Gemini 2
Vacuum Transport System
User Manual

168984 Revision D

Information provided within this document is subject to change without notice, and although believed to be accurate, Brooks Automation assumes no responsibility for any errors, omissions, or inaccuracies.

AcuLigner™, Align™, AquaTran™, AutoTeach™, ATR™, AXM™, Basic Blue™, BiSymmetrik™, CenterSmart™, Cool Solutions™, Crate to Operate™, e-RMA™, e-Spares™, e-Volution™, FastRegen™, FIXLOAD™, FrogLeg™, InLigner™, InCooler™, Interface™, Jet Engine™, LowProfile™, M2 Nano™, Mini-Ion™, PASIV™, PowerPak™, PerformanceBlue™, PowerPak™, PowerTools™, QuadraFly™, Radius™, Radient™, Radient Express™, Reliance™, Reliance ATR™, RetroEase™, SCARA™, SmartPM™, SPOTLevel™, Synetics™, The New Pathway to Productivity™, Time Optimized Trajectory™, Time Optimal Trajectory™, Time Optimized Path™, TopCooler™, TopLigner™, Ultimate Blue™, VAC-407™, VacuTran™, Vacuum Quality Monitor™, VQM™, Vacuum Quality Index™, VQI™, and the Brooks logo are trademarks of Brooks Automation, Inc.

AcuTran®, AquaTrap®, Conductron®, Convectron®, the Cool Solutions logo, Cryodyne®, Cryotiger®, Cryo-Torr®, Fusion®, GOLDLink®, Granville-Phillips®, Guardian®, GUTS®, Helix®, Jet®, Leapfrog®, MagnaTran®, MapTrak®, Marathon®, Marathon 2®, Marathon Express®, Micro-Ion®, MiniConvectron®, On-Board®, Polycold®, Razor®, Simplicity Solutions®, the Simplicity Solutions logo, Stabil-Ion®, TrueBlue®, TurboPlus®, Vision®, Zaris®, and the Brooks Automation logo are registered U.S. trademarks of Brooks Automation, Inc.

All other trademarks are properties of their respective owners.

For Technical Support:

Location	GUTS® Contact Number
North America	+1-800-FOR-GUTS (1-800-367-4887) +1-978-262-2900
Europe	+49-1804-CALL-GUTS (+49-1804-2255-4887)
Japan	+81-45-477-5980
China	+86-21-5131-7066
Taiwan	+886-3-5525225
Korea	+82-31-288-2500
Singapore	+65-6464-1481

Visit us online: www.brooks.com

April 6, 2015	ECO 81383	Revision D
September 5, 2012	ECO 62384	Revision C
November 24, 2009	ECO 49055	Revision B

This technology is subject to United States export Administration Regulations and authorized to the destination only; diversion contrary to U.S. law is prohibited.

Printed in the U.S.A.

Contents

Installation

Alignment and Teaching

Operation

Preventive Maintenance

Troubleshooting and Repair

Drawings

Appendices

1 Introduction

Overview

The Brooks Automation Gemini 2 (G2) Vacuum Transport System moves 300 mm wafers between an environment that is at atmospheric pressure and an environment that is at a high vacuum pressure. This allows semiconductor process modules that operate in vacuum pressure the ability to receive wafers at that vacuum level.

The G2 is designed to provide a clean environment to deliver wafers to several process tools that use a vacuum environment. The number of process modules that can attach to the G2 depends on the number of facets, or process module openings, available in the configuration being used.

An Equipment Front End Module (EFEM) allows wafers in carriers and cassettes to be placed on a load port, moved into a minienvironment, and then transferred by a robot to a Load Lock chamber. The Load Lock chamber encloses the wafer and can either vent to atmospheric pressure or purge the atmosphere in the Load Lock to vacuum to enter the EFEM in the front or the back end vacuum chamber.

The G2 is intended for use by industrial customers and should be serviced only by Brooks or Brooks trained representatives. The service manuals and related materials are provided in English at no charge and are intended for use by experienced technicians. It is the responsibility of the user to obtain and assure the accuracy of any needed translations of manuals. If you require assistance please contact Brooks service department. Contact information can be found at www.brooks.com.

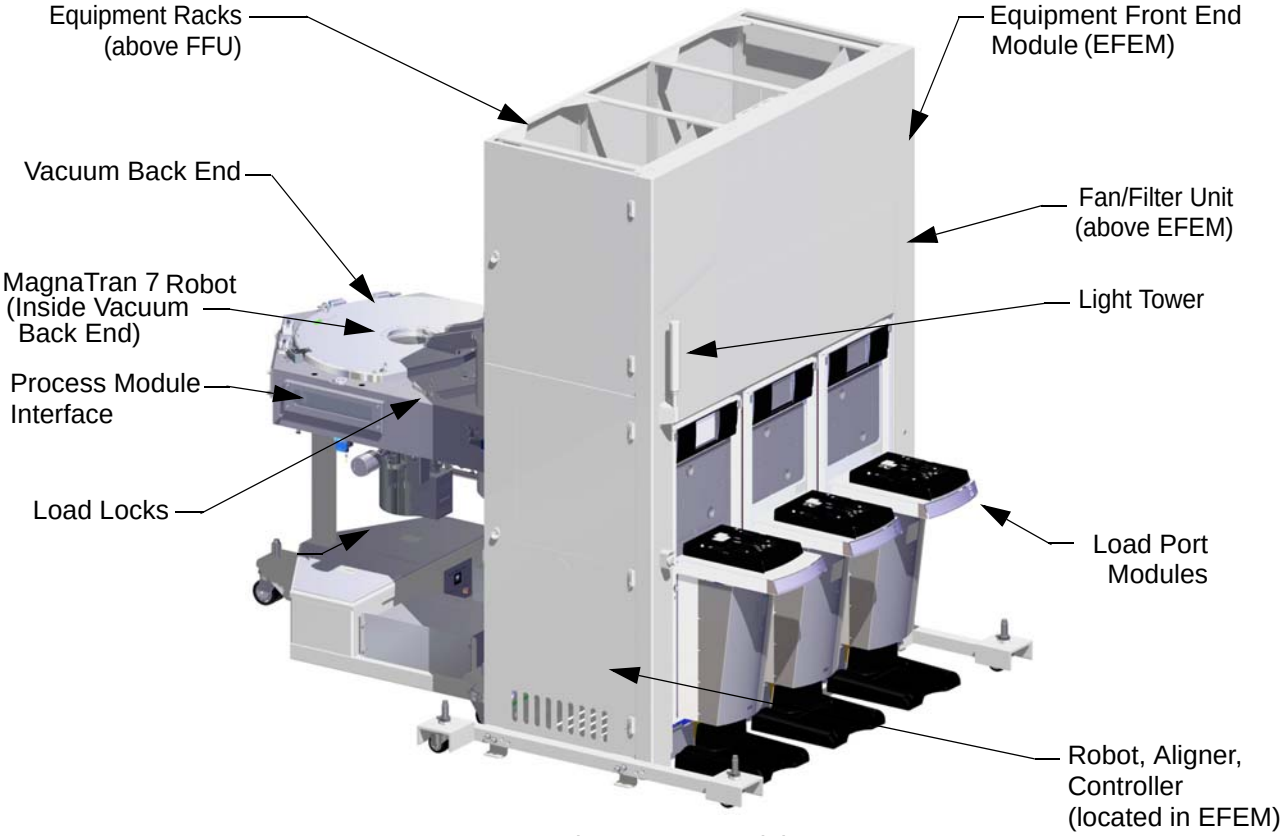


Figure 1-1: Gemini 2

Features

- Equipment Front End Module
  - Minienvironment with Integrated Fan/Filter Unit
  - Razor ATR
  - Fusion Controller
  - Razor AWA aligner
  - Razor ATK track (optional)
  - EFEM Service Light
  - Vision Load Port Modules
  - EMO button for user defined and supplied Emergency Off circuit
- Vacuum Back End
  - Transport Chamber on steel frame
  - MagnaTran 7 Robot
  - Manual lid lifter
  - Safety Hub with complete slot valve/process module/robot hardware interlocking
  - Facilities distribution for CDA, N_2, and Exhaust and cooling water, if needed
  - Vacuum, Vent, and Pneumatic Systems

Options

Options are available for the Gemini 2 system that increase its functionality. All options are available at the time of purchase for installation and configuration by Brooks Automation.

- Equipment Front End Module
  - Teach Pendant
  - Ionizer
  - Single multicolor light tower
  - Light Curtain
  - Operator Interface mounted with one of the following:
    - Swing-out arm
    - Wing panel
    - BOLTS insert in place of a LPM
  - Wafer Mapping
  - E84 interface for AMHS material transfer handshaking
  - Wafer Buffer
  - Two 9U 19” racks above the FFU for user electronics on JET systems
- Vacuum Back End
  - CenterSmart™ Automatic Wafer Centering
  - Rough Vacuum Package including pumps
  - Material Transport Plane (MTP) at 1100 mm

System Components

Equipment Front End Module (EFEM)

The EFEM is designed for manual, Automated Guided Vehicles (AGV), or Over Head Transport (OHT) loading of FOUPs or cassettes that contain wafers waiting to be processed in the process modules. The wafers are removed from FOUPs or casettes by the atmospheric robot in the EFEM aligned, and moved by the atmospheric robot to the Vacuum Back End Load Locks.

Minienvironment

Inside the EFEM is an enclosed area with an air flow to prevent particles from depositing on the wafer. Inside this area, referred to as the minienvironment, the atmospheric robot moves wafers from inside FOUPs and cassettes. The Vision Load Port Module attaches to the front openings or bays. The EFEM minienvironment may be 3-bay or 4-bay. It is possible to close off bays from the rest of the minienvironment for use as equipment racks, user interfaces, or for any other user purposes. Inside the minienvironment wafers move to and from Load Port Modules and the Vacuum Back End. The minienvironment supports the robot, aligner, load ports, and electronics and provides a single connection point for all facilities.

Razor ATR Atmospheric Robot and Fusion Controller

The Razor™ Atmospheric Transfer Robot (ATR) moves the wafers between the Load Port Modules, Aligner, and Load Ports. The robot provides up to five axes of motion allowing off-center material pick and place and fast material swap. The end effectors available offer passive support, an active edge-grip, or a vacuum grip for high operating speeds.

Fusion Compact Controller

The Fusion Compact Controller is used to provide control of all material transport functions within the EFEM. It is used to control the Razor Automation Components and other modules.

Razor AWA Aligner

The Razor™ Atmospheric Wafer Aligner (AWA) is an atmospheric pre-aligner used to align 200 mm wafers, 300 mm wafers, and other material. The Razor ATR robot and Fusion controls adjust how the Razor robot picks the wafer for alignment. The aligner provides edge contact support of the wafer during alignment. It is capable of aligning wafers with a notch type fiducial.

Load Port Modules

Each Load Port opening on the EFEM can support the complete range of Brooks Automation BOLTS-compatible Load Port Modules (LPMs). There is no requirement to have the same type of LPM installed at each interface, although that is the typical configuration. All LPMs support Carrier ID and E84 interface options.

Vision LPM

The Vision™ Load Port Modules (LPMs) are SEMI-compatible FOUP load Ports for manual or automated loading of wafer carriers. Once the FOUPs are loaded on the LPMs, the Load Port Modules move the FOUP flush to the front of the EFEM. The door on the LPM opens, and wafers or other material within the carriers are available to be unloaded by the atmospheric robot. The Vision LPMs are optimized to work with the Brooks Automation Fusion Controls.

Vacuum Back End Module

The Brooks Automation Vacuum Back End Module contains a Vacuum Transport Chamber and Load Locks.

Vacuum Transport Chamber

The Vacuum Transport Chamber for the Gemini 2 system is used to move materials from the Load Locks to a chamber under high vacuum. Inside the Transport Chamber, a vacuum robot moves wafers in and out of the Load Locks and in and out of process modules. Openings for a vacuum process module (facet) provide the ability to attach slot valves and process modules.

MagnaTran® 7 Vacuum Robot

The MagnaTran 7 (Mag 7) Vacuum Transfer Robot (VTR) moves wafers in a high vacuum environment. The Mag 7 robot is:

- Compact
- Direct drive
- Continuous rotation
- Multi-axis

The robot offers excellent repeatability using Brooks' patented Time Optimal Trajectory™ motion control to provide very high operating speeds with passive material support. The robot is controlled using integral DSP based electronics and supports a variety of arms and end effectors, including single and dual end effector arms.

Load Locks

The Load Locks provide a location where the wafers can transition between an environment that is at atmospheric pressure and an environment that is at vacuum pressure. The Load Locks are located between the Vacuum Transport Chamber and the atmospheric front end module's minienvironment.

On one side of the Load Lock is an atmospheric door and on the other side is a vacuum slot valve. When the atmospheric door and the slot valve are both closed, the Load Lock can vent to atmosphere or purge to vacuum pressure, independent of the atmospheric pressure in the EFEM and the vacuum pressure in the Vacuum Transport Chamber.

This allows the pressure inside the Load Lock to purge to vacuum so the Load Lock slot valve can open when the wafers are ready for transport by the vacuum robot. It also allows the pressure inside the Load Lock to vent to atmosphere so that the Load Lock atmospheric door can open and the atmospheric robot can move the wafer.

Generation 5 EN Controls

The Generation 5 EN control system provides a single Ethernet connection from the host controller to the Gemini 2 system. A high level of safety interlocks protect the Gemini 2 system and the wafers that move through it. These interlocks, available through the Safety Hub, include:

- Slot valve operation checks
- Robot motion checks
- Chamber lid position sensing

Operation

The Gemini 2 system consists of an Equipment Front End Module (EFEM), where the material is delivered from carriers placed on the Load Port Modules. The EFEM provides a clean laminar flow environment with an atmospheric robot, atmospheric aligner, and atmospheric doors to the Load Locks. The Load Locks are part of the Vacuum Back End (VBE). The Atmospheric robot waits for the atmospheric door to open then moves the wafer into the Load Lock.

A wafer is moved into a Load Lock that pumps down to low vacuum levels after the atmospheric door closes. After the Load Lock reaches the same vacuum pressure as the Vacuum Transport Chamber, the vacuum slot valve opens. The material is picked from the Load Lock and moves into the Transport Chamber (TC) by the vacuum robot. The Vacuum Transport Chamber has been pumped to low level vacuum levels that are the same as the vacuum levels in the process modules attached to it. The wafer is then moved between one to five Original Equipment Manufacturers (OEM) Process Modules attached to the main Vacuum Transport Chamber.

After the wafer is processed by the process modules, the wafer moves back to the FOUP or carrier. It proceeds from the process modules to the carrier or FOUP on the front of the atmospheric front end by the reverse way that it loaded into the process module.

The wafer is picked from the process module. The vacuum robot places the wafer into the Load Lock after the vacuum slot valve opens. The Load Locks are used to return the wafers to atmospheric pressure by purging the Load Lock chamber when both atmospheric door and slot valve are closed. When the atmospheric door opens, the wafer is picked from the Load Lock by the atmospheric robot. The robot moves the wafer to the carrier or FOUP.

Configuration

The configuration of the Gemini 2 system is determined by the user and is based on the Basic Configuration needed and the System Integration Level required. The system can be custom configured to three levels of integrated tool automation solutions ranging from a mechanical component set to an integrated platform with vacuum systems.

Basic Configuration

The Basic Configuration of the Gemini 2 system is determined by the number of Load Port Modules (LPMs), and the number of Process Modules (PMs) that can be attached. The various configuration available are detailed below.

Table 1-1: Equipment Front End Module Configuration Options

Platform	Robot	Aligner	Load Ports
JET	1 (Razor ATR)	1 (Razor AWA)	3 - 4 bay (Vision)

Table 1-2: Vacuum Back End Configuration Options

System	Robot	Load Locks	PM Interface
G2 5000	MagnaTran 7	Single or double (with or without cooling) or Batch	3
G2 6000	MagnaTran 7	Single or double (with or without cooling) or Batch	4
G2 7000	MagnaTran 7	Single or double (with or without cooling) or Batch	5
G2 8000	MagnaTran 7	Single or double (with or without cooling) or Batch	6

System Integration Level

The System Integration Level is determined by the user requirements for system. This manual provides complete coverage for the hardware used in all integration levels of the Gemini 2 system and the software used through the Level 2.5 integrated systems.

Level 2.5 - Gemini 2 with Electrical Integration

This level of integration provides complete Electrical Integration, including Controls Wiring and System Power. This system includes all components, integration, and testing for a complete Controls solution. Level 2.5 includes:

- Integrated Equipment Front End Module, includes:
  - Minienvironment with Fan/Filter Unit
  - Material handling robot drive, transfer arm, and end effector(s)
  - Load Port Modules
  - Aligner (optional)
- Integrated Vacuum Load Lock(s), configuration options for each load lock include:
  - Blanked (not used)
  - 2 wafer Pass Thru
  - 2 wafer Pass Thru with Cooler
  - 26 wafer Batch
  - 13 wafer Batch with Cooler

- Integrated Vacuum Back End, includes:
  - Transport chamber and frame
  - MagnaTran vacuum material handling robot drive, transfer arm, and end effector(s)
  - Facilities subsystems, including nitrogen, air, and water
  - Application specific Vacuum/Vent subsystems including common roughing and venting system, hard vacuum lines, vacuum manifolds, valves, and gauges
  - High Vacuum pumps (if required)
  - Internal DeviceNet bus, Ethernet bus, and DeviceNet, and E84 Nodes
  - Safety Hub providing full interlocking of robot, slot valve, and atmospheric door motion
- System documentation

Using this Manual

This User Manual provides documentation for operation and maintenance of the Brooks Automation Gemini 2 system. While this document covers specific information and adjustments for the G2 system, there may be information in other manuals which affect the settings or operating mode of the Gemini 2 system and attached components.

The Gemini 2 system is configured to the customer's specifications and acceptance tested at Brooks Automation. Before adjusting or changing settings on an G2 system, consult the following Brooks Automation documentation:

Brooks Automation Equipment Front End Module User Manuals
Brooks Automation load port module user manual
Command Line Reference Software Manual
Gen5 EN User Manual
OEM Components Manuals
Process Module User Manual
Robot User Manual
Transport, Process Module, and System Controller User Manuals
System Wiring Diagrams

NOTE: *All documents cited shall be the latest revision.*

This manual is intended to provide information about a wide variety of Gemini 2 system configurations and options. It may contain references to items not installed on a specific system.

The commands for controlling the robots and other components used in the Gemini 2 system are defined in their User Manuals. The *Gemini 2 User Manual* may refer the reader to these manuals for additional information.

Specifications

The Brooks Automation Gemini 2 Vacuum Transport System supports up to six Process Modules and four Load Port Modules based on the configuration. The specifications for the G2 system and its sub-systems are detailed below.

NOTICE

All drawings within this manual are generic and may not reflect specific builds of the Gemini 2 system. To obtain a complete and current set of drawings and documents contact Brooks Technical Support.

Mechanical Specifications

Equipment Front End Module

Dimensions:	Refer to the JET User Manual for typical physical dimensions, for the actual dimensions of the specific system, including foot and seismic tie-down locations refer to the Mechanical Layout Drawing supplied with this manual.
Weight:	Refer to the JET User Manual for typical system weights, for the actual weight of the specific system, including Floor Loading and Center of Gravity refer to the Mechanical Layout Drawing supplied with this manual.
Exposed Materials:	Refer to the JET User Manual for detailed information on exposed materials. Typical exposed materials include: Aluminum, Anodized Aluminum, Stainless Steel, Cold Rolled Steel, Baked Powder Coated Epoxy, Lexan®, PEEK™, Viton®
LPM Interface:	Per SEMI E63 BOLTS interface
Leveling Provision:	Adjustable feet to meet Material Transport Plane
Rolling Provision:	4 casters (minimum)
Lifting Provision:	2 removable forking brackets provided under the frame
Hold-Down Provision:	User supplied and installed brackets
Ground Clearance:	50.8 mm (2.00 in) maximum
Vacuum Port:	8 mm Quick Connect if required
Pneumatic Port:	8 mm Quick Connect if required
Exhaust Port:	8 mm Quick Connect if required

Vacuum Back End

Dimensions:	Refer to Figure 1-2, and Table 1-11 for typical physical dimensions. For the actual dimensions of the specific system, including foot and seismic tie-down locations, refer to the Mechanical Layout Drawing supplied with this manual.
Weight:	For the actual weight of the specific system, including Floor Loading and Center of Gravity refer to the CG and Foot Loading Layout Drawing supplied with this manual.
Exposed Materials: (Atmosphere)	Aluminum, Anodized Aluminum, Stainless Steel, Cold Rolled Steel, Baked Powder Coated Epoxy, Lexan®, Pyrex®, Viton®
Exposed Materials: (Vacuum)	Aluminum, 316L Stainless Steel, Sintered Nickel, Pyrex, Viton®, Kalrez®, Teflon®, Silicon Nitride (cool lock option) Alumina
Internal Volume:	
G2 6 chamber:	Approximately 141 liter (8,604 in^3)
LL chamber:	Approximately 9.6 liter (583 in^3)
Batch LL chamber:	Approximately 53 liters (3,234 in^3)
Leveling Provision:	Adjustable feet to meet Material Transport Plane
Rolling Provision:	3 casters (minimum), removable
Lifting Provision:	4 tube integral to frame
Hold-Down Provision:	User supplied and installed brackets
Ground Clearance:	71.20 mm (2.8 in)
Vacuum Ports:	KF 50
Nitrogen Port:	
Main:	$^1/_4$ in. VCR
CDA Supply:	
Main:	$^1/_2$ in. Quick Connect
PM Facet:	8 mm Quick Connect
To EFEM	8 mm Quick Connect
CDA Exhaust:	
Main:	$^1/_2$ in. Quick Connect
PM Facet:	10 mm Quick Connect
To EFEM	8 mm Quick Connect
Over Pressure Exhaust:	$^1/_2$ in. Quick Connect

PCW Supply:

Main:	$^3/_4$ in NPT Quick Connect Coupler
PM Facet:	$^3/_4$ in NPT Quick Connect Coupler

PCW Return:

Main:	$^3/_4$ in NPT Quick Connect Nipple
PM Facet:	$^3/_4$ in NPT Quick Connect Nipple

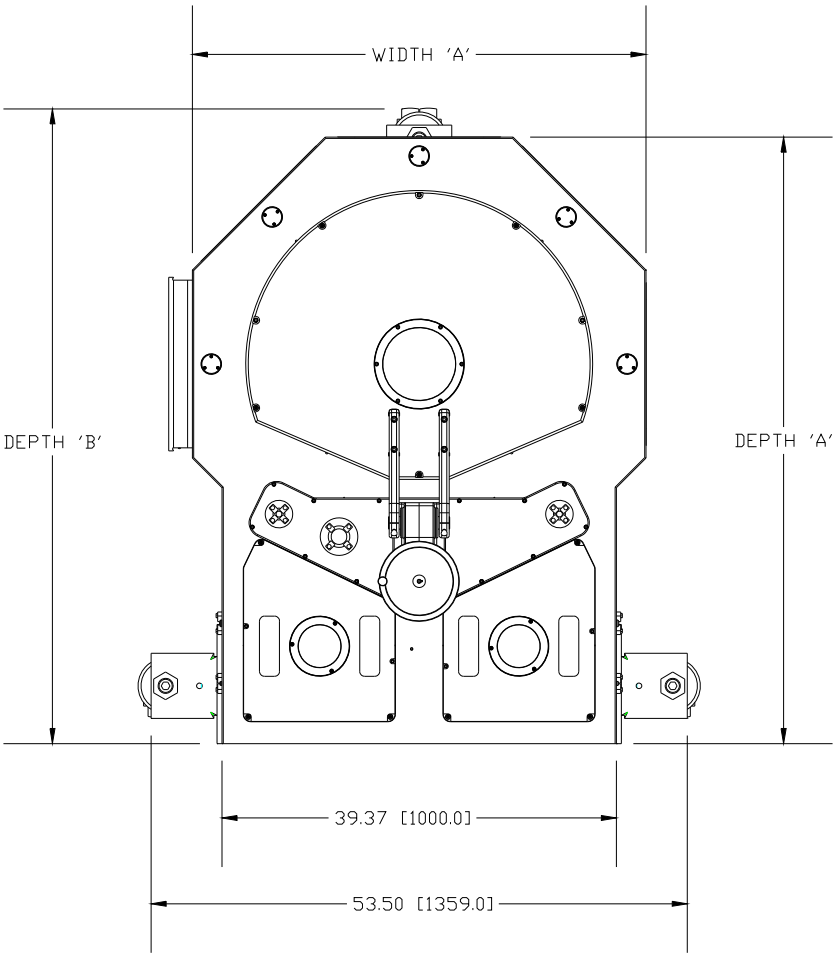


Figure 1-2: Gemini 2 Back End Dimensions - Typical

Table 1-1: Gemini Back End Dimensions - Typical

Model	Depth 'A'	Depth 'B'	Width 'A'	Height[1]
G2 5000	1421.7 mm (55.97 in)	1609.8 mm (63.38 in)	1000.0 mm (39.37 in)	1200.9 mm (47.28 in)
G2 6000	1499.5 mm (58.88 in)	16040.4 mm (63.16 in)	1000.0 mm (39.37 in)	1200.9 mm (47.28 in)
G2 7000	1536.7 mm (60.50 in)	1609.8 mm (63.38 in)	1150.0 mm (45.28 in)	1200.9 mm (47.28 in)

Table 1-1: Gemini Back End Dimensions - Typical

Model	Depth 'A'	Depth 'B'	Width 'A'	Height[1]
G2 8000	1584.1 mm (62.37 in)	1609.8 mm (63.38 in)	1244.6 mm (49.0 in)	1200.9 mm (47.28 in)

1. To top of lid when closed on chamber.

Power Specifications

Electrical, System: Wye or Delta configuration. System must be installed on the load side of a user supplied circuit breaker that meets, or exceeds, the minimum AIC rating specified by SEMI S2. System must be installed on the load side of a user supplied 10,000 AIC rated circuit breaker per SEMI S2.

EFEM (JET): 200 - 240 VAC, 50 - 60 Hz, 30 A, single phase (phase to phase or phase to neutral), 30 A max, based on configuration and operating mode.

The Gemini 2 system requires one 200 - 240 VAC power feed (phase to phase or phase to neutral) at 30 A max for operation and one 3 phase and one 200 - 240 VAC 3-phase feed at 16 A max for the heater. The actual power being drawn will depend upon operations being performed, however all power wiring must be capable of carrying the full load. Internal power converters produce the different voltages required by the different subsystems of the G2 system.

NOTE: *The facility is responsible for the main disconnect devices between the Gemini 2 system and the facility's power source, ensuring it complies with the correct electric codes. Service to the G2 system should have the appropriate fuse or circuit breaker rating. The main user installed disconnect devices must meet, or exceed, the minimum AIC rating specified by SEMI S2. All current requirements shown are maximum values, the actual current drawn depends upon the use of the G2 system.*

Power Cable

The NEMA L6-30R connector is supplied with the tool.

NOTICE

Before connecting or disconnecting the main power to the G2, be sure that all circuit breakers on the G2 and any related equipment are in the OFF position. Damage to internal components may result if the circuit breakers are left in the ON position.

Facilities Specifications

Pneumatic: Typical configurations require the following supply of clean, dry (unfiltered), oil free air:
90 psig ±10 psig at 50 slm nominal, 200 slm maximum

Nitrogen: Typical configurations require the following supply of clean, dry nitrogen:

≤1 ppm contamination
40 psig ±5 psig at 100 slm nominal, 300 slm maximum

Argon: Configurations using a facet mounted TopCooler may require the following supply of clean, dry argon:
≤1 ppm contamination
20 psig at 10 sccm

Vacuum, Backing: Typical configurations require the following supply (input to atmospheric robot):
610 mm Hg at 50 cc/sec (24 in Hg at 3.05 ci/sec)

Vacuum, Rough: Pumping speed, 900 lpm (32 cfm) minimum
Ultimate pressure, 23 mTorr

Vacuum, Foreline: Pumping speed, 900 lpm (32 cfm) minimum
Ultimate pressure, 23 mTorr

Electrical, System: 200 - 240 VAC @ 50 - 60 Hz, single phase, 30 A
Based on configuration and operating mode.
System must be installed on the load side of a user supplied 10,000 AIC rated, UL489/IEC60947-2 compliant, branch circuit breaker (circuit breaker supplied with Gen 5 and Gen 5 EN system ACPD is 5,000 AIC).

Electrical Heater: Three phase star (Y) connection
50/60 Hz (Europe, Korea, Israel)
@ 220 V 9.45 A per phase, total power 5.7 kVA
@ 230 V 9.88 A per phase, total power 6.2 kVA
@ 240 V 10.31 A per phase, total power 6.8 kVA
Delta connection
50/60 Hz (Japan, USA)
@ 200 - 208 VAC 16.85 A per phase, total power 6.2 kVA
Overvoltage Category II. The Heater Power Supply incorporates a 10,000 AIC rated, UL489/IEC60947-2 compliant, branch circuit breaker.

Water: Non-corrosive water at 15 °C ±5 °C non-condensing, corrosion inhibitors recommend
4 gpm at 30 psig nominal, 40 psig if equipped with turbo pumps (or manufacturers listed cooling requirements)
20 psi min is required to avoid boiling chamber cooling water during the system cartridge heater 120 °C bake out/70 psi max
30 psig minimum delta p

Exhaust: Sufficient to support return from air lines and exhaust from vacuum pumps

Network Interface Connections

Ethernet: 10/100 Mbps

Network communications using the Ethernet communications protocol provides the ability to connect a number of different devices to a host controller using a single communications cable, which simplifies wiring. Ethernet communication allows both the Equipment Front End Module and Vacuum Back End

to send and receive data faster than with serial communication connections. Each device connected to the network has a unique network device address. Only communications addressed to a specific device through the network will be received by that device. The configuration for the various devices using Ethernet is described in *Command Line Reference Software Manual*.

Network communications allows the Host Controller to communicate with the Gemini 2 system using the commands detailed in the *Software User Manual.* In situations where the Teach Pendant and the Host Controller are unavailable, a personal computer running a network communications application may be connected to a network port on the Ethernet Switch using a standard Ethernet cable.

The connection to the G2 system from the host controller uses standard Ethernet network communications protocols and wiring. The configuration for the G2 system's network communications protocol is described in Table 1-2. Note that if more than one Gemini 2 system will be connected to the same network the IP Address of each additional system must be changed to avoid IP conflicts.

Table 1-2: Ethernet Network Communications Protocol

Setting	Atmospheric Robot	Vacuum Robot
IP Address	20.20.249.20	20.20.249.10
Mask	255.255.255.0	255.255.255.0

The Ethernet cables used are standard network cable (UTP-Cat5) with an 8-pin RJ-45 connector. The cable plugs into the Ethernet Switch at any of the Ethernet ports. The pin-out for this connection is provided in Table 1-3. Note that pins not identified with a signal name are to be left unconnected. To establish a direct communications link to the Gemini 2 system from a service computer (i.e., laptop) using Ethernet either a crossover cable or a hub is needed.

Table 1-3: Standard Ethernet Network Connector Pin Assignments

Pin	Signal	Pin	Signal
1	TX+	2	TX-
3	RX+	4	
5		6	RX-
7		8	

Site Requirements

Service Access

The Gemini 2 system requires adequate space for service access as specified in SEMI E26 and for proper operation. Refer to the Mechanical Layout Drawing supplied with this manual for system dimensions.

Ensure that installation of the Gemini 2 system is such that it provides access to items required for service after installation, such as the lid lifter and connection panels.

Refer to the User manual for the Equipment Front End Module for its service space requirements.

