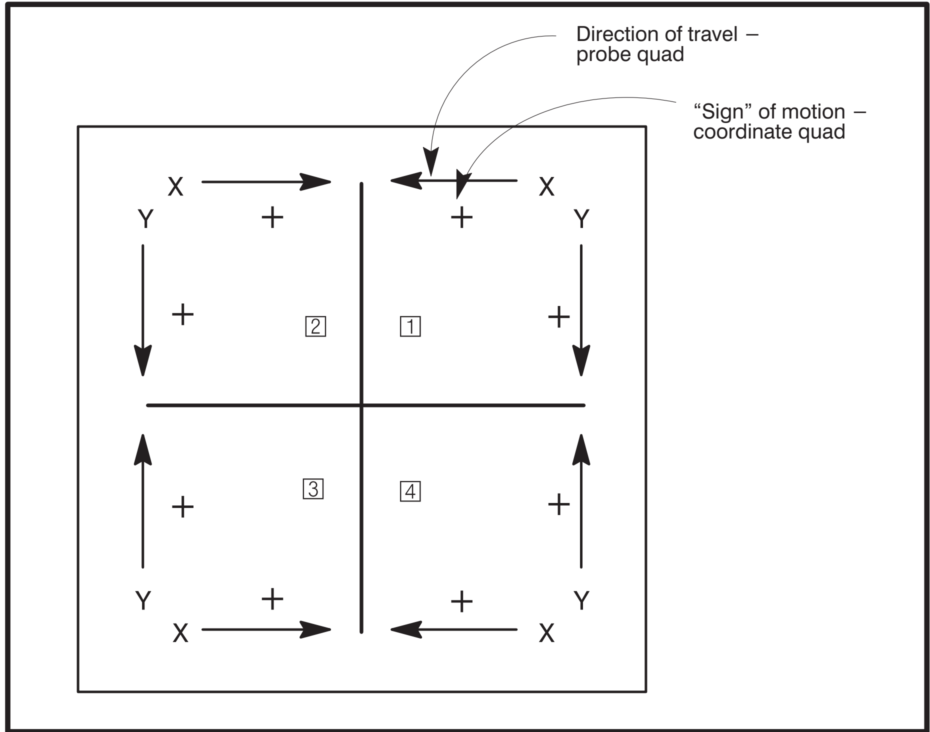


FIGURE 10−6: POSITIVE XY DIRECTIONS VS. PROBE QUADRANT

It is required that you set both the probe and coordinate quadrant parameters identically. For example, if probe quadrant 2 is to be used, also set the coordinate quadrant parameter to 2. The Electroglas coordinate system and origin are translated into the standard SECS coordinate system and the appropriate SECS origin point when the wafer map is stored from memory. The stored wafer map can be interpreted by noting the SECS header information associated with the stored map. The coordinates stored in the maps have been translated to the SECS coordinate system. These are *not* the coordinates seen on the prober's display. Wafer maps are retained in prober memory until the probing pattern is completed.

10.5.5 Using the < PAUSE/CONT > Key

Pausing can be done only during the actual testing of a die; pressing < PAUSE/CONT > while the prober is indexing between die is ignored by the prober until test start is issued for the next die.

When < PAUSE/CONT > is pressed again to continue probing, a new map row is begun at the current XY coordinates if you have indexed to another die and if `CONTINUE AT LAST DIE` is enabled (Probe Mode Menu, Line 09). In this case, the map will have a row that ends just before the paused die, and then a new row that begins with the current die.

If you continue probing past where the prober paused, again, there will be a “hole” in the map data, similar to that caused by the skipdie function, except that no bincodes are put into the map. No bincode is stored for the “holes” in the map.

10.5.6 Bincode Display Feature

When Wafer Mapping is enabled and the prober is in a Pause state, the last reported bincode for the current die under the probes will be reported at the bottom of the Run Time Display *(Figure 10−7).* This bincode display is temporarily disabled if the chuck is out of probe range or the red button on the top of the joystick is pressed.

PROBER

```
10:10:06          249799-122.DB      01/10/94
POS X .............1    DIE X ........100.0
      Y .......... 2          Y .......200.0
     ZDN .......200     INKER ......... DIS
WAFER .........   ON    DIA ........  100MM
Z-MODE ..     LIMITS
CHUCK VAC ...     ON    SECS ...........DIS
PROBER ..    -> EDGE    X I/O....    ONLINE
SCAN                    WAFER # ........ 10
IDLE                    GOOD DIE ....   100
                        BAD DIE .......  20
                        UGLY DIE ......  10
MAP BIN CODE = 4
TEST RESULT =   0
```

FIGURE 10−7: RUN TIME DISPLAY SHOWING BIN CODE

If Wafer Mapping is enabled, this feature can be used to randomly re−test die to compare results with previous values and probing/test verification. To display the bincode and re−test a particular die:

1. Pause the prober (press < PAUSE/CONT >).
2. Using the joystick, position the probe tips over the target die to be read for the bincode stored in the map. The bincode will appear on the Run Time Display (*Figure 10−6).*
3. Press < TEST CYCLE > to force a TS to be sent to the tester.
4. At the end of the test cycle, when the tester sends a new TC, the display will show the stored bincode and, beneath it, the test results, on the Run Time Display. This new TC and bincode is not added to the map data currently in the prober's memory.

If NONE is specified as the bincode, there is no bincode in memory for that die or the probes are under an untested die.

10.6 SECS PROTOCOL

SECS is an acronym for Semiconductor Equipment Communication Standard.

SECS I is a computer−to−computer communications protocol that allows data to be moved between host computers and semiconductor process equipment used in IC manufacturing. The Electroglas Wafer Mapping function is based on 1987 SEMI (Semiconductor Equipment and Materials International) Standards. The actual SECS communication link is a serial connection between the prober and the host (tester or host computer, for example).

SECS II defines methods for transporting certain types of data and units of measure as well as data formats for specific messages and types of messages. Types of messages are defined by "stream" codes; wafer maps are one type of message, process recipes another, error reports still another. SECS II groups data into *items.* An item consists of a *descriptor* followed by the data. The descriptor identifies the format or type of data.

Table 10−1 lists the streams and functions implemented in the software. Details are given in **Section 10.6.4.**

Further explanation of SECS symbols and mnemonics appears in the SEMI Standards Equipment Automation publication; a copy may be obtained from SEMI headquarters, (415) 964−5111.

TABLE 10−1: SECS II STREAMS AND FUNCTIONS CURRENTLY IMPLEMENTED

See Section 10.6.4 for Descriptions, Definitions, and Structure in addition to tables noted.

STREAM/FUNCTION

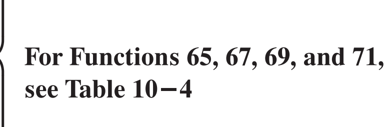
Stream 1 − Equipment Status

1	Are You There Request
2	On Line Data
3	Selected Equipment Status Request
4	Selected Equipment Status Data

(Functions 3 and 4:) **See Table 10−5.**

Stream 2 − Equipment Control & Diagnosis

65	Control Command Send Type I
66	Type I Control Command Completion
67	Control Command Send Type II
68	Type II Control Command Acknowledge
69	Control Command Send Type III
70	Type III Control Command Acknowledge
71	Control Command Send Type IV
72	Type IV Control Command Acknowledge
95	Control Command Completion Report


For Functions 65, 67, 69, and 71, see Table 10−4

Stream 5 − Exception Reporting

1	Alarm Report Send
2	Alarm Report Acknowledge
3	Enable/Disable Alarm Send
4	Enable/Disable Alarm Acknowledge

Stream 9 − System Errors

1	Unrecognized Device ID
3	Unrecognized Stream Type
5	Unrecognized Function Type
7	Illegal Data

Stream 10 − Terminal Services

5	Terminal Display, Multi−block

Stream 12 − WAFER MAPPING

(see Tables 10−2 and 10−3 for further details on functions 1−14)

TRANSMITTED HOST TO PROBER VIA SECS PORT

Function	
1	Map Setup Data Send
2	Map Setup Data Acknowledge
5	Map Transmit Inquire
6	Map Transmit Grant
7	Map Data Send Type I (row)
8	Map Data Acknowledge Type I

RECEIVED BY PROBER FROM HOST

Function	
3	Map Setup Data Request
4	Map Setup Data
13	Map Data Request Type I
14	Map Data Type I

OTHER

19	Map Error Report Send
65	Stored Map ID Request
66	Stored Map ID Data
67	Stored Map Send Request
68	Stored Map Send Request Acknowledge
69	Delete Locally Stored Map
70	Locally Stored Map Deletion Acknowledge
71	Request Permission to Probe
72	Permission to Probe Grant

10.6.1 The SECS Parameters Menu

SECS communication is enabled through the Set Option Menu line `05, SECS PROTOCOL OPTION,` which produces the SECS Parameters Menu *(Figure 10−8)*.

```
PROBER

              SECS PARAMETERS

   01  DEVICE ID . . . . . . . . . .1
   02  TIMEOUT TIMER 1 IN MS. . . 5000
   03  TIMEOUT TIMER 2 IN MS. . .10000
   04  TIMEOUT TIMER 3 IN SECS. . . 45
   05  NUMBER OF RETRIES. . . . . .  3
   06  TRANSMIT ALARMS . . . . . . DIS




   11  SECS . . . . . . . . . .OFFLINE
   12  SX PERMISSION TO PROBE . . .DIS
```

FIGURE 10−8: SECS PARAMETERS MENU

10.6.1.1 SECS PARAMETERS MENU LINE ITEMS

LINE 01 DEVICE ID

The device identifier assigned to the equipment (prober). Any SECS messages sent by the prober will use this number as the owner/sender of the message. All messages sent to the prober must use the correct device ID or the message will not be interpreted, and the prober will respond with an error message indicating the wrong ID was used.

LINE 02 TIMEOUT TIMER 1 IN MS

The Inter−Character Timeout; sets the maximum amount of time tolerated between characters of a message block (244 bytes). Range is 100 to 10000 milliseconds (msec).

LINE 03 TIMEOUT TIMER 2 IN MS

The Protocol Timeout; sets the maximum amount of time allowed the host to respond to the protocol handshake (response). Range is 200 to 25000 milliseconds (msec).

LINE 04 TIMEOUT TIMER 3 IN SECS

The Reply Timeout; sets the maximum amount of time to allow the host to reply to a message (not currently implemented).

LINE 05 NUMBER OF RETRIES

The Retry Limit; sets the maximum number of times the sender should retry following a Timer 2 timeout. Range is 0 to 31.

LINE 06 TRANSMIT ALARMS

Enables/disables transmission of prober alarm messages sent to the host device. For further details, see descriptions of Stream 5 functions in **Section 10.6.4, Supported SECS I/II Functions**.

LINE 11 SECS

This allows you to put the prober's SECS communication either Online or Offline. The prober will not send any messages via SECS when it is Offline. However, when the prober is Offline, incoming SECS messages will be received and the prober will automatically go Online.

LINE 12 SX PERMISSION TO PROBE

When this line is enabled, before probing a wafer, the prober will request permission from the host to probe the wafer on the chuck, using the S12F71 message, and wait for a response from the host with the S12F72 message. See **Section 10.6.4,** Stream 12, Functions 71 and 72.

10.6.2 SECS Wafer Map Format

The SEMI standard defines a wafer map as two messages, a header message and a data message. The map header containing setup information is sent on request, followed by an acknowledgement from the requester, followed by the transmission of the map itself.

The header is defined by Stream 12, Function 1 (S12F1) and contains wafer information such as die size, flat location, wafer ID, and total die count (Table 10−3). The map data message is defined by Stream 12, Function 7 (S12F7) and contains the X/Y coordinates and bin data for all die stored in the map. If ugly or skip die are enabled, the bincode and X/Y coordinates for those die will also be stored in the map.

The format of the map stored on the disk and the format of the map as sent over the SECS port are slightly different. The disk layout is a combination of S12F1 and S12F7.The prober does not split the map into separate header and data sections for disk storage. Instead, the header forms one element of a SECS II list and the data forms the other element.

The two lists are linked together by a nonstandard element (L,2 list of two items) at the start of the file, an exception to the SEMI standard. When the map is actually transmitted over the SECS port, S12F1 and S12F7 are transmitted separately as specified in the SECS protocol.

The prober's wafer map includes the formatting information defined by SEMI (such as lists and single and multi−byte integers) as well as the map and header data. For standard I/O (RS−232/GPIB standard or enhanced protocols), the data transmitted is an exact binary image of the disk file. Wafer map transfer is not supported for RDP protocol.

Table 10−2 identifies parameters in Stream 12 formats used in wafer map transmission for functions other than 1, 7, and 14. Those formats are given in **Table 10−3**. In both tables, the notations under the NAME column are SECS terminology describing each map field. These are listed in alphabetical order and described in **Section 10.6.5.**

TABLE 10−2:

STREAM 12 FUNCTION FORMATS USED IN WAFER MAP TRANSMISSION

Function 1, 7, and 14 formats are given in **Table 10−3.**
Details of all supported streams and functions appear in Section **10.6.4.**

S12,F3 − Map setup data request (request setup data from host to prober)

S12,F4 − Map setup data (host to prober transaction). (Send all map setup data required to link the data map with the physical wafer)

S12,F5 − Map transmit inquire (prepares host for map transmission)

S12,F13 − Map data request type (request map data for product in row/column format)

ITEMS AND LINE COUNT (L,n)						
L,9	L,15	L,4	L,2	**NAME***	**(OCTAL) FORMAT CODE**	**LENGTH**
1	1	1	1	MID	20	<27
2	2	2	2	IDTYP	10	1
3		3		MAPFT	10	
4	3			FNLOC	52	2
5				FFROT	52	0
6	4			ORLOC	10	1
	5			RPSEL	51	1
	6			L,n	00	0/1
				1. REFP1	34	8
				.		
				.		
				n. REFPn		
	7			DUTMS	20	9
	8			XDIES	54	4
	9			YDIES	54	4
	10			ROWCT	52	2
	11			COLCT	52	2
	12			PRDCT	54	4
7				PRAXI	10	1
8	13			BCEQU	51	0
9	14			NULBC	51	0
	15	4		MLCL	54	4

NAME*
Definitions are included in stream and function des− criptions in Sec− tion 10.6.4.

They are also listed in alpha− betical order and defined again in Section 10.6.4.

OTHERS	**NAME**
S12,F2 − Map setup data acknowledge (acknowledge receipt of complete map setup data)	SDACK
S12,F6 − Map transmit grant (provides permission to transfer)	GRNT1
S12,F12 − Map data acknowledge.	MDACK

10.6.3 Error Conditions

Error conditions occur at different times depending on the source of the wafer map. Since the SECS wafer map transactions occur with separate transmissions of the header and the map body, error analysis is done immediately after each section is transmitted.

10.6.3.1 WHEN THE SOURCE IS DISK OR EXTERNAL I/O

For disk and External I/O, error analysis is done only after both the header and the map are received. The error analysis checks the format byte of each list entry and for several fields looks for mismatches between the wafer map and the current settings of the prober. The format byte has two fields: the format field (bits 8−3), and the number of length byte fields (bits 2−1). The expected format field is given in the same octal notation used in the SECS−II manual.

When the source is disk or External I/O, the map is verified for matching prober parameters and correct format. The format is per SECS stream 12, S12F1 (header info) and S12F7 (map info). If the map doesn't verify, probing is halted and an error message appears on the monitor. Three error types halt probing: mismatched wafer ID and map ID, wafer map format errors, and wafer map parameter mismatch errors. The following error messages are displayed:

```
WAFER MAP WRONG WAFER ID
WAFER MAP FORMAT ERROR n
WAFER MAP PARAMETER ERROR n
```

When the prober retrieves a map from disk or from External I/O, a validation check is performed to ensure the map is correctly formatted and matches the current menu setup parameters. Common parameter errors would include wrong die size or flat orientation; a format error might be missing data elements or incorrect SECS format (a rare occurrence).

The value of "n" ranges from 0 to 23 and refers to the data field in the map that is incorrect. Fourteen of the 24 fields are validated in this manner. **Table 10−3** is a list of the map fields; those marked with an asterisk ("*") will return an error message.

For example:

```
WAFER MAP PARAMETER ERROR 3
```

As shown in **Table 10−3**, Item 3 in Stream 12 is "FNLOC," or flat location. This message means that the current menu setup for the flat orientation is different than the map that is being loaded. This usually occurs when the wafers are loaded on a prober other than the one that was used during initial test, and the menus were not changed for this product.

```
WAFER MAP FORMAT ERROR 9
```

This message means that the X die size field (Item 9 − "XDIES") is not correctly formatted per the SECS definition. The SECS format code is represented in octal (base 8) and defines the length and type of data in each field. Information on format codes and their interpretation is given in Section E5 of the SECS manual.

TABLE 10–3:
STREAM 12 MAP FIELDS

Details of Streams and Functions are given in Section 10.6.4.
NAMES are listed in alphabetical order and described in Section 10.6.5.

Function 1
Map Setup
Data Send

Disk, External I/O and Map Setup Data Header (send all map setup data common to all formats and required to link the data map with the physical wafer.)

(SECS I)

	ITEM	NAME	OCTAL FORMAT
	0	L, 15	00
*	1	MID	20
*	2	IDTYP	10
*	3	FNLOC	52
	4	FFROT	52
	5	ORLOC	10
	6	RPSEL	51
	7	L, n	00
		1. REFP1	34
		.	
		.	
		n. REFPn	
*	8	DUTMS	20
*	9	XDIES	54
*	0	YDIES	54
*	11	ROWCT	52
*	12	COLCT	52
*	13	NULBC	51
*	14	PRDCT	54
*	15	PRAXI	10

Function 7
(prober to host)

Function 14
(host to prober)

Map Data
Send Type I
(row format)

Map data transfers (send map data in row/column format).

	ITEM	NAME	OCTAL FORMAT
	16	L, 3	00
*	17	MID	20
*	18	IDTYP	10
	19	L, n	00
	20	1. L,2	00
	21	1. RSINF1	32
	22	2. BINLT1	51
*	23	2. L,2	00
		.	
		.	
		n. L,2	
		1. RSINFn	
		2. BINLTn	

* fields that will return an error message

The actions taken following the discovery of an error differ depending on the function of the source device used in the transaction. The prober responds to error conditions in a more flexible way when under SECS control. Only two conditions halt the prober: if available prober memory is too small to accept or create the map; or if the SECS link is disconnected during transmission of the header or map.

10.6.3.2 WHEN THE SOURCE IS SECS

When SECS is the source, format, parameter, and wafer ID mismatch errors will cause the prober to unload the current wafer and send the S12F19 (see **Table 10−1**) map error message to the host. The host has the responsibility to halt further prober operations should there be a mismatch between physical wafers and wafer maps in a lot. The host may also unload a wafer following the receipt of the map setup data by returning a list of "0" items in S12F14. Depending on error, the prober monitor displays the following error messages:

217 `UNLOAD – BY HOST COMMAND`
(returns 0 length S12F14, as noted above)
218 `UNLOAD – HOST ABORTED MAP XFER`
(when host sends S12F0)

Prior to communications with host:
63 `ALL MAPPING MEMORY USED UP`

S12F19 returned for these errors:
213 `UNLOAD – HOST MAP BAD WAFER ID`
214 `UNLOAD – HOST MAP FORMAT ERROR`
215 `UNLOAD – HOST MAP PARAMETER ERR`

The error location in the header of the map is sent following the guidelines of S12F19. If alarm messages are enabled in the Enhanced External I/O Mode Menu, these messages will be sent automatically over External I/O (RS−232/GPIB).

10.6.4 SUPPORTED SECS I/II FUNCTIONS

Definitions are repeated, in alphabetical order, in Section 10.6.5

S1, F0 **S, H<−>E**

ABORT TRANSACTION

Description:

Used in place of an expected reply to abort a transaction. Processing of an abort is the responsibility of the user.

Structure: Header only.

NOTE: Will accept, but does not abort, any transactions.

DEFINE: MDLN **Format: 20**

Model Number

ASCII data. MDLN may take on the following value: "4085X"

DEFINE: SOFTREV **Format: 20**

Software revision code.

The data format is: "stvvrr," where:

s = part number code (A = PN 245288)
C = PN 248899
D = PN 249799)

t = "0" (PROM) or "1" (disk)

vv = 2−digit version number (dash number of the software part number)

rr = 1 or 2 character revision (N, N3, etc.)

S1, F1 **S, H−>E, reply**

ARE YOU THERE REQUEST

Description:

Establishes if the prober is online.

Structure: Header only.

S1, F2 **S, H<−E**

ON LINE DATA

Description:

Data signifying the prober is alive.

Structure: L, 2

1. <MDLN>
2. <SOFTREV>

DEFINE: SVID

Status variable ID **Format: 32**

Identifies selected status variables.

DEFINE: SV **Format: 20, 3(), 4(), 5()**

Status variable data

Status variables return certain operational data to the host. See Table 10−4 for a list of status variables and their formats.

S1, F3 **S, H−>E, reply**

SELECTED EQUIPMENT STATUS REQUEST

Description:

A request to the prober to report selected status data. See Table 14−4.

Structure: L, n

1. <SVID1)
2. <SVID2>

: :

n. <SVIDn>

Exceptions: A zero length list means the prober will report all SVIDs. Some SVIDs are not implemented; see Table 10−4 for a list of those that are complete.

S1, F4 **M, H<−E**

SELECTED EQUIPMENT STATUS DATA

Description:

The prober reports the values of each SVID in the order requested. See Table 14−4.

Structure: L, n

1. <SV1>
2. <SV2>

: :

n. <SVn>

Exceptions: If n = 0, no response can be made. A zero length returned for SVi means that SVIDi does not exist.

Stream (S) and Function (F) Format Explanation

"S" = Single block message
"M" = Multiple block message
"H" = Host (usually tester)
"E" = Equipment (usually prober)

<− −> = Message direction
reply = Function requires an acknowledgement from the host or equipment

S2, F0 S, H<–>E

ABORT TRANSACTION

Description:

Same form as S1F0.

DEFINE: CCMD **Format: 10**

Control command

Description:

See Table 10–4 for a description of the codes.

S2, F65 S, H–>E, reply

TYPE I CONTROL COMMAND SEND

Description:

Type I control commands are those that require no parameters and little time to execute. See Table 10–5 for details.

Structure: <CCMD>

S2, F66 S, H<–E

TYPE I CONTROL COMMAND COMPLETION

Description:

Reports the completion of a Type I control command.

Structure: <CCMDC>

DEFINE: CCMDA **Format: 10**

Control command acknowledge

0 – command accepted
1 – command not accepted, try later
2 – iillegal command
>2 – reserved
255 – EG software problem. Report to EG.

S2, F67 S, H–>, reply

TYPE II CONTROL COMMAND SEND

Description:

Type II control commands are those that require no parameters and whose execution time may exceed the SECS conversation timeout. Actual command completion is signaled by the prober sending an S2,F95 to the host. The prober is unable to communicate until S2,F95 is transmitted.

Structure: <CCMD>

S2, F68 S, H<–E

TYPE II CONTROL COMMAND ACKNOWLEDGE

Description:

Reports the acceptance of a type II control command. Actual command completion is signaled by the prober sending an S2,F95 to the host. The prober is unable to communicate until S2,F95 is transmitted.

Structure: <CCMDA>

DEFINE: PARM

Type II control command parameter. See Table 10–5 for a description of the commands, their individual parameters, and their formats.

S2, F69 S, H–>E, reply

TYPE III CONTROL COMMAND SEND

Description:

Type III control commands are those that require parameters and whose execution time may exceed the SECS conversion timeout. Actual command completion is signaled by the prober sending an S2,F95 to the host. The prober is unable to communicate until S2,F95 is transmitted.

Structure:

```
<CCMD>
L, n
   <PARM1>
      :
   <PARMn>
```

S2, F70 S, H<–E

TYPE III CONTROL COMMAND ACKNOWLEDGE

Description:

Reports the acceptance of a type III control command. Actual command completion is signaled by the prober sending an S2,F95 to the host.

Structure: <CCMDA>

S2, F71 S, H–>E, reply

TYPE IV CONTROL COMMAND SEND

Description:

Type IV control commands are those that require parameters and whose execution time does not exceed the SECS conversation timeout.

Structure:

```
<CCMD>
L, n
   <PARM1>
      :
   <PARMn>
```

S2, F72 **S, H<–E**

TYPE IV CONTROL COMMAND ACKNOWLEDGE

Description:

Reports the completion of a type IV control command.

Structure: <CCMDC>

DEFINE: **CCMDCOMP** **Format: 10**

Control command completion code

0 – successfully completed
1 – stopped due to an alarm condition
2 – stopped due to local operator action
3 – stopped due to other action
>3 – reserved

S2, F95 **S, H<–E**

CONTROL COMMAND COMPLETION REPORT

Description:

Reports the completion of a type II or type III control command which was initiated by S2,F67 or S2,F69.

Structure: L, 2

1. <CCMD>
2. <CCMDCOMP>

S5, F0 **S, H<–>E**

ABORT TRANSACTION

Description:

Same form as S1F0.

DEFINE: **ALCD** **Format: 10**

Alarm Code

bit 8 = 1 means alarm set
bit 8 = 0 means alarm cleared
bits 7 – 1 are the alarm category code:

0 – not used
1 – Personal safety
2 – Equipment safety
3 – Parameter control warning
4 – Parameter control error
5 – Irrecoverable error
6 – Equipment status warning
7 – Attention flags
8 – Data integrity
>8 – other categories
9–63 – reserved

DEFINE: **ALID** **Format: 52**

Alarm ID

Alarm identification.

DEFINE: **ALTX** **Format: 20**

Alarm text

The alarm text is limited to 40 characters. This is a standard error/alarm message text.

DEFINE: **ACKC5** **Format: 10**

Acknowledge code

0 = accepted, alert operator (beeper keeps beeping)
1–63 reserved
64 = accepted, silence alarm and resume process.

S5, F1 **S, H<–E, [reply]**

ALARM REPORT SEND

Description:

This message reports the presence of an alarm condition or a change in an alarm condition. A message will be issued when the alarm is set.

Structure: L, 3

1. <ALCD>
2. <ALID>
3. <ALTX>

S5, F2 **S, H–>E**

ALARM REPORT ACKNOWLEDGE

Description:

Acknowledge or error.

Structure: <ACKC5>

DEFINE: **ALED** **Format: 10**

Alarm enable/disable code

bit 8 = 1 means enable alarms
bit 8 = 0 means disable alarms
bits 7–1 are ignored.

S5, F3 **S, H–>E, [reply]**

ENABLE/DISABLE ALARM SEND

Description:

Enables or disables alarm transmission via SECS communication port. This does not affect the standard external I/O channels or the display of alarms on the prober CRT.

Structure: L, 2

1. <ALED>
2. <ALID>

Exceptions: The value of ALID is ignored. Individual alarms may not be controlled. Alarms are enabled or disabled on a global basis by ALED.

S5, F4 **S, H<–E**
ENABLE/DISABLE ALARM ACKNOWLEDGE
Description:
Acknowledge or error.
Structure: <ACKC5>

DEFINE: MHEAD **Format: 10**
Erroneous SECS I Message Header
MHEAD is the stored SECS I header of the message that was in error.

S9, F1 **S, H<–E**
UNRECOGNIZED DEVICE ID
Description:
The device ID in the message block header did not correspond to the prober ID.
Structure: <MHEAD>

S9, F2 **Not Used**

S9, F3 **S, H<–E**
UNRECOGNIZED STREAM TYPE
Description:
The prober does not recognize the stream type in the message block header.
NOTE: If host sends S9Fx to the prober, the prober will respond with S9F3.
Structure: <MHEAD>

S9, F4 **Not Used**

S9, F5 **S, H<–E**
UNRECOGNIZED FUNCTION TYPE
Description:
The prober does not recognize the function type in the message block header.
NOTE: If host sends S9Fx to the prober, the prober will respond with S9F3.
Structure: <MHEAD>

S9, F6 **Not Used**

S9, F7 **S, H<–E**
ILLEGAL DATA
Description:
This message indicates that the stream and function were recognized but the associated data format could not be interpreted.
NOTE: If host sends S9Fx to the prober, the prober will respond with S9F3.
Structure: <MHEAD>

S9, F8 **Not Used**

DEFINE: SHEAD **Format: 10**
Stored header related to the transaction timer.

S9, F10 **Not Used**

S9, F12 **Not Used**

DEFINE: MEXP **Format: 20**
Message expected
Data is in the form SxxFyy where x is the stream and y is the function number.

DEFINE: EDID **Format: 10, 20**
Expected data identification
Possible values depend on the value of MEXP.

MEXP	EDID
S7F3	<PPID>
S12F3	<MID>

S9, F14 **Not Used**

S10, F0 **S, H<–>E**
ABORT TRANSACTION
Description:
Same form as S1F0.

DEFINE: TID **Format: 10**
Terminal ID
For the 3001X prober, the value of TID is 0.

DEFINE: TEXT **Format: 20**
A single line of ASCII data
Each line of text may be no longer than 32 characters.

S10, F5 **M, H−>E**

TERMINAL DISPLAY, MULTI−BLOCK

Description:

Data to be displayed.

Structure: L, 2

1. <TID>
2. L, n
   1. <TEXT1>
   :
   n.<TEXTn>

Exceptions: n may be 1 or 2. TEXT1 is displayed on line 14 of the prober CRT, TEXT2 is displayed on the bottom line, line 15.

S12, F0 **S, H<−>E**

ABORT TRANSACTION

Description:

Same form as S1F0.

NOTE: Aborts a wait for S12F4, S12F14, and S12F72. Will abort transmission of map from prober. Prober will send S12F0.

DEFINE: MID **Format: 20**

Material ID

27 characters maximum.

DEFINE: IDTYP **Format: 10**

ID type

0 = Wafer ID
1 = Wafer cassette ID
2 = Film frame ID

DEFINE: FNLOC **Format: 52**

Flat/Notch location

Rotation in degrees. 0 degrees is the front of the prober, 90 degrees puts the flat toward the left. Always used by the prober.

DEFINE: FFROT **Format: 52**

Film frame rotation

Not used by prober. Host should send zero length item.

DEFINE: ORLOC **Format: 10**

Origin Location

Defines where the SECS 0.0 coordinate is located.

0 = center die of wafer (not used by prober)
1 = upper right “corner” of wafer
2 = upper left “corner” of wafer
3 = lower left “corner” of wafer
4 = lower right “corner” of wafer

DEFINE: RPSEL **Format: 51**

Reference point select

Determines which of several reference points was used for this particular wafer. Previous releases of software defined this to be the number of reference points only.

DEFINE: REFPn **Format: 34**

Reference point

X,Y coordinate of a reference point. The two numbers are stored as an array with the x coordinate first.

DEFINE: DUTMS **Format: 20**

Die unit of measure

The prober sends and expects “10 ^ −1*mil”.

DEFINE: XDIES **Format: 54**

X axis die size

Defines the X axis step size.

DEFINE: YDIES **Format: 54**

Y axis die size

Defines the Y axis step size.

DEFINE: ROWCT **Format: 52**

Row count

Defines the total number of rows of die in the map.

DEFINE: COLCT **Format: 52**

Column count

Defines the total number of columns of die in the map.

DEFINE: NULBC **Format: 51**

Null bin code value

The prober does not use this item. A zero length item is used instead.

DEFINE: PRDCT **Format: 54**

Process die count

Indicates the total number of die probed. Ugly die are included but skip die are not.

DEFINE: PRAXI **Format: 10**

Process Axis

Defines how probing began. Determines whether rows or columns were probed, whether probing began at the top or bottom of the wafer, and whether the initial direction was positive (increasing X or Y coordinates) or negative (decreasing X or Y coordinates) per the following table:

0 = rows, top, increasing
1 = rows, top, decreasing
2 = rows, bottom, decreasing

(continued)

DEFINE: PRAXI (continued)

3 = rows, bottom, increasing
4 = columns, left, increasing
5 = columns, left, decreasing
6 = columns, right, increasing
7 = columns, right, decreasing
(4–7: Not used by EG)
>7 = error
8–63 reserved

DEFINE: SDACK **Format: 10**

Map setup data acknowledge

0 = received data
>0 = error
1–63 reserved

S12, F1 **S, H<–E,reply**

MAP SETUP DATA SEND

Description:

Used to send all of the map setup data required to link the map with the physical wafer.

Structure:

L, 15

1. <MID>
2. <IDTYP>
3. <FNLOC>
4. <FFROT>
5. <ORLOC>
6. <RPSEL>
7. L, n
   1. <REFP1>
   :
   n.<REFPn>
8. <DUTMS>
9. <XDIES>
10. <YDIES>
11. <ROWCT>
12. <COLCT>
13. <NULBC>
14. <PRDCT>
15. <PRAXI>

(See Table 17–3.)

S12, F2 **S, H–>E**

MAP SETUP DATA ACKNOWLEDGE

Description:

Acknowledgement of receipt of map setup parameters.

Structure: <SDACK>

DEFINE: MAPFT **Format: 10**

Map data format type

0 – Row format (used by prober)
1 – Array format (not supported)
2 – Coordinate format (not supported)
>2 – error
3–63 – reserved

DEFINE: MLCL **Format: 54**

Message length in bytes.

DEFINE: BCEQU **Format: 51**

Bin code equivalents

Array of all bins to be processed. Zero length indicates all codes to be sent.

S12, F3 **S, H<–E,reply**

MAP SETUP DATA REQUEST

Description:

Used to request setup data from the host for the wafer ready to be processed by the prober.

Structure:

L, 9

1. <MID>
2. <IDTYP>
3. <MAPFT>
4. <FNLOC>
5. <FFROT>
6. <ORLOC>
7. <PRAXI>
8. <BCEQU>
9. <NULBC>

Exceptions: If the zero length list is received from the host, the prober will unload the wafer and ready the next wafer for processing.

S12, F4 **S, H–>E**

MAP SETUP DATA

Description:

Used to send to the equipment all the setup data required to link the map to the physical wafer.

Structure:

L, 15

1. <MID>
2. <IDTYP>
3. <FNLOC>
4. <ORLOC>
5. <RPSEL>
6. L, n
   1. <REFP1>
   :
   n. <REFPN>
7. <DUTMS>
8. <XDIES>
9. <YDIES>
10. <ROWCT>
11. <COLCT>
12. <PRDCT>
13. <BCEQU>
14. <NULBC>
15. <MLCL>

Exceptions: If a zero length list is received from the host, the prober will unload the wafer and ready the next wafer for processing.

If the host sends S12F4 as L, 0, the prober will unload the wafer.

DEFINE: GRNT1 **Format: 10**

Grant code

0 = Positive response, transfer OK
1 = Busy, try again
2 = No space
3 = Map too large
4 = Duplicate ID
5 = Material ID not found
6 = Unknown map format
>6 = error
7–63 reserved

S12, F5 **S, H<–E, reply**

MAP TRANSMIT INQUIRE

Description:

Used to prepare the host for map transmission. S12, F5 must precede all S12,F7 and F8 transactions.

Structure: L, 4
1. <MID>
2. <IDTYP>
3. <MAPFT>
4. <MLCL>

S12, F6 **S, H–>E**

MAP TRANSMIT GRANT

Description:

Provides permission to transfer the map.

Structure: <GRNT1>

DEFINE: RSINF **Format: 32**

Row start information

This item is an array of 3 integers: X, Y, and Direction. X and Y are the coordinates of the first die in the row. A positive number for the direction indicates the X coordinate increases for each bin, a negative value indicates the X coordinate decreases for each bin.

DEFINE: BINLT **Format: 51**

Bin list.

Array of bin values.

DEFINE: MDACK **Format: 10**

Map data acknowledge

0 = Map received
1 = Format error
2 = No ID match
3 = Abort/discard map
>3 = error
4–63 reserved

S12, F7 **S, H<–E, reply**

MAP DATA SEND TYPE 1

Description:

Used to send a map from the prober to the host in row format.

Structure: L, 3
1. <MID>
2. <IDTYP>
3 L, n
    1. L, 2
        1. <RSINF1>
        2. <BINLT1>
    :
    n. L, 2
        1. <RSINFn>
        2. <BINLTn>

S12, F8 **S, H–>E**

MAP DATA ACKNOWLEDGE TYPE 1

Description:

Acknowledge or error

Structure: <MDACK>

S12, F13 **S, H<–E, reply**

MAP DATA REQUEST TYPE 1

Description:

Used by the prober to request a wafer map from the host in row format.

Structure: L, 2
1. <MID>
2. <IDTYP>

S12, F14 **M, H–>E**

MAP DATA TYPE 1

Description:

Used to send map data from the host to equipment in row format.

Structure: L, 3
1. <MID>
2. <IDTYP>
3 L, n
    1. L, 2
        1. <RSINF1>
        2. <BINLT1>
    :
    n. L, 2
        1. <RSINFn>
        2. <BINLTn>

DEFINE: MAPER **Format: 10**

Map error code

0 = ID not found
1 = Invalid data
>2 = Invalid error
3–63 reserved

DEFINE: DATLC **Format: 52**

Data location

Location of the invalid, represented in bytes measured from the start of the message in question, excluding all SECS I header bytes.

S12, F19 **S, H<–>E**

MAP ERROR REPORT SEND

Description:
Used to transmit map related errors.

Structure: L, 2
1. <MAPER>
2. <DATLC>

NOTE: The prober will also send S12,F19 if the map header data received from the host in S12,F4 doesn't correspond to the current prober setup. This would be sent, for example, if FNLOC does not match the current flat orientation of the wafer on the prober.

After S12,F19 is sent, the prober will send S12,F3 again for the same wafer. If this process repeats more times than the SECS I retry count, the prober will issue an alarm and unload the wafer.

S12, F20 **Not Used**

DEFINE: MSL **Format: 10**

Map search location

Location to be searched for wafer map IDs.

0 – Memory
1 – Drive A
2 – Drive B
3 – Drive C
4 – Drive D
>4 – reserved

S12, F65 **S, H–>E, REPLY**

STORED MAP ID REQUEST

Description:
Reqests the prober to send a list of material IDs representing wafer maps available in local prober storage.

Structure: <MSL>

S12, F66 **S, H<–E**

STORED MAP ID DATA

Description:
The material IDs are sent in a list structure. If no maps are available in local storage, a list with zero items is sent.

Structure: L, n
1. <MID1>
2. <MID2>
:
n. <MIDn>

DEFINE: MSACK **Format: 10**

Map send request acknowledge

0 = Map will be sent
1 = MID not found
>1 = reserved

S12, F67 **S, H–>E, reply**

STORED MAP SEND REQUEST

Description:
Requests the prober to initiate the transfer of a locally stored wafer map.

Structure: L, 2
1. <MSL>
2. <MID>

S12, F68 **M, H<–E**

STORED MAP SEND REQUEST ACKNOWLEDGE

Description:
Informs host whether the map will be sent.

Structure: <MSACK>

DEFINE: MDACK **Format: 10**

Map delete request acknowledge

0 = Map deleted.
1 = MID not found
>1 = reserved

S12, F69 **M, H–>E, reply**

DELETE LOCALLY STORED MAP

Description:
Delete a map stored in prober local storage.

Structure: L, 2
1. <MSL>
2. <MID>

S12, F70 **S, H<−E**

LOCALLY STORED MAP DELETION ACKNOWLEDGE

Description:

Informs the host whether the map was deleted or not.

Structure: <MDACK>

S12, F71 **S, H<−E, reply**

REQUEST PERMISSION TO PROBE

Description:

The prober sends this message to the host prior to probing each wafer. The host responds with S12, F72 to tell the prober whether to probe this wafer or fetch the next wafer for probing.

Structure: <MID>

DEFINE: **PP** **Format: 10**

Permission to probe

0 = Do not probe
1 = Probe
>1 = reserved

S12, F72 **S, H−>E**

PERMISSION TO PROBE GRANT

Description:

Reply to S12,F71.

Structure: <PP>

10.6.5 SECS NAME DEFINITIONS

ACKC5 **Format: 10**

Acknowledge code

0 = accepted, alert operator (beeper keeps beeping)

1–63 reserved

64 = accepted, silence alarm and resume process.

ALCD **Format: 10**

Alarm Code

bit 8 = 1 means alarm set

bit 8 = 0 means alarm cleared

bits 7 – 1 are the alarm category code:

0 – not used
1 – Personal safety
2 – Equipment safety
3 – Parameter control warning
4 – Parameter control error
5 – Irrecoverable error
6 – Equipment status warning
7 – Attention flags
8 – Data integrity
>8 – other categories
9–63 – reserved

ALED **Format: 10**

Alarm enable/disable code

bit 8 = 1 means enable alarms

bit 8 = 0 means disable alarms

bits 7–1 are ignored.

ALID **Format: 52**

Alarm ID

Alarm identification.

ALTX **Format: 20**

Alarm text

The alarm text is limited to 40 characters. This is a standard error/alarm message text.

BCEQU **Format: 51**

Bin code equivalents

Array of all bins to be processed. Zero length means process all codes are to be sent.

BINLT **Format: 51**

Bin list.

Array of bin values.

CCMD **Format: 10**

Control command

Description:

See Table 10–5 for a description of the codes.

CCMDA **Format: 10**

Control command acknowledge

0 – command accepted
1 – command not accepted, try later
2 – iillegal command
>2 – reserved
255 – EG software problem. Report to EG.

CCMDCOMP **Format: 10**

Control command completion code

0 – successfully completed
1 – stopped due to an alarm condition
2 – stopped due to local operator action
3 – stopped due to other action
>3 – reserved

COLCT **Format: 52**

Column count

Defines the total number of columns of die in the map.

DATLC **Format: 52**

Data location

Location of the invalid, represented in bytes measured from the start of the message in question, excluding all SECS I header bytes.

DUTMS **Format: 20**

Die unit of measure

The prober sends and expects “10^–1*mil”.

EDID **Format: 10, 20**

Expected data identification

Possible values depend on the value of MEXP.

MEXP	EDID
S7F3	<PPID>
S12F3	<MID>

FFROT **Format: 52**

Film frame rotation

Not used by prober. Host should send zero length item.

FNLOC **Format: 52**

Flat/Notch location

Rotation in degrees. 0 degrees is the front of the prober, 90 degrees puts the flat toward the left. Always used by the prober.

GRNT1 **Format: 10**

Grant code

0 = Positive response, transfer OK
1 = Busy, try again
2 = No space
3 = Map too large
4 = Duplicate ID
5 = Material ID not found
6 = Unknown map format
>6 = error
7–63 reserved

IDTYP **Format: 10**

ID type

0 = Wafer ID (the only code used)
1 = Wafer cassette ID
2 = Film frame ID

MAPER **Format: 10**

Map error code

0 = ID not found
1 = Invalid data
>2 = Invalid error
3–63 reserved

MAPFT **Format: 10**

Map data format type

0 – Row format (used by prober)
1 – Array format (not supported)
2 – Coordinate format (not supported)
>2 – error
3–63 – reserved

MDACK **Format: 10**

Map data acknowledge

0 = Map received
1 = Format error
2 = No ID match
3 = Abort/discard map
>3 = error
4–63 reserved

MDACK **Format: 10**

Map delete request acknowledge

0 = Map deleted.
1 = MID not found
>1 = reserved

MDLN **Format: 20**

Model Number

ASCII data. MDLN may take on one of the following values: “2001X,” “2010X,” “4085X”.

MEXP **Format: 20**

Message expected

Data is in the form SxxFyy where x is the stream and y is the function number.

MHEAD **Format: 10**

Erroneous SECS I Message Header

MHEAD is the stored SECS I header of the message that was in error.

MLCL **Format: 54**

Message length in bytes.

MID **Format: 20**

Material ID

27 characters maximum.

MSACK **Format: 10**

Map send request acknowledge

0 = Map will be sent
1 = MID not found
>1 = reserved

MSL **Format: 10**

Map search location

Location to be searched for wafer map IDs.

0 – Memory
1 – Drive A
2 – Drive B
3 – Drive C
4 – Drive D
>4 – reserved

NULBC **Format: 51**

Null bin code value

The prober does not use this item. A zero length item is used instead. This is the bincode value to use for no die at a location.

ORLOC **Format: 10**

Origin Location

Defines where the 0,0 coordinate is located in the SECS coordinate system.

0 = center die of wafer (not used by prober)
1 = upper right “corner” of wafer
2 = upper left “corner” of wafer
3 = lower left “corner” of wafer
4 = lower right “corner” of wafer

Matches coordinate quadrant parameter.

PARM

Type II control command parameter. See Table 10−4 for a description of the commands, their individual parameters, and their formats.

PP **Format: 10**

Permission to probe

0 = Do not probe
1 = Probe
>1 = reserved

PRAXI **Format: 10**

Process Axis

Defines how probing began. Determines whether rows or columns were probed, whether probing began at the top or bottom of the wafer, and whether the initial direction was positive (increasing X or Y coordinates) or negative (decreasing X or Y coordinates) per the following table:

0 = rows, top, increasing
1 = rows, top, decreasing
2 = rows, bottom, decreasing
3 = rows, bottom, increasing
4 = columns, left, increasing
5 = columns, left, decreasing
6 = columns, right, increasing
7 = columns, right, decreasing

(4–7: Not used by prober)

>7 = error
8−63 reserved

PRDCT **Format: 54**

Process die count

Indicates the total number of die probed. Ugly die are included, skip die are not.

REFPn **Format: 34**

Reference point

X,Y coordinate of a reference point. The two numbers are stored as an array with the X coordinate first.

ROWCT **Format: 52**

Row count

Defines the total number of rows of die in the map.

RPSEL **Format: 51**

Reference point select

Determines which of several reference points was used for this particular wafer.

RSINF **Format: 32**

Row start information

This item is an array of 3 integers: X, Y, and Direction. X and Y are the coordinates of the first die in the row. A positive number for the direction indicates the X coordinate increases for each bin, a negative value indicates the X coordinate decreases for each bin.

SDACK **Format: 10**

Map setup data acknowledge

0 = received data
>0 = error
1−63 reserved

SHEAD **Format: 10**

Stored header related to the transaction timer.

SOFTREV **Format: 20**

Software revision code.

The data format is: “stvvrr,” where:

s = part number code (A = PN 245288)
C = PN 248899
D = PN 249799

t = “0” (PROM) or “1” (disk)
vv = 2−digit version number (dash number of the software part number)
rr = 1 or 2 character revision (N, N3, etc.)

SV **Format: 20, 3(), 4(), 5()**

Status variable data

Status variables return certain operational data to the host. See Table 10−4 for a list of status variables and their formats.

SVID

Status variable ID **Format: 32**

Identifies selected status variables.

TEXT **Format: 20**

A single line of ASCII data

Each line of text may be no longer than 32 characters.

TID **Format: 10**

Terminal ID

For the 4085X prober, the value of TID is 0.

XDIES **Format: 54**

X axis die size

Defines the X axis step size.

YDIES **Format: 54**

Y axis die size

Defines the Y axis step size.

TABLE 10–4:

STATUS VARIABLE SET
STREAM 1, FUNCTIONS 3 AND 4

This table lists the status data that may be obtained from the 4085X probers via Stream 1, Functions 3 and 4. Note that the SVIDs are called out as decimal values.

SV 01 — X DIE POSITION
Four byte signed integer, format code 34. X axis position in die coordinates.

SV 02 — Y DIE POSITION
Four byte signed integer, format code 34. Y axis position in die coordinates.

SV 03 — X ABSOLUTE POSITION
Four byte signed integer, format code 34. X axis position in machine coordinates.

SV 04 — Y ABSOLUTE POSITION
Four byte signed integer, format code 34. Y axis position in machine coordinates.

SV 05 — Z POSITION
Format code 51. 1 = up, 0 = down.

SV 06 — Z HEIGHT
Two byte signed integer, format code 32. Units are Z motor drive steps. Divide this value by the Z scale factor returned in status variable 7 to get the Z height in mils.

SV 07 — Z SCALE FACTOR
Two byte signed integer, format code 32. The scale factor is the number of Z motor pulses required to move the chuck 1 mil. Standard scale factors are 2 for the 0.5 mil Z stage and 4 for the 0.25 mil Z stage.

SV 08 — WAFER ON CHUCK ID
String, format code 20. Maximum length of 27 characters.

SV 09 — WAFER ON CHUCK PROCESSED
Format code 51. 1 = processed, 0 = unprocessed. Processed means profiled, aligned, and completely probed according to the current probe mode.

SV 10 — WAFER(S) FOR PROCESSING AVAILABLE IN HANDLER
Format code 51. 1 = unprocessed wafers available, 0 = unprocessed wafers not available.

SV 11 — RECEIVER CASSETTE FULL
Format code 51. 1 = receiver full, 0 = receiver not full.

SV 12 — WAFER IS ON CHUCK (VACUUM SENSOR)
Format code 51. 1 = wafer on chuck, 0 = wafer off chuck.

SV 13 — CASSETTE 1 MAP (2010 ONLY)
String, format code 20. Maximum length of 26 characters. The prober will return the string

$Mn_1 n_2 n_3 ...n_{25}$.

The n_1 corresponds to slot 1, n_{25} to slot 25.

The n's may take the following values and meanings:

1 : Unmapped slot
2 : Slot empty, wafer in process (on prealigner, quickoader, chuck, or hold station
3 : Slot empty
4 : Slot occupied by unprobed wafer
5 : Slot occupied by probed wafer
6 : Slot occupied by problem wafer
7 : Slot not scheduled for probing

SV 14 — CASSETTE 2 MAP
SV 15 — CASSETTE 3 MAP
SV 16 — CASSETTE 4 MAP
SV 17 — HANDLER SYSTEM STATUS
SV 18 — HANDLER REVISION DATA
SV 19 — PREALIGNER STATUS
SV 20 — HOLD STATION STATUS
SV 21 — QUICKLOADER STATUS
SV 22 — CHUCK STATUS
SV 23 — TRANSFER ARM STATUS
Not functional.

SV 24 — LAST ERROR CODE
Two byte signed integer, format code 32. Returns the last uncleared error, warning, or message code. This is not the same as stream 5 alarms; alarms are a subset of these error codes.

SV 100 – 199 — CASSETTE SLOT STATUS
Not functional.

TABLE 10–5:

STREAM 2, FUNCTIONS 65, 67, 69, AND 71

CONTROL COMMAND SET
LEGAL COMMANDS AVAILABLE

Stream 2 Function 65 (Type I) Commands

Command Code	Function
1	Abort probing
2	Clear printer data buffers
3	Generate E.O.W. pulse on tester I/F
4	Probe 1 wafer
5	Generate start test pulse (tester I/F)
6	Begin autoprobing

Stream 2 Function 67 (Type II) Commands

Command Code	Function
1	Auto align wafer
2	Clean probe tips
3	Move to home position
4	Handle wafer (unload, load, profile, align)
5	Unload wafer and load new wafer
6	Move to first (preset) position
7	Pause/continue probing
8	Use profiler to find wafer thickness
9	Retry a failed prealign
10	Unload wafer
11	Move Z stage to down position
12	Move Z stage to up position

Stream 2 Function 69 (Type III) Commands

Cmnd Code	Parm(s) Type	Function
1	34	Micro die move relative to micro origin
2	10	Goto a micro site
3	10	Ink device, move Z up if down
4	20	Load disk file file name format – “A:xxxxxxxx” and loads .PRM, .LRN, etc.
5	10	Print wafer log or cassette log
6	34	Move relative in die steps
7	34	Move relative in machine steps
8	34	Move absolute in die steps
9	32	Move theta
10	32	Move Z stage to specified height

NOTE: Commands with X,Y pairs are always ordered with X first followed by the Y value.

Stream 2 Function 71 (Type IV) Commands

Cmnd Code	Parm(s) Type	Function
1	10	Micro die test complete
2	10	Lamp off/on
3	10	Test complete and bin device
4	10	Chuck vacuum off/on

10.7 SUMMARY

In this section, you have learned:

- How to enable the Wafer Mapping feature
- Information about the Wafer Mapping Menu and the associated parameters
- How to use the four mapping modes to run a wafer map
- Information regarding GPIB or serial wafer map transmissions
- SECS information, including communication protocols, streams and functions

SUPPLEMENT

WAFER MAPPING AND SECS

SECTION 10

DOC 254523−100 REV A

ENHANCEMENT:
MESSAGES

REF: SECTION 10.2.1
WAFER MAPPING MENU LINE ITEMS
LINE 05 − (PAGE 1): DIRECTORY OF ALL MAPS

The following information documents a change incorporated into **RTM 2 / Prober Vision 2 System Software 249799−X2X.DA.** The hardware and software requirements for this release are listed in the front of the manual, in the supplement following Page x.

Attempting a directory of an unformatted disk from Line 05 of the Wafer Mapping Menu will result in a two−second display of the disk error message:

#12 − `READING PROBLEM`

Also, attempting a directory of a double−density DOS−formatted disk from the Line 05 will result in a two−second display of disk error message:

#22, `WRONG DISK FORMAT.`

A directory of a DOS high density formatted diskette results in the message: `READING PROBLEM` instead of `WRONG DISK FORMAT` (as with double−density diskettes).

EXPANDED INFORMATION

REF: SECTION 10.4
GPIB OR SERIAL WAFER
MAP TRANSMISSION (NON−SECS)

The following information was transferred from the External I/O Interface Section.

10.4.1 WAFER MAP DATA FORMAT

The wafer map and map header data is formatted according to the l987 SEMI SECS II Stream 12 standard with one exception, noted below. This includes the formatting information defined by SECS II (lists, single and multi byte integers, etc.) as well as the map and header data. Each byte of data is converted to two ASCII characters in the range 0 to 9 and A to F for transmission.

SEMI defines a wafer map as two “messages,” a header message and a map data message. The header contains setup information such as die size and wafer rotation. The map message contains the X, Y, and bin data. The header message is defined by SECS II as Stream 12, Function 1. The map message is Stream 12, Function 7.

The prober does not split the map into separate header and map sections for use with the external I/O ports. Instead, the header forms one element of a SECS II list and the map forms the other element. This is the exception to the SEMI standard.

10.4.2 WAFER MAP COMMUNICATION METHOD

Wafer maps are communicated in much the same way as the setup parameters. Data is organized into blocks of 64 ASCII characters each. Each block is terminated by the current terminator character or characters (carriage return and/or line feed). If GPIB transmission is used, the EOI bus line is asserted during transmission of the final character of each block.

After transmitting each block, the prober will wait for a handshake from the tester before sending the next block. If RS−232 is in use, the tester will send back a message that contains a valid terminator sequence (carriage return and/or line feed). If GPIB is in use, the normal bus handshaking is used and the tester does not send any message.

10.4.3 TRANSMITTING WAFER MAPS TO THE TESTER

If wafer mapping to disk is enabled, wafer maps are stored on disk prior to transmitting the map to the tester. Maps may also be written to external I/O (serial or GPIB) or SECS.

If the prober cannot write a map to disk for any reason (such as disk full, no disk present), the map will still be transmitted to the tester. After transmission, an alarm will sound on both the CRT and the external I/O port and the prober will stop. The operator can correct the error and instruct the prober to write the map to a blank formatted disk by using the `RETRY MAP TRANSFER` option in the Wafer Mapping Menu. The prober may then be restarted by pressing the <AUTO PROBE> key.

MAP TRANSMISSION AND RE−TRANSMISSION − After the last die is tested, the prober sends the **PC** message (if enabled) to the tester. The map will then be written to disk if this option is enabled on the Wafer Mapping Menu. The prober will send the message **MR** (map receive) to the tester. If GPIB is in use and SRQ is enabled, the standard SRQ/serial poll sequence is used to transmit the **MR** message.

If RS−232 is in use, the tester will return a message that contains a valid terminator sequence (carriage return and/or line feed). If GPIB is in use, normal bus handshaking is used and the tester need not send any handshaking message.

The prober then sends the first block of data and waits for the tester to reply with a handshake (terminator sequence if RS−232, normal bus handshake if GPIB) before sending the next block. This process repeats until the last block of data has been transmitted. Following the handshake sequence from the tester after the last block has been sent, the prober will send the **MCn** message, where "n" is the prober−calculated checksum. Note that the checksum is a signed decimal value, not a hex number.

Once map transmission is complete, the tester will calculate a checksum from the received data. If the checksum agrees with that sent by the prober, the tester will send the command "Y." If the checksum doesn't agree, the tester will send the command "N."

If the prober receives a "Y" response, the wafer is unloaded and processing continues with the next wafer. If "N" is received, the prober restarts map transmission by sending the "MR" message again. The normal sequence of sending a block and waiting for a handshake is then repeated. At the end of map re−transmission, the tester again must verify correct reception with a "Y" or "N" response. The prober will try to send the current map until successful (no timeout or retry limit).

10.4.4 RECEIVING WAFER MAPS FROM THE TESTER

Reception of wafer maps is similar to receiving a download of parameter data. A similar transmission method is used. When the prober is set up to receive maps from external I/O, the prober will load a wafer, read its ID, and request the map from the tester.

TRANSMISSION AFTER LOADING THE WAFER − After a wafer is loaded, the prober will send the message **MTi** to the tester; "i" is the ASCII ID read from the wafer. If wafer reader hardware is not in use, the prober will transmit the operator−entered run and lot numbers and the prober−assigned sequence number in a format similar to that used by the **?W** I/O command.

The tester will respond with a "Y" ("I have the map you want") or "N" ("I don't have that map") followed by a terminator. If the response is "N," the prober enters the idle state awaiting commands. The wafer may then be unloaded by the tester. Processing of new wafers may be resumed by the tester issuing the **AP** (autoprobe) command.

If the response is "Y," the tester will wait for the prober to signal readiness to receive the map. The prober will do this by sending the ">" prompt with terminator via RS−232 or normal bus handshaking via GPIB. The tester will then transmit the first 64−character line of the map data and again await the ">" prompt or GPIB handshake. This process continues until all map data has been transferred to the prober.

After the final line of data is sent, the tester again awaits the ">" prompt or GPIB handshake. The tester then sends the message **CMn** to the prober to indicate that the map has been completely transferred; "n" is the tester−calculated checksum of the map data. At this time, the prober compares its calculated checksum against the checksum received from the tester. If the checksums agree, an **MC** message is sent to the tester and wafer processing continues. If the checksums do not agree, an **MF** message is sent to the tester and the prober will again send the **MTi** command to request the map.

10.4.5 ADDITIONAL HOST REQUEST CAPABILITIES

To send a list of maps stored on disk:

The tester can cause a list of wafer maps to be sent by issuing the command **LMc** where "c" is a disk drive letter A − D. The prober will respond with the ID of the first map stored and wait for a terminator from the tester. (This assumes RS−232 or GPIB SRQ/serial poll handshake, used any time the prober sends to some external piece of equipment.) After receipt of the terminator, the second ID is sent. After all IDs have been sent, the prober will wait for a terminator from the tester and then send the **MC** message. If no maps are stored on the disk, the prober will respond to the **LMc** command with an immediate **MC** message.

For a stored map to be sent to the tester:

The tester can request the prober to send a map stored on disk via the **MScIi** command; "c" is the drive letter (A − D) of the disk the map is stored on, "i" is the wafer ID as returned by the **LM** command. The prober will respond with **MC** if the map is found on the specified drive, **MF** if it is not. After the **MC** message is sent, the prober will initiate transmission with the **MR** message as defined in section **17.1.3.3 (Transmitting Wafer Maps to the Tester),** under the heading Map Transmission and Re−Transmission.

For the prober to delete a map from disk:

The **DMcIi** command deletes a map from the prober disk; "c" is the drive letter (A − D) of the disk the map is stored on, "i" is the wafer ID as returned by the **LM** command. The prober returns **MC2** after deleting the file, **MF** if it cannot be deleted for any reason. If more than one map exists for the same wafer, the most recent map is erased.

SECTION 11 − INK DOT INSPECTION

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SECTION 11
INK DOT INSPECTION

11.1 OVERVIEW

Even fully automatic probers normally require periodic maintenance of the inking system. Without the inspection feature, this is done by visual inspection of the ink dots for proper size and location within the die. If a problem is found, the prober is halted manually.

With Ink Dot Inspection (IDI), the monitoring of the ink dots is performed by the Vision Module. Once set up and trained, the feature performs fully automatic inspection of inked die as a part of the probing process, or after probing. If the inking system malfunctions, the prober can halt probing and alert the operator to take corrective action.

Each ink dot is inspected for width and height, location, area, ink density, and consistency. Inspection tolerances for ink dot size, location, area, ink density, the frequency and number of inspections, number of consecutive ink dot failures, and total number of failures allowed per wafer are all operator selectable. When the predetermined number of ink dots fail inspection, the prober will halt and signal the operator. You can display an inspection summary and either take corrective action or allow the prober to continue operation.

11.1.1 How To Use This Section

This section contains the following information about Ink Dot Inspection:

- The prerequisites required before beginning performing automatic Ink Dot Inspection
- How to enable Ink Dot Inspection
- Instructions on verifying the inker position
- How to enter ink dot specifications and inspection parameters
- Lighting calibration procedures
- How to perform ink dot training
- How to perform manual inspections
- How to read inspection summaries
- Procedures to perform if the inspection fails
- How to store IDI information on a disk

11.2 GETTING STARTED

11.2.1 Prerequisites

The following prerequisites must be performed before beginning IDI training and setup:

1. Install probe card and install and set up inker.
2. Set camera position and probe center.
3. Train an alignment image; align the wafer.
4. Set First Die position.
5. Disable Theta Compensation.

1. **Install probe card and install and set up inker. –** Then load a wafer onto the chuck. Adjust the inker position so the die will be inked in a relatively bright area near the center. Ink several die to check inker operation and ink dot location.

   The position of the inker is crucial to IDI, and the inker must always be set up prior to inspection training. Instructions for inker setup are contained in the Electroglas Inker Installation and Operation Manual, Doc 246730.

IMPORTANT
If the inker moves for any reason, you *must* retrain the inker position and the ink dot image (**Section 11.8**). Otherwise, all new ink dots inspected will be failed as having drifted to a bad location.

2. **Set camera position and probe center. –** Access the Profiler Menu by pressing < PROG > (< F5 >). Remove the wafer, position the chuck center under the camera crosshairs, and press < 8 > to set the camera position. Move the chuck center to the center of the probe tips and press < 2 > to set probe center. (This step is done without a wafer, to compensate for any error generated by loading the wafer.) Replace the wafer.

3. **Train the reference target and align the wafer. –** Perform the normal reference target training and aligning procedures (see **Section 5, AUTO ALIGN**).

IMPORTANT
If a new alignment target is trained, Ink Dot Inspection training must be repeated.

4. **Set first die position. –** Set the First Die position using the normal procedure.

   The ink dot map generated during probing is referenced to the first die. If the first die location is altered during probing, a new ink dot map will be generated, and the old map will be discarded.

5. **Disable Theta Compensation. –** See **Section 5, AUTO ALIGN, subsection 5.9, Theta Compensation,** for more information.

11.2.2 IDI Procedures

Each of the following needs to be performed before automatic Ink Dot Inspection can occur:

1. Enable Ink Dot Inspection **Section 11.3**
2. Verify inker position **Section 11.4**
3. Enter IDI specification parameters **Section 11.5**
4. Enter IDI inspection mode parameters **Section 11.6**
5. Calibrate lighting **Section 11.7**
6. Train ink dot image and position **Section 11.8**

Once these steps have been completed, inspection is automatic, and the prober can be operated normally. A summary of the inspection is available for your review.

See the Supplement at the end of the section for information about the automatic adjustment of ink dot inspection offset between wafer lots.

11.3 ENABLE INK DOT INSPECTION

Press < SET OPTION > (< F3 >) to display the Set Option Menu (*Figure 11−1*). Select Line 09, INK DOT INSPECTION. Key < 1 > (ENB). This enables IDI and displays the Ink Dot Inspection Menu (*Figure 11−1*).

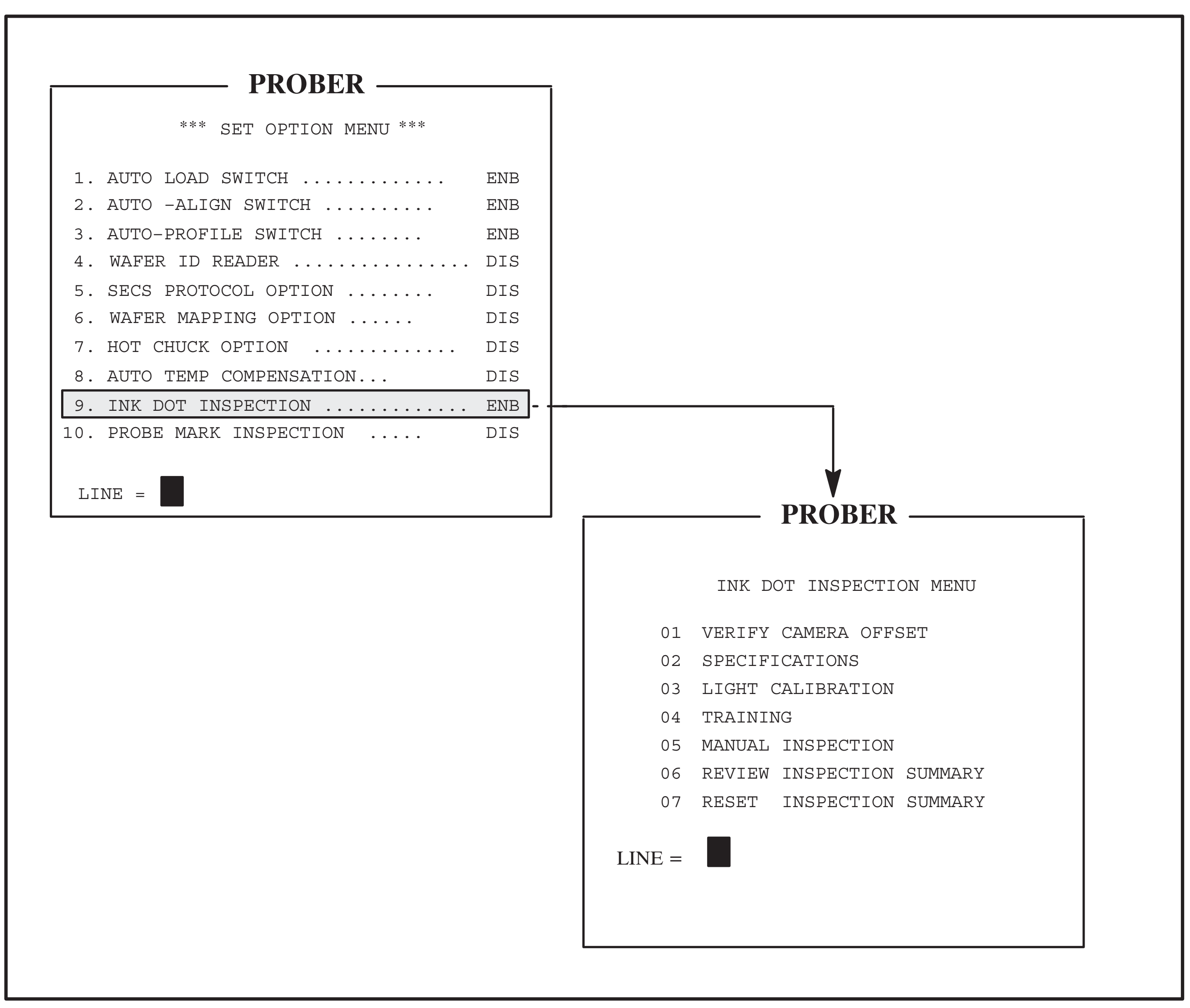


FIGURE 11−1: SET OPTION MAIN MENU AND INK DOT INSPECTION MENU

11.4 VERIFY INKER POSITION

The offset between the inker and the camera center needs to be verified. From the Ink Dot Inspection Menu (*Figure 11−2*), select Line 01,Verify Camera Offset.

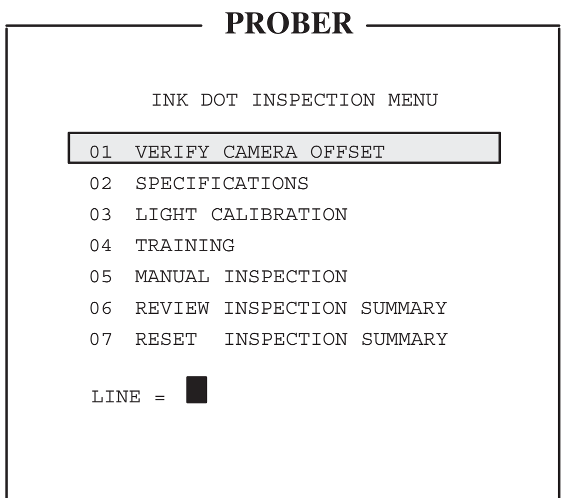


FIGURE 11−2: INK DOT INSPECTION MENU

It is necessary to verify this offset so that during inspections the same ink dot that is under the inker will be moved over to the camera for an inspection (explained in **Section 11.8, Training).**

Any unique feature on the chucktop or wafer can be used for this verify process. The goal is to land at the same spot inside the same die after moving from the inker to the camera.

The default offset value depends on the settings of the camera center and the probe tip center. The default reference is the center of the chuck. If the offset has been set previously, the previous values are used. The prober automatically moves the existing setting of the feature point under the inker and displays the screen shown in *Figure 11−3*.

Align the unique feature with the inker under the microscope. Press < PAUSE/CONT > to store the current location of the chuck as the new inker reference point.

If at any time you wish to abort the procedure, press < ENTER>. The message, “PROCEDURE ABORTED. NEW DATA NOT STORED” displays, then the system displays the Ink Dot Inspection Menu.

PROBER

```
 * VERIFY INKER TO CAMERA OFFSET *

UNIQUE FEATURE MOVED TO INKER.
VERIFY FEATURE ALIGNED TO INKER
BY PRESSING PAUSE.

IF NOT ALIGNED USE JOYSTICK TO
ALIGN UNIQUE FEATURE WITH INKER.

JOYSTICK IS ENABLED
PRESS ”Z” TO MOVE CHUCKTOP
PRESS ”PAUSE” WHEN ALIGNED
PRESS ”ENTER” TO ABORT
```

FIGURE 11−3: INKER TO CAMERA OFFSET VERIFICATION SCREEN

If the inker location is accepted, the prober responds with a confirming message (*Figure 11−3A*), moves the chuck under the camera, and displays a verification screen (*Figure 11−3B*).

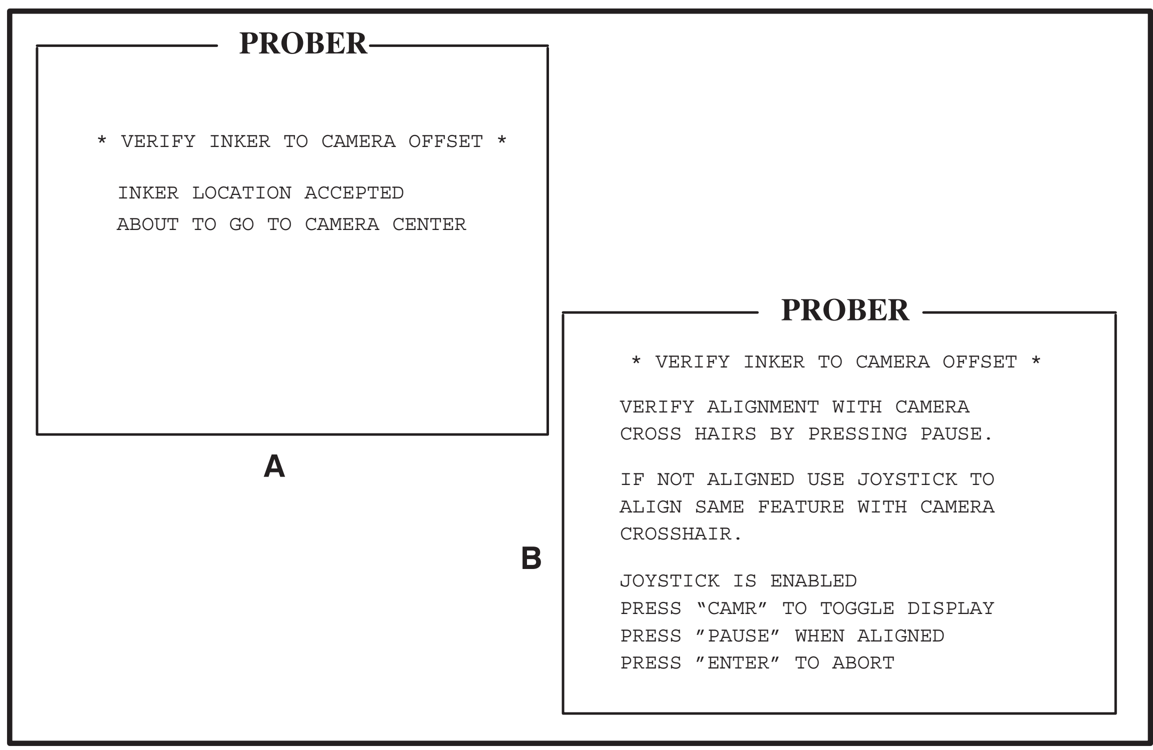


FIGURE 11−4: LOCATION ACCEPTED VERIFICATION SCREENS

Align the unique feature with the camera cross hairs and press < PAUSE/CONT > when aligned. A message will confirm, “NEW DATA ACCEPTED.” The system displays the Ink Dot Inspection Menu.