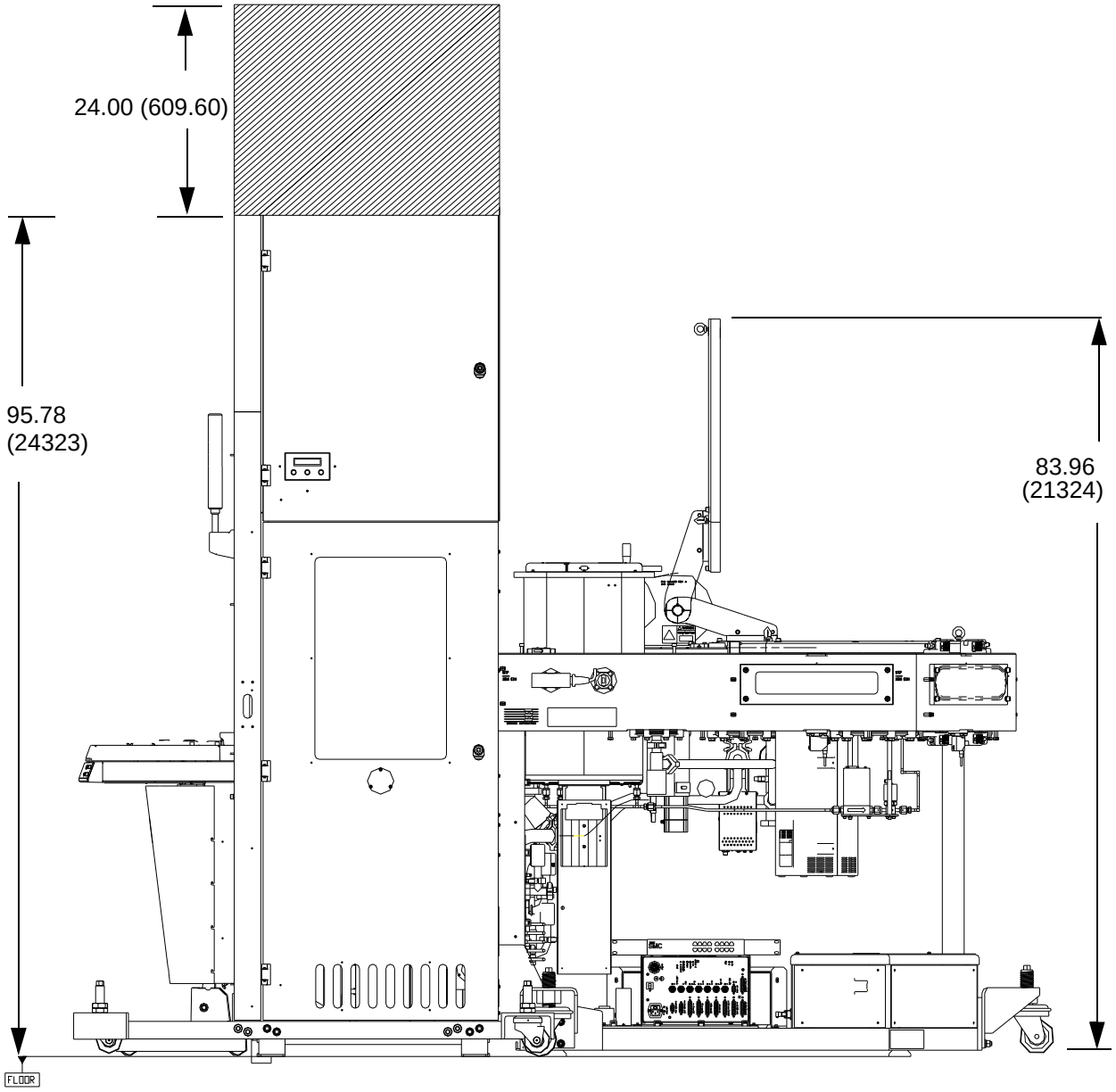


Figure 1-3: Vertical Service and Exclusion Zones

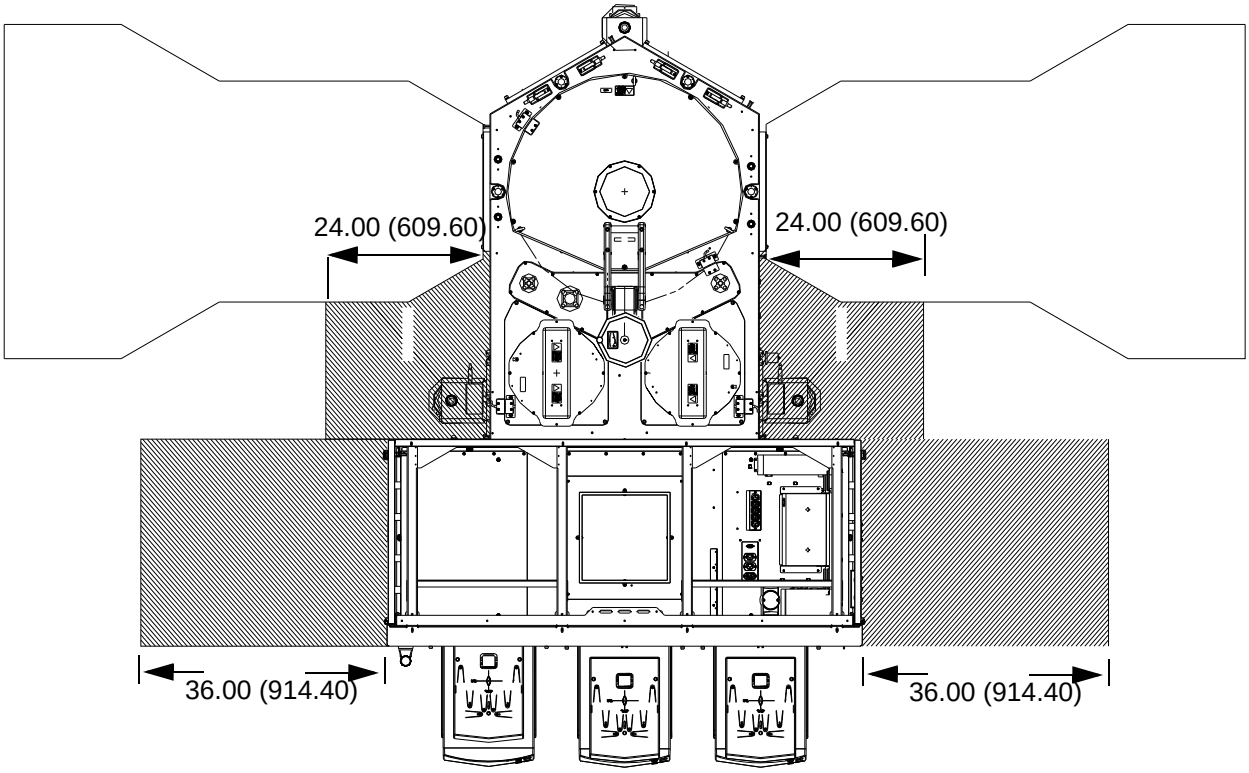


Figure 1-4: Horizontal Service and Exclusion Zones

Moving the Gemini 2 System

Various locations within the site where the Gemini 2 system will be installed must meet the following minimum requirements to ensure proper handling of the G2 system:

Door Openings:	The Gemini 2 system has been designed to separate into modules that fit through standard door openings. Note that for some doors it may be necessary to remove the Overhead Storage on the EFEM.
People:	A minimum of two people are required for moving the Load Port modules and a minimum of four people are required to move the Vacuum Back End or Equipment Front End Module within the facility.
Floor:	The G2 system has been designed to roll easily across smooth interior floors only. The floor where the Gemini 2 system will be installed must be capable of supporting the weight of the G2 system. Refer to the Equipment Front End Module's User Manual and the CG and Foot Loading Layout Drawing supplied with this manual. The weight information provided is maximum system weight, including LPMs, specific systems may weigh less.

Electrical Hazard Classifications

The following table describes the four types of electrical hazard classifications per SEMI S2. Brooks Automation has designed the Gemini 2 system to require a minimum need to conduct testing or maintenance on subsystems that may be energized. Calibrations and adjustments are performed with the power on and live circuits covered. No equipment should ever be repaired or replaced with the power on.

The following are the four types of electrical hazards:

Table 1-4: Electrical Hazard Classifications

Classification	Description
Type 1	Equipment if fully de-energized.
Type 2	Equipment is energized. Energized circuits are covered or insulated.
Type 3	Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are no greater than 30 volts RMS, 42.2 volts peak; 60 volts DC or 240 volt-amps in dry locations.
Type 4	Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are greater than 30 volts RMS, 42.4 volts peak, 60 volts DC, or 240 volt-amps in dry locations.

If a Type 1 procedure (electrically cold) is being performed, lock and tag the equipment by attaching the appropriate locking device on the power distribution point, according to the facility's safety procedures. If the facility does not have formal lockout/tagout procedures, perform lockout/tagout as directed in Lockout/Tagout on page 2-13.

If a Type 2, 3, or 4 procedure is being performed, tag the equipment by attaching the appropriate warning labels at the source of power to the system and on the equipment itself, according to the facility's safety procedures. If the facility does not have formal tagout procedures, perform tagout as directed in Lockout/Tagout on page 2-13.

Overvoltage Category

The following table describes electrical overvoltage categories. Brooks Automation has designed the Gemini 2 system as an Overvoltage Category II device.

Table 1-5: Overvoltage Category

Category	Description
Category I	Signal level (special equipment or parts of equipment, telecommunications, etc.) with smaller transient overvoltages than Overvoltage Category II.
Category II	Local level (appliances, portable equipment, etc.) with smaller transient overvoltages than Overvoltage Category III.
Category III	Distribution level (fixed installation, building wiring, etc.) with smaller transient overvoltages than Overvoltage Category IV.
Category IV	Primary supply level (overhead lines, cable systems, etc.).

2 Safety

Overview

WARNING

Failure to review the Safety chapter and follow the safety warnings can result in death or serious injury.

- All personnel involved with the operation or maintenance of the Gemini 2 must read and understand the information in this safety chapter.
- Follow all applicable safety codes of the facility as well as national and international safety codes.
- Read and understand each procedure before performing it.

NOTICE

It is the responsibility of each person working on Gemini 2 to know the applicable regulatory safety codes as well as the facility safety procedures, safety equipment, and contact information.

NOTE: *If safety-related upgrades or newly identified hazards associated with Gemini 2 are identified, the Brooks Automation Technical Support group will notify the owner of record with a Technical Support Bulletin (TSB).*

Regulatory Compliance

The Gemini 2 meets the requirements of the European Union's Machinery Directive 2006/42/EC as a partly completed machine. In accordance with the Directive, Brooks Automation has issued a Declaration of Incorporation and the Gemini 2 does not have a CE mark affixed.

The Gemini 2 meets the applicable requirements of SEMI Guidelines. In addition to this section, other sections may include regulatory information.

NOTE: *The official Declaration of Incorporation for the Gemini 2 is enclosed inside a plastic documentation packet accompanying the Gemini 2.*

Brooks	**Declaration of Incorporation of Partly Completed Machinery** According to EU Directive 2006/42/EC Annex II 1. B.	**Document #:** **XXXXX** **Rev.: X**

Description Gemini 2
Part Number: (part number)
Serial Number:

Business name and full address of the manufacturer of the partly completed machinery:
Brooks Automation Inc., 15 Elizabeth Drive, Chelmsford, MA, USA 01824

Name and address of the person, established in the Community, authorized to compile the relevant technical documentation:
Brooks Automation (Germany) GmbH, Göschwitzer Straße 25, 07745 Jena, Germany

The manufacturer declares:

- That the following Annex I essential health and safety requirements of Directive 2006/42/EC are applied and fulfilled and that the relevant technical documentation is compiled in accordance with part B of Annex VII and assembly instructions in accordance with Annex VI are provided:
  1.1.2, 1.1.3, 1.1.5, 1.1.6, 1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.6, 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.7, 1.3.9, 1.4.1, 1.5.1, 1.5.2, 1.5.3, 1.5.4, 1.5.6, 1.5.8, 1.5.9, 1.5.11, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.2, 1.7.3
- That the safety objectives set out in directive 2006/95/EC (LVD) have been applied to this partly completed machinery.
- That this partly completed machinery conforms with the provisions of directive 2004/108/EC (EMC).
- We will transmit, in response to a reasoned request by a national authority, relevant information on the partly completed machinery, on paper or in electronic form, without prejudice to our intellectual property rights.

The partly completed machinery must not be put into service until the final machinery into which it is incorporated has been declared in conformity with the provisions of Directive 2006/42/EC

Hiroshi Morimoto (date)
Manager
Product Safety and Regulatory Compliance

Figure 2-1: Sample Gemini 2 Declaration of Incorporation

Explanation of Hazard Alerts

This manual and the Gemini 2 use industry standard hazard alerts to notify the user about personal or equipment safety hazards.

Hazard alerts contain three elements:

- Signal Word and Color
- Safety Text
- Safety Icon (s) - not necessarily used with Notice

Signal Words and Color

Signal Words inform of the level of hazard.

	Danger indicates a hazardous situation which, if not avoided, **will result in death or serious injury**. Danger signal word is white on a red background with an iconic exclamation point inside a yellow triangle with black border.
	Warning indicates a hazardous situation which, if not avoided, **could result in death or serious injury**. Warning signal word is black on an orange background with an iconic exclamation point inside a yellow triangle with black border.
	Caution indicates a hazardous situation or unsafe practice which, if not avoided, **may result in minor or moderate personal injury**. Caution signal word is black on a yellow background with an iconic exclamation point inside a yellow triangle with black border.
	Indicates a situation or unsafe practice which, if not avoided, **may result in equipment damage**. Notice signal word is white on blue background with no icon.

Safety Text

Hazard alert text follows a standard, fixed-order, three-part format.

- Identify the type of hazard.
- State the source of the hazard.
- State the severity of the consequences if the hazard is not avoided.
- State how to avoid the hazard.

Safety Icons

- Hazard alerts contain Safety Icons that graphically identify the hazard involved.
- The safety icons in this manual conform to ISO 3864 and ANSI Z535 standards.

Alert Example

The example below illustrates typical hazard alert text in the order stated above.

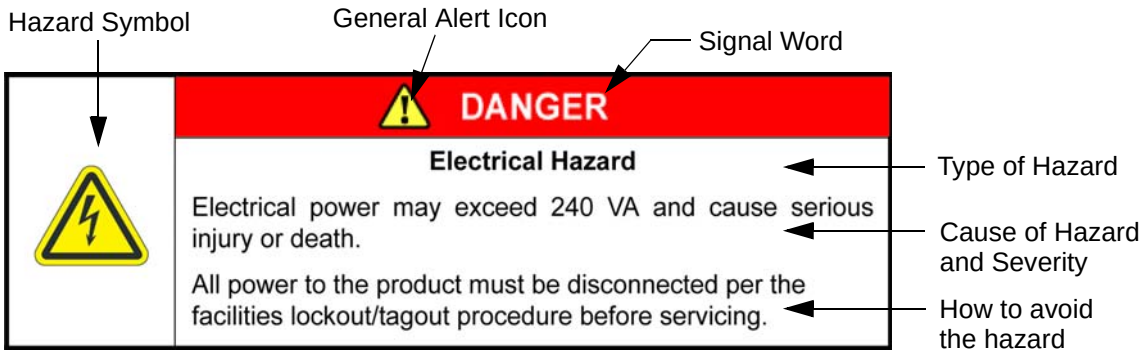


Figure 2-2: Typical Safety Label

General Safety Considerations

Brooks Automation performs safety assessments for each product manufactured by Brooks. The safety issues generated during these assessments are discussed in this manual. The complete Safety Analysis is available by request.

⚠ CAUTION

Unauthorized Service

Personal injury or damage to Gemini 2 may result if this robot is operated or serviced by unauthorized personnel.

Only qualified personnel are allowed to transport, assemble, operate or maintain the Gemini 2.

Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.

⚠ CAUTION

Training

Use by untrained personnel may cause damage to Gemini 2 or personal injury.

Only persons with proper training should attempt to install, service or operate Gemini 2.

⚠ CAUTION

Personal Protective Equipment

The Gemini 2 contains heavy objects that may cause personal injury.

- Use safety shoes and head protection when installing or maintaining the Gemini 2.
- Wear protective eye wear at all times when setting up or testing the systems.

NOTICE

Emergency Off Required

Gemini 2 is not provided with an Emergency Off (EMO) circuit.

Customers must provide an EMO circuit.

⚠ CAUTION

Seismic Restraint

The use of Gemini 2 in an earthquake prone environment may cause equipment damage or personal injury.

The user is responsible for determining whether the Gemini 2 is used in an earthquake prone environment and for installing the appropriate seismic restraint in accordance with local regulations.

⚠ CAUTION

Inappropriate Use

Use of Gemini 2 in a manner or for purposes other than what it is intended may cause equipment damage or personal injury.

Only use the Gemini 2 for its intended application.

Do not modify this Gemini 2 beyond its original design.

Always operate the Gemini 2 with the covers in place.

⚠ CAUTION

Damaged Components

The use of Gemini 2 when components or cables appear to be damaged may cause Gemini 2 malfunction or personal injury.

Do not use the Gemini 2 if components or cables appear to be damaged.

Place the Gemini 2 in a location where it will not get damaged.

Route cables and tubing so that they do not become damaged and do not present a personal safety hazard.

Illustration of Hazard Locations

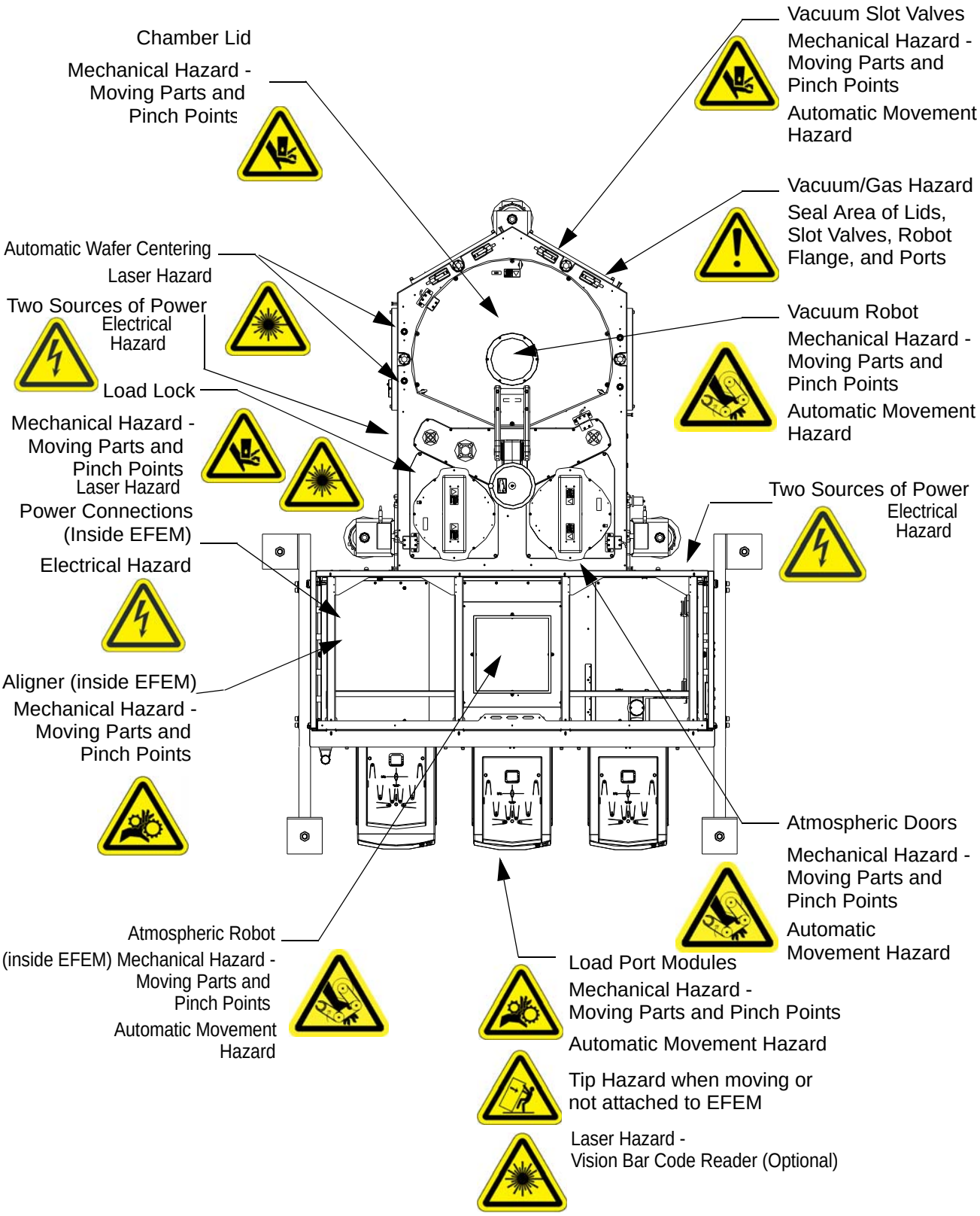


Figure 2-3: Locations of Hazardous Points

Labels on Gemini 2

Safety labels and identification labels are placed on the Gemini 2 and its components to provide operators with information.

- Safety labels provide instructions on how to avoid the hazard.
- Items that weigh over 4.5kg (10 lb) and that may be removed for service have a Mass label attached.

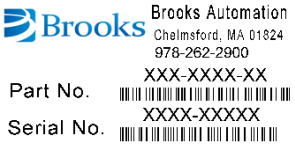
Table 2-1 lists the labels that are placed on the Gemini 2. Figure 2-4 shows the location of the labels. Table 2-2 lists the labels used on the Safety Hub. Figure 2-5 shows the location of the labels on the Safety Hub.

To replace a lost or damaged label, order from Brooks Automation using the part number in the table.

Table 2-1: Labels Used on the Gemini 2 Systems

	Warning Label - Moving parts P/N: 104162 Qty: 2 per Lid Lifter 1 per Batch Load Lock Drive Location: On sides of Lid Lifter and on front of Batch Load Lock Drive Hazard Type: Moving Parts Possible injuries: Crush or cut How to avoid the hazard: Avoid moving parts
	Warning Label - Heavy Object P/N: 102487 Qty: 1 per Batch Load Lock Cover 1 per Batch Load Lock Drive Hazard Type: Heavy Object Possible injuries: Muscle strain or back injury How to avoid the hazard: Use proper lifting techniques
	Warning Label - Impact hazard P/N: 130432 Qty: 1 Location: On Lid Lifter between lifter arms Hazard Type: Impact Hazard Possible injuries: Crush or cut How to avoid the hazard: Secure the lid before performing any service within the chamber
	Caution Label - Heavy Object P/N: 70035511 Qty: 2 Location: On top of Lid, on top of Load Lock Hazard Type: Heavy Object Possible injuries: Muscle strain or back injury How to avoid the hazard: Use the Lid Lifter to open or close the lid, use hoist to remove or replace lid

Table 2-1: Labels Used on the Gemini 2 Systems

	Caution Label - Laser Radiation P/N: 130183 Qty: 2 per Batch Load Lock, 2 per AWC sensor cover Location: Batch Load Lock cover, both sides of AWC sensor cover Hazard Type: Laser light Possible injuries: Eye damage How to avoid the hazard: Do not stare into beam
	Caution Label - Hot Surfaces P/N: 144444 Qty: 3 Location: On top of Chamber Hazard Type: Hot Surfaces Possible injuries: Burn How to avoid the hazard: Ensure all surfaces are cool before touching
	Caution Label - Two Sources of Electrical Power P/N: 169253 Qty: 2 Location: JET at Opening to EFEM PDU, below heater Hazard Type: Electrical Possible injuries: Shock or Burn How to avoid the hazard: Only qualified personnel may service equipment
	Seismic Tie Down Point Label P/N: PB37521 Qty: 3 Location: On Frame
	Product Information Label P/N: 002-5271-01 Qty: 2 Located on Chamber and Frame

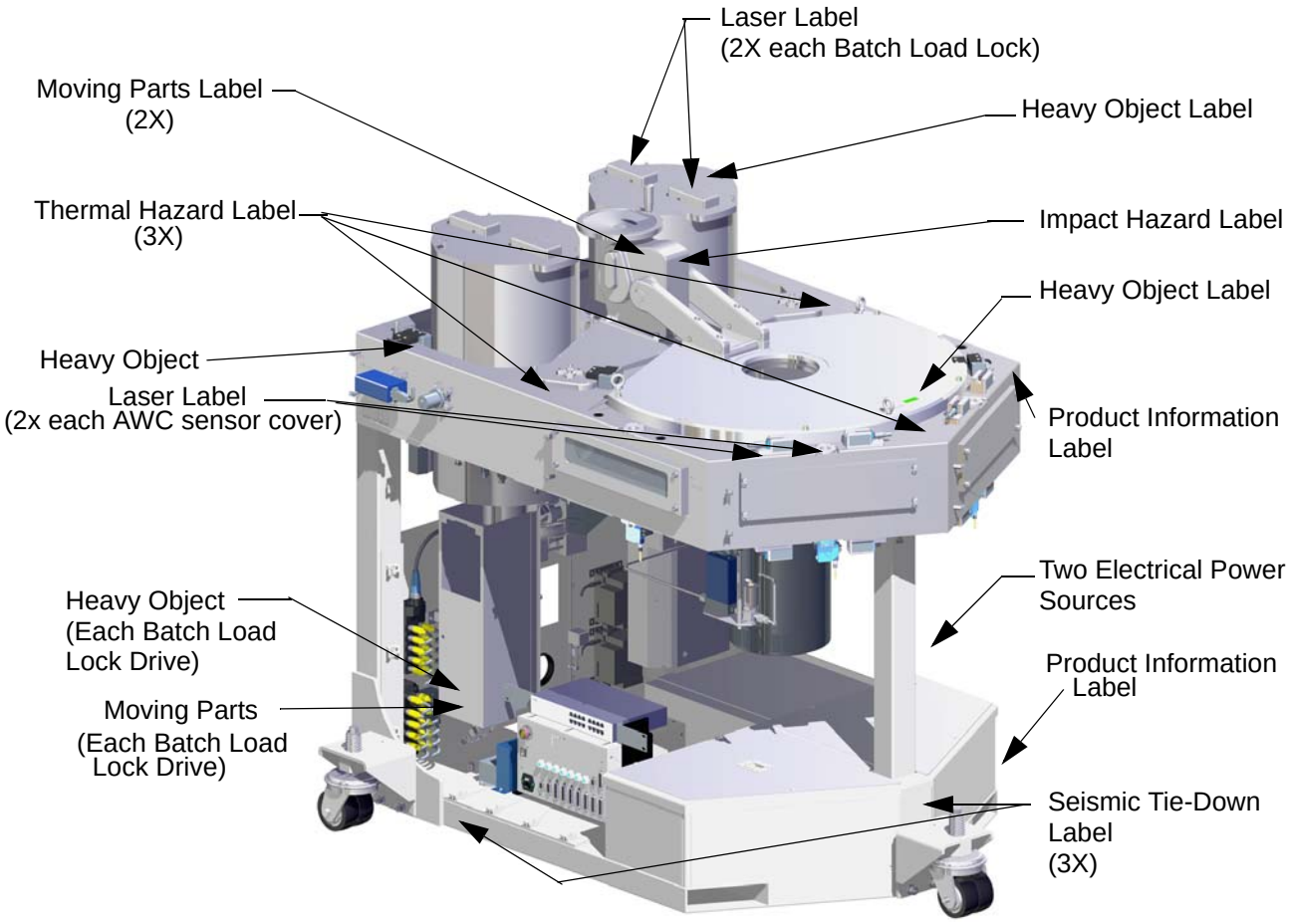


Figure 2-4: G2 Vacuum Back End

Table 2-2: Labels Used on the Safety Hub

	Warning Label - Hazardous Voltage P/N: 70022616 Qty: 1 Location: Safety Hub Hazard Type: Warning Possible injuries: Contact may cause electric shock or burn. How to avoid the hazard: Turn off and lock out system power before servicing.
	Label - Field Replaceable Unit P/N: 130165 Qty: 1 Location: Safety Hub No user serviceable parts inside

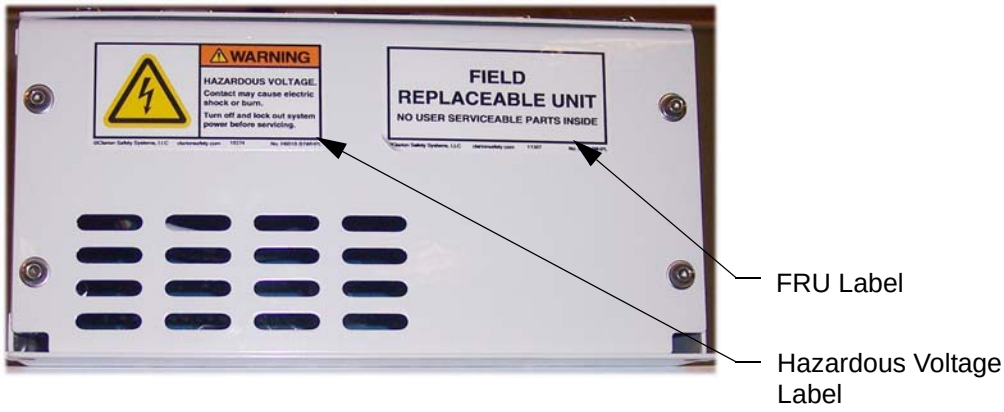


Figure 2-5: Label Locations on the Safety Hub

Interlocks

Safety interlocks protect personal safety. Operational interlocks protect the equipment safety. Additional interlocks may be added by the user.

Refer to Gen 5 EN Manual for additional details.

WARNING

Emergency Off (EMO)

Using the Gemini 2 without an Emergency Off (EMO) circuit may cause death or personal injury.

If the Gemini 2 does not equipped with an EMO disconnect device, then the user must provide one that complies with local electrical codes.

Personnel servicing the Gemini 2 are responsible for disconnecting power as specified by the facility Lockout/Tagout procedures.

WARNING

Safety Barriers or Obstructions

Operating the Gemini 2 as a stand alone unit without personal safety or obstruction interlocks may result in death or personal injury.

User must provide safety barriers or obstruction interlocks when operating the Gemini 2 as a stand alone unit.

Lockout/Tagout

WARNING

Lockout / Tagout

Working with energized equipment may cause sudden movement or electrical shock and may result in death or serious injury.

- All energy must be removed from the equipment per the facility's Lockout/Tagout procedure before servicing.
- Follow the Lockout/Tagout procedures specified by the local facility.
- If local procedures are not available, follow the procedure for Lockout/Tagout in **OSHA Standard 29CFR 1910.147**.

Lid Lockout/Tagout Procedure

Whenever the lid for the Transport Chamber is open, the Lockout/Tagout procedure must performed to be sure it cannot fall.

WARNING

Crush Hazard

The chamber lids are very heavy 47 kg (103 lb). Precautions should be taken when performing any service inside of the chamber when a lid is raised else could cause Personal injury.

Personnel should not lean inside, or place hands or arms into the chamber unless the lid is in the full upright position.

The Lifter is designed not to backdrive; however, the lid must never be left in an intermediate position. The only two acceptable positions for the lid are fully lowered, or fully raised (90°).

To Perform Lockout/Tagout on the transfer chamber lid:

1. Fully open the lid using the lid lifter. The lid is at approximately 90°.

2. Insert the Lid Stop Block Foot between the lid and the chamber and center it against the Lid Lifter

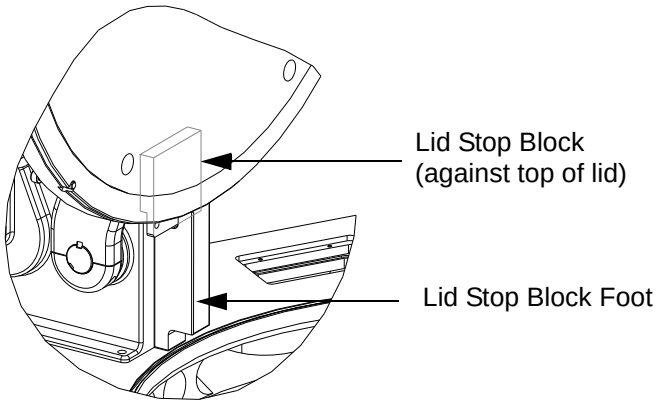


Figure 2-6: Lid Stop Block Foot

3. Insert the Lid Stop Block against the lid between the arms of the Lid Lifter and slide it down until it engages the Lid Stop Block Foot. Be sure that the block is tight.