11.5 ENTER INK DOT SPECIFICATIONS

From the Ink Dot Inspection Menu, select Line 02, Specifications. The Ink Dot Specifications Menu displays (*Figure 11−5*).

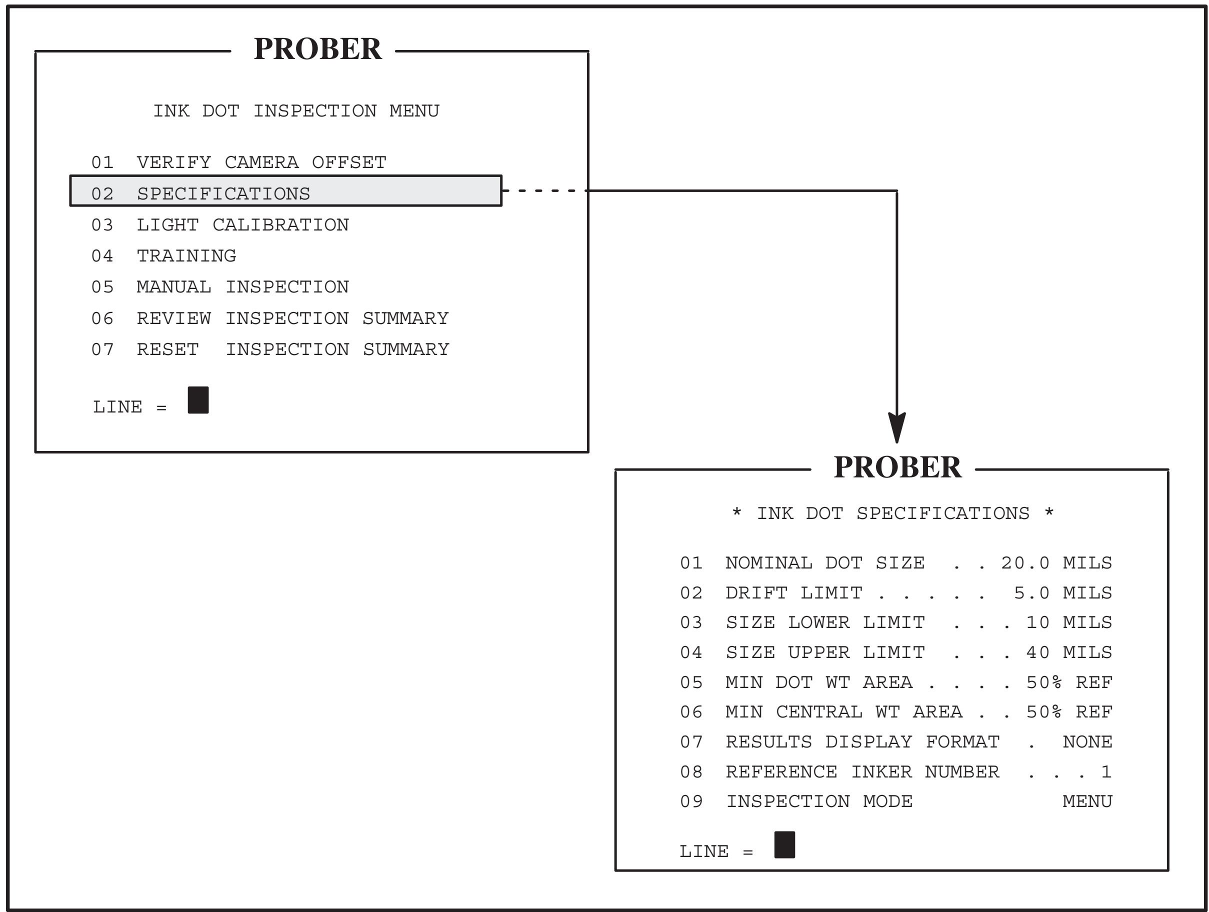


FIGURE 11−5: INK DOT INSPECTION AND SPECIFICATIONS MENUS

Information on each of the line items for the Ink Dot Specifications Menu is available in **Table 11−1** which gives the prompt, range, default, and description for each item on the menu.

NOTE
The ink dot nominal size, the position drift limit, and the dot size upper limit may not be altered after ink dot training without necessitating a new training. Always enter the ink dot specifications *prior* to training.

TABLE 11−1: INK DOT SPECIFICATIONS MENU

LINE	PROMPT *	RANGE / DEFAULT	ENTER:
01 NOMINAL DOT SIZE	SIZE ( ) =	7 – 45 / 20 mils	Approximate dot size in mils.
02 DRIFT LIMIT	LIMIT ( ) =	1 – 99 / 2 mils	Distance the center of the ink dot should be allowed to wander (in mils).
03 SIZE LOWER LIMIT	LIMIT ( ) =	10−99% / 25%	Dot size limits in mils (4.4 is the smallest lower limit allowed). The ranges are based on percentages of the Nominal Dot Size; these percentages are converted to mils when displayed with the prompt. Size is determined by height and width as opposed to area which is determined by number of dark pixels. (A long, narrow ink dot is big in size but small in area.)
04 SIZE UPPER LIMIT	LIMIT ( ) =	100% / 200%	(see above)
05 MIN DOT WEIGHTED AREA	%REF ( ) =	1−99% / 50%	The minimum acceptable weighted area of the inspected ink dot relative to the reference dot. The weighted area is the sum of all pixels attributed to the ink dot where each pixel is weighted by its darkness. A diluted or thinned dot will have a smaller weighted area than one of heavier, darker ink. During training, a proper ink dot with the right size, location, and ink density should be chosen as the reference. All subsequent ink dots are evaluated for weighted area by comparison to the reference dot. The reference dot weighted area appears on the Ink Dot Inspection Summary (see **Section 11.9, Inspection Summaries).**
06 MIN CENTRAL WEIGHT AREA	%REF ( ) =	10−99% / 50%	The weighted pixel count in a box centered within the ink dot. The box dimensions are 1/2 the width by 1/2 the height of the reference dot. The minimum central area guards against dots with acceptable overall dimensions but small area (such as a doughnut−shaped dot).
07 RESULTS DISPLAY FORMAT	0 = NONE 1 = MIN 2 = MAX 3 = DIAG	−−−−	Choice of display format showing results of each inspection, displayed over image of dot. NONE suppresses display of all data; MIN, pass or fail and a box indicating where the dot was found; MAX, pass or fail, the box, and dot dimensions in mils; DIAG is generally reserved for diagnostics and requires more time. MAX format is recommended.
08 REFERENCE INKER NUMBER	USING INKER NUMBER=	1 – 4 / 1	The inker number to be used during inspection training and during inspection as part of probing (during or after wafer is probed). Dots deposited during probing by any other inker will not be inspected.
09 SET INSPECTION MODE			(Select to access the Ink Dot Inspection Mode Menu. See **Table 11−2).**

*** The acceptable range appears inside the parenthesis of the prompts.**

11.5.1 Combinations of Values

In the *Figure 11−5* example, the values given are typical for a dot size of 20 mils. When a new "NOMINAL INK DOT SIZE" is entered which causes "SIZE LOWER LIMIT" or "SIZE UPPER LIMIT" to be outside its acceptable range, the value is adjusted to either the maximum or minimum acceptable value.

Ink Dot Inspection parameters prevent the operator from entering combinations of drift limits, nominal, and maximum sizes which would exceed the Vision Module's field of view. A message, DEPENDENT PARAMETERS ADJUSTED, will notify the operator that, because of the parameter just entered, other inspection parameters have been changed and re−displayed.

For example, if the "NOMINAL INK DOT SIZE" is set at 20 mils and the "SIZE LOWER LIMIT" is set at 4.4 mils, then if the "NOMINAL INK DOT SIZE" is changed to 45 mils, the minimum allowed for "SIZE LOWER LIMIT" is 10% of 45 mils which is 4.5 mils. Since the current setting of "SIZE LOWER LIMIT" is 4.4 mils, it will automatically be adjusted to 4.5 mils.

11.5.2 Display Formats

Line 07 on the Ink Dot Specifications Menu provides a choice of four formats to show the results of each inspection, displayed over the image of the dot.

Results are shown in two units: mils and microns. The formats are:

NONE: Only the respective ink dot area is shown.

MIN: Boxes are displayed enclosing the center and border of the ink dot.

MAX: Provides the box display and a line of text regarding the ink dot.

DIAG: Provides the greatest amount of ink dot information.

The information given in the **MIN** and **MAX** formats is illustrated in *Figure 11−6.*

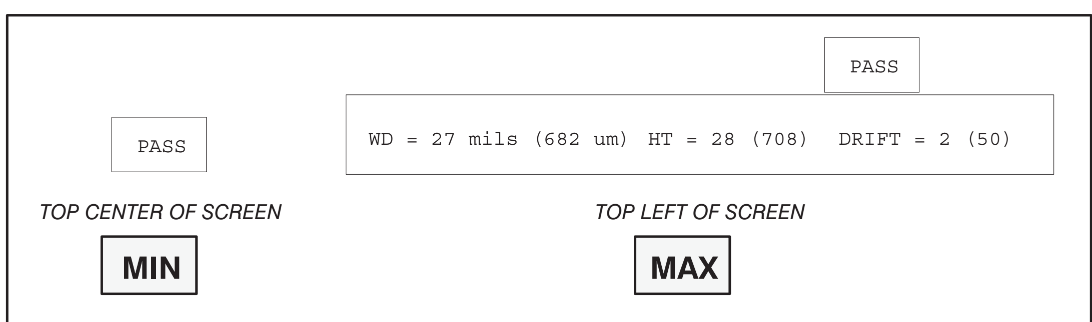


FIGURE 11−6: MINIMUM AND MAXIMUM DISPLAY FORMATS

The **DIAG** display, illustrated in *Figure 11−7,* includes the following:

1) An outer dark graphics window showing the search range.
2) A left window showing the difference between the current image and the reference no−ink−dot image. The difference is shown in reduced size.
3) A right window showing a reverse binary of the left window described in Item 2.
4) A middle white graphics window showing the bounding box of the found ink dot.
5) A bottom window showing the reverse binary of the graphics window described in Item 4.
6) An inner white graphics window showing the central weight area. This window is always in the middle of the graphics window described in Item 4; its size is one half of the reference ink−dot.

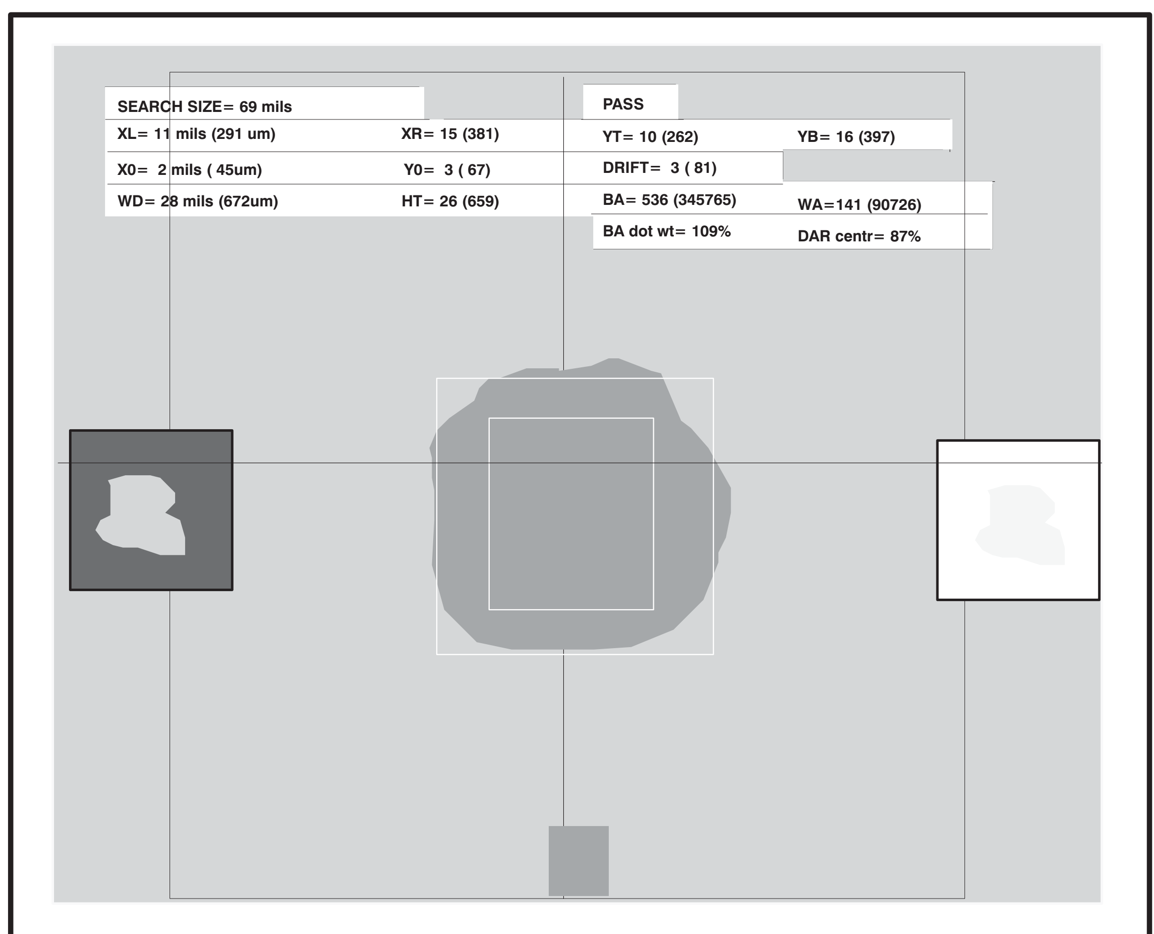


FIGURE 11−7: INK DOT INSPECTION DIAGNOSTIC DISPLAY

In the table across the top of the screen, the following values are given, shown in both mils and (microns):

Line 2 − **XL −** Distance from the center of the screen to the left edge of the bounding box.

	XR –	Distance from the center... to the right edge...
	YT –	Distance from the center... to the top edge...
	YB –	Distance from the center... to the bottom edge...
Line 3 –	**X0** and **Y0 –**	Drift in the **X** and **Y** respectively.
	DRIFT –	Drift from the center.
Line 4 –	**WD –**	Width of the ink dot.
	HT –	Height of the ink dot.
	BA –	Dot area.
	WA –	Central dot area.
Line 5 –	**BA dot wt –**	Ratio of **BA** to the area of the trained ink dot.
	DAR centr –	Ratio of **WA** to the central area of the trained ink dot.

11.6 ENTER INK DOT INSPECTION PARAMETERS

From the Ink Dot Specifications Menu, select Line 09, Inspection Mode. The Ink Dot Inspection Mode Menu displays (*Figure 11−8*).

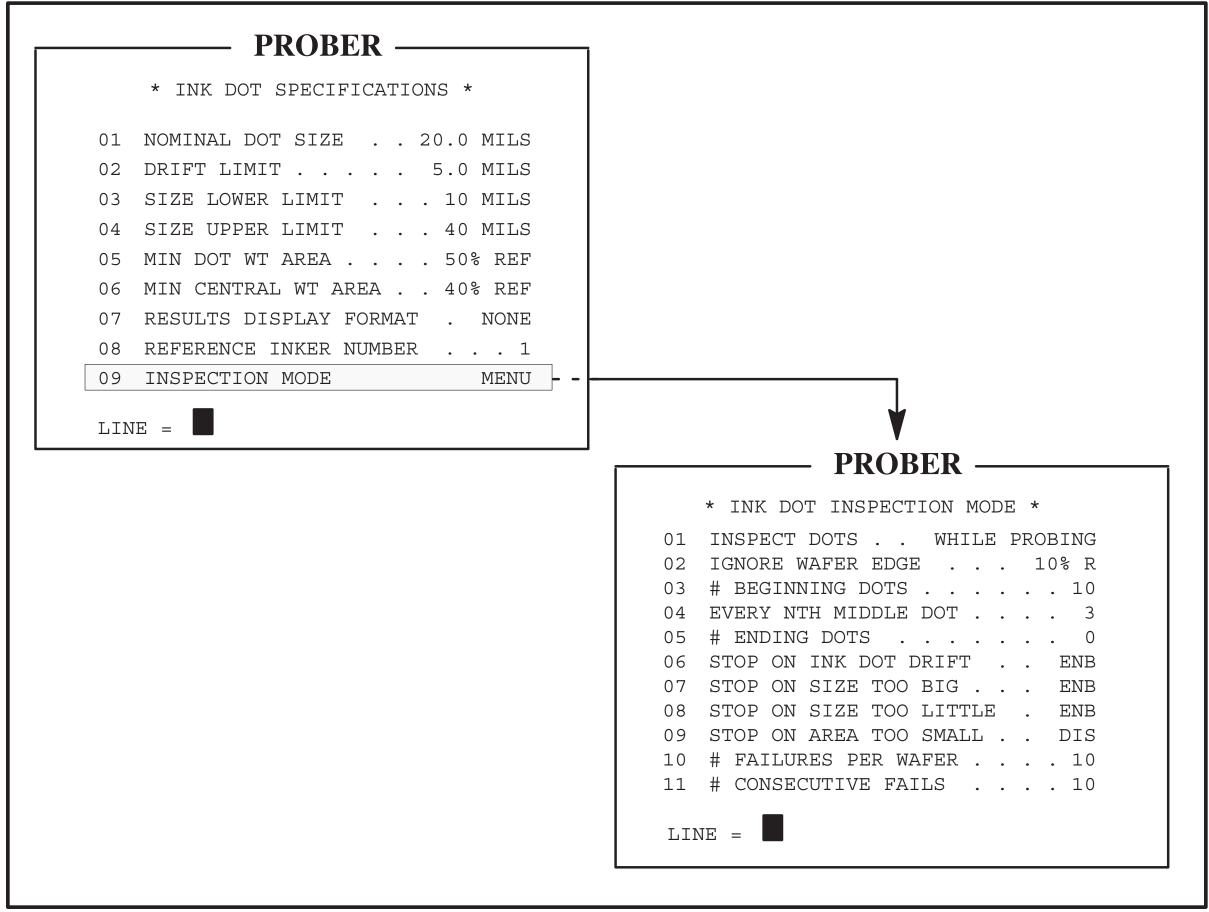


FIGURE 11−8: INK DOT SPECIFICATIONS AND INSPECTION MODE MENUS

Information on each of the line items for the Ink Dot Inspection Mode Menu is available in **Table 11−2**, which gives the prompt, range, default, and description for each item on the menu.

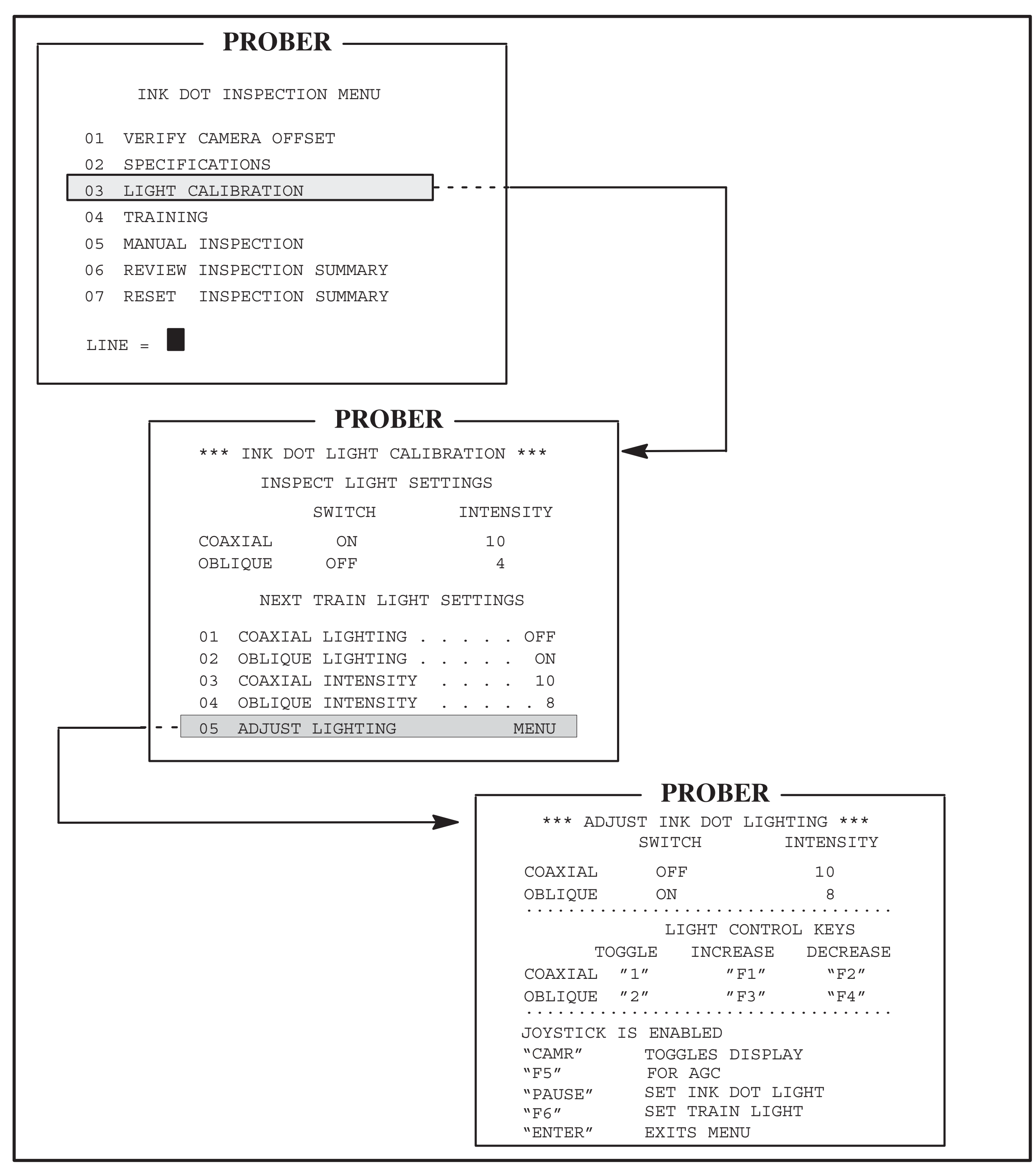
TABLE 11–2: INK DOT INSPECTION MODE MENU

Accessed from Line 09 of the Ink Dot Specifications Menu

LINE	PROMPT	RANGE / DEFAULT	ENTER:
01 INSPECT DOTS	0 = AFTER PROBING 1 = WHILE PROBING	(Default:) While Probing	Whether ink dots will be inspected as the die are probed and inked (While Probing), or after probing has been completed (After Probing).
02 IGNORE WAFER EDGE	%RADIUS=	0 – 99% 10%	The percentage of the radius of the wafer edge to ignore, to accommodate large and small dies. Ink dots on the wafer edge are not inspected due to such conditions as the presence of partial dies, variation in color, and lighting interference from wafer edge and chucktop.
03 # BEGINNING DOTS	DOTS=	0 – 99 10	A fixed number of ink dots (on the right half of the wafer) to be inspected first.
04 EVERY NTH MIDDLE DOT	DOTS=	1 – 9999 99	Inspection frequency: every "Nth" ink dot, between the beginning and ending dots, will be inspected (if it can be moved under the camera). Use the maximum value (9999) to disable inspection of middle dots.
05 # ENDING DOTS	DOTS=	0 – 99 0	A fixed number of ink dots (which can be moved under the camera) to be inspected at the end of probing. (Active only in the After Probing mode.)
06 STOP ON INK DOT DRIFT		DIS	Enable or disable. Each of these failure modes may be included in or excluded from counting toward the number of failures per wafer.
07 STOP ON SIZE TOO BIG		DIS	
08 STOP ON SIZE TOO LITTLE		DIS	
09 STOP ON AREA TOO SMALL		DIS	
10 # FAILURES PER WAFER	LIMIT=	1 – 999 50	Number of ink dot failures at which the prober stops and signals the operator (normally between 1 and 10). Every test die will be inked; therefore, inked test die may be candidates for inspection and might fail (due to their different background image). Take this into account when setting value.
11 # CONSECUTIVE FAILS	LIMIT=	1 – 999 50	Number of consecutive failures at which the prober stops and signals operator. When an ink dot fails inspection, all subsequent ink dots are inspected until either a dot passes or the specified number of consecutive failures is reached. Identifies catastrophic inker failures, yet protects against accidental prober stoppages due to occasional inker failures or other random problems.

11.7 CALIBRATE LIGHTING

From the Ink Dot Inspection Menu, select Line 03, LIGHT CALIBRATION. The Ink Dot Light Calibration Menu displays (*Figure 11−9*), which controls the lighting for the next training sequence. The goal is an image where the ink dots appear black against a light gray background.



Updated 6/14/94

FIGURE 11−9: INK DOT INSPECTION, LIGHT CALIBRATION AND ADJUST LIGHTING SCREENS

The light settings chosen will not be in effect until the next training sequence is completed. If the desired settings are known, they can be entered directly into the Ink Dot Light Calibration Menu. If the settings are not known, select Line 05, ADJUST LIGHTING, and the Adjust Ink Dot Lighting Screen displays (*Figure 11−9*).

The last reference die trained will be moved under the camera with the current light settings. If no die has been trained, default values will be used for the light settings, and the center of the wafer will be placed under the camera.

There are 15 discrete light levels. Press < CAMR > to toggle between the menu and the camera video display to observe lighting. When in the video display, the keys defined by the Adjust Ink Dot Lighting screen are still active so changes in lighting can be seen immediately. Typically, this is achieved by using oblique lighting or a combination of both coaxial and oblique lighting.

While making changes, **do not** press < ENTER > after pressing an active key; pressing < ENTER > returns the display to the Ink Dot Light Calibration Menu.

See the Supplement at the end of the section for information on manual adjustment of light intensities.

11.8 INK DOT TRAINING

After the inker has been set up and is functioning satisfactorily, deposit an ink dot on a die located on the wafer. An existing ink dot may be used. From the Ink Dot Inspection Menu, select Line 04, TRAINING, to display the Training Modes Menu (*Figure 11−10*).

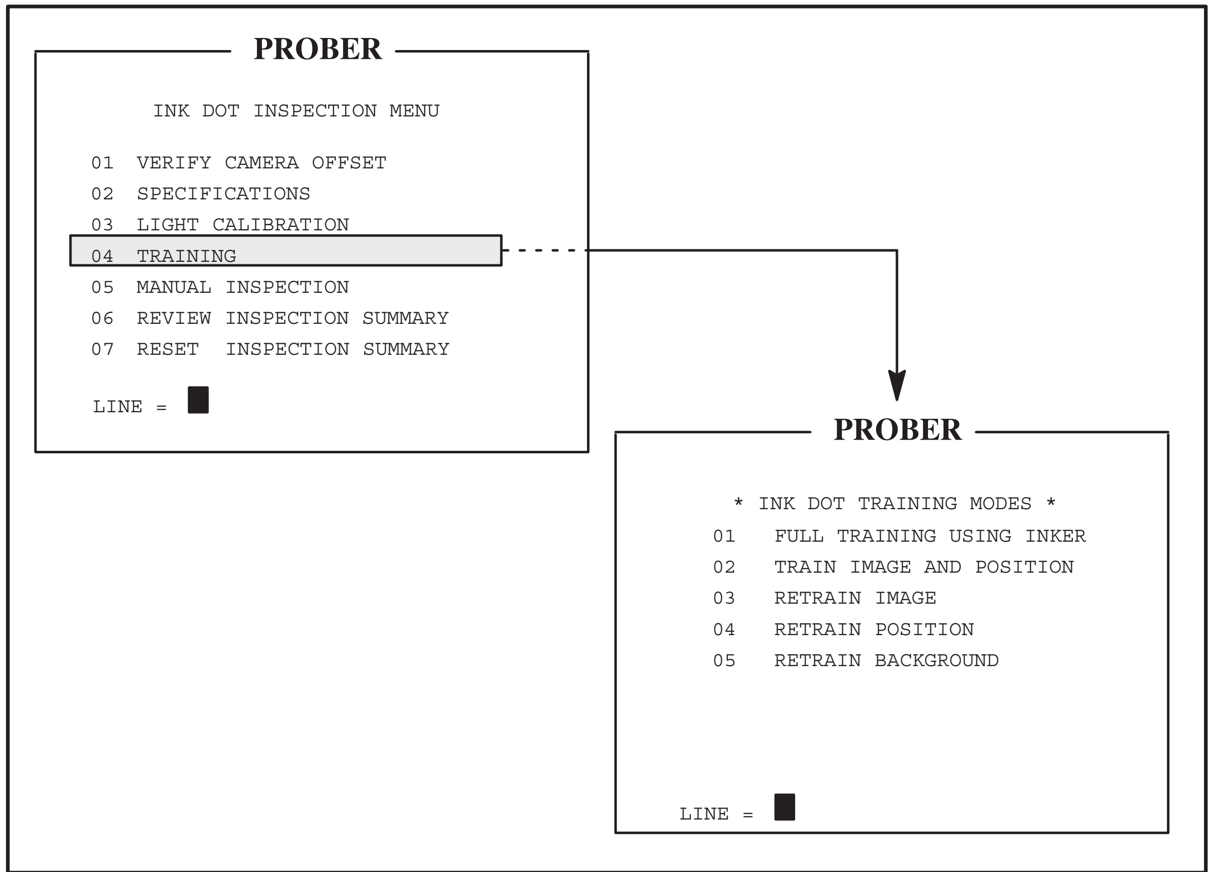


FIGURE 11−10: INK DOT INSPECTION AND TRAINING MODES MENUS

NOTE

Be sure to perform either training procedure 1 or 2 before probing. If any part of the training is omitted, the prober displays an error message when the < AUTO PROBE > key is pressed, informing you that more setup or training is required before Autoprobing can be performed.

The training procedure uses several different screens for the training steps (*Figures 11−11* through *11−13*):

To begin the training procedure, from the Ink Dot Training Modes Screen, select Line 01, Full Training Using Inker . There are 3 steps involved in this training process.

STEP 1. Deposit Reference Ink Dot

The chuck moves under the probe tips if not already there. If possible, the same die under the camera center will be positioned under the probe tips. If not possible, a die near the center of the wafer will be placed under the probe tips. If the chuck is already under the probe tips, no move is made. The joystick is now active, and a different die may be moved under the probe tips if desired. The Deposit Reference Dot Screen displays with instructions for depositing the reference dot (*Figure 11−11*).

PROBER

```
* INK DOT INSPECTION TRAINING *
     DEPOSIT REFERENCE DOT

 POSITION DIE UNDER INKER.
 PRESS INKTEST TO DEPOSIT
 REFERENCE INK DOT.
 WHEN INK DOT ACCEPTABLE, PRESS
 PAUSE.

 JOYSTICK ENABLED
 "CAMR" TOGGLES DISPLAY
 "ENTER" ABORTS TRAINING
```

FIGURE 11−11: DEPOSIT REFERENCE DOT SCREEN

Position the chuck with the joystick until the desired die is under the inker. Press < INK TEST > (located on the Joystick Keyboard) to fire the reference inker. The chuck may also be repositioned and another ink dot deposited by using the < INK TEST > key. When the ink dot is satisfactory, press < PAUSE/CONT >. The chuck moves the inked die near the center of the camera, and the Step 2 screen (*Figure 11−12*) displays.

STEP 2. Position Guard Box Around Dot

The next screen (Position Video Box Screen, *Figure 11−12*) displays instructions for positioning the video box around the ink dot.

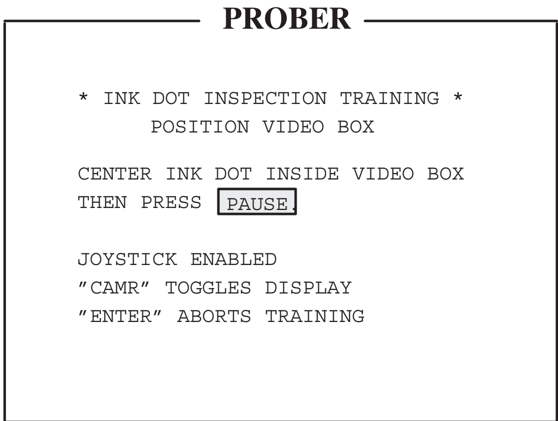


FIGURE 11−12: POSITION VIDEO BOX SCREEN

Follow the instructions on this screen and press < PAUSE/CONT >. The Step 3 screen (*Figure 11−13*) displays.

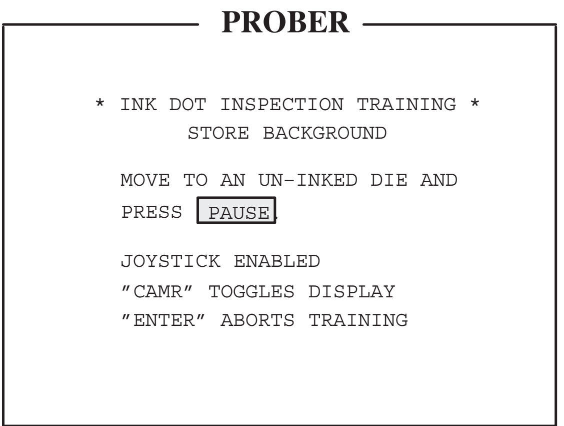


FIGURE 11−13: STORE BACKGROUND SCREEN

STEP 3. Store Background Reference

Move to an uninked die and press < PAUSE/CONT >. The screen switches to the camera image (if not already there), and the uninked die image is stored as the reference background. The chuck then automatically moves back to the reference ink dot and makes an inspection.

Based on the results of this inspection, the reference ink dot and background positions are corrected for the true dot center. The background and reference ink dot are then reinspected, and this information is stored as the reference dot image. The results are displayed over the camera image in accordance with the Display Format specified in the Ink Dot Specifications Menu. The < CAMR > key can be used to toggle between the camera image and the Ink Dot Inspection Results screen (see **Section 11.9.1 Manual Inspection**).

When < ENTER > is pressed, the display returns to the Ink Dot Training Modes screen after briefly displaying "`TRAINING COMPLETE.`"

If an error is returned from the Vision Module because the ink dot exceeds the maximum size or other parameters in the Ink Dot Specifications Menu (**Section 11.5**), or if the Vision Module communications are not working, a message describing the error will be displayed for two seconds, followed by:

```
PROCEDURE ABORTED
INK DOT INSPECTION NOT TRAINED.
```

If you don't know the size of your ink dot, set the parameters for the most liberal settings; then use manual inspection of the dot after training has been completed as a guideline.

The < ENTER > key is sometimes available for the purpose of aborting the training session. If the training session is aborted, the above message will be displayed. After the abort message, the Ink Dot Training Modes Menu (*Figure 11−10*) displays.

11.8.1 Additional Training Line Items

LINE 02 TRAIN IMAGE AND POSITION

Line 02 of the Ink Dot Training Modes Menu is used when the reference ink dot is already on the wafer. The procedure is the same as Line 01, but uses the instructions and screens for Steps 2 and 3 only, as previously described.

LINE 03 RETRAIN IMAGE

This mode is used for storing a new ink dot reference without retraining the reference position. When Line 03 is selected, the Train New Reference Dot screen appears *(Figure 11−14)*.

If any retrain mode is selected (Lines 03−05) and the reference image and position have not been trained (Line 01 or 02), the following message will appear for two seconds: "`IMAGE AND POSITION NOT TRAINED.`"

After < PAUSE/CONT > is pressed, the chuck position is automatically normalized so the ink dot should be centered under the camera and an inspection of the new reference ink dot is made. The results are displayed over the camera image.

Press < CAMR > to see the inspection results screen (as in **Section 11.9.1 Manual Inspection**). When < ENTER > is pressed, the Ink Dot Inspection Menu displays.

```
PROBER

 * TRAIN NEW REFERENCE DOT *

MOVE TO DIE WITH REFERENCE DOT
THEN PRESS PAUSE.

JOYSTICK ENABLED
"CAMR" TOGGLES DISPLAY
"ENTER" ABORTS TRAINING
```

FIGURE 11−14: TRAIN NEW REFERENCE DOT SCREEN

LINE 04 RETRAIN POSITION

Select this line to adjust the position of the reference dot without storing a new reference image. It works the same as Line 01, but uses Steps 2 and 3 only, previously described.

LINE 05 RETRAIN BACKGROUND

This mode is necessary if a newly loaded wafer contains an invalid uninked background (possibly because the old background die has been inked). This mode is recommended after loading IDI from disk.

When this mode is selected, the chuck moves to the old background position and a new background is trained using the screen of Step 3 only. No inspection is done and the display returns to the Ink Dot Training Modes screen without displaying results.

11.9 OTHER IDI FEATURES

11.9.1 Manual Inspection

Line 05 of the Ink Dot Inspection Menu accesses the Manual Inspection of Ink Dot screen (*Figure 11−15*).

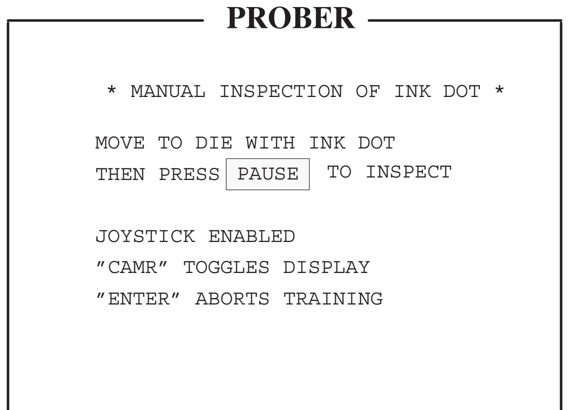


FIGURE 11−15: MANUAL INSPECTION OF INK DOT SCREEN

After < PAUSE/CONT > is pressed, the display switches to the camera image (if not already there). The chuck position is automatically normalized, so an ink dot should be centered under the camera and an inspection of the ink dot is made. The camera image and the chuck position are "frozen" (not allowed to change). The results are displayed over the camera image.

If < CAMR > is pressed, the Ink Dot Inspection Results Screen appears (*Figure 11−16*).

PROBER

```
  * INK DOT INSPECTION RESULTS *

DOT DISTANCES FROM CAMERA CENTER
    LEFT EDGE   =  ####.# MILS
    RIGHT EDGE  =  ####.# MILS
    TOP EDGE    =  ####.# MILS
    BOTTOM EDGE =  ####.# MILS
    CENTER (X)  =  ####.# MILS
    CENTER (Y)  =  ####.# MILS
DOT WT AREA     =  ####.#% REF
CENTRAL WT AREA =  ####.#% REF

PRESS ENTER TO CONTINUE
"CAMR" TOGGLES DISPLAY
```

FIGURE 11−16: INK DOT INSPECTION RESULTS SCREEN

If the Results Display Format is set to "NONE," (Line 07 on the Ink Dot Specifications Menu, described in **Section 11.5**) no results are displayed over the camera image and Ink Dot Inspection Results Screen appears automatically.

After < ENTER > is pressed, the camera image is "unfrozen" (allowed to update to the current image under the camera). If < CAMR > is pressed, the Manual Inspection of Ink Dot screen is displayed again. Another manual inspection may be performed, or press < ENTER > to display the Ink Dot Inspection Menu.

11.9.2 Inspection Summaries

Two summaries are available from Line 06 in the Ink Dot Inspection Menu.

11.9.2.1 THE WAFER SUMMARY

The initial summary displayed is the Wafer Summary (*Figure 11−17*).

PROBER

```
  ** INK DOT INSPECTION SUMMARY **
FUNC   REF-TRND    BKGN-TRND    LOADED
 YES     YES         YES          NO
 ********* WAFER SUMMARY ***********
 # DOTS INSPECTED . . . . . . .  100
 # DOTS PASSED  . . . . . . . . . 73
 # DOTS FAILED  . . . . . . . . . 22
 # DOTS DRIFTED . . . . . . . . .  5
 # DOTS SIZE TOO BIG  . . . . . . 10
 # DOTS SIZE TOO LITTLE . . . . .  7
 # DOTS AREA TOO SMALL  . . . . .  2
 # DOTS EXCEEDED FOV  . . . . . .  0
 # DOTS CONSECUTIVE FAILED  . . .  5
 ***********************************
 PRESS "F1" FOR TOTAL SUMMARY
 PRESS "F8" FOR WAFER PRINTOUT
```

FIGURE 11−17: WAFER SUMMARY DISPLAY

FUNC ("YES") displayed on Lines 01 and 02 means the pattern recognition system is processing inspections and communicating correctly with the prober.

REF−TRND ("YES") means a reference ink dot has been trained.

BKGN−TRND ("YES") says that the uninked background die has been trained. This status is cleared when training a new alignment target and after loading IDI from disk. In these cases, retrain the background using Line 05 of the Ink Dot Training Modes Menu (see **Section 11.8.1, Line 05, Retrain Background**).

LOADED ("NO") indicates whether IDI has been loaded from an external source − disk ("DISK") − or external I/O ("EXIO"). In this case, "NO" indicates that IDI has not been loaded from either source.

When "# DOTS DRIFTED," "# DOTS SIZE TOO BIG," "# DOTS SIZE TOO LITTLE," and "# DOTS AREA TOO SMALL" are enabled, the # sign before the word "DOTS" is highlighted in the summary to show that particular failure mode is enabled, as shown in *Figure 11−17*. If a failure mode is *not* enabled, the count for that particular type of failure is not included in the count of failures per wafer: "# DOTS FAILED" (**Table 11−2**).

The count for "# DOTS DRIFTED" (Wafer Summary display, *Figure 11−17)* reflects the number of inspected dots that were found to have a center position which varied from the reference center position by more than the DRIFT LIMIT of the Ink Dot Specifications Menu (described in **Section 11.5**)

The count for "# DOTS SIZE TOO BIG" reflects the number of inspected dots for which either dimension, height or width, exceeded the SIZE UPPER LIMIT of the Ink Dot Specifications. "# DOTS SIZE TOO LITTLE" shows how many dots had dimensions for which height or width was less than the SIZE LOWER LIMIT of the Specifications.

The next failure count deals with **dot area** which is a measure of dark pixel count, as opposed to **dot size** which is determined solely by the height and width of the dot (see **Table 11−1**). "# DOTS AREA TOO SMALL" shows how many inspected dots had either a total weighted area (dark pixel count) which failed to meet the minimum (MIN DOT WT AREA), or a central weighted area which failed to meet the MIN CENTRAL WT AREA of the Ink Dot Specifications.

NOTE
If no ink dot can be found during an inspection, the failure is included in "# DOTS AREA TOO SMALL"but not in the other counts for dots drifted, size too big, size too little, or field of view (FOV) exceeded.

An ink dot exceeds the FOV (Field Of View) when it touches or exceeds the inspection area. The inspection area is the same as the FOV. Since exceeding the FOV can cause an erroneous inspection result (only part of the dot was inspected), this failure mode is always enabled.

If the number of failures for "# DOTS FAILED" or "# DOTS CONSECUTIVE FAILED" equals or exceeds the number of failures allowed, the corresponding line will be highlighted. (These limits are set in the Ink Dot Inspection Mode Menu, described in **Section 11.6**.)

A die is inspected if an inspection command is sent to the Vision Module. The results possible are: inspection passed, inspection failed, or inspection impossible. Inspection is impossible when there is a defect in the Vision Module or a communication problem between the Vision Module and the prober.

In the typical Wafer Summary illustrated in *Figure 11−17*, the prober has been inspecting for some time, but a cable problem between the prober and the Vision Module has just caused the Vision Module to stop functioning. One hundred die have been inspected; 95 of these inspections occurred before the cable problem and have valid results.

For the last five ink dots, no inspection results were received from the Vision Module. They are not included in the pass/fail totals since no test occurred. The last five die inspected before the cable problem have drifted; on the last two of these die, both "too small" an ink dot area and "drifting" have occurred.

The total number of errors is 24. However, since two die had multiple failures, the number of die failed is 22. Of the 100 die inspected, 5 ink dots had no results due to the cable problem; 73 ink dots passed and 22 ink dots failed.

11.9.2.2 THE TOTAL SUMMARY

The Total Summary, illustrated in *Figure 11−18*, is similar to the Wafer Summary except it displays all errors which occurred since the last Ink Dot Inspection Summary reset. It is accessed from the Wafer Summary by means of the < <− > key, as shown in the prompt in *Figure 11−17*.

PROBER

```
 ** INK DOT INSPECTION SUMMARY **
FUNC   REF-TRND    BKGN-TRND    LOADED
 YES      YES         YES          NO
 REF INK DOT WT AREA. . .400.0 SQMIL
 ********* TOTAL SUMMARY ***********
 # DOTS INSPECTED . . . . . . . 1000
 # DOTS PASSED  . . . . . . . . .730
 # DOTS FAILED  . . . . . . . . .220
 # DOTS DRIFTED . . . . . . . . . 50
 # DOTS SIZE TOO BIG  . . . . . .100
 # DOTS SIZE TOO LITTLE . . . . . 70
 # DOTS AREA TOO SMALL  . . . . . 20
 # DOTS EXCEEDED FOV  . . . . . .  0
 ***********************************

 PRESS "F1" FOR TOTAL SUMMARY
 PRESS "PRINT" FOR TOTAL PRINTOUT
```

FIGURE 11−18: TOTAL SUMMARY DISPLAY

This display shows the value of the weighted area of the reference ink dot (the one used in training ink dot); in the example, this is is 400 square mil.

The display is of total results only and in this example assumes the same pass/fail ratio has occurred since the above Wafer Summary. The Total Summary has no meaning on a per− cassette basis.

LINE 07 RESET INSPECTION SUMMARY

When this line is selected from the Ink Dot Inspection Menu, the prompt "`CLEAR WAFER SUMMARY (Y/ENTER)`?" will appear. If < Y > is entered, a bell sounds and the wafer summary is reset to zero. Press < ENTER > to leave the wafer summary intact.

After < Y > or < ENTER > is pressed, the prompt "`CLEAR TOTAL SUMMARY (Y/ENTER)`?" appears. Again, < Y > resets the designated summary − in this case, the total summary − to zero and < ENTER > leaves the summary intact.

11.10 PROBER INSPECTION FAILURE

If the prober doesn't inspect the ink dots, then:

1. Check the "INKER" status on the Run Time Display to ensure that it is enabled (< INK ENBL > key on the Joystick Keyboard).

2. Check the Run Time Display to see if the "BAD DIE" count is greater than zero.

3. Press < PAUSE/CONT > to halt the prober.

4. Press < SET OPTION > (< F3 >).

   Check the Set Option Menu, Line 09, to ensure that IDI is enabled.

   If it is not, access Line 09 (INK DOT INSPECTION), select "ENB;" the Ink Dot Inspection Menu displays.

5. Select Line 06 (REVIEW INSPECTION SUMMARY). Check the inspection summary to see if training is complete. If necessary, retrain ink dot position and reference (Ink Dot Inspection Menu, Line 04; **Section 11.8, Ink Dot Training**).

   If training is complete, select Line 02 (SPECIFICATIONS) of the Ink Dot Inspection Menu to access the Ink Dot Specifications Menu.

   Select Line 09 (SET INSPECTION MODE) to access the Ink Dot Inspection Mode Menu (**Section 11.6**). Check the settings for Line 01 (INSPECT DOTS), Line 03 (# BEGINNING DOTS), Line 04 (EVERY NTH MIDDLE DOT), and Line 05 (# ENDING DOTS).

11.11 INK DOT FAILURE

If either the FAILURES PER WAFER or CONSECUTIVE FAILS is reached or exceeded during automatic probing of the wafer, Autoprobing is aborted, the prober bell sounds and the Wafer Inspection Summary appears (*Figure 11−15).*

Press < PAUSE/CONT > to stop the alarm. The summary will have either (or both) the lines for DOTS FAILED and DOTS CONSECUTIVE FAILED highlighted to indicate which fail count was reached. Press < ENTER > to return to the Run Time Display where the error message "* INK DOT FAILURE" appears.

If ink dots fail, first determine if the inspection results are valid. Check the summary to determine which failure mode caused the prober to stop.

Perform a manual inspection; from the Ink Dot Inspection Menu, select Line 05 (MANUAL INSPECTION − described in **Section 11.9.1**) and visually check the results.

If the results are valid and the inker requires corrective action, perform the action and retrain the ink dot.

If the results are valid but the inker cannot be corrected, then:

1. Determine if a new reference ink dot is necessary and retrain the ink dot.

2. Enter the Ink Dot Specifications Menu (**Section 11.5, Ink Dot Specifications**) and reset the parameters that are causing the failures. Set to new values, then retrain the ink dot reference.
3. From the Ink Dot Inspection Mode Menu (**Section 11.6**), disable those failure modes which are not of interest. This action prevents the inspection from stopping the prober on irrelevant ink dot variations. It is recommended that you disable "STOP ON SIZE TOO BIG" and "STOP ON INK DOT DRIFTING" first.
4. If problems still exist, call Electroglas Field Service or Technical Support.

When < PAUSE/CONT > is pressed to continue Autoprobing, the Wafer Inspection Summary values are reset to zero.

11.12 STORING INK DOT PARAMETERS ON DISK

IDI setup information is saved on disk. Pass/fail results and machine–dependent parameters such as camera and inker offsets are not saved. After restoring the IDI data and retraining the background, it is possible to inspect ink dots manually or during autoprobing.

The IDI data is saved by use of the Disk Menu function, STORE ALL PARAMETERS ON DISK Line 04). After the general parameter file (PRM), Row, Learn, Micro, and Pattern files (if any) are stored, a file with extension ".IDI" is stored if IDI has been trained.

The Vision IDI data is uploaded from the Vision Module and stored, along with prober IDI data, in the .IDI file. When the .IDI file has been written, the letters "IDI" should appear briefly on the screen after the letters "PAC" (for the pattern file).

Upload of IDI (restoring IDI data) is accomplished from the Disk Menu, Line 03 (LOAD ALL PARAMETERS TO MEMORY). After the pattern ("PAC") file is loaded, the .IDI file is loaded if it exists. The new IDI information is then downloaded to the Vision Module.

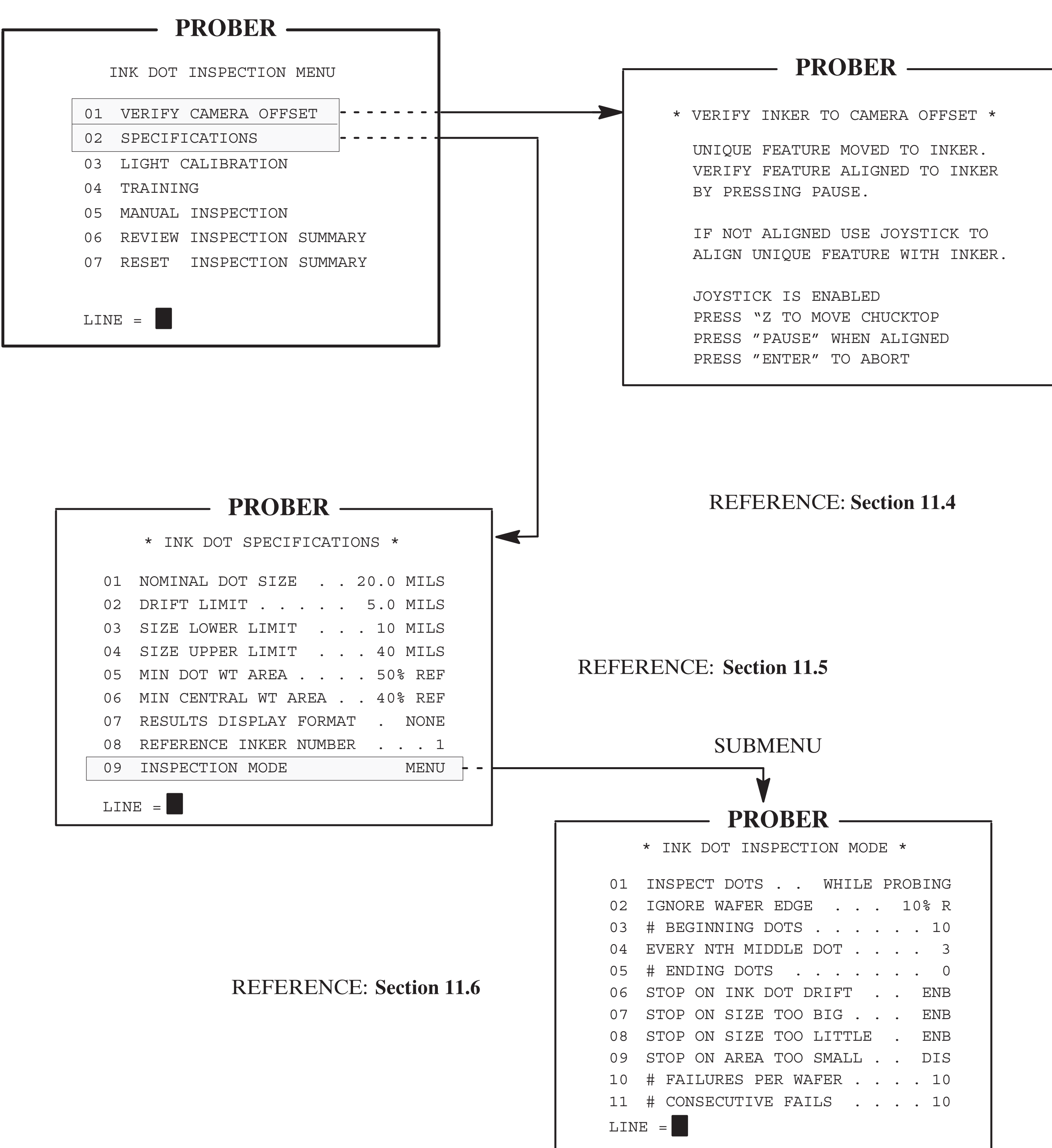
At the end of a successful load of the IDI file, the following message appears:

```
VERIFY INKER TO CAMERA OFFSET
AND TRAIN UN-INKED BACKGROUND
```

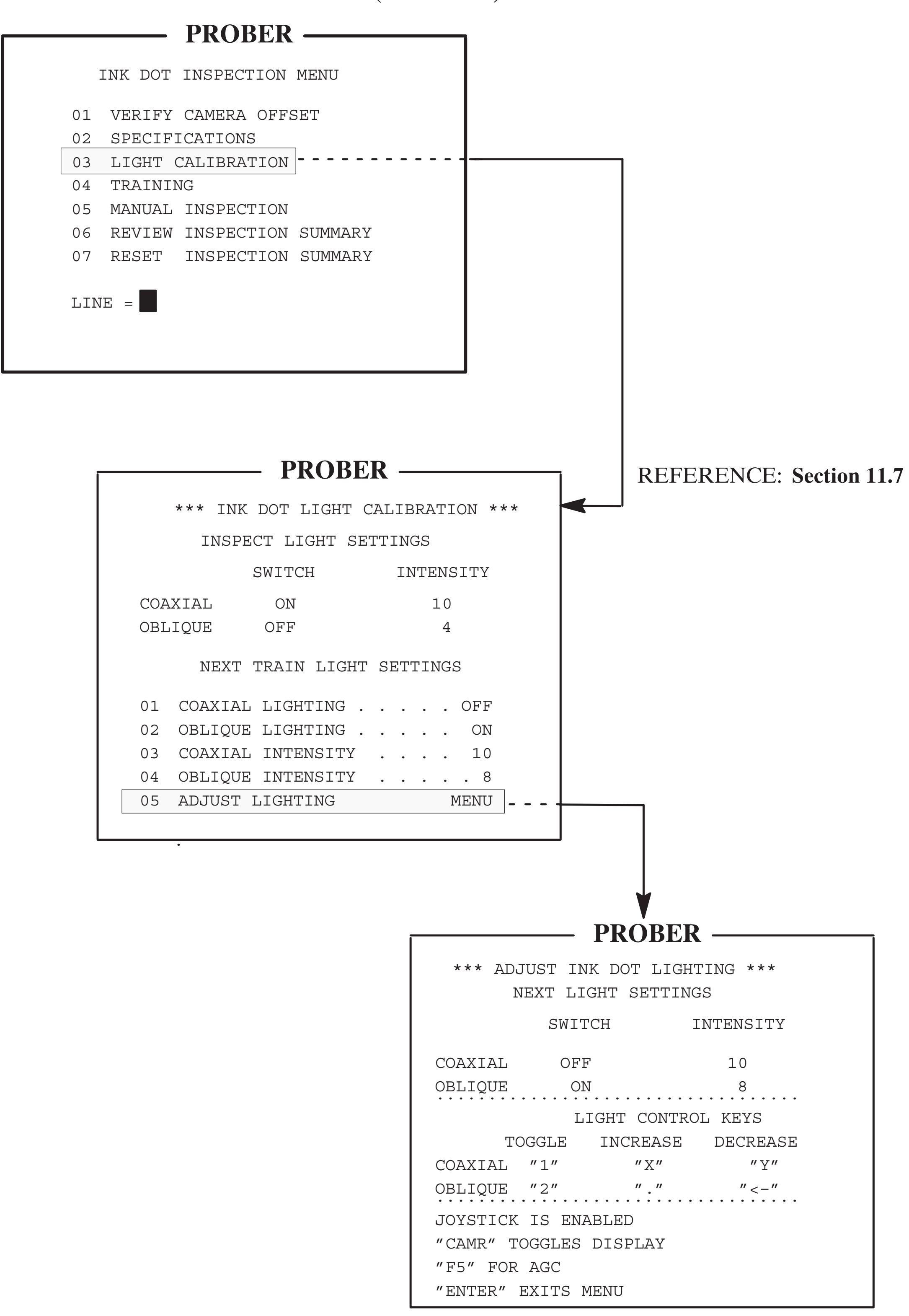
The Loaded status is set to "DISK" and the BKGN-TRND status is cleared (see **Section 11.9, Inspection Summaries**). The background must be retrained (and verifying inker/camera offset is recommended) before ink dots can be inspected. The background is automatically retrained by the Auto Align function if IDI is enabled (and trained or downloaded).

11.13 INK DOT INSPECTION MENUS, SUBMENUS, AND SCREEN STRUCTURES

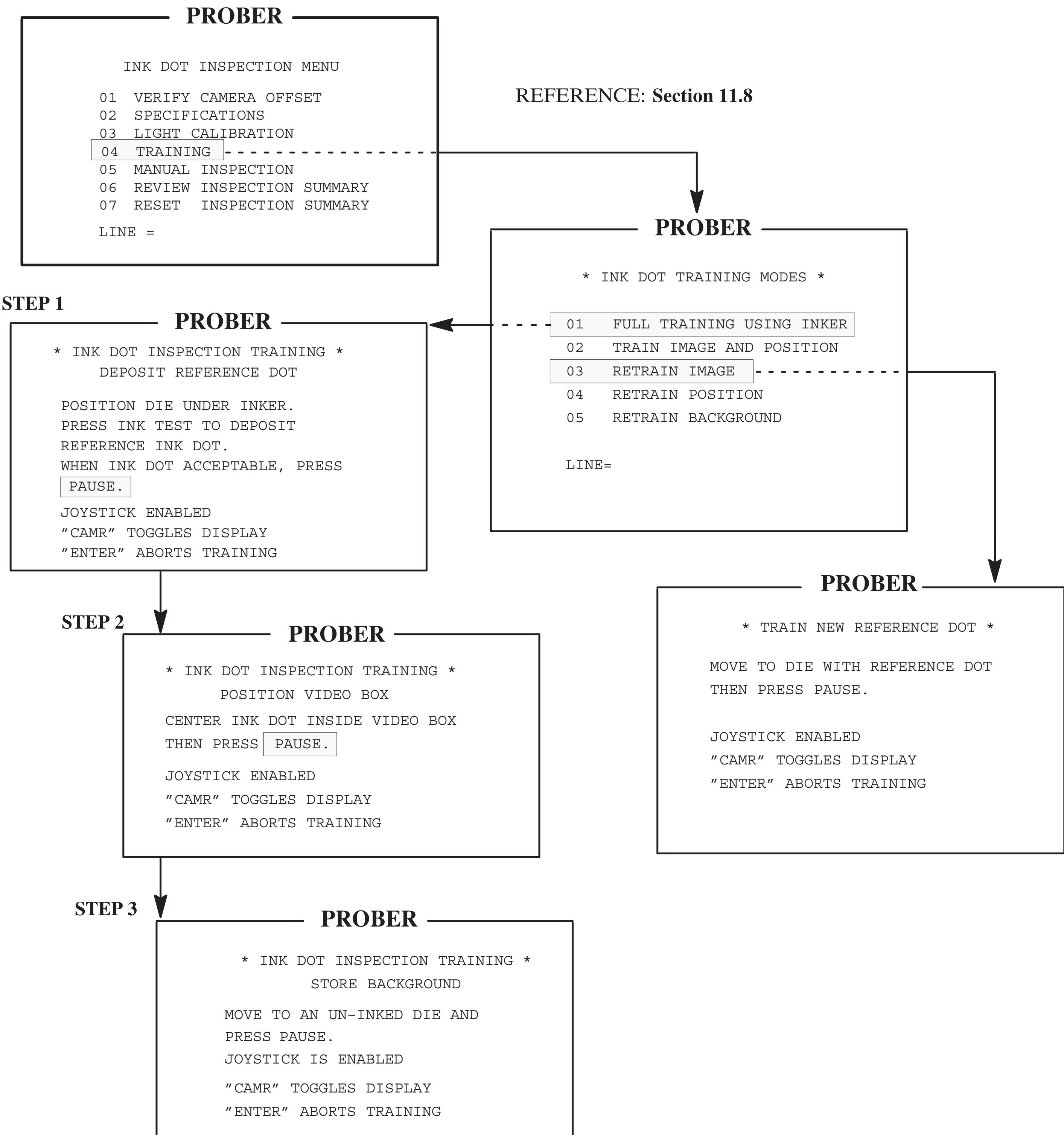
INK DOT INSPECTION MENU



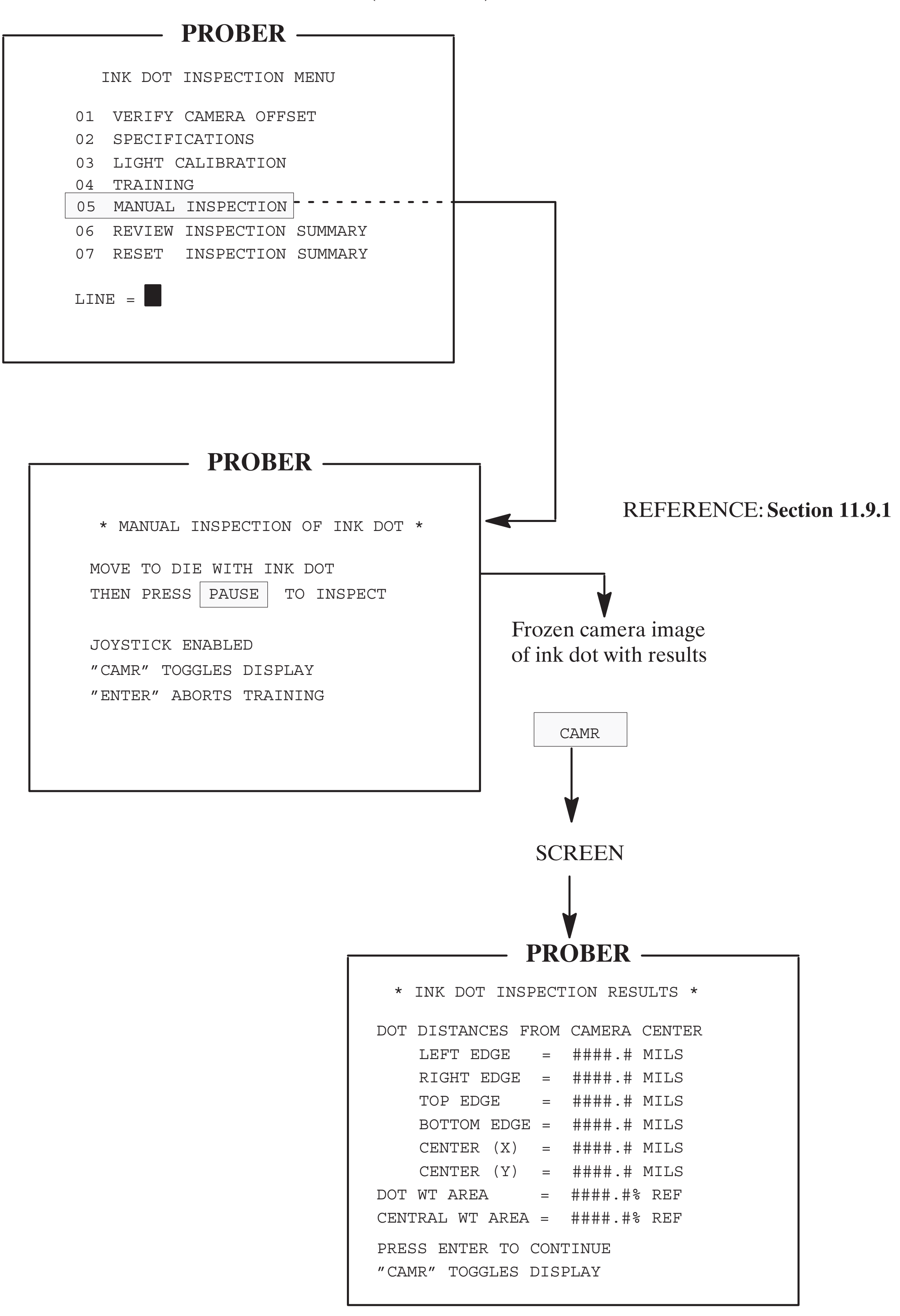
INK DOT INSPECTION MENU (continued)



INK DOT INSPECTION MENU (continued)

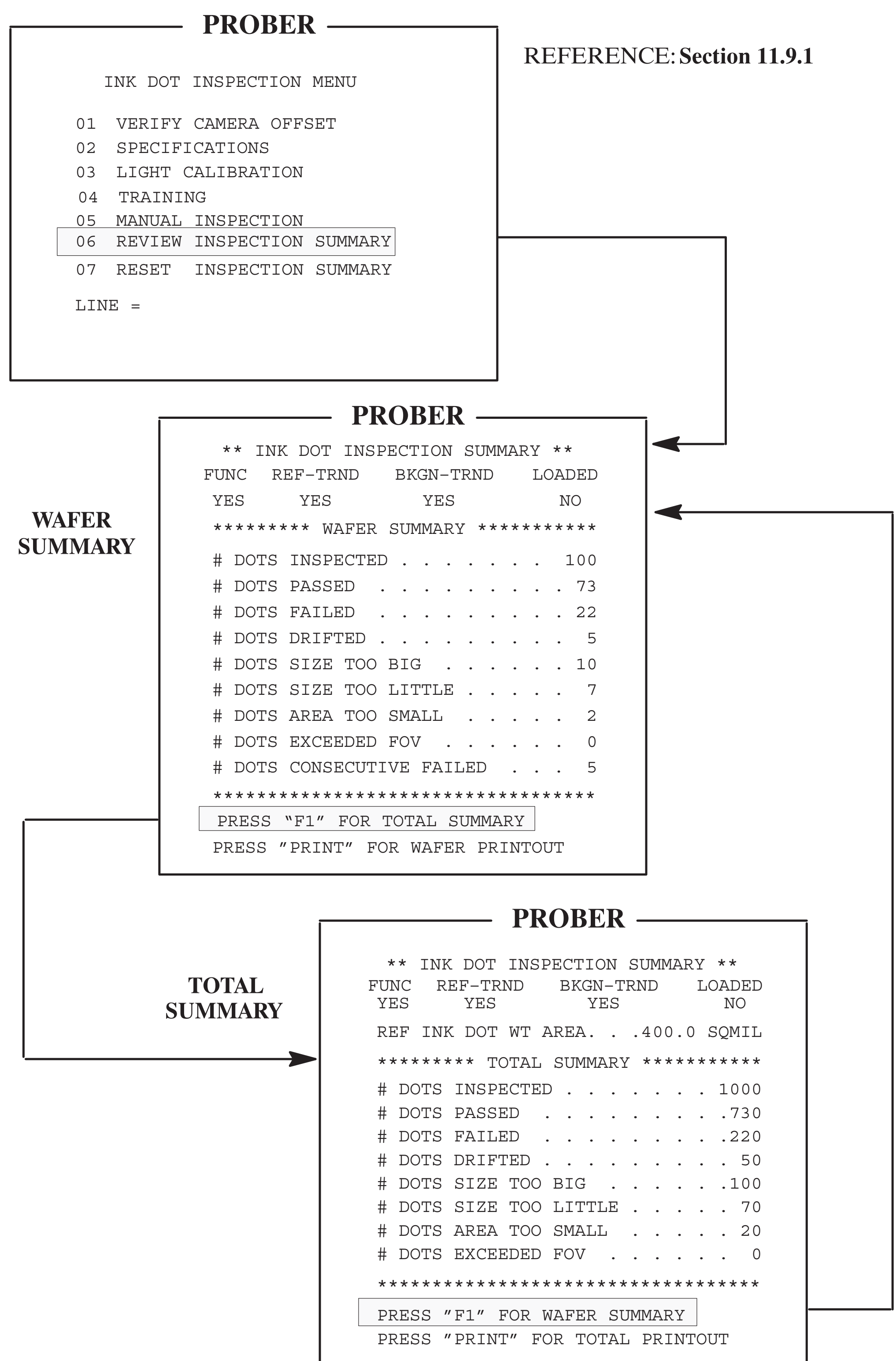


INK DOT INSPECTION MENU (continued)



INK DOT INSPECTION MENU (continued)

REFERENCE: **Section 11.9.1**



11.14 SUMMARY

In this section, you have learned:

- The prerequisites required before beginning performing automatic Ink Dot Inspection
- How to enable Ink Dot Inspection
- Instructions on verifying the inker position
- How to enter ink dot specifications and inspection parameters
- Lighting calibration procedures
- How to perform ink dot training
- How to perform manual inspections
- How to read inspection summaries
- Procedures to perform if the inspection fails
- How to store IDI information on a disk

SUPPLEMENT

INK DOT INSPECTION

SECTION 11

DOC 254523−110 REV A

The following information includes additions and changes that apply to Section 11, Ink Dot Inspection.

Each item in the Supplement contains a heading for identification. The box at the left identifies the type of information (such as NEW or CHANGE) and the subject; the box at the right classifies the information by the single or major subsection to which it relates and the title of that subsection. Information is given in section numerical order.

The new features in this supplement were implemented in Software Revision DB.

CONTENTS

	Manual Section Number	Page
NEW FEATURES		
AUTOMATIC ADJUSTMENT OF INK DOT INSPECTION OFFSET BETWEEN WAFER LOTS	**11.2.2**	SUPP 11−3
MANUAL ADJUSTMENT OF IDI LIGHT INTENSITIES	**11.7**	SUPP 11−3

NEW FEATURE
AUTOMATIC ADJUSTMENT OF INK DOT INSPECTION OFFSET BETWEEN WAFER LOTS

REF: SECTION 11.2.2
IDI PROCEDURES

This feature eliminates the need for Ink Dot Inspection retraining after setting up for a new lot of wafers if the inker setup has not changed.

You train IDI only at the time of inker setup. When wafer lots are changed, the prober automatically adjusts the current Ink Dot Inspection training for the new wafer and allows probing to continue based on the initial IDI setup parameters.

Following is the procedure for processing different wafer lots:

1. Download Ink Dot Inspection or train IDI for the first wafer of the first lot after the inker has been set up.

2. Probe the first lot and inspect the ink dots according to the IDI setup.

3. Download the setup parameters and alignment pattern for a new wafer lot via external I/O (**DS** & **DP** commands) or from disk files (.PRM & .PAC). (Ink Dot Inspection setup is *not* downloaded; that is, no **DK** external I/O command is issued nor does the disk file .IDI exist.)

4. Manually, or through external I/O, command an alignment.

5. Set FIRST DIE position. The background will be *automatically* retrained before the first die is tested.

6. The new lot of wafers will be probed and the ink dots inspected using all the parameters from the original IDI setup except the actual position of the ink dots (which have been adjusted).