4. Install a lock through the hole provided on the Lid Stop Block.

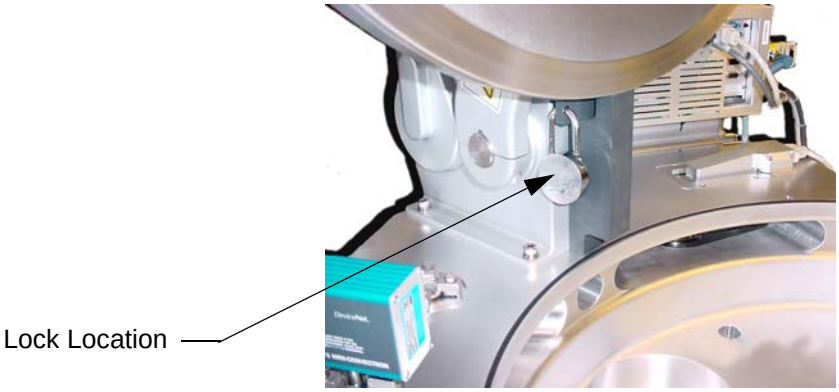


Figure 2-7: Installing Lid Lockout/Tagout Device

5. Label a tag with the information and attach it to the lock.

To remove the lid Lockout/Tagout:

1. After the service procedure is complete, remove the lock, the Lid Stop Block, and the Lid Stop Block Foot.

2. As soon as the lockout/tagout device is removed, close the lid.

Mechanical Hazards

WARNING

Potential Automatic Movement

The robot has the potential for automatic motion that may cause serious injury.

- Avoid working inside the robot path or under extended components.
- Use physical barriers to prevent injury when working in the robot movement path.

WARNING

Moving Mechanisms

Moving mechanisms do not have obstruction sensors and can cause serious personal injury.

Be aware of the potential movement area of the product whenever power is applied.

CAUTION

Pinch Point

Moving parts of the product may cause squeezing or compression of fingers or hands resulting in personal injury.

Do not operate the Gemini 2 without the protective covers in place.

Electrical Hazards

Refer to the specifications of the Gemini 2 for the electrical power.

WARNING

Electrical Shock

Working with energized equipment may cause electrical shock and may result in death or serious injury.

- All energy must be removed from the equipment per the facility's Lockout/Tagout procedure before servicing.
- Follow the Lockout/Tagout procedures specified by the local facility.
- If local procedures are not available, follow the procedure for Lockout/Tagout in **OSHA Standard 29CFR 1910.147**.
- Refer the units specifications for the actual system power requirements and use appropriate precautions.

Grounding

The power source to which the Gemini 2 is connected must be properly grounded in accordance with local electrical codes and all electrical codes pertaining to high voltage electrical equipment in an industrial environment.

WARNING

Electrical Shock

Improper electrical connection or connection to an improper electrical supply can result in electrical shock, burns, fire, and damage to the equipment and death or serious injury.

Always use proper power and proper electrical compliant connections in accordance with local electrical code.

Laser Hazards

The Brooks Automation Gemini 2 system uses low power laser light for material detection in optional wafer mappers and in the Automatic Wafer Centering system.

The Automatic Wafer Centering (AWC) laser is located on the material transfer port at each facet of the Vacuum Back End, and is active whenever power is applied to the G2 system. It is a red light Class II laser that is enclosed and not visible during normal operation, so it is Class I as implemented. Under normal operation, no hazardous levels of laser radiation are emitted.

CAUTION

Laser Radiation

Laser radiation may cause serious eye injury.

- Know the power and hazard level of all lasers.
- Avoid exposure to laser hazards.
- Do not look directly at or into the laser beam (no matter what Class of laser).
- Follow any posted laser warnings or labels.
- Do not attempt to service, repair, or remove the protective housing of the laser device.

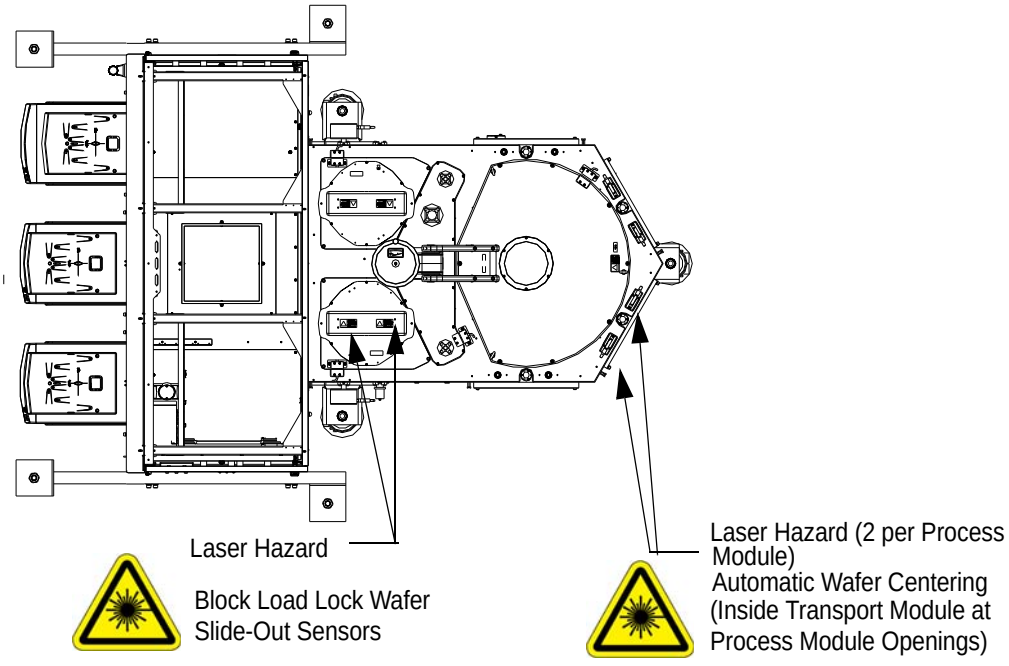


Figure 2-8: Laser Locations

Fire and Explosion Hazards

The Gemini 2 provides no direct fire or explosion hazard.

WARNING

Fire Hazard

Flammable cleaning products such as Isopropyl alcohol may cause fire if used on hot parts which may lead to death or personal injury.

Allow the Gemini 2 to completely cool before using flammable cleaning products for maintenance procedures.

High Pressure Gas Hazards

CAUTION

High Pressure Refrigerant

The Gemini 2 creates high pressure compressed gas. Internal pressure is monitored by sensing devices and is regulated by over pressure relief valves. Tampering with the relief valves may lead to moderate to serious injury.

Do not tamper with, disable, or replace internal sensor devices or over pressure relief valves with unauthorized devices.

Ensure that if gases are vented, the venting meets local regulations.

CAUTION

High Pressure Gas

Use of high pressure gas or compressed air during cleaning may cause flying debris.

When using high pressure gas for cleaning, wear personal protection equipment such as safety glasses.

Follow safety guidelines for cleaning with high pressure gas as specified by the facility.

Thermal Hazards

WARNING

Extreme Temperature

Surfaces heated during system brake-out can reach temperatures of 121° C (250° F), which could cause burns when in contact with skin. Allow time for the system to cool before servicing or operating.

Once system heating has been started, all personnel must keep away from the system to avoid possible burn injury due to high temperatures.

NOTICE

Allow the Gemini 2 System to completely cool before performing maintenance involving volatile chemicals.

Ergonomic Hazards

Heavy Object Hazard

CAUTION

Lift Aid Required

The Gemini 2 weighs greater than 36.2 kg (80 lb). Improper lifting may result in personal injury.

Do not attempt to move or lift the Gemini 2 without a lift aid such as a forklift or a hoist.

Tip Hazard

WARNING

Tip Hazard

Moving the Gemini 2 without a hoist could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without use of a fork lift or a hoist.
- Roll on smooth floors only.

Trip Hazard

CAUTION

Trip Hazard

Power cable, communication cables, and cool head lines may create trip hazards.

Route the cables and lines in an area where there is no travel.

Environmental Hazards

Recycling and Hazardous Materials

NOTICE

Hazardous lubrication is used in the arm bearings and the drive linear rails and ball screw.

If the armset or the drive is removed or replaced, it must be handled following all Federal, State, Local and Facilities' procedures for the disposal of hazardous materials.

NOTICE

A lithium battery is located in the controller.

If the controller is being removed or replaced, it must be handled following all Federal, State, Local, and Facility procedures for the disposal of hazardous material.

Follow all facility and government regulations regarding recycling and disposal when discarding product components that have been replaced.

Material Safety Data Sheets

Hazardous materials may be present in the Gemini 2 as shipped by Brooks.

Read and understand the Material Safety Data Sheet (MSDS) for each material. These sheets provide crucial information pertaining to the hazardous material used in the equipment. The facility where the product is used is responsible for the maintenance and distribution of each MSDS. Ensure that there is a copy in each workplace for all hazardous materials involved in the operation and maintenance of the product. Obtain the MSDS for these materials from their supplier.

This Page Intentionally Left Blank

3 Installation

Overview

This chapter provides complete installation procedures for the Brooks Automation Gemini 2 system including: unpacking, assembly, facilities connections, initial setup, and initial check-out.

Unpacking and Inspection

The Brooks Automation Gemini 2 system is shipped in separate packages which are individually sealed to maintain cleanroom conformance. Unpack each crate carefully; inspect and verify its contents against the shipping documents. Report any damage immediately to the shipper and to Brooks Automation.

One set of shipping documents are attached to the outside of the main shipping crate An additional set of the same documents are attached to the equipment inside the shipping crate.

CAUTION

Lift Aid Required

The Equipment Front End Module weighs at least 756.6 kg (1668 lb).The Vacuum Back End weighs at least 960.3 kg (1600 lb). Improper lifting may result in personal injury.

Do not attempt to move or lift the Equipment Front End Module and Vacuum Back End without a lift aid such as a forklift or a hoist.

WARNING

Tip Hazard

Moving the Gemini 2 without a hoist could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without the use of a fork lift or a hoist.
- Roll on smooth floors only.

⚠ CAUTION

Personal Protective Equipment

The Gemini 2 contains heavy objects that may cause personal injury.

- Use safety shoes and head protection when installing or maintaining the Gemini 2.
- Wear protective eye wear at all times when setting up or testing the systems.

NOTICE

When rolling the Vacuum Back End on its casters, place your hands on the dummy process modules or on the process module blankoffs. Gauges and sensors are located in other areas of the module and could be damaged if you push against them.

Tools and Materials

The following tools and materials are required during the unpacking of the Gemini 2 system.

- Fork truck or appropriate lift
- Open End Wrench, minimum length 16 in., adjustable or size 19 mm, $^{1}/_{2}$ in, $^{3}/_{4}$ in, and 1 $^{1}/_{8}$ in
- Metric Hex wrenches
- Phillips screwdriver
- 1/2 drive ratchet 16 in. minimum with a 19mm or 3/4 socket
- 1/8 in. open end wrench

Unpacking and Moving Instructions

1. Inspect the indicators on the crate to be sure the G2 was properly handled during shipping. Check that the crate is not damaged. Inform the freight carrier and Brooks Automation of any damage.

2. Remove the cover of each shipping crate.

3. Unpack, inspect, and verify the contents against the shipping documents.

NOTE: *Do not remove any protective wrapping.*

4. Inspect the travel route of the Gemini 2 system. Cover dips, thresholds, or any uneven floor transitions with plates.

NOTE: *Save all shipping materials for possible future use. If the Gemini 2 system is returned to Brooks for service or shipped to another location, the original shipping materials must be used. If the original shipping materials have become lost or damaged, contact Brooks Automation for replacements. Refer to* *Appendix F: Packing and Shipping Instructions on page 9-8**.*

The Gemini 2 system was assembled and bagged in plastic in a cleanroom environment. To ensure the cleanliness of the G2 system, only unbag it in a cleanroom environment.

The contents of the shipping crates will depend on the items purchased. Refer to the shipping documents for the exact contents. *Table 3-1* *is provided for reference only.*

Table 3-1: Packing Checklist Reference

Package	Contents
Equipment Front End Module	Minienvironment on wheels with installed options that may include, Fan/Filter Unit, Robot, Aligner, etc.
Vacuum Back End	Chamber mounted on frame with wheels with installed options that may include: MagnaTran 7, custom end effector, vacuum Load Locks.
Load Port Module(s)	Load Port Modules with stand/cart
Installation Kit	• Copy of AT (Certificate of Performance Testing)[1] • Connector for power cable • System cables • Mounting Hardware • User Manuals

1. The Acceptance Test (AT) is a permanent record of the Gemini 2 system as it was manufactured by Brooks Automation. In addition to providing information about serial numbers, model numbers, and embedded software versions it also provides critical data about load port designations, system assignments, station numbers, etc. Make copies of this record and keep a copy close to the G2 system. If maintenance is required, data from the AT will be needed.

5. Remove the EFEM from the crate and move the Equipment Front End Module into its final location in the cleanroom, as specified in the JET User Manual (191061).

6. Remove the walls of the crate that contains the Vacuum Back End.

7. Unbolt the caster brackets from the pallet floor (3 places minimum).

8. Using a fork lift, lift the VBE up far enough to clear the shipping skid. The fork lift channels are located on the frame at the process module end of the VBE.

9. Slide out the shipping skid.

10. Lower the VBE jacking casters.

NOTE: *Turning the casters requires up to 70 ft-lbs of torque. Do not turn more than 1 to 2 turns at a time before moving to the next caster. Do not raise the caster all the way up at one time.*

11. Lower the Vacuum Back End to the floor.

12. Roll the Vacuum Back End into the Depack area.

13. Move the contents of all other crates into the Depack area.

14. Vacuum and wipe down the bags for all items while in Depack.

15. Remove all bags.

16. Remove all inner bags and any additional wrapping.

17. Move all items to their final location in the cleanroom (refer to the Installation Procedure on page 3-5).

18. Remove any additional wrapping.

19. Carefully inspect the Gemini 2 system and all additional items for signs of damage that may have occurred during shipping.

NOTICE

Recycle all packaging materials.

Procedures for re-packaging the Gemini 2 system for shipment are provided in Appendix F: Packing and Shipping Instructions on page 9-8.

Installation Procedure

The Gemini 2 system is typically supplied in a standard configuration. The information required to install the standard configuration of the G2 system is provided in the following procedures:

- Remove Protective Packaging on page 3-6
- Installing the Equipment Front End Module on page 3-6
- Connecting the Gemini Vacuum Back End to the EFEM on page 3-7
- Install the Batch Load Lock Wafer Support Assembly on page 3-10
- Mounting the Process Modules on page 3-11
- Removing Shipping Brackets on page 3-13
- Intermodule Connections on page 3-14
- Facilities Connections on page 3-15
- Communication Connections on page 3-20

WARNING

Tip Hazard

Moving the Equipment Front End Module (EFEM) or the Load Port modules (LPM) without a hoist could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without the use of a fork lift or a hoist.
- Roll on smooth floors only.

Safety glasses and steel toe shoes should be worn at all times when installing the Gemini 2 system.

Tools and Materials

The following tools and materials are required during the installation of the Gemini 2 system.

- Metric Hex Wrenches
- Standard Hex Wrenches
- $^{15}/_{16}$ inch Open End Wrench
- Scale (ruler)
- I-beam Level
- Small Beam Level
- Bubble Level
- Torque Wrench
- Electronic Wafer Level (MicroTool or equivalent)

- Adjustable wrench capable of 1 $^{1}/_{4}$ inch maximum
- M16 Bolt, Qty 2, for JET tie-down or 1/2 threaded rod for seismic tie-down
- M12 Bolt, Qty 3, for Vacuum Back End seismic tie-down

Remove Protective Packaging

The modules of the Gemini 2 system are shipped with their internal components (robots, aligner, etc.) covered in protective packaging. This packaging must be removed before installation can be started. Packaging may be locate on:

- Robot arm assemblies
- Aligner
- Optional equipment
- Loose cable ends or connectors
- Film from all windows

Installing the Equipment Front End Module

The Equipment Front End Module (EFEM) must be properly located in the facility so that Automated Guided Vehicle (AGV) or Over Head Transport (OHT) systems can hand-off wafer carriers to the Load Port Modules attached to it. Once located, the EFEM must be leveled, then it may then be bolted to the floor using the tie-down points provided to prevent any movement. After the EFEM module is installed the Vacuum Back End is docked to the EFEM and secured. Refer to the JET User Manual for detailed installation information.

Installing the Vision Load Port Module

To ensure proper hand-off of the wafer carriers, the Load Port Modules must be attached to the front of the Equipment Front End Module to determine the proper placement of the EFEM.

WARNING

Tip Hazard

Moving the Equipment Front End Module (EFEM) or the Load Port modules (LPM) without a hoist could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without the use of a fork lift or a hoist.
- Roll on smooth floors only.

1. Refer to the EFEM and *Vision LPM User Manuals* and mount the LPMs to the EFEM's minienvironment.

NOTE: *The mounting provisions for the LPMs on the EFEM are leveled at the factory. No leveling adjustments are required.*

2. Position the Equipment Front End Module such that the Load Port Modules are in the proper position for carrier hand-off.

Leveling the EFEM and Setting the Material Transport Plane

Adjustable feet are provided on the Equipment Front End Module minienvironments. These feet are used to support the EFEM, to set the Material Transport Plane to compensate for an uneven floor, and to relieve the wheels once the EFEM is properly located.

NOTICE

Do not raise the non-supporting feet more than 1 mm from the floor to ensure that the system is not allowed to “twist” as this could damage any components connected to the system and could cause a potentially unsafe operating environment.

Refer to the EFEM User Manual for all EFEM adjustments.

Mounting Floor Ties/Seismic Brackets

Floor tie-down points are provided to secure the Equipment Front End Module to the floor. The tie-down points provide seismic anchoring per SEMI S2 to eliminate movement and for earthquake protection. User supplied tie-down brackets may be used when seismic anchoring is not required, but bolting to the floor is desired. Refer to the EFEM’s User Manual for the appropriate procedure for securing the EFEM to the floor.

Connecting the Gemini Vacuum Back End to the EFEM

The Gemini Vacuum Back End must be mated to the EFEM, adjusted to the Wafer Transport Plane, and leveled. Once mated, the Gemini Vacuum Back End should be bolted to the floor using the seismic tie-downs provided.

Mating the Gemini Vacuum Back End to the EFEM

To mate the Gemini Vacuum Back End to the EFEM, guides are provided to ensure proper positioning of the Gemini Vacuum Back End relative to the JET.

1. Remove, and save, the M8 mounting hardware from the face of the Gemini Vacuum Back End that will be mounting to the EFEM (8 places).

2. Prior to rolling the Gemini 2 Vacuum Back End up to the EFEM, ensure all the casters are turned in the direction of travel. Move the Gemini 2 Vacuum Back End until it is 6 inches away from the EFEM rear panel.

3. Ensure that the positioning of the EFEM and the Gemini 2 Vacuum Back End relative to each are such that the JET Facilities Panel will not hit any part of the Vacuum Back

End. With the casters in the proper direction continue to move the Gemini Vacuum Back End closer to the JET (note that the height of the VBE frame may need to be adjusted).

4. Once the two systems are close to each other (within $^1/_2$ inch), look inside the JET to see what adjustments need to be made to line up the holes in the rear panel of the JET with the holes in the chamber of the Gemini 2 Vacuum Back End. Once the holes are lined up, assemble the mounting hardware (M8 x 25 mm screw, split washer, and flat washer) eight places without tightening.

5. Continue to move the Gemini 2 Vacuum Back End until the gap between the modules is eliminated. Do not tighten the mounting hardware until after the Gemini 2 Vacuum Back End has been leveled.

Leveling the Gemini Vacuum Back End and Setting the Wafer Transport Plane

Adjustable feet are provided on the frame of the Gemini Vacuum Back End. These feet are used to support the Gemini Vacuum Back End transport chamber, to set the Wafer Transport Plane, and to compensate for an uneven floor. This procedure assumes that the Process Modules conform to SEMI/MESC cluster tool specifications, and in particular that the station access port mating pins are located at the SEMI/MESC height.

NOTICE

Do not raise the non-supporting feet more than 1 mm from the floor to ensure that the system is not allowed to “twist” as this could damage any components connected to the system and could cause a potentially unsafe operating environment.

1. Lower the leveling feet, shown in Figure 3-1, until the feet are fully supporting the module’s weight.

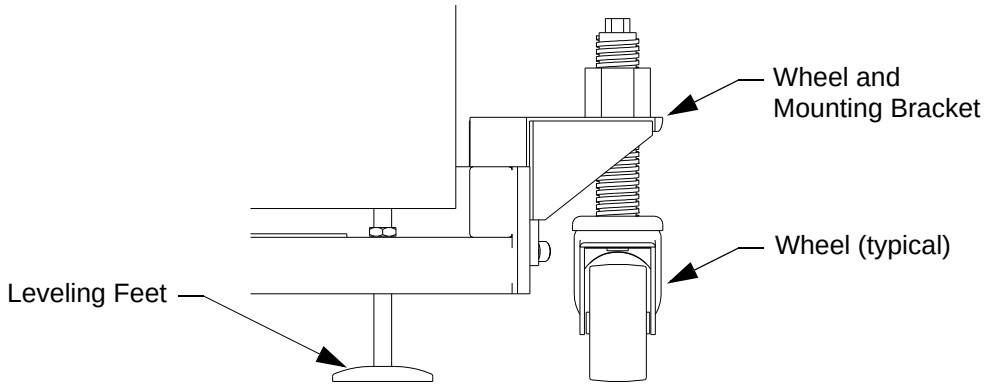


Figure 3-1: Lowering the Leveling Feet

2. Raise and remove the wheels and retain them for future use.

3. The Wafer Transport Plane (WTP) can be established at 1100 mm by setting the distance from the WTP scribe mark on the side of the chamber to the floor at 1100 mm (43.3 in) per SEMI E21 as shown in Figure 3-2. Alternately, the center of a facet alignment pin may be used.

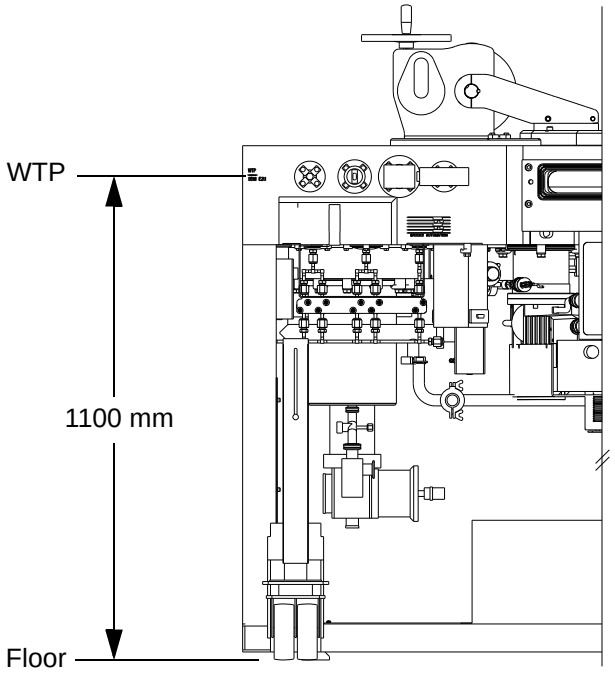


Figure 3-2: Setting the Wafer Transport Plane

4. Level the Gemini 2 Vacuum Back End using an I-beam level placed along the chamber by adjusting each foot as necessary.

5. Verify the WTP height from the floor to the center of each vacuum facet alignment pin. The slot center line is 1084.5 mm from the floor or 15.5 mm below the WTP.

6. Once the Gemini 2 Vacuum Back End module is leveled, tighten the bolts inside the EFEM connecting the two modules together.

Installing Seismic Tie-down Brackets

Seismic brackets must be provided to secure the Gemini Vacuum Back End to the floor to eliminate movement and for earthquake protection. The caster brackets must be removed from the system and the system secured with angle brackets (not supplied) using the tapped holes in the side of the frame.

NOTE: *Seismic hold-down for facilities requiring earthquake protection are the responsibility of the user.*

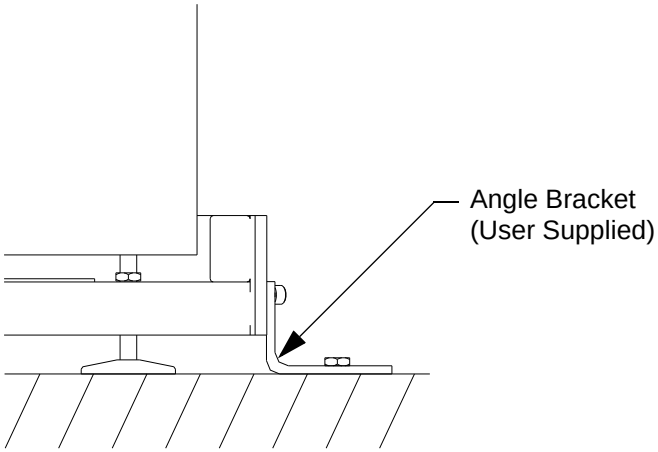


Figure 3-3: Seismic Bracket Mounting

1. Remove the bolts with lock and flat washers securing the Jacking Caster Brackets to the lower beam of the frame.

2. Locate the Seismic Brackets at the points the casters were attached to the frame.

3. Position the brackets so that the seismic mounting holes are against the floor.

4. Replace the four bolts and washers to secure the bracket to the frame.

5. Install one M12 or equivalent size bolt (not supplied) through the bracket and into the floor.

NOTE: *Save the casters and brackets for future use in moving the Gemini 2.*

Install the Batch Load Lock Wafer Support Assembly

The Batch Load Lock wafer support assembly is packed separately for shipment to protect the fragile support rods.

1. Remove the six screws securing the top cover, and lift the cover off.

2. Carefully unpack the Batch Load Lock wafer support assembly.

3. Guide the wafer support assembly down into the Load Lock. Note that the side of the wafer support assembly with two rods faces the exterior wall of the chamber.

4. Replace the cover and the six retaining screws.

NOTE: *If the Batch Load Lock is equipped with wafer slide out sensors, check and re-align them if necessary, before using the tool. Refer to the* *Wafer Sensor Adjustment for the Batch Load Lock on page 6-10**.*

Mounting the Process Modules

Any components that will be mounted to the Gemini 2 Vacuum Back End are assumed to conform with SEMI/MESC standards.

NOTE: *It may be convenient to mount these components after initial installation and testing.*

1. Remove the blankoffs from the vacuum facets of the Gemini 2 Vacuum Back End transport chamber.

2. Adjust the Process Module so that its Wafer Transport Plane is at 1100 mm (refer to the *Process Module User Manual*). Ensure that the Process Module remains level while making any adjustments to the height.

3. Mate the Process Module to the vacuum facet of the Gemini Vacuum Back End by inserting the pins on the Process Module into the holes on the Vacuum Slot Valve of the facet.

   NOTE: *It may be necessary to re-adjust the height of the module(s) to align them to the Vacuum Back End. If a height re-adjustment is required, be sure that the module remains level.*

4. Once the Process Module is mated, clamp the flanges of the Process Module and the Gemini 2 Vacuum Back End together using the ISO clamps provided.

Intermodule Connections

The standard configuration of the Gemini 2 requires several connections be made between the JET and the Gemini 2 Vacuum Back End modules once they are physically connected together. All internal connections within the modules of the Gemini 2 are shipped from the factory already made.

Wiring Diagrams are supplied with the System Manual. Refer to these diagrams while installing the system to verify correct connections. The configuration of the Gemini 2 determines which components may be included with the system. Use the following instructions as a reference for step order only. Some connections may have been installed at the factory. In this case, only verification of the connection is required.

Gemini Vacuum Back End to JET

Ensure all connections between the EFEM and the Gemini 2 Vacuum Back End are routed through a Panduit® duct or equivalent cable management system.

1. Connect an RJ-45 cable from the Ethernet Switch to the EFEM facilities panel. Connect cable from the Safety Hub to the Dr. INTLK on the EFEM facilities panel.

2. Route the AC cable from the power strip in the Vacuum Back End through the pass through opening between the front end and the back end and plug it into the EFEM PDU.

3. Connect a Ground Strap between the JET module and the Gemini 2 Vacuum Back End module.

4. On JET modules an optional power strip may be provided under the Facilities Panel to supply power to Turbo Pumps on the Gemini 2 Vacuum Back End. If this is the case, connect the Turbo Pumps' AC Power to the power strip.

5. If the Safety Hub Reset function is being used, connect a cable from the RESET connector on the JET Facilities Panel to J2 - RESET on the VBE Safety Hub.

Heater Connection

If the optional Heater Power Supply is installed, connect the Main Heater Harness cable from the Heater Power Supply to facilities supplied 240 V.

NOTE: *Do not connect the facility power at this time. Facility power will be connected after all other connections have been made.*

Facilities Connections

The standard configuration of the Gemini 2 requires compressed air, nitrogen (vent gas), vacuum, exhaust, electrical power, communications connections, and optionally cooling water, and drain. Refer to the Facilities Specifications on page 1-12 for detailed descriptions of the required user-supplied facilities.

All Gemini 2 Cluster Tools come with the required connectors to facilitate interfacing the system, including connectors for the vacuum sources. All facility lines connect to the Gemini 2 via the facilities interfaces located on the back of the EFEM and under the VBE chamber. All the connectors on the facilities interface panels are labeled for easy identification. Refer to the electrical and mechanical drawings supplied with the System Manual.

WARNING

Lockout / Tagout

Working with energized equipment may cause sudden movement or electrical shock and may result in death or serious injury.

All energy must be removed from the equipment per the facility's Lockout/Tagout procedure before servicing.

If local procedures are not available, follow the procedure for Lockout/Tagout in OSHA Standard 29CFR 1910.147.

⚠ CAUTION

Flying Shards of Glass

Breaking wafers may cause flying shards of glass and cause eye injury.

Protective eye wear must be worn at all times when using wafers for setup or test.

Removing Shipping Brackets

The modules of the Gemini 2 system are shipped with shipping brackets attached to them. These shipping brackets are red in color to easily identify them. All shipping brackets must be removed before the G2 system may be used.

NOTE: *Save the shipping brackets for possible future use. If any of the modules of the Gemini 2 system are returned to Brooks for service or shipped to another location, the original shipping brackets must be used. Refer to* *Appendix B: Station Identification on page 9-3.*

Equipment Front End Module

The robot arm is secured in place for protection during shipment. Refer to the EFEM User Manual for detailed information.

Shipping brackets are used to secure the robot arm to the robot flange. The type of brackets will vary based on the type of arm installed on the robot. Remove the brackets and save for future use. If the EFEM is shipped, the brackets must be replaced before shipping.

Vacuum Back End

The robot arm is secured in place within the Vacuum Back End's Transport Chamber for protection during shipment. These shipping brackets must be removed before attempting to operate the robot. The chamber is shipped under vacuum and the vacuum must be purged before lifting the lid.

1. Manually open the slow vent valve, then the fast vent valve to purge the system.

2. Raise the lid from the top of the vacuum chamber.

WARNING

Crush Hazard

The chamber lids are very heavy 47 kg (103 lb). Precautions should be taken when performing any service inside of the chamber when a lid is raised else could cause Personal injury.

Personnel should not lean inside, or place hands or arms into the chamber unless the lid is in the full upright position.

The Lifter is designed not to backdrive; however, the lid must never be left in an intermediate position. The only two acceptable positions for the lid are fully lowered, or fully raised (90°).

Refer to Lid Lockout/Tagout Procedure on page 2-13.

3. Unscrew the arm shipping fixtures. Remove the fixtures and save for future use. If the Vacuum Back End module is shipped, the fixtures must be replaced before shipping.

4. The end effectors were removed for shipping and must be re-installed. Refer to the MagnaTran 7 User Manual.

5. Remove the lid Lockout/Tagout and lower the lid.

Load Port Module(s)

The door opening paddle of the Load Port Module(s) is secured in place for protection during shipment. These shipping brackets must be removed before attempting to operate the LPMs. Refer to the appropriate Load Port Module User Manual for detailed information.

- Refer to each LPM User Manual for instructions on the LPM installation and the removal of shipping brackets.
- If the Load Port module is shipped, the brackets must be replaced before shipping.