As long as the inker position does not change, new wafer lots may be processed and inspected for ink dots without complete IDI re–training or downloading the IDI setup. If the inker position is changed, Ink Dot Inspection must be retrained.

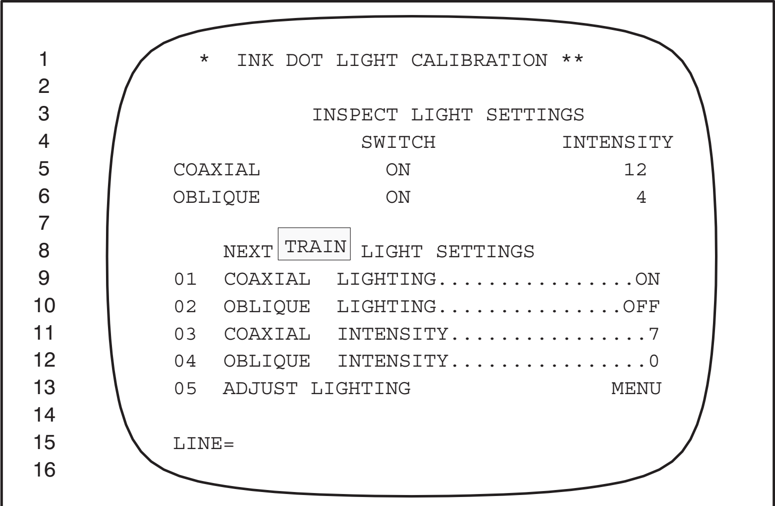
NEW FEATURE
MANUAL ADJUSTMENT IF IDI LIGHT INTENSITIES

REF: SECTION 11.7
CALIBRATE LIGHTING

As of ProberVision 2 System Software REV DB, you are able to change the current align light settings. This makes it easier to adjust the IDI lighting without retraining the target.

On the Ink Dot Light Calibration Menu, illustrated below, the intensities displayed under the heading "`ALIGN LIGHT SETTINGS`" are the current light values.

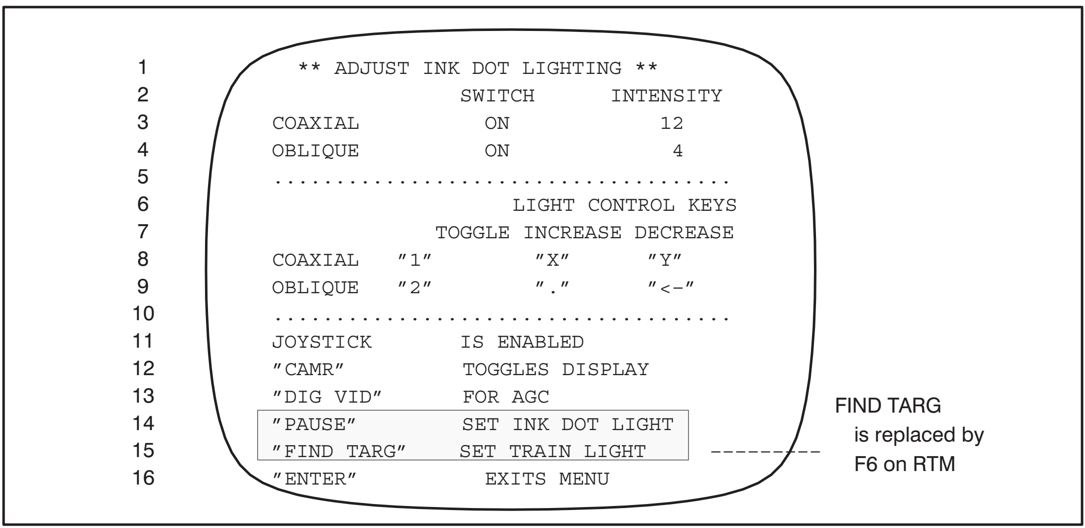
The values displayed for Lines 01–04 are for the next align train (FIND TARG function). The eighth line of the display reads "`NEXT TRAIN LIGHT SETTINGS`".



The Adjust Ink Dot Lighting screen, illustrated below, prompts for the following new action keys:

The 14th line will read "'PAUSE' SET INK DOT LIGHT"; this will cause the current light settings to become the settings used for the next ink dot inspection.

The 15th line will read "'FIND TARG' SET TRAIN LIGHT"; this key will cause the current light settings to become the settings used for the next ink dot inspection.



Restriction – Patterns trained using oblique lighting will most likely *not* be portable to another prober equipped with different camera optics.

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SECTION 12
PROBE MARK INSPECTION

12.1 OVERVIEW

The Probe Mark Inspection feature (PMI) enables the prober to inspect probe marks on up to 128 pads per user−selected die on a wafer. It operates during the probing process, and can be used in manual or automatic probing modes.

To qualify, the pads must be larger than or equal to 4 mils square and smaller than or equal to 10 mils square. You select the number of beginning dies to inspect and the frequency of inspection thereafter. Summaries show inspection results in two formats − by wafer and by total.

The inspection reveals a failure if a probe mark less than an operator−defined limit is found or if any part of the probe mark touches or exceeds the guard band window. The *guard band window* is an operator−defined rectangle placed within the pad area. The rectangle should exclude any overlapping chemical layers that are detrimental to probe tip integrity.

If the number of die per wafer with probe mark failures reaches an operator−defined limit, the prober pauses, an alarm sounds, and the screen displays a Probe Mark Failure Summary defining the problem.

12.1.1 How To Use This Section

This section contains the following:

- The prerequisites required before beginning performing automatic PMI
- How to enable PMI
- Verifying probe to camera offset procedures
- How to enter PMI specifications and inspection parameters
- Lighting calibration procedures
- How to train pad locations, including retraining the first pad location
- How to perform manual inspections
- How to read inspection summaries
- How to perform PMI diagnostics
- Information on PMI error handling and failure summaries
- How to store PMI information on a disk

12.2 GETTING STARTED

12.2.1 Prerequisites

The following prerequisites must be performed before beginning PMI training and setup:

1. Install and setup Zoom Lens.
2. Set offset between probe tip array center and center of camera.
3. Train a reference target and align the wafer.
4. Set First Die position.
5. Disable Theta Compensation.

1. **Install and setup Zoom Lens. –** Contact Electroglas Field Service for assistance.

2. **Set offset between probe tip array center and center of camera. –** Access the Profiler Menu by pressing < PROG > (< F5 >). Remove the wafer, position the chuck center under the camera crosshairs, and press < 8 > to set the camera position. Move the chuck center to the center of the probe tips and press < 2 > to set probe center. (This step is done without a wafer, to compensate for any error generated by loading the wafer.) Replace the wafer.

3. **Train a reference target and align the wafer. –** Train the target and align the wafer using the normal procedure (see **Section 5, AUTO ALIGN**).

IMPORTANT
If a new alignment target is trained, Probe Mark Inspection training must be repeated.

4. **Set First Die position. –** Set the First Die position using the normal procedure.

5. **Disable Theta Compensation. –** See **Section 5, AUTO ALIGN, subsection 5.9, Theta Compensation,** for more information.

12.2.2 PMI Procedures

Each of the following needs to be performed before automatic Probe Mark Inspection can occur:

1. Enable Probe Mark Inspection **Section 12.3**
2. Verify probe–to–camera offset **Section 12.4**
3. Enter PMI specification parameters **Section 12.5**
4. Calibrate lighting **Section 12.6**
5. Train pad locations for inspection **Section 12.7**

Once these steps have been completed, inspection is automatic, and the prober can be operated normally. A summary of the inspection is available for your review.

12.3 ENABLE PROBE MARK INSPECTION

Press <SET OPTION> (< F3 >) to display the Set Option Menu (*Figure 12−1*). Select Line 10, PROBE MARK INSPECTION. Select option 1, ENB. This enables PMI and displays the Probe Mark Inspection Menu (*Figure 12−1*).

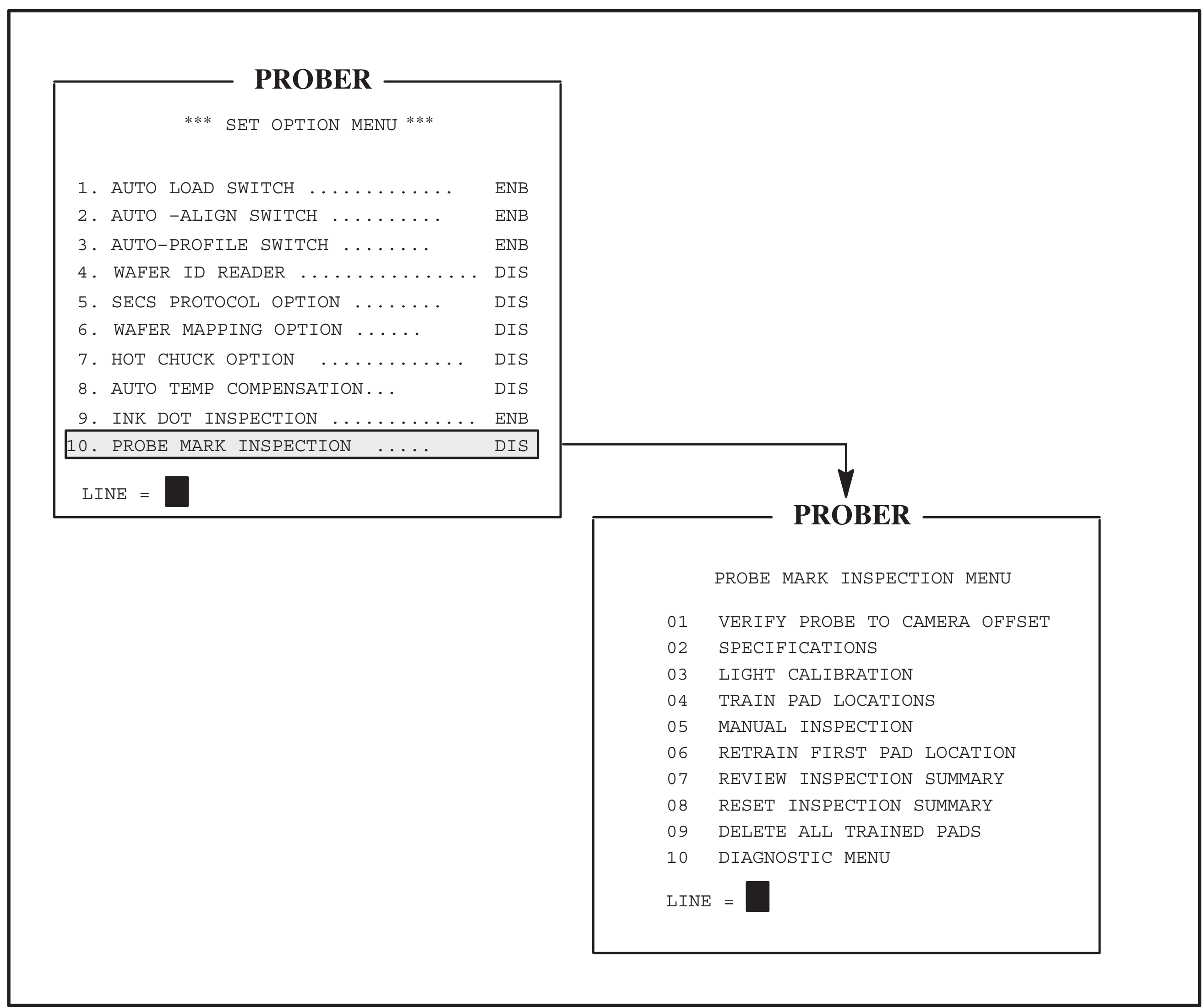


FIGURE 12−1: SET OPTION MAIN MENU AND PROBE MARK INSPECTION MENU

Menus, submenus, and screens are illustrated in the following sections with explanations of the line items. In addition, screens are illustrated in the **Section 12.11**, in a format which helps define their relationship and hierarchy.

12.4 VERIFY PROBE TO CAMERA OFFSET

From the Probe Mark Inspection Menu (*Figure 12−2*), select Line 01, VERIFY PROBE TO CAMERA OFFSET.

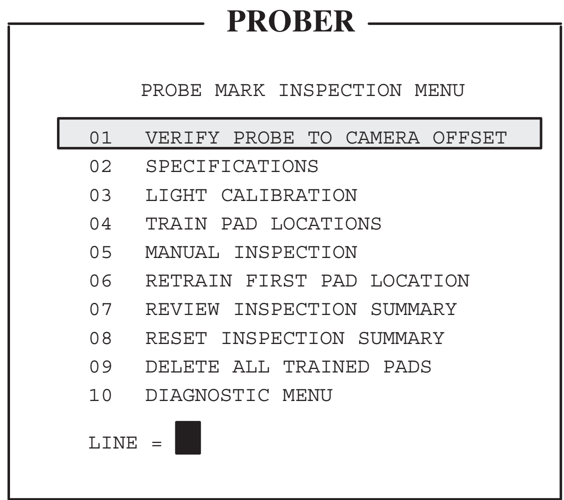


FIGURE 12−2: PROBE MARK INSPECTION MENU

The Verify Probes to Camera Offset Screen *(Figure 12−3)* displays.

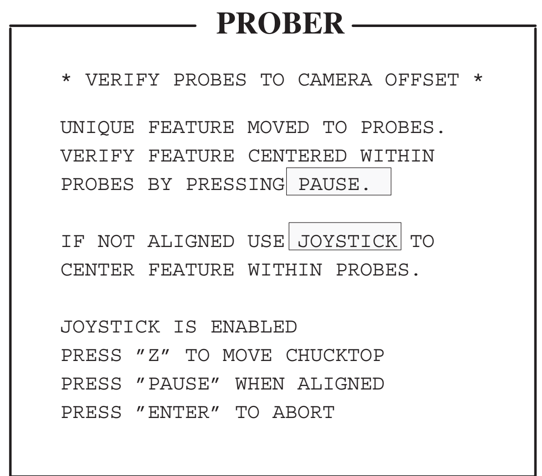


FIGURE 12−3: VERIFY PROBES TO CAMERA OFFSET SCREEN

This function sets or verifies the default offset between die center and camera center so automatic inspection during probing will move the same die from the probe array center to the camera center.

During this procedure, any unique feature on the chucktop or on a wafer can be used. The objective is to land at the same spot inside the same die after moving from the probe array to the camera.

The locations entered for the reference at the probe array and at the camera center are relative locations stored only to indicate the offset between the two positions. They are not necessarily the same as the camera and probe tip locations set in the Profiler Menu, Lines 02 and 08. The default value for the probe array to camera offset, however, does use the settings of the camera center and the probe tip center.

If the offset has been previously set through this screen, the values determined at that time apply. Otherwise, the default setting is used. The prober automatically moves to the existing setting under the probes and displays the Verify Probes to Camera Offset Screen (*Figure 12−3*).

Align the unique feature with the probe array under the microscope.

At any time, if the present prober settings are correct, press < PAUSE/CONT > to verify the settings. If the monitor is displaying the camera and you need to see the screen, press < CAMR > to toggle to the screen.

Press <PAUSE/CONT> and the current location of the chuck becomes the probe center reference point. Press < ENTER > to abort the procedure and the system displays a two−line, timed message:

```
PROCEDURE ABORTED.
NEW DATA NOT STORED.
```

The system then displays the Probe Mark Inspection Menu.

If the probe array location is accepted, the screen displays that the location is accepted, and the prober automatically moves the unique feature the current offset distance (which should place it under the camera). A two−line message,

```
PROBE ARRAY LOCATION ACCEPTED
ABOUT TO GO TO CAMERA CENTER
```

displays for a short time, after which the next screen, the Location Accepted Screen (*Figure 12−4*) displays automatically.

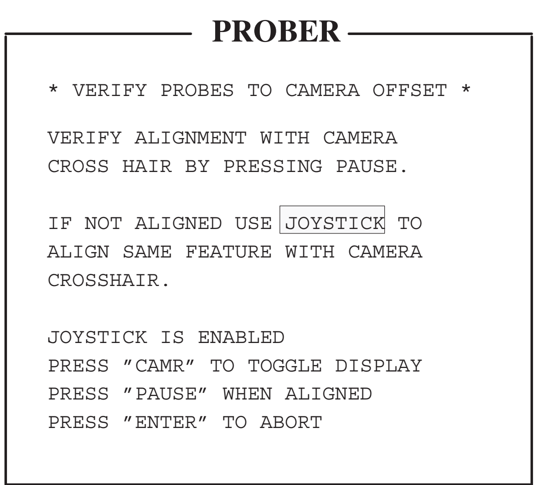


FIGURE 12−4: LOCATION ACCEPTED SCREEN

Align the unique feature with the camera crosshairs and press < PAUSE/CONT >. The prober displays the message `NEW DATA ACCEPTED.` The offset between the probe array and the camera center is now set. When completed, the system displays the Probe Mark Inspection Menu.

12.5 ENTERING PMI SPECIFICATIONS

From the Probe Mark Inspection Menu, select Line 02, SPECIFICATIONS. The Probe Mark Specifications Menu displays (*Figure 12−5*). An explanation of the line items of this menu follows.

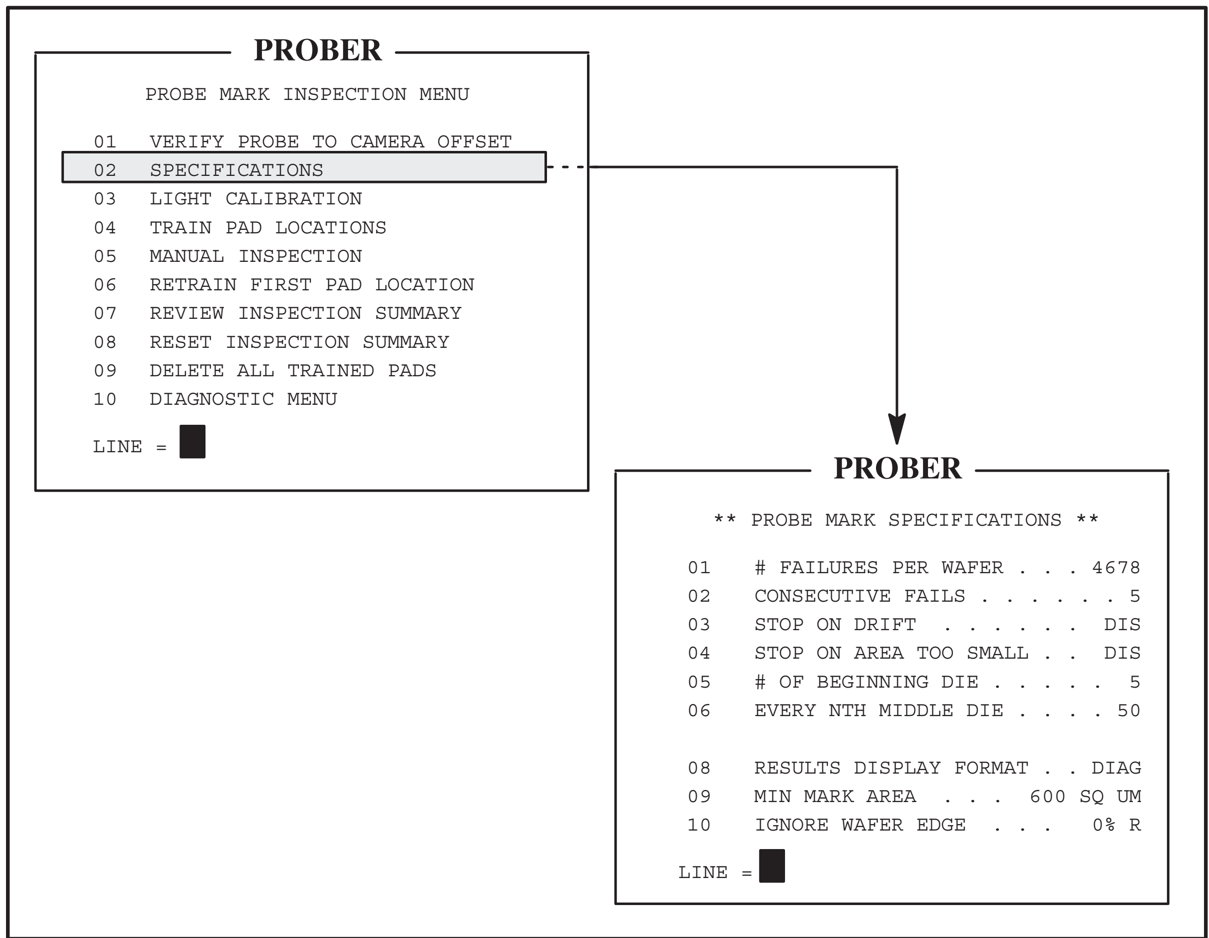


FIGURE 12−5: PROBE MARK INSPECTION AND SPECIFICATIONS MENUS

LINE 01 # FAILURES PER WAFER

This line is used to limit the number of Probe Mark Inspection failures occurring during the inspection of a single wafer. Should this limit be reached, a critical failure occurs, the prober pauses, and the Probe Mark Failure Summary is displayed (see **Section 12.9, PMI Error Handling**). A failure consists of any type of enabled error, such as `STOP ON DRIFT` or `STOP ON AREA TOO SMALL`, on a per pad basis. If 100 errors occur on 70 pads, 100 errors are accumulated.

LINE 02 CONSECUTIVE FAILS

Whenever a Stop On parameter is enabled (Line 03 and 04 of this menu), the number of failures on a pad basis is accumulated. Should any single pad or all the pads trained fail, the die fails. In this

event, the prober inspects consecutive dies without regard for the selected frequency of inspection. Should the number of consecutive dies failed equal this line, a critical failure occurs, and the prober pauses and displays the Probe Mark Failure Summary.

During consecutive inspections, assuming the consecutive die doesn't coincide with a die that would normally be inspected, the prober inspects only the failed pads. Each pad has a separate counter of consecutive failures; if this counter is greater than zero, the pad is inspected. Any time a pad passes during inspection, its consecutive failure counter is reset to zero.

If during the consecutive fail inspection sequence a die that would normally be inspected is encountered, all trained pads on the die are inspected. Next, all the pad counters are checked. If all pads pass, at any point during the consecutive inspection, the consecutive fail sequence is broken and normal inspection resumes. If even a single pad still fails, consecutive dies continue to be inspected until either all pass or the Consecutive Fails is reached, creating a critical failure situation.

LINE 03 STOP ON DRIFT

Any probe tip that creates marks on or beyond the guard band window perimeter causes a probe mark drift error. Such marks must either be connected to the main probe mark or of greater weight/size than the main probe mark to be considered a failure. If this line is enabled, any drift on a pad causes that pad to fail and its consecutive fail counter is incremented as explained for Line 02. In addition, enabling this line allows the accumulation of total failures.

LINE 04 STOP ON AREA TOO SMALL

Any probe mark less than an operator−defined minimum, set in Line 09 of the Probe Mark Specifications Menu, causes this type of failure. The default is 600 square microns which corresponds to approximately 1.2 mils. If this line is enabled, both the pad consecutive fail and the total failure counters are incremented.

When the Vision Module finds a mark that is too big, it will report to the prober using the `PM AREA TOO SMALL` error code, because there is no error code for `PM AREA TOO BIG`. Since the error code for `PM AREA TOO BIG` is not recognizable by the prober, the prober will display `PADS PM AREA TOO SMALL`.

To set the parameter for either minimum or maximum, see Line 09, Min Mark Area.

LINE 05 # OF BEGINNING DIE

This line sets the number of consecutive die to be inspected at the beginning of a wafer. All the pads trained are inspected regardless of the previous results.

LINE 06 EVERY NTH MIDDLE DIE

The value selected for the nth in this line sets the frequency of Probe Mark Inspection following the beginning die string. The prober will only inspect probe marks every nth die. If a die failure occurs, the consecutive die failure sequence begins from that failed die. If an nth middle die occur again during the consecutive die check, all trained pads are inspected rather than only failed pads.

LINE 08 RESULTS DISPLAY FORMAT

Four result displays are possible: **None**, **Min**, **Max**, and **Diag**. None does not display results following an inspection. **Table 12−1** shows the information provided by each display mode and each mode is discussed next.

TABLE 12−1: RESULT DISPLAY MODES

MODE	INFORMATION PROVIDED
None	None
Min	Pass/Fail Message
Max	Pass / Fail Message, Guard Band Image, Binary Image
Diag	Pass / Fail Message, Guard Band Image, Binary Image, Statistics

Min Display

The **Min** display shows, towards the bottom center of the screen, a single result as *one* of the following :

Pad number: xx PASS
Pad number: xx FAIL Pad not found
Pad number: xx FAIL Mark not found
Pad number: xx FAIL Mark too small
Pad number: xx FAIL Mark too big
Pad number: xx FAIL Mark drifted
Pad number: xx FAIL Mark too small & drifted
Pad number: xx FAIL Mark too big & drifted

Max Display

In addition to the single line result described in **Min**, the **Max** display shows:

1. A window of guard band picture on the left of the screen.
2. A binary picture of the guard band with binary threshold shown on the picture.
3. Bounding boxes of all the marks found in the original guard band window.

Diag Display

In addition to the **Max** display, the **Diag** will paint the found marks in black and show the statistics of marks of this pad and a summary of all marks since the last target loading (see Note below) or simply enter and leave the PMI Diagnostic Menu. **Table 12−2** illustrates the **Diag** display statistics.

> **NOTE**
>
> Target loading is one of the following:
> 1. A new alignment target is trained by < FIND TARGET >, or
> 2. **Any** (even if the same target) alignment target is loaded from disk, or
> 3. A new alignment target is trained using Self−Teach Auto Align.

TABLE 12−2: DIAG RESULT DISPLAY STATISTICS

Pad	Min. Distance or % of drifted				Mark Dimension		Area		% Fail	
	Left	Right	Top	Bottom	Min	Max	Min	Max	Min	Max
% 1	1.8/45	0.4/11	2.0/52	0.6/14	1.9/47	1.7/42		1145		
3	1.8/45	0.4/11	1.9/48	0.6/14	1.6/42	1.9/48	1133	1262	0	0

ACROSS TOP OF SCREEN

```
Pads:  0 w/o mark; 0 w/drift
Min Mark Area Spec 0.930 (600)
Max Mark Area Check Not Enabled
```

```
Pad number:  1 PASS
```

TOWARDS BOTTOM CENTER OF SCREEN

LINE 09 MIN MARK AREA (SQUARE MICRONS)

Select this line to set the minimum acceptable probe mark size. The default is 600 square microns. Currently there is no real calibration relating the pixel size on the monitor to the physical size on the wafer.

As noted for Line 04, when the Vision Module finds a mark that is too big, it will report to the prober using the PM AREA TOO SMALL error code, because there is no error code for PM AREA TOO BIG.

The maximum probe mark size checking feature is invoked by using *hidden keys*, or information not displayed on the screen.

To enable maximum mark size checking:

1. Set Min Mark Area to 32767 − the hidden key to notify the Vision firmware that the next Min Mark Area entered will be the maximum area.
2. Set Min Mark Area to 5000 − user's maximum mark area.
3. Set Min Mark Area to 600 − user's **real** minimum mark area.

To disable maximum mark size checking:

1. Set Min Mark Area to 32766. This disables maximum mark size checking.
2. Set Min Mark Area to − user's **real** minimum mark area.

LINE 10 IGNORE WAFER EDGE

Select this line to set a minimum edge around the wafer that is ignored for inspection purposes. Any die touching this edge is not inspected. This line is selected to set a non−inspection zone from the wafer's edge in toward the wafer's center. This zone is defined as a percentage of the wafer's radius. A die is considered within this non−inspection zone if any part of it touches the zone edge.

The range for this parameter is 0 to 99% (the default is 10%).

All die around the minimum edge can be inspected with the setting at 0%, which disables IGNORE WAFER EDGE. This is especially important for Multi−Die applications where the entire die array must be readable by the camera before any one die of that array can be inspected. This restriction refers to the fact that the entire wafer is not within the Field of View of the camera; therefore, if any of the die in the array cannot be positioned under the camera, none of the die will get inspected.

12.6 CALIBRATE LIGHTING

From the Probe Mark Inspection Menu, select Line 03, LIGHT CALIBRATION. The Probe Mark Light Calibration Menu displays (*Figure 12−6*), which controls the lighting for PMI. The goal is an image where the ink dots appear black against a light gray background.

PROBER

```
     PROBE MARK INSPECTION MENU

 01   VERIFY PROBE TO CAMERA OFFSET
 02   SPECIFICATIONS
 03   LIGHT CALIBRATION
 04   TRAIN PAD LOCATIONS
 05   MANUAL INSPECTION
 06   RETRAIN FIRST PAD LOCATION
 07   REVIEW INSPECTION SUMMARY
 08   RESET INSPECTION SUMMARY
 09   DELETE ALL TRAINED PADS
 10   DIAGNOSTIC MENU

 LINE =
```

PROBER

```
      * PROBE MARK LIGHT CALIBRATION *

         PROBE MARK LIGHT SETTINGS

 01   COAXIAL LIGHTING . . . . . OFF
 02   OBLIQUE LIGHTING . . . . .  ON
 03   COAXIAL INTENSITY  . . . .  10
 04   OBLIQUE INTENSITY  . . . . . 8
 05   ADJUST LIGHTING           MENU

 LINE =
```

PROBER

```
   ** ADJUST PROBE MARK LIGHTING **
                SWITCH         INTENSITY

COAXIAL         OFF              10
OBLIQUE          ON               8
...................................
              LIGHT CONTROL KEYS
       TOGGLE   INCREASE   DECREASE
COAXIAL  "1"      "F1"       "F2"
OBLIQUE  "2"      "F3"       "F4"
...................................
JOYSTICK IS ENABLED
"CAMR"      TOGGLES DISPLAY
"F5"        FOR AGC
"PAUSE"     SET PROBE MARK LIGHT
"F6"        SET TRAIN LIGHT
"ENTER"     EXITS MENU
```

FIGURE 12−6: PROBE MARK INSPECTION, LIGHT CALIBRATION AND ADJUST LIGHTING SCREENS

The settings can be entered in two ways. If the desired settings are already known, enter the settings directly in the Probe Mark Light Calibration Menu. The current inspection light settings are displayed for reference only and will not change while in this menu.

If the desired settings are unknown, select Line 05 of the Probe Mark Light Calibration Menu (`ADJUST LIGHTING`). A wafer area, such as the last pad trained, will automatically be placed under the camera with the current inspection light settings and the Adjust Lighting Screen (*Figure 12−6*) displays.

Assuming that no pad has been trained, default values will be used for the inspection light settings and the align reference die will be placed under the camera. You may move to a different die to find a suitable pad. At this point, the lights can be toggled on/off by pressing the indicated key.

To change the intensity setting, select the coaxial and/or oblique lamp and then use the keys for increasing/decreasing to set the intensity. At any time during this process, press < CAMR > to toggle the display between the screen and the camera.

When in the camera mode, the keys defined in the screen are still active so you can immediately see changes in the light settings. Note that in the Adjust Probe Mark Lighting screen (*Figure 12−6*), all keys pressed *should not* be followed by pressing < ENTER >. The < ENTER > key returns you to the previous menu.

12.7 TRAIN PAD LOCATIONS

From the Probe Mark Inspection Menu, select Line 04, TRAIN PAD LOCATIONS. The All Pads Untrained Screen displays (*Figure 12−7*).

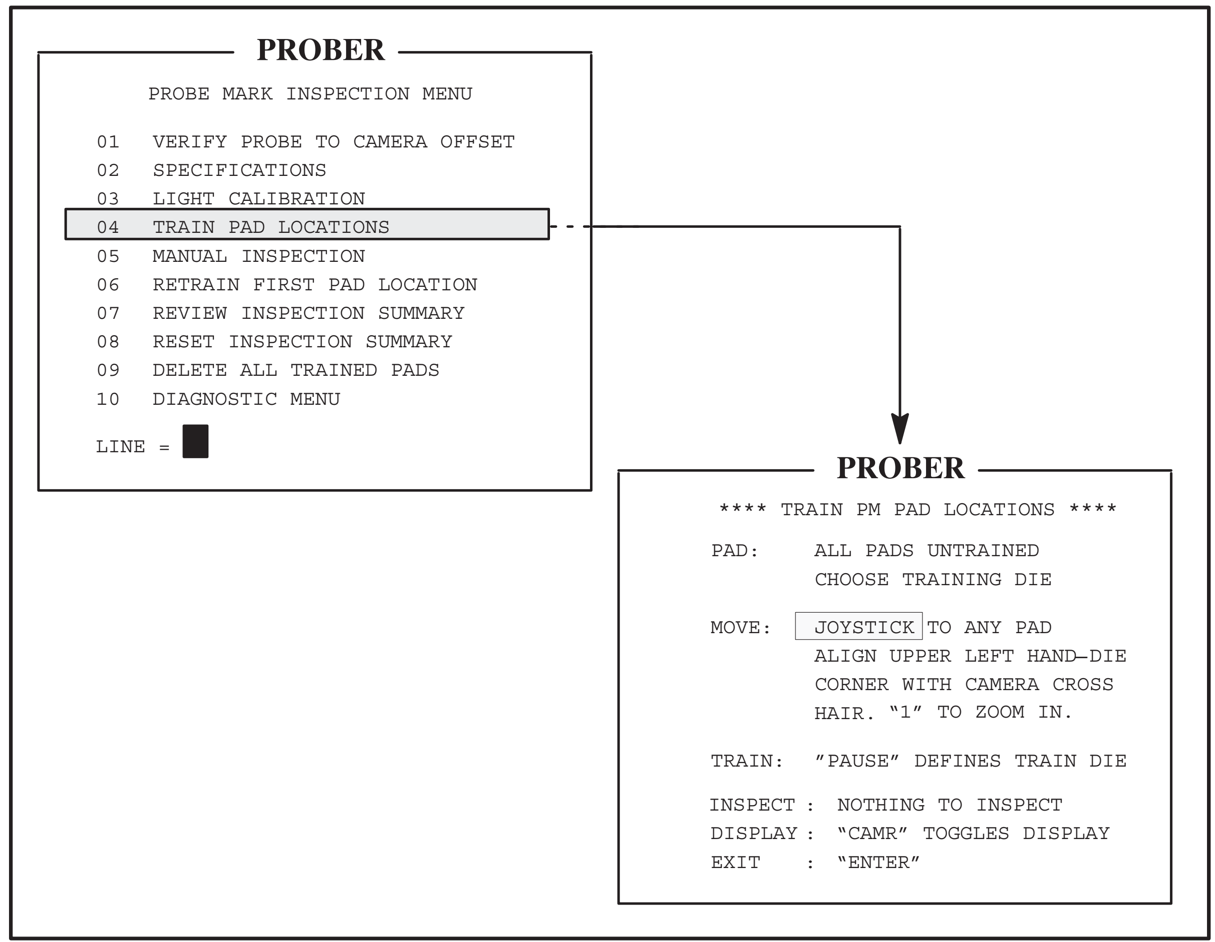


FIGURE 12−7: PROBE MARK INSPECTION MENU AND ALL PADS UNTRAINED SCREEN

If the wafer is not under the camera when the Train Pad Locations item is selected, the prober automatically moves it there.

12.7.1 Training Tips

It is recommended that PMI training be performed using the die at the center of all the dies whose probe marks will be inspected by PMI. This minimizes the potential problem of a PMI guard band drift error occurring, caused by position error. Since the position error will increase for dies that are farther away from the PMI trained die, the position error will be minimized when the center die is used in PMI training.

If no pads have been trained, the Zoom Lens goes to the Macro position and the lighting is adjusted accordingly. If at least one pad has been trained, the Zoom Lens goes to the Micro position, and the trained die moves to its first pad position.

If the First Die has not been set, or the wafer has not been aligned, or the alignment target has changed since the last training session, training is aborted and a timed message indicates either `REFERENCE NOT STORED`, `FIRST DIE NOT SET`, or `RETRAIN FIRST PAD`.

If any part of the training is omitted and the option is enabled, the prober will display an error message when the < AUTO PROBE > key is pressed. The message states that more setup or training is required before Autoprobing can be performed.

If there are too many pads to edit, or you wish to retrain all pads for any reason, you can delete all the trained pads. If the default parameters need to be changed for a particular device type, these can be reset through the Probe Mark Diagnostic Menu (**Section 12.8.3, PMI Diagnostics**).

If the prober is ready for training, one of two different screens is displayed, described next.

12.7.2 Training the First Pad

If no pad has been trained, the All Pads Untrained (*Figure 12−7*) displays. To zoom in to the corner, press < 1 > or < PAUSE/CONT > to produce Train Pad Locations Screen (*Figure 12−8)* and the Zoom Lens goes to Micro.

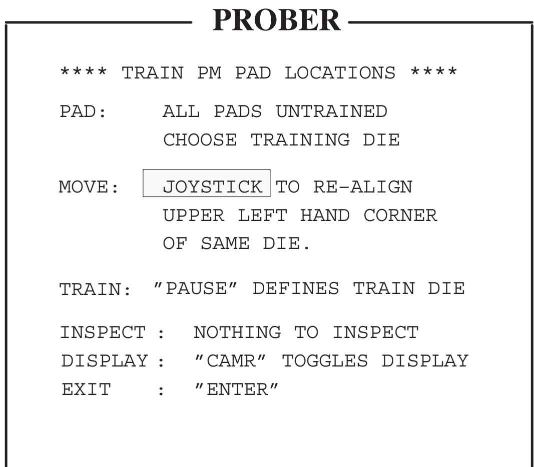


FIGURE 12−8: TRAIN PM PAD LOCATIONS SCREEN

Using the Joystick, realign the upper left corner. To complete the corner offset setup and to prepare for determining the guard band window, press < PAUSE/CONT > to produce the Training Pads Screen (*Figure 12−9 A* or *B*).

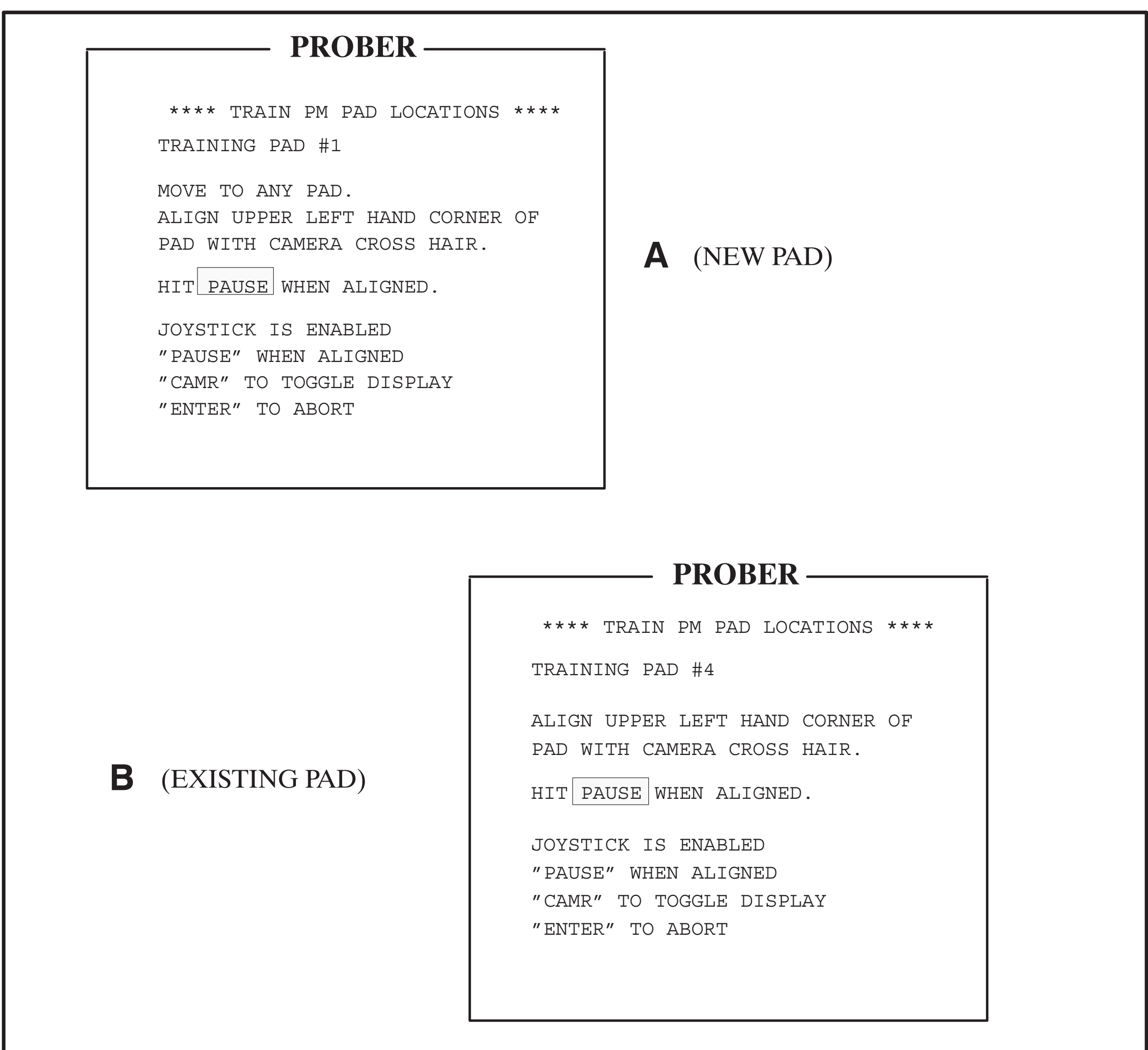


FIGURE 12−9: TRAINING PADS SCREENS

At this point, the first pad is ready to be trained. Align the upper left corner of the pad with the camera crosshairs and press < PAUSE/CONT >. At any time during the training sequence, press < ENTER > to abort and return to the previous screen. Press < CAMR > to toggle between the camera and the screen until < PAUSE/CONT > is pressed. When the pad is aligned and < PAUSE/CONT > is pressed, the Align Guard Box Control Screen (*Figure 12−10)* appears.

PROBER

```
**** TRAIN PM PAD LOCATIONS ****
TRAINING PAD #1
JOYSTICK:
CONTROLS GUARD BAND BOX.
MOVE BOX:
CW OR MIDDLE HANDLE POSITION.
GROW BOX:
CCW HANDLE POSITION.
JOYSTICK CONTROLS X, Y MOVES.
BUTTON SPEEDS UP MOVEMENT.

ALIGN GUARD BOX WITHIN PAD.
PRESS "PAUSE" WHEN ALIGNED.

"CAMR" TO TOGGLE DISPLAY
"ENTER" TO ABORT
```

FIGURE 12−10: ALIGN GUARD BOX CONTROL SCREEN

When this screen is displayed, the Joystick controls a box superimposed on the wafer image. The Joystick causes the box to either move or grow depending on the positions of the Joystick handle. These positions correspond to the Scan, Index and Jog positions active when the Joystick controls the forcer.

The box may be forced outside the center of the screen area. Since the Vision Module needs to see the area around the pads' periphery, the prober automatically recenters the pad when certain limits are reached.

When you press < PAUSE/CONT >, the Vision Module trains the pad and the necessary parameters are stored. If the text is currently being displayed, the screen below (*Figure 12−11*) appears:

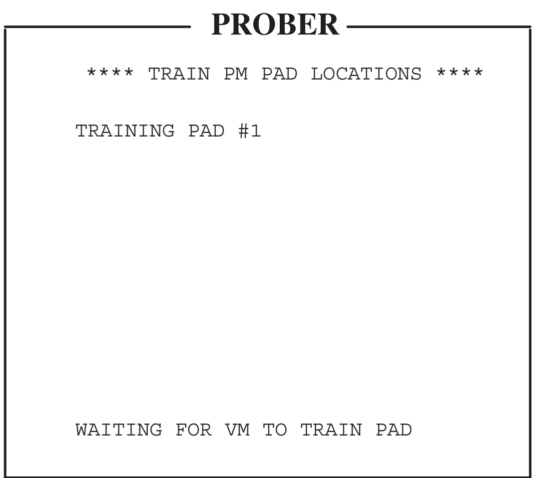


FIGURE 12−11: WAITING FOR VM SCREEN

Finally, when the Vision Module has successfully completed the operation, the message displays:

```
NEW DATA ACCEPTED
```

Once the first pad is trained, an offset is determined from the die corner to the upper left corner of the first pad. The offset is useful if a new alignment target is trained by < FIND TARG > following the completion of a training session.

A new offset can be defined without requiring all the trained pads be retrained. See **Section 12.7.4, Retrain First Pad Location**.

12.7.3 Adding and Inserting New Pads

If at least one pad has already been trained, the One Pad Trained Screen *(Figure 12−12)* displays.

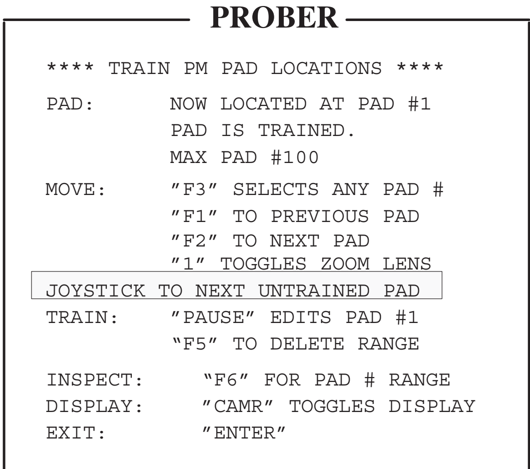


FIGURE 12−12: ONE PAD TRAINED SCREEN

ADDING A NEW PAD

Use the Joystick to move the wafer until the upper left corner of the new pad is aligned with the camera crosshairs. Press < PAUSE/CONT > to add the new pad to the end of the list.

If you press < CAMR > and the current pad is not a previously trained pad, the Add New Pad Mode Screen *(Figure 12−13)* displays.

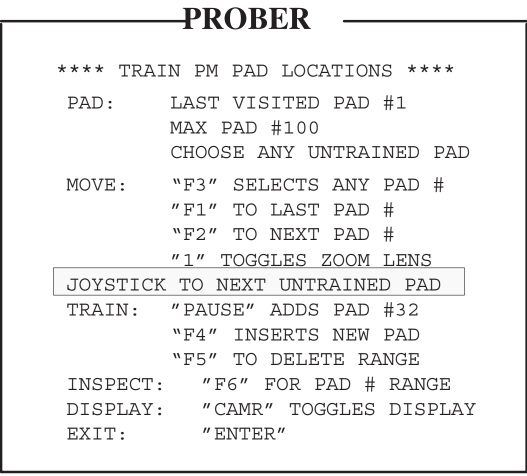


FIGURE 12−13: ADD NEW PAD MODE SCREEN

Press < PAUSE/CONT > to add the pad to the end of the list. Press < F3 > and enter the pad number to move to that pad number; press < F1 > to return the prober to the last pad visited; or, press < F2 > to move the prober to the next higher pad from the last pad visited. If you decide the training session is over, press < ENTER > to exit and return to the Probe Mark Inspection Menu.

INSERTING A NEW PAD

To insert a new pad, press < F4 >, producing the Inserting a Pad Screen *(Figure 12−14)*.

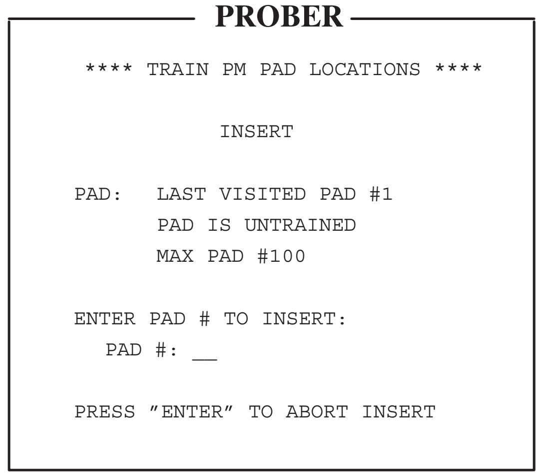


FIGURE 12−14: INSERTING A PAD SCREEN

Enter the pad number to be inserted. The prober renumbers all the higher pad numbers and the maximum pad number is incremented.

After training, the Full Editing Screen is displayed (*Figure 12−15*). For this example, assume mid−list pad #21 was just inserted.

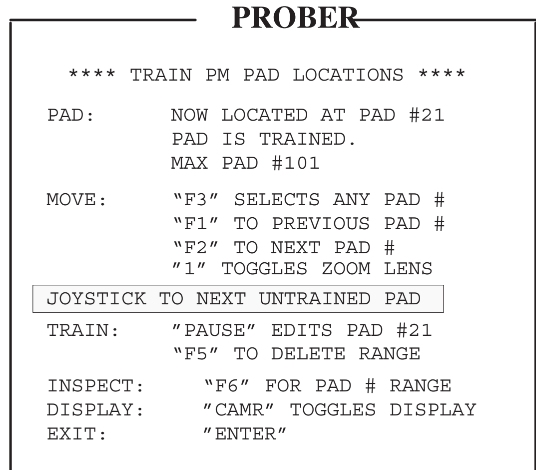


FIGURE 12−15: FULL EDITING SCREEN

In full editor mode, the Joystick controls the forcer and can be moved to a different pad. You can also move to another already trained pad using either < F1 > to go to the next smaller pad number, < F2 > to go to the next larger pad number, or < F3 > to select a particular pad number. The system displays the Train PM Pad Locations Screen (*Figure 12−16A*).

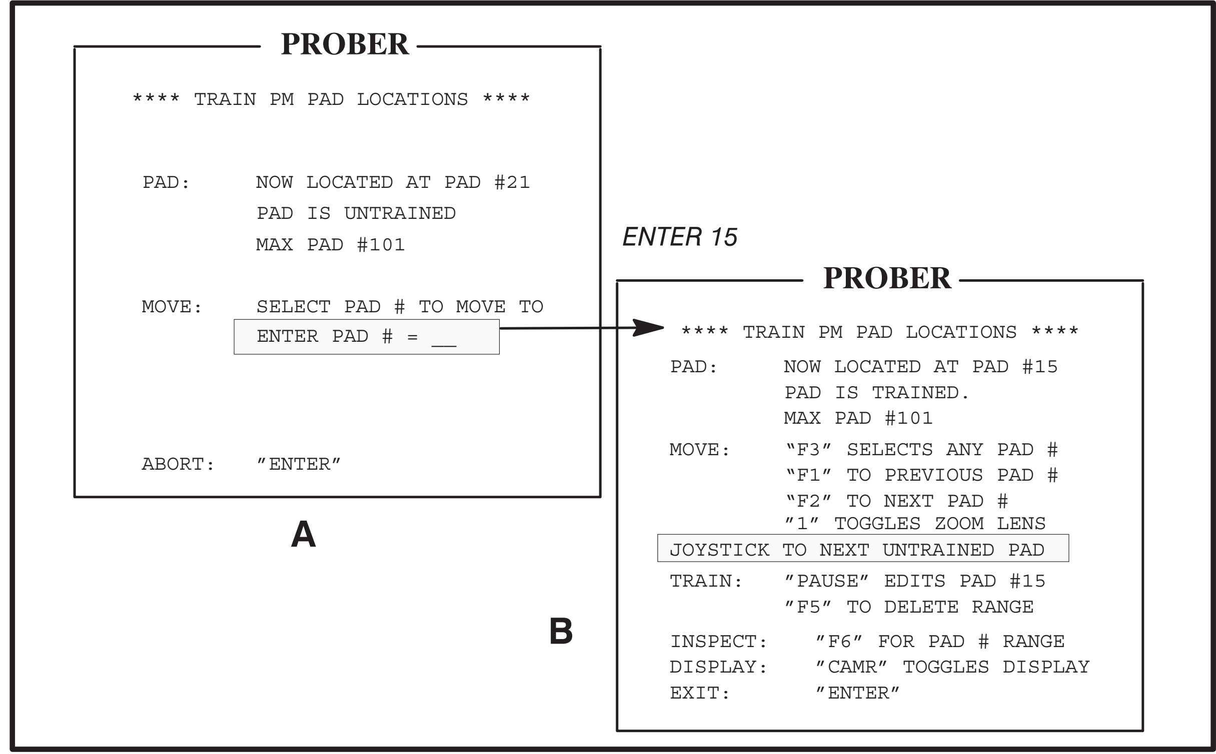


FIGURE 12−16: TRAIN PAD LOCATIONS SCREEN − SELECTING A PARTICULAR PAD NUMBER

Enter the desired pad number (15, in the example). If the pad number entered is less than zero or greater than the maximum pad number, an alarm sounds, the warning message `PAD OUT OF RANGE` is displayed, and the screen resets for a new pad.

Immediately after an acceptable pad number is entered, the prober moves automatically to that pad, the display returns to the full editor screen, and the cycle continues (*Figure 12−16B*).

You can cycle through the pads and add, edit, insert, or delete at will. At any time, the Zoom Lens can be toggled with the < 1 > key to see more of the die for choosing pads. When the session is finished, press < ENTER > to end training and the system displays the Probe Mark Inspection Menu.

It is not necessary to train all pads from a single die. The prober automatically calculates the offset from a newly trained die to the local die's first pad reference location. If the first pad is deleted or a new pad is inserted, the reference point does not change to the new first pad. Once the first training die's reference point is established, it is maintained until all pads are deleted or a new device is trained.

12.7.4 Retrain First Pad Location

The locations of all trained pads are stored with respect to a reference point created when the first pad is defined. This reference point is relative to the alignment target location under the camera. If the alignment target location is changed by pressing < FIND TARG > (< F6 >) and realigning the wafer, the first pad reference point is no longer valid. Since it would be inconvenient to retrain up to 128 pad locations in this event, it is only necessary to retrain the original first pad reference point so it reflects the new alignment target.

When Line 06 is selected from the Probe Mark Inspection Menu, if the wafer is not already under the camera, the prober automatically moves the wafer to the alignment target position and adjusts the Zoom Lens to the Macro position. The Retrain First Pad Location Screen *(Figure 12−17)* displays.

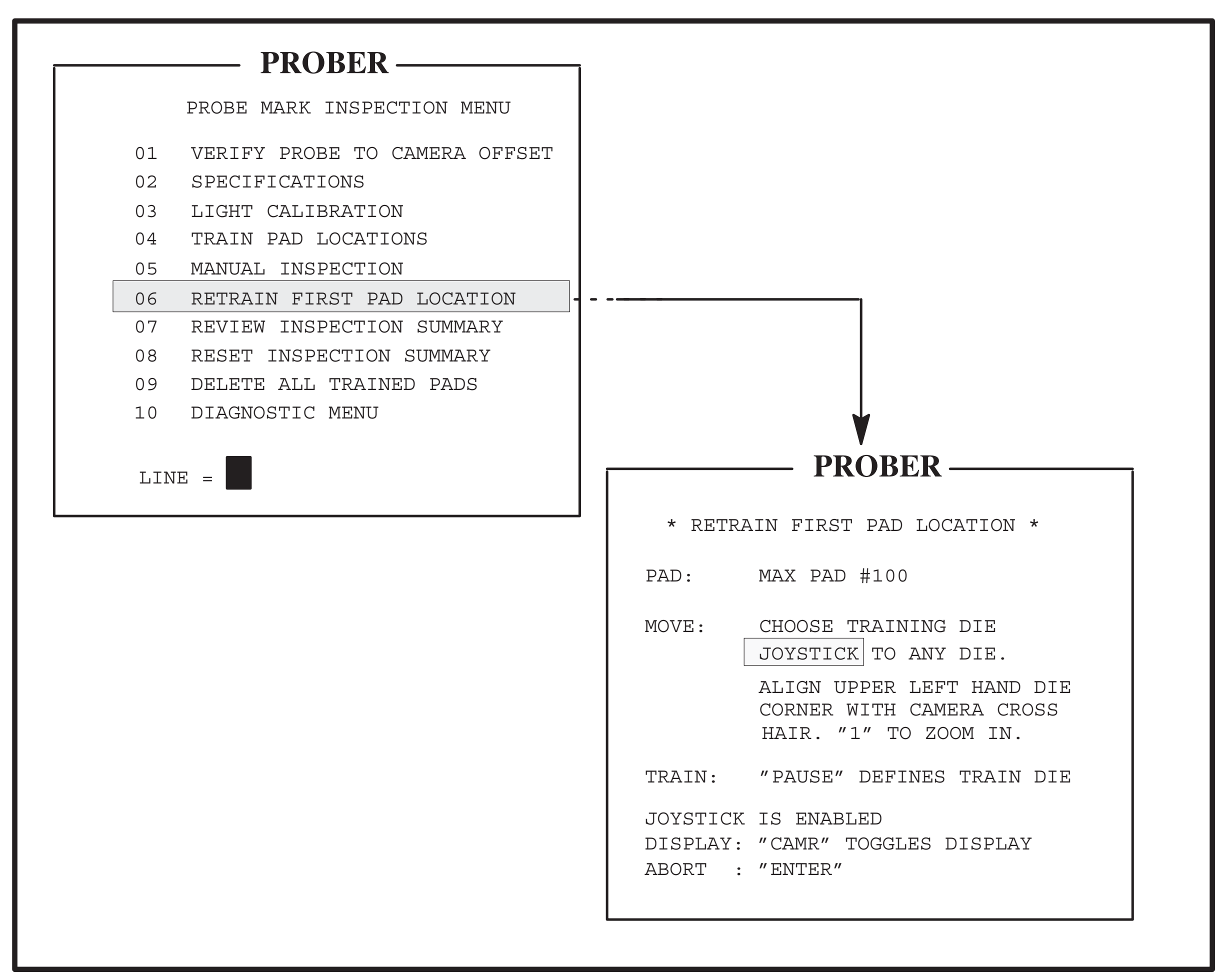


FIGURE 12−17: PROBE MARK INSPECTION MENU AND RETRAIN FIRST PAD LOCATION SCREEN

The following procedure reestablishes the distance from the upper left corner of the die to a point near the original pad reference point.

1. Reestablish the upper left corner of the die. The prober then automatically moves the original offset from the upper left corner of the die to the original pad reference point. You cannot, in general, exactly match the location of the upper left corner of the die, so the upper left corner of the original pad trained will be slightly offset from the camera crosshair at this point.
2. Align the upper left corner of the first pad to the camera crosshairs to reestablish the relationship between the die's upper left corner and the first pad's upper left corner.
3. Press < 1 > to zoom the lens to the Micro position. The screen shown in *Figure 12−18A* displays.

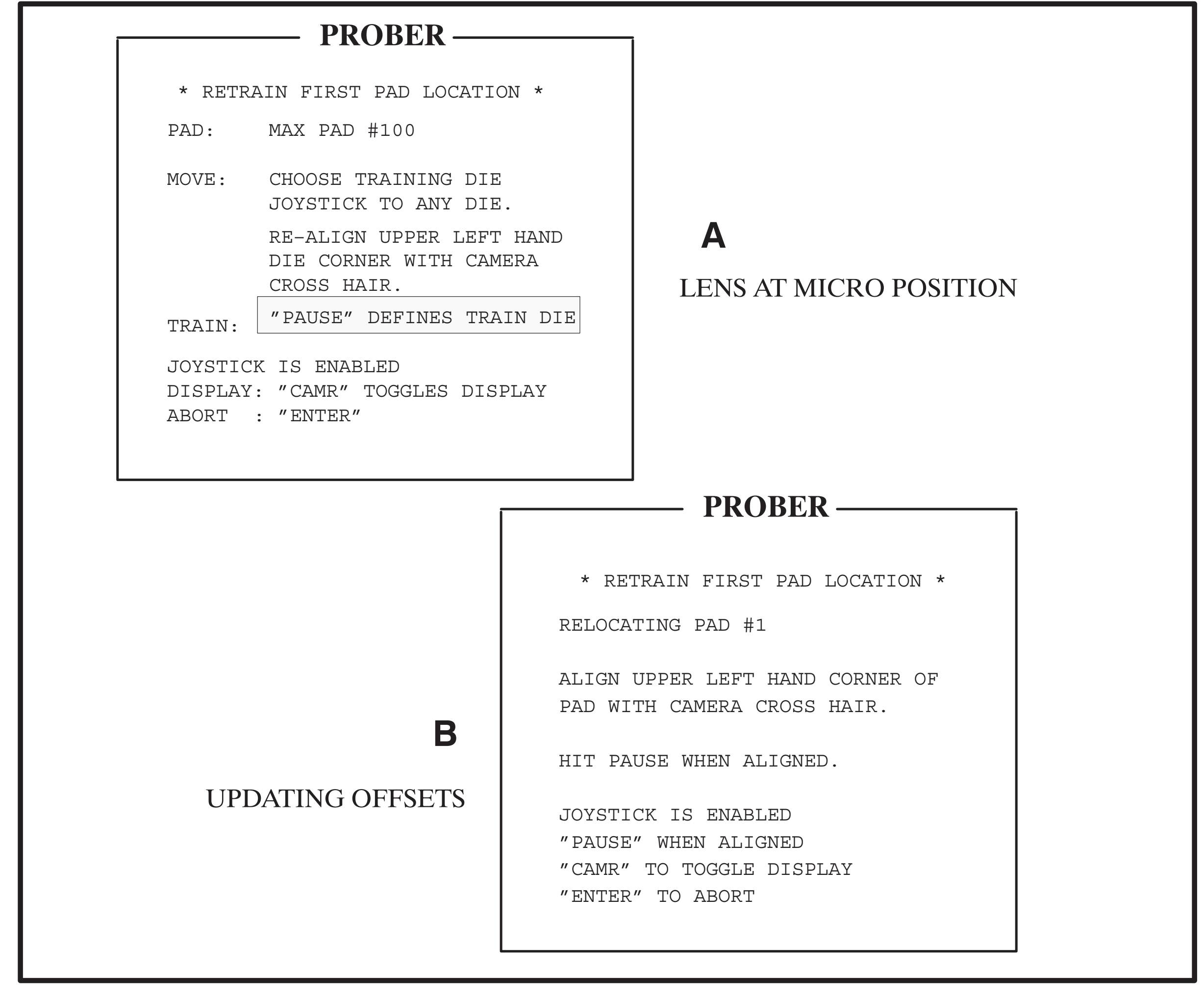


FIGURE 12−18: RETRAIN FIRST PAD LOCATION SCREEN AND VARIATIONS

4. Reestablish the upper left corner die alignment with the camera crosshair in the Micro position. The prober automatically moves to the approximate first pad position when < PAUSE/CONT > is pressed. The screen changes to the configuration shown in *Figure 12−18B*.
5. Press < CAMR > to toggle the camera display. Press < PAUSE/CONT > key to calculate the new first pad location offset from the alignment target; all offsets from the new pad alignment

reference point to all trained pads are then updated and the system displays the Probe Mark Inspection Menu. Probe Mark Inspection can proceed, from this point, without retraining any other pad locations.

12.7.5 Additional Training Line Items

DELETING PADS

The Full Editing Screen *(Figure 12−15)* is also used to delete specific pads. When you press < F5 >, the instructions shown in *Figure 12−19 (A* and *B)* display.

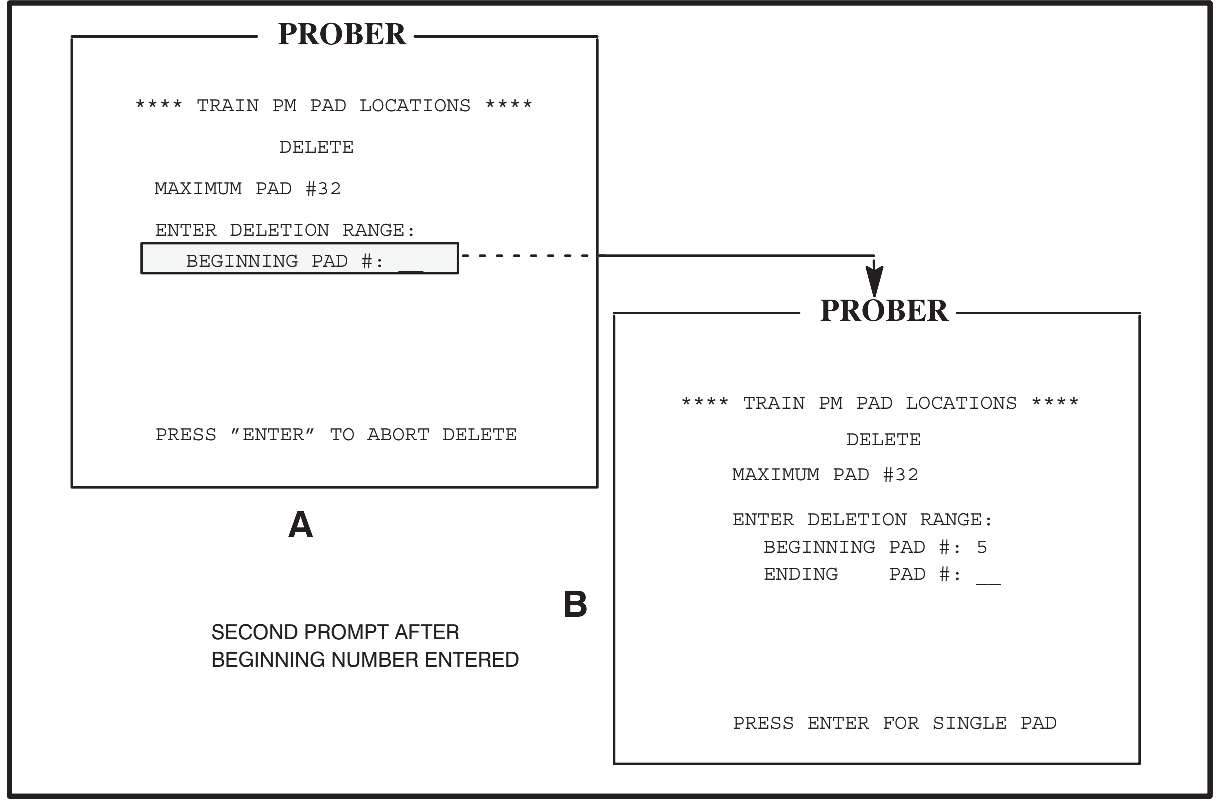


FIGURE 12−19: TRAIN PAD LOCATIONS SCREENS − DELETE

Enter a beginning pad number, as prompted. A new instruction will prompt for an ending number. Press < ENTER > for a single pad, or enter an ending pad number and press < ENTER > to display a last chance message:

```
ARE YOU SURE? _
     "Y" DELETES, "ENTER" ABORTS
```

Press < Y > to delete all pads defined in the range. All pad numbers greater than the ending pad number entered are shifted down by the number of pads deleted, and the maximum pad number is decreased by the number of pads deleted. For example, if the ending pad location is pad #10, and the current pad is pad #8, the prober automatically moves to the newly renumbered pad #8. The display automatically returns to the Full Editing Screen.

Pads also can be deleted through Line 09 of the Probe Mark Inspection Menu, described next.

DELETING ALL TRAINED PADS

If a training session has failed, from the Probe Mark Inspection Menu, select Line 09, DELETE ALL TRAINED PADS *(Figure 12−20)*.

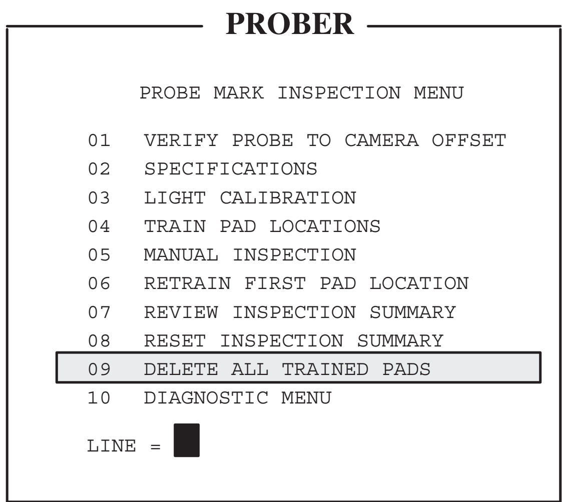


FIGURE 12−20: PROBE MARK INSPECTION MENU

This line item allows you to delete all trained pads and reset the pad list to empty. A prompt displays:

```
ARE YOU SURE? _
     "Y" DELETES, "ENTER" ABORTS
```

Press < Y > to delete or < ENTER > to abort.

Note that this deletion only deletes and resets on the prober side. To reset the Vision Module in addition, see **Section 12.8.3, PMI Diagnostics.**

INSPECTING PADS

The Inspect function is accessed from the Full Editing Screen (*Figure 12−15*) by pressing < F1 >. Snapshot or automatic sequencing inspection is available if there is at least one pad trained. You are prompted for a range of pad numbers to inspect. If only one die is desired, enter the beginning pad number and press < ENTER > when the prompt `LAST PAD NUMBER` displays. Otherwise, the prober will perform an inspection and return results from the lowest pad number to the highest pad number entered in an auto sequencing mode.

This sequence is the same as initiated in the Probe Mark Inspection Menu by entering Line 05 (`MANUAL INSPECTION`), described next, and displays the same screens (*Figures 12−21 through 12−24*).

If the lighting is not suitable, return to the Probe Mark Inspection Menu and enter the Light Calibration Menu to make adjustments. See **Section 12.6, Calibrate Lighting,** for instructions.

12.8 OTHER PMI FEATURES

12.8.1 Manual Inspection

The Probe Mark Manual Inspection Screens *(Figure 12−21)* display when you select Line 05, MANUAL INSPECTION, from the Probe Mark Inspection Menu.

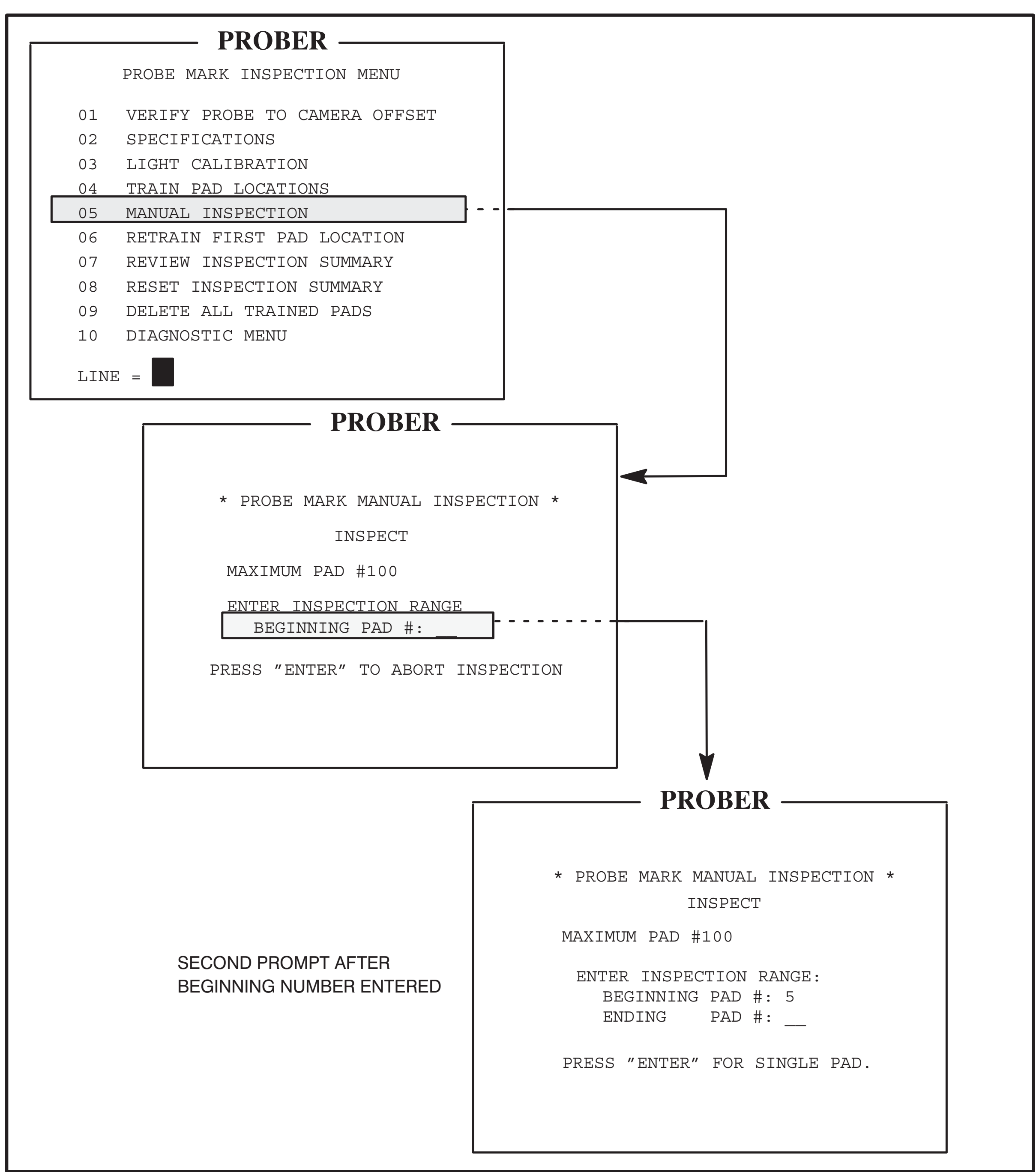


FIGURE 12−21: PROBE MARK INSPECTION AND MANUAL INSPECTION SCREENS

The prober confirms that at least one pad has been trained. If none has been trained, manual inspection aborts with the timed message: `NO PADS TRAINED`. Otherwise, the Zoom Lens moves into the Macro position.