Intermodule Connections

The standard configuration of the Gemini 2 system requires several connections be made between the Equipment Front End Module and Vacuum Back End modules once they are physically connected together. The G2 system is shipped from the factory with all EFEM and VBE internal connections already made.

Wiring Diagrams are supplied with the System Manual. Refer to these diagrams while installing the system to verify correct connections. The configuration of the Gemini 2 system will determine which components may be included with the system. Use the following instructions as a reference for step order only. Some connections may have been installed at the factory. In this case, only verification of the connection is required.

Facilities Connections

The standard configuration of the Gemini 2 system requires compressed air, nitrogen (vent gas), vacuum, exhaust, electrical power, communications connections, and optionally cooling water, and cooling water return. Refer to the Facilities Specifications on page 1-12 for detailed descriptions of the required user-supplied facilities and Mechanical Specifications on page 1-9 for fitting specifications.

All facility lines connect to the Gemini 2 system via the facilities interfaces located under the chamber. All the connectors on the facilities interface panels are labeled for easy identification. Refer to the electrical and mechanical drawings supplied with the System Manual for more information.

The following procedures provide the information required to make all facilities connections to the Gemini 2 system. Connections to the Equipment Front End Module are shown in Figure 3-4. Refer to *Command Line Reference Software Manual* for wiring pinouts.

WARNING

Lockout / Tagout

Working with energized equipment may cause sudden movement or electrical shock and may result in death or serious injury.

All energy must be removed from the equipment per the facility's Lockout/Tagout procedure before servicing.

If local procedures are not available, follow the procedure for Lockout/Tagout in OSHA Standard 29CFR 1910.147.

Safety glasses should be worn at all times when connecting any facilities to the Gemini 2 system.

Figure 3-4: Facilities Connections - Equipment Front End Module (EFEM)

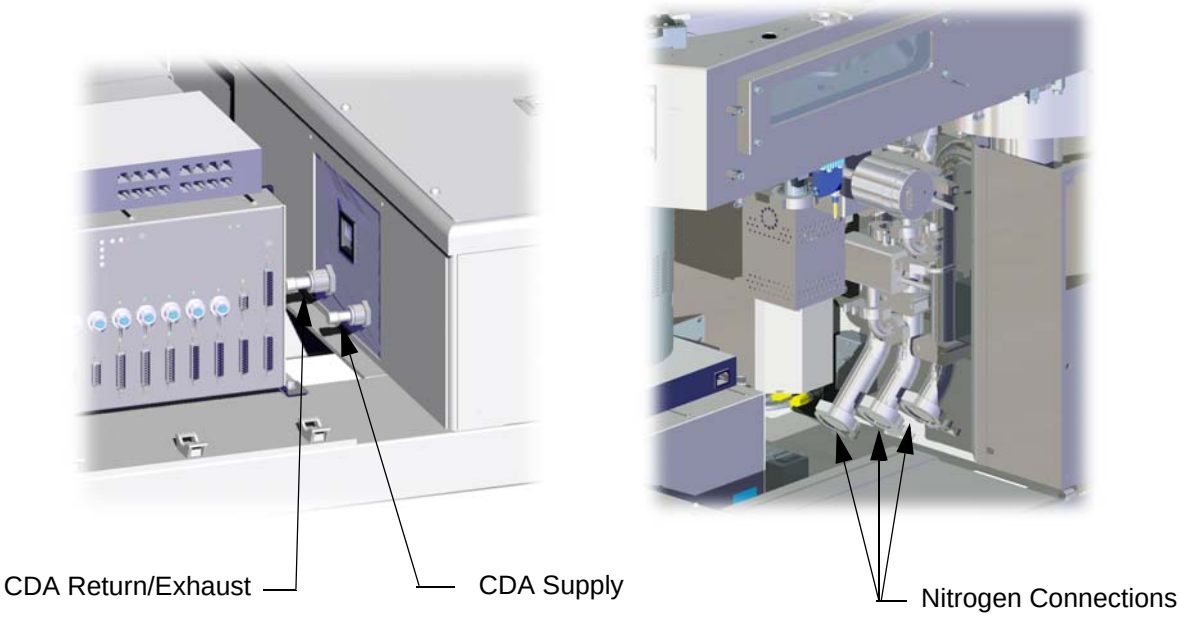


Figure 3-5: Facilities Connections - Gemini 2Vacuum Back End

Facilities Panels

The Equipment Front End Module is supplied with facilities connections, including power, and interface panels located as shown in Figure 3-5. The standard configurations the EFEM modules are shown respectively. The standard configurations for the Facilities Panels referenced in the figures are shown in Figure 3-6.

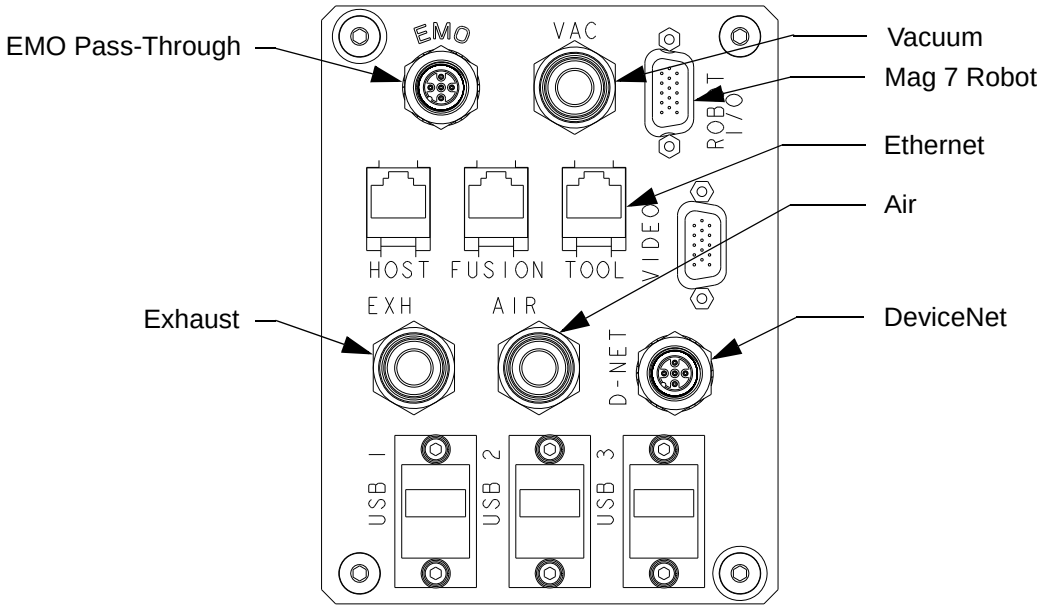


Figure 3-6: JET Facilities Panel

The Vacuum Back End is supplied with facilities air and vacuum connections. The standard configurations for the JET Facilities Panel referenced in the figures is shown in Figure 3-6.

Electrical

Electrical power is connected to the Gemini 2 system for operation of the robots, sensors, and other subsystems. Refer to the Facilities Specifications on page 1-12 for electrical requirements. Ensure that the electrical connection is for the appropriate voltage.

NOTICE

Do not turn on the electrical supply from the facility until all connections to the Gemini 2 system and all installation procedures have been completed.

Connect the AC power cable from the facility's main power disconnect to electrical connection on the Power Distribution Unit inside the EFEM.

EMO Circuit

The EMO button supplied with the Gemini 2 system is provided to allow the user to configure a single EMO button that removes power from all material handling and processing components

in the Gemini 2 system and the Process Modules. A pass-through connection to the user's EMO circuit is provided at the Equipment Front End Module's Facilities Panel through an M-12 male connector, which connects to the EMO Junction Block is provided on the Vacuum Back End. The VBE EMO Junction Block provides a central connection point for all EMO switches in the tool including any switches provided on the Process Modules.

NOTE: *If this circuit is used, the action caused by pressing the EMO button is determined by the user.*

Nitrogen

Nitrogen is used in the G2 system as the vent gas to ensure that venting does not contaminate the chamber. A $^{1}/_{4}$ in VCR connection is provided on the Vacuum Back End. Refer to the Facilities Specifications on page 1-12 for nitrogen gas requirements. Ensure that the nitrogen connection is for the appropriate pressure.

NOTICE

Do not turn on the nitrogen supply until all connections to the Gemini 2 system and all installation procedures have been completed.

1. Run a $^{1}/_{4}$ in. O.D. Nitrogen supply line to the N2 connection on the VBE as shown in Figure 3-5.

2. Connect the nitrogen line from the facility to the nitrogen connection on the Vacuum Back End.

Process Gases

Process gas connections may be provided on the Gemini 2 system for the user's convenience. All connections to the process gas lines must be made as specified by the user.

NOTICE

Do not turn on the process gas supply until all connections to the Gemini 2 system and all installation procedures have been completed.

Pneumatic

Air is used in the G2 system for operation of the Load Port Modules, Slot Valves, Atmospheric Doors, and other devices. A 10 mm connection is provided on the Vacuum Back End. Refer to the Facilities Specifications on page 1-12 for the pneumatic requirements. Ensure that the pneumatic connection is for the appropriate pressure.

NOTICE

Do not turn on the pneumatic supply until all connections to the Gemini 2 system and all installation procedures have been completed.

Connect the compressed air line from the facility to the 10 mm quick connect CDA SPLY connection on the VBE. Refer to.

Exhaust

A line to receive exhaust from operation of the Gemini 2 system is connected to the Vacuum Back End. One 10 mm quick connect exhaust port is provided on the Vacuum Back End's Pneumatic Facilities Panel. Refer to the Facilities Specifications on page 1-12 for exhaust requirements.

1. Connect the line for clean exhaust from the facility to the $^{1}/_{2}$ inch Swagelok quick connect CDA EXH connection on the VBE as shown in Figure 3-5.

2. Connect the line for scrubbed exhaust from the facility to the OVER PRESS. EXH connection on the VBE as shown in Figure 3-5.

3. Connect the exhaust from any vacuum roughing pumps supplied with the system to the facility's gas exhaust system.

Vacuum

An appropriate user supplied vacuum system must be connected to the Gemini 2 system for evacuating the Transport Chamber in the Vacuum Back End. Ensure the vacuum system is capable of providing the desired pump down times for the vacuum chamber. Refer to the Facilities Specifications on page 1-12 for vacuum requirements.

Depending upon the configuration of the Gemini 2 system, differential vacuum may need to be supplied to various modules including the robot, aligner, and Load Port Modules in the Equipment Front End Module for proper operation of these units.

NOTICE

Do not turn on the vacuum connection until all connections to the Gemini 2 system and all installation procedures have been completed.

1. Connect the facilities' rough vacuum line to the Rough Manifold on the VBE.

2. If required, connect the vacuum line from the facility to the 6 mm quick connect VAC connection on the EFEM's Facilities Interface Panel.

Water

Depending upon the configuration of the Gemini 2 system, water may need to be supplied for cooling of components attached to the Transport Chamber, such as turbo pumps, or for the

cooling of material in the Load Lock. Refer to the Facilities Specifications on page 1-12 for water supply and return requirements. Ensure that the water connection is for the appropriate pressure and temperature and is maintained to avoid corrosion.

NOTICE

Do not turn on the water connection until all connections to the Gemini 2 system and all installation procedures have been completed.

Run an appropriate size Teflon line from the facility water supply to the SUPPLY connection on the VBE Facilities Panel.

Water Return

Run an appropriate size Teflon line from the facility water return to the RETURN connection on the VBE as shown in Figure 3-5.

Communication Connections

The modules within the Gemini 2 system use Ethernet, DeviceNet, and RS-242 for communications.

NOTICE

Never connect or disconnect the communications lines with power applied to the Gemini 2 system as damage to internal components or unexpected motion may result.

Ethernet

The standard configuration of the Gemini 2 system supports Ethernet communication between the host controller and the G2 system. Make the Ethernet communications connection to the G2 system as shown in Figure 3-7.

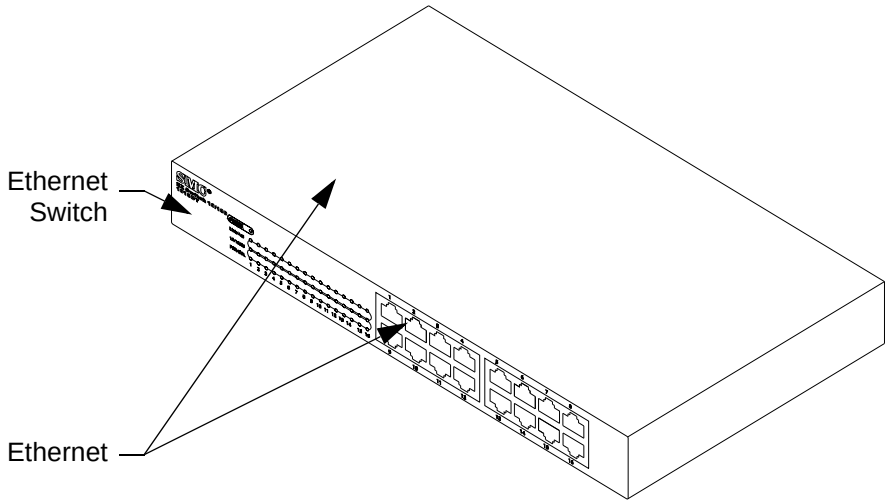


Figure 3-7: Ethernet Communications Connection

Be sure that the Ethernet cable for communications from the host controller to any Ethernet port on the Ethernet Switch on the VBE has been connected to the EFEM facilities.

DeviceNet

The standard configuration of the Gemini 2 system uses DeviceNet communication in the VBE. The system is configured to use an internal DeviceNet Master so no external connection is required.

Software Installation

The Gemini 2 system requires no software installation in any of its modules. All G2 system control software is pre-loaded on the MagnaTran 7 robot or the Fusion Controller and the Razor Automation Components at the factory.

Upgrades to the software can be downloaded through the Ethernet connection. Refer to the Upgrade Procedure in the Release Notes supplied with any upgrades.

NOTE: *Alterations or changes to the software should only be made by qualified Brooks Automation personnel.*

Power-up Sequence

The following procedure describes the steps to safely apply power to the Gemini 2 system and verify that it is ready for operation.

WARNING

Automatic Movement / Crush Hazard

If any interlocks are disabled the possibility exists of automatic movement of systems within the Gemini 2 system.

The following systems have the possibility of automatic movement:

Atmospheric Robot
Atmospheric Aligner
Load Port Modules
Batch Load Locks
Vacuum Robot
Atmospheric Doors
Vacuum Slot Valves
Isolation Valves

Moving mechanisms have no obstruction sensors and can cause serious personal injury or death.

Do not operate the Gemini 2 system without the protective covers in place.

1. Check to ensure that all of the installation procedures previously described in this chapter have been completed.

2. Operational Safety and Interlock Checks:
   - Ensure that the Equipment Front End Module minienvironment doors are closed and secured.
   - Ensure that the Vacuum Back End vacuum chamber and load lock lids are closed and secured.

3. Mechanical Checks:
   - Verify all shipping brackets have been removed.
   - Ensure that the Equipment Front End Module is properly and securely installed in the facility.
   - Ensure that the Load Port modules are properly and securely mounted to the Equipment Front End Module.
   - Ensure that the Vacuum Back End has been properly secured within the facility.
   - Ensure that the Vacuum Back End is properly and securely mounted to the Equipment Front End Module.
   - Ensure that the OEM Process Module(s) are properly and securely mounted to the Vacuum Back End.
   - Ensure that all hardware is secure.
   - Ensure that the EMO button supplied on the Equipment Front End Module is functional and remove the Warning label from the EMO button.

4. Facility Checks

   - Ensure that all facilities are capable of meeting, or exceeding, the requirements as described in the Facilities Specifications on page 1-12.
   - Ensure that the power, communications, air, exhaust, nitrogen, vacuum, water, and any other connections have been completed.
   - Check all cables. Verify the connectors are fully seated and screws/locks are secured to ensure good continuity.
   - Verify all internal cables are routed in a safe place and away from any internal movement.
   - Verify all external cables are routed in a safe place and away from any travel areas.
   - Inspect all cables and tubing for restricting bend radii or excessive tension.

5. Ensure that there are no obstructions in the travel path of the robots and their end effectors within the Equipment Front End Module and the Vacuum Back End.

   NOTE: *Some of the internal components of the Gemini 2 system may present travel obstructions to the robot end effectors in certain cases. It is the user's responsibility to control the robots such that the robots, and any material in transport, do not come into contact with these components.*

6. Verify the AC power connection from the Gemini 2 to the plant's electrical services.

NOTICE
HIGH VOLATAGE: 200 - 240 VAC at 30 Amps. The AC circuit must be properly protected.

7. Verify the AC power connection to the power strip for the Vacuum Back End from the Equipment Front End Module Power Distribution Unit.

NOTICE
HIGH VOLATAGE: 200 - 240 VAC at 30 Amps. The AC circuit must be properly protected.

8. Turn on vacuum, air, nitrogen, and water supply if used.

WARNING

Potential Robot Motion

Turning on facilities create the possibility of automatic movement. Personal injury could result in the squeezing or compression of fingers or hands between moving parts.

Keep away from moving parts.

9. Turn on the circuit breakers on the Power Distribution Unit in the EFEM. The following sounds and indicators should be observed:
   - Audible sounds: fans in robot drive
   - The indicators listed in Table 3-2 will be lit as shown:

Table 3-2: Start-up Indicators - Vacuum Back End

Component	Indicator	Status
MagnaTran 7 Robot	24V Power	Green
Safety Hub	24V Power	Green
Air Pressure Sensor	Pressure Sensor Status LED	Green
Nitrogen Pressure Sensor	Pressure Sensor Status LED	Green

Table 3-3: Start-up Indicators - JET ATS

Component	Indicator	Status
Fusion Controller	PC	Green
	24V	Green
	48V	Green
Razor ATR robot	Servo Enable	Green
	Power	Green
Load Port Modules	Lights lit determined by user	

10. Perform a Ground Continuity check from the surfaces of the Equipment Front End Module and the Vacuum Back End to a known good ground.

11. If a Reset switch is installed, engage it twice.

12. Verify proper operation of all interlocks (refer to *Gen5 EN User Manual*).

13. If the initialization sequence executes without error, then the Brooks Automation Gemini 2 system has been properly installed, all the components are communicating successfully, and the system is ready for alignment and teaching.

NOTICE

The host controller initiates all motion control in the Gemini 2 system. It is the user's responsibility to initiate a safe start-up of the G2 system.

If start-up was successful, the Gemini 2 system is ready to accept commands. If, however, the start-up sequence was unsuccessful, refer to Chapter 7: *Troubleshooting and Repair*.

NOTICE

Do not attempt to operate the Gemini 2 system until all setup procedures described in this chapter have been completed.

14. Return Gemini 2 system to operation or teach the G2 system as required.

The Brooks Automation Gemini 2 system must be aligned with the system that it will be operating in to prevent misplacement of the material being moved through the system or collision of the robot with other parts of the system. Note that even a small misalignment can interfere with proper G2 system operation and may cause material breakage or G2 system damage.

The user must perform a complete alignment as part of installing the G2 system in a larger system. Refer to Chapter 4: *Alignment and Teaching* for the alignment procedures.

NOTICE

Do not attempt to operate the Gemini 2 system until it has been properly aligned. The alignment procedure in this manual must be completed prior to commanding motion.

This Page Intentionally Left Blank

4 Alignment and Teaching

Overview

This chapter provides complete adjustment and calibration directions for the Brooks Automation Gemini 2 system and its components.

CAUTION

Unauthorized Service

Personal injury or damage to Gemini 2 may result if this robot is operated or serviced by unauthorized personnel.

Only qualified personnel are allowed to transport, assemble, operate or maintain the Gemini 2.

Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.

Read and understand Chapter 2: *Safety* before performing any procedure.

Gemini 2 System Alignment and Teaching

The components within the Brooks Automation Gemini 2 system must be aligned to each other to prevent misplacement of material or collision of the robot in the Equipment Front End Module (EFEM) or Vacuum Back End with other parts of the system. Note that even a small misalignment can interfere with proper system operation. The components of the system were aligned at the factory prior to shipment.

Typical system alignment starts with leveling the Equipment Front End Module (EFEM) and then aligning the Vacuum Back End (VBE) to the EFEM. Once the VBE is aligned to the EFEM the Process Modules are then aligned to the Gemini 2 system.

The user must perform the following alignment procedure as part of installing the Gemini 2 system in a system, during routine maintenance, or whenever the robot end effector or one of the system modules requires replacement. Brooks Automation recommends an alignment check under the following circumstances:

- A complete alignment when the G2 system is first setup at the user's site.
- A complete check when any of the controllers or any of the material handling modules (aligner, load port, robot, robots' end effectors, etc.) are replaced.
- A complete check if the G2 system was involved in a material transfer error.
- A complete check if the G2 system was involved when an Emergency Off (EMO) occurred.
- A partial check at the appropriate station(s) whenever any component, such as a Load Lock or a Process Module, is replaced.
- A complete check of the robot if it was involved in a collision.

Before attempting to align the Gemini 2 system, be familiar with the subsystems attached to the system.

- Be prepared to use each robots' hand-held Teach Pendant (refer to the robots' User Manual).
- Understand the operation of the Equipment Front End Module (refer to the JET User Manual).
- Understand the operation of the Load Port Modules (refer to the LPMs' User Manual).
- Understand the operation of the Load Lock Modules or other devices the system is interfacing with for material transfer.
- Read through the entire alignment procedure before beginning.
- Record the Station coordinates for each robot in the appropriate worksheet provided in Appendix B: Station Identification on page 9-3.

NOTE: *Even a small misalignment can interfere with proper system operation and cause unnecessary downtime. Follow all steps to ensure precise alignment.*

Required Tools and Test Equipment

Performing the alignment procedure requires the following tools and materials:

- The parameter sheet for all robot stations from the System Acceptance Test (AT) shipped with the system
- A computer running a terminal emulator or a dumb terminal with an RS-232 Serial or Ethernet communications connection
- The Teach Pendant (Control/Display Module (CDM)) for each robot

- A set of hex key wrenches in inch sizes
- A set of hex key wrenches in metric sizes
- A 150 mm (6 in) steel ruler graduated in hundredths
- $^{15}/_{16}$" open end or socket wrench
- Small screwdriver
- A wafer carrier of the type used in normal processing
- MicroTool Dummy Wafers or test material of the type and size for which the system is being set up
- MicroTool Electronic Wafer Level (or bubble level with an accuracy of 0.10mm/m)
- Dial indicator and fixture (Brooks P/N JC-1262 or equivalent).
  See Appendix E: Tooling and Fixtures on page 9-7.
- All teach fixtures
- The User Manuals for any devices the Gemini 2 system will interface with
- The User Manuals for all components within the Vacuum Back End
- The User Manuals for the EFEM and all components within the Equipment Front End Module

Alignment Strategy

The alignment procedure is performed to ensure mechanical integrity between the motion of the robot and the stations being served. The Gemini 2 system is an Atmospheric to Vacuum Equipment Front End System for Process Modules. To properly align the G2 system it must be attached to the Process Modules it will be used with. The alignment consists of adjusting and aligning mechanical components of the system to ensure proper operation and to prevent any accidental contact or interference between moving and static elements of the system during material transfer operations.

The mechanical alignment phase includes robot end effector adjustment, system component adjustment, and programming actual station values (R, T, and Z) into the robot. These procedures are generally performed using fixtures (available from Brooks) and measuring instruments (e.g., scales, dial indicators, etc.). Another very useful tool is the robots' Teach Pendant, which provides very precise local control of the robot.

The alignment is performed to ensure proper equipment operation and precise material transport within the user system. The Teach Pendants or a computer running a Terminal Emulator, and the command set described in the *WAVE II User Manual* and the *Fusion Controls User Manuals* are used during the performance of the Alignment Procedure.

NOTE: *A thorough alignment protects against equipment damage and misaligned or sliding material.*

It is crucial that the alignment is performed in the given sequence for maximum operating performance of the Gemini 2 system. Brooks recommends reading the entire Alignment procedure prior to performing it.

The following elements will be addressed in the Alignment Procedure:

1. Verify that all components are properly installed and leveled.

2. Adjust station locations as required.

3. Final system check-out.

NOTICE

Safety interlocks may be overridden while using the Gemini 2 system's Teach Pendants. The user is responsible for any damage to the Gemini 2 system or their system as a result of using the Teach Pendants incorrectly.

The MagnaTran 7 robot within the Vacuum Back End does not have leveling adjustments. The robot is mounted directly to the chamber of the VBE. Adjustment of the Vacuum Back End is part of the alignment of the Gemini 2 system during installation. Adjustment of the EFEM is part of the alignment of the Gemini 2 system during installation. All components of the G2 system must be leveled prior to operation.

Alignment Overview

The typical system alignment progresses as follows:

1. Locating and setting the height and leveling the Equipment Front End Module
2. Setting the height and leveling the Vacuum Back End
3. Docking the Vacuum Back End to the EFEM
4. Docking the Process Module(s) to the Gemini 2 system VBE

The major steps of the alignment process are detailed below. Detailed descriptions of each step are provided in the section Alignment Process.

1. Ensure the end effectors of all robots in the system are set up properly.
2. Level the Equipment Front End Module to ensure the rotation axis of the robot is perpendicular to the reference plane of the Gemini 2 system and that the Material Transport Plane to the VBE, determined by the height of the handoff opening on the rear of the EFEM, is set to 1100 mm (43.307 in).
3. Attach the Load Port Modules to the Equipment Front End Module and level them. Ensure the that the Transport Plane is set to 900 mm (35.5 in).
4. Level the atmospheric aligner in the EFEM.
5. Configure the atmospheric robot's stations (aligner, load ports, load locks, etc.) and teach the handoff positions.
6. Level the Vacuum Back End and verify that the Material Transport Plane is set to 1100 mm (43.307 in).
7. Configure the vacuum robot for operation within the Vacuum Back End.
8. Teach the handoff positions in the Vacuum Back End for the atmospheric and vacuum robots.

9. Level the Process Module(s) ensuring the material stage is parallel to the reference plane of the Gemini 2 system and that the Material Transport Plane is set to 1100 mm (43.307 in).

10. Test the system alignment by running a series of test material to ensure proper material transport throughout the Gemini 2 system.

Alignment Process

A complete and accurate alignment ensures that no part of the robots or of any material being transported contacts any of the system's interior surfaces and that no sliding motions occur between any material and any support surfaces. The alignment will be done using the robots' Teach Pendants and a computer running a terminal emulator with an Ethernet communications connection.

NOTE: *The following procedures are provided as a reference to the alignment of a full cluster tool system. Special alignment procedures in the actual components User Manuals will take priority over the procedures supplied in this manual.*

WARNING

Potential Robot Motion

The robot has the potential for automatic motion that may cause serious injury. Each motor has 9 N-m of potential torque. The following systems have the possibility of automatic movement:

Atmospheric Robot
Atmospheric Robot Track
Atmospheric Aligner
Load Port Modules
Fans
Vacuum Robot
Batch Load Locks
Atmospheric Doors
Vacuum Slot Valves
Isolation Valves

- Avoid working inside the robot path or under extended robot arms.
- Use physical barriers to prevent injury when working in the robot path.

WARNING

Tip Hazard

Moving the Equipment Front End Module without a hoist or when it is not attached to the Vacuum Back End, could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without the use of a fork lift or a hoist.
- Roll on smooth floors only.

It is crucial that the alignment is performed in the sequence shown in this section for maximum operating performance of the Gemini 2 system. Many of the adjustments are made using the robots' Teach Pendant or a computer. Prior to beginning the alignment procedure, ensure the following steps have been completed.

1. Read the Alignment Overview and the Alignment Procedures.

2. Read and understand Chapter 2: *Safety*.

3. Become familiar with the safety warnings and the procedures to ensure safety while performing the procedure.

4. Become familiar with all attached subsystems, including the Teach Pendants, and the command sets to be used.

5. Ensure the Vacuum Back End, the Equipment Front End Module, the Process Module(s), and all associated components are at room temperature.

6. Power up and initialize the Gemini 2 system and all devices that interface with the G2 system. The system must be in the following state:
   - All vacuum chambers must be at atmosphere
   - All vacuum chamber slot valves and atmospheric doors must be open

7. Follow the alignment procedures provided in this section in the order presented. Note that this section provides a detailed overview of the alignment process, which will reference the actual procedures as required.

Dock the Load Port Modules to the EFEM

The LPMs are attached to the Equipment Front End Module using the kinematic mounts attached to the EFEM's frame. Refer to Load Port Useruser Manual for installation.

Locate and Level the Minienvironment

Adjustable feet are provided on the frame of the minienvironment. These feet are used to support the EFEM, to compensate for an uneven floor, and to relieve the wheels. The EFEM must

be located such that the Load Port modules attached to the front are properly positioned for carrier hand-off with the facility's automated material carrier equipment. Refer to Installing the Equipment Front End Module on page 3-6 for complete installation information.

NOTE: *It should not be necessary to level the Equipment Front End Module unless this is a new installation.*

Level the Load Port Modules on the EFEM

The LPMs are provided with independent pitch and roll adjustments to facilitate alignment. These adjustments are performed at the factory using the kinematic mounting bars attached to the EFEM's frame. Normally, when a Load Port Module is replaced, no leveling adjustments are required. Refer to the Load Port User Manual for instructions on leveling the LPM.

NOTE: *It should not be necessary to level the Load Port Modules.*

Locate and Level the Vacuum Back End

Adjustable feet are provided on the frame of the Vacuum Back End. These feet are used to support the Vacuum Transport Chamber, to compensate for an uneven floor, and to relieve the wheels. The Vacuum Back End must be located to ensure proper hand-off of the material with the EFEM. Refer to Connecting the Gemini Vacuum Back End to the EFEM on page 3-7.

NOTE: *It should not be necessary to level the Gemini 2 system unless this is a new installation.*

Level the Process Modules and Dock to the Vacuum Back End

Follow the manufacturers directions for leveling the Process Modules that are connected to the Gemini 2 system. Ensure that the Material Transport Plane is set to 1100 mm (43.307 in).

NOTE: *It should not be necessary to level the Process Modules unless it is a new module or significant changes have been made to it.*

Adjust the Robot's End Effectors

The condition of all end effectors must be verified to ensure proper material handoff.

NOTE: *It should not be necessary to adjust the end effectors.*

1. Verify all end effectors are flat. Refer to *Robot User Manual*.

2. Verify the dip and twist of all end effectors is within specifications and make any necessary corrections or adjustments. Refer to *Robot User Manual*.

Level the Aligner

The aligner in the EFEM must be leveled for proper wafer transfer. Refer to the EFEM User Manual for instructions on leveling the aligner.

NOTE: *It should not be necessary to level the aligner.*

Teach the Atmospheric Robot the Stations for all Atmospheric Material Transfer Points

The robot's software uses a station coordinate system for identifying specific locations within the EFEM. By identifying physical locations in this manner, it is only necessary to provide the robot with the station name instead of the complete coordinate set each time a command is issued to the robot. Multiple station names may be assigned to a single physical location.

The teaching procedures assume that the atmospheric robot has been configured with the appropriate software. The procedures then cover setting up the robot. For detailed information on teaching the Razor robot refer to the *Fusion Service User Interface User Manual.*

Teach the Robot the Atmospheric Aligner Location

The aligner acts as the center point of wafer transfers through the EFEM. It is used to orient the fiducial of all wafers, and it may be used to assist in centering the wafer on the robot's end effector. To ensure proper handoff of the wafer between the robot and the aligner, the aligner station must be taught to the robot. Refer to the *Fusion Controls Service User Interface User Manual* for instructions on teaching the aligner station.

Teach the Robot the LPM Locations

The Load Port Modules provide the interface for wafer transfer from the facility. To ensure proper handoff of the wafer between the robot and the Load Port Modules the LPM stations must be taught to the robot. Refer to the *Fusion Controls Service User Interface User Manual* for instructions on teaching the LPM stations.

Teach the Robot the Load Lock Locations

The Load Locks provide the interface for material transfer to the vacuum environment. To ensure proper handoff of the material between the robot and the Load Locks, the LL stations must be taught to the atmospheric robot. Refer to the *Fusion Controls Service User Interface User Manual* for instructions on teaching the LL stations.

Teach the Vacuum Robot the Stations for all Vacuum Material Transfer Points

The MagnaTran robots' software uses a station coordinate system for identifying specific locations. By identifying physical locations in this manner, it is only necessary to provide the robots with the station number instead of the complete coordinate set each time a command is issued to the robot. Multiple station numbers may be assigned to a single physical location for logistical purposes.

Teach the Robot the Load Lock Locations

The Load Locks provide the interface for material transfer to the atmospheric environment. To ensure proper handoff of the material between the robot and the Load Locks,

the LL stations must be taught to the vacuum robot. Refer to Teach the Vacuum Robot the Load Locks on page 4-11 for instructions on teaching the LL stations.

Teach the Robot the Process Module Locations

The Process Modules attached to the Vacuum Back End provide the actual processing of the material and require precise placement of the material within them. To ensure proper handoff of the material between the vacuum robot and the Process Modules, the PM stations must be taught to the robot. Refer to Teach the Vacuum Robot the Process Modules on page 4-13 for instructions on teaching the PM stations.

Verify Proper Operation of the Material Presence Sensors

Once the modules of the Gemini 2 system have been properly aligned the AWC sensors within the system must be aligned for proper operation.

Verify proper operation of the Material Presence Sensors. Contact Brooks Automation for instructions.

Verify Proper Operation of the Gemini 2 System

Verify proper material transfer between all stations within the Gemini 2 system. Refer to System Alignment Check-out on page 4-15.

Teaching Procedures

The following alignment procedures provide the information required for standard user alignment of the Brooks Automation Gemini 2 system. Table 4-1 is provided as a quick reference to all of the alignment procedures. For a full system alignment follow the Alignment Process on page 4-5.

Table 4-1: Alignment Procedures

System Preparation

The system must be properly prepared before starting the Alignment and Teaching Procedure to ensure the procedure can be completed in a quick and safe manner.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer. Refer to Electrical Hazards on page 2-16.

Safety

- Read, understand, and follow the safety advise in Chapter 2: *Safety*.
- During the teaching procedure, the system is at a Type 2 Electrical Hazard Category. Refer to Electrical Hazard Classifications on page 1-17.
- Breaking material can cause flying shards. Always wear eye protection when teaching the robot and using a test material.

Preparation Procedure

If preparing for alignment after installation, power up and initialize the Gemini 2 system as specified in Power-up Sequence on page 3-21.

If preparing for an alignment after replacing a component or performing an alignment check, first ensure that the Transport Chamber, the Load Locks, and any Process Module chambers are vented.

NOTICE

Do not proceed to the next step until all vacuum chambers within the system are at atmospheric pressure. Damage to the system could result from opening unequalized slot valves.

1. Open each slot valve and each atmospheric door.
2. Shut off the vacuum and venting subsystems and perform lockout/tagout procedures to ensure that the Slot Valves and other associated valves do not move unexpectedly.

Initiating the CDM

Verify that all installation procedures in the robot's User Manual including arm installation have been completed. Some steps may have been performed at the factory prior to shipment.

Performing a system alignment on the Gemini 2 system requires moving the robot arm and entering station coordinates or other robot parameters into the robot's memory. This is most conveniently done using the robot's hand-held Control/Display Module (CDM) supplied with the robot. Before the robot's CDM can be used, it must be connected to the robot. Follow the procedure for connecting and initiating the CDM in the Razor ATR User Manual.

Opening the Chamber Lid

If the vacuum robot has not been taught, the Transfer Chamber Lid and Load Lock Lids may be opened to allow access to the end effectors. This allows visual verification of the station assignments.

WARNING

Potential Robot Motion

The robot has the potential for automatic motion that may cause serious injury. Each motor has 9 N-m of potential torque.

- Avoid working inside the robot path or under extended robot arms.
- Do not climb into the chamber or leave tools on the floor of the chamber.
- Use physical barriers to prevent injury when working in the robot path.

Teach the Vacuum Robot the Load Locks

The following procedure teaches the MagnaTran 7 robot in the Vacuum Back End the Load Lock stations. Note that this procedure is for use with Gemini 2 systems running WAVE II Software. Refer to the *WAVE II Software User Manual* for information on determining the version of software being used.

NOTE: *The stations referenced in this procedure are for a standard configuration (refer to Station Coordinate System on page 5-6). Actual station assignments may vary based on the system configuration.*

Changing station assignments may cause interlocks to be ignored. Changing the station numbers requires re-configuration of all station options.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the service computer. Refer to Electrical Hazards on page 2-16.

Required Tools and Test Equipment

- Teach Fixture Kit
- Calipers, 150 mm (6 in)
- Control/Display Module
- The vacuum robot User Manual
- PC running a terminal emulator or a communications program such as Procomm™ or RSU™ (available from Brooks)
- MicroTool Dummy Wafer or test material of the appropriate type and size

Adjustment/Calibration Strategy

This procedure consists of several steps. Each step must be completed before proceeding to the next step. This sequence assumes the vacuum robot uses passive backside material contact.

For the procedure provided below, the following configuration is assumed:

- Load Lock B (on the right-hand side) is Station 1 for the vacuum robot
- Load Lock A (on the left-hand side) is Station 2 for the vacuum robot

Teaching the Load Lock Values for the Vacuum Robot

NOTICE

All slot valves and doors must be open before teaching the robots.

1. Using the MagnaTran robot's CDM, teach the robot the R and T values for Load Lock B.

   ```
   SETUP -> STATIONS -> 1 -> CR -> LEARN R, T, BTO -> HAND LOCATE
   ```

   A. Using the CDM, move the Z axis until the end effector can enter the Load Lock and manually move the robot's end effector into the Load Lock.

   B. Position the arm so the hole in the end effector lines up with the hole in the base of the Load Lock.

   C. Insert the 1/8 inch diameter pin through the hole in the end effector and into the hole in the Load Lock base (adjust the EE as necessary to ensure the pin is fully seated).

   D. Once the end effector is positioned correctly save the R and T values for the vacuum robot using the CDM.

   ```
   ESCAPE -> STORE -> R -> T -> QUIT
   ```

2. Using the MagnaTran robot's CDM, teach the robot the BTO value for Load Lock B.

   ```
   SETUP -> STATIONS -> 1 -> CR -> LEARN R, T, BTO -> HAND LOCATE
   ```

   A. Remove the pin from the end effector.

   B. Move the robot's end effector out of the Load Lock.

   C. Place the MicroTool test wafer on the end effector.

   D. Move the end effector up or down until it is positioned 68.6 mm (2.70 in) from the top of the chamber to the top of the test wafer. Note that if material other than a MicroTool Test Wafer is used the dimension specified must be adjusted to account for the differences.

E. Once the end effector is positioned correctly save the BTO value for the vacuum robot using the CDM.

```
ESCAPE -> STORE -> BTO -> QUIT
```

3. Using the MagnaTran robot's CDM, move the robot's arm out of the Load Lock.

```
SETUP -> STATIONS -> 1 -> CR -> LEARN R, T, BTO -> HAND LOCATE
```

4. Move the robot's arm with the material out of the Load Lock and exit use of the vacuum robot using the CDM.

```
QUIT
```

5. Assign the Lower value for Station 1 (Standard Load Lock/Cool Load Lock).

```
SETUP -> STATIONS -> 1 -> CR -> ASSIGN LOCATION -> L -> 14000 -> CR ->
QUIT
```

6. Record the Station coordinates in the appropriate worksheet provided in Appendix B: Station Identification on page 9-3.

7. If the robot has dual end effectors, repeat the procedure for End Effector B.

8. Repeat the procedure for Load Lock A using the appropriate station number (Station 2).

Teaching the vacuum robot the coordinates of the Load Locks is now complete. Return control of the robot to the host controller and shut off the CDM.

Teach the Vacuum Robot the Process Modules

The following procedure teaches the MagnaTran 7 or MagnaTran 8 robot the Process Module stations. Note that this procedure is for use with Gemini 2 systems running WAVE II Software. Refer to *WAVE II Software User Manual* for information on determining the version of software being used.

NOTE: *The stations referenced in this procedure are for a standard configuration (refer to Station Coordinate System on page 5-6). Actual station assignments may vary based on the system configuration.*

Changing station assignments may cause interlocks to be ignored. Changing the station numbers requires re-configuration of all station options.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the service computer. Refer to Electrical Hazards on page 2-16.

Required Tools and Test Equipment

- Teach Fixture Kit
- Control/Display Module

- The vacuum robot User Manual
- PC running a terminal emulator or a communications program such as Procomm™ or RSU™ (available from Brooks)
- MicroTool Dummy Wafer or test material of the appropriate type and size

Adjustment/Calibration Strategy

This procedure consists of several steps. Each step must be completed before proceeding to the next step. This sequence assumes the vacuum robot uses passive backside material contact.

For the procedure provided below, the following configuration is assumed:

- The first Process Module on the left-hand side is Station 3 for the vacuum robot

NOTE: *It may be helpful to use a glass wafer with cross-hairs scribed into it to locate the centers of the Process Module stations.*

Teaching Procedure

Refer to Station Coordinate System on page 5-6 for an illustration of station assignments.

1. Using the MagnaTran robot's CDM, teach the robot the R and T values for the Process Module.

   ```
   SETUP -> STATIONS -> 3 -> CR -> LEARN R, T, BTO -> HAND LOCATE
   ```

   A. If the Process Module does not have a hole for the locating pin install the PM Teach Fixture.

   B. Using the CDM, move the Z axis until the end effector can enter the Process Module and manually move the robot's end effector into the Process Module.

   C. Position the arm so the hole in the end effector lines up with the hole in the base of the Process Module or in the Teach Fixture.

   D. Insert the 1/8 inch diameter pin through the hole in the end effector and into the hole in the Process Module/Teach Fixture base (adjust the EE as necessary to ensure the pin is fully seated).

   E. Once the end effector is positioned correctly save the R and T values for the vacuum robot using the CDM.

   ```
   ESCAPE -> STORE -> R -> T -> QUIT
   ```

2. Using the MagnaTran robot's CDM, teach the robot the BTO value for Process Module.

   ```
   SETUP -> STATIONS -> 3 -> CR -> LEARN R, T, BTO -> HAND LOCATE
   ```

   A. Remove the pin from the end effector.

   B. Move the robot's end effector out of the Process Module.

   C. Place the MicroTool test wafer on the end effector.

D. Move the end effector up or down until it is positioned 68.6 mm (2.70 in) from the top of the chamber to the top of the test wafer. Note that if material other than a MicroTool Test Wafer is used the dimension specified must be adjusted to account for the differences.

E. Once the material is positioned correctly save the BTO value for the vacuum robot using the CDM.

```
ESCAPE -> STORE -> BTO -> QUIT
```

3. Assign the Lower value for the Process Module.

```
SETUP -> STATIONS -> 3 -> CR -> ASSIGN LOCATION -> L -> 12000 (or as required) -> CR -> QUIT
```

4. Record the Station coordinates in the appropriate worksheet provided in Appendix B: Station Identification on page 9-3.

5. If the robot has dual end effectors, repeat the procedure for End Effector B.

6. Repeat the procedure for each Process Module using the appropriate station number.

Teaching the vacuum robot the coordinates of the Process Modules is now complete. Return control of the robot to the host controller and shut off the CDM.

System Alignment Check-out

To verify that the alignment has been completed successfully, use the system's controller. Otherwise, use a PC and the CDM's material transfer functions to move material from each cassette through the system. Perform the entire check-out using the robot's pan 'A'; if a dual end effector arm set is being used, perform the entire check-out for pan 'B' also.

Once all robot's R, T, and Z axes have been set up for all transfers, it is necessary to verify proper transfer of material to and from all modules within the system.

NOTE: *This procedure must be performed during initial setup and at any time that the robot's arms or end effector(s) are damaged, removed and replaced, or changed.*

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the service computer. Refer to Electrical Hazards on page 2-16.

Required Tools and Test Equipment

- The robot's Control/Display Module (CDM)
- PC running a terminal emulator or a communications program such as Procomm™ or RSU™ (available from Brooks)
- MicroTool Dummy Wafers or test material of the appropriate type and size
- FOUP of the type that will be used in production

⚠ CAUTION

Flying Shards of Glass

Breaking wafers may cause flying shards of glass and cause eye injury.

Protective eye wear must be worn at all times when using wafers for setup or test.

Limits and Tolerances

- All FOUPs/cassettes used with the Gemini 2 systems must meet SEMI/MESC standards.

Adjustment/Calibration Strategy

This procedure verifies proper operation of material transfer between all modules by observing system operation during material transfers. The material should not slide on the end effectors or on any material transfer points. There should be no bumping of material against cassette walls or other system components.

Procedure

Using the PC and the robot's CDM, position material for transfer within the modules and PICK the material from one module and PLACE it into another module. During the PICK and PLACE procedures, observe the system to verify proper operation. Repeat the procedure to transfer the material back to its original location.

NOTE: *Observe material transfer from each Process Module, from each shelf of each Load Lock, from the Aligners, and from each slot in each Load Port Module. When using a dual arm set, repeat the above procedure to check system alignment using pan 'B'.*

5 Operation

Overview

This chapter describes the operation of the Brooks Automation Gemini 2 system. For operation instructions related to major components of the system, such as pumps, valves, etc., reference the appropriate user manuals.

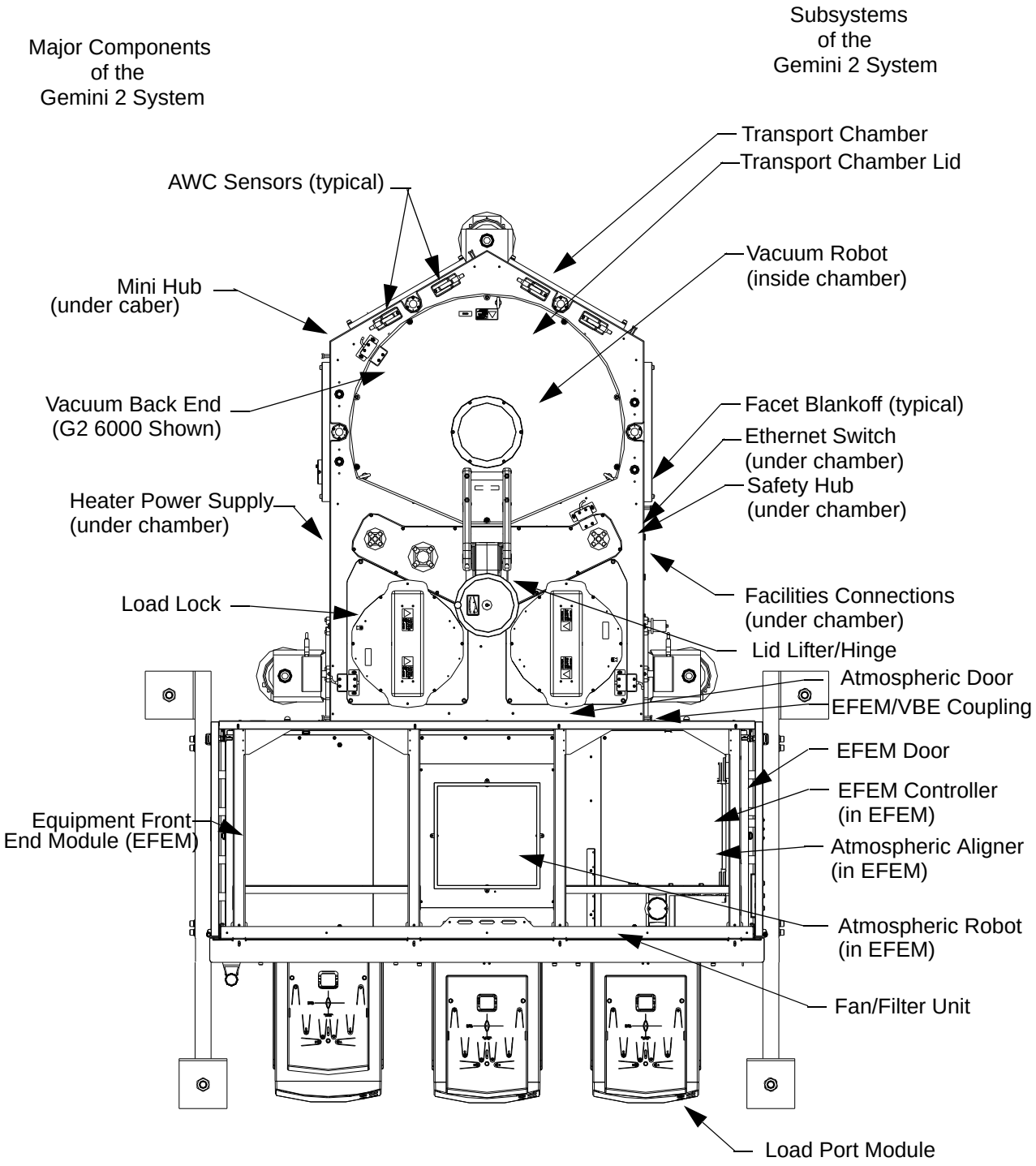


Figure 5-1: Gemini 2 Systems

Operation Overview

The operation of the G2 system (Figure 5-1) consists of communication between the components of the Atmospheric Front End and Vacuum Back End and the Transport Module Controller. The detailed operation of these components is described in their respective User Manuals. This operation section provides information about these components as part of a Gemini 2 system. In the case of any contradiction, this manual takes precedent.

Configuration and operation of the G2 system is through the user's host controller. Refer to the controller's documentation for information on its setup and operation.

The following sequence demonstrates the normal material transfer operation of the Gemini 2 system.

1. Load material to be processed into the system.

   A. A wafer carrier is placed in one of the Load Port Modules attached to the EFEM.

   B. Once the LPM is open the host controller initiates a mapping of the wafers in the carrier and retrieves the wafer map when it is completed.

2. Pick a wafer from the carrier and align.

   A. The host controller vents the Load Lock to atmospheric pressure.

   B. The host controller instructs the atmospheric robot to pick a wafer from the carrier on the LPM and place it on the aligner within the EFEM.

3. Align the wafer and place it into the Load Lock.

   A. The host controller instructs the aligner to orient the fiducial of the wafer and the atmospheric robot to pick the wafer from the aligner.

      The aligner measures the eccentricity if required and communicates the position of the wafer to the robot controller.

   B. Once the Load Lock chamber is at atmospheric pressure the host controller opens the Atmospheric Door.

   C. The host controller instructs the atmospheric robot to transfer the centered and oriented wafer to the incoming wafer shelf in the Load Lock. For the Batch Load Lock, the Razor robot continues to pick wafers from the carrier, align them, and transfers them to the Batch Load Lock. The Batch Load Lock elevator moves so the robot can access an empty shelf.

   D. The host controller closes the atmospheric door to the Load Lock.

   E. The host controller starts a pump-down of the Load Lock to vacuum pressure.

4. Place the wafer into the first Process Module. Pick the next wafer from the carrier and align.

   A. Once the Load Lock chamber is at the vacuum set point, the host controller opens the Vacuum Slot Valve.

B. The host controller instructs the vacuum robot within the Vacuum Back End to transfer the incoming wafer into the first Process Module.

NOTE: *For the Batch Load Lock, all the wafers in the Load Lock are processed before returning the Load Lock to atmospheric pressure.*

C. The host controller closes the Vacuum Slot Valve.

D. The host controller vents the Load Lock to atmospheric pressure.

E. While the first wafer is in process, the host controller instructs the atmospheric robot to remove the next wafer from the LPM and place it on the aligner within the EFEM.

5. Align the wafer and place it into the Load Lock. Move the processed wafer to the next processing stage.

A. The host controller instructs the aligner to orient the fiducial of the next wafer and the atmospheric robot to pick the wafer from the aligner.

The aligner measures the eccentricity if required and communicates the position of the wafer to the robot controller.

B. Once the Load Lock chamber is at atmospheric pressure the host controller opens the Atmospheric Door.

C. The host controller instructs the atmospheric robot to transfer the centered and oriented wafer to the incoming wafer shelf in the Load Lock.

D. The host controller closes the atmospheric door to the Load Lock.

E. The host controller initiates a pump down of the Load Lock.

F. The host controller instructs the vacuum robot to transfer the wafer from the first Process Module to the Second Process Module, or to the Load Lock depending upon the process's recipe.

6. Pick the next wafer from the carrier and align. Place the wafer into the first Process Module, place the fully processed wafer into the Load Lock.

A. Once the Load Lock chamber is at the vacuum setpoint the host controller opens the Vacuum Slot Valve.

B. The host controller instructs the vacuum robot to transfer the incoming wafer into the first Process Module.

C. The host controller instructs the vacuum robot to transfer the processed wafer from the second Process Module to the outgoing wafer shelf (bottom shelf) in the Load Lock.

D. The host controller closes the Vacuum Slot Valve.

E. The host controller vents the Load Lock.

F. The host controller instructs the atmospheric robot to remove the next wafer from the LPM and place it on the aligner within the EFEM.

7. Align the wafer and place it into the Load Lock. Move the processed wafer to the next processing stage, and place the fully processed wafer into the carrier.

   A. The host controller instructs the aligner to orient the fiducial of the next wafer and the atmospheric robot to pick the wafer from the aligner.

      The aligner measures the eccentricity if required and communicates the position of the wafer to the robot controller.

   B. Once the Load Lock chamber is at atmospheric pressure the host controller opens the Atmospheric Door.

   C. The host controller instructs the atmospheric robot to transfer the centered and oriented wafer to the incoming wafer shelf in the Load Lock.

   D. The host controller instructs the atmospheric robot to remove the processed wafer from the outgoing wafer shelf of the Load Lock and place it into the LPM.

   E. The host controller closes the atmospheric door to the Load Lock.

   F. The host controller initiates a pump-down of the Load Lock.

   G. The host controller instructs the vacuum robot to transfer the wafer from the first Process Module to the Second Process Module, or to the Load Lock depending upon the process's recipe.

8. The cycle (Steps 6 and 7) repeats until all wafers in the carrier have been processed.

9. Once all of the wafers within the wafer carrier have been processed, the wafer carrier is removed and replaced with the next carrier to be processed.

Station Coordinate System

The robot software uses a station coordinate system for identifying specific locations within the Gemini 2 system, as shown in Figure 5-2. Each station is identified by its:

- Theta position: Rotational location
- Radial position: Amount of arm extension away from the robot
- Z position: Vertical distance from Home

Some Gemini 2 systems may have additional parameters specified for a station, based on additional functions provided by the robot, such as Wrist position and VIA point position.

Station numbers are assigned to represent each module connected to the G2 and each material transfer point within the G2. All station number assignments depend on the specific system configuration. By identifying the stations in this manner, you only need to provide the robot with the station number instead of the complete coordinate set each time a command is issued to the robot. Multiple station numbers may be given to a single physical location, or the same location may be referred to by a different station number by different robots.

Brooks Automation configures the stations on the G2 as shown unless different station assignments are specifically requested. All references to setting stations in this manual reflect the standard Brooks G2 system station assignments shown in Figure 5-2.

NOTE: *The stations referenced here are for the Gemini 2 system configuration.*

If the station numbers were assigned at the factory, changing the station numbers may cause interlocks to be ignored.

Changing the station numbers requires re-configuration of all station options.

All numbering of stations within the Transport Chamber for the MagnaTran 7 robot is done in a clockwise direction, starting with the Load Lock on the right when looking at the Gemini 2 system from the top (See Figure 5-2). Any intermodule stations are numbered on a second clockwise circuit of the Transport Chamber. All numbering of stations within the Minienvironment is done in a counter-clockwise direction, starting with the Load Lock on the right when looking at the Gemini 2 system from the top.

The R (outward extension of the arm from the robot), T (rotational), and Z (up and down) values for each station should be recorded for each type of material that is used with the system. These values are different for different size wafers and for different systems.

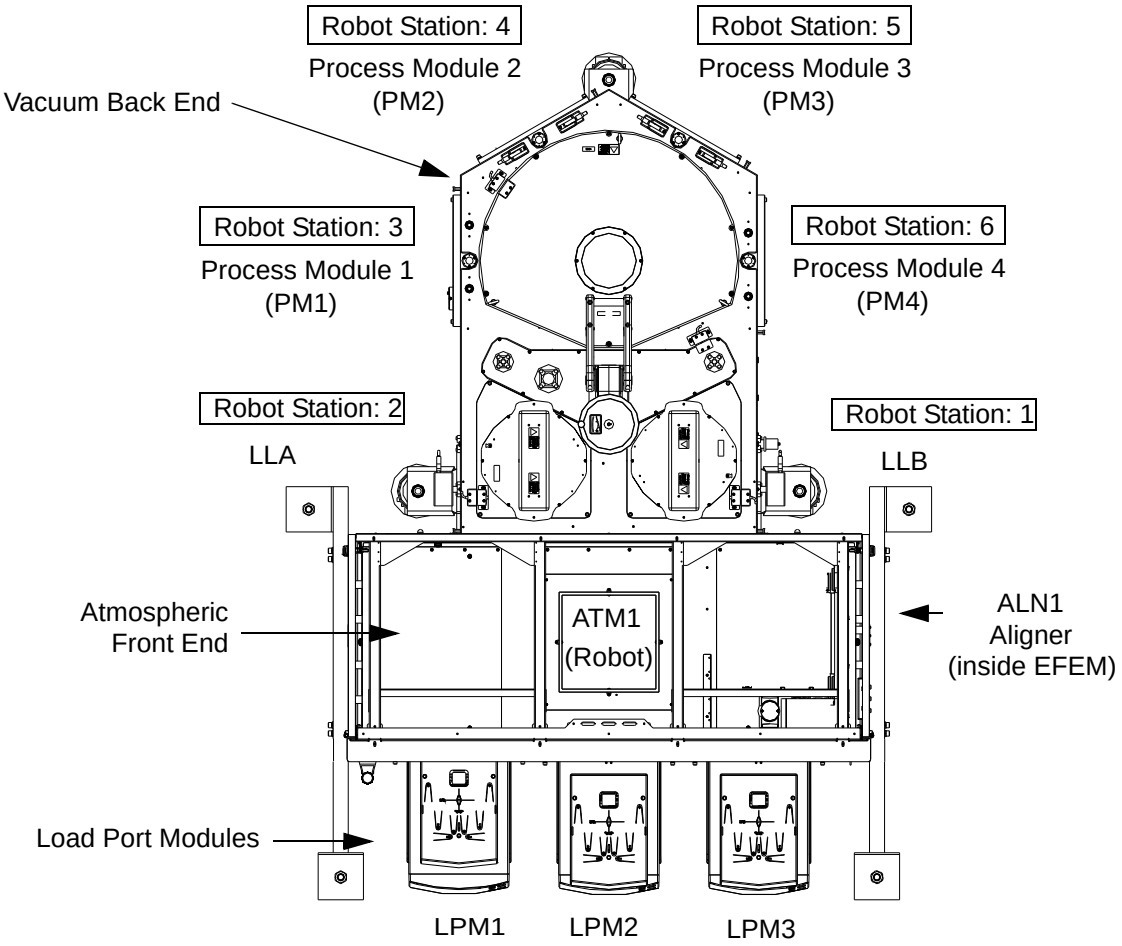


Figure 5-2: Station Assignment Example (G2 6000 shown)

When the Z Axis is being used, there are a number of user definable parameters that must be provided for proper operation. The Base Transfer Offset (BTO) provides the distance from the robot's Home position to the systems Material Transfer Plane (MTP). The Lower parameter provides the distance from the MTP that the robot must move down to deposit the material, which also defines the height at which the robot must enter a module to pick up the material.

The Slot parameter is used to define the number of slots in a station. The default slot parameter is 1. Slot also specifies the slot for the robot's operation. If none is specified the default value is assumed. The Pitch parameter is used to define the distance between slots. When using the Slot and Pitch parameters, the total number of slots may not exceed the vertical distance that the robot is capable of traveling.

NOTE: *Any or all of these values can differ from station to station.*

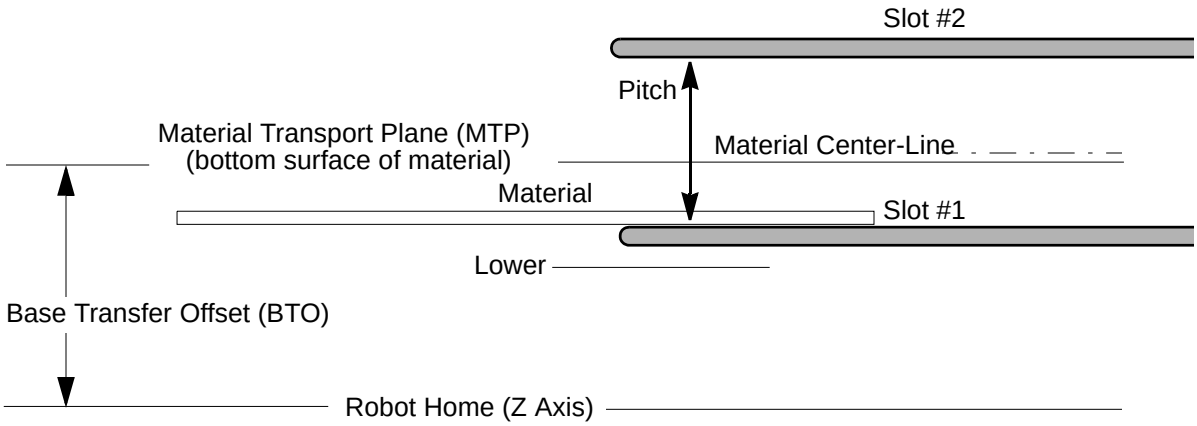


Figure 5-3: Robot Z-Axis

Memory Structure

The controllers for each robot feature both volatile and non-volatile memory. The non-volatile memory holds the control program, version information, build date, application specific parameters, an event log, and a factory-loaded set of working parameters. The default application specific parameters are listed in the Acceptance Test (AT). The arm parameters, which are part of the application specific parameters, have been set for the arm geometry ordered, and the robot has been optimized for the specific application.

The user must set up the robot for the specific user configuration by storing the actual station parameters to the non-volatile memory. The new station values must also be recorded in the worksheets provided in Appendix B: Station Identification on page 9-3. Every time the robot is started or reset, the values of all parameters stored in non-volatile memory are loaded into RAM for active use by the controller. Using non-volatile memory, the robot is able to store a unique set of station parameters, described in Table 5-1, for each of the 50 possible stations. The STORE commands must be used to load the parameters into non-volatile memory on the disk-on-chip.

Table 5-1: Station Parameters

Station Parameter	Description
R	The full radial extension in increments of 0.001 mm
T	The rotational position, Theta, in increments of 0.001 ° over a range of 360 °
W WA/WB FastSwap	The end effector flipping position in increments of 0.001 ° over a range of +10° to -190°
Z	The vertical position in increments of 0.001mm
S	The horizontal axis of the traverser in microns
BTO	The Z axis location, in microns, of the Material Transport Plane, which is also the Up position of the robot arm in Station 1
LOWER	The distance in microns below the Material Transport Plane at which the Down position of the robot arm is located
NSLOTS	The number of slots at the station
PITCH	The uniform distance, in microns, between the slots

NOTE: *Any or all of these values can differ from station to station.*

Frames of Reference

Before setting stations or using the G2 System, it is important to understand the Frames of Reference used within the system.

Material is transported to specific locations, or stations, within the system by the robots. Each location is defined by its T and R polar coordinates and its Z position within the system's Frame of Reference. Station definition is the process of defining each of these locations. These values are then stored in the robot's memory for future reference by the robot. It is important to note that the system's frame of reference is defined by the robot as described below and that each station is defined by the R, T, Z, and other station values programmed into the robot.