NOTE

If the Zoom Lens has a mechanical problem and cannot go to the Macro position, a message is displayed:

```
ZOOM LENS MALFUNCTION
```

Contact Electroglas Field Service for assistance.

If the chuck is not under the camera, it moves there. If the chuck is not under the probe tips, the chuck positions the trained die under the lens. Otherwise, the current die under the probe tips is placed under the camera.

NOTE

Pressing < 0 > moves the die presently under the probe tips under the camera when Auto Align is enabled. The feature starts in the Macro position, and subsequent presses of the < 0 > key toggle the Zoom Lens between Macro and Micro positions. While the wafer is under the camera, the Joystick is enabled so you can inspect any part of the wafer. Press < ENTER > to return the die to the probe tips.

There is one restriction. If the die under the probe tips cannot be moved under the camera, the center of the wafer will be moved to that position.

The range of pads to be inspected is described in **Section 12.7.4, Inspecting Pads**. Enter the beginning and ending pad numbers as prompted. If only one pad is to be inspected, enter the number as a beginning die, and press < ENTER >. To abort the procedure before entering a beginning pad, press < ENTER >.

If a range has been selected, the screen shown in *Figure 12−22A* is displayed. If the Zoom Lens offset has not been set, you need to zoom in to guarantee the same die is still under the cross hair (*Figure 12−22B*).

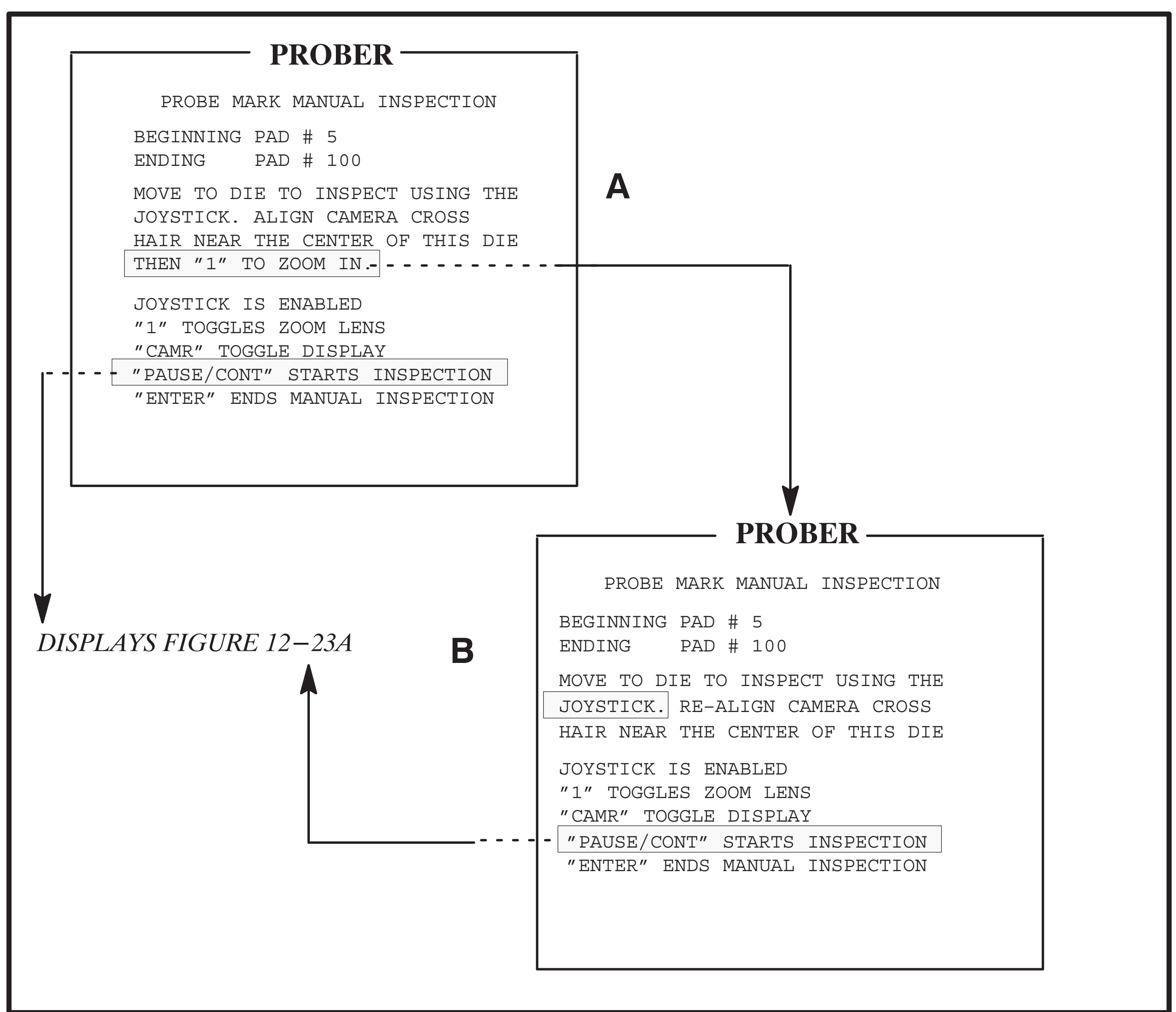


FIGURE 12−22: MANUAL INSPECTION SCREENS

When the Zoom Lens offset has been set, the < PAUSE/CONT > key drives the Zoom Lens to the Micro position, looking at the same point automatically. The prober moves to the beginning pad which produces the screen shown in *Figure 12−23A*.

When < PAUSE/CONT > is pressed, the prober automatically goes to the beginning pad number, inspects, and displays the results (*Figure 12−23B*). The inspection continues with the next successive pad each time < ENTER > is pressed, to the ending number, unless interrupted. Review the results and press < ENTER > to continue. If you press < PAUSE/CONT >, the prober stops the automatic mode and stays at the current pad number, displaying the screen shown in *Figure 12−24B*, until < PAUSE/CONT > is pressed again.

PROBER

PROBE MARK MANUAL INSPECTION
MAXIMUM PAD #100
BEGINNING PAD # 5
ENDING PAD # 100
NOW AT PAD #6
JOYSTICK IS ENABLED
"PAUSE/CONT" GOES TO AUTO MODE
"F3" SELECTS NEXT PAD NUMBER
"F1" REPEATS PREVIOUS INSPECTION
"CAMR" TOGGLES DISPLAY
"ENTER" EXITS

A

DISPLAYS FIGURE 12−24A

B

DISPLAYS FIGURE 12−24B

PROBER

PROBE MARK MANUAL INSPECTION RESULTS
NOW LOCATED AT PAD #6
PAD FOUND.
PAD INSPECTED
PROBE MARK FOUND
PROBE MARK AREA OK
PROBE MARK DID NOT DRIFT
"CAMR" TOGGLE DISPLAY
"PAUSE" ABORTS AUTO MODE
"ENTER" CONTINUES INSPECTION

FIGURE 12−23: MANUAL INSPECTION SCREENS

If you wish to jump to an out−of−sequence pad number, from the screen shown in *Figure 12−23B*, press < PAUSE/CONT > to see screen shown in *Figure 12−24B*. Press < ENTER > to return to screen *12−23A*. Press < PROG > (< F5 >); you will be prompted for the pad number *(Figure 12−24A*). Press < ENTER > to return to *Figure 12−23A*.

After the out−of−sequence pad is inspected and results are displayed, you can continue from the current pad number (*12−23A to 12−23B*) or return to the previously interrupted pad number before continuing automatic mode. If you wish to repeat the last pad inspected, press < PAUSE/CONT > from screen *12−23B* to stop automatic inspection. Press < ENTER > to return to the previous screen (*12−23A*), then press < PAUSE/CONT >. You will see the the query:

```
RETURN TO INTERRUPTED PAD?:
      "Y" RETURNS
      "ENTER" GOES TO THE NEXT PAD
```

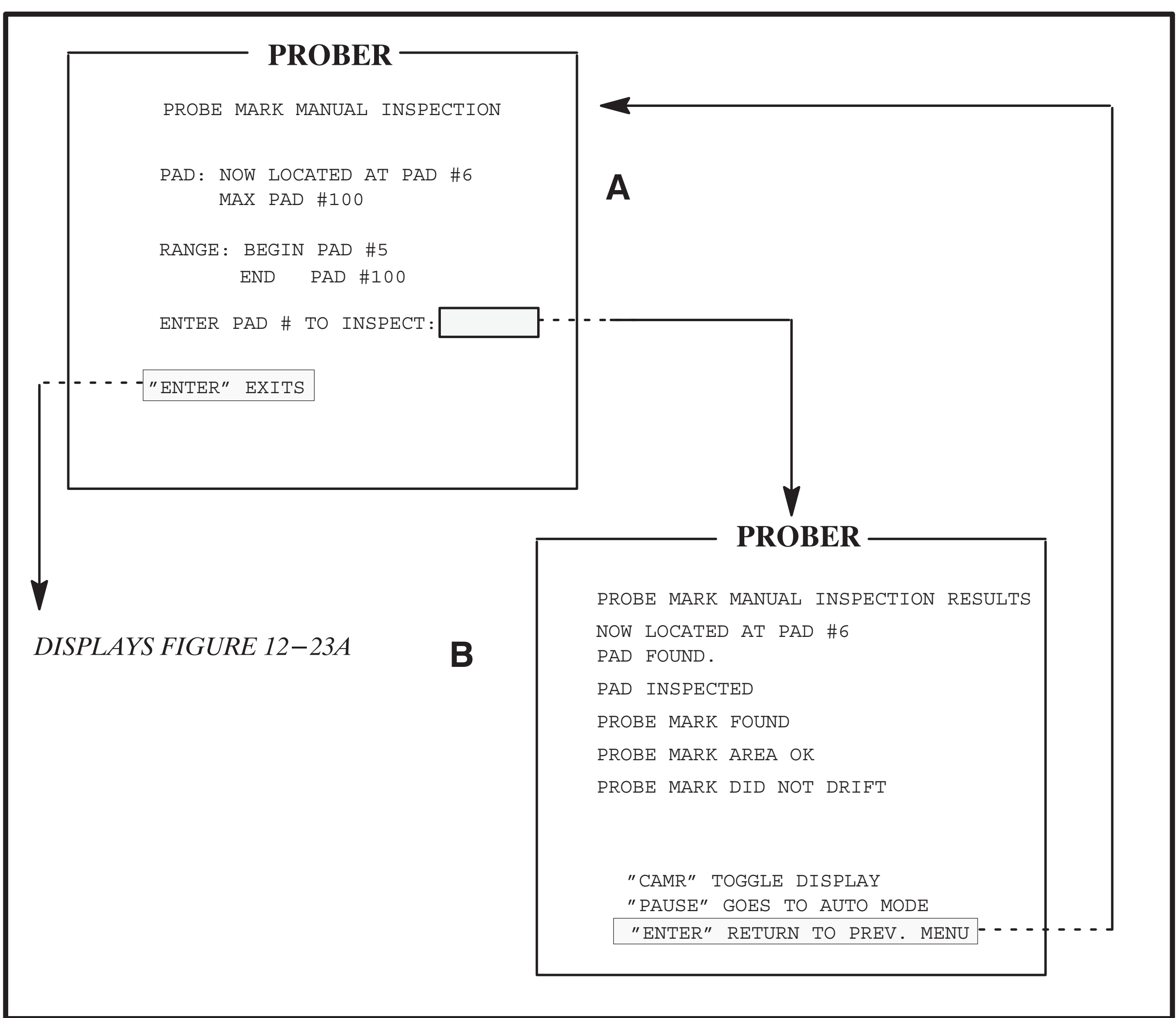


FIGURE 12−24: MANUAL INSPECTION SCREENS

When paused, you can use the Joystick to move around the wafer. Once the < PAUSE/CONT > key toggles back to auto mode, the Joystick is disabled. The < ENTER > key returns to the Pad Select Menu (*Figure 12−24A*) where you can inspect another pad or exit from Manual Inspection.

12.8.2 Inspection Summaries

The Probe Mark Inspection Summary *(Figure 12−25)* displays when you select Line 07, REVIEW INSPECTION SUMMARY, from the Probe Mark Inspection Menu.

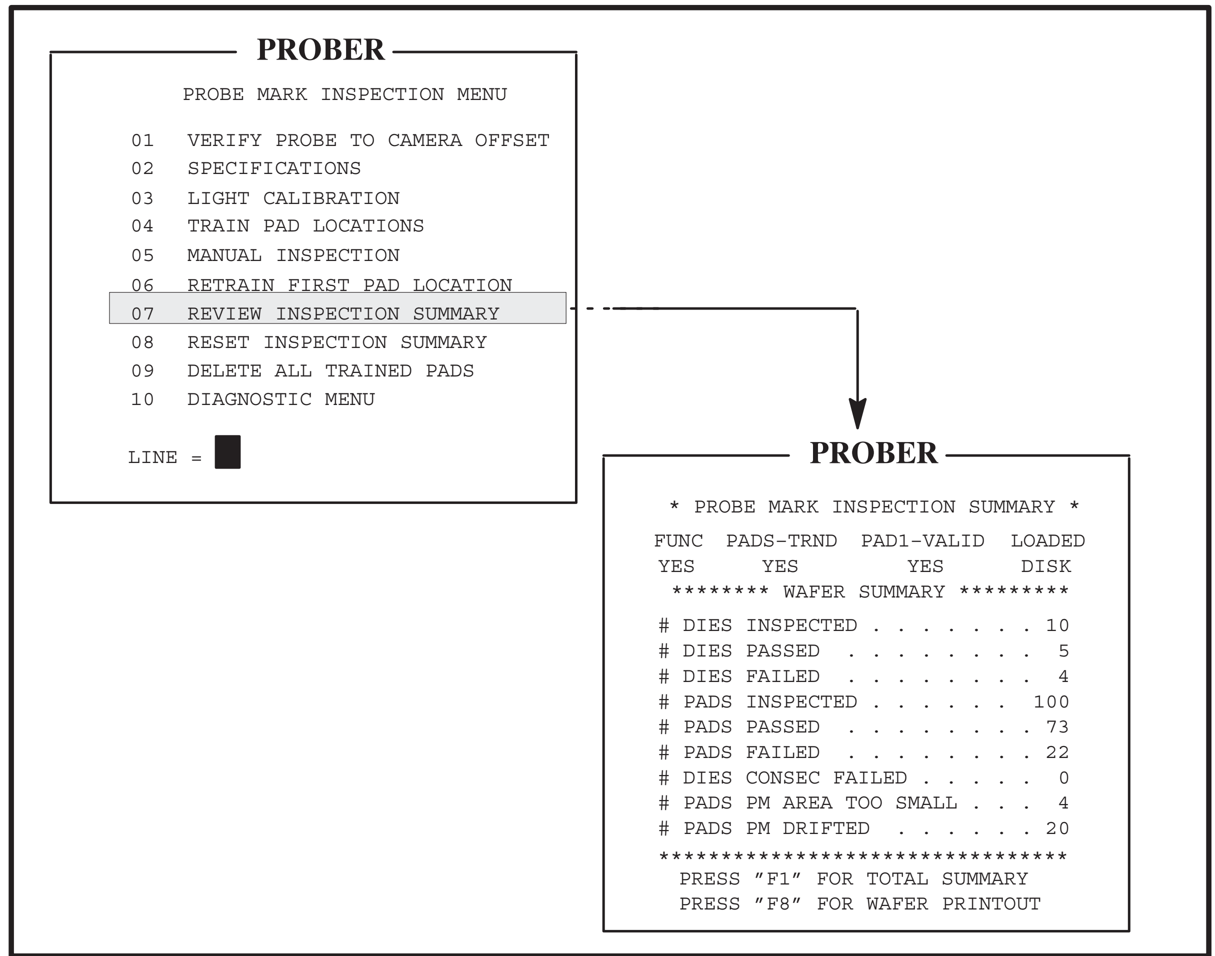


FIGURE 12−25: PROBE MARK INSPECTION MENU AND INSPECTION (WAFER) SUMMARY

Two summaries are available: the Wafer Summary and the Total Summary.

12.8.2.1 THE WAFER SUMMARY

When you select Line 07 of the Probe Mark Inspection Menu, the initial menu displayed is the Wafer Summary *(Figure 12−25)*. The status of Probe Mark Inspection is displayed on Lines 2 and 3. In the example in *Figure 12−25*:

FUNC (YES) means the Vision Module is processing Probe Mark Inspections correctly and is communicating correctly with the prober.

PADS−TRND (YES) means at least one pad has been trained.

PAD1−VALID (YES) means the first pad has been referenced to the alignment target. (This is cleared when a new target is trained − the first pad should be retrained in this case − see **Section 12.7**.4)

LOADED (DISK) means that Probe Mark Inspection parameters have been loaded from disk (see **Section 12.10, Storing PMI Data on Disk**).

For Probe Mark Inspection to work, it must be enabled, the Vision Module must be functional, and at least one pad must be trained. A die is considered to be inspected if at least one pad has been inspected. A die is considered failed if at least one pad failed.

In the *Figure 12−25* example, ten die have been inspected. Ten pads are inspected on each die so 100 pads have been inspected. The last four die inspected have probe mark problems (dies failed). A probe tip fatigued causing one pad to have too small a probe mark on the seventh through tenth die inspected. The last two die have excessive drift. The total number of pads with area too small is four. The total number of pads with excessive drift is 20. Note that on dies 9 and 10 one pad has both too small a probe mark and has drifted.

The total number of errors is (4 + 20) = 24. However, since one pad on each of two dies had multiple errors, the number of pads failed is 22. Five pads could not be located by the Vision Module. These pads are not included in the pass/fail totals since no test occurs. So of the 100 pads inspected, 5 pads could not be found, 73 pads passed and 22 pads failed. The number of dies consecutive failed shows the current total if < PAUSE/CONT > is pressed during probing.

The summary highlights the # sign on `PADS PM AREA TOO SMALL` and `PADS PM DRIFTED` if the Stop On parameters have been enabled (Lines 03 and 04 of the Specifications Menu). If the Stop On parameters have not been enabled, no pads can fail which means no die can fail and those counts remain zero. The only totals which change are the number of dies inspected, the number of dies passed, and the number of individual failures noted: `PAD PM AREA TOO SMALL` or `PAD PM DRIFTED`.

Note that there are variations in the terminology used in the Wafer Summary for Multi−Die Probing. See **Section 12.11** for an illustration.

12.8.2.2 THE TOTAL SUMMARY

To display the Total Summary *(Figure 12−26)*, from the Wafer Summary, press < F1 >.

PROBER

```
 * PROBE MARK INSPECTION SUMMARY *
 FUNC   PADS-TRND  PAD1-VALID  LOADED
  YES      YES         YES       YES
 ******** TOTAL SUMMARY *********
# DIES INSPECTED . . . . . . 1000
# DIES PASSED  . . . . . . .  990
# DIES FAILED  . . . . . . . . 10
# PADS INSPECTED . . . . .  10000
# PADS PASSED  . . . . . . . 9973
# PADS FAILED  . . . . . . . . 22
# PADS PM AREA TOO SMALL . . .  4
# PADS PM DRIFTED  . . . . . . 20
*********************************
  PRESS "F1" TO GO TO WAFER SUMMARY
  PRESS "PRINT" FOR TOTAL PRINTOUT
```

FIGURE 12−26: TOTAL SUMMARY DISPLAY

The Total Summary results are similar to the Wafer Summary results except the Total Summary displays all failures occurring since the last Probe Mark Inspection summary reset. It does not include the consecutive die fail counter since the purpose of this counter is to regulate failures on a per−wafer basis. The totals displayed assume no more failures occurred since the Wafer Summary *(Figure 12−25)* was run.

12.8.2.3 RESET INSPECTION SUMMARY

To reset the wafer and/or total inspection summaries, from the Probe Mark Inspection Menu, select Line 08, RESET INSPECTION SUMMARY (*Figure 12−27*).

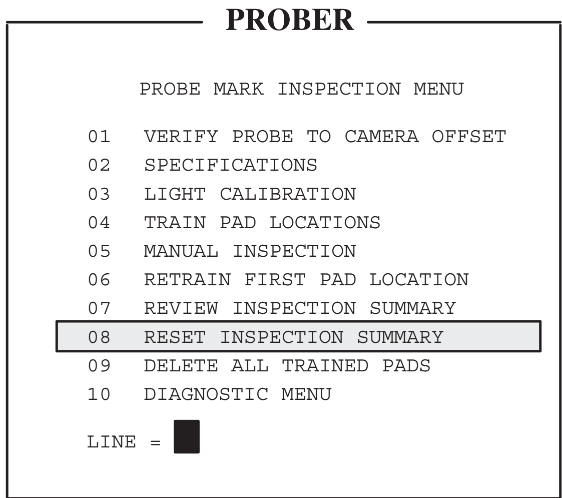


FIGURE 12−27: PROBE MARK INSPECTION MENU

Select the summary desired and press < Y > in response to the prompt to reset that summary. If you press < ENTER > the summary is not reset.

Since probe mark failures correspond to a particular probe card, and since there is no automatic way to know when that probe card has been changed, reset the Total Summary following the installation of a new probe card. The Wafer Summary is automatically reset at the beginning of each wafer.

12.8.3 PMI Diagnostics

The Diagnostic Menu *(Figure 12−28)* displays when you select Line 10, DIAGNOSTIC MENU, from the Probe Mark Inspection Menu.

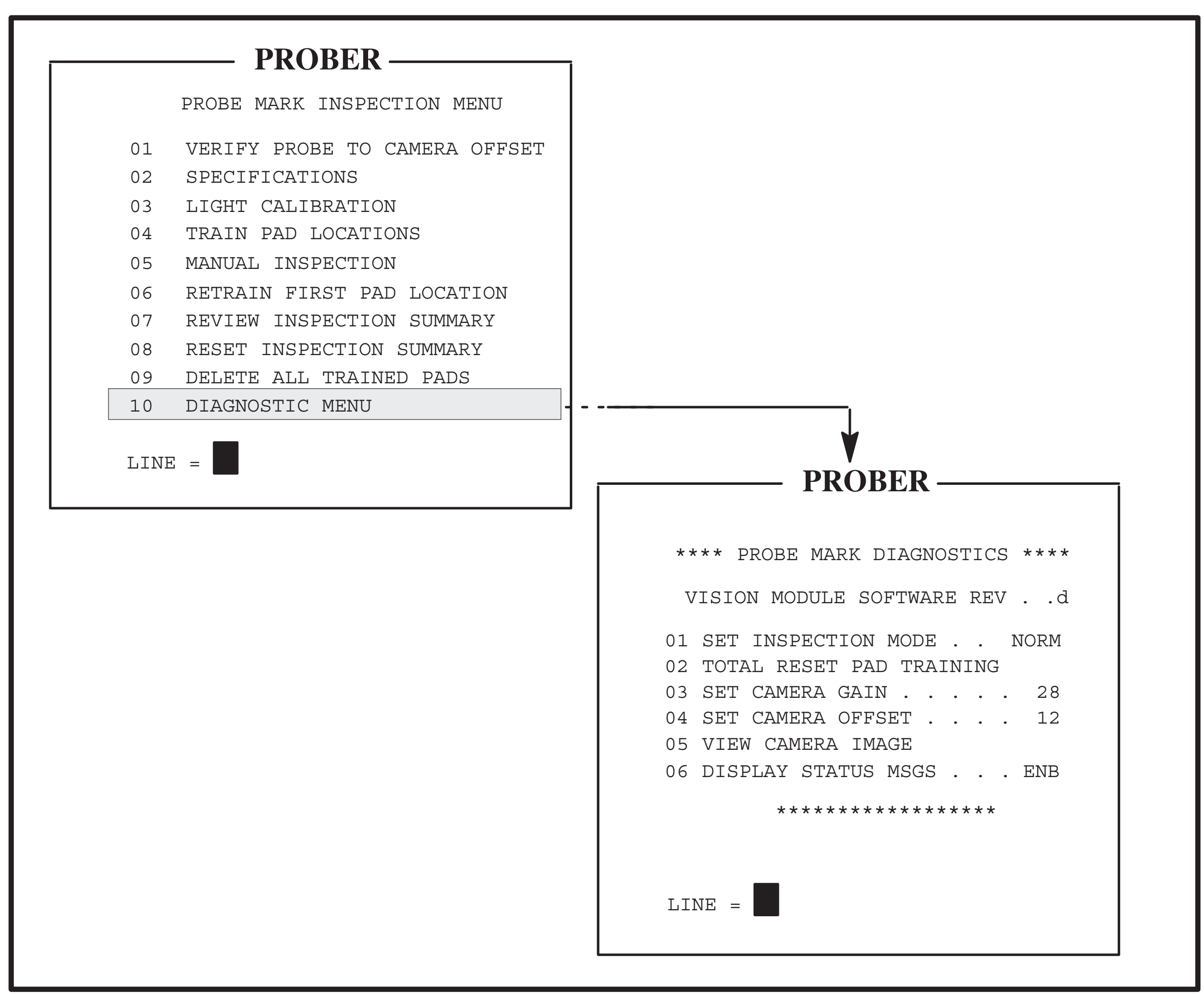


FIGURE 12−28: PROBE MARK INSPECTION AND DIAGNOSTIC MENUS

This screen is used to set the inspection mode and set the camera gain and offset parameters. An explanation of the line items follows.

LINE 01 SET INSPECTION MODE

The four inspection modes are identified here by the numbers of the keys used to select them:

0 = FAST	2 = SLOW
1 = NORM (normal)	3 = SPEC (by specification)

The *FAST* mode uses no filter and uses automatic gain and offset on the first pad inspected only. Time is saved by not doing an adjustment on subsequent pads inspected.

The *NORMAL* mode, which is the default, uses a mid−range filter and automatic gain on the first pad inspected only during probing. This mode takes longer than the fast mode because it uses a background filter.

The *SLOW* mode uses the highest filter number available and does automatic gain and offset adjustments on every pad.

Other combinations of factors may be necessary on certain wafer types. Nonstandard sets can be user−defined by choosing the *SPECIFICATION* mode. The probe mark filter screen appears in this case *(Figure 12−29A)*.

The filters range from 0, no filter, to a maximum of 5. The larger the number, the stronger the filters. Choose a suitable filter by trial and error. Enter the number or, if no change is desired, press

< ENTER >; with either entry, the display changes to the next screen in the sequence.

The next parameter to set is the on/off threshold for the pixel light intensity (*Figure 12−29B*). These values determine how the Vision Module interprets the intensity of light at a pixel in the pad area. The Off threshold should always be greater than the On threshold. Press < ENTER > to leave the present value unchanged. The next screen appears automatically. The pixel Off threshold is set in the same manner (*Figure 12−29C*).

Finally, the inspection mode is defined by choosing between first pad only and every pad *(Figure 12−29D*). The inspection mode set will be used during the next manual or automatic probe mode inspection.

LINE 02 TOTAL RESET PAD TRAINING

If excessive failures are recorded, the training may have been done incorrectly or the hardware in the Vision Module may need to be reset. This line of the Diagnostics Menu completely resets both the Vision Module and the prober with respect to Probe Mark Inspection. Only do this reset as a last resort. The prober asks `ARE YOU SURE?` before resetting so you have a chance to abort the reset. The reset done by Line 09, Probe Mark Inspection Menu, DELETE ALL TRAINED PADS, resets only the prober.

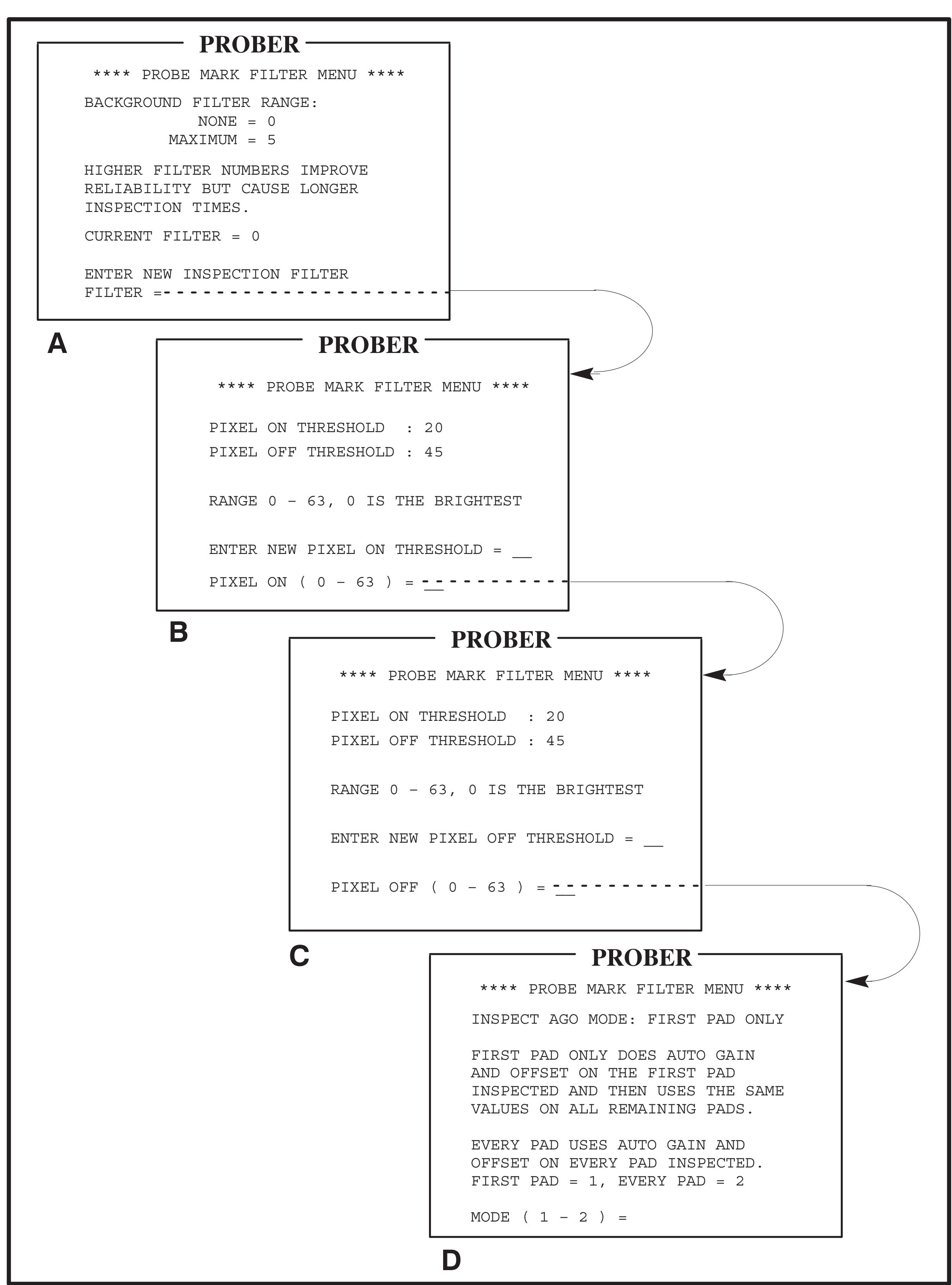


FIGURE 12−29: PROBE MARK FILTER SCREEN AND VARIATIONS

LINE 03 SET CAMERA GAIN

LINE 04 SET CAMERA OFFSET

To experiment with the camera image, the camera gain and offset can each be changed from 0 to 255 through Lines 03 and 04 of the Diagnostics Menu. To view the camera image, select Line 05.

LINE 05 VIEW CAMERA IMAGE

When this line is selected, press < CAMR > to see the camera image. Pressing < ENTER > returns to the Diagnostics Menu.

LINE 06 DISPLAY STATUS MSGS

Enable this line item to display various Vision Module/prober communication error messages which may occur during inspection.

12.9 PMI ERROR HANDLING

For Probe Mark Inspection error handling to work, either or both of the Stop On parameters must be enabled (Lines 03 and 04, Probe Mark Specifications Menu, **Section 12.5, Entering PMI Specifications**). Once enabled, two limits are activated in the same menu:

Line 01, # FAILURES PER WAFER: Every time a pad fails, a counter is incremented. If this counter reaches or exceeds its limit, the prober begins the error handling procedure. The purpose of this limit is to protect against a probe mark setup which may intermittently fail because it is on the margin.

Line 02, # CONSECUTIVE FAILS: Any time at least one pad fails during an inspection, the next tested die will be inspected regardless of the inspection frequency counters. Each trained pad has a separate consecutive fail counter. If at least one trained pad fails the number of consecutive times specified, the prober goes into the error handling procedure.

Should a critical failure condition occur, the prober displays the Probe Mark Failure Summary (*Figure 12−30*), and normal probing is paused. Note the variations in the summary lines for Multi−Die Probing.

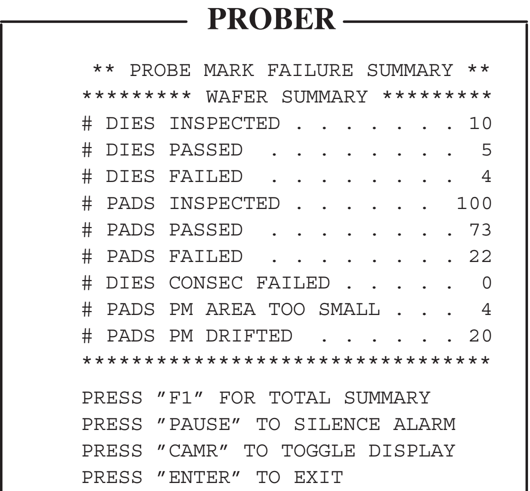


FIGURE 12−30: PROBE MARK FAILURE SUMMARY

When the summary is first displayed, the alarm is On and either `# DIES CONSEC FAILED` or `# PADS FAILED` is highlighted, or both. Press < PAUSE/CONT > to silence the alarm. Press < CAMR > to display the frozen Vision Module image, which shows the last failure to cause the error condition. The prober automatically moves the last die inspected under the probe tips so you can visually inspect the die using the microscope.

Once the problem is identified, press < ENTER > to exit the summary. The Run Time Display, still paused, returns to the screen. At this point, corrective action, such as correcting for drift, can be taken.

Once paused, all the prober's menus and screens are accessible to assist in readjusting the prober to eliminate the failure condition. If the error condition was caused by the counter reaching or exceeding the `# FAILURES PER WAFER` limit, the counter is automatically reset when < PAUSE/CONT > is pressed to continue probing.

If the error condition was caused by CONSECUTIVE FAILS, the counters are automatically reset whenever the particular pad passes. If on the next inspection one or more of the consecutive failed pads again fails, the prober will go into the critical failure error handling procedure again.

12.10 STORING PROBE MARK PARAMETERS ON DISK

Probe Mark Inspection setup and pad information are saved on disk as PMI (pass/fail results and machine−dependent parameters like camera offset are not saved). After restoring the PMI data, it is possible to inspect pads for probe marks manually and during Autoprobing.

The PMI data is saved by means of the Disk Menu function, STORE ALL PARAMETERS ON DISK (Line 04). After the general parameter file (PRM), Row, Learn, Micro, Pattern, and Ink Dot files (if they exist) are stored, a file with extension".PMI" may be stored depending on the trained status of Probe Mark Inspection.

If one or more pads have been trained, the Probe Mark Inspection data is uploaded from the Vision Module and stored (along with prober Probe Mark Inspection data) in the .PMI file, When the .PMI file has been written, the letters PMI should appear briefly on the screen after the letters, PAC (for the pattern file) or IDI (if Ink Dot Inspection is stored).

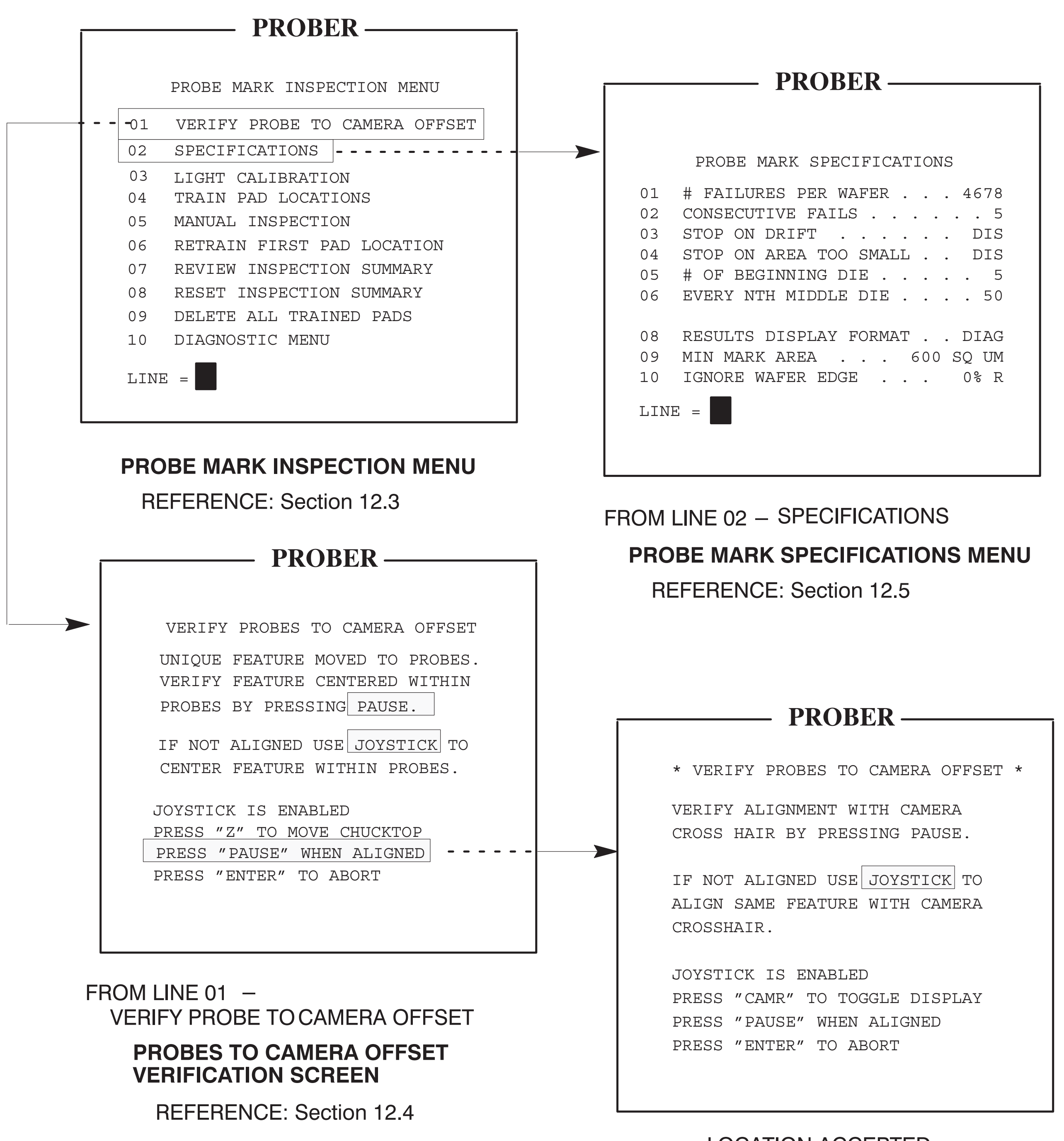
Upload of Probe Mark Inspection (restoring PMI data) is also accomplished from the Disk Menu, using Line 03, LOAD ALL PARAMETERS TO MEMORY. After the pattern (PAC) is loaded and the Ink Dot Inspection (IDI) file (if it exists), the .PMI file is loaded if it exists. The new Probe Mark Inspection pad information is then downloaded to the Vision Module.

At the end of a successful load, the following message appears:

```
VERIFY PROBE TO CAMERA OFFSET
   AND CHECK FIRST PAD LOCATION
```

Probe Mark Inspection may then be done using the restored PMI data.

12.11 PROBE MARK INSPECTION MENUS, SUBMENUS AND SCREEN STRUCTURES



PROBE MARK INSPECTION MENU

REFERENCE: Section 12.3

FROM LINE 02 – SPECIFICATIONS

PROBE MARK SPECIFICATIONS MENU

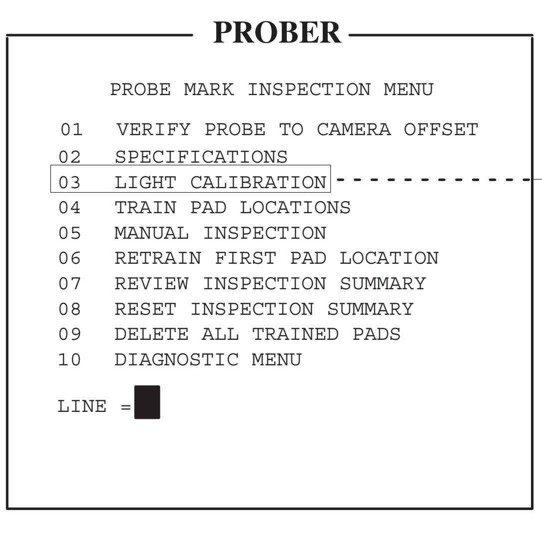
REFERENCE: Section 12.5

FROM LINE 01 – VERIFY PROBE TO CAMERA OFFSET

PROBES TO CAMERA OFFSET VERIFICATION SCREEN

REFERENCE: Section 12.4

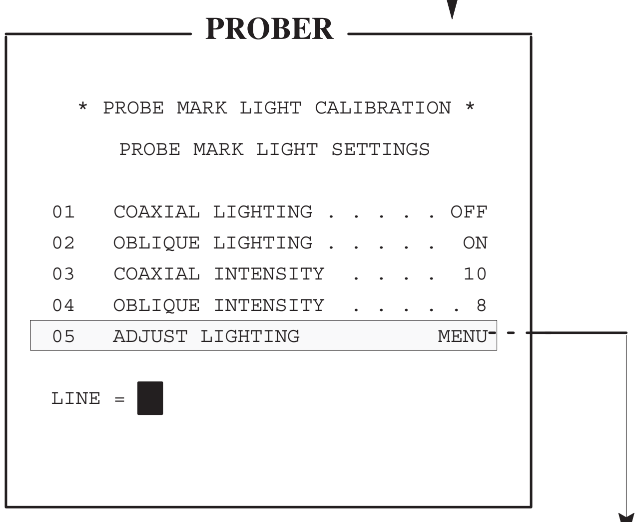
LOCATION ACCEPTED CONFIRMATION



FROM LINE 03 – LIGHT CALIBRATION

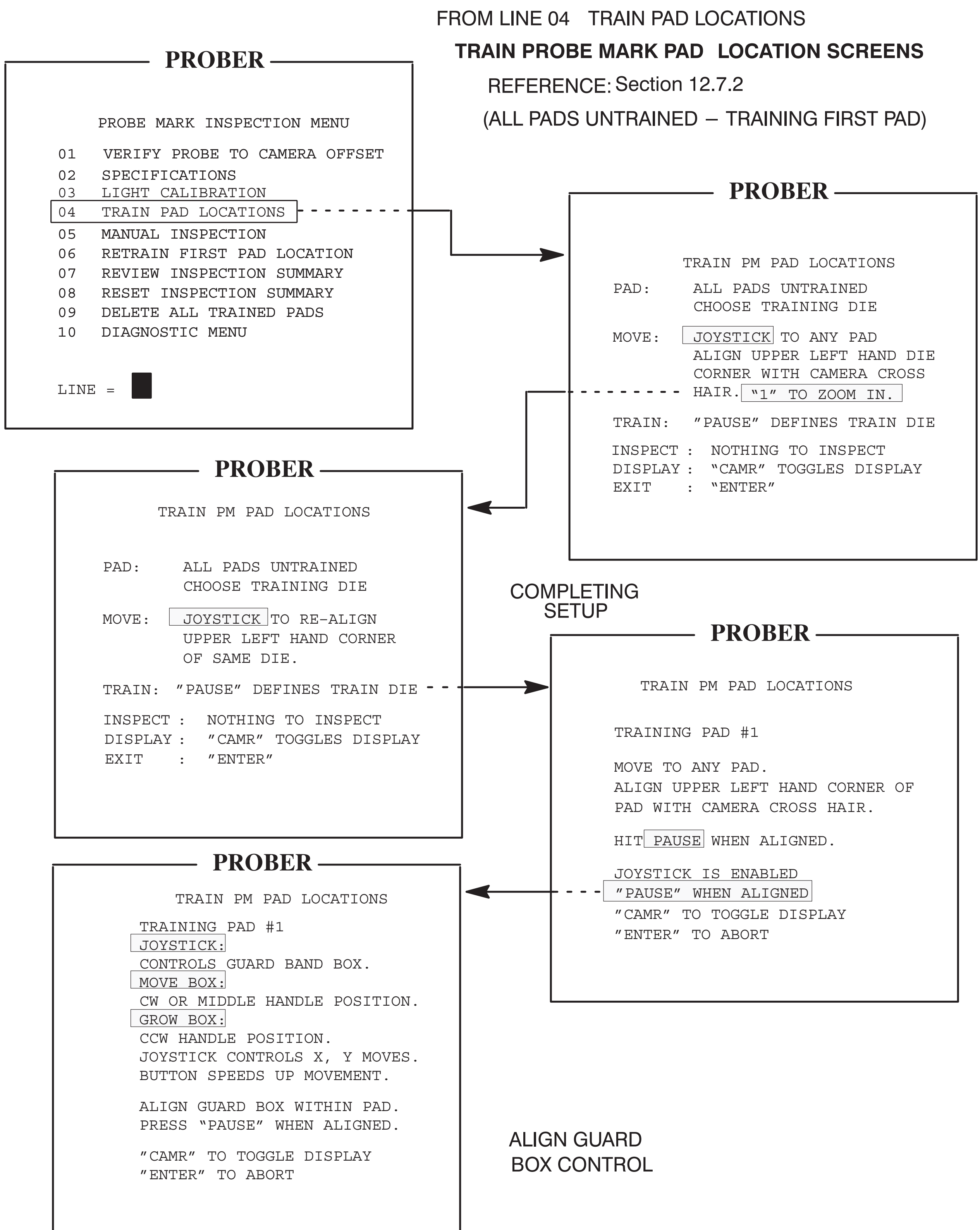
PROBE MARK LIGHTING CALIBRATION MENU AND CONTROL SCREEN

REFERENCE: Section 12.6



PROBER

```
** ADJUST PROBE MARK LIGHTING **
            SWITCH         INTENSITY
COAXIAL      OFF              10
OBLIQUE       ON               8
..................................
             LIGHT CONTROL KEYS
       TOGGLE   INCREASE   DECREASE
COAXIAL  "1"      "F1"       "F2"
OBLIQUE  "2"      "F3"       "F4"
..................................
JOYSTICK IS ENABLED
"CAMR"      TOGGLES DISPLAY
"F5"        FOR AGC
"PAUSE"     SET PROBE MARK LIGHT
"F6"        SET TRAIN LIGHT
"EXIT"      EXITS MENU
```


FROM LINE 04 TRAIN PAD LOCATIONS
TRAIN PROBE MARK PAD LOCATION SCREENS
REFERENCE: Section 12.7.2
(ALL PADS UNTRAINED – TRAINING FIRST PAD)
PROBER
PROBE MARK INSPECTION MENU
01 VERIFY PROBE TO CAMERA OFFSET
02 SPECIFICATIONS
03 LIGHT CALIBRATION
04 TRAIN PAD LOCATIONS
05 MANUAL INSPECTION
06 RETRAIN FIRST PAD LOCATION
07 REVIEW INSPECTION SUMMARY
08 RESET INSPECTION SUMMARY
09 DELETE ALL TRAINED PADS
10 DIAGNOSTIC MENU
LINE =
PROBER
TRAIN PM PAD LOCATIONS
PAD: ALL PADS UNTRAINED
CHOOSE TRAINING DIE
MOVE: JOYSTICK TO ANY PAD
ALIGN UPPER LEFT HAND DIE
CORNER WITH CAMERA CROSS
HAIR. "1" TO ZOOM IN.
TRAIN: "PAUSE" DEFINES TRAIN DIE
INSPECT : NOTHING TO INSPECT
DISPLAY : "CAMR" TOGGLES DISPLAY
EXIT : "ENTER"
PROBER
TRAIN PM PAD LOCATIONS
PAD: ALL PADS UNTRAINED
CHOOSE TRAINING DIE
MOVE: JOYSTICK TO RE-ALIGN
UPPER LEFT HAND CORNER
OF SAME DIE.
TRAIN: "PAUSE" DEFINES TRAIN DIE
INSPECT : NOTHING TO INSPECT
DISPLAY : "CAMR" TOGGLES DISPLAY
EXIT : "ENTER"
COMPLETING
SETUP
PROBER
TRAIN PM PAD LOCATIONS
TRAINING PAD #1
MOVE TO ANY PAD.
ALIGN UPPER LEFT HAND CORNER OF
PAD WITH CAMERA CROSS HAIR.
HIT PAUSE WHEN ALIGNED.
JOYSTICK IS ENABLED
"PAUSE" WHEN ALIGNED
"CAMR" TO TOGGLE DISPLAY
"ENTER" TO ABORT
PROBER
TRAIN PM PAD LOCATIONS
TRAINING PAD #1
JOYSTICK:
CONTROLS GUARD BAND BOX.
MOVE BOX:
CW OR MIDDLE HANDLE POSITION.
GROW BOX:
CCW HANDLE POSITION.
JOYSTICK CONTROLS X, Y MOVES.
BUTTON SPEEDS UP MOVEMENT.
ALIGN GUARD BOX WITHIN PAD.
PRESS "PAUSE" WHEN ALIGNED.
"CAMR" TO TOGGLE DISPLAY
"ENTER" TO ABORT
ALIGN GUARD
BOX CONTROL

FROM LINE 04 – TRAIN PAD LOCATIONS

TRAIN PROBE MARK PAD LOCATION SCREENS (continued)

REFERENCE:Section 12.7.3

(ONE PAD TRAINED – ADDING NEW PADS)

PROBER

```
PROBE MARK INSPECTION MENU
01  VERIFY PROBE TO CAMERA OFFSET
02  SPECIFICATIONS
03  LIGHT CALIBRATION
04  TRAIN PAD LOCATIONS
05  MANUAL INSPECTION
06  RETRAIN FIRST PAD LOCATION
07  REVIEW INSPECTION SUMMARY
08  RESET INSPECTION SUMMARY
09  DELETE ALL TRAINED PADS
10  DIAGNOSTIC MENU
LINE =
```

PROBER

```
TRAIN PM PAD LOCATIONS
PAD:       NOW LOCATED AT PAD #1
           PAD IS TRAINED.
           MAX PAD #100
MOVE:      "F3" SELECTS ANY PAD #
           "F1" TO PREVIOUS PAD #
           "F2" TO NEXT PAD #
           "1" TOGGLES ZOOM LENS
JOYSTICK TO NEXT UNTRAINED PAD
TRAIN:     "PAUSE" EDITS PAD #1
           "F5" TO DELETE RANGE
INSPECT:   "F6" FOR PAD # RANGE
DISPLAY:   "CAMR" TOGGLES DISPLAY
EXIT:      "ENTER"
```

PROBER

```
TRAIN PM PAD LOCATIONS
PAD:      LAST VISITED PAD #1
          MAX PAD #100
          CHOOSE ANY UNTRAINED PAD
MOVE:     "F3" SELECTS ANY PAD #
          "F1" TO PREVIOUS PAD
          "F2" TO NEXT PAD
          "1" TOGGLES ZOOM LENS
JOYSTICK TO NEXT UNTRAINED PAD
TRAIN:    "PAUSE" ADDS PAD #32
          "F4" INSERTS NEW PAD
          "F5" TO DELETE RANGE
INSPECT:  "F6" FOR PAD # RANGE
DISPLAY:  "CAMR" TOGGLES DISPLAY
EXIT:     "ENTER"
```

– ADD NEW PAD MODE

PROBER

```
TRAIN PM PAD LOCATIONS

INSERT

PAD:   LAST VISTED PAD #1
       PAD IS UNTRAINED
       MAX PAD #100

ENTER PAD # TO INSERT:
PAD #: __

PRESS "ENTER" TO ABORT INSERT
```

– INSERTING A PAD

PROBER

```
TRAIN PM PAD LOCATIONS
PAD:       NOW LOCATED AT PAD #21
           PAD IS TRAINED.
           MAX PAD #100
MOVE:      "F3" SELECTS ANY PAD #
           "F1" TO PREVIOUS PAD
           "F2" TO NEXT PAD
           "1" TOGGLES ZOOM LENS
JOYSTICK TO NEXT UNTRAINED PAD
TRAIN:     "PAUSE" EDITS PAD #21
           "F5" TO DELETE RANGE
INSPECT:   "F6" FOR PAD # RANGE
DISPLAY:   "CAMR" TOGGLES DISPLAY
EXIT:      "ENTER"
```

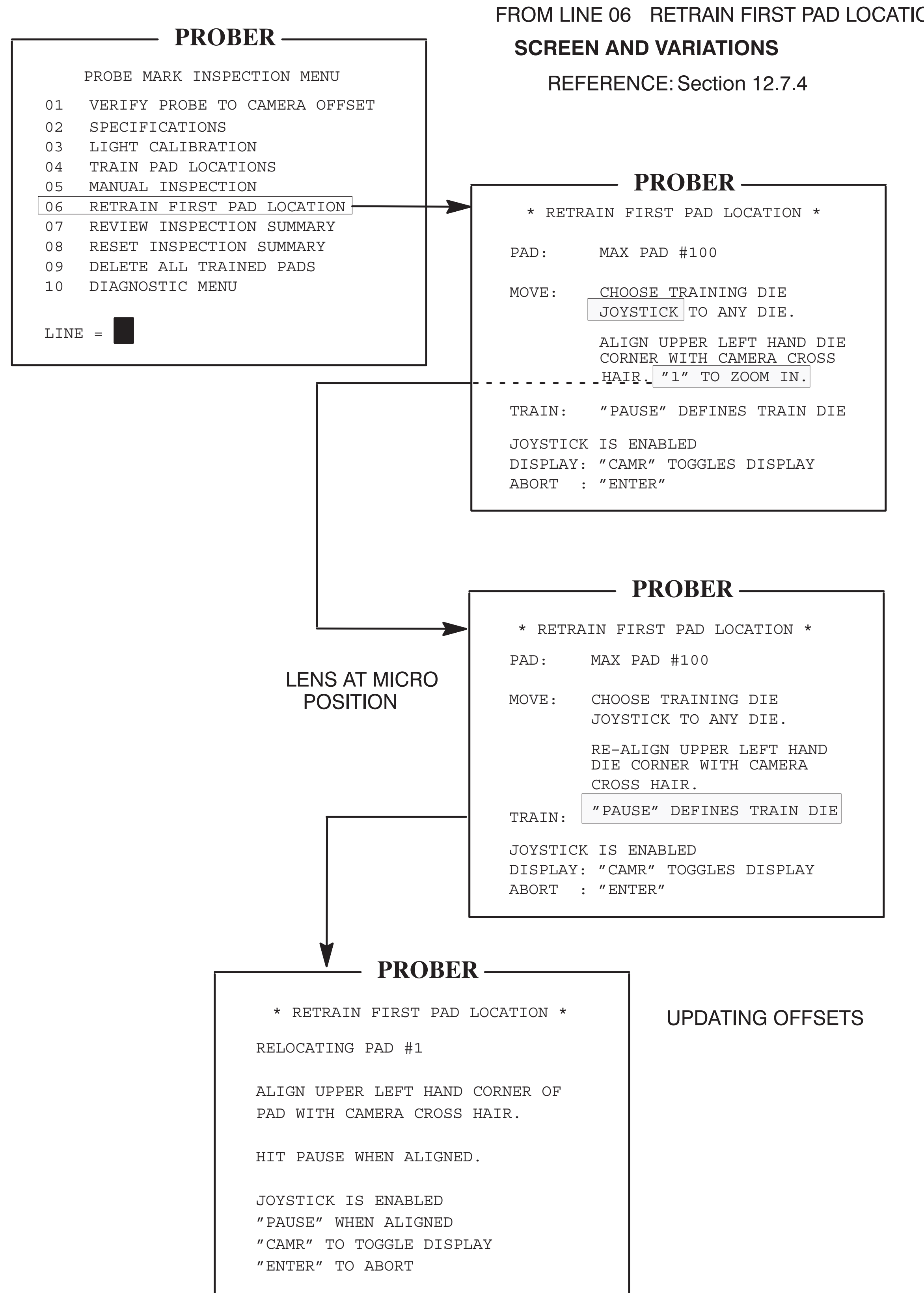
– FULL EDITING SCREEN

PROBER

```
TRAIN PM PAD LOCATIONS

PAD:      NOW LOCATED AT PAD #21
          PAD IS UNTRAINED
          MAX PAD #100

MOVE:     SELECT PAD # TO MOVE TO
          ENTER PAD # = __

ABORT:    "ENTER"
```

– SELECTING A PARTICULAR PAD NUMBER

CONTINUED

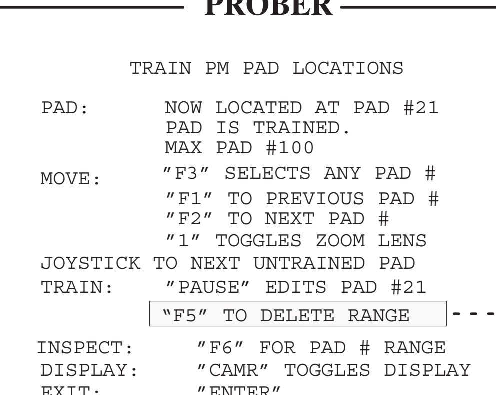

FROM LINE 06 RETRAIN FIRST PAD LOCATION
SCREEN AND VARIATIONS
REFERENCE: Section 12.7.4
PROBER
PROBE MARK INSPECTION MENU
01 VERIFY PROBE TO CAMERA OFFSET
02 SPECIFICATIONS
03 LIGHT CALIBRATION
04 TRAIN PAD LOCATIONS
05 MANUAL INSPECTION
06 RETRAIN FIRST PAD LOCATION
07 REVIEW INSPECTION SUMMARY
08 RESET INSPECTION SUMMARY
09 DELETE ALL TRAINED PADS
10 DIAGNOSTIC MENU
LINE =
PROBER
* RETRAIN FIRST PAD LOCATION *
PAD: MAX PAD #100
MOVE: CHOOSE TRAINING DIE
JOYSTICK TO ANY DIE.
ALIGN UPPER LEFT HAND DIE
CORNER WITH CAMERA CROSS
HAIR. "1" TO ZOOM IN.
TRAIN: "PAUSE" DEFINES TRAIN DIE
JOYSTICK IS ENABLED
DISPLAY: "CAMR" TOGGLES DISPLAY
ABORT : "ENTER"
LENS AT MICRO POSITION
PROBER
* RETRAIN FIRST PAD LOCATION *
PAD: MAX PAD #100
MOVE: CHOOSE TRAINING DIE
JOYSTICK TO ANY DIE.
RE-ALIGN UPPER LEFT HAND
DIE CORNER WITH CAMERA
CROSS HAIR.
TRAIN: "PAUSE" DEFINES TRAIN DIE
JOYSTICK IS ENABLED
DISPLAY: "CAMR" TOGGLES DISPLAY
ABORT : "ENTER"
PROBER
* RETRAIN FIRST PAD LOCATION *
RELOCATING PAD #1
ALIGN UPPER LEFT HAND CORNER OF
PAD WITH CAMERA CROSS HAIR.
HIT PAUSE WHEN ALIGNED.
JOYSTICK IS ENABLED
"PAUSE" WHEN ALIGNED
"CAMR" TO TOGGLE DISPLAY
"ENTER" TO ABORT
UPDATING OFFSETS

FROM LINE 04 – TRAIN PAD LOCATIONS

TRAIN PROBE MARK PAD LOCATION SCREENS

REFERENCE: Section 12.7.5

(DELETE)



– FULL EDITING SCREEN

```
PROBER

**** TRAIN PM PAD LOCATIONS ****

DELETE

MAXIMUM PAD #100

ENTER DELETION RANGE:
  BEGINNING PAD #: 1
  ENDING    PAD #: __

PRESS ENTER FOR SINGLE PAD
```

DELETE MODE
(after prompt for ending pad number)

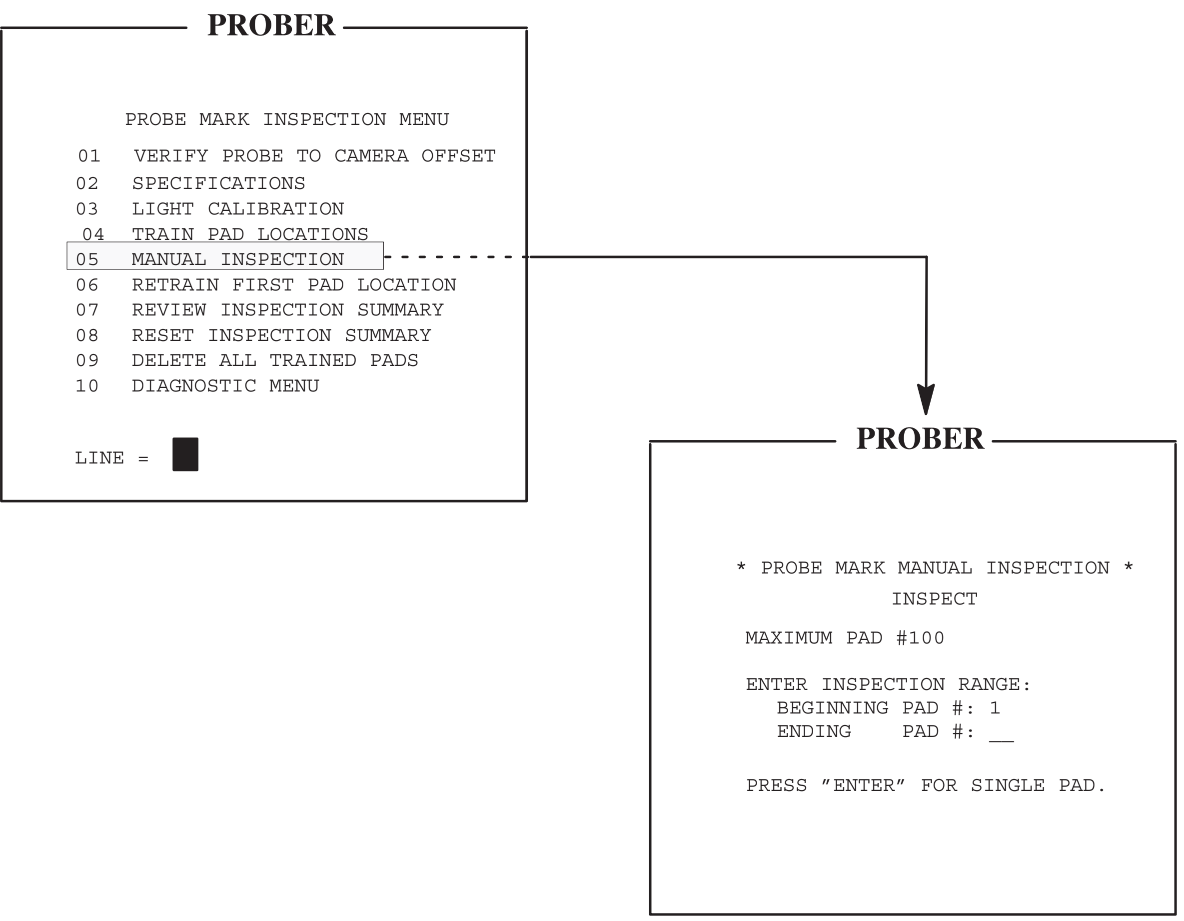
```
PROBER

PROBE MARK INSPECTION MENU

01  VERIFY PROBE TO CAMERA OFFSET
02  SPECIFICATIONS
03  LIGHT CALIBRATION
04  TRAIN PAD LOCATIONS
05  MANUAL INSPECTION
06  RETRAIN FIRST PAD LOCATION
07  REVIEW INSPECTION SUMMARY
08  RESET INSPECTION SUMMARY
09  DELETE ALL TRAINED PADS
10  DIAGNOSTIC MENU

LINE = █
```

DELETES ALL TRAINED PADS

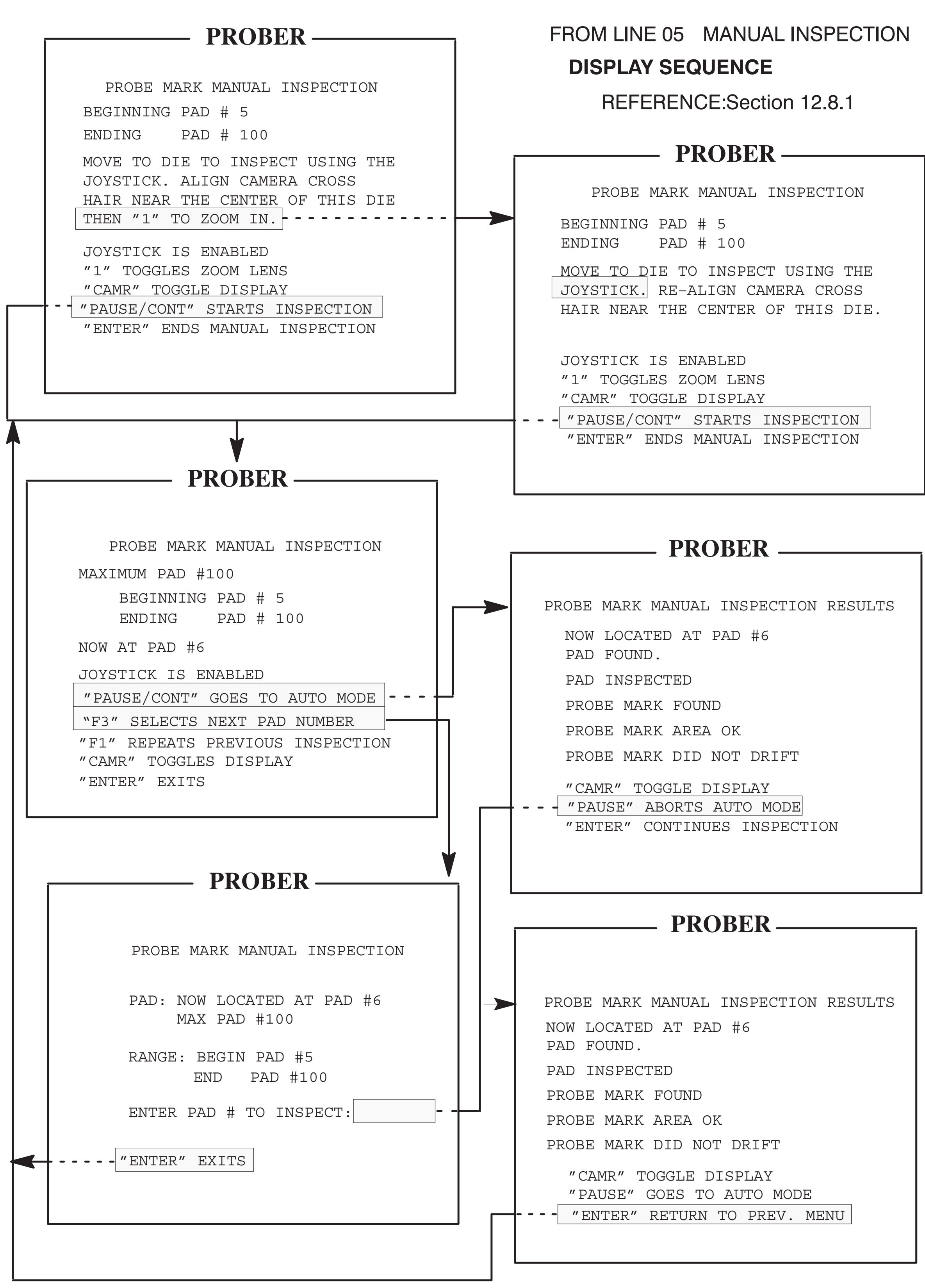
FROM LINE 05 – MANUAL INSPECTION

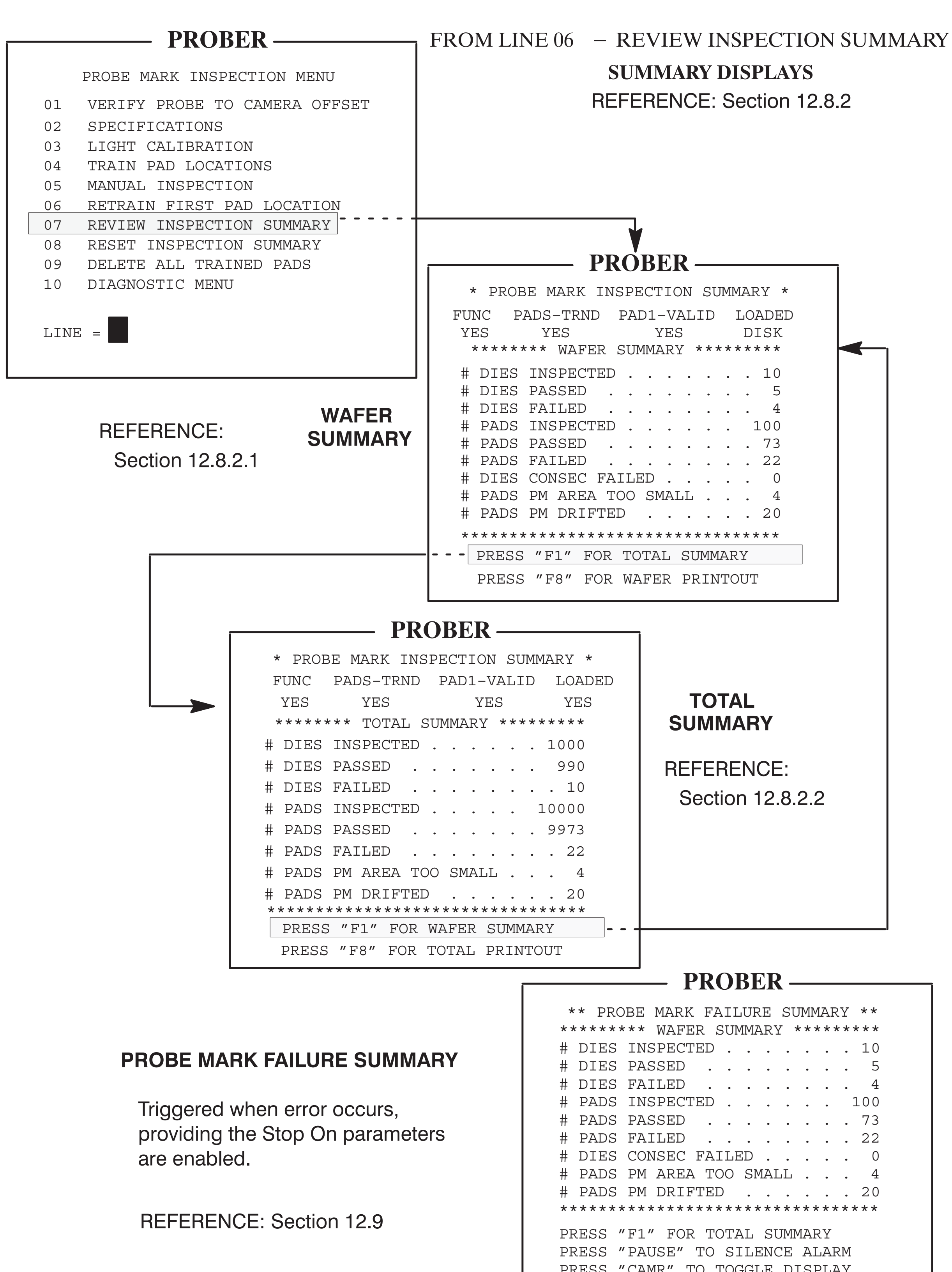
MANUAL INSPECTION SCREENS

REFERENCE: Section 12.8.1



(after prompt for ending pad number)


PROBER
PROBE MARK MANUAL INSPECTION
BEGINNING PAD # 5
ENDING PAD # 100
MOVE TO DIE TO INSPECT USING THE
JOYSTICK. ALIGN CAMERA CROSS
HAIR NEAR THE CENTER OF THIS DIE
THEN "1" TO ZOOM IN.
JOYSTICK IS ENABLED
"1" TOGGLES ZOOM LENS
"CAMR" TOGGLE DISPLAY
"PAUSE/CONT" STARTS INSPECTION
"ENTER" ENDS MANUAL INSPECTION
FROM LINE 05 MANUAL INSPECTION
DISPLAY SEQUENCE
REFERENCE:Section 12.8.1
PROBER
PROBE MARK MANUAL INSPECTION
BEGINNING PAD # 5
ENDING PAD # 100
MOVE TO DIE TO INSPECT USING THE
JOYSTICK. RE-ALIGN CAMERA CROSS
HAIR NEAR THE CENTER OF THIS DIE.
JOYSTICK IS ENABLED
"1" TOGGLES ZOOM LENS
"CAMR" TOGGLE DISPLAY
"PAUSE/CONT" STARTS INSPECTION
"ENTER" ENDS MANUAL INSPECTION
PROBER
PROBE MARK MANUAL INSPECTION
MAXIMUM PAD #100
BEGINNING PAD # 5
ENDING PAD # 100
NOW AT PAD #6
JOYSTICK IS ENABLED
"PAUSE/CONT" GOES TO AUTO MODE
"F3" SELECTS NEXT PAD NUMBER
"F1" REPEATS PREVIOUS INSPECTION
"CAMR" TOGGLES DISPLAY
"ENTER" EXITS
PROBER
PROBE MARK MANUAL INSPECTION RESULTS
NOW LOCATED AT PAD #6
PAD FOUND.
PAD INSPECTED
PROBE MARK FOUND
PROBE MARK AREA OK
PROBE MARK DID NOT DRIFT
"CAMR" TOGGLE DISPLAY
"PAUSE" ABORTS AUTO MODE
"ENTER" CONTINUES INSPECTION
PROBER
PROBE MARK MANUAL INSPECTION
PAD: NOW LOCATED AT PAD #6
MAX PAD #100
RANGE: BEGIN PAD #5
END PAD #100
ENTER PAD # TO INSPECT:
"ENTER" EXITS
PROBER
PROBE MARK MANUAL INSPECTION RESULTS
NOW LOCATED AT PAD #6
PAD FOUND.
PAD INSPECTED
PROBE MARK FOUND
PROBE MARK AREA OK
PROBE MARK DID NOT DRIFT
"CAMR" TOGGLE DISPLAY
"PAUSE" GOES TO AUTO MODE
"ENTER" RETURN TO PREV. MENU



PROBE MARK FAILURE SUMMARY

Triggered when error occurs, providing the Stop On parameters are enabled.