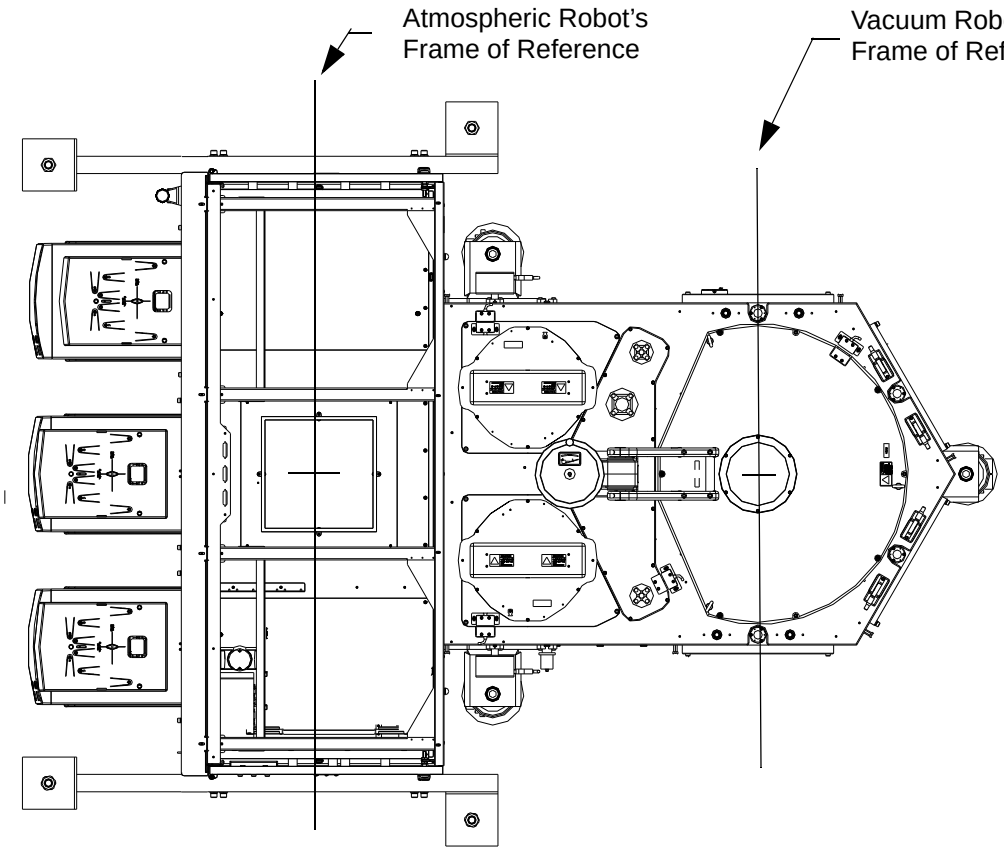


Figure 5-4: Frames of Reference (Typical System)

Robot's Frame of Reference

The typical frame of reference for the Transport Chamber is defined by the robot's coordinate system. The top view shown in Figure 5-4 is a horizontal x-y plane, and each position within this plane is defined using a polar coordinate notation for each robot.

NOTE: *The system's 0° axis is defined by the robot's 0° position. This is typically the robot's rotational Home position.*

Looking at the top view of the system, the robot's rotational, or T (theta), position value increases from 0° at the Home position to 360° in a clockwise direction. The robot's radial, or R, axis is measured from the center line of the robot radially outward in millimeters.

The third axis in the Transport Chamber's Frame of Reference is the vertical, or Z, axis. The zero position for the Z axis is defined by the robot's vertical Home position.

Determining Material Locations

This section describe methods to determine material presence within the G2 system.

Robot Pick and Place Commands

Each robot assumes it has material after power-up. The robot assumes it has material after a PICK command at a station without sensors. The robot assumes it does not have material after a PLACE command at a station without sensors. For stations with sensors, the robot checks the station sensor to verify that the PICK/PLACE was successful.

Material Presence Sensing

The vacuum grip on the atmospheric robots can be used to determine the presence of material.

The passive edge contact end effector on the atmospheric robots has a through-beam sensor to detect material presence. The aligner can also use the CCD to determine wafer presence by looking for the shadow of a wafer on the chuck.

Material Mapping

The Load Ports may have Optical Wafer Mappers that are used to map wafer carriers and report the presence of wafers in particular slots. The LPM mounted mapper is capable of identifying present, missing, cross-slotted, and double-slotted wafers.

Transport Chamber Material Sensors

AWC sensors can be used to determine wafer presence. The vacuum robot can be commanded to do a `CHECK LOAD` to determine material presence. This command causes the robot to move the material so that the edge of material present on the end effector triggers the sensor. If the material present state does not match the expected state the robot will generate an error.

Vacuum Back End

The Vacuum Back End includes:

- Transport Chamber and Frame
- Vacuum/Venting Systems
- Gas System
- Gas System
- Cooling System
- Electrical System
- Automatic Wafer Centering
- Pressure Switch
- Vacuum Robot
- Ethernet

Operation

The Vacuum Back End (VBE) includes a vacuum transport chamber that provides a controlled environment for transfer of material from the EFEM to the Process Modules. The VBE provides mounting for the load locks, vacuum robot, controls electronics, pumps, valves, and gauges. The vacuum transport chamber is maintained at vacuum. The load locks are pumped to vacuum and vented to atmosphere to allow transfer of wafers between atmosphere and vacuum pressure.

Operation of the VBE includes the control of vacuum and vent systems, transfer isolation valves, and the lid switches for safety. Any type of supported material is placed into one of the Load Locks (LL). The robot in the VBE removes the wafer from the LL once the LL is pumped down. The robot in the VBE then passes the wafer on to the Process Module (PM). After processing, the robot removes the wafers from the PM and returns them to the LL. The wafers are retrieved by the atmospheric robot once the LL is vented to atmosphere and the atmospheric door opens.

Transport Chamber and Frame

There are several different chamber designs used in the VBE. These designs provide from two to six Process Module openings (facets) with different footprint configurations to maximize floor space usage. A central vacuum robot is used for wafer transfer inside the vacuum transport chamber. This allows the user the ability to select the smallest footprint available for processes requiring multi-step processing without the need to remove the wafers from the vacuum environment.

Multi-Faceted Chamber

All multi-faceted Vacuum Transport Chambers for the G2 system are designed to provide an ultra-clean, high-vacuum environment for transfer of wafers among Process Modules. Each process module opening (facet) is designed to accept a slot valve. When installed, this provides a custom opening for connecting to a Process Module. Slot valves are also located between the main vacuum chamber and the Load Locks. The Load Locks have atmospheric doors on their atmospheric side.

The Vacuum Back End chamber and Load Lock openings are machined from a single aluminum block to provide greater structural and vacuum integrity. The vacuum chamber provides for installation of the wafer handling robot. It also includes ISO compatible ports for vacuum system components such as gauges and pumps associated with the chamber. The vacuum transport chamber also has opening for the AWC Sensor system. All seals on the chamber are preprocessed elastomer seals.

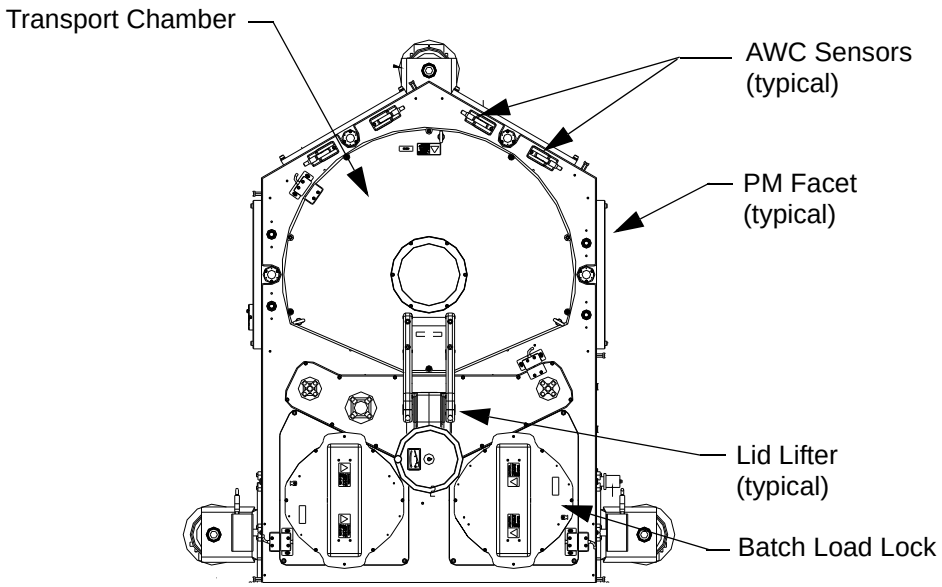


Figure 5-5: Chamber Overview

Transport Chamber Lid Assembly

The Vacuum Back End lid is located on the top of the Vacuum Transport Chamber, sealing the chamber and providing access into the chamber. The lid meets all SEMI S2 and EU safety standards.

Transport Chamber Lid Assembly

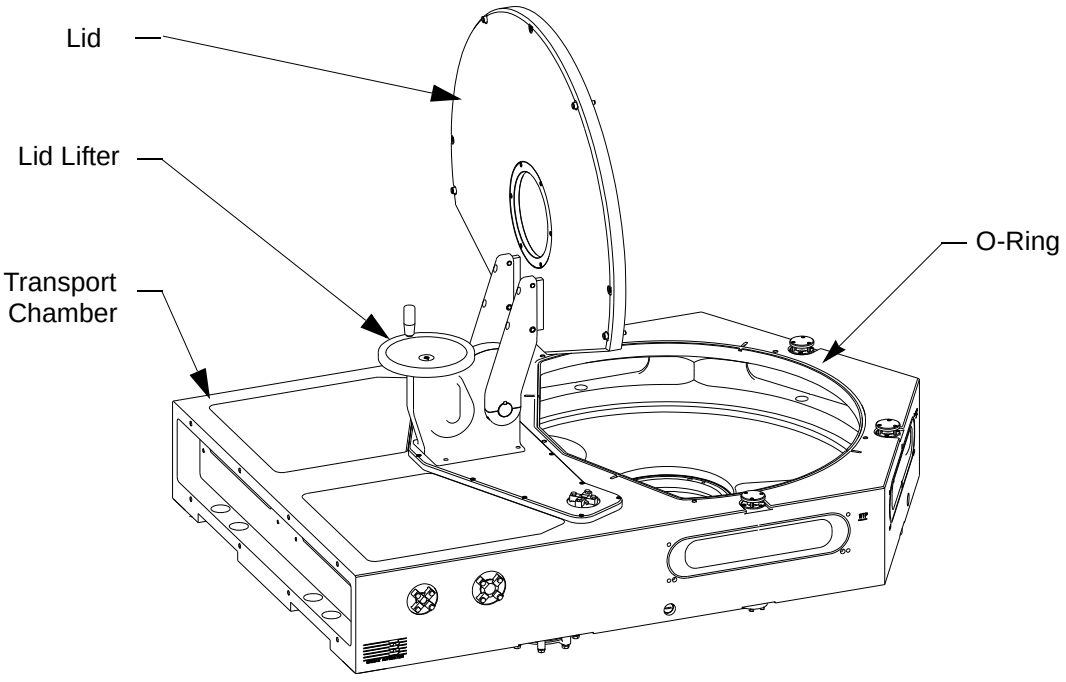


Figure 5-6: Chamber Lid Overview

The lid is fabricated from a solid block of aluminum and can weigh up to 47 kg (103 lb). This lid provides a central viewport consisting of an o-ring sealed Pyrex® window with a 7.25 inch ID bezel in the center. The vacuum sealing surface on the bottom edge of the lid mates with the o-ring on the vacuum chamber. No locking provisions are required.

The Lid Lifter mounts to the top of the Transport Chamber. The Lid Lifter arm is bolted to the chamber lid. The lifter is used to safely raise and lower the lid when service is required.

Lid Lifter

The lid is provided with a manually operated, gear-driven lifter. The Lifter provides a 90° opening angle in the vertical plane.

WARNING

Crush Hazard

The chamber lids weigh up to 47 kg (103 lb). Precautions should be taken when performing any service inside of the chamber when a lid is raised, to prevent personal injury.

Personnel should not lean inside, or place hands or arms into the chamber unless the lid is in the full upright position.

The Lifter is designed not to backdrive; however, the lid must never be left in an intermediate position. The only two acceptable positions for the lid are fully lowered, or fully raised (90°).

Refer to Lid Lockout/Tagout Procedure on page 2-13.

Frame Assembly

The Gemini Vacuum Back End frame is used to support the:

- Vacuum Transport Chamber
- Peripheral modules
- Various vacuum system components such as pumps, gauges, and valves
- Facilities connections associated with the G2 system

The frame consists of a welded, tubular construction, steel structure and is capable of supporting up to 100 kg (220 lb) per Process Module at each facet for cantilevered installations.

The height of the frame allows the height of the vacuum chamber's WTP to conform to the SEMI/MESC cluster tool specification (1100 mm/43.3 in.). Refer to Connecting the Gemini Vacuum Back End to the EFEM on page 3-7.

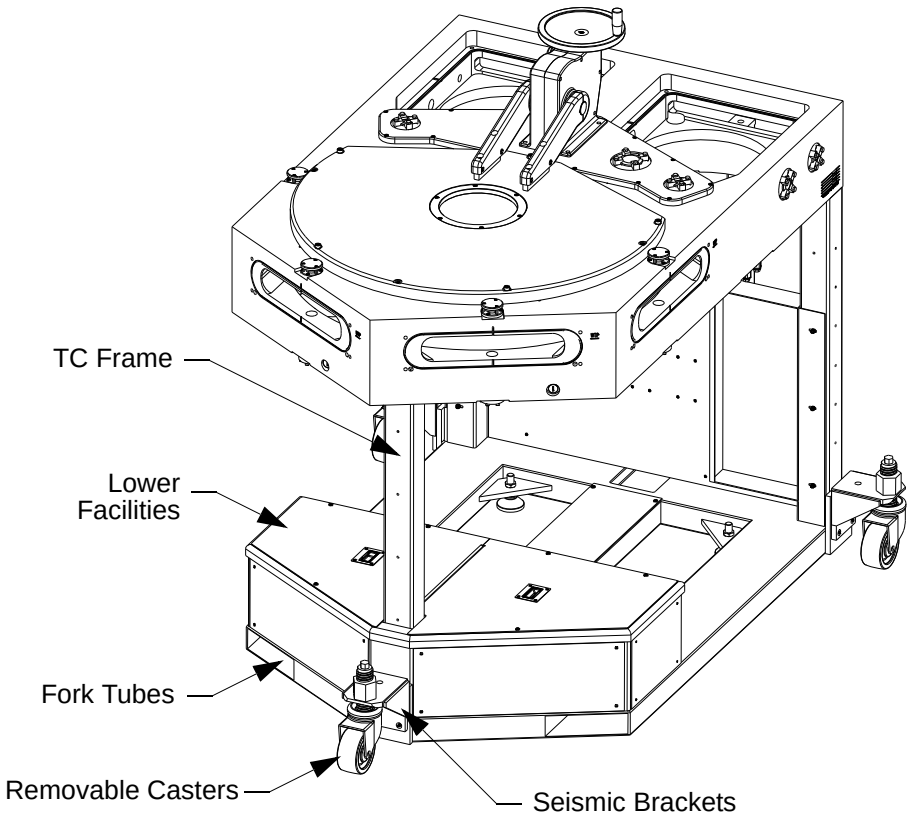


Figure 5-7: Gemini 2Frame Assembly

NOTICE

The minimum overturning moment is 800 lb-ft applied to any Process Module facet.

The Gemini Vacuum Back End frame is provided with removable casters for rolling the chamber and frame. Built-in fork tubes allow moving the frame with a fork lift. The frame is also equipped with adjustable feet that allow adjusting and leveling of the Gemini 2 Vacuum Back End. Seismic hold-down for facilities requiring earthquake protection are the responsibility of the user. Refer to Installing Seismic Tie-down Brackets on page 3-9. Service access is provided under the chamber behind the EFEM and between the Process Modules.

Vacuum Load lock

The Vacuum Load Block is part of the Gemini 2 Vacuum Back End transport chamber tooled block. It is an isolated area between the JET EFEM and the vacuum transport chamber. This area can be used for load locks, wafer storage, metrology systems, wafer cooling, or clean wafer storage. Each load lock can

be Rough Only or High Vacuum. A system may require only one load lock to meet wafer throughput needs.

Vacuum Load Block options:

- 2 wafer Pass Thru Load Lock
- 2 wafer Pass Thru Load Lock with Cooler
- 26 wafer Batch Load Lock
- 13 wafer Batch Load Lock with Cooler
- Blanked off (Load Lock not used)

For the Batch Load Locks, Z-axis motion is provided by a standard Brooks Automation VCE 6 Indexer Drive. This drive has a travel of 231 mm (9.12 in) and provides an adjustable pitch (set to 9.14 mm (0.360 in) for the Batch Load Lock. The vertical position repeatability is ±0.1 mm (±0.004 in). The drive is capable of lifting 11.3 kg (25 lb) in 1.3 sec. per 10 mm travel. The drive uses the standard Brooks VCE 6 Drive command set with communication over a switch selectable RS-232/RS-422 serial connection running at 1200, 2400, 9600, 19200 baud (set to 9600 baud for the Batch Load Lock).

Access for cleaning or servicing the 2 wafer Load Locks is from the top side of the G2 system by removing the top cover. The cover weighs only 14.5 kg (32 lb). Access for cleaning or servicing the Batch Load Locks is from the top side of the G2 system by removing the top Load Lock chamber. The entire Batch Load Lock or Batch Load Lock with Cooler can be installed or removed for service in less than 60 minutes.

Pass Thru Load Lock

The Pass Thru Load Lock mounts in either the ‘A’ or ‘B’ Load Lock of the machined Vacuum Load Block section of the Gemini Vacuum Back End. The Pass Thru Load Lock provides two shelves for supporting 300 mm wafers in transition between the atmosphere and vacuum environments.

The Pass Thru Load Lock consists of an aluminum blankoff plate that is mounted in the floor of the Load Lock chamber. The blankoff plate supports a two-level shelf system and weighs 6.4 kg (14 lb). The lower shelf consists of three stainless steel pins attached to the blankoff plate. The upper shelf consists of stainless steel tabs. The upper shelf attaches horizontally to two support blocks that are mounted on the perimeter of the plate.

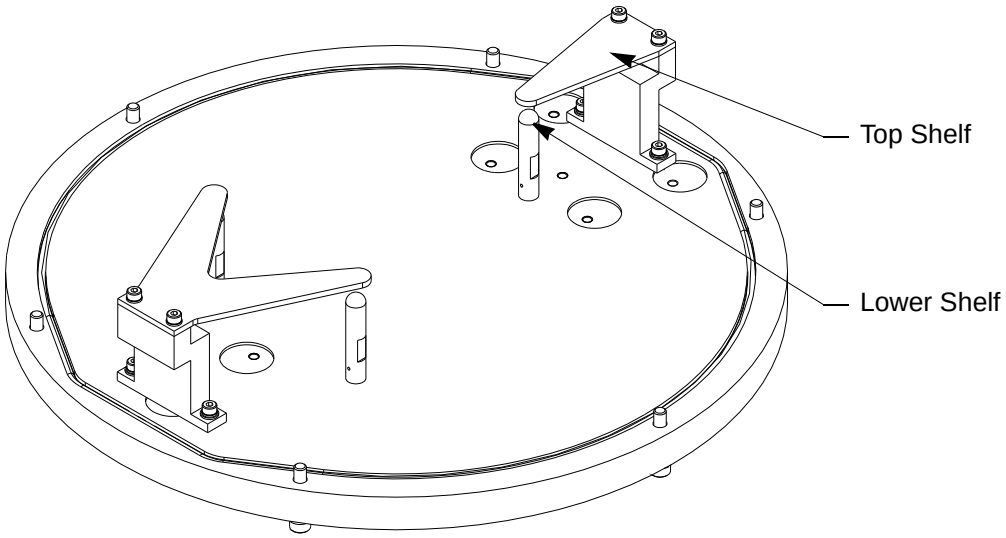


Figure 5-8: Pass Thru Load Lock

Batch Load Lock

The Batch Load Lock assembly mounts in either the ‘A’ or ‘B’ Load Lock and provides 26 shelves for supporting 300 mm wafers in moving between the atmosphere and vacuum environments. Different top chambers are required for installation in the ‘A’ and ‘B’ Load Locks. Optional wafer slide-out and wafer presence sensing is available.

The Batch Load Lock allow indexing and support for a vertical stack of 25 or 26 300 mm wafers in the load lock during vacuum pumping and venting. This can be used when rapid wafer cooling is not required. This option also provides the means to quickly load a batch of wafers into the vacuum environment.

The Batch Load Lock assembly consists of aluminum top and bottom chambers weighing 6.8 kg (15 lb) each. These attach to the load lock area of the transport chamber, creating the vacuum chamber for the batch load lock. The wafer support assembly sits inside the batch load lock. This assembly connects to a standard Brooks Automation VCE 6 Z-axis Drive. You must disassemble and re-assemble to change to a different size wafer. The VCE 6 drive weighs 13.6 kg (30 lb). It positions the wafer support assembly slots to allow for wafer transfer.

Wafers are accessed from either the atmospheric side or the vacuum side of the chamber.

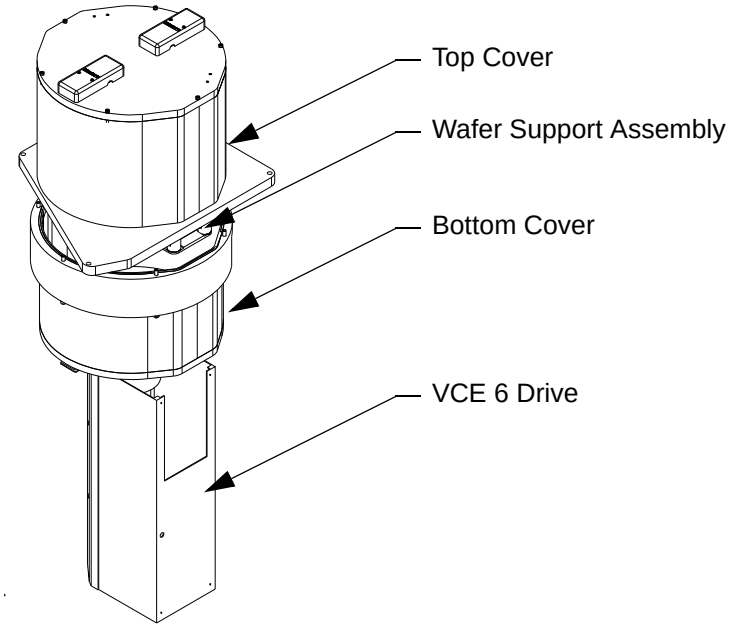


Figure 5-9: Batch Load Lock

Vacuum/Venting Systems

The G2 systems are supplied with vacuum system packages to provide environmental control for the Transport Chamber, the Load Locks, and any other peripheral items, as requested. Vacuum system packages are designed to minimize the introduction of contaminants into the chambers during evacuation and vent processes by using profiled pump-downs and profiled vent-ups.

Each vacuum system package has five elements:

- Vacuum Pumping System
- Chamber Isolation Valves
- Venting System
- Vacuum Measurement System
- Vacuum System Control

Vacuum Pumping System

The pumping system is designed to bring the modules of the G2 system from atmospheric pressure to vacuum with minimum introduction of contaminants and turbulence. Each module to be vented to vacuum generally incorporates the following:

- main pump
- backing pump
- pump vent valve

High Vacuum Pumps

Optional high vacuum pumps, which are normally turbomolecular (turbo) pumps or cryogenic (cryo), are used to vent the Vacuum Transport Chamber and Load Lock chambers. Turbomolecular pumps require backing vacuum pumps to operate properly.

A two-stage, slow/fast roughing process is used on the Load Lock, and a single-stage fast rough process is used in the Vacuum Transport Chamber. When a turbo pump is installed, the same dry pump may sometimes be used as a backing pump for the turbo.

Pump Vent Valve

For high vacuum systems using turbo pumps, the pumping system includes valves to permit venting and braking of each turbomolecular pump when it is to be stopped during evacuation and vent cycles. These valves, each connected directly to the vent port of its respective pump, are controlled by the host controller.

Cryogenic pumps are equipped with a regeneration kit, which contains vent and rough vacuum valves.

Chamber Isolation Valves

Isolation valves are used to isolate the chambers of the system from vacuum system components or other chambers. All control and monitoring of the isolation valves is done through the I/O communications link with the host controller.

Vacuum Isolation Valves

The Load Locks and Vacuum Transport Chamber vacuum systems include a valve located between the each chamber and its respective pumps. This valve is used to isolate the chamber from the module's vacuum system during chamber vent cycles. The valve also isolates the chambers when the vacuum system is not operating.

Transfer Isolation Valves

The Gemini 2 system is supplied with Transfer Isolation Valves (Slot Valves) located between the Transport Chamber and the Load Locks and Process Modules. Additional Transfer Isolation Valves (Atmospheric Doors) are located between the Load Locks and the JET EFEM.

These valves are used to isolate the Vacuum Transport Chamber from the environment inside the Process Modules during material processing. They also isolate chambers during vent cycles (load and unload operations).

Vacuum Slot Valves

Vacuum slot valves are located between the Process Modules and the Vacuum Transport Chamber. These valves isolate the Process Module to allow independent pumping/venting of the PM chamber and to prevent contamination of the environment within the Vacuum Transport Chamber by the hostile environmental conditions within the Process Modules during wafer processing.

Vacuum slot valves are located between the Load Locks and the Vacuum Transport Chamber. These valves allow the Vacuum Transport Chamber to maintain a vacuum while the Load Lock is vented to atmospheric pressure for wafer transfer into the EFEM.

Atmospheric Doors

The atmospheric door is located between the Atmospheric Front End and the Vacuum Load Locks. When the atmospheric door is closed and the vacuum slot valve is closed, the Load Locks can be pumped down to vacuum pressure or vented to atmospheric pressure.

Venting System

The G2 system uses two stage venting through a filter/diffuser. The Transport Chamber uses a fixed orifice vent valve, and a filter/diffuser which is either open or closed. Typically the Load Lock uses two-stage fixed orifice venting to minimize particle contamination.

To minimize particulate redistribution during the Load Lock chamber vent cycle, the variable flow venting employs a controlled flow of nitrogen to vent the evacuated chamber. The initial rate of flow of nitrogen into the chamber remains low. It is a molecular pressure regime with no boundary layer restricts particle movement. Venting remains slow until the chamber pressure reaches a predetermined set-point. After reaching the set-point, venting proceeds at a higher rate. This is a viscous pressure regime, boundary layer suppresses particle movement. Venting stops when the chamber reaches atmospheric pressure.

Vent System

The vent system provides less than 18 second vent cycling, depending on control configuration, for each Load Lock. Construction is of Electro-polished stainless steel tubing with welded fittings. A 0.012µm high purity Point-of-Use (POU) filter/diffuser membrane is installed on all vent inlet ports to provide true point of use filtration. A digital pressure gauge is provided to monitor vent gas pressure.

Purge System (Transport Chamber)

A Mass Flow Controller is located in parallel with the Transport Chamber vent line. Typically this is a 500 SCCM (N2 Calibration) device; however other flow ranges are available. This DeviceNet Mass Flow Controller may be used to control the flow of purge gas into the Transport Chamber as required.

Vacuum Measurement System

The vacuum measurement system permits the host controller to monitor and control pressure in each environmentally controlled chamber during evacuation and venting cycles. For each chamber, the system consists of a vacuum measurement controller and one or two vacuum gauges.

Vacuum Measurement Controller

The vacuum measurement system includes Vacuum Measurement Controllers located in the smart gauges that interpret signals from the gauges and communicate with the host controller.

Gauges

High vacuum systems using turbo pumps or cryo pumps require gauges to monitor the vacuum pressure from atmosphere down to the $5x10^{-8}$ Torr region. Two types of vacuum gauges are used on the Gemini 2 system: MicroIon and MiniConvectron. MiniConvectron gauges are heat transfer based and have a pressure range from atmospheric level down to 1 mTorr ($1x10^{-3}$ Torr). MicroIon gauges are hot cathode ion gauges which cover the pressure range from 50 mTorr down to $5x10^{-8}$ Torr. The ranges of both gauges overlap, so that the MicroIon gauges are turned on when the MiniConvectron indicates the pressure is below the maximum level for ion gauges. Each gauge contains a controller and uses DeviceNet for power and communications. All set-point relay signals are available through DeviceNet I/O points.

Convectron style gauges are installed on each Load Lock and on the Transport Chamber. A standard convectron gauge is also installed in the foreline manifold to measure backing vacuum.

Vacuum System Control

Vacuum System control resides with the host controller. During venting and evacuation cycles, each gauge monitors pressure levels in its respective chamber to ensure proper timing of vent and evacuate operations.

Vacuum/Vent System Operation

The Vacuum System is designed to distribute vacuum to the Load Locks and Transport Chamber. The Vent System is designed to deliver N2 to the G2 system for venting from vacuum to atmosphere.

Pressure Switch

The Pressure Switch on the N2 vent stick monitors the manifold pressure. The switch has an LCD display on the face of the gauge for setup and system troubleshooting. If a low pressure condition occurs, the switch may be used to send an alarm message to the host controller.

Diaphragm Valves

The diaphragm valves in the vent system are normally closed and require pneumatic pressure to open. The pneumatic line requires venting for the spring return to close the valve. These valves provide Fast Vent and Slow Vent (profiled) control for soft-start. Refer to Vent System on page 5-20.

Vacuum System, Typical Vent Cycle

Vent Transport Chamber

1. Shut the pump foreline valve.
2. Open the fast vent valve.
3. Close the vent when the chamber pressure gauge indicates pressure is equal to outside (atmospheric) pressure.

Vent Load Locks

1. Shut the pump foreline valve.
2. Open the profiled vent valve.
3. When the pressure is > 80 Torr (or any other specified crossover pressure), open the fast vent valve.
4. Close the vent valve when the chamber pressure gauge indicates pressure is equal to outside (atmospheric) pressure.

Vacuum System, Typical Vacuum Cycle

Pump Transport Chamber

1. Verify the vent valves are closed.
2. Open the rough valve.
3. Shut the rough valve when the Transport Chamber is at the desired vacuum level.

Pump Load Locks

1. Open the slow rough valve.
2. Open the fast rough valve at crossover pressure. This is at > 80 Torr, or at any other specified crossover pressure.
3. Close the slow and fast rough valves.

Gas System

The G2 system frame assembly includes a gas facilities interface. This provides a connection for the G2 system to nitrogen supplied by the facility. These connections are located on the roughing pipes.

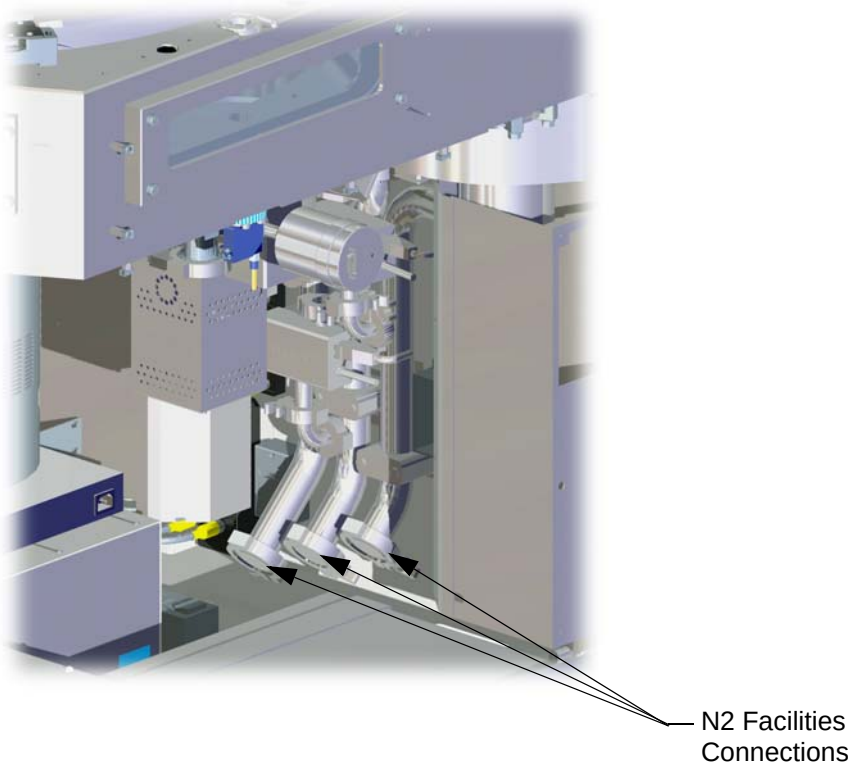


Figure 5-10: Nitrogen Facilities

The Nitrogen Facilities connection is located underneath the chamber. The gas pressure is monitored by a Digital Pressure Switch; refer to Pressure Switch on page 5-29. Refer to the Facilities Specifications on page 1-12, Vacuum/Venting Systems on page 5-18, and Pressure Switch on page 5-29 for operation. Refer to the Pneumatics Diagram supplied with the System Manual for additional information.