REFERENCE: Section 12.9

FROM LINE 10 DIAGNOSTIC MENU

DIAGNOSTIC MENU AND FILTER SCREEN VARIATIONS

REFERENCE: Section 12.8.3

PROBER

```
PROBE MARK INSPECTION MENU

01  VERIFY PROBE TO CAMERA OFFSET
02  SPECIFICATIONS
03  LIGHT CALIBRATION
04  TRAIN PAD LOCATIONS
05  MANUAL INSPECTION
06  RETRAIN FIRST PAD LOCATION
07  REVIEW INSPECTION SUMMARY
08  RESET INSPECTION SUMMARY
09  DELETE ALL TRAINED PADS
10  DIAGNOSTIC MENU

LINE =
```

PROBER

```
**** PROBE MARK DIAGNOSTICS ****

VISION MODULE SOFTWARE REV . .d

01 SET INSPECTION MODE . .  SPEC
02 TOTAL RESET PAD TRAINING
03 SET CAMERA GAIN . . . . .  28
04 SET CAMERA OFFSET . . . .  12
05 VIEW CAMERA IMAGE
06 DISPLAY STATUS MSGS . . . ENB

*****************

LINE =
```

PROBER

```
**** PROBE MARK FILTER MENU ****

BACKGROUND FILTER RANGE:
         NONE = 0
      MAXIMUM = 5

HIGHER FILTER NUMBERS IMPROVE
RELIABILITY BUT CAUSE LONGER
INSPECTION TIMES.

CURRENT FILTER = 0

ENTER NEW INSPECTION FILTER
FILTER =
```

PROBER

```
**** PROBE MARK FILTER MENU ****

PIXEL ON THRESHOLD  : 20
PIXEL OFF THRESHOLD : 45

RANGE 0 - 63, 0 IS THE BRIGHTEST

ENTER NEW PIXEL ON THRESHOLD = __

PIXEL ON ( 0 - 63 ) = __
```

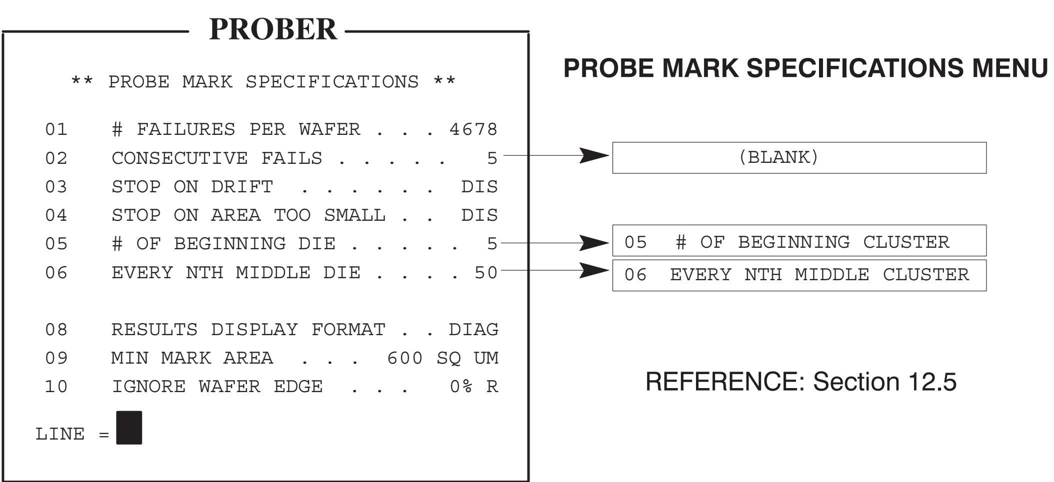
PROBER

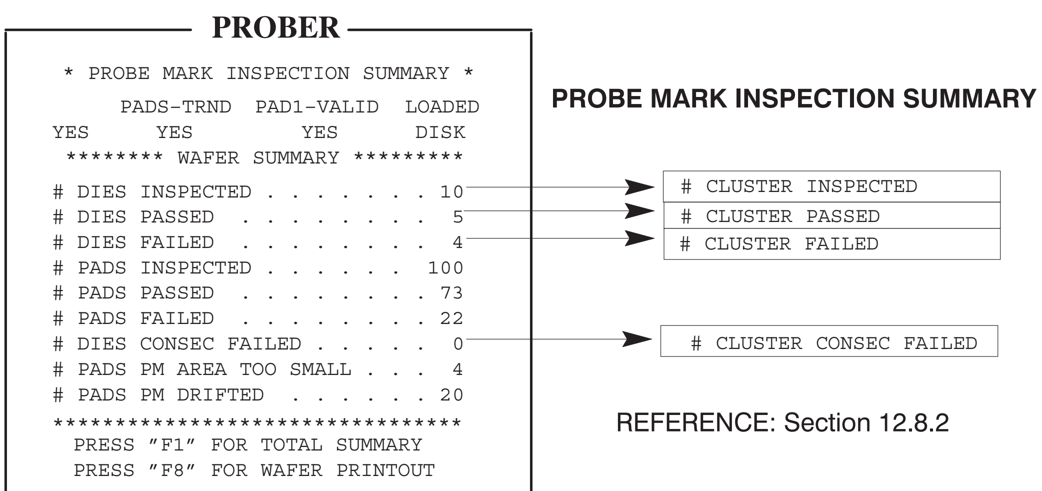
```
**** PROBE MARK FILTER MENU ****

PIXEL ON THRESHOLD  : 20
PIXEL OFF THRESHOLD : 45

RANGE 0 - 63, 0 IS THE BRIGHTEST

ENTER NEW PIXEL OFF THRESHOLD = __

PIXEL OFF ( 0 - 63 ) = __
```

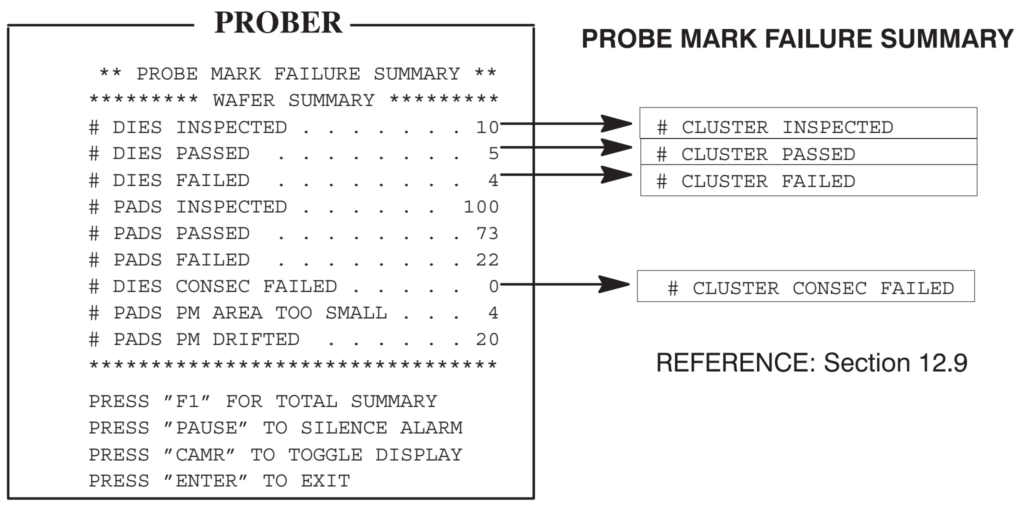
PROBER

```
**** PROBE MARK FILTER MENU ****

INSPECT AGO MODE: FIRST PAD ONLY

FIRST PAD ONLY DOES AUTO GAIN
AND OFFSET ON THE FIRST PAD
INSPECTED AND THEN USES THE SAME
VALUES ON ALL REMAINING PADS.

EVERY PAD USES AUTO GAIN AND
OFFSET ON EVERY PAD INSPECTED.
FIRST PAD = 1, EVERY PAD = 2

MODE ( 1 - 2 ) =
```

MULTI−DIE PROBING SCREEN VARIATIONS







12.12 SUMMARY

In this section, you have learned:

- The prerequisites required before beginning performing automatic PMI
- How to enable PMI
- Verifying probe to camera offset procedures
- How to enter PMI specifications and inspection parameters
- Lighting calibration procedures
- How to train pad locations, including retraining the first pad location
- How to perform manual inspections
- How to read inspection summaries
- How to perform PMI diagnostics
- Information on Probe Mark Inspection error handling and failure summaries
- How to store PMI information on a disk

SECTION 13
OCR / BACK SIDE BAR CODE READER

13.1 OVERVIEW

The OCR (Optical Character Reader) identifies wafers by reading symbols or characters on the wafer's flat or crown. This information is transmitted to the prober where it is converted into ASCII data and retained in memory as the wafer ID number.

Once the required settings have been made for a set (lot) of wafers, assuming the reader is properly aligned, operation is automatic, a matter of enabling and disabling the function. If the reader is enabled, the ID number of the current wafer appears on the Run Time Display.

ID data is deliberately erased when a wafer is unloaded, when the prober is reset or powered up, when the reader is enabled or disabled, and when a read error occurs. This assures that the ID data sent to the host/tester matches the wafer on the chuck.

Two types of readers are available. The OCR reads alphanumeric character strings laser−etched into wafers as identification. The Back Side Bar Code Reader, a new feature for the 4085X, decodes black and white bars according to their width.

13.1.1 How To Use This Section

This section contains the following information:

- The hardware features of OCR
- How to enable and select OCR modes
- Information on OCR specifications, including fonts and illumination
- OCR prerequisites
- EG/OCR setup and calibration procedures
- Non−EG/OCR setup procedures
- Information on the Statistics Summary Table
- ID Read Fail procedures
- Back Side Bar Code Reader information, including hardware requirements and how to enable it
- A special section that includes a separate OCR Setup Procedure, fielding analysis information and a OCR Sample Report

13.2 OPTICAL CHARACTER READER FEATURES

The Optical Character Reader assembly, illustrated in *Figure 13−1,* applies a CCD camera located in the prealign area of the prober. The camera is adjustable in the X, Y, and Z axes to adapt to different wafer diameters, to different character string locations on the wafer, and to different character dimensions.

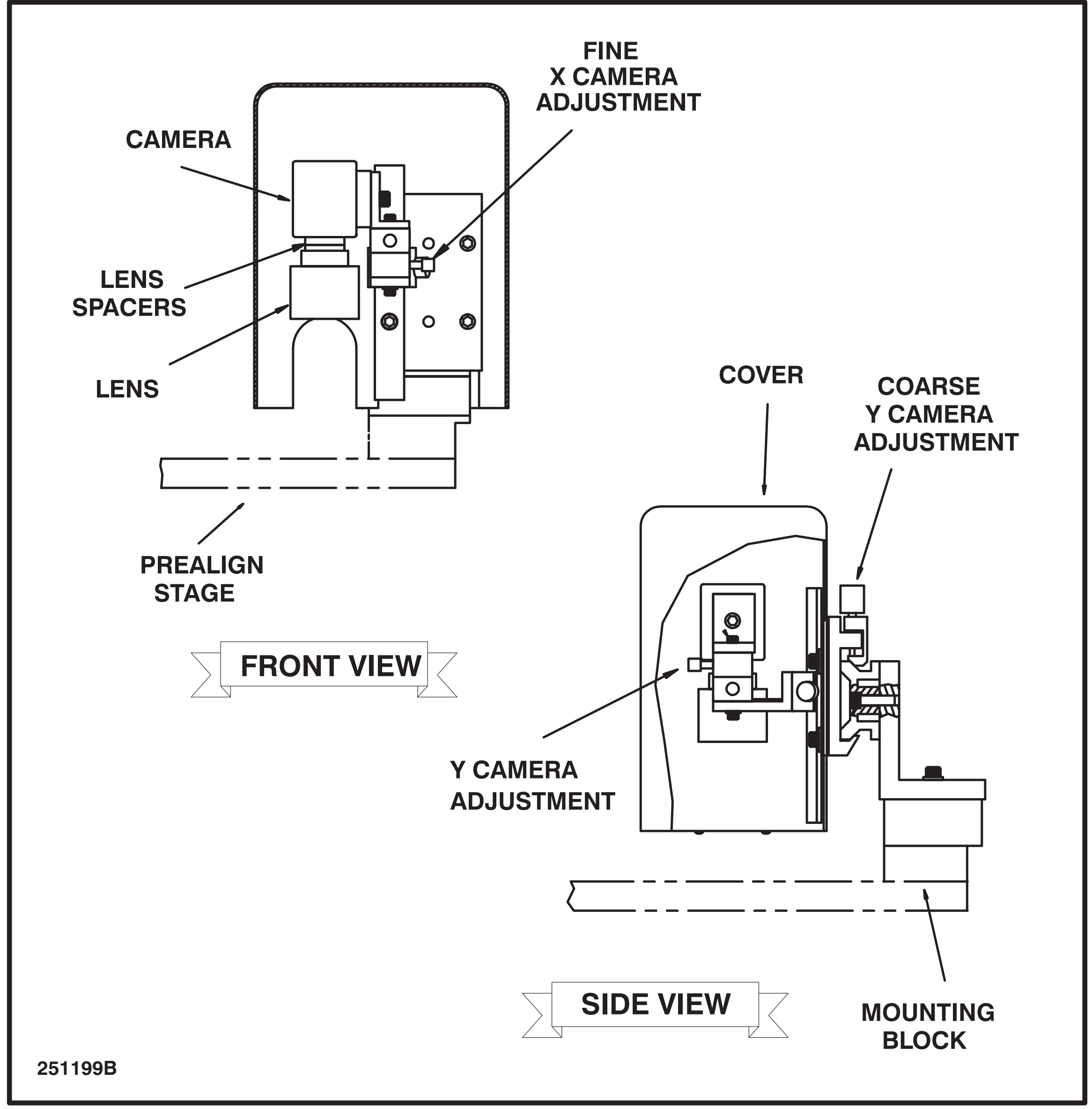


FIGURE 13−1: OCR ASSEMBLY

Two camera lenses are available. To achieve the maximum reading reliability of the character string, the lenses are fitted with adjustable aperture and focus rings. The aperture adjustment may vary the reflected light intensity, while the focus adjustment permits the camera to view sharply focused character images.

The use of lenses and lens spacers is described in **Sections 13.5, EG/OCR Preparation** and **13.5.2.2, Character Size Calibration**.

13.2.1 Manual Entry

An option in the ID Reader setup allows the operator to enter the wafer ID manually if an OCR read fails.

Before probing a wafer, the prober checks to see if the wafer ID is valid. If it is, probing continues as usual. If the ID is not valid, the prober will attempt to get a valid ID from the Handler. If the prober is successful in getting the ID, the wafer is then probed. If it is not, probing is aborted.

An exception is when the ID Recovery Mode is set to Ignore. (This mode is described in **Section 13.12.1**). If the ID is found to be invalid when beginning to probe and `ID RECOVERY MODE` is set to `IGNORE,` the prober will attempt to get the correct ID from the handler, but will probe the wafer, either using the invalid ID or the valid ID if the handler was able to supply one.

Also, when the wafer ID is requested via EXIO, the prober will attempt to update an invalid ID before sending it.

13.2.2 Application

Setup and calibration details for the Electroglas OCR are given in **Section 13.5.1**; the Non−EG OCR is discussed in **Section 13.6**.

The External I/O Interface feature provides for the uploading/downloading of setup data between the prober and the tester or host computer (see **Section 8**).

13.3 ENABLING AND SELECTING MODES

The operation of both the EG/OCR and the non−EG OCR is done from the Handler mode; press the < PROBE/HDLR > key to toggle from the Prober to the Handler. To enable the EG/OCR system, press the < SET MODE > key to access the Handler Set Mode Menu *(Figure 13−2)*. The two ID Reader settings are:

HANDLER

```
HANDLER SET MODE MENU

01  ID READER TYPE . . . .  OCR
02  PREALIGN TO  . . . . . FLAT
03  ALLOW UV INK CURE . . . ENB
04  ID READ FAIL RECOVERY . DIS
```

FIGURE 13−2: HANDLER SET MODE MENU

LINE 01 (ID READER TYPE) – This line enables the EG or external Optical Character Reader (OCR) system, or Back Side Bar Code Reader. The following prompts will appear:

`ID POSITION`: This is the position of the start of the ID field relative to the wafer flat in degrees (clockwise). Generally, this will be “0” (zero).

`ID READER RETRIES`: If an OCR ID read is not registered within 20 seconds, a retry will be done based on the parameter set by the operator. This is the number of attempts the system will make to read the ID in addition to the original attempt. For example, a value of “2” will result in the system attempting to read the ID up to three times.

Once the OCR is enabled, these values can be reset directly through the Handler Set Parameter Menu.

LINE 04 ID READ FAIL RECOVERY – Enables/disables the option for handling wafer ID read failures. This feature is explained in **Section 13.12.1, ID Fail Recovery Mode**.

If you attempt to disable the option during a read, a message will ask, `PLEASE WAIT, ID READ IN PROGRESS.` The OCR will complete the read in progress before disabling the option.

13.4 OCR SPECIFICATIONS

13.4.1 Fonts

For optimum performance of the system, it is *essential* that wafer markings use the SEMI character font, and adhere to SEMI specifications, except for characters requiring special software. Many of the SEMI specifications are included in the information given in this Section and in **Table 13–1 (Alphanumeric Marking Specifications)**. Especially important criteria include these items:

- A clear zone immediately beneath and around the wafer ID number should be a minimum of 20 mils (.5 mm). It should be of consistent reflectivity, free of scratches, blemishes, process and lithography overlay. Edge bead removal lines through the characters will degrade the read rate.

- To ensure OCR reliability, the marks should be inspected under a microscope to verify their legibility. Check the area of the marking and the clear zone for surface quality, especially scratches, blemishes, and the amount of silicon debris caused by the laser.

  The laser power determines the depth of the wafer marking. Deeper character marking causes more debris than shallow marking and should be avoided if possible. (The specified character depth is 0.0004 inch).

  In *Figure 13–3*, the “hardmark” and “softmark” scribe methods illustrate the debris condition in relation to the depth and impact of the character etching. “Debris” in this context refers to microscopic silicon particles which are dislodged from the crater wall and bottom by laser action and fall on the wafer surface. Due to the high temperature of the particles at impact, they melt to the passivation layer of the wafer and cannot be removed.

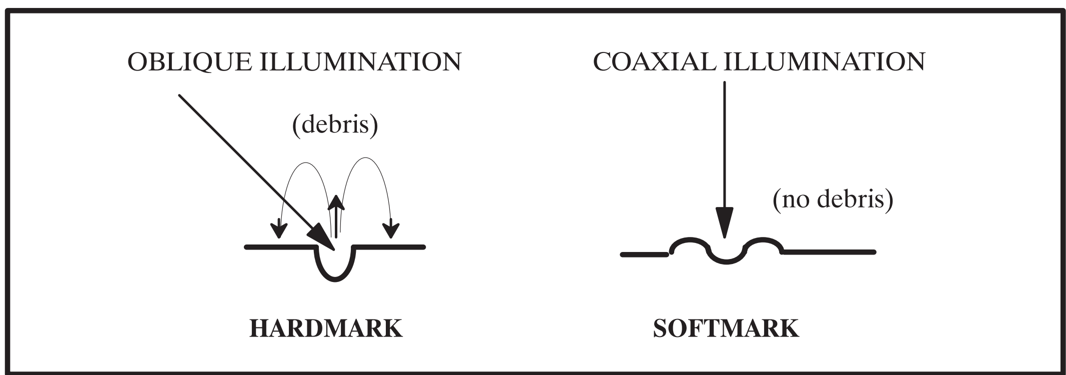


FIGURE 13−3: DIAGRAM OF SCRIBE METHODS AND ILLUMINATION TYPES

13.4.2 Illumination

Two types of illumination are available on OCR assemblies − oblique and coaxial, as illustrated with the diagram of two types of fonts in *Figure 13−3*.

Oblique lighting is recommended for wafers marked with character etch depths of at least .0004 inch, illustrated as the "hardmark" method. This type of illumination enhances the contrast of these character marks on polished silicon so that *white* characters appear on a *black* background.

Coaxial illumination is used when the wafer marks are not deep enough to reflect oblique light rays, identified here as "softmark." The contrast of these character marks on polished silicon is enhanced so that *black* characters appear on a *white* background. Depending on the depth of the laser marks, the setup may be selected to achieve either contrast enhancement or background defect rejection.

Automatic OCR lighting works with either the dual LED OCR illuminator 253001−001, or the coaxial tube OCR illuminator 248438−001. (It is not to be used with the original florescent ring illuminator since it can provide only on and off, not a range of light as the coaxial tube illuminator does; nor can it be used with a fiber optic bar light).

The dual LED OCR illuminator 253001−001 consists of two LED lights, identified in the following diagram (**Table 13−1**):

TABLE 13−1: OCR LED ILLUMINATORS

Position	Name	Illumination	Character color	Good for
Bottom	Main	Bright Field	Black	Hard Mark
Top	Auxiliary	Oblique Dark field	White	Soft Mark

An original tube coaxial illuminator 248438−001 is connected as a **main** light. **Table 13−2** shows the light settling times for these two illuminators:

TABLE 13−2: OCR ILLUMINATOR SETTING TIMES		
Illuminator	**Light Settling time for each internal light intensity change**	**Total Auto Light Time**
253001−001 LED	50 msecs.	about 1 second
248438−001 Tube	500 msecs	about 5 seconds

The vision software can automatically select its light settling time according to the following sequence (illustrated in *Figure 13−4*):

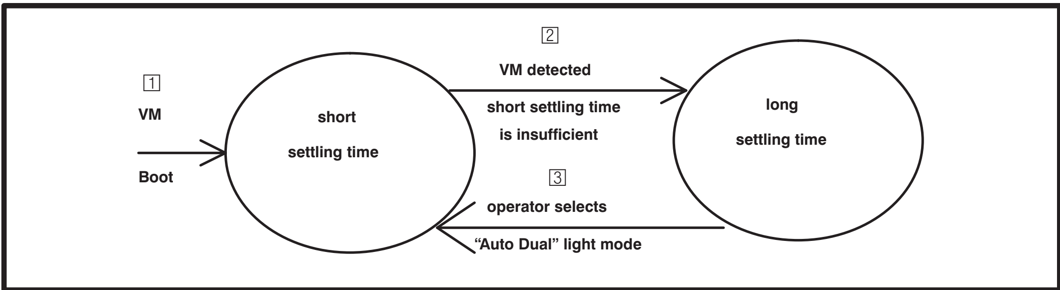


FIGURE 13−4: MANIPULATION OF LIGHT SETTLING TIME

1. The Vision Module will use the short settling time as the default.
2. The Vision Module switches to use the long settling time as soon as it detects that the short settling time is insufficient during auto light.
3. The operator can force it to use short settling time by selecting AUTO DUAL light in the Light Calibration Menu, and selecting the actual light mode such as AUTO MAIN. These modes are described in **Section 13.5.1.9, Light Control Mode**.

13.5 PREREQUISITES

Before OCR setup and calibration procedures are performed, it is important to establish all parameters. Many of them are included in **Table 13−3** (**Alphanumeric Marking Specifications per SEMI M12.89**). All of them are listed in greater detail on the Electroglas OCR Evaluation (Test) Report, Page 1, found in the **OCR Special Reference Section**, located after the Summary.

It is especially important to establish the character height in order to select the correct lens from the two available. The standard lens is a 25 mm 1.4 lens, for character heights of 32 to 68 mils. Any character height of more than 68 mils requires the use of a 16 mm 1.4 lens.

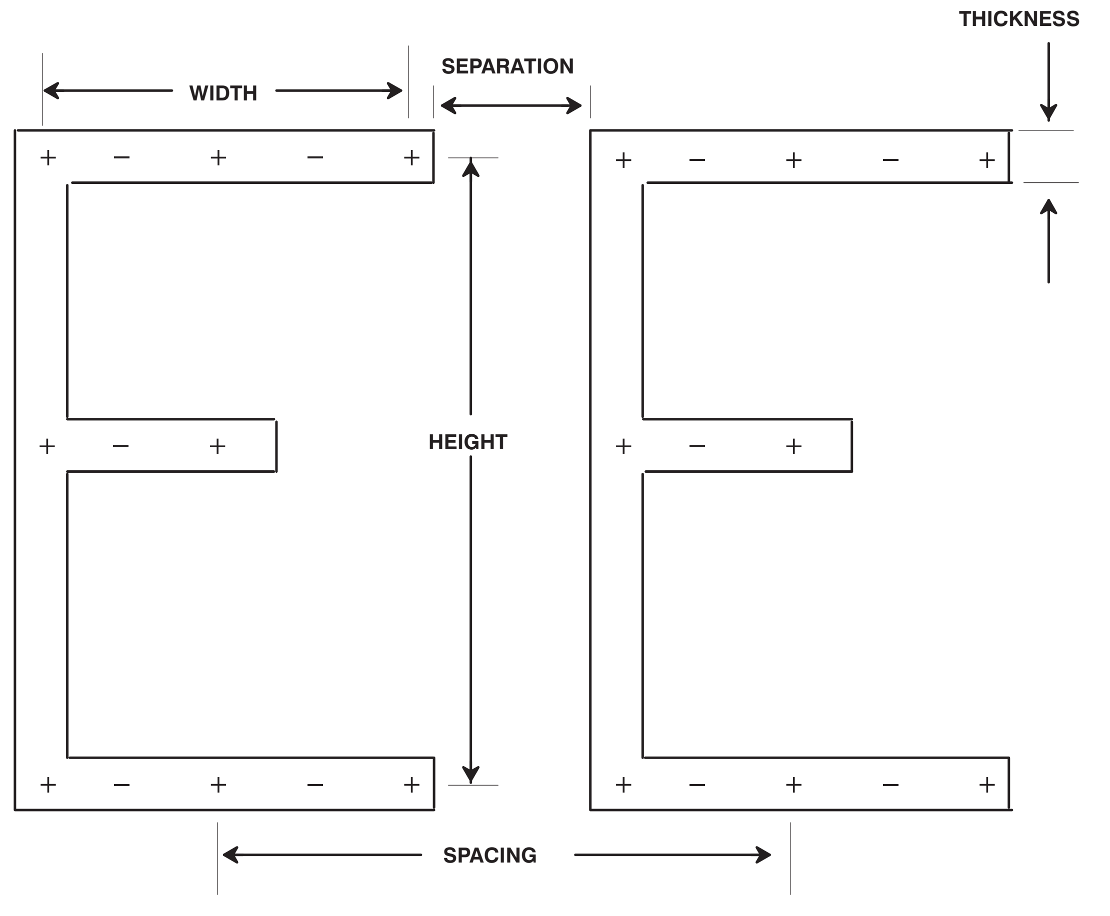
If necessary, character height can be determined either by machine manipulation or by use of the microscope. By machine:

1. Enable Auto Align.
2. Press the < FIND TARG > key. Move the character string under the camera.
3. Set X and Y to < 1 > (through the prober Set Parameter Menu, Lines 01 and 02).
4. Press the < FIRST > key, and use the joystick to scan one character for height and width.
5. Read the X or Y travel (character size) on the Run Time Display.

The same general procedure can be followed to determine the character thickness and separation parameters.

TABLE 13−3:
ALPHANUMERIC MARKING SPECIFICATIONS per SEMI M12.89

Character Height	64 mils (1.624 mm)	
Aspect Ratio	2:1 (centerline height to centerline width)	
Character Stroke Thickness	8 mils (0.2 mm)	
Character Width	32 mils (0.812 mm) centerline to centerline	
Number of Characters	12 min., 16 max., plus 2 checksum. If no checksum is used, 16. Digits−only will read faster. Use of the characters "B" and "N" is not recommended.	
Angle of character string to wafer flat	3 degrees maximum	
Clear Zone around characters	20 mils (0.5 mm) min	
Spacing between characters	57 mils (1.42 mm). No open space (dash ok).	
Dimensional Tolerances of Characters	Line Thickness:	+0.2/0.6 mils (+0.05/−0.15 mm)
	Height: Width: Spacing:	+/− 1 mil (+/− 0.25 mm)



13.6 SETUP

Once the OCR standard setup has been performed, it is possible to read and adjust the optical character reader while the wafer is in the prealign station. All parameters can be set through the Handler Set Parameter Menu. Thereafter, when a new wafer is loaded into the prealigner, the OCR offset angle is added so adjustments can be made while the preceding wafer is probing. (The setup procedure in the format of action steps is given in an application at the back of this section.)

Setup of the Electroglas OCR system is done through the EG/OCR Setup Menu *(Figure 13−5)*. From the Handler mode, press the < DIAG > key to access the Maintenance Menu; select Line 10. If EG/OCR has been enabled through the Handler Set Mode Menu, the EG/OCR Setup Menu will appear.

```
                  PROBER
              EG/OCR SETUP                    (ALTERNATE SETTINGS)
   1  FONT TYPE .............. SEMI           SPECIAL
   2  CHAR COLOR ............ BLACK           WHITE
   3  CHECKSUM ................ DIS           SEMI, EG, SPECIAL
   4  MAX ID LENGTH ............ 32
   5  ID FIELD .............NORMAL            INVERTED
   6  FIELDING ................ DIS
   7  ID POSITION ............... 0
   8  CALIBRATION ........ LIGHTING           SIZE, SPACING, OR
   9  LIGHT CONTROL MODE ......SEMI               WINDOW
  10  READ MODE..........AGGRESSIVE
  11  DISPLAY TIME.............MIN
  12  FILTER SIZE.................1

  LINE=
      "DIG VID" TOGGLES DISPLAY
```

FIGURE 13−5: EG/OCR SETUP MENU

When the EG/OCR Setup Menu is accessed, if a wafer is available, it will be retrieved and rotated into position so the ID field is underneath the camera.

If no wafer is present on the prealign stage, the message PLEASE MAKE A WAFER AVAILABLE AT THE INPUT STATION appears on the screen. If an unprobed wafer is available, you may place a wafer on the prealign stage. Or, the handler will retrieve a wafer from its cassette and place it on the prealign stage. (If the handler cover is open and the handler is idle, the cover must be removed to gain access to the stage.)

Once a wafer is present on the prealign stage, you will see the message PRESS ENTER TO CONTINUE. At this point, the wafer can be repositioned. Press the < ENTER > key to prealign and rotate the wafer into position so the ID field is underneath the camera.

With the EG/OCR Setup Menu on display, review and correct the settings, if necessary. As the recurring prompt indicates, the < DIG VID > key toggles between the setup screen and the OCR camera image.

No communication with the Vision Module is necessary at the time of uploading the OCR setup; the prober (and handler) OCR setup record should already reflect the current setup in the Vision Module. After loading the OCR setup data from disk, the prober or handler sends the setup (including the new items) to the Vision Module.

LINE 1 FONT TYPE

Select font type which will be either SEMI standard or one specifically defined by the customer. Any non−SEMI font requires a special software set to be installed in the EG/OCR vision system. (This must be created by EG.)

LINE 2 CHAR COLOR

Define the ID character color. Depending on lighting conditions and wafer processing, the color of the ID characters may appear to be either black or white. Oblique lighting produces white characters, coaxial, black.

LINE 3 CHECKSUM

Choose the checksum algorithm of the ID string. Valid algorithms are `DIS`, `SEMI`, `EG`, or `SPECIAL`. If `DIS` is selected, no checksum will be performed on the ID string. If `SPECIAL` is chosen, a customer−supplied checksum algorithm will be applied. The checksum option is discussed in **Section 13.8.3.**

LINE 4 MAX ID LENGTH

Enter the maximum number of characters in the ID string. This value is used to approximate the initial read window size and to determine the default number of characters in the spacing calibration procedure. The length of a returned ID string will be equal to the character length defined in this line.

LINE 5 ID FIELD

Identify the ID field orientation. If the characters appear upside down, select `INVERTED`; otherwise, select `NORMAL`.

LINE 6 FIELDING

Enable or disable fielding. If disabled, all valid characters will be accepted for each ID character location. If enabled, character acceptance for each character location may be edited (see **Section 13.5.4, Fielding Screen**).

LINE 7 ID POSITION

Fine−position the ID field underneath the OCR camera using the < BS > (Backspace) and < • > keys. The < BS > key rotates the wafer counter−clockwise while the < • > key rotates the wafer clockwise. The display indicates the position, in degrees clockwise, of the ID field relative to the prealigned flat. The initial position may be set through the handler Set Mode Menu, Line 01 (`ID READER TYPE`), ID Position prompt.

LINE 8 CALIBRATION − Select Line 8 to adjust any of the four functions. The options available are described in **Section 13.5.2**.

NOTE

The following four lines are temporarily overwritten when the operator selects some of the other EG/OCR Setup parameters which require several lines for input (for example, Calibration on Line 8), but they will reappear after the operator has completed input to the selected item.

LINE 9 LIGHT CONTROL MODE

Four modes of OCR lamp intensity calibration are available:

Manual
Automatic − Dual (both lamps)
Automatic − Main Lamp (default)
Automatic − Auxiliary Lamp

In the manual mode, no change in lamp intensities takes place when the Vision Module performs an OCR read (the values set up in Line 8, the Calibration − Lighting function, are used). In the auto modes, light calibration will be done on either one or both lamps as part of any requested ID (OCR) read and size calibration.

When the operator selects Line 9 of the EG/OCR Setup Menu, (`LIGHT CONTROL MODE`), the following prompt will be displayed:

```
0=MANUAL,        1=AUTO DUAL,
2=AUTO MAIN,     3=AUTO AUXILIARY
```

After the desired Light Control Mode is selected, the prober (or Material Handler) will send the mode to the Vision Module.

Manual mode does not change the lamp intensity when the Vision Module performs and OCR is read. It uses the lamp intensity selected by the operator from Line 08, `CALIBRATION (LIGHTING)`, of the EG/OCR Setup Menu.

In the automatic modes, light calibration is done on the specified lamp(s) as part of any requested ID (OCR) read. After the light calibration, the OCR read will be attempted. If successful, the new calibrated intensity values will become the current intensities to be used for the next OCR read; if not, the values previous to the automatic calibration will remain as the current intensities.

Auto Main mode automatically selects the best light intensity by optimizing the connected *main* light. It uses either:

1) the bottom LED of a new dual LED light, or
2) an original coaxial tube coaxial illuminator.

Auto Auxiliary mode automatically selects the best light intensity by optimizing the top LED of a new dual LED light.

Auto Dual mode automatically selects the best from **Auto Main** or **Auto Auxiliary.**

The **Manual** mode will still use the operator–selected character color (Line 2 of the EG/OCR Setup Menu, `CHAR COLOR`). However, the other three auto light modes will automatically determine the character color based on the image.

LINE 10 READ MODE

The Read Mode determines which type of OCR read will be done: conservative (fast) or aggressive (reliable). When Line 10 is selected from the EG/OCR Setup Menu, the following prompt will offer a choice of the two reading strategy modes:

`0=CONSERVATIVE, 1=AGGRESSIVE` (default)

The modes are illustrated in **Table 13–4.**

TABLE 13–4:
OCR READING STRATEGY MODES

MODE	PERFORMANCE		MATCHING METHODS BY SEQUENCE		
	Read rate	Misread rate	Template Matching	Edge Matching	Feature Matching
Aggressive (default)	Higher	Higher	1st	2nd	3rd
Conservative	Lower	Lower	1st	2nd	N/A

OCR uses the following three–step strategy for reading a character:

1) TEMPLATE MATCHING

The OCR first attempts to recognize the character using template matching or grey–scale correlation.

2) EDGE MATCHING

If the template matching correlation score is inconclusive, the OCR attempts to recognize the character using edge matching.

3) FEATURE MATCHING

If the edge matching score is still inconclusive, then, depending on the mode, conservative mode reports a character read fail, while aggressive mode would attempt to read the character using feature–matching. If feature–matching does not yield a conclusive result, then aggressive mode reports a character read fail.

In general, conservative mode will read faster than aggressive mode, generate less false reads (misreads), but yield more reject reads. Aggressive mode is slower, but all Electroglas' tests indicate that the number of successful reads is higher than for conservative mode.

Aggressive mode minimizes reject readings at the cost of marginally increased false reads. **The checksum can almost always guarantee that there is no misread and it is highly recommended by Electroglas to use "Aggressive" mode when checksum is enabled.**

After a value is entered, the prober will update the Vision Module.

LINE 11 DISPLAY TIME

The Display Time determines how long the results (OCR string) will be displayed at the end of an OCR read. This time is currently limited to .5 (minimum), 5 (maximum), and 20 (diagnostics) seconds. When set for 20 seconds, the display will include a 3–line statistics summary table, described in **Section 13.7.**

Select Line 11 from the EG/OCR Setup Menu to display the following prompt:

`0 = MIN, 1 = MAX, 2 = DIAG` (default is `MIN`)

LINE 12 FILTER SIZE

An image filter (morphology opening) can be invoked to improve the image quality of characters composed with unconnected dots. This is accomplished by using a morphology erosion followed by a morphology dilation.

For example, when a structuring element shaped like a disk is used, the opening has an effect of smoothing object contours by eliminating small object "islands" or "dots" without significantly affecting the size or shape of the main object.

The size of filtering determines the diameter of the structuring element, which means the size of filtering specifies the range of filtering. *Figure 13–6* illustrates the results of a morphology opening using a circular structuring element.

The Filter Size determines which size filter is installed on the OCR camera. The sizes are currently limited to 1 (no filter), 3, 5, 7, 9. When you select Line 12 from the EG/OCR Setup menu, the following prompt will be displayed:

`FILTER (1=NONE, 3, 5, 7, 9) =` (default is `NONE`)

Any positive number is allowed (this is to accommodate future Vision Module needs).

Filtering is also applied to the size calibration image. Use the size calibration score to judge the effects of filtering at different filtering sizes.

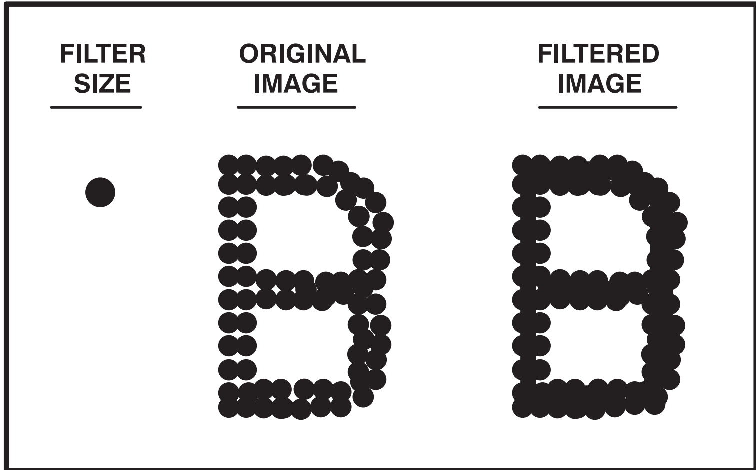


FIGURE 13−6: EFFECTS OF OPENING FILTERING

13.7 CALIBRATION

A software zoom capability in the calibration functions allows for the easier readability of characters in larger sizes and characters with various aspect ratios, which in turn increases the read rate. Also, a flexible "anywhere" window can be accessed. The zoom and flexible window can be invoked by means of key sequences described in appropriate places. From the EG/OCR Setup Menu, select Line 8 to see the four calibration options (*Figure 13−7),* described next.

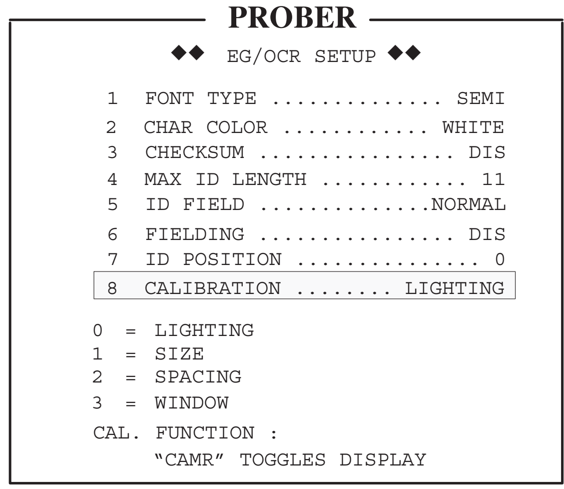


FIGURE 13−7: CALIBRATION SELECTIONS

13.7.1 Lighting Calibration

To set the proper illumination levels for ID reads, access the Light Calibration Screen (*Figure 13−8*); from the EG/OCR Setup Menu, select Line 8 (Calibration), then press < 0 > (LIGHTING). When the settings are selected, the prober updates the current illumination values for both lamps. The illumination values are also updated after each ID (OCR) read while this screen is active.

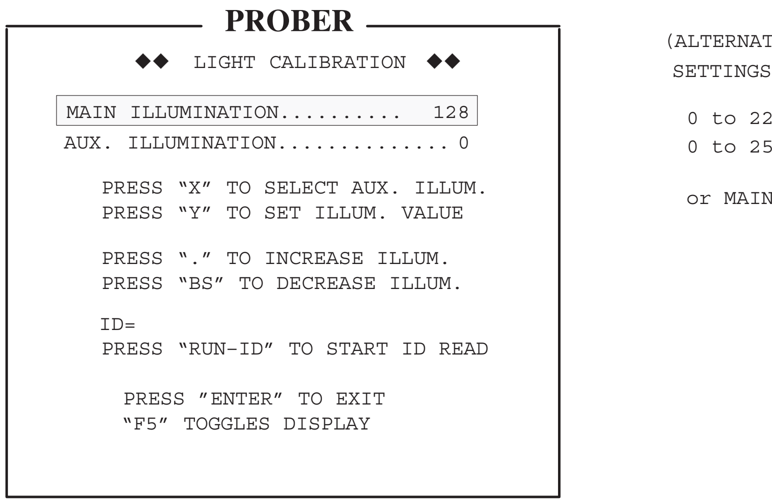


FIGURE 13−8: LIGHT CALIBRATION SCREEN

The default value for the main illuminator is set to mid−range (128) while the auxiliary illuminator default value is set to OFF (0). Each illuminator may have an illumination value of 0 to 255 where 0 is OFF and 255 is the maximum brightness. To specifically set an illumination value, press < X > or < Y > as instructed and enter the number.

To automatically cycle through a range of illumination values, press either < • > or < BS >. If "< • > is pressed, the monitor will switch to the camera display and increment the illumination value from its present setting up to 255. If < BS > is pressed, the monitor will switch to the display and decrement the illumination value down to 0. In either case, pressing any other key will stop the automatic action.

Currently, only the coaxial light source may be varied in intensity in this manner. For oblique illumination, the intensity can be manipulated by adjusting the aperture of the lens. Height adjustments for both illuminators permit a mechanical light intensity adjustment, as opposed to the electrical light intensity adjustment from the keyboard.

NOTE

If a fluorescent illuminator is used, the illumination value must be set at 255.

13.7.2 Character Size Calibration

Sizing is the most time−consuming of all calibration procedures. The objective of size calibration is to find the reduction factor in the X and Y directions. The task is done by a combination of window manipulation by key strokes, in addition to the adjustment of the camera optics to display the ID characters at the proper magnification. *Figure 13−9* illustrates the factors involved in the mechanical adjustment.

The advantages of software zoom are especially notable in size calibration. The image size will be reduced to match the character size to that of SEMI font before reading.

During OCR setup, the scaling factor displayed corresponds to the character selected for size calibration. The goal is a character “scale” of 70−80. Values outside the scale of 100 during setup will result in an error message. The size calibration window image is read using the scaled image and the score is displayed. A graphics window in the left corner will be overlaid with the size calibration image.

Adjust the optics to enlarge the character in order to improve the read rate. The size calibration window should be large enough to enclose the outer background of the character.

When the contrast value or spread of pixels within the size calibration window are low, there is not enough brightness change. This implies a bad selection of light for size calibration.

There are 64 brightness or gray levels in the Vision Module. The contrast is computed as the standard deviation of the gray levels and the minimum allowed contrast setting for size calibration and reading set at 2.5. If the contrast value is low (below 2.5), the following message is displayed:

```
POOR LOW CONTRAST 1.2 ( <= 2.5)
```

The contrast must be increased by the adjustment of light or optics.

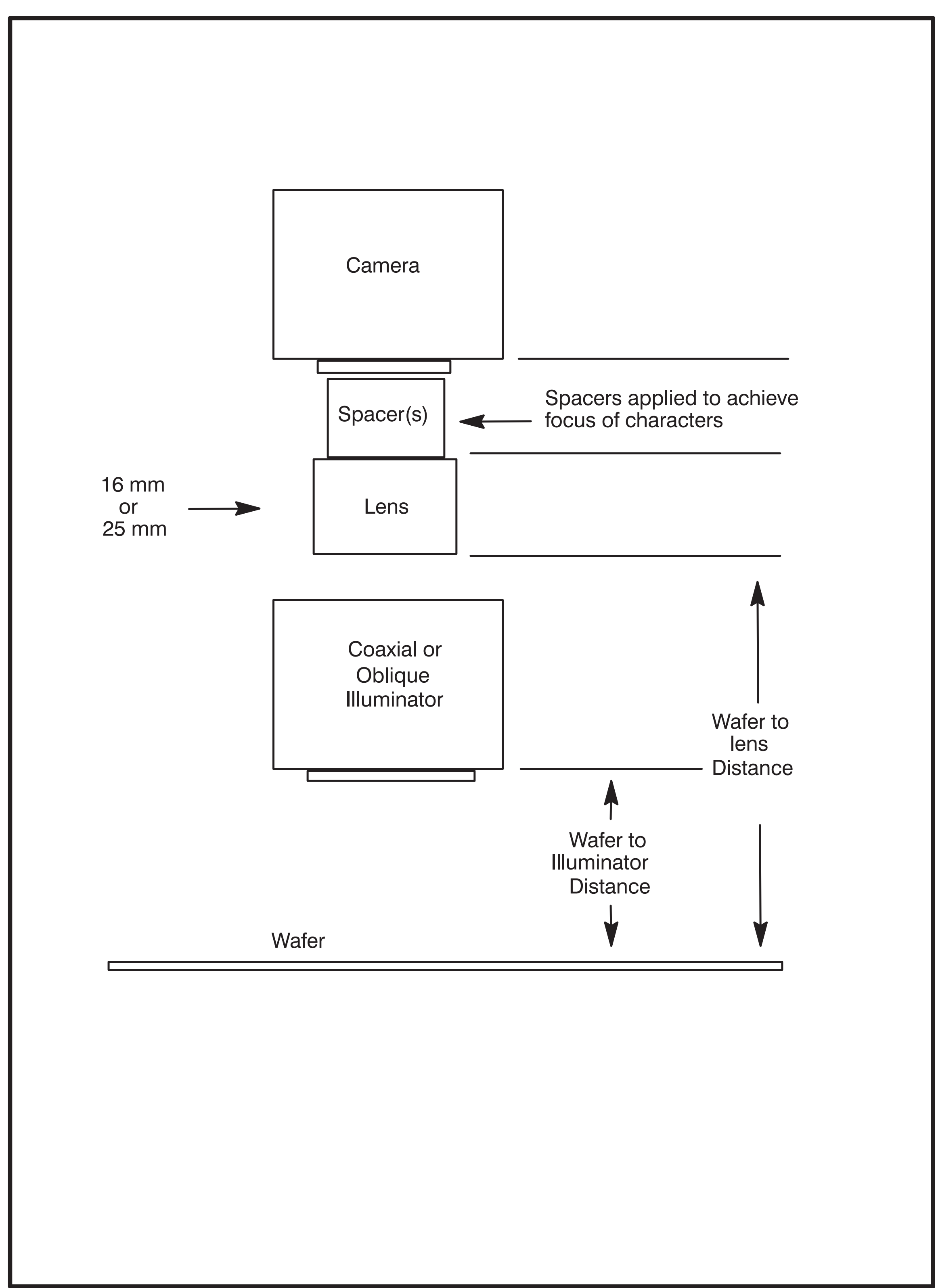


FIGURE 13−9: CAMERA AND OPTICS SETUP

From Line 8 of the EG/OCR Setup Menu, choose option “1.” When the size calibration screen is first displayed *(Figure 13−10)*, a command is issued to the OCR to fix a window the size of one character in the center of the camera field.

PROBER

```
 **  CHARACTER SIZE CALIBRATION  **
ADJUST WINDOW TO FILL WITH CHAR
“0” = CHARACTER IMAGE ............5
“M” SELECTS WINDOW MOVES
“A” SELECTS AREA (SIZE) CHANGE
“X” SELECTS X AXIS
“Y” SELECTS Y AXIS
“1” TO “4” SELECTS RESOLUTION
OF WINDOW POSITIONING........1

PRESS “BS” “.” TO RESIZE / MOVE
PRESS “RUN-ID” TO START ID READ

PRESS “ENTER” TO EXIT
“F5” TOGGLES DISPLAY
```

FIGURE 13−10: CHARACTER SIZE CALIBRATION SCREEN

Messages on this screen provide operator instructions for using keys to move the calibration window and change the window size. Keys < 1 > − < 4 > change the resolution of window positioning, keys < 5 > − < 9 > set the resolution to maximum, 4.

Three fields are highlighted (inverse video):

1. The Character image number.

2. Either `WINDOW MOVES` or `AREA (SIZE) CHANGE` (depending on whether “M” or “A” was last selected).

3. `X AXIS` or `Y AXIS` (whichever was selected, and only in “`MOVE`” mode).

Press < 0 > if you wish to change the default character used for size calibration. The default is “0,” but any numerical character (0 through 9) may be substituted. Examples that follow use the character “5.”

Using the keys as shown in combination with the mechanical fine adjustment of the OCR camera and camera lens, place the appropriate character inside the window.

During the sizing procedure, the camera may be mechanically adjusted in X, Y, and Z; X and Y to position the character inside the “sizing box,” Z to refocus the character. The X and Y adjustment is also possible with the keyboard by moving the sizing box in the X and Y axis instead of moving the camera. This is done using the < BS > and < • > keys as directed on the Size Calibration screen.

Press < RUN−ID > to start the OCR size calibration.

After a size calibration, the lower left corner of the screen will display a 4X image of the character under size calibration. The contrast value represents the contrast measurement for the size calibration window. The X−scale and Y−scale values show the ratio of the SEMI font versus the image:

scale = 100 x (SEMI Font / image)

Adjust the optics to obtain the best image possible for improving the read rate (desired scale of 70−80). Figure *13−1* provides a cutaway view which will assist in locating controls on the OCR Assembly.

If the scale is greater than 100, the following message is displayed:

```
CHARACTER IMAGE LOOKS TOO SMALL (>100)
PLEASE RE-CALIBRATE SIZE AFTER ADJUSTING
LIGHT OR OPTICS
```

Figure 13−11 illustrates an unacceptable adjustment. The character is too small, and the scale value is far over the maximum allowable 100 reading.

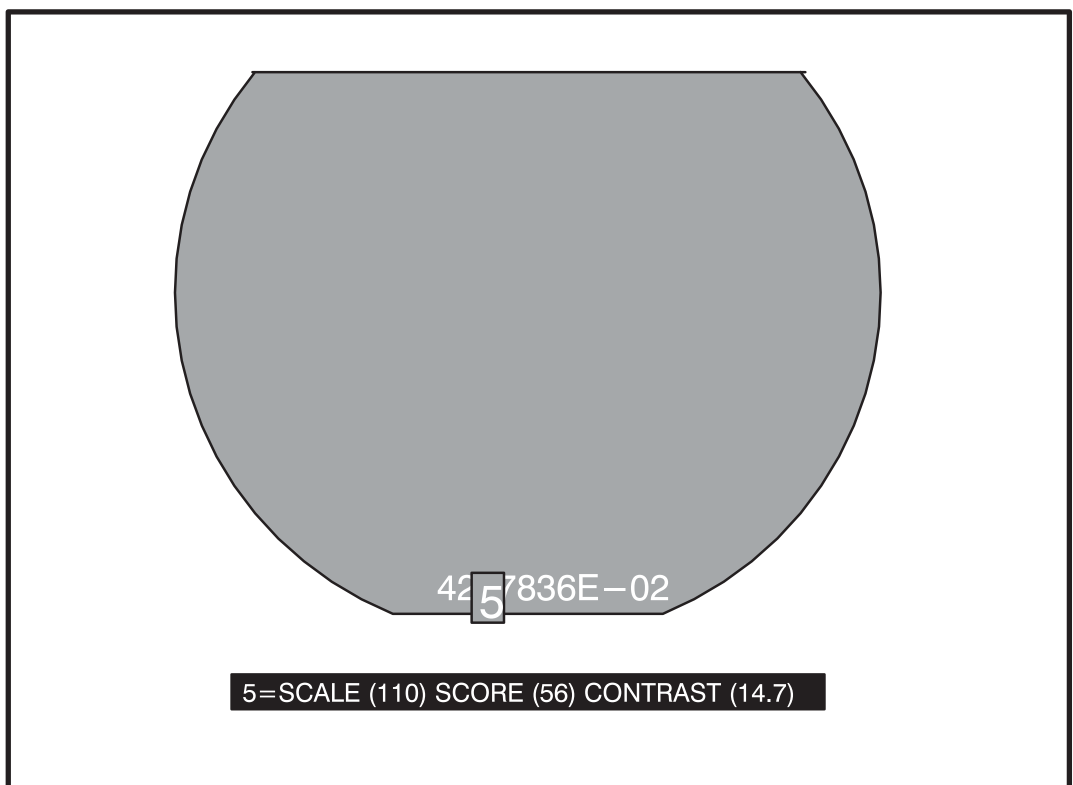


FIGURE 13−11: UNACCEPTABLE SIZING READ

After the short display of the image, the size calibration screen is displayed again so further adjustments can be made.

A scale greater than 100 could be caused by one of the following problems:

Possible Problem	**Solution**
Character color incorrect	Switch character color to black or white
Character image is too small	Adjust optics to make image as big as possible.
Character quality is poor	Adjust optics and/or slightly shift the size calibration window, then repeat size calibration test.

To adjust the optics:

1. Move the camera *down* to magnify the character, *up* to de−magnify.
2. Readjust the focus by adjusting the shutter opening and/or by adding/removing spacers between the camera body and camera lens. Standard spacers are 20, 40, 100, 200, 400, 800, and 1600 mils.

Note the example message for size calibration in *Figure 13−12:*

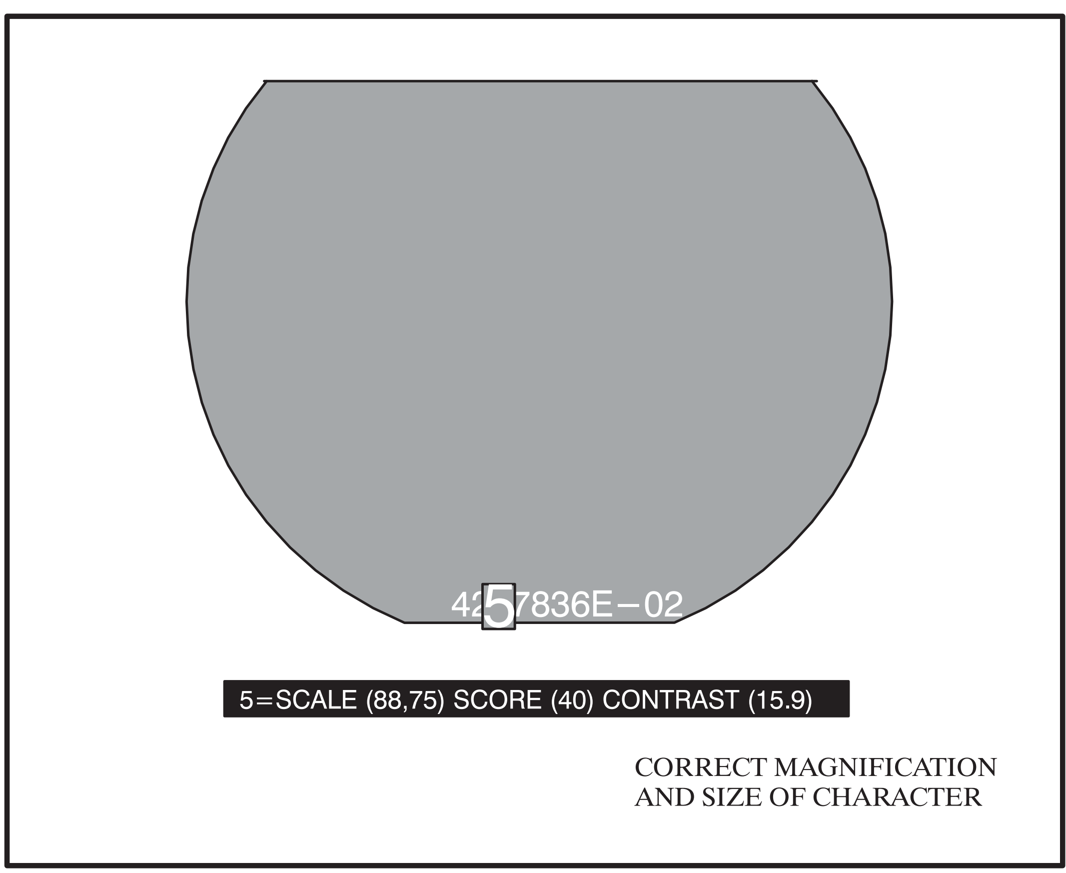


FIGURE 13−12: ACCEPTABLE SIZING

5=SCALE(88,75) SCORE(40) CONTRAST(15.9)

The image of the character "5" will be reduced to 88% in the X−direction and 75% in the Y−direction to match the SEMI font. The score is 40 and the contrast is 15.9. The *score* or normalized correlation coefficient of the character should be at least 25 when matching the SEMI font.

Figure 13−12 illustrates a character of the correct size (showing the acceptable scale of 88,75), after the focus adjustment. Both reading speed and reliability improve by attempting to achieve a scale of 70−80.

13.7.3 Spacing Calibration

The objective of spacing calibration is to obtain the spacing between two consecutive characters. Vertical lines are overlaid with the space calibration window to indicate the spacing of individual characters. The spacing is computed as the average distance between characters within two vertical lines.

The following message is displayed for spacing calibration:

CHAR SPACING = X% Character Width

NOTE
SEMI specification of *spacing* is 150% of the character width; *separation* is 50% of the character width.

From Line 8, choose Option "2". When the spacing calibration screen is displayed *(Figure 13−13)*, the OCR unit displays a window the size of which is a function of the number of characters used for this calibration. (Don't confuse "window" with the "box" designation used in the sizing calibration.) The default number of characters used is one less than the maximum number in the ID string.

Minor window position and size adjustments are done with the < BS > and < • > keys. The < X > key toggles the function of the left edge and right edge vertical line modes (< BS > and < • > keys to move the vertical line). Select the `WINDOW` move and position the left vertical line on the left edge of the first character in the ID string.

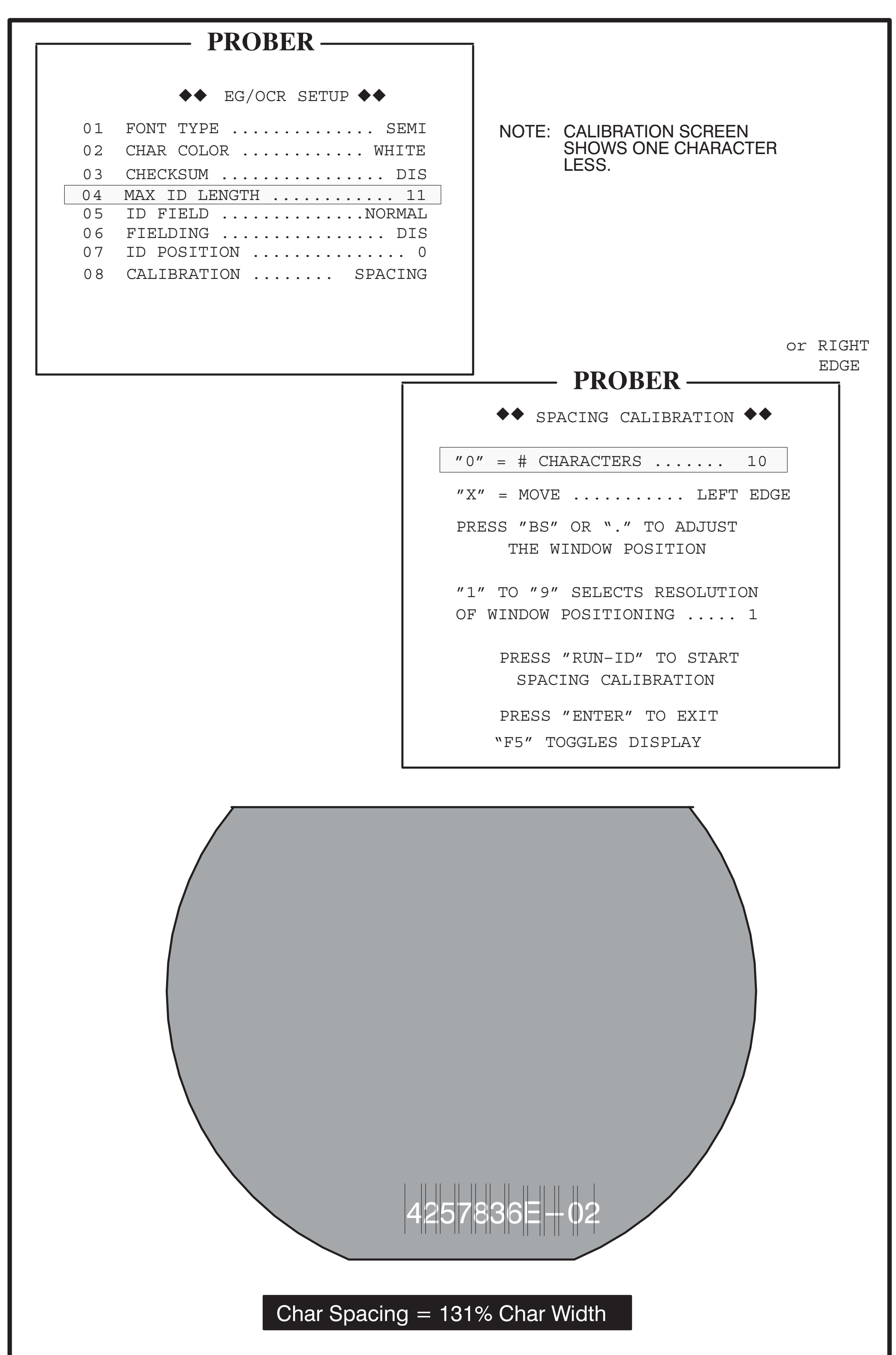


FIGURE 13−13: SPACING CALIBRATION SCREEN AND CONFIRMATION DISPLAY

Key sequences used for the manipulation of the window and the character are illustrated in **Table 13−5**.

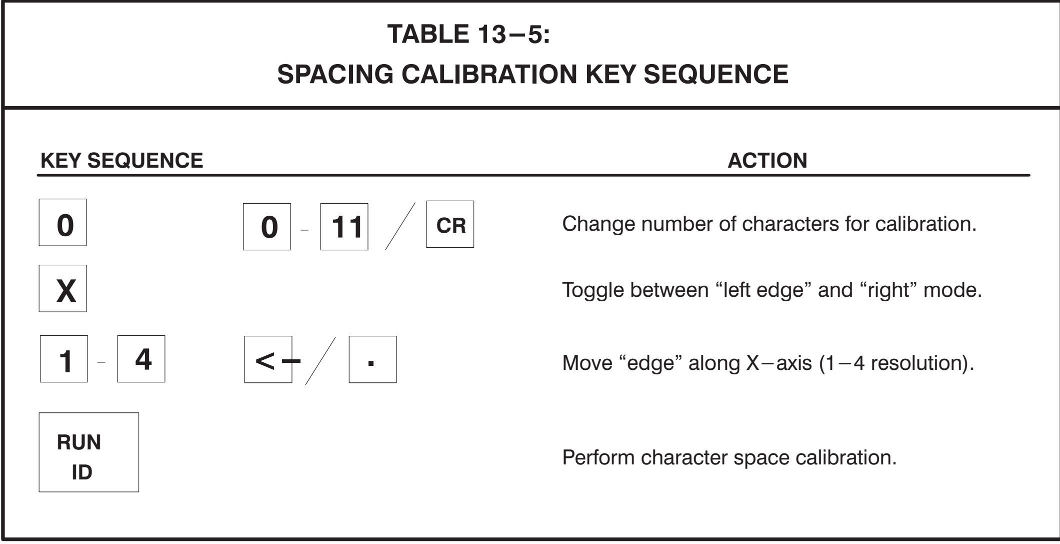


TABLE 13−5:
SPACING CALIBRATION KEY SEQUENCE

KEY SEQUENCE		ACTION
0	0 - 11 / CR	Change number of characters for calibration.
X		Toggle between “left edge” and “right” mode.
1 - 4	<– / .	Move “edge” along X−axis (1−4 resolution).
RUN ID		Perform character space calibration.

Select the `EDGE` move and position the right vertical line so there are the same number of *complete* characters inside the vertical lines as the `# CHARACTERS` indicates (total number of characters minus 1).

Position the left vertical line until it is at the left edge of the first character, as illustrated:

| 4 2 5 7 8 3 6 E − 0 2 | |

Press < RUN−ID > to initiate the spacing calibration. The OCR camera will display the image with a value indicating the character spacing as a percentage of character width *(Figure 13−13* and **Table 13−1**). Separation, which has no established specification, is the difference between spacing less width.

The confirmation of the calibration is displayed for one to two seconds.

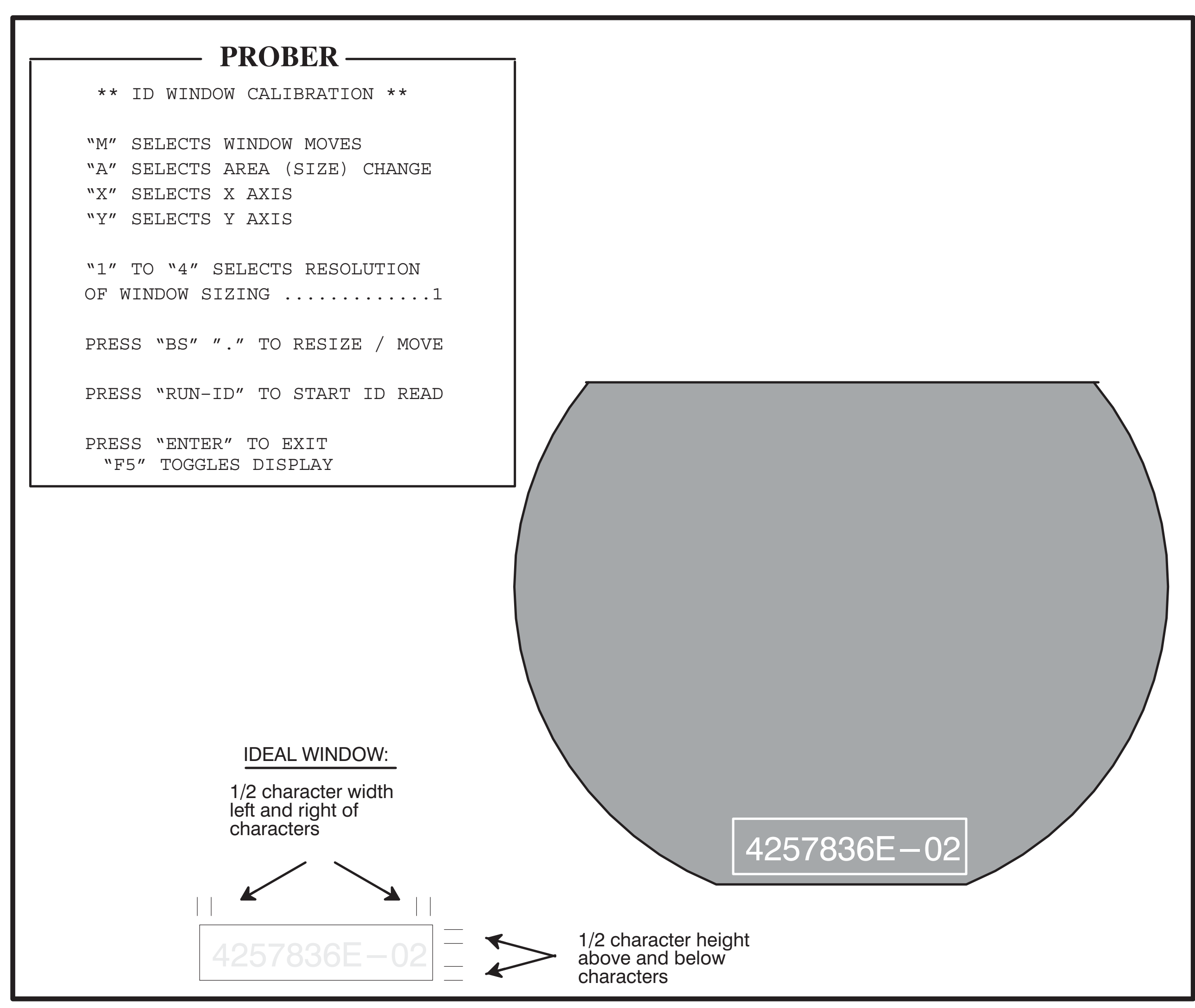


FIGURE 13−14: ID WINDOW CALIBRATION SCREEN AND CONFIRMATION DISPLAY

13.7.4 Reading Calibration

Select Line 8, option “3” to finalize the ID read window size. The default window size is two characters wider and one character taller than the ID string. Centering the window around the ID string with approximately 1/2 character leeway on all sides will help speed up the read time.

Messages on the ID Window Calibration screen *(Figure 13−14)* provide operator instructions for using keys to move the calibration window in X and Y. (Keys 5 − 9 will result in resolution being set to maximum 4 − see **Section 13.7.2, Character Size Calibration.**)

Two fields are highlighted (inverse video):

a) Either `WINDOW MOVES` or `AREA (SIZE) CHANGE` (depending on whether “M” or “A” was last selected), and

b) `X AXIS` or `Y AXIS` (depending on whether “X” or “Y” was last selected).

The window size adjustments are symmetrical around the center of the screen. The < BS > and < • > keys allow minor size adjustments to be made.

As prompted, press the < RUN ID > key to begin the ID read. *Figure 13−15* illustrates a wafer with the display of the reading evaluation for the individual characters and the notation of the reading time required. Note the significant difference in reading values and time between a wafer that contains debris and one that is “clean.”

4257836E–02

4:82 2:83 5:99 7:97 8:99 3:99 6:95 E:99 –:8 0:92 2:91

4257836E–02

Time 1.598 seconds.

WAFER WITH DEBRIS

Low shape scores (below 90) indicate that reading quality is being affected by the debris around certain characters – in this case, numbers 4 and 2.

4257836E–02

4:99 2:99 5:99 7:99 8:99 3:99 6:95 E:99 –:8 0:96 2:97

4257836E–02

Time 1.082 seconds.

WAFER WITH DEBRIS REMOVED

FIGURE 13–15: ID READING VALUES AND TIME

13.8 LOGGING

Once the setup and calibration have been performed for a particular wafer ID, it is strongly advised that you log the pertinent data which cannot be stored to ensure that an identical setup will be performed for all wafers with that ID. This data includes such information as the focal distance of the lens, and the camera lens and illuminator height.

Page 2 of the Electroglas OCR Evaluation (Test) Report (see the **OCR Special Reference Section** at the back of this section) lists parameters, measurements, and characteristics which should be noted for each wafer ID.

All EG/OCR parameters entered through the keyboard may be stored on the prober disk and/or uploaded and downloaded to/from the host, including the Fielding data (described next). See **Section 8, External Control I/O Interface**, for more information regarding uploading and downloading OCR data.

13.9 FIELDING

Fielding is a technique which instructs the EG/OCR system to evaluate only those characters in a specified field. This is done through the fielding screen which allows the editing of an array of acceptable characters for each ID character location.

NOTE
A detailed analysis of the fielding system is provided in the back of this section.

The fielding screen, shown in *Figure 13−16*, is accessed by enabling the Fielding option on the EG/OCR Setup Menu (Line 6).

```
                    PROBER
              * * OCR FIELDING * *
LINE
 3      ABCDEFGHIJKLMNOPQRSTUVWXYZ
 4      0123456789-.

 6        CHARACTER = A        LOCATION = 1

             PRESS "Y" TO ACCEPT (HIGHLIGHT)
             PRESS "X" TO REJECT (NORMAL)
10           PRESS "1" TO ACCEPT ALPHAS                 or REJECT
11           PRESS "2" TO ACCEPT NUMERICS               or REJECT
             PRESS "BS" OR "." TO SELECT
               NEXT CHARACTER FOR ACCEPTANCE

15                                                    ID LOCATION (1 - 14):
16           PRESS "ENTER" TO ACCEPT FIELD
```

FIGURE 13−16: EG/OCR FIELDING SCREEN

Once fielding is set, data will not be lost if the option is disabled.

In many serial numbering schemes, one or two specific fields will contain the sequential numbering which is used to track the wafer through the process.

For example, each wafer ID listed below contains 14 characters. Read in their entirety, a total of 70 characters would be imaged and passed or failed.

49060400−02−E7
49060400−03−E7
49060400−04−E7
49060400−05−E7
49060400−06−E7

In the sequence of IDs listed, it can be seen that the only characters which vary from wafer to wafer are the two numbers separated by dashes. The EG fielding capability permits the OCR system to read only those characters which change; that is, the 02, 03, 04, 05, and 06. With a total of 10 characters to read versus the 70 required by OCR systems without fielding, read time is decreased, and the possibility for error significantly reduced.

When first accessed, the screen will appear as shown with all acceptable characters displayed in reverse video. When < ENTER > is pressed, the fielding (as shown in lines 3 and 4) is accepted and you are then prompted to select the next ID location to be edited.

Press < DIG VID > to toggle the display between the OCR camera and fielding screen.

Line 3: Lines 3 and 4 display in reverse video the accepted characters for the
Line 4: selected ID location (including the hyphen "−" and dot "•" characters).

Line 6: This line displays the present character to be considered for acceptance.
`LOCATION` indicates the present ID location for which fielding is considered.

Line 10: The words `REJECT` and `ACCEPT` toggle depending on whether any
Line 11: alpha/numeric characters have been selected.

Line 15: Normally left blank except when prompting for the next ID location to be edited.

Line 16: When editing the field, Line 16 will display as shown. When prompting for the next ID location (via Line 15), Line 16 will display `PRESS "ENTER" TO EXIT.`

When fielding is complete, press < ENTER > to return to the EG/OCR Setup Menu.

13.10 NON−EG OCR SETUP PROCEDURE

From the handler mode, with the OCR enabled (Handler Set Mode Menu, Line 01) press the < DIAG > key to produce the Handler Maintenance Menu. Select Line 10 (`WAFER ID READER SETUP`). This will access the OCR Reader Setup Menu *(Figure 13−17)*.

The last line shows the wafer ID number after the OCR has read it.

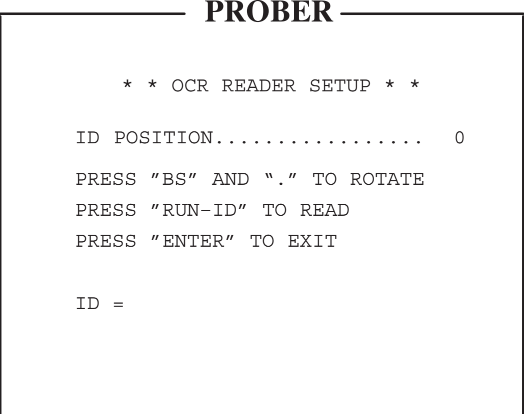


FIGURE 13−17: NON−EG OCR READER SETUP MENU

13.11 STATISTICS SUMMARY TABLE

A three line statistics summary table can be displayed when the delay−display is set to 20 seconds through Line 11 of the EG/OCR Setup Menu.

The ID reader sends the results to the material handler before any messages are displayed. The Vision Module will not respond to any external commands while the summary table is displayed. The table will be reset to zero when a new alignment target is trained by Find Target or trained by Find Target using Self−Teach, or when any alignment target is loaded from disk.

The ID Reader summary table typically looks like **Table 13−6** (an explanation of the items follows):

TABLE 13−6:
ID READER SUMMARY TABLE EXAMPLE

678 Str_Success		37 Str_Partial			107 Str_Fail			(Str_Total = 822)	
A−Z	0−9	*	A−Z	0−9	Read	Memory	Contrast	Segment	Else
5421	3	89	207		0	0	3	103	1

LINE 1 − STRING READ RESULTS

Str_Success (String Success) is the number of string reads that are successful when there is no asterisk (*) character in the string.

Str_Partial (String Partial) is the number of partial string reads in which the ID reader could not read all the characters within the string, but was able to read some of the characters.

Str_Fail (String Fail) is the number of string reads in which the ID reader was unable to read any of the characters in the ID string.

Str_Total (String Total) is the total number of ID strings that the ID reader attempted; which is equal to Str_Success + Str_Fail + Str_Partial counts.

LINE 3 − CHARACTER READ RESULTS (Str_Partial and Str_Fail)

Characters (* A−Z 0−9):

the total number of characters read for all the string successes.

Left Box: the total number of unknown characters (*) found in a partially read ID string.

Right Box: the total number of known characters (A−Z, 0−9) found in a partially read ID string.

Read:

the number of strings the ID reader was unable to read because of poor character quality within the string.

The ID reader will report a `READ FAILURE` and put an asterisk (*) in the character position of the string it generates.

To correct: Recalibrate, adjust optics, adjust size and spacing.

Memory:

the number of strings the reader fails because of insufficient memory.

The ID reader will report a `MEMORY FAILURE` and display the following error:

```
ERROR:   MEMORY TOO SMALL;  LARGEST=XXXXX
         TOTAL=YYYYY  CONTRAST=ZZZZZ
```

where “xxxxx” is the value of the largest consecutive memory, “yyyyy” is the total amount of memory, and “zzzzz” is the co ntrast value.

To correct: Reduce the size of the read window or the number of stored PMI pads. Contact your local Electroglas field representative.

Contrast:

the number of ID strings the reader fails because of insufficient contrast.

The ID reader will report a `CONTRAST FAILURE` and display the following type of error message:

```
ERROR:  LOW CONTRAST &lt; 2.5  CONTRAST=XXXXX
```

where 'xxxxx' is the contrast value.

To correct: Increase the light, adjust the optics, free the ID from any foreign substance that might be hindering the read.

Segment:

the number of ID strings that the ID reader fails because of failure to segment the image into character images prior to the read. Most likely, there are not enough characters in the read window.

The ID reader will report a `SEGMENT FAILURE` and display the following type of error message:

```
ERROR:   FAILED TO SEGMENT IMAGE  CONTRAST=XXXXX
```

where 'xxxxx' is the contrast value.

To correct: Increase the light, adjust the optics, free the ID from any foreign substance that might be hindering the read, check the requested character number for correctness.

Else:

the number of ID strings that the ID reader fails because of an AGC (Auto Gain and Offset Control) failure, argument failure, or signal failure.

An **AGC FAILURE** is caused by a failure in the AGC of the vision module digitizer. Usually caused by too much light.

The ID reader will report a `AGC FAILURE` and display the following type of error message:

```
ERROR: AGC CONTRAST=XXXXX
```

where 'xxxxx' is the contrast value.

To correct: Decrease the light, adjust the optics. Contact your EG field service representative.

An **ARGUMENT FAILURE** is caused by a invalid argument range. Usually caused by reading without size and/or space calibration set, or using an incorrect checksum with unexpected characters.

The ID reader will report an `ARGUMENT FAILURE` and display the following type of error message:

```
ERROR: BAD ARGUMENT  CONTRAST=XXXXX
```

where 'xxxxx' is the contrast value.

To correct: Calibrate size and/or spacing, check for incorrect checksum selection in the ID. Contact your EG field service representative.

A **SIGNAL FAILURE** is caused by all errors not listed previously. The ID reader will report a `SIGNAL FAILURE` and display the following type of error message:

```
ERROR: SIGNAL  XXXXX  YYYYY  CONTRAST=ZZZZZ
```

where 'xxxxx' is the error code, 'yyyyy' is the description, and 'zzzzz' is the contrast value.

To correct: Calibrate size and/or spacing. Contact your EG field service representative.

13.12 ID READ FAIL PROCEDURES

The upper left corner of the screen displays the image window acquired by the ID reader with two long lines showing the upper and lower boundary of the string. Each box represents the bounding window for each segmented character.

The cross lines show the center and upper left corner of each character. The read results are shown under each character in the upper left window. After a read fails, the results are displayed in white characters when using the template matching method or in black character when using contour matching method.

The lower large window shows the SEMI font large display. The highlighted bottom line on the display shows the read result. The read result is displayed using one of the following forms:

`xxxxxxxx-xx-xx (10.6 SECS) CONTRAST = 10`	(read pass)
`FAIL: LOW CONTRAST <= 2.5. CONTRAST=n`	(read fails)
`FAIL TO SEGMENT IMAGE  CONTRAST = n`	(read fails)
`FAIL TO READ ANY CHAR  CONTRAST = n`	(read fails)
`ERROR: MEMORY TOO SMALL LARGEST lll`	
`TOTAL= ttt   CONTRAST = n`	
`ERROR: AGC ERROR  CONTRAST = n`	(read fails)
`ERROR: BAD ARGUMENT  CONTRAST = n`	(read fails)
`ERROR: SIGNAL # reason  CONTRAST = n`	(read fails)
`CHECKSUM  FAIL`	(read fails)

13.12.1 ID Fail Recovery Mode

The method for handling wafer ID read failures is selected through the Handler Set Mode Menu, Line 4, ID READ FAIL RECOVERY.

If this line is enabled, the wafer remains on the prealign stage and alerts the operator that the system is unable to read the wafer ID; the beeper will sound and the message,

```
UNABLE TO READ WAFER ID
```

appears on the screen.

Four recovery mode options are available: **Manual, Unload, Ignore** and **Hold − Stay on Prealign.**

MANUAL

When the recovery mode selected is **Manual**, after the alarm is cleared, a menu offers five options *(Figure 13−18),* explained next.

PROBER

```
          ID READ FAIL

1  EDIT ID STRING
2  ID READER RETRY
3  ID READER SETUP
4  RETURN WAFER TO SOURCE CASS.
5  IGNORE ERROR AND CONTINUE
```

FIGURE 13−18: ID READ FAIL MENU

LINE 1 EDIT ID STRING

This choice allows you to edit the wafer ID. The prober displays the last ID read from the ID reader and moves the cursor to each, if any, of the unreadable characters so you can correct these. After all unreadable character spaces are filled in, you may press the < CE > key at any time to clear the entire ID string.

When entering the wafer ID string manually in immediate probe mode, no more than 27 characters can be entered as the wafer ID string, and the backspace key <← > may be used to delete input errors. When editing is complete, press the < ENTER > key.

The editing process is described in **Section 13.7.2 (Editing Strings with Unreadable Characters)**.

The prober does not allow a NULL (no characters) ID string. If a wafer is loaded on the chuck with a NULL ID, the prober will create an ID for the wafer by concatenating the device type name, the lot number, and the wafer number. When editing is complete, press the < ENTER > key.

The prober will ask you to verify the ID before loading the wafer onto the chuck and using the verified ID as the wafer ID. If you choose not to verify the wafer ID, the prober will ask whether to abort the ID entry. If you choose “yes,” the above menu will be displayed again for choosing another option. If “no” is selected, continue editing the ID string.

Selecting the “Edit ID String” option causes the prober to return to the automatic ID reader process and continue with normal prober processing after the ID string is edited.

LINE 2 ID READER RETRY

When you select this option, the wafer will go through one complete cycle of an ID read. The ID reader task is enabled and if the read is successful, the system will continue processing the wafer. If the ID read fails, the ID is displayed on the screen and a prompt asks whether another ID read is desired. If another cycle is not requested, you may select any of the other options displayed on the `ID READ FAILURE` screen.

LINE 3 ID READER SETUP

This option is only available when using EG/OCR as the ID reader. It provides access to the EG/OCR Setup Menu to make changes to the EG/OCR setup.

LINE 4 RETURN WAFER TO SOURCE CASSETTE

This selection returns the wafer on the prealign to its source cassette. A prompt asks for verification of this selection. `ID FAIL` status is issued to the cassette slot.

LINE 5 IGNORE ERROR AND CONTINUE

Selection of this line causes the prober to use the ID as read and continue as though a successful ID read been performed. A prompt requests verification of this selection.

UNLOAD

When you select this recovery mode, a wafer with a failed ID read will be returned to its proper source. This is normally a cassette slot, but may be the hold station.

IGNORE

Updated 4/28/94

This selection tells the prober to ignore ID reader errors and not to treat them as failures. The wafer is continued through processing as though the ID read was successful. The ID provided with the wafer is the exact ID received from the ID reader. If the ID read fails, it will display the full string of unreadable characters.

HOLD – STAY ON PREALIGN

This mode will keep the wafer at the prealign station without sounding the alarm bell when an ID read fail is detected. The "ID READER FAIL" message to the prober is sent one time only per ID read fail.

If Line 4 (ID READ FAIL RECOVERY) of the Handler Set Mode Menu is disabled, the wafer is returned to its source slot for later processing. You may recall the wafer by pressing the < RUN ID > key while the Handler Run Time Display is on the screen.

If an ID read failure is found, the display will show the source cassette and slot of the wafer. You may either process the wafer or look for another ID read failure. If you elect to process the wafer, it is brought to the prealign station and properly positioned beneath the OCR camera.

In the case of ID read failures on non–EG OCR, the system will be queried for the ID based on the total number of retries you requested in the Handler Set Mode Menu.

13.12.2 Editing Strings With Unreadable Characters

Following is one method for editing wafer ID strings which contain unreadable characters:

1. When the ID string is sent by the ID reader, the cursor appears on the first unreadable character. Press the key for the correct character... any key *except:*

   ENTER
   Backspace
   CE
   S

   Pressing any of the first three causes the system to beep. Pressing the < • > key will cycle through the < • > level characters, the letters "N" through "Z."

   Once the proper character is displayed, press < ENTER > to accept it into the ID string. The cursor will then move to the next unreadable character. This step will be repeated until all unreadable characters have been resolved. When the cursor appears at the end of the ID string, the string has been accepted, but any character may be edited.

2. The < BS > and < CE> keys are now active. When the < BS > key is pressed, the cursor will cycle through the ID string in reverse. If the key is pressed when the cursor is at the beginning of the string, the cursor will position itself after the last character of the string.

3. If < ENTER > is pressed at this point, a message on the screen will prompt you to verify the accuracy of the ID string. To force the acceptance of the string, press < Y >. To continue the edit cycle from Step 2, press < ENTER >.

NOTE

If all else fails, the <CE>key will clear the entire ID string so you can enter the string manually.

13.12.3 Checksum

The checksum is an optional two−digit code added to the end of the ID string by the laser marker. When the OCR system reads the ID, it recalculates what the check digits should be and compares the result to the characters it has read. This test provides a guarantee that reading results are correct.

The EG OCR checksum is an 8 character alpha−numeric (no B no N) code; a “special” (customer−supplied) OCR checksum is a 7 character alpha−numeric code such as A8E7139. To distinguish whether “special” or “EG” is for the 7−digit checksum, remember that there are 7 letters in “special.”

If the ID checksum has been enabled (EG/OCR Setup Menu, Line 3), the OCR unit is requested to verify the operator−generated ID string. If the checksum verification fails, you may edit the ID again, return the wafer to its source slot, or disregard the checksum error and continue processing the wafer. The system will accept a manually−entered wafer ID without having to validate the checksum.

When there is only one unreadable character, the checksum can compute the character value using the other characters in the string. The checksum corrected character must pass the verification read before a successful read of the string is reported.

A double−check read function is used to verify the checksum computed character and to ensure there is no misread of the string.

It is possible to use the bar code checksum feature while reading wafers with a bar code.

13.13 OCR TEST

To test the operation of the ID Reader:

1. Enter the appropriate ID position angle and size angle, as described in **Section 13.3 (Enabling and Selecting Modes).**
2. Press the < DIAG > key; select Line 02 from the Diagnostic Exercise Menu.
3. Adjust the camera position for the correct reads for every scan.

The wafer ID is displayed each time a successful pass is made. If a particular pass fails to read the wafer ID, any ID previously displayed on the screen is erased. The numbers are displayed on the bottom of the screen. The first number represents attempted reads and the second is the number of valid reads obtained. To stop the test, press the < PAUSE/CONT > key.

13.14 BACK SIDE BAR CODE READER

A bar code is a self−contained message with information coded in physical widths of bars and spaces in a printed pattern. Bar codes printed on the back or underside of wafers identify them as they are prepared for probing. The BSBCR (Back Side Bar Code Reader) automatically recognizes and interprets commonly used bar codes, decoding the bars according to their width.

This feature requires special hardware and has caused a new item to be added to the ID Reader Type selection on the Handler Set Mode Menu (discussed in **Section 13.10.3**).

13.14.1 Hardware Requirements

A new BSBCR Communication Board allows the Material Handler software to determine the model and operation of the Handler (manual or SMIF−E Arm™ cassette loading). Also required are the latest modified PC boards: the Main System Board and the Solenoid I/O Interface Board.

13.14.2 Scanner and Controller Units

The BSBCR consists of a Micro−Scanner or sensor and a decoder/controller unit. As the bar code on the wafer is prealigned and rotated in front of the sensor area, the visible and infrared light pass from the LEDs to the bar code. It is then reflected back through the slit aperature to the internal detector where it is converted to electrical pulses. These electrical pulses are bar code signals, transmitted to the decoder unit.

Bar code signals received from the Micro−Scanner are converted to digital logic by a high−speed A/D converter, then routed to a decoding processor. All decoded characters are checked for accuracy via checksum and multiple−read compare software. The data is then converted to ASCII format and transmitted to the Material Handler through RS−232 communication.

Operating parameters can be selected via a DIP switch located behind the rear panel of the BSBCR decoder/controller. The DIP switch must be set: 1 and 5 On and all others Off. The RS−232 communication baud rate between the Material Handler and the BSBCR is set to 9600 with 7 data bits odd parity, and protocol is used according to the DIP switch setting. The baud rate on the Handler must be set up the same as the BSBCR controller; the Handler baud rate is set through the Handler Maintenance Menu (accessed with the < DIAG > key).

13.14.3 Enabling BSBCR

To enable BSBCR, access the Handler Set Mode Menu (while in the Handler Mode, press <SET MODE>). See *Figure 13−19*.

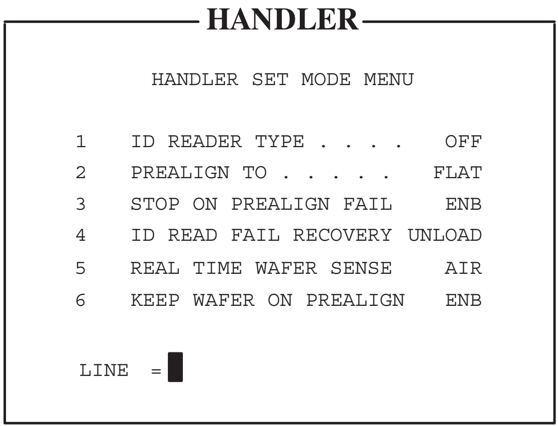


FIGURE 13−19: HANDLER SET MODE MENU

Select Line 01, ID Reader Type and the following screen displays (*Figure 13−20*) with these options:

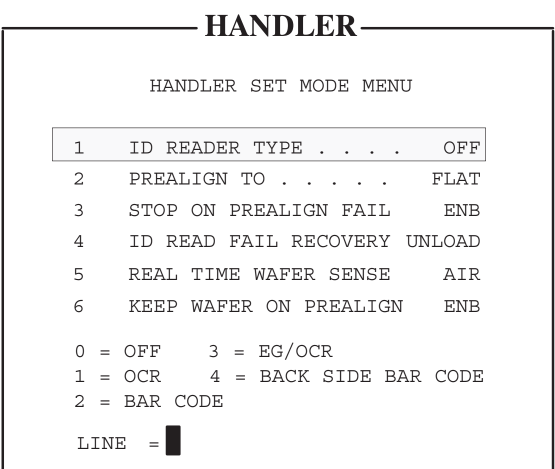


FIGURE 13−20: ID READER TYPE SELECTIONS

Enter < 4 > to select the BSBCR and further prompts display:

`ID POSITION`: This is the position of the start of the ID field relative to the wafer flat in degrees (clockwise). Generally, this will be zero.

`ID READER RETRIES`: This is the number of attempts the handler will make to read the ID in addition to the original attempt and one extra attempt. For example, a value of “2” will result in the handler attempting to read the ID up to four times Each retry takes up to 32 seconds.

13.15 SUMMARY

In this section, you have learned:

- The hardware features of OCR
- How to enable and select OCR modes
- Information on OCR specifications, including fonts and illumination
- OCR prerequisites
- EG/OCR setup and calibration procedures
- Non−EG/OCR setup procedures
- Information on the Statistics Summary Table
- ID Read Fail procedures
- Back Side Bar Code Reader information, including hardware requirements and how to enable it
- A special section that includes a separate OCR Setup Procedure, fielding analysis information and a OCR Sample Report

OCR SPECIAL REFERENCE SECTION

CONTENTS

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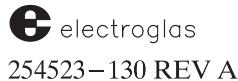
FIELDING ANALYSIS . . . . 13−51

SAMPLE OCR EVALUATION REPORT . . . . 13−55



OCR SETUP PROCEDURE

(See Section 13.5.1 for explanation and details)

Press <SET OPTION > (< F3 >) to access Set Option Menu.

Select Line 04 – Wafer ID Reader.

Press < 1 > to enable.

Press < ENTER >.

	OPERATOR ACTION	TO... (RESULT) and/or FURTHER ACTION (in italics)	FIG
1	Press <PROBE HDLR> (<F9>).		
2	Press <SET MODE> (<F2>).	Access Handler Set Mode Menu.	1
3	Select < 1 > – ID READER TYPE	Enable EG/OCR.	2
4	Select ID POSITION	*Enter 180° if character string is opposite from wafer flat.*	2
5	Select ID READER RETRIES	*Enter "2" to expedite setup time.*	3
6	Press <DIAG> (<F1>).	Access Handler Maintenance Menu.	4
7	Select < 10 > – WAFER ID READER SETUP	Access EG/OCR Setup Menu.	5
8	Select < 1 > – FONT TYPE	*Select* SEMI *font.*	6
9	Select < 2 > – CHAR COLOR	*Select character color:* BLACK. *(If* WHITE, *can be corrected later.)*	6
10	Select < 3 > – CHECKSUM	*Select* SEMI, *usually.*	7
11	Select < 4 > – MAX ID LENGTH	*Enter maximum ID length (count number of characters).*	7
12	Select < 5 > – ID FIELD	*Select* INVERTED *if characters are upside down.*	7
13	Select < 6 > – FIELDING	*Enable, if subsequent wafers have many identical characters; it may expedite the reading time.*	7
14	Select < 8 > – CALIBRATION	Access Calibration selection screen.	8
15	Select < 0 > – LIGHTING	Access Light Calibration Menu	9

	OPERATOR ACTION	TO... (RESULT) and/or FURTHER ACTION (in italics)	FIG
16	Press <DIG VID> (<F8>).	*Observe character's light level and contrast. Adjust lighting:* *If coaxial, press* < • > or <← > *to obtain optimal contrast.* *If oblique, "128" is the default intensity value for the fluorescent lamp. It is not possible to modify the light intensity but it may be varied by:* *1. Adjusting the height of the lamp fixture.* *2. Adjusting the lens aperture.*	10
17	Press < Y >.	*Observe light contrast of characters.*	
18	Press <ENTER> two times.	Return to EG/OCR Setup Menu.	
19	Select < 8 > – `CALIBRATION`	Access Calibration selection screen.	11
20	Select < 1 > – `SIZE`	Access Character Size Calibration screen.	
21	Press < 0 >	*Select appropriate character image ("8" or "0" are preferred).*	
22	Press <DIG VID> (<F8>).	*Adjust X, Y, and Z and bring character into "size box." (See Section 13.6.2.2 for details.)*	
23	Press <RUN ID> (<F3>).	*Observe character inside the box and the score underneath. Scores over 100 are errors. If an error has occurred, adjust the lens aperture and apply lens spacers if needed. Re–focus the image after the adjustments. Repeat to achieve a character scale of less than 100 (70 to 80 preferred).*	12
24	Press <ENTER> 2 times.	Return to EG/OCR Setup Menu.	
25	Select < 8 >– `CALIBRATION`	Access Calibration selection screen.	13
26	Select < 2 > – `SPACING`	Access Spacing Calibration screen. *Ensure that the* `X` *selection specifies* `WINDOW`.	
27	Press <DIG VID> (<F8>).	Return image to screen.	
28	Press < • > or <← >	*Move left vertical bar so that it lines up with left side of first character of string.*	
29	Press < X >	*Set* `X` *to* `EDGE`.	14
30	Press < • > or <← >	*Move right vertical bar so it lines up with left side of last character of string.*	
31	Press <RUN ID> (<F3>).	Start spacing calibration.	15

	OPERATOR ACTION	TO... (RESULT) and/or FURTHER ACTION (in italics)	FIG
32	Press <ENTER> 2 times	Return to EG/OCR Setup Menu.	16
33	Select < 8 > – CALIBRATION	Access Calibration selection screen.	16
34	Select < 3 > – WINDOW	Access Window Calibration screen.	16
35	Press <DIG VID> (<F8>).	Return image to screen. *Adjust window (as described in Section 13.6.2.4). Height should be 1/2 character above and below characters. Width should be 1/2 character either side.*	17

This is the final calibration setup. To verify the correct reading of the character string, Press <RUN ID> (<F3>). The character string will appear on the monitor screen together with "shape score" numbers and total reading time. (Fig. 18)

Depending on the quality of the characters and the correct execution of the calibration procedures, the shape score numbers should be as high (maximum "99") and the reading time as low as possible. The shape score of each character indicates the "quality" (and resulting reading reliability) *of recognition* of each character. Shape score numbers in the nineties are acceptable.

The reading time is another indication of reading reliability. The lower this time, the better.

Both the "shape score" numbers and the reading time are affected by many factors such as:

Reflected light contrast	Character dimensions	Line thickness	Condition of clear zone
Font style	Aspect ratio	Character misalignment	Checksum application
Total number of characters			

When the reader is enabled, the ID number of the current wafer appears on the RUN TIME DISPLAY. For the Cognex OCR Reader, a diamond – ◆ – appears as part of the string to show that a particular character has not been read; for example: ID = 12345 A ◆ CD. If the option "ID READ FAIL RECOVERY" has been enabled and the system is unable to read the wafer ID, a message `UNABLE TO READ WAFER ID` appears below the RUN TIME DISPLAY. (For details, see Section **13.9 – ID Read Fail Procedures.)**

For complete information on OCR parameters and specifications, see the publication:

SEMI M12–89 – Specifications for Serial Alphanumeric Marking of the Front Surface of Wafers

To ensure the best possible reading consistency and reliability from wafer to wafer, it is recommended to mark the wafers in accordance with these specifications. The specifications given in the Electroglas TEST REPORT, OPTICAL CHARACTER READER, have been derived from the M12–89 documentation.

This report may also be used to log and file test and setup data.

PROBER

```
09:15:55     249799.122.DB       1/10/94

 POS   X . . . . .-21  DIE   X . 388.000
       Y . . . . . .5        Y . 176.000
       ZDN      200.00  INKER. . . . .ENB
 WAFER . . . . . . ON  DIA . . . . 125 MM
 Z MODE  . .  PROFILE
 CHUCK VAC . . . . ON  SECS . . . . . DIS
 PROBE  . ────▶ MATRX  X I/O . . OFFLINE

 JOG                   WAFER #    . . . 3
 IDLE                  GOOD DIE . . .  0
                       BAD DIE . . . .  0
                       UGLY DIE. . . .  0
 ID = R11-0575-07
```

RUN TIME DISPLAY showing ID of current wafer.

PROBER

```
HANDLER SET MODE MENU

1  ID READER TYPE . . . . . . . OFF
2  PREALIGN TO    . . . . . . . FLAT
3  U.V. INK CURE  . . . . . . . DIS

LINE =
```

FIGURE 1
Step 2

PROBER

```
HANDLER SET MODE MENU

1  ID READER TYPE  . . . .  EG/OCR
2  PREALIGN TO    . . . . . .  FLAT
3  U.V. INK CURE   . . . . . .  DIS

ID POSITION = 0 DEG.
POSITION (0 - 359 DEG)
```

FIGURE 2
Steps 3, 4

PROBER

```
HANDLER SET MODE MENU

1  ID READER TYPE  . . . .  EG/OCR
2  PREALIGN TO    . . . . . .  FLAT
3  U.V. INK CURE   . . . . . .  DIS

ID READER RETRIES = 5
RETRIES (0 - 30) : 2
```

FIGURE 3
Step 5

PROBER

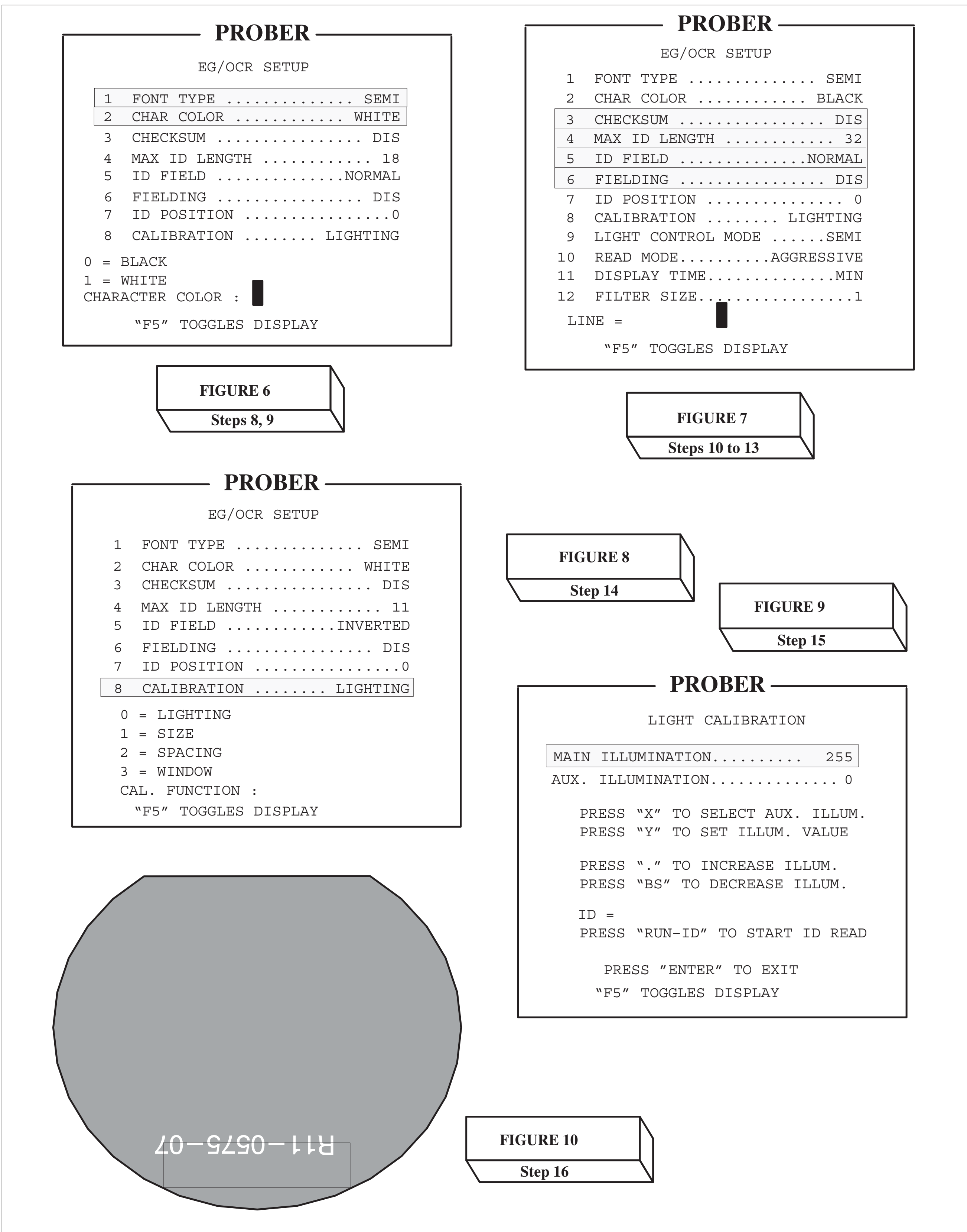
```
HANDLER MAINTENANCE MENU

1   BURN-IN MODE . . . . . . . . OFF
2   PNEUMATICS MODULE
3   QUICK LOADER MODULE
4   SWITCHES, LATCHES, SENSORS
5   X MOTOR   SUBSYSTEM
6   TRANSFER  SUBSYSTEM
7   PREALIGN  SUBSYSTEM
8   SETUP STATION HEIGHTS
9   ALIGN STATIONS
10  WAFER ID READER SETUP

LINE =
```

FIGURE 4
Step 6

PROBER

```
EG/OCR SETUP
1   FONT TYPE .............. SEMI
2   CHAR COLOR ............ BLACK
3   CHECKSUM ................ DIS
4   MAX ID LENGTH ............ 32
5   ID FIELD .............NORMAL
6   FIELDING ................ DIS
7   ID POSITION ............... 0
8   CALIBRATION ........ LIGHTING
9   LIGHT CONTROL MODE ......SEMI
10  READ MODE..........AGGRESSIVE
11  DISPLAY TIME..............MIN
12  FILTER SIZE.................1
LINE=
    "F5" TOGGLES DISPLAY
```

FIGURE 5
Step 7


PROBER
EG/OCR SETUP
1 FONT TYPE .... SEMI
2 CHAR COLOR .... WHITE
3 CHECKSUM .... DIS
4 MAX ID LENGTH 18
5 ID FIELD ....NORMAL
6 FIELDING .... DIS
7 ID POSITION 0
8 CALIBRATION .... LIGHTING
0 = BLACK
1 = WHITE
CHARACTER COLOR :
"F5" TOGGLES DISPLAY
FIGURE 6
Steps 8, 9
PROBER
EG/OCR SETUP
1 FONT TYPE .... SEMI
2 CHAR COLOR .... BLACK
3 CHECKSUM .... DIS
4 MAX ID LENGTH 32
5 ID FIELD ....NORMAL
6 FIELDING .... DIS
7 ID POSITION 0
8 CALIBRATION .... LIGHTING
9 LIGHT CONTROL MODE ......SEMI
10 READ MODE..........AGGRESSIVE
11 DISPLAY TIME.............MIN
12 FILTER SIZE.................1
LINE =
"F5" TOGGLES DISPLAY
FIGURE 7
Steps 10 to 13
PROBER
EG/OCR SETUP
1 FONT TYPE .... SEMI
2 CHAR COLOR .... WHITE
3 CHECKSUM .... DIS
4 MAX ID LENGTH 11
5 ID FIELD ....INVERTED
6 FIELDING .... DIS
7 ID POSITION 0
8 CALIBRATION .... LIGHTING
0 = LIGHTING
1 = SIZE
2 = SPACING
3 = WINDOW
CAL. FUNCTION :
"F5" TOGGLES DISPLAY
FIGURE 8
Step 14
FIGURE 9
Step 15
PROBER
LIGHT CALIBRATION
MAIN ILLUMINATION.......... 255
AUX. ILLUMINATION.............. 0
PRESS "X" TO SELECT AUX. ILLUM.
PRESS "Y" TO SET ILLUM. VALUE
PRESS "." TO INCREASE ILLUM.
PRESS "BS" TO DECREASE ILLUM.
ID =
PRESS "RUN-ID" TO START ID READ
PRESS "ENTER" TO EXIT
"F5" TOGGLES DISPLAY
R11–0575–07
FIGURE 10
Step 16

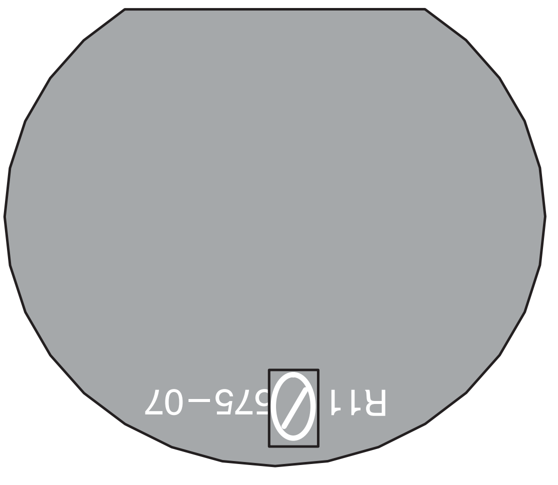
PROBER

```
           EG/OCR SETUP
 1  FONT TYPE .............. SEMI


 7  ID POSITION ..............180
 8  CALIBRATION ........     SIZE
  0 = LIGHTING
  1 = SIZE
  2 = SPACING
  3 = WINDOW
  CAL. FUNCTION :
     "F5" TOGGLES DISPLAY
```

FIGURE 11
Steps 18, 19, 20

PROBER

```
  ** CHARACTER SIZE CALIBRATION **

ADJUST WINDOW TO FILL WITH CHAR
"0" = CHARACTER IMAGE ............. 5

"M" SELECTS WINDOW MOVES
"A" SELECTS AREA (SIZE) CHANGE
"X" SELECTS X AXIS
"Y" SELECTS Y AXIS
"1" TO "4" SELECTS RESOLUTION
OF WINDOW POSITIONING ........1

PRESS "BS"." TO RESIZE / MOVE
PRESS "RUN-ID" TO START ID READ

PRESS "ENTER" TO EXIT
"CAMR" TOGGLES DISPLAY
```



0: SCALE (88,77) SCORE (47) CONTRAST (14.4)

FIGURE 12
Steps 22, 23

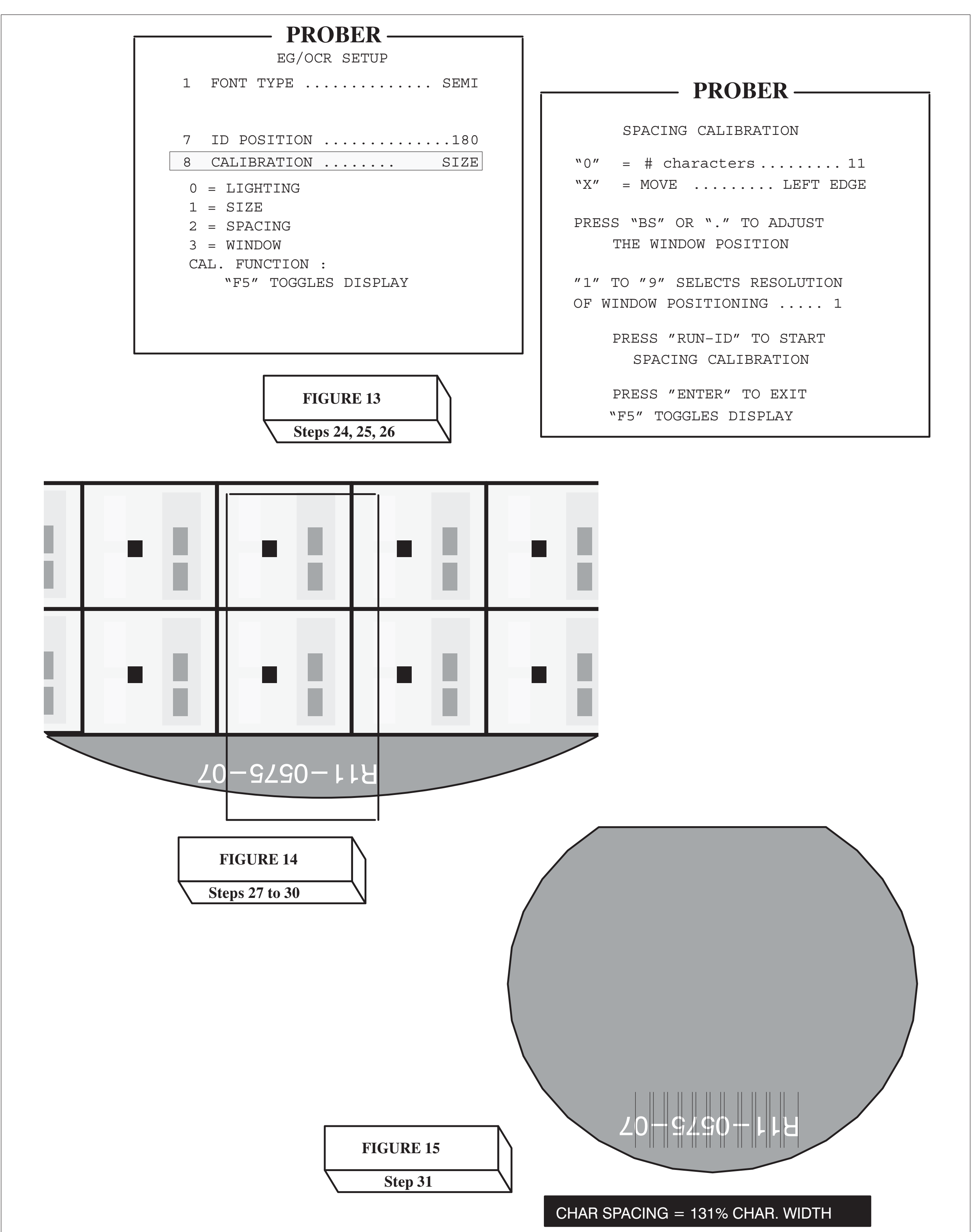


FIGURE 13
Steps 24, 25, 26

FIGURE 14
Steps 27 to 30

FIGURE 15
Step 31

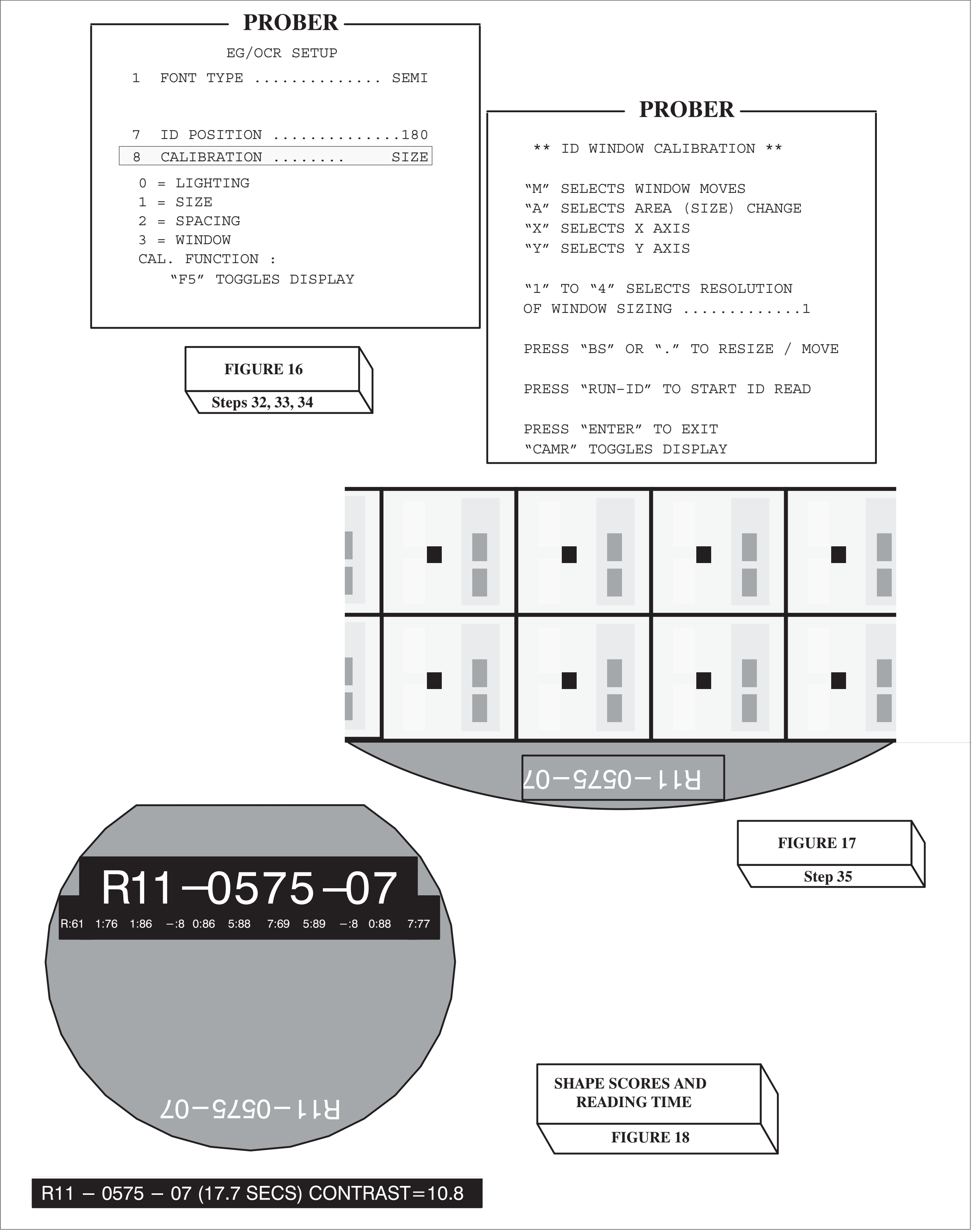


FIGURE 16
Steps 32, 33, 34

FIGURE 17
Step 35

SHAPE SCORES AND READING TIME
FIGURE 18

FIELDING ANALYSIS

The purpose of fielding is to expedite the reading of the wafer ID string. This is accomplished by allowing the user to limit the range of characters that may be allowed in any given field (position) of the ID.

Any character position in the ID may incorporate fielding; however, if a checksum is used, force fielding should not be used on the checksum characters since these characters are guaranteed to be unique for each wafer ID.

Example 1:

If the wafer IDs for a lot of wafers always uses the values "1", "3", and "A" for any of the first three characters, then fielding can be set to exclude all other characters from these positions. By limiting the search range, the OCR algorithm can eliminate comparisons on characters that will never be found. Likewise, if the seventh position will always be a "9", then fielding can be set to limit comparisons to that one character.

Wafer ID (spaces added for clarity):

Note that positions 1, 2, and 3 have one of the three acceptable characters ("1", "3", or "A"), and position 7 has the only acceptable character ("9").

If fielding is disabled, then the entire alphanumeric character set will be used to compare each character position.

The acceptable alphanumeric character set is:

0 to 9, A to Z, hyphen "−", and dot ".".

(spaces are not suitable characters)

In practice, since OCR wafer IDs tend to be sequential within a lot, most of the character positions can be fielded to accept only a single character. The remaining positions would be used for the changing incremental numbers assigned to each wafer.

Example 2:

If a lot of wafers have the ID "49060400−xx−??" where "xx" are the only unique sequentially incremental numbers of the ID, you can set fielding for positions 1 through 9, and 12. Since this ID has a checksum (represented by "??"), those positions will naturally be different for each wafer and should not be restricted by fielding, as illustrated below:

	Location in 14–character string													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Wafer #1	4	9	0	6	0	4	0	0	–	0	1	–	?	?
2	4	9	0	6	0	4	0	0	–	0	2	–	?	?
3	4	9	0	6	0	4	0	0	–	0	3	–	?	?
4	4	9	0	6	0	4	0	0	–	0	4	–	?	?
5	4	9	0	6	0	4	0	0	–	0	5	–	?	?
6	4	9	0	6	0	4	0	0	–	0	6	–	?	?
7	4	9	0	6	0	4	0	0	–	0	7	–	?	?
8	4	9	0	6	0	4	0	0	–	0	8	–	?	?
9	4	9	0	6	0	4	0	0	–	0	9	–	?	?
10	4	9	0	6	0	4	0	0	–	1	0	–	?	?

The characters in positions 1 to 9 and 12 are identical, and positions 10 and 11 are numeral–sequenced through the lot of wafers.

Field One Character Per Location:

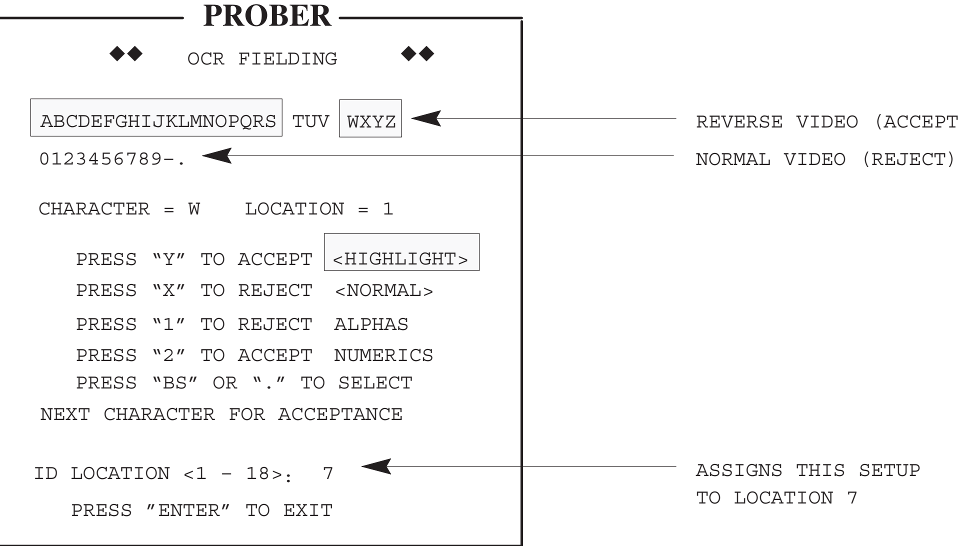
In character location 1 the system will only look for 4.
In character location 2 the system will only look for 9.
In character location 3 the system will only look for 0.
In character location 4 the system will only look for 6.
In character location 5 the system will only look for 0.
In character location 6 the system will only look for 4.
In character location 7 the system will only look for 0.
In character location 8 the system will only look for 0.
In character location 9 the system will only look for –.
In character location 12 the system will only look for –.

Field Ten Characters Per Location:

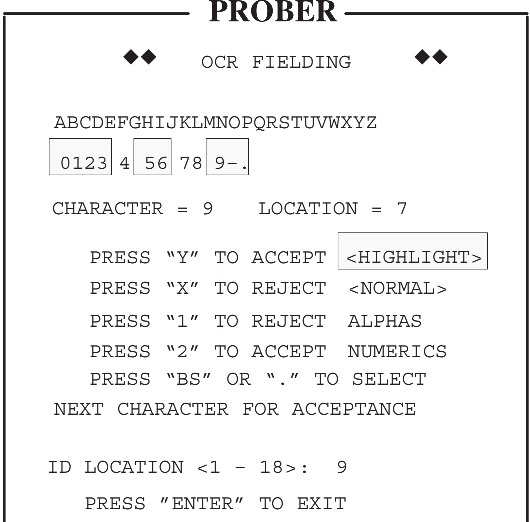
In character location 10 the system will look for 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
In character location 11 the system will look for 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Example 3:

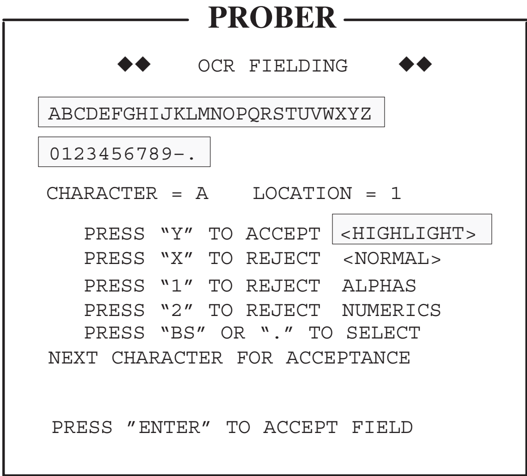
Using the Fielding Menu below, an ID with a maximum length of 18 has location 7 fielded to accept alphas “A” to “S”, and “W” to “Z” (note that those characters are shown in reverse video). Alphas “TUV” and all numerics are rejected (shown in normal video).



The next ID location fielded was at position 9 in the ID string. This was fielded to reject all alphas (shown in normal video) and accept numerics of “0123569−.” (reverse video) but reject numerics “478” (normal video).



The Fielding Menu is only available from the EG/OCR Setup Menu, Line 06. When the line is enabled, the following screen is displayed:



Initially, all characters are accepted (note reverse video on both alphas and numerics).

The < Y > key is used to accept the current character (as seen on the third line, “CHARACTER = ?” as valid. Use the “< −” or “.” keys to cycle through the alphabet/numbers until the appropriate character is displayed at the prompt (third line). Alternatively, the < X > key is used to reject (normal video) the current character from consideration.

Note that the hyphen (”−”) and dot (“.”) characters are included with the numbers. Either or both must be specifically selected if contained in the ID string.

Fielding can be done for multiple characters as seen in the above example. Keys < 1 > and < 2 > are used to reject or accept the entire alpha or numeric character set without having to select each character individually.

Once the appropriate character(s) are accepted or rejected, press < ENTER > to store the character location in the ID string. The bottom of the screen will now display the prompt:

ID LOCATION (1 − 14):
PRESS “ENTER” TO EXIT

This ID location is the string position that will be fielded with the settings just selected. Note that the valid ID locations are limited to the “MAX. ID LENGTH” menu item (line 4 of the EG/OCR SETUP menu) selected before fielding was set up. This maximum length is reflected in the prompt above and is appropriate for Example 2 (14 characters).

Once the ID location is selected, pressing < ENTER > continues the fielding setup. If fielding is complete for this ID, press < ENTER > again to return to the EG/OCR SETUP menu.

SAMPLE OCR EVALUATION REPORT

Page 1 of 2

TEST REPORT
OPTICAL CHARACTER RECOGNITION (OCR)

DATE :
WAFER ID# :

Company :
Address :
Phone :
Contact :

	PARAMETERS	SPECIFICATIONS	TO SPECS	NOT TO SPECS	COMMENTS
1.	Font Style	SEMI M12−89			
**2.	Character height (center line to center line)	64 mils (1.624 mm)			
*2a.	Minimum number of dots	9 vertical			
**3.	Character width (center line to center line)	32 mils (0.812 mm)			
*3a.	Minimum number of dots	5 horizontal			
4.	Aspect ratio (center line height to center line width)	2 : 1			
**5.	Line thickness of character	8 mils (0.2 mm)			
6.	Spacing between two characters (center line to center line)	57 mils (1:42 mm)			
7.	Adjacent character misalignment	9 mils (0.23 mm) maximum			
8.	Line character misalignment	18 mils (0.46 mm) maximum			
9.	Angle of character string to wafer flat	3 degrees maximum			
10.	Distance of character string to wafer flat	60 mils (1.5 mm) minimum			
11.	Number of characters	12 (including two checksum characters)			
12.	Dimension of clear zone around the character string	20 mils (0.5 mm) minimum			
*13.	Assigned identification (wafer)	Numeric: 1 thru 8			
*14.	Assigned identification (vendor)	Alpha: 9 and 10			
*15.	Checksum identification	Alpha: 11 / Numeric: 12			
16.	Open spacing between characters	A dash must be used; no _ open space is allowed			
17.	Condition of clear zone	To be consistent reflectivity and free of scratches, blemishes, process and lithography overlay			

** Dimensional Tolerances of Characters:

Line Thickness: +0.2 − 0.6 mils (+0.05 − 0.15 mm)
Height: +/− 1 mil (+/− 0.025 mm)
Width: +/− 1 mil (+/− 0.025 mm)
Spacing: +/− 1 mil (+/− 0.025 mm)

*Notes:

Items 2a and 3a refer to laser marking only.
Items 13, 14 are preferred by “SEMI” but are not affecting the reading reliability of the characters.
Item 15 is recommended by “SEMI” and will enhance the reading reliability of the character string.

TEST REPORT
OPTICAL CHARACTER RECOGNITION (OCR)

WAFER ID# :

	DESCRIPTION OF OCR SET–UP	PROBER 1	PROBER 2	PROBER 3
1.	Camera			
2.	Camera lens 25 mm 1.4			
2a.	16 mm 1.4			
3.	Focal distance from bottom edge of lens ring to wafer surface (in inches)			
4.	Lens spacing between camera lens and camera body (in inches)			
5.	Illumination: Oblique			
5a.	Coaxial			
6.	Illuminator height, measured from bottom part of lamp housing to wafer surface Oblique			
6a.	Coaxial			
7.	Light intensity: Oblique			
7a.	Coaxial			
8.	Average reading time in seconds			
9.	Prober Software			
10.	Vision Module Software			
11.	Laser marking			
12.	Other marking			
13.	ID Position (in degrees to flat)			
14.	Reading reliability			

SPACE FOR VIDEO PICTURE

COMMENTS:

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14.3.1 SMIF−POD ....14− 4
14.3.2 SMIF−E ARM ....14− 6
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SECTION 14
CLEAN ROOM OPTIONS

14.1 OVERVIEW

The 4085X takes a new approach in microcontamination control: providing an ultraclean processing environment built around the prober, plus an ultraclean transport container for the wafers. This is accomplished by the use of the two clean room options:

CAMS (Clean Air Management System)
SMIF−E™ (Standard Machine Interface) by Asyst Technologies

The CAMS option is an air filtration system that controls the air cleanliness within the prober. The SMIF−E™ option holds the wafers in an isolated container so that they will not be exposed to the environment.

The SMIF−E™ option can only be used in conjunction with the CAMS option. Each of these options is discussed in this section.

14.1.1 How To Use This Section

This section contains the following:

- Basic information about CAMS
- Maintenance procedures for CAMS
- Basic information about Asyst's SMIF−E™ products
- SMIF−E™ operating instructions

14.2 CLEAN AIR MANAGEMENT SYSTEM (CAMS)

The 4085X's CAMS (Clean Air Management System) creates a Class 1 environment within the prober for 5−, 6−, and 8−inch wafers, when the prober is located in up to Class 10,000 areas. This mini−environment eliminates the need for a clean room setup.

The interior is designed so that the operator can interact with tool control panels, keyboards, and screen displays without opening the enclosure. In operation, the enclosure facilitates managed air flow through all process and product handling areas, directing potential contaminants away from the product.

Air cleanliness in the CAMS is controlled by the use of HEPA filters, as well as a combination of an air moving system, an air filtration system, and double−walled, sealed external skins to direct air flow *(Figure 14−1)*.

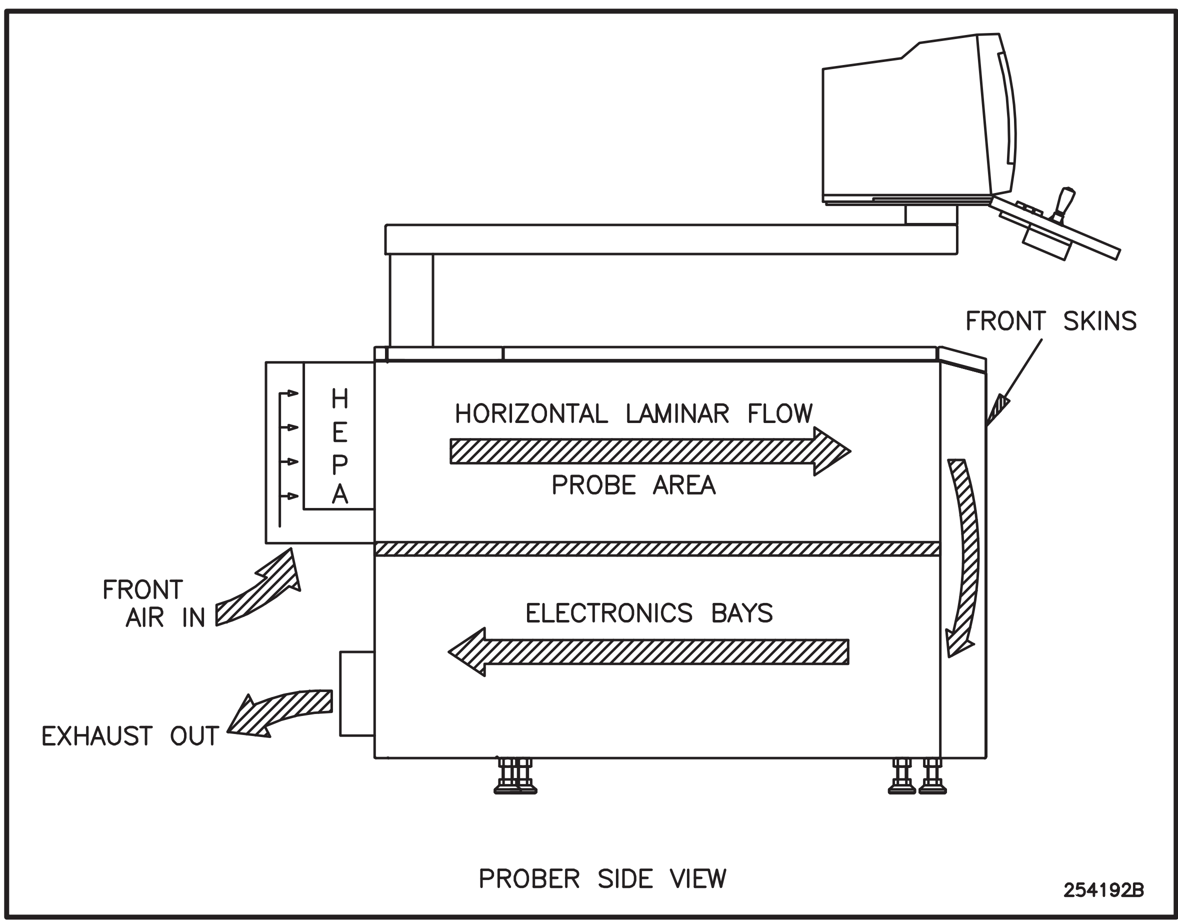

FIGURE 14−1: FLOW OF AIR IN A PROBER WITH CAMS

The air supply system consists of fans, filtration, and connections to the building HVAC per specifications. Provisions are made for cooling and particulate control and exhaust for the electronics bays.

See *Figure 14−2* for the location of the HEPA Filters. These filters need to be changed at least once a year.

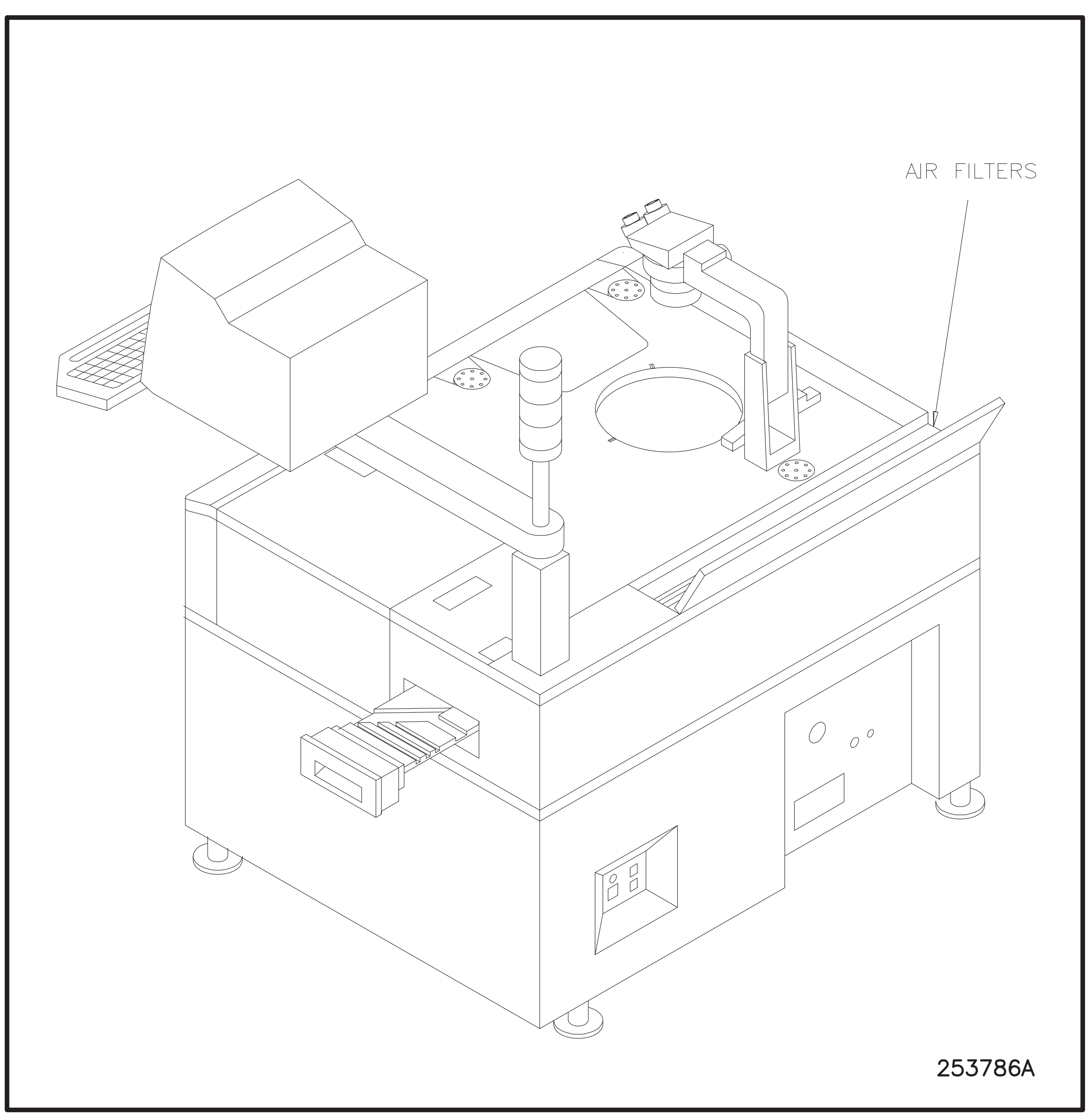

FIGURE 14−2: HEPA FILTERS LOCATION

14.3 STANDARD MACHINE INTERFACE (SMIF−E™)

Used in conjunction with CAMS, the SMIF−E™ (Standard Machine Interface) from Asyst Technologies, Inc. provides robotics which allow wafers to be loaded and unloaded free of exposure to the environment.

SMIF consists of three components:

1. Clean environment enclosures (SMIF−Enclosures™),
2. A sealed wafer carrier container (SMIF−Pod™),
3. A robotic arm for transferring wafers from pod to enclosure (SMIF−E Arm™).

14.3.1 SMIF−Pod™

The SMIF−Pod™ is an environmentally secure wafer cassette container designed to reduce the level of particle contamination caused by the loading, unloading and transfer of wafers. The SMIF−Pod™ is a transparent box *(Figure 14−3)* that secures the cassette within a sealed Class 10 or better microenvironment, and is easily transported from station to station.

The pod has a handle on top, used to place it on the cassette plate on the SMIF−E Arm™. An interlock feature prevents the port doors from opening unless the pod is properly mounted, assuring a particle−tight connection. Additionally, a WaferLock™ mechanism secures the wafers within the cassette during storage and transport. It is a specially designed wafer retainer that prevents wafer movement or vibration within the cassette to minimize the release of submicron particles into the SMIF−Pod™.

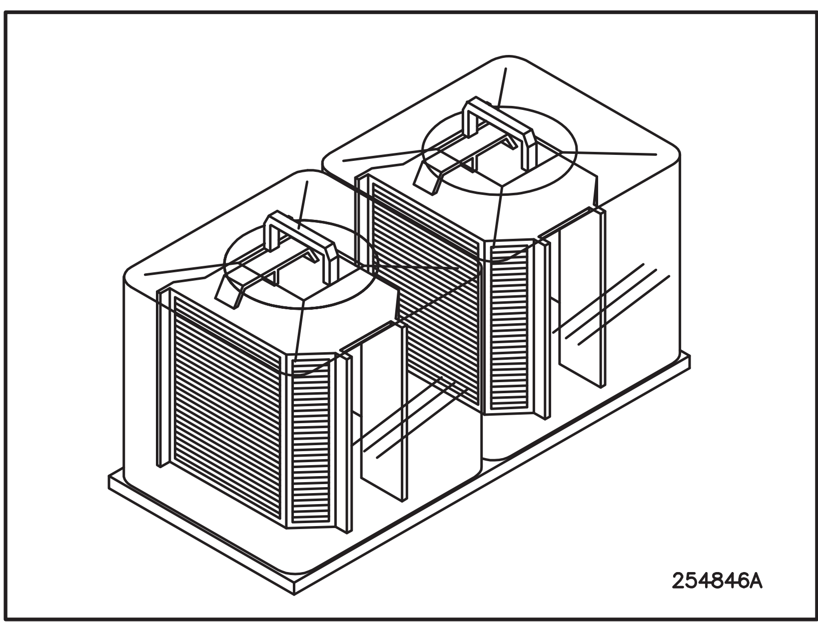

FIGURE 14−3: SMIF POD

Figure 14−4 illustrates the SMIF−Pod™ travel in the 4085X prober.