Cooling System

The G2 system frame assembly may include optional cooling water distribution. This provides a connection for the G2 system to water supplied by the facility for cooling of pumps and any other system components that require water cooling.

There are three water cooling systems within the G2 system. One is used to distribute cooling water to the Process Modules. Another cooling system is used for the pumps and any other system components that require water cooling. Another cooling system provides cooling of hot wafers before they are returned to the Atmospheric Front End for storage in a wafer carrier. Each of the cooling tasks is optional and may not be installed on a specific system.

Transport Chamber Heating System

An optional single zone vacuum chamber heating system may be provided. The heater system consists of the Heater Power Supply, Heater Cartridge assemblies, a Temperature Controller, a Thermal Switch, and a Thermocouple. This system is capable of heating the G2 Vacuum Back End chamber from 20 °C to 120 °C in 3 hours. Heating the Transport Chamber removes free water molecules attached to the chamber walls, allowing a lower base vacuum to be obtained. Thermal Blankets are available to minimize heat loss, providing a faster bake-out cycle.

NOTE: *Heating/cooling times are for the VBE chamber only and do not account for any additional equipment, such as process modules, connected to the chamber.*

WARNING

Extreme Temperature

Surfaces heated during system brake-out can reach temperatures of 121° C (250° F), which could cause burns when in contact with skin. Allow time for the system to cool before servicing or operating.

Once system heating has been started, all personnel must keep away from the system to avoid possible burn injury due to high temperatures.

Heater Power Supply

The rack-mountable Heater Power Supply is shown in Figure 5-11. The power supply provides power distribution to the Heater Cartridge assemblies and the Temperature Controller. The Heater Power Supply contains power control, switching, and over temperature cutout circuits. Maximum bake-out temperature is fixed by a safety thermo-switch on the chamber. The Temperature Controller uses a thermocouple to monitor the Vacuum Transport Chamber temperature, and a Thermal Switch provides over-temperature protection.

The Heater Power Supply uses a Watlow Series 96 Temperature Controller, shown in Figure 5-14, to regulate the Vacuum Transport Chamber temperature. The 24V controller has 1 input and 3 output software interfaces to the heater system, using a DeviceNet line to the DeviceNet master. The Temperature Controller is mounted in the Lower Facilities Bay on the G2 Vacuum Back End frame.

The Main Heater Cable connects the Heater Power Supply to the Main Heater Harness. The Main Heater Harness branches power to the Heater Cartridge assemblies and the Temperature Controller. The Main Heater Cable has 34 conductors of 18 AWG, which can carry a maximum current load of 7 amps per heating element.

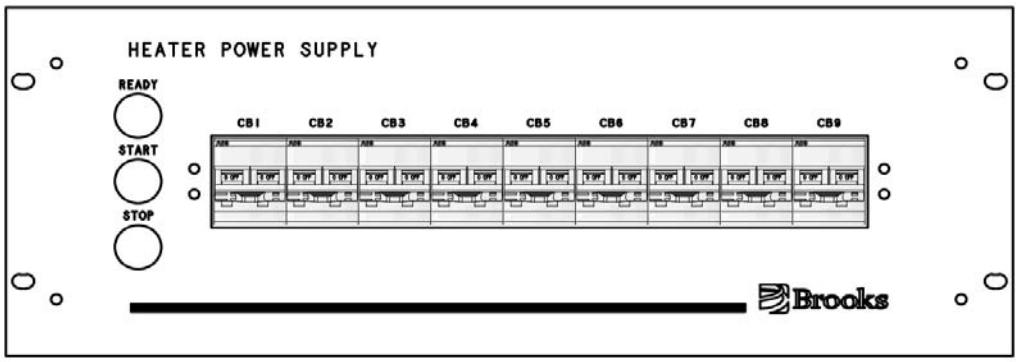


Figure 5-11: Heating System Power Supply

Heaters

Up to eight Heater Cartridge assemblies (1200 W @ 240 VAC) are positioned around the bottom of the Transport Chamber (TC), as shown in Figure 5-12. Each Heater Cartridge is made into a subassembly for quick replacement as shown in Figure 5-13. The Temperature Controller uses a thermocouple attached to the TC to monitor the TC temperature and a thermal switch to provide over-temperature protection.

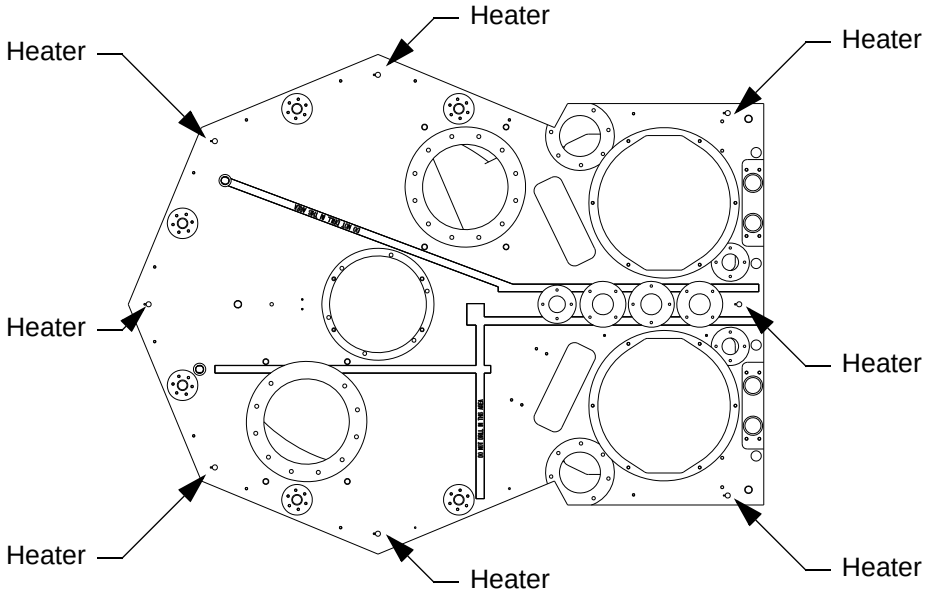


Figure 5-12: Chamber Heating System, Typical

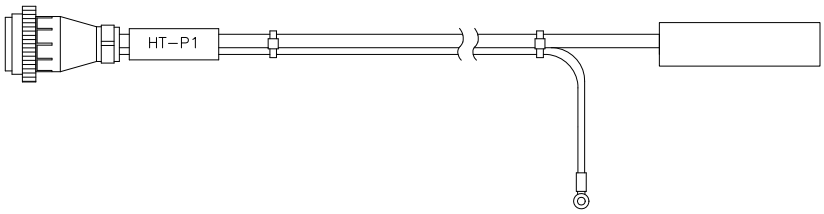


Figure 5-13: Cartridge Heater Assembly

Temperature Controller

The Temperature Controller is a dual display controller that offers many advanced functions. There is one universal input, a second auxiliary input, and four outputs. The controller provides fast 10 Hz sampling, variable time base burst firing outputs, NEMA 4X front panel and 0.1% calibration accuracy.

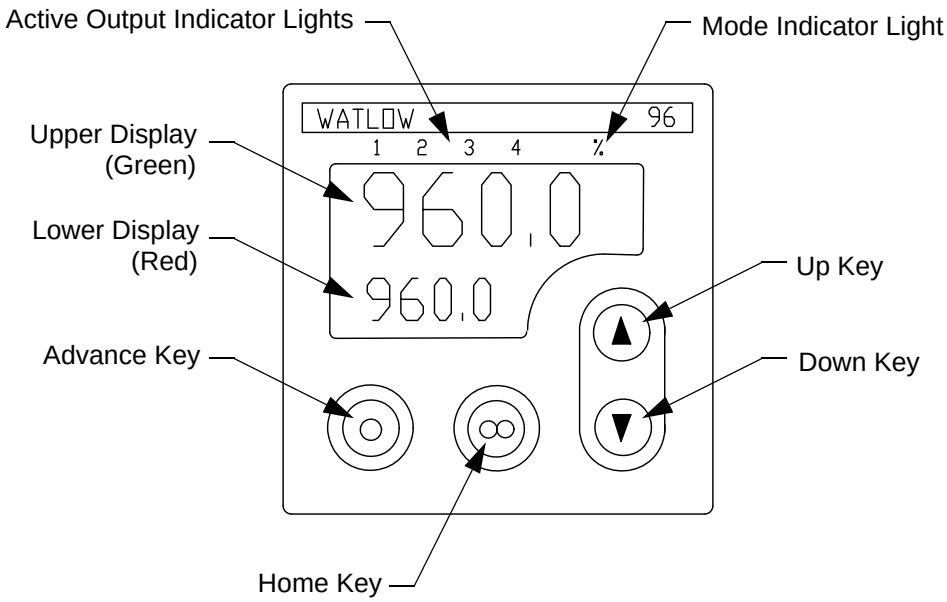


Figure 5-14: Temperature Controller

The G2 exceeds the CENELEC safety standards by implementing Ground Fault Protection for systems where water is present for cooling. A GFI fault trips the main circuit breaker, shutting down power to all systems. Refer to the Heater Power Supply on page 5-24, Temperature Controller on page 5-26, and the Heater Subsystem drawings for more information.

Thermal Blankets

To ensure quick heating with little heat loss and to protect service personnel, Thermal Blankets are available. These provide a custom fit around the top and sides of the G2 Vacuum Back End chamber, lid, and lid lifter. These blankets must be in place before a bake-out process begins. The blankets may be left in place during normal operation of the G2 system, as they do not interfere with operation.

Ethernet Switch

Table 5-2: Mini Hub Connections

Label	Description	Connector Type
J1	not used	-
J2	Vacuum Robot	Female DB-50
P3	Interlocks (to Safety Hub)	Male DB-25
J4	Station material sensors	Female DB-25
J6	Expansion	Female DB-25
AUX POWER	24 VDC @ 5 A to aligner	Female DB-13W3
MAG 7 POWER	24 VDC @ 15 A to robot	Female DB-9W4
AC IN	200 - 240 VAC @ 3.5 A	Male IEC 320

The Ethernet Switch provides a single point of connection for Ethernet communication. The switch is mounted on the Vacuum Transport Chamber frame under the chamber and provides distribution for up to fifteen Ethernet devices. LEDs on the switch indicate the status of each Ethernet channel. The switch is plugged into the Power Strip under the G2 chamber.

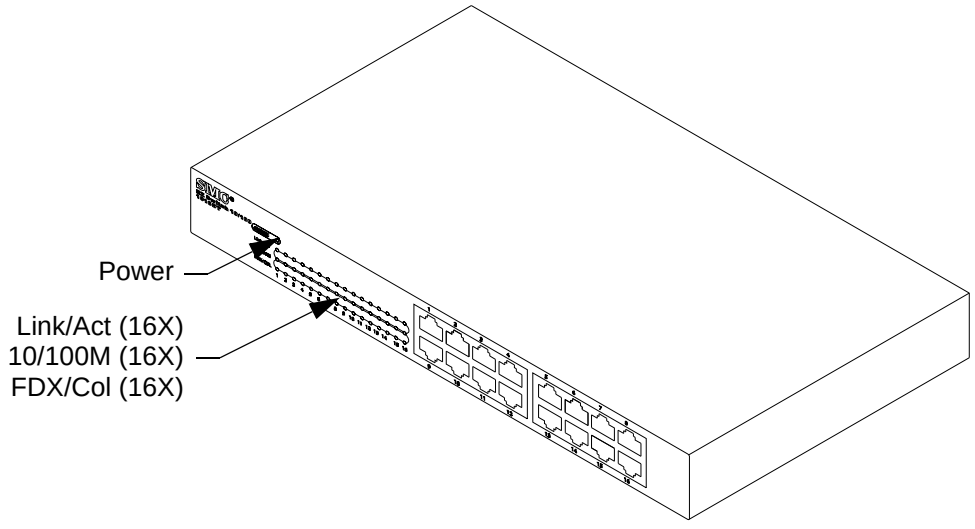


Figure 5-15: Ethernet Switch Module - Controls and Indicators

Switch Operation

The devices connected to the Ethernet Switch are accessed through standard Ethernet communications to the specified IP Address for each device connected to the switch. LEDs on the switch indicate the status of each Ethernet channel.

Refer to the System Block Diagram supplied with this manual for additional information, Table 5-3 for pinouts, and Table 5-4 for controls and indicators.

Table 5-3: Ethernet Switch Module Connections

Label	Description	Connector Type
Ethernet (x16)	10/100 Mbps MDI-X	RJ-45
PWR	110-240 VAC	Male IEC 320

Table 5-4: Ethernet Switch Module - Controls and Indicators

Name	Type	Function
Power	Green Lamp	Power Normal condition: ON
10/100M (16X)	Green Lamp	Connection Speed ON: 100 Mbps OFF: 10 Mbps
Link/Act (16X)	Green Lamp	Link Status/Activity ON: Port connected Off: Port not connected Blink: Port active
FDX/Col (16X)	Green Lamp	Duplex Mode/Collisions ON: Full duplex Off: Half duplex Blink: Data transfer packet collisions

Automatic Wafer Centering

The optional CenterSmart™ Automatic Wafer Centering (AWC) system located at each process module opening (facet) is used to correct for off-center wafers when placing wafers into the station. The AWC system is able to correct for wafers with maximum deviation of 6 mm off-center. The robot can then properly center the wafers when they are placed.

NOTE: *CenterSmart is only used by the robot during PLACE, XFER, and SWAP operations.*

Each AWC sensor uses two low power laser beam-break sensors to determine the location of the wafer edge, an example of which is shown in Figure 5-16. The two receivers are mounted on the bottom of the transport chamber. The two laser emitters are mounted on the top of the chamber.

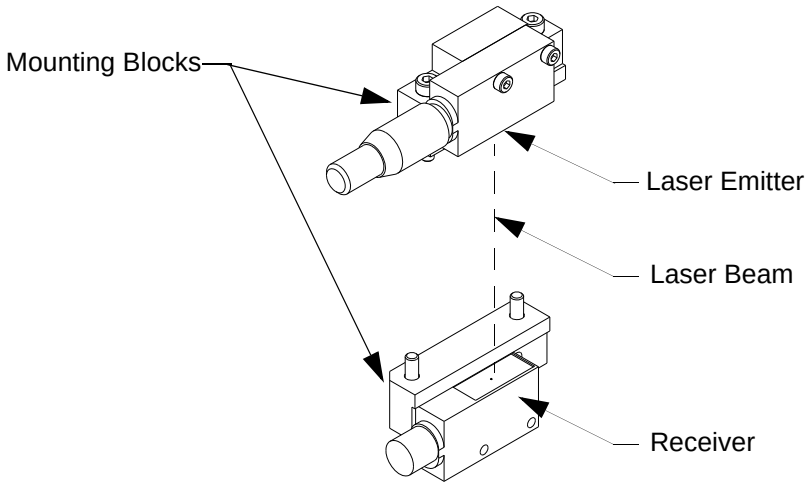


Figure 5-16: Wafer Centering Sensor

The AWC sensors at each active process module opening is calibrated using a Calibration Wafer. The calibration wafer is used to determine the “ideal center” of a wafer on the end effector. The calibration data is then stored and used for comparison with the data from the actual wafer as it is passed under the AWC during a PLACE, XFER, or SWAP operation. The robot determines the wafer’s deviation from the ideal center previously determined and performs an offset place of the wafer in R and T, so that the wafer is centered in the station. The quality of the correction performed depends on the quality of the station teaching. The AWC sensors must be re-calibrated after re-teaching a station.

Pressure Switch

Pressure Switches on each G2 system are used to monitor the pneumatic and nitrogen pressure. Both the pneumatic Pressure Switch and the nitrogen Pressure Switch are connected to DeviceNet through an I/O Block. The signals from these switches are sent to the system controller for monitoring the status of the air pressure within the Pneumatic System and the status of the nitrogen pressure within the Vent System.

The Pneumatic Pressure Switch is mounted in the Pneumatic Manifold at the facilities connection for compressed air; refer to Gas System on page 5-23. The Nitrogen Pressure Switch is mounted on the Vent Manifold at the facilities connection for nitrogen; see Gas System on page 5-23.

Refer to the System Block Diagram and Vacuum and Vent Diagrams supplied with this manual for additional information.

Nitrogen Switch Setup and Operation

The nitrogen switch is set at the factory for proper operation.

Pneumatic Switch Setup and Operation

The pneumatic switch is set at the factory for proper operation.

Connections, Controls, and Indicators

Figure 5-17 shows the location of all connections, controls, and indicators found on the N2 Pressure Switch. Table 5-5 provides descriptions of the user accessible controls and indicators on the switch.

The G2 system uses Digital Pressure Switches for monitoring the pressure of facility-supplied N2 and Air. Figure 5-17 shows the location of the controls and indicators on the N2 Pressure Switch; Table 5-5 shows their function.

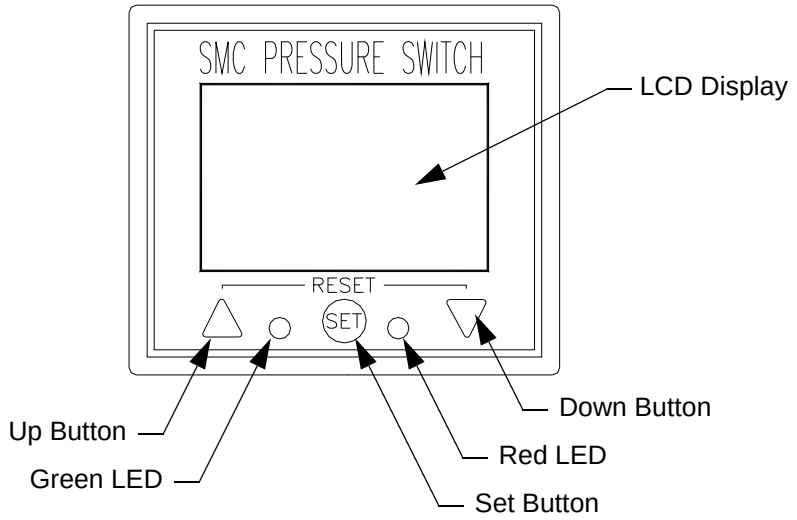


Figure 5-17: N2 Pressure Switch - Controls and Indicators

Table 5-5: N2 Pressure Switch Controls and Indicators

Name	Type	Function
LCD Display	LCD Display	Displays pressure and programming.
Green LED	Green Light	Switch status Normal condition: ON
Red LED	Red Light	Fault indicator Normal condition: OFF Fault condition: Blinking - error code displayed on LCD Display
Up Button	Momentary Push-button Switch	Increases display units
Set Button	Momentary Push-button Switch	Enters user set configuration information
Down Button	Momentary Push-button Switch	Decreases display units

Ethernet

Ethernet communication allows the G2 system to send and receive data faster than with serial communication. Ethernet communication allows multiple devices to communicate over the same cable through the use of a network switch.

Ethernet Implementation

Each device connected to Ethernet has its own address. Refer to the System Block Diagram supplied with this manual for identification of all factory-configured Ethernet addresses. For additional information on Ethernet IP addresses, refer to the Software Programmer's Reference.

Ethernet Switch

The Ethernet Switch provides a single point of connection for host controller communication. Each device using Ethernet for communication is connected to the Ethernet Switch.

Start-up

The G2 system is started by applying power and plant facilities as specified in Chapter 3: *Installation*. Once this is done, the G2 system is ready to operate and accepts commands over the communications line.

NOTE: *All switch settings, communications connections, power connections, and facilities connections should be made before power is applied.*

This section describes the recommended procedure for powering up the G2 System under normal circumstances.

1. Verify that all of the installation procedures outlined in Chapter 3: *Installation* have been completed.

2. Turn on the G2 system following the Power-up Sequence on page 3-21.

   If the initialization sequence executes without error, then all the components are referenced, and all the components are communicating successfully.

3. Power up the Controller located in the EFEM.

4. Once all systems are up and running properly the host controller typically instructs the G2 system to begin pumping down the Vacuum Transport Module chamber.

Normal Running

The exact usage of the G2 must be determined by the user. Each component has been described in this manual with the intention of providing the user with the knowledge to use this tool in the most appropriate manner for their individual processes. During normal operation, once the Transport Module chamber has been pumped down, proceed as directed by the Fusion Compact Controller.

Typical VBE Operating Sequences

Pick

The robot picks material from the specified slot in the specified station. If no slot is specified, Slot 1 is assumed.

1. The host controller checks to verify that there is material present in the station's slot.
2. The robot rotates to the specified station.
3. The robot checks the station sensors to verify that there is no material on the end effector.
4. The host controller opens the slot valve after checking that the pressures are equal between the two chambers.
5. The robot extends, picks the material, and retracts.
6. The robot checks the station sensors to verify that there is material present on the end effector.
7. The host controller checks to verify that there is no material in the slot.
8. The slot valve closes.

Place

The robot places material to the specified slot in the specified station. If no slot is specified Slot 1 is assumed.

1. The host controller checks to verify that there is no material in the station's slot.
2. The robot rotates to the specified station.
3. The robot checks the station material sensor to verify that there is material present on the end effector.
4. The host controller opens the slot valve after checking that the pressures are equal between the two chambers.
5. The robot extends, places the material, and retracts.
6. The robot checks the station material sensor to verify that there is no material on the end effector.

7. The host controller checks to verify that there is material present in the slot.

8. The slot valve closes.

Safe Shutdown

The following shutdown procedure is used to remove power from the G2 in an orderly manner, and to place the robots and all other components within the system in a safe condition. This procedure is used to prepare the system for repair, removal, or maintenance.

NOTE: *When the host controller is to be shut down, the G2 is shutdown first.*

NOTICE

This procedure completely removes the power source and all other facilities supplied to the G2 and provides guidelines for lockout/tagout. This procedure is NOT the same as an EMO circuit or other safety interlock.

1. Complete all wafer transfers. Only the Load Port Modules are allowed to contain wafers. If this is not possible, ensure at a minimum that no wafers are left on the end effectors.

2. If permanent storage of values is desired for robots using WAVE II software, store the values using appropriate STORE commands for each robot, load port, and aligner.

   NOTE: *WAVE II SET commands only load parameter values into RAM and reset to default values if power is removed without the values being stored.*

3. Be sure that all robots are in the Home position with the arm(s) retracted.

4. Be sure that all chambers of the system are at atmosphere.

5. Be sure that all Load Port Modules are closed.

6. Be sure that all other material handling modules are in their Home position.

7. Turn off power to each robot by turning off the power switch on the Controller or power supply for each robot.

8. Turn off the air supply from the facility to the G2 system.

9. Turn off the nitrogen supply from the facility to the G2 system.

10. Turn off the vacuum supply from the facility to the G2 system.

11. Turn off the water supply, if used, from the facility to the G2 system.

12. Turn off the main power disconnect on the Power Distribution Unit in the JET EFEM for the G2 system.

13. Isolate all potential energy on the Gemini 2 system using Lockout/Tagout procedures as defined by the facility.

    These procedures may include an energy isolating device to prevent the controller from being plugged into the facilities power outlet, along with information about the purpose of the lockout and the person responsible. If no such procedures exist, follow the guidelines provided in Laser Hazards on page 2-17.

14. Isolate all potential energy from all vacuum supply lines using Lockout/Tagout procedures defined by the facility.

    These procedures may include an isolating device to prevent the supply lines from being connected into the facilities supply, along with information about the purpose of the lockout and the person responsible. If no such procedures exist, follow the guidelines provided in Laser Hazards on page 2-17.

NOTE: *This procedure only shuts down facilities to the Gemini 2 system and its subsystems. Any user Process Modules or other equipment remain powered up.*

6 Preventive Maintenance

Overview

This chapter provides the schedule and procedures for routine preventive maintenance of the Gemini 2 system. It is recommended that the preventive maintenance procedures and schedule be followed to extend the operating life of the G2 system and to minimize unscheduled downtime. If additional procedures are required, they will be supplied along with their maintenance schedules by Brooks Automation.

All Preventive Maintenance procedures and schedules provided here assume that the Brooks Gemini 2 system is operating in a clean, dry, inert environment. Any change from this basic environment will affect the scheduling of PM and may also require that additional PM procedures be performed. Adjust the Preventative Maintenance Schedule as appropriate to account for any deviations from this environment.

NOTE: *Brooks Automation offers training for troubleshooting and repair of the Gemini 2 system. Only qualified, properly trained persons should perform any maintenance or repair procedures. Damage resulting from improperly performing a procedure is not covered under warranty or service agreements.*

CAUTION

Unauthorized Service

Personal injury or damage to the G2 system may result if it is operated or serviced by unauthorized personnel.

Only qualified personnel are allowed to transport, assemble, operate or maintain the G2.

Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.

Read and understand Chapter 2: *Safety* before performing any procedure.

Parts

Brooks Automation can provide all parts required for Preventive Maintenance. For a list of these parts, contact Brooks Automation Technical Support at 978-262-2900.

Preventive Maintenance Schedule and Procedures

The following maintenance schedule and procedures provide the information required for standard user maintenance of the G2 system. Table 6-1 is provided as a quick reference for all scheduled maintenance and how often it must be performed.

Refer to the individual component manuals and any separate preventative maintenance procedures provided with the individual system components for additional maintenance procedures.

WARNING

Tip Hazard

Moving the Atmospheric Front End or Load Port Modules without a hoist or when not attached could cause a tip hazard which may cause death or serious injury.

- Do not attempt to move the Gemini 2 without the use of a fork lift or a hoist.
- Roll on smooth floors only.

WARNING

Potential Robot Motion

The robot has the potential for automatic motion that may cause serious injury. Each motor has 9 N-m of potential torque. The following systems have the possibility of automatic movement:

Atmospheric Robot
Atmospheric Aligner
Load Port Modules
Vacuum Robot
Batch Load Locks
Atmospheric Doors
Vacuum Slot Valves
Isolation Valves

- Avoid working inside the robot path or under extended robot arms.
- Use physical barriers to prevent injury when working in the robot path.

NOTE: *When equipment is off and power is secured per the facility's lockout/tagout procedure, the Gemini 2 system is classified as a Type 1 hazard category. When equipment is energized, live circuits covered, and work performed remotely, the G2 system is classified as a Type 2 category (refer to Electrical Hazards on page 2-16).*
All power to the unit must be disconnected per the facility's lockout/tagout procedure before

servicing to prevent the risk of electrical shock and injury due to moving mechanisms. If no such procedures exist, follow the guidelines provided in Laser Hazards on page 2-17. Before connecting or disconnecting main power to the Gemini 2, ensure all circuit breakers on the G2 and any related equipment are in the OFF position.

Table 6-1: Preventive Maintenance Schedule

Component	Maintenance Action	Frequency	Page #
All Material Supports	Material Support (Pad) Inspection	3 months or as required	
	Pad Cleaning Procedure	3 months or as required	
Gemini 2 System	Cleaning Procedure	12 months or as required	
	O-Ring Removal/Replacement/Cleaning	Frequency stated in procedure or as required	
	Verifying Flatness of Robot's End Effector	12 months or as required	
	Adjusting the Robot's End Effector(s)	12 months or as required	
	Teaching Procedures	12 months or as required	4-9
Batch Load Locks	Lift Tube Bellows Cleaning	12 months	6-7
	Drive Belt Replacement	12 months	6-10
	Wafer Sensor Adjustment for the Batch Load Lock	12 months or as required	
Vacuum Pumps	As specified for pumps being used Refer to the Pump User Manual		
Gauges	As specified for gauges being used Refer to the Gauge User Manual		
MagnaTran 7	Inspect every 6 months Refer to the Robot User Manual		
Atmospheric Aligner	Inspect every 6 months Refer to the Aligner User Manual.		
Atmospheric Robot	Clean Arm and End Effector every 6 months Refer to the Robot User Manual.		
	Inspect every 6 months Refer to the Robot User Manual.		

Table 6-1: Preventive Maintenance Schedule (Continued)

Component	Maintenance Action	Frequency	Page #
Load Port Modules	Inspect every 6 months Refer to the appropriate Vision LPM User Manual.		
Fan Filter Unit	Inspect every 6 months Refer to the FFU User Manual.		

Lift Tube Bellows Cleaning

To clean particles or contamination from the bellows that isolates the Batch Load Lock chamber from the VCE 6 Drive mechanism, follow this procedure for removal and replacement.

Tools and Equipment

- Hex wrenches: 2.5 mm, 3 mm, 5 mm
- Phillips screwdriver
- A computer running a terminal emulator or a dumb terminal

Maintenance Strategy

The Lift Tube Bellows is accessible after removing the Batch Load Lock cover and the wafer support assembly. Turn off and disconnect all power, communications, and air connections as detailed in Safe Shutdown on page 5-33.

NOTICE

The Gemini 2 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

Dispose of cleaning cloths per the facility's procedures and local regulations.

Removal

1. Isolate the Batch Load Lock from the system using the slot valves and atmospheric doors, and bring the chamber to atmospheric pressure.

2. Command the Batch Load Lock to slot 3. This provides enough clearance on the top and bottom of the bellows to access the mounting screws.

3. Remove the Batch Load Lock cover.

4. Remove the wafer support assembly.

5. Remove power from the Batch Load Lock drive. Remove the drive cover using a Phillips screwdriver to remove the four mounting screws.

6. From beneath the chamber, use a 3 mm hex wrench to remove the four M4 screws holding the bellows to the chamber support flange near the top of the drive.

7. Inside the chamber, use a 2.5 mm wrench to remove the four screws which fasten the feed-through cover plate to the platform support flange. Remove the cover plate, revealing six screws.

8. Mark the orientation of the platform support flange, so it can be re-assembled in the same position. Use a 5 mm hex wrench to remove the six M6 screws securing the platform support flange to the bellows top weldment.

   NOTE: *Do not remove the vented screw in the center of the feed-through.*

9. Carefully lift off the platform support flange. Mark the wires connected to the underside of the feed-through so they can be re-attached to the same pins.

10. Disconnect the cassette present and arm/platform sensor electrical connectors from the bottom of the feed-through.

NOTICE
Do not damage the o-ring seals on the bottom of the flange.

11. Note the orientation of the bellows mounting holes so it can be re-mounted in the same position. Lift the bellows out of the recess in the chamber support flange.