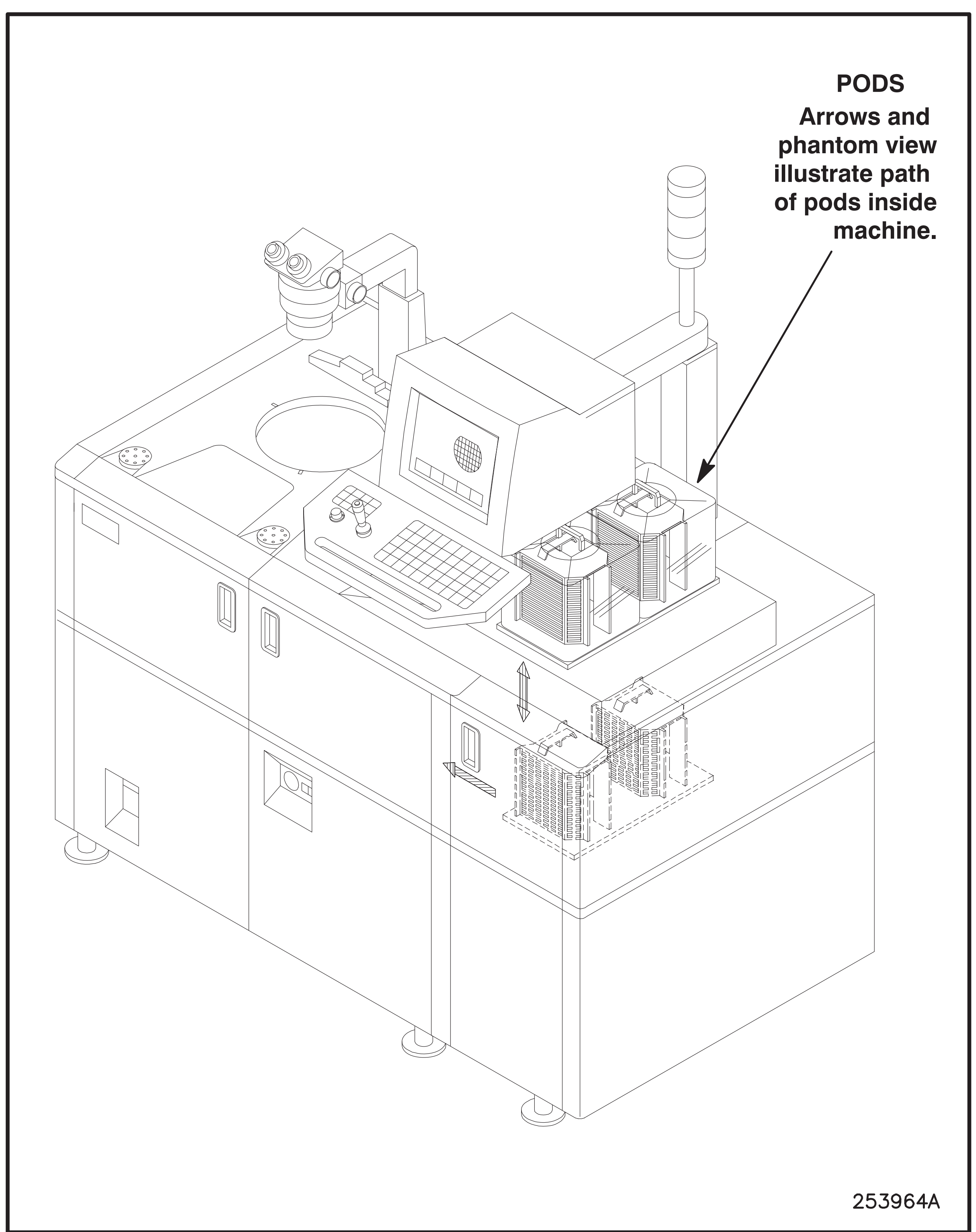

FIGURE 14−4: SMIF POD TRAVEL

14.3.2 SMIF−E Arm™

The SMIF−E Arm™ is a robotic transfer mechanism that allows an I/O device, with a mating interface, to open the pod and transfer the product into the tool area without exposing the outside of the pod to the inside of the enclosure. This protects the product from sources of contamination outside of the immediate process area of each tool or cluster.

A gripper mechanism removes the cassette from the SMIF−Pod™ base and places it precisely onto the cassette platform, allowing the pod base to return to the closed position. Except for this brief load/unload cycle, the pod remains sealed to the environment.

More detailed information on any of Asyst Technologies' SMIF products can be obtained by contacting Asyst at (408) 263−5111.

14.3.3 LOADING AND UNLOADING FROM THE SMIF−E ARM™

You can load and unload the pod containing the wafers either using the SMIF−E Arm™ controls or the SMIF Arm Diagnostic Menu.

LOADING/UNLOADING FROM THE SMIF−E ARM™

1. Ensure that the power switches on the SMIF−E Arms™ have been turned on.
2. Press the ◗LOAD◖ or ◗UNLOAD◖ button on top of the arm to begin that function.

OTHER SMIF−E ARM™ FUNCTIONS

When the ◗HOME◖ button is lit, the SMIF−E Arm™ has detected errors during the operation. The arm can be commanded to return to the **HOME** position by pressing the lit ◗HOME◖ button.

When the Material Handler is powered on, the system determines if the Handler is equipped with a SMIF−E Arm™. If it is, when the < ENTER > key on the monitor keyboard is pressed to start system initialization, the Handler checks the presence of the SMIF−E Arms™ and notifies the operator if any are not found or are not ready. The Handler will then display a prompt asking the operator's permission to proceed.

If any joint of the arm is not in its **HOME** position after the SMIF−E Arm™ is powered on, the SMIF−Arm™ beeper will sound continuously.

Ensure that the MCP is connected and set up in **MANUAL** mode to command each joint to its **HOME** position individually in order to clear the beeper:

1. If the MCP is *not* connected to the SMIF−E Arm™, press the ◗LOAD◖ or ◗UNLOAD◖ button on top of the arm. (If the MCP *is* connected, pressing the lit ◗LOAD◖ or ◗UNLOAD◖ button will *not* initiate the operation.)

2. If the MCP *is* connected to the arm and is switched to **AUTO** mode, when the monitor displays the message `HOST READY TO LOAD` or `HOST READY TO UNLOAD`, press the < LOAD > or < UNLOAD > keys on the MCP.

3. Use remote control from the Handler to set the **START LOAD/UNLOAD** signal line to active.

LOADING/UNLOADING FROM THE DIAGNOSTIC MENU

As in the other diagnostic menus, the operator is responsible for safe control of the SMIF−E Arms™ when using this menu.

To access the SMIF Diagnostic Menu (*Figure 14−5*), press < DIAG > (< F3 >) and at the next screen, press < ENTER >.

PROBER

10:10:06	249799.122DB		1/10/94
POS X	1	DIE X	100.0
Y	2	Y	200.0
ZDN	200	INKER	DIS
WAFER	ON	DIA	100MM
Z−MODE .. LIMITS			
CHUCK VAC ...	ON	SECS	DIS
PROBER –> CIRCL		X I/O....	OFFLINE
SCAN		WAFER #	10
IDLE		GOOD DIE	100
		BAD DIE	20
		UGLY DIE	10

HANDLER

** SMIF ARM MODULE **

** ARM 1 **
STATUS LOADING POD IN
1 = START LOAD/UNLOAD
2 = *READY TO LOAD
3 = READY TO UNLOAD
4 = PORT LOCK
** ARM 2 **
STATUS OK UNLOAD POD IN
5 = START LOAD/UNLOAD
6 = READY TO LOAD
7 = *READY TO UNLOAD
8 = *PORT LOCK
PRESS “ENTER” TO EXIT

FIGURE 14−5: SMIF DIAGNOSTIC MENU

1. For SMIF−E Arm™ 1, enter 2 (Ready to Load) and an asterisk appears next to the line item.

2. Enter 1 (Start Load/Unload) and the load/unload process begins. The ▶LOAD◀ button on the top of the arm should be lit.

To unload:

1. For SMIF–E Arm™ 1, enter 3 (Ready to Unload) and an asterisk appears next to the line item.
2. Enter 1 (Start Load/Unload) and the load/unload process begins. The ▶UNLOAD◀ button on the top of the arm should be lit.

14.4 SUMMARY

In this section, you have learned:

- ✓ Basic information about CAMS
- ✓ Maintenance procedures for CAMS
- ✓ Basic information about Asyst's SMIF–E™ products
- ✓ SMIF–E™ operating instructions

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APPENDIX A
CUSTOMER SPECIAL – SAFETY

DEFINITION OF ELECTRICAL WORK AND SERVICE BY TYPES

All electrical work or services described in the manual shall be identified by type numbers as defined in the SEMI S2−93A if such work or service is type 3 or higher. A comprehensive power distribution diagram is presented in *Figure A−1*. The following are the five types of electrical work or services:

Type 1: Equipment is fully de−energized (electrically cold).

Type 2: Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock.

Type 3: Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposure is less than 30 Volts RMS, 42.2 Volts peak, 240 Volt−Amps, and 20 Joules.

Type 4: Equipment is energized. Live circuits are exposed and accidental contact is possible. Voltage potentials are greater than 30 Volts RMS, 42.2 Volts peak, 240 Volt−Amps, or radio frequency (RF) is present.

Type 5: Equipment is energized and measurements and adjustment required physical entry into the equipment, or measurements using the non−clamp−on probes in areas where voltages are greater than 50 Volts.

FIGURE A–1: POWER DISTRIBUTION DIAGRAM – 100/115/230V

EARTHQUAKE RETENTION PROCEDURES

Attachment of retention devices to secure the 4085X prober are available. Access to the attaching points is from the bottom of the frame assembly near each caster location.

Attachments to the unused caster locations are used for restraining the prober from movement; the only difference is the size of the hardware needed if a specific ring carrier option is installed. Probers ordered with the S9000 Ring Carrier interface use lower profile casters than any other configuration. The attaching hardware for S9000 applications is 3/8–16 cap screws. The length of the fastener is dependant upon the attaching fixture plus 1/2" for insertion into the frame.

The fasteners for all other probers (other than S9000) is 1/4–20 cap screws. Length is dependent upon the attaching fixture but only 5/16" more thread can be used.

For absolute safety from movement during an earthquake, it is recommended to use at least two attaching positions diagonal to the frame for S9000 applications. For all other probers, it is recommended to use four attaching positions, one at each corner of the frame.

SAFETY OPERATION OF THE POWER CONTROL MODULE

Functions

This appendix describes the functions of the Power Control Module (PCM) circuit and the safety operation of the Emergency Machine OFF (EMO) and Power OFF push–button switches.

These push–button switches are appropriately labeled with indicating lights and are located in the front panel of the PCM. The ON and OFF switches have flip–open safety covers, while the EMO push button is a large red mushroom–type switch 1.25 inches in diameter.

POWER ON

Power is available to the prober system and subsystems whenever the system Power ON push button is activated, and is indicated by the amber light on the button. For safety reasons, simultaneous pressing the EMO or the OFF push button *and* the Power ON push button will *not* start the prober system or its subsystems.

POWER OFF

The Power OFF function, when activated, removes all power from the prober system.

The OFF function only removes power from the prober system and does not de–energize other interfacing equipment such as a tester. Repeating the OFF function will *not* re–start the prober.

EMERGENCY MACHINE OFF (EMO)

The EMO function, when activated, removes all power from the prober system (including subsystems and other interfacing systems such as the tester), and places the system in a de–energized, safe condition, with one exception; the EMO control circuit (24VDC) can only be de–energized by turning the main circuit breaker off, located on the back of the Power Supply Module/Power Distribution System (PSM/PDS).

The EMO function, therefore, overrides all power control functions except the main circuit breaker. Continual pressing of the EMO push button will *not* re–start the system or any subsystem.

System Description

The AC power in the 4085X is controlled by the PCM circuitry. The PCM integrates the functions of power ON, OFF, and EMO.

The Power Control System operates from a 24VDC power supply for safety purposes. The primary power disconnect is by means of a large circuit breaker on the Power Supply Module (PSM).

The ON condition of the circuit breaker is indicated by a lamp on the PSM. The OFF condition of the circuit breaker also removes power from the Power Control System (+24VDC).

The main power ON is indicated by a white lamp on the front panel of the PCM and indicates that the +24VDC control voltage is available and that the main circuit breaker is on (PSM). An amber light located in the ON push button indicates that system power is on.

Simplified System Diagram

A simplified schematic diagram is shown in *Figure A–2.*

The main circuit breaker is turned on as indicated by the lamp next to the circuit breaker and the lamp on the front panel of the PCM. Therefore, point **A** has +24VDC. Since the external EMO jumper exists and the EMO and OFF push button are normally closed (NC), point **B** also has +24VDC.

If the ON push button is pressed, +24VDC will be seen at the relay coil, point **C.** This +24VDC will operate the relay which closes the relay contacts. The closing of the relay contacts connects points **B** and **C.**

If the ON push button is now released, the relay stays energized through its own contact. This is called *latching relay circuit*. Note that the other relay contact applies AC power to the system power supplies.

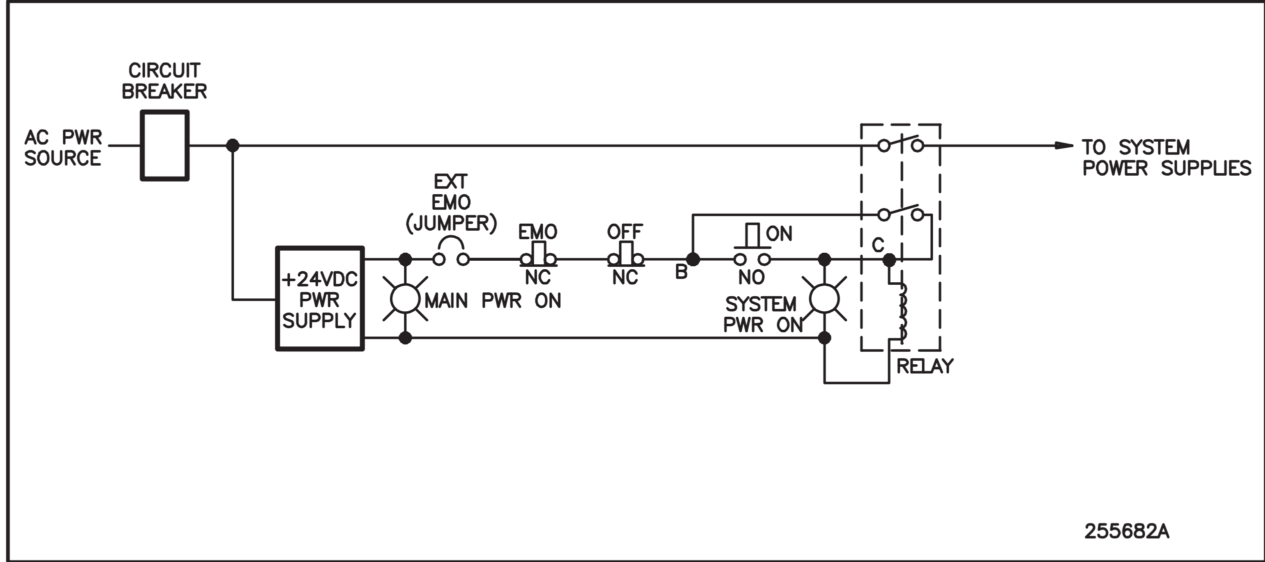

FIGURE A–2: POWER CONTROL SYSTEM SIMPLIFIED DIAGRAM

The current path is:

From the +24VDC Power Supply
Through the External EMO (Jumper)
Through the EMO push button
Through the "OFF" push button
Through the relay contacts
Through the relay coil
Back to the power supply

If anything interrupts the current path, the relay coil will be de–energized and therefore open the relay contacts. This can be accomplished by pressing the EMO or OFF push buttons or removing the External EMO jumper. The only way to reactivate the Power Control System is to press the ON push button again. Note that the ON button cannot override the OFF, EMO, or External EMO functions.

Detailed System Connections

The Power Control System connections are shown in *Figure A–3.*

The External EMO (jumper) is brought to a connector, J418, on the back of the Pneumatic Module. This allows the expansion of the EMO capacity; that is, an additional EMO button can be placed externally to the Electroglas probing system.

When no external EMO capability is required, the jumper connector is necessary, from J418, Pin 3 to J418, Pin 4.

Also note that the EMO push button is actually a 2–pole type. This second pole is wired to J418 at pin 1 and 2. This provides additional EMO capabilities.

The Power Control System provides for a remote relay control capability. This allows the ON, OFF, and EMO functions to be expanded to an assembly outside the Electroglas prober.

This could be accomplished by wiring a 24VDC coil between J419–6 and J419–7 (GND). The schematic indicates a relay (typical). There are actually multiple relays in which the coils are connected in parallel.

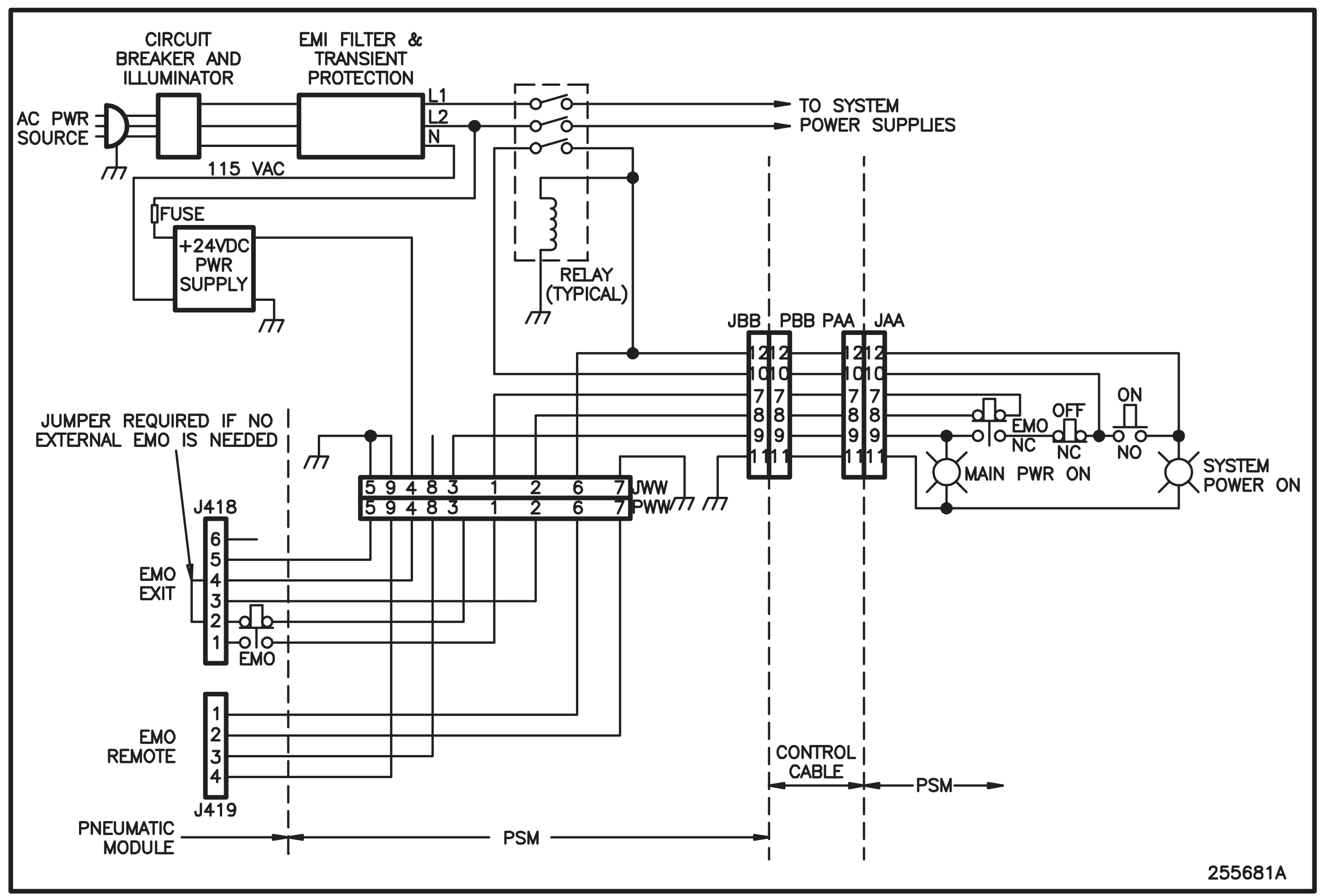

FIGURE A–3: POWER CONTROL SYSTEM CONNECTIONS

POWERING DOWN

The system displays the DOS prompt. You may complete the powering–down procedures by pressing the System Power OFF circuit breaker, located on front of the machine (see *Figure A–6*).

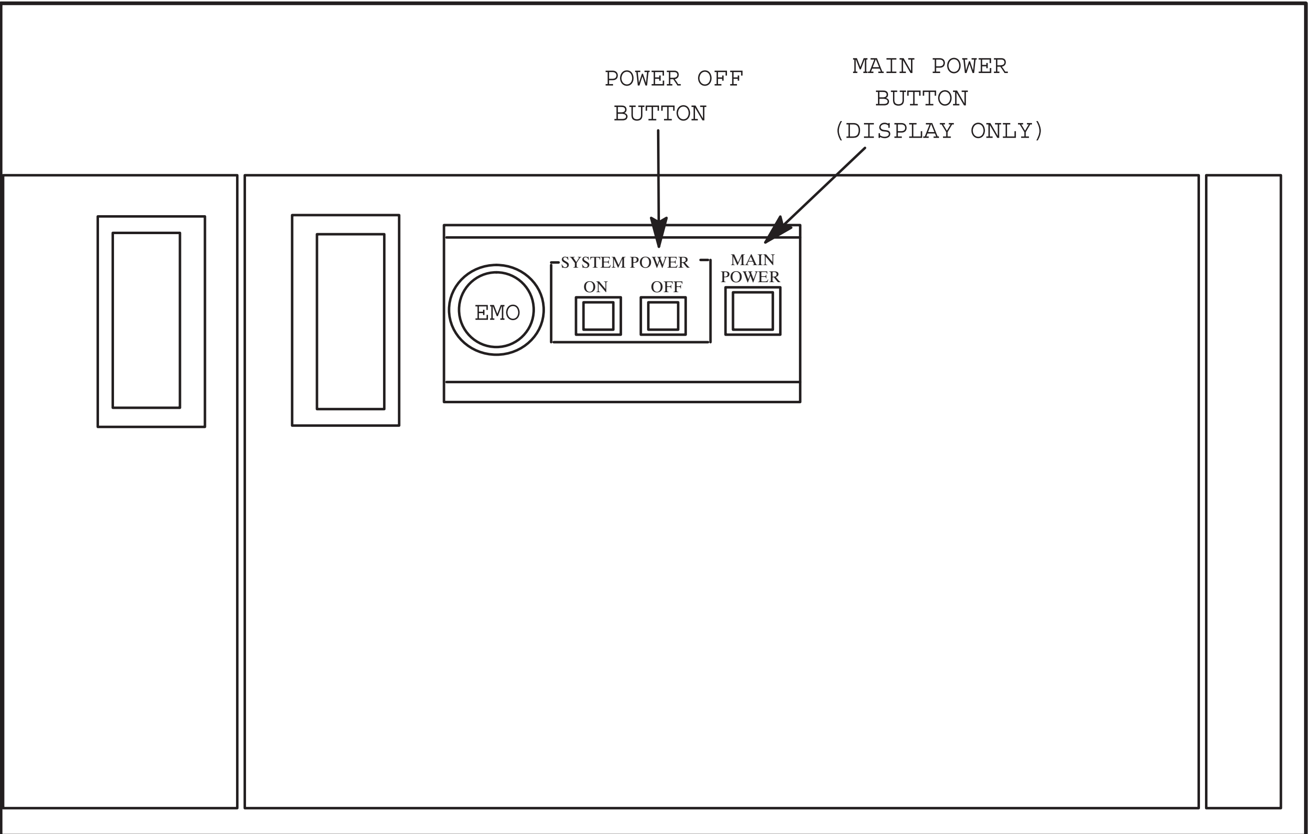

FIGURE A–6 POWER SWITCH LOCATIONS

After you have pressed the System Power OFF button, the Main Power button will always remained lighted unless the Power Supply circuit breaker (located at the back of the prober) is powered off. It is recommended that you keep the Power Supply powered on at all times and only power down by pressing the System Power OFF button. The facility circuit branch should have a rating of 10,000 AIC.

PRODUCT COMPLIANCE

The Electroglas 4085X Series wafer probers meet the SEMI S2 Design Guidelines and the following European CE Mark Requirements:

- Electromagnetic Compatibility (EMC) Directive (89/336/EEC)
- Machinery Directive (91/368/EEC)
- Low Voltage Directive (73/23/EEC)

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APPENDIX B
PROCEDURES

This Appendix contains various procedures to be performed on the prober, including:

- Theta Alignment
- Z Drive Verification
- Manual Probe−to−Pad Optimization
- Partial Wafer Probing
- Setting First Die
- Returning to and using DOS on the prober

APPENDIX C
KEYS AND SCREEN REFERENCE

This section gives a brief explanation of the following:

- Function keys
- Joystick keys
- Run Time Display items

This section is intended to be used as a reference section only; detailed information on parameters and functionality of the system does not appear here.

KEY	FUNCTION	DESCRIPTION
GROUP ONE	**MENU KEYS**	Display menus on monitor screen for selection of parameters and input of instructions.
SET PARM	Displays Set Parameter Menu	Enter numerical value for each parameter to be changed.
SET MODE	Displays Set Mode Menu	Select variables for each mode of operation to be changed.
SET OPTN	Displays Set Option Menu	Use numerical keys to input values and/or enable/disable optional features as appropriate.

DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	RESET LAMP Z	WAFER MAP W
SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

KEY	FUNCTION	DESCRIPTION
GROUP TWO	**ENTER VALUES AND SELECTIONS**	Enter numerical values, line selections, and parameter variable selections.
0 9	Numerical keys – to input data and select lines.	Access menu; select line; enter value or select variable. Press <ENTER> to complete input and enter data into memory.
ENTER	Enter data or exit menus	Press after selection of lines and after input of value or variable. Press again to exit menus. Other functions are discussed in text.
CE	Clear present numerical input	Clears values, line, or parameter variable selection PRIOR to pressing the <ENTER> key.
◄	Backspace over numerical input	Backspaces over digits entered; write over digits, if desired.
	OR: Reverse X travel during Autoprobe	Press <PAUSE/CONT> key. An arrow by "PROBE" on the Run Time Display shows the direction of travel.
.	Decimal Point	Provides the decimal point for numerical values.
–	Numerical negative assignment	Generally used to assign negative values to the coordinates of the starting die point.
X	Enable XY Jog	Use with the Profiler Menu (see **Section 6, NONCONTACT EDGE SENSOR**), and with External I/O (**Section 8, EXTERNAL CONTROL I/O INTERFACE**).
Y	Yes	Press to replay "yes" to prompts for Yes/No answers to prompts.

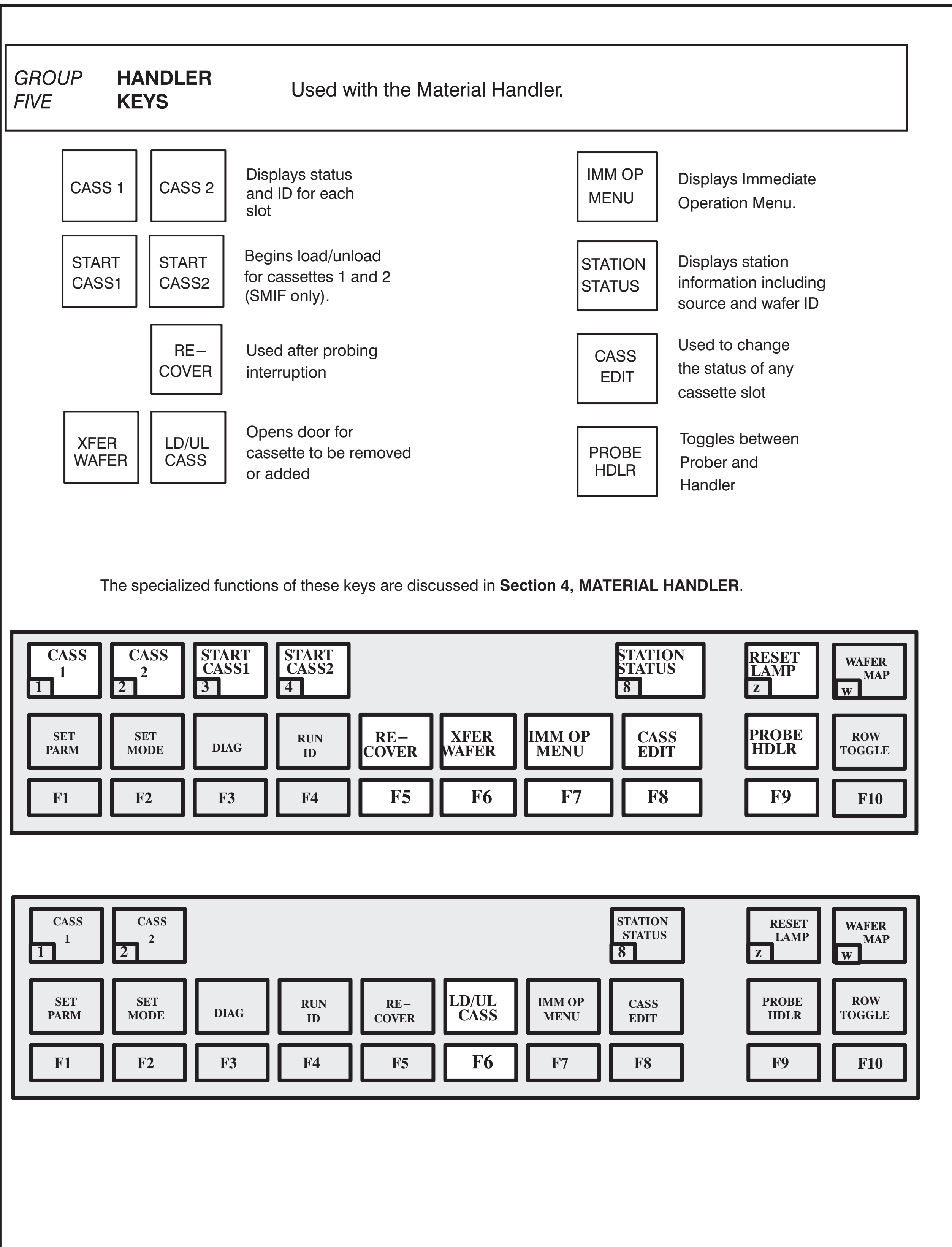
(continued)

KEY	FUNCTION	DESCRIPTION
GROUP THREE	**STORING DIE POINTS IN MEMORY**	Used to store First Die point and store and delete specific die points.
FIRST	Enter in memory First Die location	Used after First Die of wafer is positioned beneath the test probes. With appropriate options and probe mode, each new wafer is positioned at the same starting point.
STORE	Enter into memory single die points of microdie coordinates	Used after die is positioned beneath test probes with the Joystick or by interrupting the Autoprobe operation with the <PAUSE/CONT> key. Press to store die point to memory.
DELE	Delete single die point from memory	Used after die is positioned beneath test probes. The beeper will sound once each time the <STORE> or <DELE> key is pressed to store or delete a die position to confirm that some action was taken.
LEARN	Displays Learn Menu for input of die points and microdie sites.	Enter die points as XY coordinates (and/or as rows). Enter numerical values for each coordinate.

SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	RESET LAMP Z	WAFER MAP W
DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

KEY	FUNCTION	DESCRIPTION
GROUP FOUR	**AUTO ALIGN KEYS**	Used with Automatic Alignment System (Vision Module).
FIND TARG	Select target pattern for pattern recognition	Press to position wafer beneath camera and display image. Use joystick to improve the pattern's position. Press <PAUSE/CONT> to store pattern. Press <FIND TARG> to restore stored pattern and repeat the process. (Other controls and keys are also used with this key.)
AUTO ALIGN	Initiates Automatic Alignment Sequence	Die patterns are viewed under camera and compared to patterns stored by the Find Target command. A series of patterns is sampled, and theta adjustments correct wafer–to–prober XY alignment. Wafer moves to First Die position. (Other controls and keys are also used with this key.)
DIG VID	Displays digitized video from Vision Module	Displays the area seen by the camera and digitized by the Vision Module. Toggles between the video window and Automatic Gain and Offset adjustment (AGO).

SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	RESET LAMP Z	WAFER MAP W
DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10


GROUP FIVE
HANDLER KEYS
Used with the Material Handler.
CASS 1
CASS 2
Displays status and ID for each slot
START CASS1
START CASS2
Begins load/unload for cassettes 1 and 2 (SMIF only).
RE– COVER
Used after probing interruption
XFER WAFER
LD/UL CASS
Opens door for cassette to be removed or added
IMM OP MENU
Displays Immediate Operation Menu.
STATION STATUS
Displays station information including source and wafer ID
CASS EDIT
Used to change the status of any cassette slot
PROBE HDLR
Toggles between Prober and Handler
The specialized functions of these keys are discussed in Section 4, MATERIAL HANDLER.
CASS 1
CASS 2
START CASS1
START CASS2
STATION STATUS
RESET LAMP
WAFER MAP
SET PARM
SET MODE
DIAG
RUN ID
RE– COVER
XFER WAFER
IMM OP MENU
CASS EDIT
PROBE HDLR
ROW TOGGLE
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
CASS 1
CASS 2
STATION STATUS
RESET LAMP
WAFER MAP
SET PARM
SET MODE
DIAG
RUN ID
RE– COVER
LD/UL CASS
IMM OP MENU
CASS EDIT
PROBE HDLR
ROW TOGGLE
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10

GROUP SIX	**MISCELLANEOUS FUNCTION KEYS**	Most are related to some external function.

Key	Function	Description
DIAG	Diagnostics	Select a set of exercise functions; see **Section 3, TUTORIALS**.
DISK	Used for disk operations	Used, with other keys, to format and copy disks, store and load parameters, and access or leave the disk program.
RUN ID	Displays menu for LOG ID entry	Menu items are: 1. Clear all log data 2. Current wafer number 3. Device type 4. Lot number
ON LINE	Activates interface port – RS232 or GPIB (IEEE–488)	The interface permits external control of the prober by host computer. Each key activation alternates between On Line and Off Line. The status is given in the Run Time Display.
PROG	Produces Profiler Menu	For setting up parameters related to the Noncontact Edge Sensor. Details are given in **Section 6, NONCONTACT EDGE SENSOR.**

SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	RESET LAMP Z	WAFER MAP W
DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

JOYSTICK KEYBOARD FUNCTIONS

Table updated May, 1996

Keys described as located, from left to right and top to bottom

Key	Function	Description
VAC	Manually switches vacuum to chuck alternately "ON"/"OFF"	Usually used in connection with manual loading/unloading of wafers. Vacuum is "OFF" during load to allow orientation of wafer flat. With wafer in place, vacuum is switched "ON." After probe, wafer returns to load area and vacuum is shut "OFF" to allow unloading. "ON/OFF" status is shown on the RUN TIME DISPLAY. NOTE: When the prober requires vacuum for a move and vacuum is "OFF," the vacuum is switched "ON" automatically.
LOAD	Returns chuck to "HOME" or load position	Positions chuck for manual loading/unloading of wafers. Prober waits about two seconds to allow vacuum to bleed before chuck drops to 30 mils. If Material Handling is enabled, wafer on chuck is unloaded and a new wafer loaded.
ALIGN SCAN	Initiates theta alignment; positions wafer for scan.	Moves chuck from present position to within probe area. Wafer is then advanced along X axis and theta−aligned. Although it can be activated from any position, "ALIGN SCAN" usually follows load operation. In any case, Vacuum Chuck Assembly must be at rest.
INK ENBL	Enable/disable inkers.	Status of system inkers is monitored on RUN TIME DISPLAY as `ENB` or `DIS`. The switchkey alternates between the two.
LAMP	Enable/disable lamp	Turns microscope and camera lamps "ON"/"OFF."
AUTO PROBE	Activates "AUTOMATIC PROBE" function	Normally, "AUTOPROBE" is part of a sequence and follows the theta alignment procedure. Probe operation starts from first die point. When key is pressed, prober executes pattern selected by operator from Set Mode Menu. After probe, chuck returns to load position.
PAUSE /CONT	(Many applications)	o Interrupts "AUTO PROBE" o Activates "ALIGN SCAN" o Stores Pattern Recognition Unit (PRU) reference for auto align.

(continued)

JOYSTICK KEYBOARD FUNCTIONS (continued)

Keys described as located, from left to right and top to bottom

Key	Function	Description
INK TEST	Test designated inkers	Produces prompt “Turn which inker on? (1 to 4)”.Select one. For example, test inker 4 by pressing the < 4 > key to initiate a visible test. Cancel the request by pressing the key again, or by input outside the inker range of 1 to 4.
TEST CYCLE	Initiate probe test	Starts probe test, as indicated by the prompt “Start test” at the bottom of the screen. Upon completion, the bin code is displayed.
Z	Moves chuck to Z upper or lower position	Both “UP” and “DOWN” positions are determined by respective limits or by limits associated with the edge sensor or profiler. After the prober detects a Z slip, an attempt is made to correct the Z position maintained by the prober. The < Z > key may be pressed after a Z slip; the chuck will be lowered to 200 mils.
CAMR	Camera enable/disable	Used as alternating switch with Auto Align is enabled. With camera enabled, monitor displays camera’s field of view.

As of Software Revision DF, when the < CAMR > key is pressed, the Display Control Module (DCM) software displays either the Camera or the High Frequency (HF) Microscope Video image, based on information about the present forcer location and the presence of the Video Blaster Board.

This ProberVision software will make a check to see if the wafer is under the probe tip when the operator presses the < CAMR > key.

If the wafer is under the probe tip area, the DCM software displays the HF microscope image. Otherwise, it displays the Camera image.

To support this feature, the following DCM subsystem and PVS subsystem are needed at or above the specified revision level:

DCM (RTM) PN 250450−001.AE
PVS PN 249799−X2X.DF

RUN TIME DISPLAY – EXPLANATION

DISPLAY ITEM	EXPLANATION
(CURRENT TIME)	In hours, minutes, and seconds, based on a 24–hour system. The date appears at the end of the line.
POS X Y Z (POSITION XYZ)	The X and Y elements identify the current die coordinates with respect to the preset die point. Depending on travel direction, the X coordinate increases or decreases as it advances along the X axis. The Y coordinate changes as it advances along the Y axis. The Z element shows the status of chuck UP / DOWN travel and the Z height in mils.
WAFER	Current chuck vacuum status; ON indicates a properly mounted wafer, OFF an improperly mounted or absent wafer. Status is determined by the vacuum system, and also refers to the status of the vacuum switch itself. The status indication may be ignored when probing partial wafers by Material Handling and enabling IGNORE VAC (Set Mode/Miscellaneous Options Menus).
Z MODE (Z TRAVEL MODE)	Defines which device will establish the limits of Z travel during probing. The three modes possible are: o LIMITS – Use Z Upper and Lower Limits entered in the Set Parameter Menu. (No clearance or overtravel.) o EDGE SENSE – Uses the edge sensor contact point and adds overtravel of clearance, depending on the direction of movement. o PROFILE – Uses an operator–determined Z height (the point at which the wafer first makes contact with the probes) as its center of travel. The probing height is modified mathematically to reflect surface variations. Overtravel and clearance are used.
CHUCK VAC (CHUCK VACUUM)	On / Off status as triggered by the <VAC> function key (Joystick Keyboard). A vacuum failure shows Off.
PROBE	EDGE, MTRX, CIR, LEARN, ROW, XTRN, PTIAL, and OFF. The automatic probe pattern, as entered through the Set Mode Menu. In addition, the arrow indicates the current direction of prober travel along the X axis. (The arrow is not active in the LEARN, ROW, or XTERN modes.)
(JOYSTICK MODE)	Joystick modes are Jog, Index, and Scan, selected by rotating the Joystick.
(PROBER STATUS)	One of seven possible status messages will appear: ALIGN, STOREREF, PROBE, AUTOPRB, ABORTED, BUSY, IDLE. The first four can also be combined with <PAUSE/CONT>; the reverse image PAUSE will then appear beside the Joystick mode.
ID=	Wafer identification.

(continued)

RUN TIME DISPLAY – EXPLANATION (continued)

(SOFTWARE IDENTIFICATION)	The software revision number and part number appear in the center of the top line.
(UNIT OF MEASURE)	The Measurement System (ENGLISH or METRIC) currently active for the instrument. Shown as MIL or MM.
DIE X... Y... (DIE SIZE)	X and Y dimensions, as entered in Line 01 of the Set Parameter Menu, are shown in 7–character floating–point numbers.
INKER	ENBL / DIS status of the Inkers, as triggered by <INK ENBL> key (Joystick Keyboard).
DIA (WAFER DIAMETER)	The value entered for Line 04, Set Parameter Menu, always given in millimeters.
SECS (STATUS)	The status of SECS (Semiconductor Equipment Communication Standards) communication.
X I/O (INTERFACE STATUS)	Status (ONLINE / OFFLINE) of the interface port, triggered by the <ON LINE> key <F4>.
WAFER #	The number of the wafer currently being probed. The number for the initial wafer is set by the operator and is automatically incremented for each subsequent wafer.
GOOD DIE **BAD DIE**	Counters used to indicate the total number of good/bad die probed up to and including the current die position. The total is reset to zero with the <RUN ID> key or the start of a new wafer. The judgement (GOOD or BAD) comes from the Preset Inker Assignment (Assign Logical Ink Code Menu). When multi–die returns both good and bad bincodes from a single test, both counters will be updated.
UGLY DIE	This line displays the ugly die count and is an accumulated total in the same manner as the good and bad counts. If the cassette log is reset, all three counts resets to 0. The ugly die count is displayed independently of the enabling of the ugly die function.

SPECIAL DISPLAY:

MAP BIN CODE **TEST RESULT**	When Wafer Mapping is enabled and the prober is in a PAUSE state, the last reported bin code for the current die under the probes will be reported at the bottom of the display. This can be used to randomly re–test die to compare results with previous values and probing/test verification. This feature is explained in **Section 10 (WAFER MAPPING AND SECS**).

OTHER DISPLAYS, MESSAGES, AND PROMPTS APPEAR IN CONNECTION WITH VARIOUS FUNCTIONS AND PROBLEMS. THEY ARE EXPLAINED ELSEWHERE IN THE MANUAL.

THETA ALIGNMENT

The Theta Alignment Procedure is used to align the wafer prior to the probe operation. Two of the more common alignment procedures are given here.

Wafer reference is aligned with respect to the X axis.

THETA ALIGNMENT PROCEDURE #1

1. Set the joystick to Jog. The mode status is shown on the Run Time Display.
2. Press the <ALIGN SCAN> key to position the left side of the wafer at probe tip center.
3. Using the joystick and microscope, position the wafer so that the horizontal microscope cross hair lines up with a street along the X axis. It is important to use the exact edge of the street.
4. Press the <PAUSE/CONT> key. The wafer is moved so that its right side is now at probe tip center. Observe the reference as the wafer advances.
5. Using the joystick, align the same street edge with the microscope crosshair.
6. Press the <PAUSE/CONT> key. The chuck will rotate slightly and immediately start to scan back and forth in the X axis, allowing visual confirmation of alignment. Use the joystick during the scan to bring the street edge adjacent to the crosshair so that alignment accuracy can be visually judged.
7. Using the microscope, observe the alignment of the crosshair and street edge. The two should be aligned as the wafer scan progresses. If not, either repeat the procedure or use the theta control knob to complete the adjustment. Press the <PAUSE/CONT> key to stop the scan.

(continued)

THETA ALIGNMENT (continued)

THETA ALIGNMENT PROCEDURE #2
1. Set the joystick to Jog. The mode status is shown on the Run Time Display. 2. Press the <ALIGN SCAN> key to position the left side of the wafer at probe tip center. 3. Using the joystick and microscope, position the wafer so that the horizontal microscope cross hair lines up with a street along the X axis. It is important to choose the exact edge of the street. 4. Press the <PAUSE/CONT> key twice. The scan begins immediately, back and forth across the wafer. 5. Observe the crosshair and reference as the scan progresses. If the two are not aligned, use the theta control knob to adjust. Remember, the theta control is limited to a total travel of +/− 10 degrees. Press the <PAUSE/CONT> key to stop the scan.

Z DRIVE VERIFICATION PROCEDURES

ELECTRICAL ZERO PROCEDURE

1. Enter parameter values of 200 mils for Z Lower Limit and 400 mils for Z Upper Limit.
2. Manipulate forcer to convenient work location.
3. Blank and reset forcer.
4. Remove indicator and position the dial indicator over a flat portion of the chucktop surface and set the dial to zero.
5. Turn on the chuck vacuum.
6. Press <PROG> to access the Profiler Menu.
7. Press the <Z> key to enable Z jog.
8. Use the joystick to raise the chuck to Z=175.
9. Use a straightedge to see if the pins protrude above the chuck surface. Jog the Z stage upward one (1) step at a time until the last pin is flush with the surface. The Z value on the screen should be between 175 and 185.
10. If necessary, locate shutter and set screw, and make adjustment. Clockwise set screw rotation increases separation.
11. If adjusted, confirm each adjustment (step 10) by blanking and resetting the forcer and repeating the procedure.

Z DRIVE VERIFICATION PROCEDURES (continued)

PROBE Z LIMITS PROCEDURE

1. Enter Set Option Menu and disable NCES (Profiler).
2. Reset Z drive to Electrical Zero by blanking and resetting the forcer.
3. Confirm parameters of 200 mils Lower Limit and 400 mils Upper Limit.
4. Place chuck vacuum in on position by pressing <VAC> key.
5. Position dial indicator over chucktop and reset dial to zero.
6. Press <Z> key to drive chuck to Z Upper Limit.
7. Read dial indicator to determine Z Upper Limit. A reading of .400” +/− .001” is acceptable.
8. Press <Z> key to drive chuck to Z Lower Limit.
9. Read dial indicator to determine Z Lower Limit. A reading of .200” +/− .001” is acceptable.

CHUCK LEVELING PROCEDURE

1. Use forcer release button to reset Z drive to Electrical Zero.
2. Place chuck vacuum in On position.
3. Press <Z> key to advance chucktop to Z Upper Limit.
4. Position indicator probe tip near one of the three vacuum pin clearance holes and set indicator dial to zero.
5. Measure an area near each of the remaining two vacuum pin holes. The three points must fall within a total indicator reading of .0005” to be acceptable.
6. If necessary, locate Z drive mounting screws and adjust high points back toward low.
7. Confirm each adjustment and repeat level measurement as needed.

MANUAL PROBE–TO–PAD OPTIMIZATION

Following is the recommended procedure for manual probe–to–pad optimization after installing a new probe card.

1. Auto Align a wafer.
2. Train PMI pads. (If not using all the pads, at least use an equal number of pads at four corners of the die to get better pad position distribution).
3. Run Test Start to probe one die which is inside of the camera view area – that is, one the right side of the wafer.
4. Set the Probe mark Specifications Results Display Form to Diag to see the PMI summary results on the following PMI inspection. (The PMI results, including distances to guard bands in four directions, are collected for any PMI run; the summary results are displayed when the Result Display Format is either Max or Diag.)
5. Perform a manual Probe Mark Inspection to display the PMI summary result.
6. Press <CAMR> to see the PMI report on the monitor.
7. Study the PMI report. If Distance to Left Guard Band, Distance to Right Guard Band, Distance to Top Guard Band and Distance to Bottom Guard Band is small, there is no need to adjust the probe card. Skip to Step 10.
8. Adjust the probe card position based on the information from Step 7.
9. Set the PMI Specification Result Display Format to None in order to avoid a PMI Summary Result Display after each pad. Repeat from Step 3.
10. Press the <LEARN> key to enter all the probed die positions into Skip list to avoid double probing.
11. Press <AUTO PROBE> to start probing the rest of the dies.
12. Edit the Skip list to delete the dies used for this run. Resume Autoprobing.

Probing of Partial Wafers

Partial wafers can only be loaded on the chuck manually. If the portion is large enough and can be positioned on the chuck so that the camera can view the remnant, alignment can be done by using Auto Align. Otherwise, the partial wafer needs to be aligned manually with align scan.

This mode causes profiling to be performed on a row−by−row basis. In order to find the first and last complete die of each row, the prober indexes in die steps at the corner of dies (in the streets) along the edge of the wafer. During this process, the last wafer position gets stored in a *partial row list*. Profiling is completed when the row with the First Die is reached after circumnavigating the wafer's perimeter. The wafer can be placed anywhere on the chuck, even offset from the chuck's center, as long as it can be held accurately by vacuum.

However, there are limitations. Profiling may not work if the wafer is warped by more than 3 mils along the edge. Any position not reached is assumed to be outside of the wafer; this may result in an unprobed area of the wafer. In addition, neither Wafer Mapping nor SECS can be used if the probe mode is set to Partial.

PARTIAL WAFER PROBING PROCEDURES

1. Access the Set Option Menu (press <SET OPTION>), then select Line 02, Auto−Probe Pattern. Select <8>, Partial Mode.
2. The First Die must be reset even if the normal probe mode (prior to using Partial mode) already set the First Die for whole wafers.
3. Set the First Die to the outermost die in the first row to be probed. As in normal probing, rows outside the row containing First Die are not probed.
4. Press <AUTOPROBE> and the partial wafer will be profiled and probed. The chuck will return to the Home position where the prober will wait for another partial wafer. The vacuum is disabled automatically to allow profiling of the new partial wafer.
5. When pressing <AUTOPROBE> in partial wafer probing mode, the usual sequence of profile, then align is reversed. The system checks for prerequisites including checking for First Die and a reference target.
6. Normal wafer probing is restored by returning to the Set Mode Menu, Line 02, and selecting any normal probe mode.

SETTING FIRST DIE

1. Use the joystick to locate the First Die under the probe array and the <Z> key to check for pad alignment.
2. Press <FIRST> to set the First Die position.
3. The prober beeps and the screen displays the message: FIRST DIE SET.
4. After First Die has been set, each new wafer will be positioned at the same starting point.

DOS FUNCTIONS

RETURNING TO DOS FROM RTM

1. Press and hold <ALT> and press <X>.
2. A prompt displays, `EXIT TO DOS?`
3. Enter <Y> then <ENTER> for Yes, <N> then <ENTER> for No.

PERFORM DOS FUNCTIONS FROM PROBER

1. Place an MS–DOS system disk in the A drive.
2. Reboot the Display Control Module – press and hold <CTL> then press and hold <ALT>, then press <DEL>.
3. After the screen displays A>, perform the desired DOS operations.
4. When done, remove the DOS system disk from the A drive and reboot the Display Control Module (step 2).

APPENDIX C
KEYS AND SCREEN REFERENCE

This section gives a brief explanation of the following:

- Function keys
- Joystick keys
- Run Time Display items

This section is intended to be used as a reference section only; detailed information on parameters and functionality of the system does not appear here.

KEY	FUNCTION	DESCRIPTION
GROUP ONE	**MENU KEYS**	Display menus on monitor screen for selection of parameters and input of instructions.
SET PARM	Displays Set Parameter Menu	Enter numerical value for each parameter to be changed.
SET MODE	Displays Set Mode Menu	Select variables for each mode of operation to be changed.
SET OPTN	Displays Set Option Menu	Use numerical keys to input values and/or enable/disable optional features as appropriate.

DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	RESET LAMP Z	WAFER MAP W
SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

KEY	FUNCTION	DESCRIPTION
GROUP TWO	**ENTER VALUES AND SELECTIONS**	Enter numerical values, line selections, and parameter variable selections.
0 9	Numerical keys – to input data and select lines.	Access menu; select line; enter value or select variable. Press <ENTER> to complete input and enter data into memory.
ENTER	Enter data or exit menus	Press after selection of lines and after input of value or variable. Press again to exit menus. Other functions are discussed in text.
CE	Clear present numerical input	Clears values, line, or parameter variable selection PRIOR to pressing the <ENTER> key.
◄	Backspace over numerical input	Backspaces over digits entered; write over digits, if desired.
OR:	Reverse X travel during Autoprobe	Press <PAUSE/CONT> key. An arrow by “PROBE” on the Run Time Display shows the direction of travel.
.	Decimal Point	Provides the decimal point for numerical values.
–	Numerical negative assignment	Generally used to assign negative values to the coordinates of the starting die point.
X	Enable XY Jog	Use with the Profiler Menu (see **Section 6, NONCONTACT EDGE SENSOR**), and with External I/O (**Section 8, EXTERNAL CONTROL I/O INTERFACE**).
Y	Yes	Press to replay “yes” to prompts for Yes/No answers to prompts.

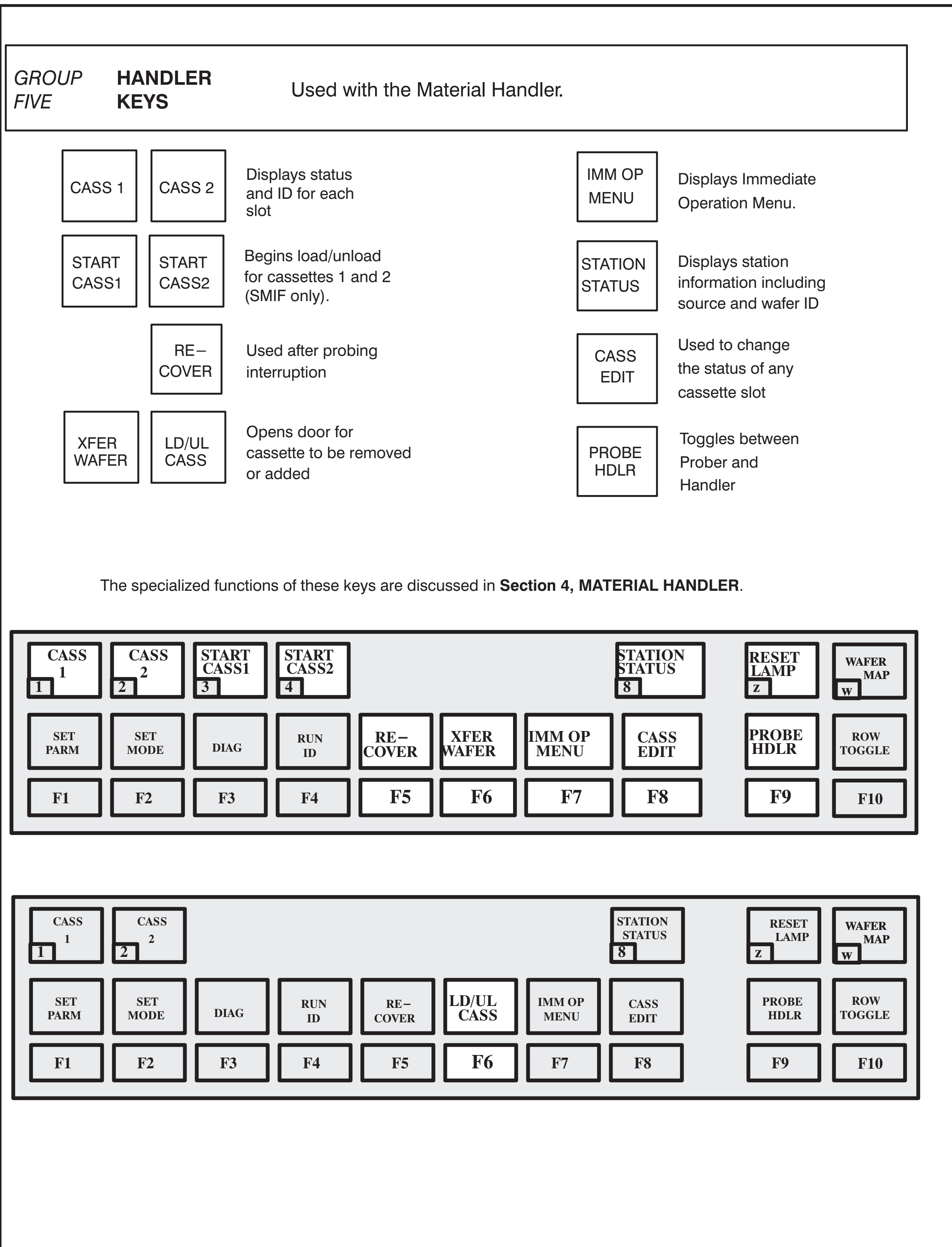
(continued)

KEY	FUNCTION	DESCRIPTION
GROUP THREE	**STORING DIE POINTS IN MEMORY**	Used to store First Die point and store and delete specific die points.
FIRST	Enter in memory First Die location	Used after First Die of wafer is positioned beneath the test probes. With appropriate options and probe mode, each new wafer is positioned at the same starting point.
STORE	Enter into memory single die points of microdie coordinates	Used after die is positioned beneath test probes with the Joystick or by interrupting the Autoprobe operation with the <PAUSE/CONT> key. Press to store die point to memory.
DELE	Delete single die point from memory	Used after die is positioned beneath test probes. The beeper will sound once each time the <STORE> or <DELE> key is pressed to store or delete a die position to confirm that some action was taken.
LEARN	Displays Learn Menu for input of die points and microdie sites.	Enter die points as XY coordinates (and/or as rows). Enter numerical values for each coordinate.

SET PARM	SET MODE	SET OPTN	FIRST	PROG	FIND TARG	AUTO ALIGN	DIG VID	RESET LAMP Z	WAFER MAP W
DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10

KEY	FUNCTION	DESCRIPTION
GROUP FOUR	**AUTO ALIGN KEYS**	Used with Automatic Alignment System (Vision Module).
FIND TARG	Select target pattern for pattern recognition	Press to position wafer beneath camera and display image. Use joystick to improve the pattern's position. Press <PAUSE/CONT> to store pattern. Press <FIND TARG> to restore stored pattern and repeat the process. (Other controls and keys are also used with this key.)
AUTO ALIGN	Initiates Automatic Alignment Sequence	Die patterns are viewed under camera and compared to patterns stored by the Find Target command. A series of patterns is sampled, and theta adjustments correct wafer–to–prober XY alignment. Wafer moves to First Die position. (Other controls and keys are also used with this key.)
DIG VID	Displays digitized video from Vision Module	Displays the area seen by the camera and digitized by the Vision Module. Toggles between the video window and Automatic Gain and Offset adjustment (AGO).

SET PARM	SET MODE	SET OPTN	FIRST	PROG	**FIND TARG**	**AUTO ALIGN**	**DIG VID**	RESET LAMP Z	WAFER MAP W
DIAG	DISK	RUN ID	ON LINE	STORE	DELE	LEARN	PRINT	PROBE HDLR	ROW TOGGLE
F1	F2	F3	F4	F5	**F6**	**F7**	**F8**	F9	F10


GROUP FIVE
HANDLER KEYS
Used with the Material Handler.
CASS 1
CASS 2
Displays status and ID for each slot
START CASS1
START CASS2
Begins load/unload for cassettes 1 and 2 (SMIF only).
RE– COVER
Used after probing interruption
XFER WAFER
LD/UL CASS
Opens door for cassette to be removed or added
IMM OP MENU
Displays Immediate Operation Menu.
STATION STATUS
Displays station information including source and wafer ID
CASS EDIT
Used to change the status of any cassette slot
PROBE HDLR
Toggles between Prober and Handler
The specialized functions of these keys are discussed in Section 4, MATERIAL HANDLER.
CASS 1
CASS 2
START CASS1
START CASS2
STATION STATUS
RESET LAMP
WAFER MAP
SET PARM
SET MODE
DIAG
RUN ID
RE– COVER
XFER WAFER
IMM OP MENU
CASS EDIT
PROBE HDLR
ROW TOGGLE
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
CASS 1
CASS 2
STATION STATUS
RESET LAMP
WAFER MAP
SET PARM
SET MODE
DIAG
RUN ID
RE– COVER
LD/UL CASS
IMM OP MENU
CASS EDIT
PROBE HDLR
ROW TOGGLE
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10

GROUP SIX	**MISCELLANEOUS FUNCTION KEYS**	Most are related to some external function.

Key	Function	Description
DIAG	Diagnostics	Select a set of exercise functions; see **Section 3, TUTORIALS**.
DISK	Used for disk operations	Used, with other keys, to format and copy disks, store and load parameters, and access or leave the disk program.
RUN ID	Displays menu for LOG ID entry	Menu items are: 1. Clear all log data 2. Current wafer number 3. Device type 4. Lot number
ON LINE	Activates interface port – RS232 or GPIB (IEEE–488)	The interface permits external control of the prober by host computer. Each key activation alternates between On Line and Off Line. The status is given in the Run Time Display.
PROG	Produces Profiler Menu	For setting up parameters related to the Noncontact Edge Sensor. Details are given in **Section 6, NONCONTACT EDGE SENSOR.**

JOYSTICK KEYBOARD FUNCTIONS

Table updated May, 1996

Keys described as located, from left to right and top to bottom

Key	Function	Description
VAC	Manually switches vacuum to chuck alternately "ON"/"OFF"	Usually used in connection with manual loading/unloading of wafers. Vacuum is "OFF" during load to allow orientation of wafer flat. With wafer in place, vacuum is switched "ON." After probe, wafer returns to load area and vacuum is shut "OFF" to allow unloading. "ON/OFF" status is shown on the RUN TIME DISPLAY. NOTE: When the prober requires vacuum for a move and vacuum is "OFF," the vacuum is switched "ON" automatically.
LOAD	Returns chuck to "HOME" or load position	Positions chuck for manual loading/unloading of wafers. Prober waits about two seconds to allow vacuum to bleed before chuck drops to 30 mils. If Material Handling is enabled, wafer on chuck is unloaded and a new wafer loaded.
ALIGN SCAN	Initiates theta alignment; positions wafer for scan.	Moves chuck from present position to within probe area. Wafer is then advanced along X axis and theta–aligned. Although it can be activated from any position, "ALIGN SCAN" usually follows load operation. In any case, Vacuum Chuck Assembly must be at rest.
INK ENBL	Enable/disable inkers.	Status of system inkers is monitored on RUN TIME DISPLAY as `ENB` or `DIS`. The switchkey alternates between the two.
LAMP	Enable/disable lamp	Turns microscope and camera lamps "ON"/"OFF."
AUTO PROBE	Activates "AUTOMATIC PROBE" function	Normally, "AUTOPROBE" is part of a sequence and follows the theta alignment procedure. Probe operation starts from first die point. When key is pressed, prober executes pattern selected by operator from Set Mode Menu. After probe, chuck returns to load position.
PAUSE /CONT	(Many applications)	o Interrupts "AUTO PROBE" o Activates "ALIGN SCAN" o Stores Pattern Recognition Unit (PRU) reference for auto align.

(continued)

JOYSTICK KEYBOARD FUNCTIONS (continued)

Keys described as located, from left to right and top to bottom

Key	Function	Description
INK TEST	Test designated inkers	Produces prompt “Turn which inker on? (1 to 4)”.Select one. For example, test inker 4 by pressing the < 4 > key to initiate a visible test. Cancel the request by pressing the key again, or by input outside the inker range of 1 to 4.
TEST CYCLE	Initiate probe test	Starts probe test, as indicated by the prompt “Start test” at the bottom of the screen. Upon completion, the bin code is displayed.
Z	Moves chuck to Z upper or lower position	Both “UP” and “DOWN” positions are determined by respective limits or by limits associated with the edge sensor or profiler. After the prober detects a Z slip, an attempt is made to correct the Z position maintained by the prober. The < Z > key may be pressed after a Z slip; the chuck will be lowered to 200 mils.
CAMR	Camera enable/disable	Used as alternating switch with Auto Align is enabled. With camera enabled, monitor displays camera’s field of view. As of Software Revision DF, when the < CAMR > key is pressed, the Display Control Module (DCM) software displays either the Camera or the High Frequency (HF) Microscope Video image, based on information about the present forcer location and the presence of the Video Blaster Board. This ProberVision software will make a check to see if the wafer is under the probe tip when the operator presses the < CAMR > key. If the wafer is under the probe tip area, the DCM software displays the HF microscope image. Otherwise, it displays the Camera image. To support this feature, the following DCM subsystem and PVS subsystem are needed at or above the specified revision level: DCM (RTM) PN 250450−001.AE PVS PN 249799−X2X.DF

RUN TIME DISPLAY – EXPLANATION

DISPLAY ITEM	EXPLANATION
(CURRENT TIME)	In hours, minutes, and seconds, based on a 24–hour system. The date appears at the end of the line.
POS X Y Z (POSITION XYZ)	The X and Y elements identify the current die coordinates with respect to the preset die point. Depending on travel direction, the X coordinate increases or decreases as it advances along the X axis. The Y coordinate changes as it advances along the Y axis. The Z element shows the status of chuck UP / DOWN travel and the Z height in mils.
WAFER	Current chuck vacuum status; ON indicates a properly mounted wafer, OFF an improperly mounted or absent wafer. Status is determined by the vacuum system, and also refers to the status of the vacuum switch itself. The status indication may be ignored when probing partial wafers by Material Handling and enabling IGNORE VAC (Set Mode/Miscellaneous Options Menus).
Z MODE (Z TRAVEL MODE)	Defines which device will establish the limits of Z travel during probing. The three modes possible are: o LIMITS – Use Z Upper and Lower Limits entered in the Set Parameter Menu. (No clearance or overtravel.) o EDGE SENSE – Uses the edge sensor contact point and adds overtravel of clearance, depending on the direction of movement. o PROFILE – Uses an operator–determined Z height (the point at which the wafer first makes contact with the probes) as its center of travel. The probing height is modified mathematically to reflect surface variations. Overtravel and clearance are used.
CHUCK VAC (CHUCK VACUUM)	On / Off status as triggered by the <VAC> function key (Joystick Keyboard). A vacuum failure shows Off.
PROBE	EDGE, MTRX, CIR, LEARN, ROW, XTRN, PTIAL, and OFF. The automatic probe pattern, as entered through the Set Mode Menu. In addition, the arrow indicates the current direction of prober travel along the X axis. (The arrow is not active in the LEARN, ROW, or XTERN modes.)
(JOYSTICK MODE)	Joystick modes are Jog, Index, and Scan, selected by rotating the Joystick.
(PROBER STATUS)	One of seven possible status messages will appear: ALIGN, STOREREF, PROBE, AUTOPRB, ABORTED, BUSY, IDLE. The first four can also be combined with <PAUSE/CONT>; the reverse image PAUSE will then appear beside the Joystick mode.
ID=	Wafer identification.

(continued)

RUN TIME DISPLAY – EXPLANATION (continued)

(SOFTWARE IDENTIFICATION)	The software revision number and part number appear in the center of the top line.
(UNIT OF MEASURE)	The Measurement System (ENGLISH or METRIC) currently active for the instrument. Shown as MIL or MM.
DIE X... Y... (DIE SIZE)	X and Y dimensions, as entered in Line 01 of the Set Parameter Menu, are shown in 7–character floating–point numbers.
INKER	ENBL / DIS status of the Inkers, as triggered by <INK ENBL> key (Joystick Keyboard).
DIA (WAFER DIAMETER)	The value entered for Line 04, Set Parameter Menu, always given in millimeters.
SECS (STATUS)	The status of SECS (Semiconductor Equipment Communication Standards) communication.
X I/O (INTERFACE STATUS)	Status (ONLINE / OFFLINE) of the interface port, triggered by the <ON LINE> key <F4>.
WAFER #	The number of the wafer currently being probed. The number for the initial wafer is set by the operator and is automatically incremented for each subsequent wafer.
GOOD DIE **BAD DIE**	Counters used to indicate the total number of good/bad die probed up to and including the current die position. The total is reset to zero with the <RUN ID> key or the start of a new wafer. The judgement (GOOD or BAD) comes from the Preset Inker Assignment (Assign Logical Ink Code Menu). When multi–die returns both good and bad bincodes from a single test, both counters will be updated.
UGLY DIE	This line displays the ugly die count and is an accumulated total in the same manner as the good and bad counts. If the cassette log is reset, all three counts resets to 0. The ugly die count is displayed independently of the enabling of the ugly die function.

SPECIAL DISPLAY:

MAP BIN CODE **TEST RESULT**	When Wafer Mapping is enabled and the prober is in a PAUSE state, the last reported bin code for the current die under the probes will be reported at the bottom of the display. This can be used to randomly re–test die to compare results with previous values and probing/test verification. This feature is explained in **Section 10 (WAFER MAPPING AND SECS**).

OTHER DISPLAYS, MESSAGES, AND PROMPTS APPEAR IN CONNECTION WITH VARIOUS FUNCTIONS AND PROBLEMS. THEY ARE EXPLAINED ELSEWHERE IN THE MANUAL.

APPENDIX D
ERROR MESSAGES

Error messages are listed below in numerical order, by External I/O code. Following this list, major messages are listed again in alphabetical order with cause and recovery instructions and/or source information. Messages listed in italics are self−explanatory or for special applications and are not included in the alphabetical list. Parenthesis are for clarification and enclose words or portions of words which do not actually appear on the screen.

ERROR MESSAGES LISTING BY EXTERNAL I/O CODE NUMBER

❍ Triggers audible alarm.
✓ May or may not trigger audible alarm.
★ Triggers External I/O alarm (if Alarm Messages is enabled on the Enhanced External I/O Menu, Line 09).

ERROR CODE		AND MESSAGE
0		NO ERROR
1		THETA SENSOR NOT FOUND. CONTINUE?
2		Z SENSOR NOT FOUND. CONTINUE?
3	✓	VAC(UUM) OFF
4		LEARN LIST FULL
5		NOT IN LEARN LIST
6		*WRONG PRU PATTERN TYPE*
7		WRONG!
8	❍★	NO EDGE SENSE CONTACT
9	❍★	EDGE DIE ROW LIST FULL
10	❍★	(OUTPUT) CASSETTE FULL
11	❍★	(INPUT) CASSETTE EMPTY
12	❍★	WAFER XFER ERROR
13		(AUTO ALIGN) REF STORED, Q=
14		REF(ERENCE) NOT STORED
15	★	ALIGN FAIL
16		ALIGN COMPLETE
17	★	NO WAFER
18	❍★	(EDGE) CONTACT AT Z DOWN
19	✓★	PREALIGN FAIL
20		X−Y MOTOR BLANK
21	❍★	RECEIVER ERROR
22	❍★	SENDER ERROR
23	✓	DIE SIZE < 10 (MILS)
24	❍★	REPROBE LAST GOOD DIE−FAILED
25	❍★	NO GOOD DIES (TO RE−TEST)
26	★	ZOOM LENS MALFUNCTION
27		RUNTIME ERROR
28		NO SUCH EXTERNAL I/O COMMAND
29	✓★	PROFILING FAIL
30		FIRST DIE NOT SET
31		X−Y MOTION CONTROL FAILURE
32	✓	WAFER NOT PROFILED
33	❍	Z OUT OF RANGE
34	✓	START OUT OF RANGE
35		EXTERNAL I/O (ERROR)
36	❍★	(PROFILER) SENSOR NOT UP
37	❍★	Z SLIP
38		X−Y OUT OF PLATEN
39		OPTION NOT INSTALLED
40	✓	PRINTER NOT AVAILABLE
41		LEARN LIST EMPTY
42		ROW LIST EMPTY
43		ROW LIST FULL
44	❍★	WAFER LOAD ABORT
45	❍★	LOT−NUMB CONFLICT
46	✓★	ID READER FAIL
47		X−Y OVERHEATED
48		SENSOR POSITION SET
49	❍★	FIND CENTER FAIL
50	✓	NO WAFER ON CHUCK

ERROR MESSAGES BY EXTERNAL I/O CODE NUMBER (continued)

ERROR CODE AND MESSAGE		
51	❍	Z OUT OF LIMIT
52	❍	Z POSITION LOST
53	✓	PRU COMMUNICATION FAILURE
54	★	SENSOR TOO LOW
55	✓	Z SLIP
56		WAFER NOT ALIGNED
57	❍★	WAFER MAP MEMORY FULL
58		NOT SUPPORTED IN THIS SOFTWARE
59	✓★	NOT ENOUGH MEMORY
60		NOT IN THIS I/O PROTOCOL
61		HEAP PROBLEM
62	❍	MAPPING MEMORY PROBLEM
63	❍★	ALL MAPPING MEMORY USED UP
64		TOTAL MAP HAS BEEN ERASED
65	❍★	SENSOR NOT SEATED CORRECTLY
66		SECS I/O (PROBLEM) (see SECS list at end)
67		NOT USING FRACTIONAL PRU DATA
68		TESTER BUSY
69		*TESTER RUNNING DIAGNOSTICS*
70	★	TESTER DOWN
71		HOT CHUCK PROBLEM
72		HOT CHUCK IS AT X.XX
73	★	CHUCK TEMP OFF LIMIT
74	❍★	DOWN LOAD PROBLEM
75		SYSTEM IS IN AUTOMATIC MODE
76		ILLEGAL SITE NUMBER
77	❍★	GENERIC − (see DISK list at end)
78	❍★	MAP NOT IN MEMORY
79	❍	WRONG PROBE MODE
80		NO MAP IN MEMORY
81	★	OLD MAP NOT SAVED
82	❍	SECS NOT ENABLED
83	❍★	CONTINUITY TEST FAILED
84	❍★	COUNT EXCEEDED INKER
85		*OPERATOR ABORT OF TESTER S(ELF) TEST*
86	❍	RECEIVED RESTART FROM MH
87	✓	MH COMMUNICATION FAILURE
88		MH SELFTEST FAILURE
89		ILLEGAL MH RESPONSE
90	✓	UNABLE TO COMMUNICATE WITH MH
91	❍	UNABLE TO SET QUICK LOADER REF
92	❍	MH COMMUNICATION INTERRUPTION
93		MH WAFER TRANSFER PROBLEM
94	✓	QUICK LOADER NOT RAISED
95		HANDLER COVER IS UNLATCHED
96	❍	HANDLER NOT READY
97	❍	ORPHAN WAFER ON CHUCK

ERROR CODE AND MESSAGE		
98		HANDLER ERROR RECOV IN PROGRESS
99		HANDLER DIAGNOSTICS IN PROGRESS
100		HANDLER IN SELF−TEST MODE
101		SYSTEM I/O BOARD NOT WORKING
102		X SUBPROCESSOR NOT WORKING
103		ARM PROCESSOR NOT WORKING
104		PREALIGN PROCESSOR NOT WORKING
105		WAFER ID SUBSYSTEM NOT WORKING
106		WAITING FOR HANDLER TO COMPLETE
107	❍	ALL WAFERS PROCESSED
108		TIMEOUT WAITING FOR HANDLER
109	❍	UNEXPECTED MH COMM ERROR CODE
110		HANDLER BUSY WITH PRIOR COMMAND
111		HANDLER INIT IN PROGRESS
112		SOURCE IS UNAVAILABLE
113		SOURCE & DEST(INATION) ARE UNAVAILABLE
114		DESTINATION IS UNAVAILABLE
115		DEVICE/SLOT NOT VALID
116		EXTERNAL I/O PARAMETER ERROR
117		HANDLER ARM NOT IN POSITION
118		WAFER LOST
119	✓★	EMERGENCY HANDLER STOP
120		X OR Y OUT OF LOAD TOLERANCE
121	★	WAFER MAP SOURCE DEV NOT SET
122	★	WAFER MAP DESTINATION NOT SET
123		FEATURE NOT SUPPORTED BY HANDLER
124	★	TIME EXCEEDED INKER
125	❍★	PROBE STOPPED DUE TO POOR YIELD
126		*(RESERVED)*
127		*(RESERVED)*
128		*OPTION NOT ENABLED*
129		DIE OUTSIDE OF WAFER DIAMETER
130		WAITING FOR WAFER TO HEAT UP
131		ARE ALL PROBES WITHIN PAD?
132		CENTER PROBES ON PAD, TRY AGAIN
133		WILL PAUSE AFTER TC OR PAUSE
134		*(RESERVED)*
135	★	AUTOLOADER NOT INSTALLED
136	★	AUTOALIGN NOT INSTALLED
137	★	PROFILER NOT INSTALLED
138	★	ID READER NOT INSTALLED
139	★	SECS PORT NOT INSTALLED

ERROR MESSAGES BY EXTERNAL I/O CODE NUMBER (continued)

ERROR CODE AND MESSAGE		
140	★	AUTO TEMP COMP NOT INSTALLED
141	★	NOT SUPPORTED IN THIS S/W
142	★	NOT ENOUGH MEMORY
143	★	HOT CHUCK PROBLEM
144	✓	AUTO ALIGN NOT ENABLED
145		TCA SETUP PROCEDURE ABORTED
146	❍	POOR TARGET SELECTION
147		1ST REFERENCE STORED
148		ALIGN MODE SET TO NORMAL
149		ONLY NORMAL ALIGN W/THETA COMP
150		CHECK SUM ERROR
151		TIMEOUT DURING FILE TRANSFER
152		RECORD OUT OF RANGE
153		INCOMPATIBLE DATA FILE
154		EXIO INPUT OUT OF RANGE
155		MICRO LIST FULL
156	★	INK DOT INSPEC NOT INSTALLED
157	★	P(ROBE)MARK INSPECT NOT INSTALLED
158		WAITING TO POSITION ZOOM LENS
159	❍	MAP TRANSFER VIA SECS TIMED OUT
160		IDENTICAL BIN CODES
161		MODEL PARAMETERS CHANGED
162		HANDLER PARAMETERS CHANGED
163		WAFER MAP STILL EXISTS IN MEMORY
164	★	*PCI CIRCULAR BUFFER FULL*
165		HANDLER −− DEVICE NOT INSTALLED
166		*HANDLER HARDWARE NOT INSTALLED*
167		UNKNOWN HANDLER ERROR (see list at end)
168		HANDLER −− WAFER IN PROCESS
169		*RESETTING TRAINING, PLEASE WAIT*
170		NEED DA CMD BEFORE DB CMD
171		NEED DD CMD BEFORE DE CMD
172		ILLEGAL ALIGN MODE W/ SELF TEACH
173		DISABLE SELF TEACH? (Y/ENTER)
174		*SYSTEM FREE ERROR*
175		USE A DIE ON RIGHT SIDE OF WAFER
176		INK DOT ERROR
177		PROCEDURE ABORTED
178		INK DOT INSPECTION NOT TRAINED
179		IMAGE AND POSITION NOT TRAINED
180		NEW DATA NOT STORED
181		NEW DATA ACCEPTED
182		NO PADS TRAINED!
183		*WARNING: POSSIBLE BAD LOCATION*
184		RETRAIN FIRST PAD
185		FIRST PAD STILL VALID
186		PAD LIST FULL
187		PADS DELETED
188	★	INK DOT FAILURE
189	★	PROBE MARK FAILURE

ERROR CODE AND MESSAGE		
190		ZOOM LENS NOT FUNCTIONAL
191		UN−INKED BACKGROUND NOT TRAINED
192		INSPECTION OPTIONS MUST BE OFF
193		THETA COMPENSATION MUST BE OFF
194		CAN'T USE SELF TEACH 'AUTO' MODE
195		USE SEMI MODE? (Y/ENTER)
196		SELF TEACH DISABLED!
197		SELF TEACH 'SEMI' MODE ENABLED
198		CAN'T USE AUTO WITH THETA COMP
199		*INDEX TO NEXT DIE & PRESS PAUSE*
200		GPIB PORT IN USE BY SECS
201		GPIB PORT IN USE BY EXTERNAL I/O
202		AUTO PROFILE NOT ENABLED
203		AUTO DIAMETER NOT ENABLED
204		PROF W/FIND CENTER NOT ENABLED
205		EXIO MAP TRANSFER UNSUCCESSFUL
206	✓	PERMISSION TO PROBE WAFER DENIED
207	❍	SECS NOT ONLINE, NEED PERMISSION
208	❍	EXIO NOT ONLINE
209	❍	CANNOT USE RDP FOR EXIO MAP XFER
210		EXIO MAP RECEIVE, UNSUCCESSFUL
211		EXIO MAP RECEIVE, TOO MANY TRIES
212		EXIO MAP RECEIVE, INVALID ID
213	❍★	UNLOAD − HOST MAP BAD WAFER ID
214	❍★	UNLOAD − HOST MAP FORMAT ERROR
215	❍★	UNLOAD − HOST MAP PARAMETER ERR
216	❍★	SECS NOT ONLINE
217	❍★	UNLOAD − BY HOST COMMAND
218	❍★	UNLOAD − HOST ABORTED MAP XFER
219	✓	*TEST POSITION HAS NOT BEEN SET*
220	✓	CLEAN POSITION HAS NOT BEEN SET
221		NEED AUTO PROFILE & FIND CENTER
222		*VALUE < 0 OR VALUE > RADIUS*
223		*VALUE < UGLY OR VALUE > IGNORE*
224		POSITION NOT BETWEEN 0 AND 359
225		*VELOCITY VALUE NOT WITHIN RANGE*
226		*Z BASE MUST BE IN 0−200 MILS*
227		*WARNING! TESTER PIN 9 REDEFINED!*
228		*WARNING! TESTER PIN 23 REDEFINED!*
229		*PCI XMIT, NO COMM AFTER BCC*
230		*PCI XMIT, OFFLINE*
231		*PCI XMIT, RECEIVED SVR*
232		*PCI XMIT, GO TO RECEIVE*
233		*PCI XMIT, IN SYNC AFTER BCC*
234		*PCI XMIT, IN SYNC 3 TRIES*
235		*PCI RX, NO INPUT*
236		*PCI RX, SENT BCC*
237		*PCI RX, SVR RECEIVED*
238		*PCI RX, SENT WAT*
239		*PCI RX, SENT NAK1*

ERROR MESSAGES BY EXTERNAL I/O CODE NUMBER (continued)

ERROR CODE AND MESSAGE	
240	*PCI RX, SENT NAK2*
241	*PCI RX, SENT NAK3*
242	*PCI RX, SENT NAK4*
243	*PCI RX, INSYNC AFTER BCC*
244	*PCI RX, NO COMM AFTER BCC*
245	*PCI RX, PCI TIME OUT*
246	*PCI NOT INSTALLED*
247 ★	VM COMMUNICATION TIMEOUT
248	WILL PAUSE UPON TC FROM TESTER
249	HOT CHUCK IS DISABLED
250	FILENAME REQUIRED IN EXIO CMD
251	FILENAME ALREADY EXISTS (EXIO)
252	CAN NOT OPEN FILE (EXIO)
253	DRIVE NOT READY (EXIO)
254	DRIVE WRITE PROTECTED (EXIO)
255	ILLEGAL DRIVE DESIGNATION (EXIO)
256 ❍★	*ABORT: 1ST DIE OUT OF RANGE*
257	ILLEGAL MOVE REQUESTED
258	*FIRST DIE MAY NOW BE SET*
259 ❍	ERROR − INCORRECT FIRST DIE
260	*DATA FROM A DIFFERENT PART #*
261 ❍	PLEASE SET PPI INKER POSITION
262	EXIO DOWN−LOAD PROBLEM
263	EXIO UP−LOAD PROBLEM
264	CAN NOT OPEN FILE (SECS)
265	DRIVE NOT READY (SECS)
266	FILENAME REQUIRED IN SECS CMD
267	ILLEGAL DRIVE DESIGNATION (SECS)
268	*ID READ IN PROGRESS*
269	*VM COMMUNICATION ERROR*
270	*OCR BLOCK 0 NOT YET RECEIVED*
271	*ERROR: NUM OCR BLOCKS REMAINING*
272	*OCR BLOCK NUMBER TOO LARGE*
273 ★	*TEST COMPLETE TIMEOUT EXCEEDED*
274	*STOPPED AT 1ST DIE*
275	*BEGIN PROBING? (Y/ENTER)*
276	EXCEEDED MAXIMUM REPROBE LIMIT
277	REPROBE LIMIT REACHED
278	ENTER 1 TO REPROBE SEQUENCE
279	*ENTER 2 TO CONTINUE TO NEXT DIE*
280	*PLEASE SET REFERENCE DIE*
281 ★	CAN'T REMOVE WAFER FROM CASSETTE
282 ★	CAN'T INSERT WAFER INTO CASSETTE
283 ★	*LOW SYSTEM AIR/VACUUM*
284 ★	*WAFER LOST DURING PROCESS*
285 ★	*CASSETTE LIFTED DURING MAPPING*
286 ★	WAFER LOST DURING TRANSIT
287 ★	MOTOR SLIP WHILE WAFER ON ARM
288	*LOW PROBER FACILITIES*
289	CLEAN POSITION Z HEIGHT ADJUSTED
290	CONTINUITY TST Z HEIGHT ADJUSTED
291	CLEAN POSITION Z OUT OF RANGE
292	CONTINUITY TEST Z OUT OF RANGE
293	*PLEASE RESET*
294	*INKER HEIGHT OUT OF Z RANGE*
295	*CANNOT MOVE Z OUTSIDE OF LIMITS*
296	*MACHINE DEPENDENT VARS DEFAULTED*
297	*PROCESS DEPENDENT VARS DEFAULTED*
298	CLEAN POSITION Z HEIGHT CLEARED
299	CONTINUITY TEST Z HEIGHT CLEARED
300	CHUCK NOT IN PROBE AREA
301	CLEAN POSITION Z NOT ADJUSTED
302	CONTINUITY TEST Z NOT ADJUSTED
303 ❍	Z HEIGHT NOT SET
304	MDV FIELD READ OUT OF RANGE
305	MDV FIELD WRITE OUT OF RANGE
306	MDV BAD CRC, DEFAULT INIT REQD
307	BAD MDV DOWNLOAD, NO CHANGE
308	DEPENDENT PARAMTERS ADJUSTED
309	CLEARED FOLLOWING Z HEIGHTS:
310	MH WAFER RECOVERY IN PROGRESS
311 ✓	FAILED TO SET LIGHT INTENSITY
312	MDV CAMERA Z SET
313	Z ALIGN SET
314	FINISHED PROCESSING CASSETTE
315	NCES POSITION SET TO DEFAULTS
316	DIE SIZE < 4
317	OUTSIDE OF INTERNAL MAP
318	HANDLER NOT ENABLED
319	START DIE HAS NOT BEEN SET
999	*UNDEFINED ERROR CODE*

(continued)

Special Disk Error Messages
(submessages of Error Code 77)

1 CAN NOT OPEN FILE
2 DRIVE NOT READY
3 DISK IS WRITE PROTECTED
4 DISK FULL
5 FILE NOT ON DISK
6 OUT OF MEMORY
7 FORMAT(T)ING
8 COPYING PROBLEM
9 NO 2ND DRIVE FOUND
10 VERIFYING PROBLEM
11 CAN NOT CREATE FILE
12 READING PROBLEM
13 CAN NOT CLOSE FILE
14 *MISSING WAFER XREF FILE*
15 WAFER MAP NOT ON DISK
16 EMPTY WAFER MAP DIRECTORY
17 WAFER ID ALREADY MAPPED
18 WAFER MAP FORMAT ERROR
19 WAFER MAP PARAMETER ERROR
20 *WAFER MAP WRONG WAFER ID*
21 *WRITING PROBLEM*
22 *WRONG DISK FORMAT*
23 DISK − HEAD RESTORE ERROR
24 DISK CONTROLLER BUSY ERROR
25 WRONG DISK DRIVE SPECIFIED
26 UNFORMATTED DISK IN DRIVE A
27 UNFORMATTED DISK IN DRIVE B
28 UNFORMATTED DISK IN DRIVE C
29 UNFORMATTED DISK FOUND
30 WRONG DISK FORMAT IN DRIVE A
31 WRONG DISK FORMAT IN DRIVE B
32 WRONG DISK FORMAT IN DRIVE C
33 WRONG DISK FORMAT FOUND
34 CANNOT WRITE. MAP LIMIT REACHED
35 NO DISK FOUND IN DRIVE A
36 NO DISK FOUND IN DRIVE B
37 NO DISK FOUND IN DRIVE C
38 NO DISK FOUND

999 *DISK PROBLEM*

Special SECS Error Messages
(submessages of Error Code 66)

1 DOWN
3 BAD RECORD
4 CHECKSUM ERROR
10 TIMEOUT A
11 TIMEOUT B
12 TIMEOUT C
13 TIMEOUT D

SECS ACIA ERROR − PARITY
SECS ACIA ERROR − OVERRUN
SECS ACIA ERROR − FRAMING

SECS I/O − BUFFER OVERFLOW
SECS I/O − SPURIUS INTERRUPT
SECS I/O − EOI BEFORE ALL DATA
SECS I/O − NON−INT XMIT TIME OUT

Special HANDLER Error Messages
(submessages of Error Code 167)

#	Message	Also generated as major message #:
1	HANDLER BUSY	110
2	DEVICE NOT INSTALLED	165
3	DEVICE NOT INITIALIZED	
4	ORPHANED WAFER ON CHUCK	97
5	DEVICE/SLOT NOT VALID	115
6	ALARM PENDING	
7	BLOCK SIZE TOO LONG	
8	MH ERROR RECOVERY IN PROGRESS	98
9	NO WAFERS AVAILABLE	
10	ALL SLOTS FULL	
11	DIAGNOSTICS IN PROCESS	99
12	MENU CHANGE ALARM	

#	Message	Also generated as major message #:
13	HANDLER COVER IS OPEN	95
14	ALL WAFERS PROCESSED	107
21	DESTINATION UNAVAILABLE	114
22	SOURCE UNAVAILABLE	112
23	SOURCE AND DEST UNAVAILABLE	113
32	WAFER LOST	118
33	ID READER FAIL	46
34	PREALIGN FAIL	19
48	HANDLER ARM NOT IN POSITION	117
64	EMERGENCY STOP	119
65	WAFER IN PROCESS	168

ERROR MESSAGES ALPHABETICAL LISTING CAUSE AND RECOVERY

❍ Triggers audible alarm.
✓ May or may not trigger audible alarm.
★ Triggers External I/O alarm (if Alarm Messages is enabled on the Enhanced External I/O Menu, Line 09).

	MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
	ALIGN COMPLETE	(16)	Successful wafer alignment.	Continue operation.
★	ALIGN FAIL	(15)	Unable to find acceptable pattern.	Initiate Align sequence. See Section 5, AUTO ALIGN, for more information.
	ALIGN MODE SET TO NORMAL	(148)		Mode is set through Autoalign Option Menu, Line 02 (accessed from Set Option Menu, Line 02). See Section 5, AUTO ALIGN.
❍ ★	ALL MAPPING MEMORY USED UP	(63)	Not enough memory to read in SECS map.	Allowing maps in memory queued for storage to be stored.
❍	ALL WAFERS PROCESSED	(107)	Load attempted but all wafers have been probed.	Reload cassettes to start another run.
	ARE ALL PROBES WITHIN PAD?	(131)	Prompt requesting Yes or No answer when setting Z height through the Profiler Menu.	See Section 6, NONCONTACT EDGE SENSOR, for discussion of this setting.
	ARM PROCESSOR NOT WORKING	(103)	Handler response indicates malfunction in Handler Arm Processor.	Hardware must be fixed or replaced.
✓	AUTO ALIGN NOT ENABLED	(144)		Auto Align (the Vision Module) is enabled through the Set Option Menu, Line 02.
★	AUTOALIGN NOT INSTALLED	(136)	Loading a setup from a prober which had Auto Align enabled onto a prober without Auto Align.	Reference: Section 5, AUTO ALIGN.
	AUTO DIAMETER NOT ENABLED	(203)		The Use Auto Diameter function (for circular probing) is enabled through either the Autoprofiler Option Menu (Line 04) or the Probe Mode Menu (Line 08). The Probe Mode Menu is a submenu of the Set Mode Menu, accessed from Line 03.
★	AUTOLOADER NOT INSTALLED	(135)	Loading a setup from a prober with auto−loader enabled onto a prober without auto−load.	Reference: Section 4, MATERIAL HANDLING.
	AUTO PROFILE NOT ENABLED	(202)		Enable through the Set Option Menu, Line 03. See Section 6, NONCONTACT EDGE SENSOR.
★	AUTO TEMP COMP NOT INSTALLED	(140)	Loading setup from prober with auto Temperature Compensation onto prober without platen sensor.	This feature is discussed in Section 7, Z STAGE, HOT CHUCK AND TEMP. COMPENSATION.

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
B		
BAD MDV DOWNLOAD, NO CHANGE (307)	Indicates corrupted data.	External I/O Command MF is returned, and no update occurs.
C		
CAN NOT OPEN FILE (EXIO) (252)	File name specified does not appear on disk.	Specify correct file name.
CAN NOT OPEN FILE (SECS) (264)		See Section 10, WAFER MAPPING AND SECS.
❍ CANNOT USE RDP FOR EXIO MAP XFER (209)	Wrong I/O protocol selected.	Change to SECS through Wafer Mapping Menu, or select RS232 or GPIB from I/O Control Menu, Line 03 (I/O Port). See Section 8, EXTERNAL CONTROL I/O INTERFACE, or Section 10, WAFER MAPPING AND SECS.
★ CAN'T INSERT WAFER INTO CASSETTE (282)		See Section 4, MATERIAL HANDLING.
★ CAN'T REMOVE WAFER FROM CASSETTE (281)		
CAN'T USE AUTO WITH THETA COMP (198)	Theta compensation is incompatible with Self−Teach Auto Align.	Disable Self−Teach Auto Align or Theta Compensation.
CAN'T USE SELF TEACH AUTO MODE (194)	Self Teach not available for selected setup.	Disable Self−Teach Auto Align (Set Opetion Menu, Line 02 / Autoalign Option Menu, Line 09.
❍★ CASSETTE EMPTY (11) ❍★ CASSETTE FULL (10)	Sender cassette empty. Receiver cassette full.	In both cases: Press <PAUSE/CONT> key to silence alarm. Reload cassette.
CENTER PROBES ON PAD, TRY AGAIN (132)	In probe tip cleaning operation, the reply to a prompt has indicated that probe tips are not still on pad after a position change.	As prompted, center the probe tips and repeat the operation. See Section 6, NONCONTACT EDGE SENSOR.
CHECK SUM ERROR (150)	Block download of data file has bad checksum.	Regenerate data file or verify accuracy of transmission link.
CHUCK NOT IN PROBE AREA (300)	Chuck is not under probe tips when attempt is made to set probe tip Z height.	Use joystick to move wafer under the probe tip and reset. See Section 6, NONCONTACT EDGE SENSOR.
★ CHUCK TEMP OFF LIMIT (73)	After probing was begun, current chuck temperature fell out of its tolerance limits (+/− 0.2 degrees off the setpoint temperature).	Prober should halt until temperature is again within range. If problem does not correct itself, reset, reverify, and try again.
✓ CLEAN POSITION HAS NOT BEEN SET (220)	Probe tip clean position was not set by the operator.	Clean position is set through the Profiler Menu (Press <1>).

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
CLEAN POSITION Z HEIGHT ADJUSTED (289)		See Section 6, NONCONTACT EDGE SENSOR.
CLEAN POSITION Z HEIGHT CLEARED (298)		See Section 6, NONCONTACT EDGE SENSOR.
CLEAN POSITION Z NOT ADJUSTED (301)		See Section 6, NONCONTACT EDGE SENSOR.
CLEAN POSITION Z OUT OF RANGE (291)		See Section 6, NONCONTACT EDGE SENSOR.
❍★ CONTACT AT Z DOWN (18)	Insufficient Z clearance. (Stage reached lower limit before contact was lost).	Pause; check edge sensor. Input correct Z clearance and continue. See Section 7, Z STAGE, HOT CHUCK AND TEMP. COMPENSATION.
❍★ CONTINUITY TEST FAILED (83)	Bin code was not 0 when continuity test attempted by prober.	Verify probes and try again.
CONTINUITY TEST Z HEIGHT ADJUSTED (290)		See Section 6, NONCONTACT EDGE SENSOR
CONTINUITY TEST Z HEIGHT CLEARED (299)		See Section 6, NONCONTACT EDGE SENSOR
CONTINUITY TEST Z NOT ADJUSTED (302)		See Section 6, NONCONTACT EDGE SENSOR
CONTINUITY TEST Z OUT OF RANGE (292)		See Section 6, NONCONTACT EDGE SENSOR.
❍★ COUNT EXCEEDED INKER [1,2,3,4] (84)	The inker dot count limit has been exceeded for the inker(s) noted.	Reset or service the inker(s), as applicable. See Section 3, TUTORIALS.
D		
DESTINATION IS UNAVAILABLE (114)	The destination specified in an external I/O command is occupied or otherwise unavailable.	Specify correct destination. If destination involves an uninitialized chuck, initialize the chuck via the Auto Load option on the Set Option Menu.
DEVICE/SLOT NOT VALID (115)	Illegal source or destination specified by external I/O command.	Reissue external I/O command specifying correct source/destination.
DIE OUTSIDE OF WAFER DIAMETER (129)	Current placement of die under probes is outside wafer border.	Move wafer under probe area.
✓ DIE SIZE <10 (MILS) (23)	Die size too small, not supported.	Input larger die size value and continue. See Section 3, TUTORIALS.
DISABLE SELF TEACH? (Y/ENTER) (173)		Reference: Section 5, AUTO ALIGN.
★❍ DOWN LOAD PROBLEM (74)	I/O error; system could not complete download of information from host.	Double−check setup and try again.
DRIVE NOT READY (EXIO) (253)	Drive specified does not exist or there is no disk in specified drive.	Verify drive letter; check if door is closed.

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
DRIVE NOT READY (SECS) (265)		See Section 10, WAFER MAPPING AND SECS.
DRIVE WRITE PRO−TECTED (EXIO) (254)	Drive specified contains a write−protected disk.	Remove write−protect tab (5 1/4” disk) or move switch (3 1/2” disk).
E		
❍★ EDGE DIE ROW LIST FULL (9)	Reached max capacity of row list (830).	Change edge die inking parameters.
✓★ EMERGENCY HANDLER STOP (119)	Response to action command indicates handler stopped (due to lost wafer or other emergency).	Switch to handler screen for directions (press <PROBE/HDLR> key).
ENTER 1 TO REPROBE SEQUENCE (278)		See Section 3, TUTORIALS.
❍ ERROR − INCORRECT FIRST DIE (119)		See Section 5, AUTO ALIGN.
EXCEEDED MAXIMUM REPROBE LIMIT (276)		See Section 3, TUTORIALS.
EXIO DOWNLOAD PROBLEM (262)		See Section 8, EXTERNAL CONTROL I/O INTERFACE.
EXIO INPUT OUT OF RANGE (154)	Parameter sent with I/O command not acceptable.	Use same parameter as in menu item.
EXIO MAP RECEIVE, INVALID ID (212)		Reference: Section 10, WAFER MAPPING AND SECS.
EXIO MAP RECEIVE, TOO MANY TRIES (211)	Map retry limit exceeded.	Verify communication link from prober to host.
EXIO MAP RECEIVE, UNSUCCESSFUL (210)	Prober did not receive complete map.	Verify communication link from prober to host.
EXIO MAP TRANSFER UNSUCCESSFUL (205)	Prober did not transmit complete map.	Verify communication link from prober to host.
❍ EXIO NOT ONLINE (208)	SECS Wafer Maps are to be transmitted or received on XIO port, but XIO is not online..	Use the <ON LINE> key.
EXIO UPLOAD PROBLEM (263)		See Section 8, EXTERNAL CONTROL I/O INTERFACE.
EXTERNAL I/O (ERROR) (35)	Host communication problem.	Check communication link, verify program protocol.
EXTERNAL I/O PARAMETER ERROR (116)	Parameters of the I/O command were not of correct format.	Reissue I/O command using correct format.

F

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
FEATURE NOT SUPPORTED BY HANDLER (123)	Selected feature not available with prober used.	Upgrade prober to support desired feature.
FILENAME ALREADY EXISTS (EXIO) (251)	File name is duplicated on the disk.	To save the new file, use the “DD” command first to delete the old file.
FILENAME REQUIRED IN EXIO CMD (250)	File name was omitted from command.	Re−issue I/O command with file name.
FILENAME REQUIRED IN SECS CMD (250)		See Section 10, WAFER MAPPING AND SECS.
❍★ FIND CENTER FAIL (49)	Incorrect method or data for finding profiler center.	Initiate Profiler Setup procedure. Verify profiler nozzle placement (hardware).
FIRST DIE NOT SET (30)	X and Y coordinates not established for first die position.	Jog to First Die. Press <FIRST> key to set first position and continue operation.
FIRST PAD STILL VALID (185)		Reference: Section 12, PROBE MARK INSPECTION.
1ST REFERENCE STORED (147)	Accepted pattern is valid 1st ref target.	

G

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
❍★ GENERIC ERROR (77)	See separate list of Disk Messages at the end of this Appendix.	
GPIB PORT IN USE BY EXTERNAL I/O (201)		Reference: Section 8, EXTERNAL CONTROL I/O INTERFACE.
GPIB PORT IN USE BY SECS (200)		Reference: Section 8, EXTERNAL CONTROL I/O INTERFACE.

H

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
HANDLER ACTION INTERRUPTIONS:	An “action” command was sent while...	The message and the action command will be repeated...
HANDLER COVER IS UNLATCHED (95)	... the handler cover was open; OR	... until the cover is closed; OR
HANDLER DIAGNOSTICS IN PROGRESS (99)	... the handler was in its diagnostic mode; OR	... as long as the handler is in one of the two modes; OR
HANDLER ERROR RECOV IN PROGRESS (98)	... the handler was in its error recovery mode.	... until the <PAUSE/CONT> key is pressed.
HANDLER ARM NOT IN POSITION (117)	Handler received unload command when the transfer arm was not under wafer on chuck.	Reissue command. Restart handler if not successful.

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
HANDLER BUSY WITH PRIOR COMMAND (110)	Handler receiving commands out of se–quence. (Handler is still processing last command when a new one is received.)	Wait for handler to be ready.
HANDLER – – DEVICE NOT INSTALLED (165)		Reference: Section 4, MATERIAL HANDLER.
HANDLER IN SELF–TEST MODE (100)	Handler has been reset and is temporarily in self–test.	Switch screen to handler (press <PROBE/HDLR> key) and press any key to continue if so directed.
HANDLER INIT IN PROGRESS (111)	Handler has been reset and is temporarily in initialization (self–test has been completed).	Wait for handler initialization to complete.
❍ HANDLER NOT READY (96)	Handler not ready to set quickloader reference before transferring wafer to/from chuck.	Restart handler and retry operation.
HANDLER PARAMETERS CHANGED (162)	Data file loaded not same REV as current software.	Re–store new setup files.
HANDLER – – WAFER IN PROCESS (168)		Reference: Section 4, MATERIAL HANDLER.
HEAP PROBLEM (61)	System memory is full when prober attempts to write into global area.	Verify setup, clear memory, and try again.
HOT CHUCK IS AT XX.X (72)	Current temperature of hot chuck does not conform to desired setpoint value.	System will wait for the TC–2000 to adjust until the temperatures comply.
HOT CHUCK IS DISABLED (249)	Attempt is made to change Delta T Silicon value when hot chuck disabled. Value is set at 0.	Enable Hot Chuck (Set Option Menu, Line 07; Hot Chuck Menu, Line 01).
★ HOT CHUCK PROBLEM (71, *143)	Prober believes that hot chuck is in factory test mode.	Press Mode Switch twice to clear the error.

I

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
IDENTICAL BIN CODES (160)	Bin code selected for skipdie is the same as for ugly die.	Choose another code for skip die or ugly die (Line 05, Inking Mode Menu).
✓★ ID READER FAIL (46)	ID reader has failed to read wafer.	Press <PAUSE/CONT> to silence alarm; press "." (period) key on monitor keyboard; then press <LOAD>. Wafer will be transferred to chucktop for probing.
★ ID READER NOT INSTALLED (138)	Optical Character Reader not available.	
ILLEGAL ALIGN MODE W/SELF TEACH (172)	Align mode not compatible with Self–Teach Auto Align.	Either disable Self–Teach Auto Align or change align mode.
ILLEGAL DRIVE DESIGNATION (EXIO) (255)	Drive specified is outside of the range A to H (drives above C: are not supplied by EG).	

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
ILLEGAL DRIVE DESIGNATION (SECS) (267)		See Section 10, WAFER MAPPING AND SECS.
ILLEGAL MH RESPONSE (89)	Handler response was not in the expected format.	Restart handler and retry operation.
ILLEGAL MOVE REQUESTED (257)	Attempt was made to move chuck outside the "extended virtual platen zone." Movements within the zone will be allowed. The message "X−Y OUT OF PLATEN" will appear. The chuck will be against the rail and move only in the X or Y direction within the boundaries of the physical platen. X and Y coordinates will be updated. Index positions will not be lost when indexing is done outside the physical platen before returning to the physical platen area.	Check setup of prober (center position, diameter, probe pattern, edge−sensor, etc.); move chuck back to probing area.
ILLEGAL SITE NUMBER (76)	Micro−site number entered is outside range of 1−126.	Re−enter correct site number.
IMAGE AND POSITION NOT TRAINED (179)	An Ink Dot Inspection retrain mode has been selected, but reference image and position have not been trained.	Follow training procedure. See Section 11, INK DOT INSPECTION.
INCOMPATIBLE DATA FILE (153)	File not readable with this REV of software.	All files should be regenerated.
INK DOT ERROR (176)		Reference: Section 11, INK DOT INSPECTION.
★ INK DOT FAILURE (188)	A preset fail count has been reached or exceeded.	Determine reason. For possible causes, see Section 11, INK DOT INSPECTION.
★ INK DOT INSPEC NOT INSTALLED (156)	Ink Dot Inspection not enabled or not available on user's software.	Function is enabled through Set Option Menu, Line 09.
INK DOT INSPEC T NOT TRAINED (178)	Ink dot training has been aborted; the Training Modes Menu is displayed.	Repeat training procedure. See Section 11, INK DOT INSPECTION.
INSPECTION OPTIONS MUST BE OFF (192)	Feature in use requires that Ink Dot and Probe Mark Inspection functions be disabled.	Disable (Set Option Menu, Lines 09 and 10).

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
L		
LEARN LIST EMPTY (41)	Attempting to use Learn Mode without die point entries.	Input X and Y die coordinates or halt use of Learn mode.
LEARN LIST FULL (4)	Exceeded maximum memory available for die point entry.	Delete die points from learn list or abort attempted entry.
❍ ★ LOT–NUMB (ER) CONFLICT (45)	Incorrect wafer lot or incorrect ID input.	Remove incorrect wafers or change ID input.
★ LOW SYSTEM AIR/VACUUM (283)	Low pressure or vacuum to the handler has been detected.	
M		
❍ ★ MAP NOT IN MEMORY (78)	Wafer map does not exist under name entered.	Check for correct name.
❍ MAPPING MEMORY PROBLEM (62)	Could be disk error.	Verify setup; try again.
❍ MAP TRANSFER VIA SECS TIMED OUT (159)	Unable to send map to host via SECS within allowed time.	Check host communication link.
MDV BAD CRC, DEFAULT INIT REQD (306)	Cyclic Redundancy Code is generated to ensure integrity and validity of the data.	Press any key to continue.
✓ MH COMMUNICA–TION FAILURE (87)	Handler gives no response or response is out of sync with prober.	Check communication cable and I/O board. Restart handler and retry.
❍ MH COMMUNICATION INTERRUPTION (92)	Operator pressed <PAUSE/CONT> key while waiting for a handler response.	Repeat operation if desired or take other course of action. In this case, operator must repeat key sequence.
MH SELFTEST FAILURE (88)	Handler has failed its self–test.	Restart handler and retry; or fix/replace hardware.
MH WAFER TRANSFER PROBLEM (93)	Handler cannot complete the requested command involving a transfer of a wafer.	Retry operation. Check transfer arm using handler diagnostics.
MICRO LIST FULL (155)	Micro site list has reached maximum size.	Delete micro points.
MODEL PARAMETERS CHANGED (161)	Old data files loaded to newer software.	Regenerate files.
★ MOTOR SLIP WHILE WAFER ON ARM (287)	After a reported error, the system will attempt to initialize the motors. If a wafer is detected on the transfer arm, an Emergency Stop occurs.	Press <ENTER> to silence alarm. Remove wafer from arm. The system will do a restart procedure. See Section 4, MATERIAL HANDLER.

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
N			
NEED AUTO PROFILE & FIND CENTER	(221)	For the operation requested, these features must be enabled.	Enable Auto−Profiler through Set Option Menu, Line 03. This will access the Autoprofiler Option Menu; select Line 01 to enable Profile with Find Center.
NEED DA CMD BEFORE DB CMD	(170)	(RDP protocol) − Need to send “DA” command first.	Reference: Section 8, EXTERNAL CONTROL I/O INTERFACE.
NEED DD CMD BEFORE DE CMD	(171)	(RDP protocol) − Need to send “DD” command first.	Reference: Section 8, EXTERNAL CONTROL I/O INTERFACE.
NEW DATA ACCEPTED	(181)	Message returned after successful procedure to verify camera offset or train pads.	See Section 11, INK DOT INSPECTION or Section 12, PROBE MARK INSPECTION.
NEW DATA NOT STORED	(180)	In Ink Dot or Probe Mark Inspection, in set or verify offset, operator has aborted by pressing <ENTER>.	Reset or re−verify. See Section 11, INT DOT INSPECTION, or Section 12, PROBE MARK INSPECTION.
❍ ★ NO EDGE SENSE CONTACT	(8)	Chucktop failed to reach edge sensor; sensor enabled but shorted, or not installed.	Check contacts; correct sensor status and continue operation.
❍ ★ NO GOOD DIES	(25)	Probe started with all consecutive bad die.	Press <PAUSE/CONT> key, fix testing problem, and start again.
NO MAP IN MEMORY	(80)	Wafer map file is blank.	
NO PADS TRAINED!	(182)	Manual inspection has been attempted but no pads have been trained.	Follow procedure to train pads. See Section 12, PROBE MARK INSPECTION.
NO SUCH EXTERNAL I/O COMMAND	(28)	Attempting to send incorrect command.	Enter correct command and continue operation.
✓ ★ NOT ENOUGH MEMORY	(59, 142)	Disk is full.	New disk required.
NOT IN LEARN LIST	(5)	Incorrect X or Y coordinate entry.	Reenter X and Y coordinates.
NOT IN THIS I/O PROTOCOL	(60)	Attempted standard I/O call during special I/O protocol.	Correct command or I/O mode.
★ NOT SUPPORTED IN THIS SOFTWARE	(58, *141)	Feature exists in a software REV other than the one in use.	
✓ ★ NO WAFER (ON CHUCK)	(*17, 50)	No wafer or vacuum loss to chuck.	Verify wafer location and check vacuum status.

	MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
	O		
★	OLD MAP NOT SAVED (81)	Old wafer map is about to be erased.	Keep (save) if desired.
	ONLY NORMAL ALIGN W/THETA COMP (149)	To use the Theta Compensation feature, the Auto Align mode must be set to Normal.	Reset: Set Option Menu, Line 02 to access Autoalign Option Menu; select Line 02 (Auto Align Mode) to set. See Section 5, AUTO ALIGN.
	OPTION NOT INSTALLED (39)	Attempting to enable an EG hot chuck which has not been installed.	Check hardware.
❍	ORPHAN WAFER ON CHUCK (97)	The handler has been commanded to un–load an unassigned wafer but has no place to put it (hold station is already occupied).	The wafer will not be unloaded. Clear the bell and the message.
	P		
	PAD LIST FULL (186)	Pad list for Probe Mark Inspection is full (128 maximum).	Delete some pads. See Section 12, PROBE MARK INSPECTION.
	PADS DELETED (187)		Reference: Section 12, PROBE MARK INSPECTION.
✓	PERMISSION TO PROBE WAFER DENIED (206)	SECS protocol needs permission to probe (S12F71/S12F72).	See Section 10, WAFER MAPPING AND SECS.
❍	PLEASE SET PPI INKER POSITION (261)		See Section 9, MULTI–DIE PROBING.
★	PMARK INSPECT NOT INSTALLED (157)	Probe Mark Inspection not enabled or not available on user's software.	Enable; Set Option Menu, Line 10.
❍	POOR TARGET SELECTION (146)	Reference pattern chosen for Theta Compensation Angle is not usable; auto setup procedure is aborted.	Use auto setup procedure to select a different reference. See Section 5, AUTO ALIGN.
	POSITION NOT BETWEEN 0 AND 359 (224)	Zone or flat value out of range.	Enter value between 0 and 359 in appropriate menu: **Menu** — **Line** **Ugly Die** — **05** **Handler Set Parameter** — **03** **Wafer Mapping** — **10**
✓★	PREALIGN FAIL (19)	Wafer has failed to seat properly on the prealign spindle.	Press <PAUSE/CONT>; system asks "Retry Prealign?" If <Y> is pressed, system will retry. Or remove current wafer and press <ENTER> (for No). System will load a new wafer.
	PREALIGN PROCESSOR NOT WORKING (104)	Handler response indicates malfunction in prealign processor.	Hardware must be fixed or replaced.
✓	PRINTER NOT AVAILABLE (40)	Printer cable not connected or switches set wrong.	Confirm printer is connected, or check with Field Service.

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
★ PROBE MARK FAILURE	(189)	A preset fail count has been reached or exceeded.	Determine reason. For possible causes, see Section 12, PROBE MARK INSPECTION. Correct and continue.
❍ ★ PROBE STOPPED DUE TO POOR YIELD	(125)	Percentage of die failing test has has reached the operator−set limit.	Operator discretion. See Section 3, TUTORIALS.
PROCEDURE ABORTED	(177)	Ink Dot or Probe Mark Inspection aborted. Message is followed by one of several explanations of error.	See Section 11, INK DOT INSPECTION or Section 12, PROBE MARK INSPECTION.
★ PROFILER NOT INSTALLED	(137)	Noncontact Edge Sensor not installed.	Reference: Section 6, NONCONTACT EDGE SENSOR.
✓ ★ PROFILING FAIL	(29)	Followed by: NOT WORKING NCES TOO LOW NCES TOO HIGH FIRST OUTSIDE OVER 3 TRIES OVER MAX ROW OVER Z DELTA	Initiate Profiler Setup Procedure. Review instructions regarding partial wafers. See Section 6, NONCONTACT EDGE SENSOR.
PROF W/FIND CENTER NOT ENABLED	(204)	This feature must be enabled in order to run current options.	Used with the Noncontact Edge Sensor. Enable through Set Option Menu, Line 03; accesses Autoprofiler Option Menu. Select Line 01 to enable feature. See Section 6, NONCONTACT EDGE SENSOR.
✓ PRU COMMUNICATION FAILURE	(53)	PRU system failure.	Reset. If reset fails, have system checked by a qualified technician.

Q

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
✓ QUICK LOADER NOT RAISED	(94)	A failure has occurred during loading and the quickloader could not be raised.	Use handler diagnostics mode to attempt to raise quick loader. See Section 4, MATERIAL HANDLER.

R

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
❍ RECEIVED RESTART FROM MH	(86)	Handler was restarted after prober−handler communication was initialized.	Retry operation if not successful.
❍ ★ RECEIVER ERROR	(21)	Missing or improperly seated cassette.	Pause; reset indexer (<LOAD>); load or reseat cassette. To reseat, lift clear of sensor and install prop−erly on elevator platform. Press <START>.
RECORD OUT OF RANGE	(152)	Message for Row, Learn, or Micro List error.	

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
REF NOT STORED	(14)	Pattern not accepted as reference.	Initiate Find Target sequence; see Section 5, AUTO ALIGN.
REF STORED, Q=	(13)	Pattern stored with indicated Q value.	Continue operation.
❍ ★ REPROBE LAST GOOD DIE − FAILED	(24)	Reprobe failure, such as exceeding reprobe count limit. Last bad die is moved under the probe tips.	As prompted, index to next die in probe pattern, press <PAUSE/CONT> and resume probing.
REPROBE LIMIT REACHED	(277)		See Section 3, TUTORIALS.
RETRAIN FIRST PAD	(184)	Training has aborted for some reason.	Retrain first pad; see Section 12, PROBE MARK INSPECTION.
ROW LIST EMPTY	(42)	Attempting to use row mode without row entries.	Input rows or columns or abort use of row mode. See Section 3, TUTORIALS.
ROW LIST FULL	(43)	Exceeded maximum memory available for row entry.	Delete rows from list or abort attempted entry. See Section 3, TUTORIALS.
RUNTIME ERROR	(27)	System failure.	Power system down and up again; if message reappears, call Field Service.

S

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
SECS I/O (PROBLEM)	(66)	(Message will be followed by one of the special SECS messages listed at the end of this appendix.)	
❍ SECS NOT ENABLED	(82)	SECS feature has not been enabled.	Enable (Set Option Menu − Line 05).
❍ ★ SECS NOT ONLINE	(216)		Enable; Set Option Menu, Line 05.
❍ SECS NOT ONLINE, NEED PERMISSION	(207)	SECS must grant permission to probe.	Review SECS protocol S12F71, S12F72. See Section 10 WAFER MAPPING AND SECS.
★ SECS PORT NOT INSTALLED	(139)	SECS not available on prober used.	Need disk drive option to use the SECS port.
SELF TEACH DISABLED!	(196)	Self Teach turned itself off − incompatible with current options.	Check other options enabled. Enable Self Teach: Set Option Menu, Line 02; Autoalign Option Menu, Line 09.
SELF TEACH ‘SEMI’ MODE ENABLED	(197)	Self−teach semiautomatic mode requires limited operator assistance.	Reset as required. Self−teach switch, to enable (see menu item just above) also sets modes. See Section 5 AUTO ALIGN.
❍ ★ SENDER ERROR	(22)	Missing or improperly seated cassette.	See recovery for RECEIVER ERROR (#21).
❍ ★ SENSOR NOT SEATED CORRECTLY	(65)	Center point measurements by the profiler are not equal.	Verify setup and hardware. See Section 6, NON−CONTACT EDGE SENSOR.

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
❍ ★ SENSOR NOT UP	(36)	Noncontact Edge Sensor is in the probe range. System won't move.	Check all Noncontact Edge Sensor hardware. See Section 6, NONCONTACT EDGE SENSOR, Section 3, TUTORIALS.
SENSOR POSITION SET	(48)	Profiler air–sensor confirmed.	Continue operation.
★ SENSOR TOO LOW	(54)	Profiler sensor head is physically too low, or Z up limit too low.	Reposition head at Z255.
SOURCE AND DEST ARE UNAVAILABLE	(113)	The source and destination specified in an external I/O command are both unavailable.	Specify correct source and destination. If destination involves an uninitialized chuck, initialize the chuck via the Auto Load option.
SOURCE IS UNAVAILABLE	(112)	The source specified in an external I/O command is unoccupied or otherwise unavailable.	Specify correct source.
✓ START OUT OF RANGE	(34)	Attempting to start circular probe out of pattern range.	Locate start position within pattern and continue. See Section 3, TUTORIALS.
SYSTEM I/O BOARD NOT WORKING	(101)	Handler response indicates malfunction in handler system I/O board.	Hardware must be fixed or replaced.
SYSTEM IS IN AUTOMATIC MODE	(75)	Attempting to manually enter data when system is in automatic mode.	If serious about entering data, disable option (Set Option Menu).

T

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
TCA SETUP PROCEDURE ABORTED	(145)	Theta Compensation procedure aborted by operator.	Reference: Section 5, AUTO ALIGN.
TESTER BUSY	(68)	Host is currently busy (TTC board only).	Wait or reset.
★ TESTER DOWN	(70)	TTL port only.	Verify setup and hardware.
THETA COMPENSATION MUST BE OFF	(193)	Inspection features will not work if theta compensation is enabled.	Disable; Set Mode Menu, Line 11.
THETA SENSOR NOT FOUND. CONTINUE?	(1)	Exceeded theta align limit.; or, theta LED not read by CPU.	Check connections at chuck I/F board. Press "Y" to continue. If message recurs, reset system.
★ TIME EXCEEDED INKER [1,2,3,4]	(124)	The inker time limit has been exceeded for the inker(s) named.	Reset or service the inker(s), as applicable. See Section 3, TUTORIALS.
TIMEOUT DURING FILE TRANSFER	(151)	Host did not respond within expected time.	Verify host communication, try again.
TIMEOUT WAITING FOR HANDLER	(108)	<PAUSE/CONT> key was pressed while waiting for a handler response; 60 seconds have elapsed without a response.	After a few seconds, Error #92 (MH COMMUNICATION INTERRUPTION) is reported.
TOTAL MAP HAS BEEN ERASED	(64)	Map has been erased, at initiation of operator.	

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
U			
✓ UNABLE TO COMMUNICATE WITH MH	(90)	Invalid response received. Communication attempt repeated five times without a valid response.	Check communication cable and I/O board. Restart handler.
❍ UNABLE TO SET QUICK LOADER REF	(91)	Handler attempt to measure quickloader height was unsuccessful.	Use handler diagnostics to check action of quickloader. Restart handler. See Section 4, MATERIAL HANDLER.
❍ UNEXPECTED MH COMM ERROR CODE	(109)	Prober I/O routines reported an unknown error in prober–handler communication.	Communication modules need attention; call service representative.
UN–INKED BACKGROUND NOT TRAINED	(191)	For Ink Dot Inspection, need to train un–inked die.	See Section 11, INK DOT INSPECTION.
UNKNOWN HANDLER ERROR	(167)	See list of handler submessages at the end of this appendix.	Reference: Section 4, MATERIAL HANDLER.
❍ ★ UNLOAD – BY HOST COMMAND	(217)	When SECS is the wafer map source, format, parameter, and wafer ID mismatch errors will cause the prober to unload the current wafer and send an error message to the host.	See Section 10, WAFER MAPPING AND SECS.
❍ ★ UNLOAD, HOST ABORTED MAP XFER	(218)		
❍ ★ UNLOAD – HOST MAP BAD WAFER ID	(213)		
❍ ★ UNLOAD – HOST MAP FORMAT ERROR	(214)		
❍ ★ UNLOAD – HOST MAP PARAMETER ERR	(215)		
USE A DIE ON RIGHT SIDE OF WAFER	(175)	In the step to deposit a reference ink dot, the move calculated to place the die from under the probe tips to the camera is not possible.	Position another die or abort. See Section 11, INK DOT INSPECTION.
USE SEMI MODE? (Y/ENTER)	(3)		Reference: Section 5, AUTO ALIGN.
V			
✓ VAC “OFF”	(3)	Vacuum off or lost during Autoprobe.	Turn vacuum on (<VAC> key) and continue probing.
★ VM COMMUNICATION TIMEOUT	(247)	Vision Module has internal communication error.	Reset Vision Module.

MESSAGE	CAUSE	RECOVERY AND/OR SOURCE INFORMATION
W		
WAFER ID SUBSYSTEM NOT WORKING (105)	Handler response indicates malfunction in wafer ID subsystem.	Hardware must be fixed or replaced.
❍ ★ WAFER LOAD ABORT (44)	Material Handling Module failure.	Reset system. If reset fails, Material Handling Module requires service.
WAFER LOST (118)	A wafer is detected as missing from normal stations and locations.	Open cassette cover and inspect; follow directions on handler screen for recovery.
WAFER LOST DURING TRANSIT (286)	The system has detected a change in the state of the transfer arm vacuum sensor while transporting a wafer between stations.	Press <ENTER> to silence the alarm. The motor will be blanked, allowing manipulation of the tower assembly. See Section 4, MATERIAL HANDLER.
★ WAFER MAP DESTINATION NOT SET (122)	No destination device had been enabled to receive wafer map.	Specify destination device(s) (Lines 02, 03, and/or 04, Page 2, Wafer Mapping Menu). See Section 10, WAFER MAPPING AND SECS.
WAFER MAP STILL EXISTS IN MEMORY (163)	A wafer map is still in memory.	Store it to disk or to external host. See Section 10 WAFER MAPPING AND SECS.
❍ ★ WAFER MAP MEMORY FULL (57)	Memory/disk full.	New disk required; or, offload memory maps.
★ WAFER MAP SOURCE DEV NOT SET (121)	A device has not been specified as the source of the wafer map.	Specify source device (Line 01, Page 2, Wafer Mapping Menu). See Section 10, WAFER MAPPING AND SECS.
WAFER NOT ALIGNED (56)	Autoprobe attempted on unaligned wafer.	Align wafer and continue. See Section 5, AUTO ALIGN.
✓ WAFER NOT PROFILED (32)	Attempt to auto probe before profiling.	Profile wafer to initialize; see Section 6, NON-CONTACT EDGE SENSOR.
❍ ★ WAFER XFER ERROR (12)	Wafer has failed to properly transfer and seat on vacuum chuck.	Remove wafer. Press <LOAD> or <AUTOPROBE> key (depending on system) to resume.
WAITING FOR HANDLER TO COMPLETE (106)	<PAUSE/CONT> key was pressed while waiting for a handler response, or handler response indicated problem with wafer transfer.	Prober will continue to wait up to 60 seconds after <PAUSE/CONT> is pressed. After 60 seconds, or response is received. MH COMMUNICATION INTERRUPTION message will appear.
WAITING FOR WAFER TO HEAT UP (130)	Hot chuck pausing to get to temperature.	Wait. Reference: Section 7, Z STAGE, HOT CHUCK AND TEMP. COMPENSATION.
WAITING TO POSITION ZOOM LENS (158)	Mechanical problem or no zoom lens installed.	If mechanical problem, call service technician. Reference: Section 12, PROBE MARK INSPECTION.

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
WILL PAUSE AFTER TC OR PAUSE	(133)	Pause pending message enabled from External I/O Mode Menu.	Send TC or PA command from I/O.
WILL PAUSE UPON TC FROM TESTER	(248)	Pause message enabled from External I/O Mode Menu.	Send PA or press <PAUSE/CONT> key.
❍ WRONG PROBE MODE	(79)	Wrong probe mode selected for operation attempted.	Select correct mode (Set Mode Menu, Line 02).
X			
X OR Y OUT OF LOAD TOLERANCE	(120)	Load/unload reference position set is more than 0.3 inches from default load position.	Move the chuck and reset the load reference. See Section 4, MATERIAL HANDLER.
X SUBPROCESSOR NOT WORKING	(102)	Handler response indicates malfunction in X subprocessor.	Hardware must be fixed or replaced.
X–Y MOTION CON–TROL FAILURE	(31)	Motor control logic not properly initialized.	Reset motor or system.
X–Y MOTOR BLANK	(20)	Forcer not locked to platen.	Move forcer to Home position and press forcer release switch to lock.
X–Y OUT OF PLATEN	(38)	Attempting to exceed physical platen X–Y travel range (but within the “ex–tended virtual zone”). Probing is abor–ted, chuck moves to the rail. X/Y posi–tion and die coordinates are updated as though chuck had moved along out–side the platen. See error message “ILLEGAL MOVE REQUESTED.”	Check setup of prober (center position, diameter, probe pattern, edge–sensor, etc.)
X–Y OVERHEATED	(47)	Failure in XY drive or related circuit. This failure will blank the X–Y motor.	XY drive, fans, and sensor should be checked by a qualified technician.
Z			
❍ Z HEIGHT NOT SET	(303)		See Section 6, NONCONTACT EDGE SENSOR or Section 7, Z STAGE, HOT CHUCK AND TEMP. COMPENSATION.
★ ZOOM LENS MALFUNCTION	(26)	The zoom lens has a mechanical problem.	Verify hardware setup or call Field Service.
ZOOM LENS NOT FUNCTIONAL	(190)		Verify hardware setup or call Field Service.
❍ Z OUT OF LIMIT	(51)	System failure; may not be initialized properly. Dialing in all parameters may fix problem.	Reset. If reset fails, have system checked by a qualified technician.

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
❍ Z OUT OF RANGE	(33)	Attempting to exceed Z up or down limit.	Change Z up or down limit. (OR: Input Z value within upper and lower limits).
❍ Z POSITION LOST	(52)	System failure.	Power−up, reset; if reset fails, have system checked by a qualified technician.
Z SENSOR NOT FOUND. CONTINUE?	(2)	Z drive sensor failed to detect.	Check connections at chuck interface board. Press <Y> to continue. If message recurs, reset system.
❍ ★ Z SLIP	(37)	Z drive has stalled; any Z−move is automatically disabled.	Pause; blank the motor. Bring to Home position and reset motor.
✓ Z SLIP	(55)		

Z SLIP error #37 prints on first encounter; on any motion after that, message #55 shows problem on screen but doesn't print.

FOLLOWING...

DISK MESSAGES

SECS MESSAGES

HANDLER MESSAGES

DISK MESSAGES

(Following Disk Error Code 77)

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
CAN NOT CLOSE FILE	(13)		
CAN NOT CREATE FILE	(11)		
CAN NOT OPEN FILE	(1)	Disk error, or file is locked.	Verify hardware.
CANNOT WRITE. MAP LIMIT REACHED	(34)	The floppy has reached the 255 maps maximum capacity.	Insert a new formatted disk.
COPYING PROBLEM	(8)	Disk will not copy for some reason.	
DISK FULL	(4)	Disk capacity reached.	Swap disk with empty formatted disk.
DISK IS WRITE PROTECTED	(3)	Material cannot be written to disk until write−protection is removed.	
DRIVE NOT READY	(2)	Disk error or busy.	Wait, try again; verify hardware.
EMPTY WAFER MAP DIRECTORY	(16)	Disk cross−reference file is nonexistent.	
FILE NOT ON DISK	(5)	File requested is not on disk used.	Check filename; check other disks.
FORMAT(T)ING PROBLEM	(7)	Disk won't format for some reason.	
NO DISK FOUND	(38)	No disk found in drive.	Insert a disk.
NO DISK FOUND IN DRIVE A	(35)	No disk found in drive.	Insert a disk.
NO DISK FOUND IN DRIVE B	(36)	No disk found in drive.	Insert a disk.
NO DISK FOUND IN DRIVE C	(37)	No disk found in drive.	Insert a disk.
NO 2ND DRIVE FOUND	(9)	System cannot find 2nd drive specified.	Check connections.
OUT OF MEMORY	(6)	Disk full.	New disk required.
READING PROBLEM	(12)	Disk error.	Check write protection tab; make sure disk is formatted.

DISK MESSAGES (continued)

MESSAGE		CAUSE	RECOVERY AND/OR SOURCE INFORMATION
UNFORMATTED DISK FOUND	(29)	The floppy in use is not formatted.	Format the floppy before use.
UNFORMATTED DISK IN DRIVE A	(26)	The floppy in the drive named is unformatted.	Format the floppy before use.
UNFORMATTED DISK IN DRIVE B	(27)		
UNFORMATTED DISK IN DRIVE C	(28)		
VERIFYING PROBLEM	(10)	Disk error.	Try copying again; verify hardware.
WAFER ID ALREADY MAPPED	(17)		
WAFER MAP FORMAT ERROR n	(18)	A field ('n') in the wafer map is not the correct type.	Validate correctness of map format. See Section 10 WAFER MAPPING AND SECS.
WAFER MAP NOT ON DISK	(15)	Can't find map file corresponding to ID given.	Enter different ID, try again.
WAFER MAP PARAMETER ERROR n	(19)	A field ('n') in the wafer map is out of range for that type.	Validate prober is set up to same parameters as those stored in wafer map. See Section 10, WAFER MAPPING AND SECS.
WRITING PROBLEM	(4)	Disk error.	Try copying again; verify hardware.
WRONG DISK DRIVE SPECIFIED	(25)	No such disk drive exists.	Select a valid disk drive.
WRONG DISK FORMAT FOUND	(33)	The floppy has a wrong format.	Format for CPM before using.
WRONG DISK FORMAT IN DRIVE A	(30)	The floppy in the drive named has a wrong format.	Format for CPM before using.
WRONG DISK FORMAT IN DRIVE B	(31)		
WRONG DISK FORMAT IN DRIVE C	(32)		

FOLLOWING...

SECS MESSAGES

HANDLER MESSAGES

SECS MESSAGES

Reference: Section 10, WAFER MAPPING AND SECS.

BAD RECORD	(3)
DOWN	(1)
TIMEOUT A	(10)
TIMEOUT B	(11)
TIMEOUT C	(12)
TIMEOUT D	(13)

SECS ACIA ERRORS
- FRAMING
- OVERRUN
- PARITY

SECS I/O ERRORS
- BUFFER OVERFLOW
- CHECKSUM ERROR
- EOI BEFORE ALL DATA
- NON−INT XMIT TIME OUT
- SPURIOUS INTERRUPT

HANDLER MESSAGES

Reference: Section 4, MATERIAL HANDLING.

		Also generated as major message #:
1	HANDLER BUSY	110
2	DEVICE NOT INSTALLED	165
3	DEVICE NOT INITIALIZED	
4	ORPHANED WAFER ON CHUCK	97
5	DEVICE/SLOT NOT VALID	115
6	ALARM PENDING	
7	BLOCK SIZE TOO LONG	
8	MH ERROR RECOVERY IN PROGRESS	98
9	NO WAFERS AVAILABLE	
10	ALL SLOTS FULL	
11	DIAGNOSTICS IN PROCESS	99
12	MENU CHANGE ALARM	

		Also generated as major message #:
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APPENDIX E
PACKAGING

The following procedure is for any international shipment or long term storage to prevent moisture, dust and contamination damage.

STEP 1: Appropriate crate is designed and manufactured for your product depending on the sensitivity, weight, type of handling and transportation your item will experience during the shipping process.

STEP 2: The item is then prepared for the vacuum pack process. The sharp corner or edges are covered with appropriate cushioning, then wrapped in shrink wrap material or stretch film.

STEP 3: The item is then placed into a barrier bag (MIL B 131 type material), desiccant (moisture absorbent preventive) is added and all excess air is removed to create a vacuum seal. The pack is then wrapped a third time in a shrink wrap material or stretch film.

STEP 4: The item is then secured in base accordingly, and the appropriate cap is installed and secured.

STEP 5: Appropriate 'Ship To' markings are applied along with tilt indicator and shock watch systems.

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2 PT 1 ALIGNMENT
Aligning at two points on the wafer using two reference targets with the same pattern.

2 PT 2 ALIGNMENT
Aligning at two points on the wafer using two reference targets with two different die patterns on two halves of the wafer.

ABSOLUTE MOVE
Specific number of steps to move a motor (from position 0,0).

ACTIVE AREA
Defines the die boundary so that edge die can be determined and probe–to–pad alignment will be accurately performed.

AIR BEARING
A mechanical technique that uses air as a physical support medium.

The distance between the platen and the forcer under normal operation (usually .6 to .9 mils). Compressed air is forced downward through orifices in the bottom of the forcer at 75 psi, which counteracts the magnetism and causes the forcer to float above the platen for a friction–free surface–to–surface connection.

ASCII
Acronym for American Standard Code for Information Interchange.

AUTO ALIGN
Uses the prober and a vision processor to align the streets of the wafer to XY axis of the forcer.

AUTOMATIC PROBING SEQUENCE
The automatic prober operation involving transporting the wafer from the cassette, prealigning, profiling, aligning, probing and transporting the wafer back to the cassette.

AUTOMATIC WAFER PROBER
A machine which quickly and accurately moves wafers through the test process.

AUTOPROBE
See *Automatic Probing Sequence.*

BACK SIDE BAR CODE READER (BSBCR)
Identifies wafers by reading the bar codes laser–etched on the back or under side of the wafer.

BAUD
A unit of time describing serial data transmission rate, generally measured in bits per second.

BINCODES
A number that is converted to either a binary 5–bit code or an ASCII character used by the tester to assign test results to a die.

BINNING
The process of assigning bincodes to individual devices on a wafer.

BLANK THE FORCER
Causes all motor drive electronics to remove the power from the forcer coils.

BONDING PADS
Metallic areas on a die to which electrical contact is made with the die.

BURN–IN MODE
Allows the prober to be run continuously, until all wafers are probed, without a test time simulator plug.

BURNISHING PAD
The ceramic pad used to clean probe tips.

CAMERA CONTROL UNIT (CCU)
Provides power and control signals to the camera for Auto Align, OCR and PMI.

CLEAN AIR MANAGEMENT SYSTEM (CAMS)
Module that is attached to the prober to create a Class 1 mini–environment within the prober.

CASSETTE
A container that holds wafers.

CHUCK
Flat metal platform that holds the wafer during probing.

CIRCULAR PATTERN
A serpentine probing pattern similar to Edge Sense except uses NCES to turn around.

COAXIAL LIGHTING
Illumination that uses light injected coaxially into the optics path by means of a beam−splitter and collects light reflected from the wafer surface, causing the field to appear bright.

COMPOUND MOTION
A coordinated motion between two axis.

CONTINUITY PAD
A pad that allows the tester to bring an electrically conductive area in contact with the probe tips for testing.

COORDINATES
A pair of numbers assigned to a die indicating its position on the wafer.

CORRELATION PROCESS
Auto Align process of matching pixel values of one image to another to compare how much the new image looks like the stored image.

CORRELATION WAFER
A wafer with known test results used to verify system operation.

CPU
Central Processing Unit.

CROSSHAIRS
Two perpendicular lines super−imposed on the camera image and appearing in the center of the monitor. Used during Auto Align to select a reference target.

DAR
Digital−to−Analog Resolver − resolves digital information to analog form for production of forcer drive signals.

DIE
Individual devices on a wafer.

DISKETTE
A floppy disk used by the prober.

EDGE DIE
Partial die around the perimeter of the wafer that are incomplete and untestable.

EDGE SENSE PATTERN
A serpentine pattern that begins at the first die and continues until the edge sensor is no longer in contact with the wafer.

EDGE SENSOR
See *Profiler*.

EXTERNAL I/O INTERFACE
Provides communication channels to systems outside the prober, such as testers, host computers, cell controllers, or external printers.

FIELD OF VIEW (FOV)
An area of coverage on the wafer defined by the optical system.

FIELDING
The technique which instructs the OCR system to evaluate characters based on a specified set of predefinitions. Characters are evaluated as either part of or not part of the specified set.

FIRST DIE
Refers to first whole die on one of the four corners of the wafer to be probed. This die serves as a reference point for all other die.

FLAT
The straight edge of the wafer.

FLAT (NOTCH) SELECT
Indicates the selected orientation of either the flat or the notch of the wafer, relative to the front of the chucktop. The operator selects wafer positioning based on 360° rotation at the prealign stage, prior to wafer transfer to the chucktop.

FORCER
The moveable half of the linear motor which carries the Z stage and chucktop on an air bearing over the platen.

FORCER REGISTRATION
Alignment of forcer to platen for strongest magnetic attraction (maximum alignment of grids).

GPIB
General Purpose Interface Bus (IEEE−488 interface).

HARBOR (OR HOME) POSITION
Position on platen where the forcer is initialized.

HOT CHUCK
A chuck that increases the wafer's temperature to above room temperature.

IMAGE MODEL LIBRARY
Stored target images, such as ID wafer characters.

INDEX
Both a distance and a motion type. One Index corresponds to the die size, and is a necessary parameter to preset. Also, Index is a joystick motion type that moves the forcer in the X or Y direction one die size per click.

INK DOT INSPECTION (IDI)
Ink dots that are placed on the wafer for specifying passed/failed die are inspected for presence, position, and integrity.

INKED DIE
A tested and sorted die.

INKER
A device which deposits ink upon a die to identify bad die.

JOG MODE
A joystick motion type that moves the forcer in the X or Y direction 0.039 mil per click.

JOYSTICK
A control lever which manually controls positioning of the forcer.

LEARN LIST
A list of XY coordinates maintained by the prober, used as a list of die to be probed or a list of die to be skipped.

LIFT OFF
The amount of clearance between the forcer and the platen.

LINEAR MOTOR
Horizontal positioning system (X and Y axis) based on Sawyer principle and composed of a platen (fixed surface analogous to a stator in a conventional rotary electric motor) and a forcer (moveable surface analogous to a rotor).

LISTS
Individual die defined by their placement on a wafer.

LOAD
The process of removing a wafer from a cassette and transporting it to the prealign stage.

MATERIAL HANDLER MODULE
Prober subsystem that transports, prealigns, transfers, and unloads wafers.

MATRIX PATTERN
A pattern that establishes the limits of a rectangular probing pattern.

MENU
A readout or display on the monitor showing a selection of command or parameters to be set.

MULTI−DIE PROBING
Probing several die at the same time using multi−die probe cards.

NONCONTACT EDGE SENSOR (NCES)
See *Profiler*.

NORMAL ALIGNMENT MODE
Auto Align mode that stores one reference target and performs alignment from that target.

OBLIQUE LIGHTING
Illumination that uses light directed obliquely to the wafer surface, causing the field to appear dark.

OFFLINE INKING
A process by which one prober is dedicated exclusively as an inking station and supplied with a product by other probers. Inking is done according to a wafer map transferred between the probers and the ink station via diskettes.

OPTICAL CHARACTER READER (OCR)
An application of vision technology that reads alphanumeric characters etched into the surface of the wafer.

PAD
See *Bonding Pads*.

PARAMETER
An element that must be defined for the prober.

PARTIAL DIE
An incomplete die located on the edge of the wafer.

PIPELINING
The process of moving the wafers from the cassette to various stations en−route to the chucktop.

PLATEN
Ferromagnetic surface on which the forcer rests. Platen and forcer are separated by an air bearing to provide frictionless movement.

POD
Part of the SMIF option, a transparent box that encases cassettes for isolated transport within the mini−environment of the prober.

POSITIONER
See *Forcer*.

POST−PROBE INKING
Option which permits inking after probing of the whole wafer, using data from a wafer map.

PROBER CONTROL MODULE
The power supply for the 4085X Automatic Wafer Prober and all the operating electronics.

PREALIGN
Process of positioning the wafer so that all flats or notches will be in the same position (0−359 degrees).

PREALIGNER
Module that performs prealigning. The wafer is placed in the prealign stage and the wafer is rotated for flat or notch alignment.

PROBE
A fine point which contacts the pad on a die in order to connect to a tester for electrical functional testing.

PROBE CARD
Fits into the ring insert; contains probe points and is used as the primary interface between the tester and the device under test on the wafer.

PROBE MARK INSPECTION (PMI)
A procedure in which test−induced probe marks are inspected for presence, position, and size within a customer−defined target area on the test pad.

PROBE OPTICS
Microscope for operator to view wafer in the align mode.

PROBE QUADRANT
A parameter that determines the direction of travel for probing patterns.

PROFILER
Measures wafer diameter and finds the center of the wafer in relation to the center of the chucktop.

PROGRAMMABLE CHUCK (PZ6)
Allows Z−axis operation to be programmed for contact clearance and overtravel.

psi
Pounds per square inch, used in reference to air pressure.

QUADRANT SELECT
Indicates the selected starting quadrant on the wafer. This determines the initial probing direction and the X−Y coordinate reporting direction.

RAILS
Metal bars with rubber bumpers serving as barriers to retain the forcer on the platen and as a mechanical stop for positioning the forcer in magnetic registration with the platen at Harbor position.

RDP PROTOCOL
The communication between the prober and tester and between the tester and external controller.

READ RATES
The number of ID character readings divided by the total wafers attempted.

READ TIMES
The time required to acquire sufficient character data to make pass/fail judgements.

REFERENCE TARGET
A pattern that is selected and stored in memory, then used by the Vision Module to perform alignment.

RING CARRIER
Metal plate suspended over the platen which holds the ring insert which, in turn, supports the probe card.

RING INSERT
A circular device which contains the probes and holds the probe card, and which is inserted into the ring carrier.

ROW / COLUMN PATTERN
A pattern used to probe selected die points defined by rows on the wafer.

RS−232 PORT
A serial communications outlet.

SCAN MODE
A joystick motion type that moves the forcer freely with no discernible steps or clicks.

SECS
Acronym for Semiconductor Equipment Communication Standard.

SELF−TEACH AUTO ALIGN (STAA)
Automatically selects the reference target needed to perform Auto Align.

SEMI SPECIFICATIONS
Proposed character standards by Semiconductor Equipment and Materials Institute (SEMI) about ID wafer characters for the semiconductor industry.

SINGLE WAFER HANDLING STATION
Used for manually loading a single wafer into the system.

SKIP DIE
Die that is not probed, tested or inked.

STANDARD MACHINE INTERFACE (SMIF)
Robotic module used in connection with CAMS to automatically load and unload wafers within the clean environment.

THETA MOTION
Rotation of the wafer or chuck independent of X, Y or Z position.

TRANSFER ARM
The unit which transports the wafer from the prealign stage to the chuck.

UGLY DIE
A die category used for whole die around the perimeter of the wafer that test bad. These die can be automatically inked to improve throughput.

UNLOAD
The process of automatic removal of a wafer from the chucktop to a receiving cassette.

USER−DEFINED REGION (UDR)
A function of Self−Teach Auto Align, it selects a reference target from region selected by the user within the camera's field of view.

VISION MODULE
A unit which collects, compares, and stores wafer reference patterns fed to it by a camera. This data is used to align a wafer and to provide identical alignment prior to probing for all successive wafers.

WAFER
Thin slices cut from a silicon ingot (or similar material) upon which semiconductor devices are created. After processing, the wafer is cut into individual die or circuit chips.

WAFER ID READER (OCR)
See *Wafer ID Reader*.

WAFER MAPPING
Process by which information regarding a wafer is mapped during the probing process and stored on diskettes.

X AXIS
Left/right direction on the platen from the operator's position in front of the machine.

X−Y COORDINATES
Location information on grid using X and Y axes.

Y AXIS
Forward/backward direction on the platen from the operator's position in front of the machine.

Z ELECTRICAL ZERO
PZ6 Level when 0.00 shows on monitor; the PZ6 initializes at this level.

Z DOWN LIMIT
Term used for PZ6 at 200 mils for wafer loading/unloading alignment (Z−200 level).

Z MECHANICAL ZERO
PZ6 level 20 mils below Electrical Zero when the chuck physically hits a mechanical stop.

Z MOTION
Up and down movement of the chuck.

Z OVERTRAVEL
The distance the Z stage travels after making physical contact with the probes.

Z STAGE
Controls the up/down movement of the chucktop.

Z TWIST
An error in motion caused by bad bearings or bent theta fixation pin (when a change in Z position and a change in theta position occur simultaneously).

Z UP LIMIT
Term used for PZ6 at 400 mils for wafer loading/unloading alignment.

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