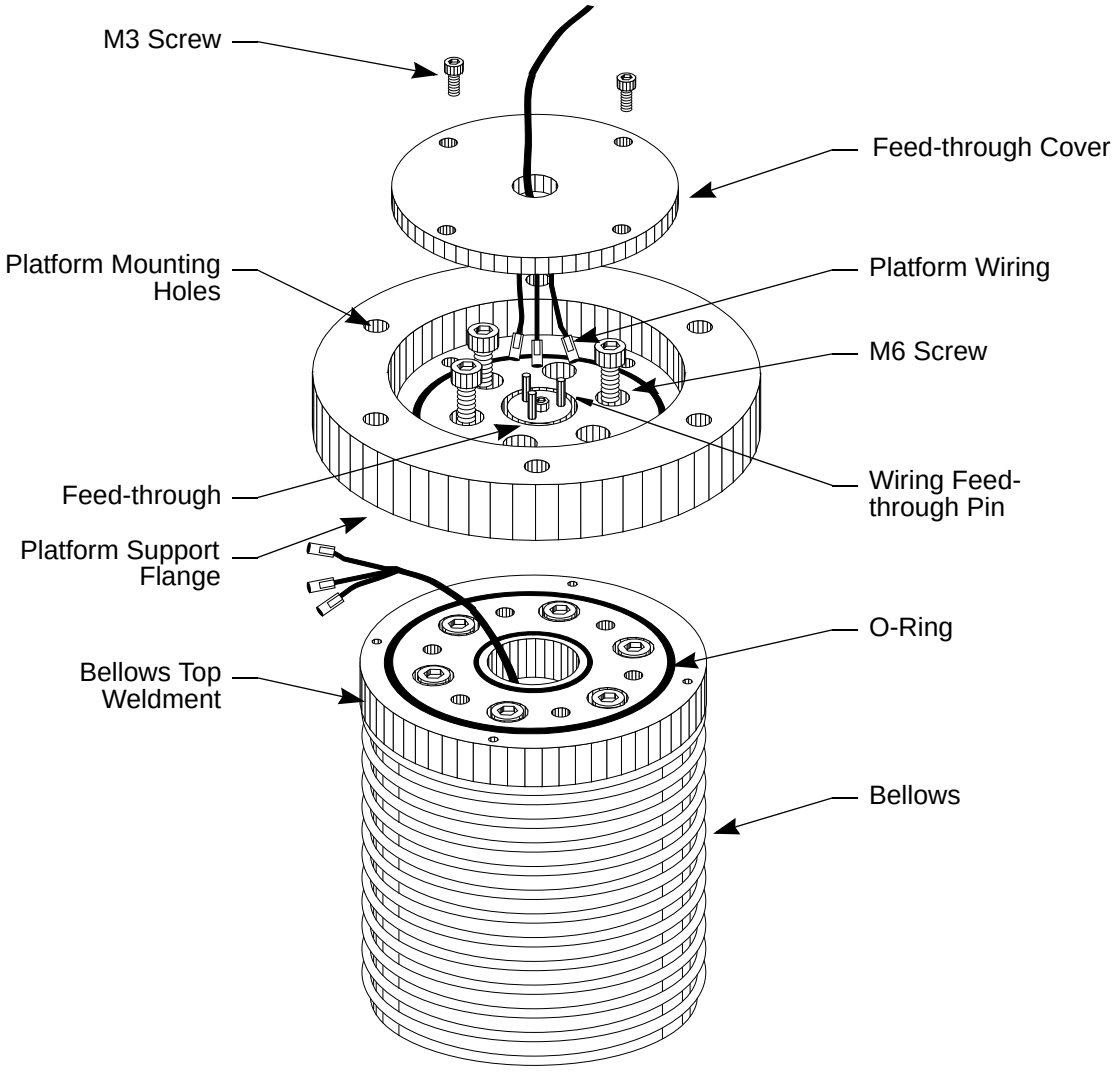


Figure 6-1: Platform Support Flange and Bellows

Installation

1. Inspect the sealing surface inside the top hole in the chamber support flange which accepts the bellows. Clean the surface, if necessary. Clean the o-ring on the bottom weldment of the bellows.

2. Carefully lower the bellows over the lift tube into the chamber support flange. Feed the wires through the center hole of the bellows top weldment.

3. Align the six screw holes in the top of the bellows weldment with those on the lift tube as they were on disassembly. This will align the four mounting holes on the bottom of the bellows.

NOTICE

Be careful not to damage the o-ring on the bellows weldment or the sealing surface at the bottom of the chamber support flange.

4. Using a 3 mm hex wrench, install the four M4 screws that secure the bellows to the chamber support flange underneath the chamber.

5. Using a 3 mm hex wrench, install six M4 screws to secure the bellows weldment to the top of the lift tube.

6. Re-attach the wiring to the bottom of the feed-through on the platform support flange according to the markers applied on disassembly.

7. Place the platform support flange on top of the bellows weldment, and install six M6 screws to secure it to the bellows weldment.

8. Install the feed-through cover in the top of the platform support flange with four M3 screws.

9. Replace the wafer support assembly.

10. Mount the cover on the elevator drive.

11. Check and re-align the Batch Load Lock platform.

12. Replace the Batch Load Lock cover.

Drive Belt Replacement

The motor for the VCE 6 Drive used in the Batch Load Locks is connected to the lead screw with a heavy duty toothed rubber belt. It is designed for long reliable service, but replacement at controlled maintenance intervals will prevent unscheduled downtime due to normal belt wear.

Tools and Equipment

- Hex wrenches - 3 mm, 4 mm, $^{7}/_{64}$ inch
- #2 Phillips screwdriver
- Drive belt

Maintenance Strategy

The Drive Belt is accessible after removing the VCE 6 Drive cover, access into the vacuum environment is not required. Turn off and disconnect all power, communications, and air connections as detailed in Safe Shutdown on page 5-33.

NOTE: *When equipment is off and power is secured per the facility's lockout/tagout procedure, the Gemini 2 is classified as a Type 1 hazard category. When equipment is energized, live circuits covered, and work performed remotely, the G2 is classified as a Type 2 category.*

All power to the unit must be disconnected per the facility's lockout/tagout procedure before servicing to prevent the risk of electrical shock and injury due to moving mechanisms. If no such procedures exist, follow the guidelines provided in Laser Hazards on page 2-17. Before connecting or disconnecting main power to the Gemini 2, ensure all circuit breakers on the G2 and any related equipment are in the OFF position.

Procedure

1. Remove power from the VCE 6 Drive

2. Remove the cover panels from the drive with a Phillips screwdriver. Refer to Figure 6-2.

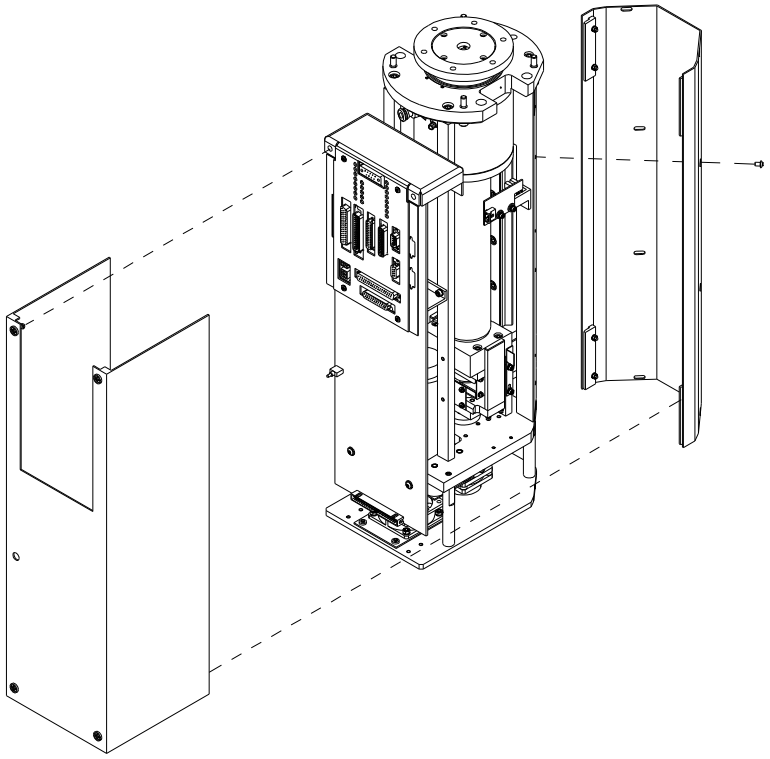


Figure 6-2: Batch Load Lock Drive Cover Removal

3. Using a 3 mm hex wrench, remove the two socket head cap screws that hold the control board to the standoff on the bottom board mounting brackets.

4. Using a 4 mm hex wrench, remove the four low-profile socket head cap screws that hold the drive lower plate to its standoffs.

5. Remove the lower drive plate and position it out of the way without damaging the fan and brake wires.

6. Locate the shaft brake collar on the bottom end of the lead screw. See Figure 6-3. Loosen the collar using a $^{7}/_{64}$ inch hex wrench.

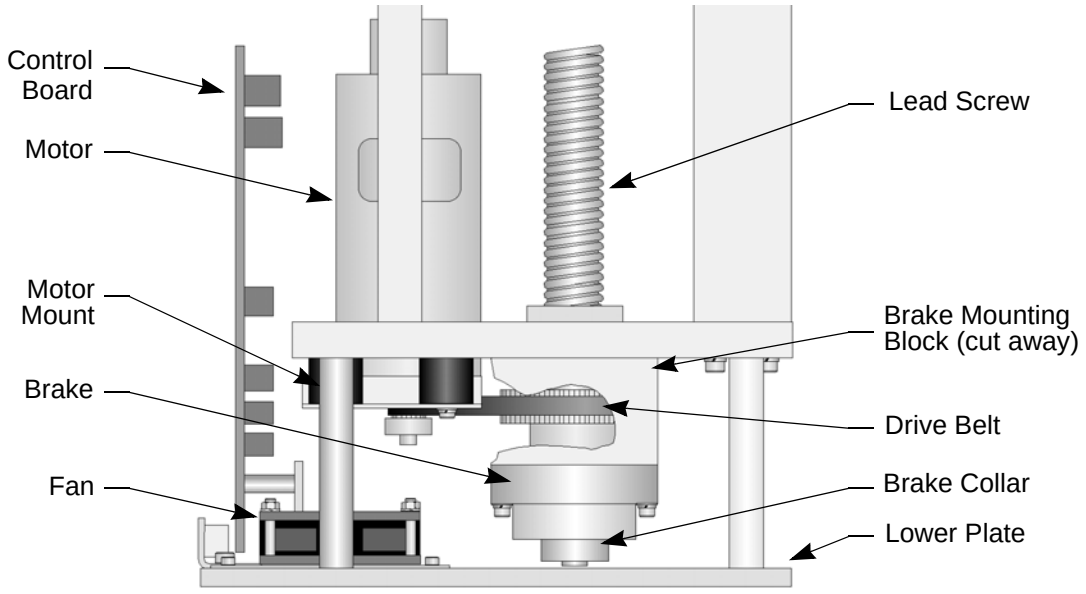


Figure 6-3: Drive Belt Replacement

7. Remove the shaft brake, collar, and brake mounting block as one unit by removing (with a 3 mm hex wrench) the four long socket head cap screws which attach the brake mounting block to the lead screw bearing plate.

   NOTE: *Do not remove the black screws securing the brake to its mounting block.*

8. Using a 4 mm hex wrench, loosen the four low profile socket head cap screws which secure the motor mounting bracket to its black rubber vibration isolators. See Figure 6-3.

9. Slide the motor assembly toward the lead screw to loosen the belt. Remove the old belt from the motor and lead screw pulleys.

10. Install the new belt. Slide the motor assembly back until the belt is snug, but not in tension.

11. Tighten the four motor mounting bracket screws.

12. Slide the brake assembly onto the end of the lead screw. Replace and secure the four long screws in the brake mounting block. Then tighten the brake collar clamp.

13. Replace the drive lower plate and control board mounting screws.

14. Apply power to the VCE 6 Drive and cycle it to check operation.

WARNING

Moving Mechanisms

Moving mechanisms do not have obstruction sensors and can cause serious personal injury.

Be aware that whenever power is applied that the possibility exists of automatic motion that can cause serious injury or death.

15. Remove power and replace the drive cover panels.

16. Apply power.

Wafer Sensor Adjustment for the Batch Load Lock

The following procedure is used to adjust the Wafer Slide Out (WSO) sensors in the G2 26-wafer Batch Load Locks.

Required Tools

- Computer with Brooks Automation VisComm software version 2.2 or later, and a serial cable.
- Metric Hex wrench set

Replacement Strategy

NOTICE

The Gemini 2 may be used in an process modules where hazardous chemicals are used, and surfaces may be contaminated by those chemicals. Refer to the facility's Material Safety Data Sheets for those chemicals to determine proper handling and follow the facility's procedures to be sure that the environment is safe.

NOTE: *When equipment is off and power is secured per the facility's lockout/tagout procedure, the Gemini 2 is classified as a Type 1 hazard category. When equipment is energized, live circuits covered, and work performed remotely, the G2 is classified as a Type 2 category (refer to* *Electrical Hazard Classifications on page 1-17**).*

Procedure

1. Remove all wafers from the Batch Load Lock.

2. With the Batch Load Lock at atmosphere, loosen the 6 lid mounting screws, and center the lid rotational movement allowed by the clearance holes.

3. With the Batch Load Lock under vacuum, tighten the 6 lid mounting screws and the top and bottom chamber mounting screws.

4. Remove laser sensor covers from the lid assembly. See Figure 6-4.

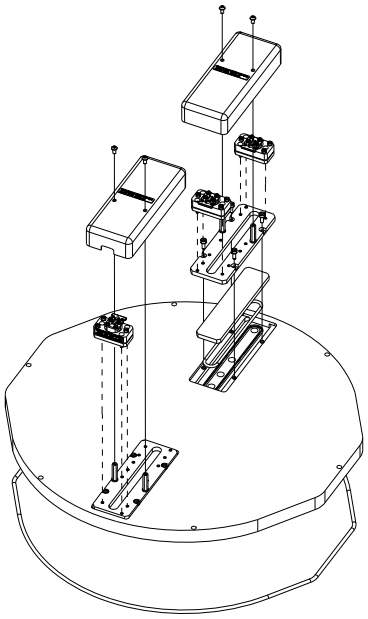


Figure 6-4: Batch Load Lock WSO Top

5. Disconnect WWSO and WSO Extension cables from the wafer-slide-out sensor PCBs, underneath the Load Lock bottom chamber. See *Figure 6-5*.

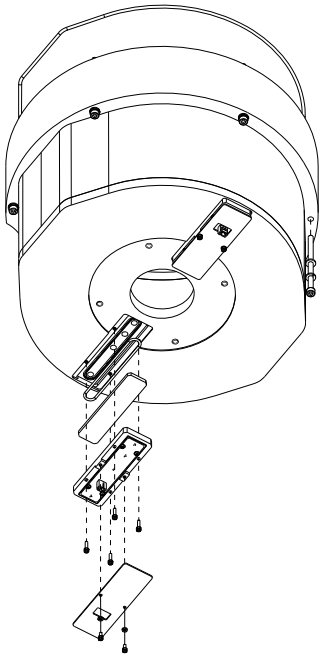


Figure 6-5: Batch Load Lock WSO Bottom

6. Remove the two, card covers and two WSO PCBs from the bottom chamber assembly and set them aside.

Initial Adjustment

1. Place a sheet of white paper 3 to 30 inches below the window in the bottom chamber to see the laser beam spot shining through the window.

2. There are 3 adjusting screws for each laser assembly. Adjust the 3 laser mount adjusting screws on the top chamber lid assembly, until the bright laser beam spot (approx. 3mm dia.) exits the opposite hole in the bottom chamber, and reflects off the white paper.

CAUTION

Laser Radiation

Laser radiation may cause serious eye injury.

- Know the power and hazard level of all lasers.
- Avoid exposure to laser hazards.
- Do not look directly at or into the laser beam (no matter what Class of laser).
- Follow any posted laser warnings or labels.
- Do not attempt to service, repair, or remove the protective housing of the laser device.

Check that the beam is adjusted directly through the hole and not a diffuse reflection off the side of the hole, or the chamber wall. Looking through an adjacent sensor hole in the top lid when adjusting the laser beam helps in directing and adjusting the beam.

Adjust each screw back and forth, watching the laser beam spot on the white paper, and adjust the screw so the spot is centered through the corresponding hole in the bottom chamber.

3. Repeat this procedure for each laser.

4. Install the wafer-slide-out detector PC boards to the bottom chamber window clamps.

5. Install the WSO PCB covers to the bottom chamber window clamps.

6. Connect WSO cable to detector board #1, on the atmosphere side (Razor ATR robot side) of the bottom chamber.

7. Connect WSO Extension cable, to detector board #2, on the vacuum side (MagnaTran 7 side) of the bottom chamber.

Final Adjustment

1. Disconnect the G2 system serial line from the Batch Load Lock Drive's serial port (P6, COM 0).

2. Connect the serial port from the laptop computer to the serial port (P6, COM 0) of the Batch Load Lock Drive.

3. Use the laptop computer & VisComm software to request the firmware configuration with the command:

```
R,CONFIG,VCE,APPLIC
```

The correct application name is: VCE6_GX. If this is displayed, go to the next step. If it is not set correctly, refer to *Wave II Software Manual* for exceptions.

```
CONFIG,VCE,APPLIC,VCE6_GX.
```

And again request the application as stated previously, to confirm that it is correct.

4. The WSO 1 & 2 outputs are visible on the Batch Load Lock Drive I/O panel. An illuminated red LED indicates a clear path for the wafer sensor laser beam. If the LED is off, the beam is either blocked or misaligned. Fine adjust the 3 adjusting screws for each laser assembly, adjusting each screw back & forth, watching the corresponding LED indicator on the Batch Load Lock Drive I/O panel, leaving each adjusting screw midway in the range of adjustment.

Test

1. Home the VCE 6 Drive with the command:

```
A,HM
```

Press enter to clear the busy response.

2. Use the laptop computer & VisComm software to enable the wafer-slide-out interlocks with the command:

   ```
   S,WS,Y
   ```

3. Use the VisComm software system controller window to run a script file to continuously cycle the wafer support assembly from slot 1 to slot 26, and run the script file for 15 cycles, to confirm no WSO sensor stops cycling under vacuum.

4. Vent the lock while continuing to cycle 15 more times, to confirm no WSO sensor stops cycling at atmosphere.

5. Disconnect power from the lock.

6. Reinstall the two covers to the lid of the Batch Load Locks. See Figure 6-4

7. Remove the laptop computer serial cable from the Batch Load Lock Drive's serial port (P6, COM 0).

8. Reconnect the G2 system serial cable to the Batch Load Lock Drive's serial port (P6, COM 0).

7 Troubleshooting and Repair

Overview

Troubleshooting is provided to the Field Replaceable Unit (FRU) level. Once the FRU has been identified a replacement may be ordered from Brooks Automation. The replacement FRU is supplied with the appropriate remove/replace procedure.

Be sure that only trained, qualified persons attempt to troubleshoot the G2 system. Brooks Automation provides training in the troubleshooting and repair of the G2 system.

Initial Troubleshooting

Troubleshooting tables in this section help the user determine and resolve the problems within the Gemini 2 system. If a specific problem is suspected refer to that problem in Table 7-1. If the problem has not been identified review each step of Table 7-1. If the problem is not covered here, refer to the individual User Manuals for the components within the system.

This section provides a list of commonly encountered problems and the appropriate solution for each problem. Refer to the individual component manuals for additional troubleshooting procedures.

Table 7-1: Initial Troubleshooting

Problem	Corrective Action
Unexpected movement of modules	See Mechanical Troubleshooting on page 7-2.
Power lights do not turn on	See Power Distribution Troubleshooting on page 7-3.
System powered, but not all modules are on	
System powered but no response to host controller	See Communications Troubleshooting on page 7-3
System powered but no response from components within system	
Load Port Modules not operating	See Material Transport Troubleshooting on page 7-4.
Unexpected movement of modules	
Material slipping or left on end effector	
Load Port Modules not operating	See Load Port Module Troubleshooting on page 7-5.
Pressure switch not responding correctly	See Pressure/Indicator Switch Troubleshooting on page 7-5.
Chamber not pumping down correctly	See Vacuum System Troubleshooting on page 7-6.

Mechanical Troubleshooting

This section covers determination of problems within the frame and other mechanical subsystems.

Table 7-2: Mechanical Troubleshooting

Problem	Corrective Action
System loses alignment over time	• Modules may be moving; verify the Atmospheric Front End and Vacuum Back End are bolted to the floor using the tie down points provided. • Verify the EFEM and VBE are firmly secured to each other and to the Process Modules. • Verify taught positions at all stations.

Power Distribution Troubleshooting

This section covers determination of problems within the AC and DC power distribution. Refer to the System Block Diagram supplied with this manual for additional information.

Table 7-3: Power Distribution Troubleshooting

Problem	Corrective Action
Power lights do not turn on.	• Check the facility's power to the system. Verify correct power rating. • Verify Power Cable from the facility's power is fully seated and secured.
Individual module (pump, robot, etc.) not turned on.	• Verify circuit breakers on the JET PDU are in the ON position. • Verify circuit breaker(s) on the module are in the ON position. • If the module uses DC power, verify the voltage output from the power supply supplying power to the module. • If the module receives power through DeviceNet, verify the voltage output from the power supply supplying power to DeviceNet (e.g. Safety Hub).

Communications Troubleshooting

This section covers determination of communications problems within the Gemini 2 system. Refer to the System Block Diagram supplied with this manual for additional information.

Table 7-4: General Communications Troubleshooting

Problem	Corrective Action
System powered but no response to host controller.	• Verify Interface Cable is fully seated and secure. • Verify proper connection and continuity. • Verify host controller is correctly set-up.
System powered but no response from components within system.	• Verify the Ethernet cable is properly connected at both ends. • Verify all DeviceNet and Ethernet IP Addresses are properly configured (refer to the System Block Diagram and the G2 Software Programmer's Reference). • Verify that serial communications cables are properly connected at both ends. • Verify that the CDM does not have control of the robot.

Table 7-5: DeviceNet Troubleshooting

Problem	Corrective Action
System powered but no response from DeviceNet components within system.	• Check DeviceNet Node LEDs Power: Green - OK; Orange - 24V Low Status: Green - OK; Flashing Green - On line, no communication signal; Red - Critical Module Fault; Flashing Red - Recoverable Fault Node Address: Solid Red - Address not valid Output Fault: Solid Red - Short, Overload, Over Temp
System powered (*Continued*)	• Verify node addresses are correct (refer to the System Block Diagram and the Programmer's Reference Guide).
Intermittent Communication.	• Ensure all network cables are properly seated. • Ensure network is properly terminated. Only one terminator required, typically located in the Series 8 Controller or the Safety Hub.
Fault lights displayed on one or more modules.	• Ensure all network cables are properly seated.

Material Transport Troubleshooting

This section covers determination of problems within the material transport subsystems (aligner, robot, etc.).

Table 7-6: Material Transport Troubleshooting

Problem	Corrective Action
Material slipping on end effector.	• For vacuum-grip end effectors, check that vacuum is connected and meets pressure specifications. • Verify that robot application number is correct for the arm set/end effector (contact Brooks Technical Support)
Material is left on the end effector. Material must be placed back into a Load Lock or a Process Module.	• Identify cause of the failure that left the material on the end effector. • Put the material back into the desired Module using the robot's CDM.
Material is left on the end effector. Corrective actions outlined above failed.	• Shut down the system and recover manually. • Remove the vacuum chamber's lid and check all components associated with the failure. Manually remove the material.

Load Port Module Troubleshooting

This section covers determination of problems within the Load Port Modules. Refer to the LPM User Manual for additional troubleshooting information.

Table 7-7: Load Port Module Troubleshooting

Problem	Corrective Action
Load Port Modules not operating.	• Check that air is connected and meets pressure specifications; check that exhaust is not obstructed. • Verify LPM communications is properly configured. • Verify Interface Cable is fully seated and secure. • Check proper connection and continuity.

Pressure/Indicator Switch Troubleshooting

This section covers determination of problems within the N2 Digital Pressure Switch. Errors of the Pressure Switch are displayed on the LCD.

Table 7-8: N2 Digital Pressure Switch Troubleshooting

Display		Problem	Solution
E1	dE	Calibration settings have changed.	1. Press Reset 2. Set all data again
E2	CE1	Output 1 current exceeding 80 mA.	1. Turn off power 2. Verify load connected to output 3. Verify output not shorted 4. Press Reset
E2	CE1	Output 2 current exceeding 80 mA.	1. Turn off power 2. Verify load connected to output 3. Verify output not shorted 4. Press Reset
E3	PE	Max operating pressure has been exceeded for more than 2 seconds.	1. Reduce supply pressure 2. Press Reset
E4	HP	Pressure is 2% above rated pressure during clear.	1. Apply atmospheric pressure 2. Press Reset

Vacuum System Troubleshooting

This section covers determination of problems within the Vacuum System.

Table 7-9: Vacuum System Troubleshooting

Problem	Corrective Action
Vacuum chamber does not pump down in a normal manner.	• Ensure that the vacuum chamber's vacuum gauge is calibrated and is functioning properly. • Check for contaminants on substrates, cassettes, or in the chamber. • Ensure that the vacuum chamber's pump controller is functioning properly. Reset it if necessary; refer to the Pump Controller User Manual. • Ensure that the vacuum chamber's pump stack isolation valve is functioning properly (air pressure is within acceptable range). • Check vacuum chamber's slot valve seals to ensure they are still in place, free of debris, and in working order. • Check the backing pump system if present. • Perform a leak check if all above fails to isolate possible leaks.
Vacuum chamber fails to pump down in set time.	• Ensure the vacuum gauge is calibrated and is functioning properly. • Check for contaminants in the chamber. • Ensure that the pump controller is functioning properly. Reset it if necessary; refer to the Pump Controller User Manual. • Ensure that the isolation valve is functioning properly. • Check the lid seals to ensure that they are still in place, free of debris, and in working order. • Check the seals on all valves and blankoffs to ensure that they are still in place, free of debris, and in working order. • Perform a leak check if all above fails to isolate possible leaks.

Repair Service

If a Gemini 2 system malfunctions, refer to Initial Troubleshooting on page 7-1 in this manual for diagnostic procedures. If these procedures are not adequate to determine the source of the problem, refer to the G2 system operational descriptions in *Command Line Reference Software Manual* for in-depth descriptions of the various subsystems of the G2 system.

Once the failed unit has been identified, a Field Replaceable Unit (FRU) can be ordered. The FRU is shipped with directions for removing the failed unit from the G2 system and installing the new unit. Refer to the appropriate component User Manuals for additional troubleshooting and repair procedures.

Chapter 8: *Drawings*, lists FRUs for the Gemini 2 system. A number of alternatives are available for obtaining FRUs and other parts to repair the G2 system. The following service options are available:

- On-site repair via a Service Sales Order using Brooks Field Service personnel and factory authorized repair parts
- Advanced Exchange Units can be established for all major systems
- Brooks Factory Repair Services
- Brooks spare parts can be ordered from Brooks Technical Support on both a priority and non priority basis

Contact Brooks Automation Technical Support for more information or quotes.

NOTE: *Safety and Operations training classes on how to troubleshoot and repair a Gemini 2 system to a FRU level are available. Contact Brooks Automation for information about these classes.*

This Page Intentionally Left Blank

8 Drawings

Overview

This chapter identifies standard items that have been identified as Field Replaceable Units (FRUs) at the system level. Some items may be identified here as FRUs that are not needed for specific configurations.

FRUs for individual Brooks Automation components within the system are identified in the individual component's User Manual. Refer to the system AT for part and serial numbers. Configuration-specific FRUs that are not covered in this section are detailed in the System Manual Addendum.

Field Replaceable Units (FRU) for the Equipment Front End Module are specified in the JET User Manual. FRUs for the Vision Load Port Module are listed in the Vision LPM User manual. FRUs may be ordered and stocked by the user as Spares.

FRUs for the Gemini 2 Vacuum Back End have not been identified in this revision.

NOTICE

This list of FRU is not controlled. Changes may have been made or additional items added to the list at any time. To inquire about the latest FRU list or to verify the need of a specific FRU to a specific G2 system, contact Brooks Automation Technical Support.

MagnaTran 7 FRUs

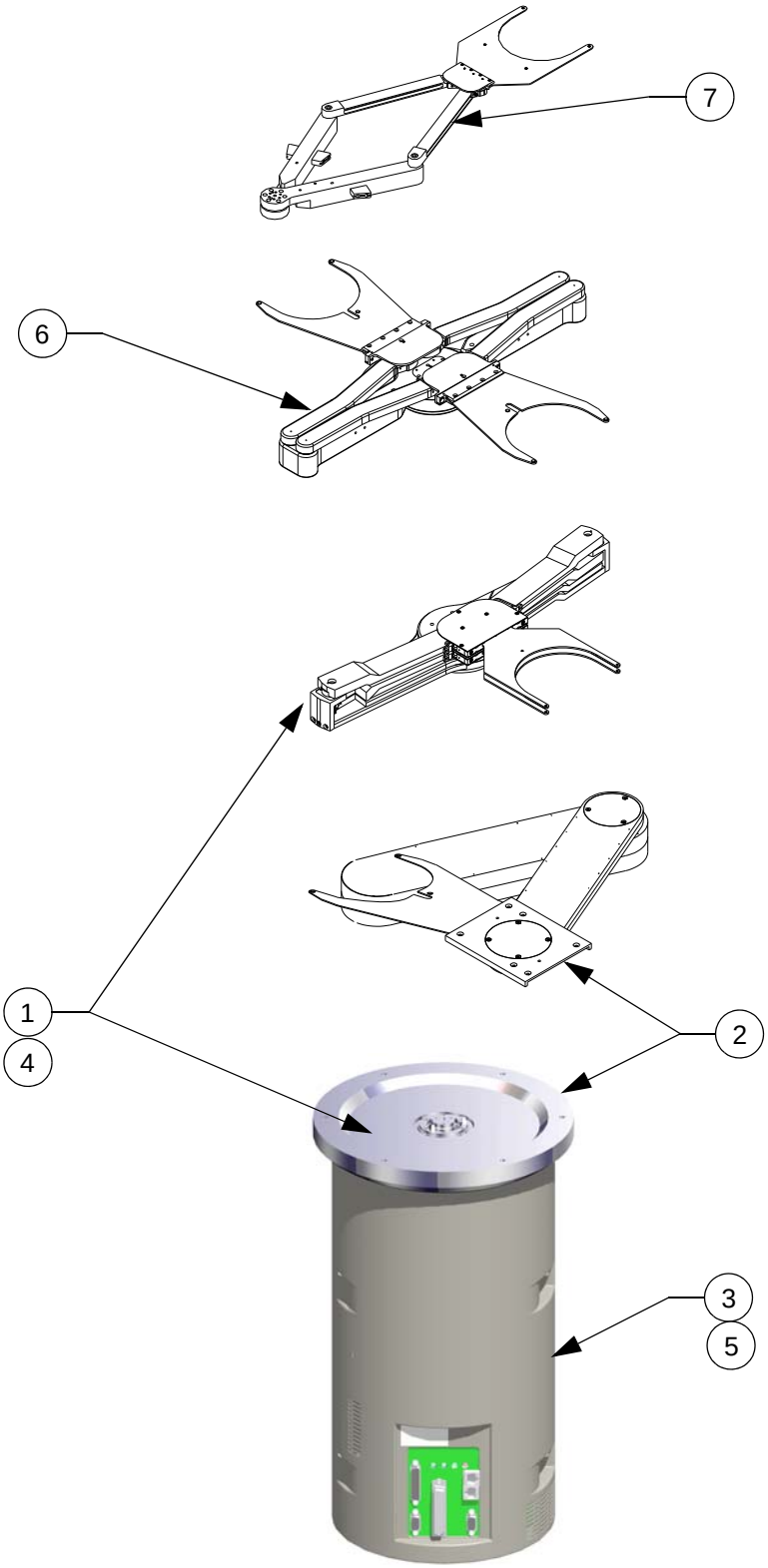


Figure 8-1: MagnaTran 7 Robot FRUs

Table 8-1: VBE Robot FRUs

Balloon	Item Description
1	ROBOT, MAG 7, LEAPFROG KIT (ARM, DRIVE, EE)
2	ROBOT, MAG 7, SINGLE ARM SCARA (ARM, DRIVE, EE)
3	ASSY, MAG 7B, 300MM, PD, CER, 7.51
4	ASSY, MAG 7.1 ROBOT/LEAPFROG 300MM
5	ASSY, MAG 7.1, 35Z, 0 DEG, GX, E-NET, KIT, CC, PENT, HI, I/O
6	ASSY, DUAL ARM, HUBBED, 300MM STD, MAG-7
7	ROBOT, MAG 7, FROGLEG ARM

This Page Intentionally Left Blank

9 Appendices

Overview

The following appendices are included to provide the user with a single location for specific information related to the Brooks Automation Gemini 2 system.

Appendix A: Contact Brooks Automation Technical Support

When contacting Brooks Automation for Technical Support, please have the following information available.

1. Record the part number and serial number from the equipment.
2. Provide the installed location of the equipment.
3. Provide name, e-mail address, and telephone number of the person to contact.
4. List any error codes received during the failure.
5. Prepare a detailed description of the events relating to the error.
   - Time that the equipment has been in operation
   - Work that was done on the equipment prior to the error
   - Functions that the equipment was performing when the error occurred
   - Actions taken after the error and the results of those actions
   - Other information that may assist the Specialist
6. Contact Brooks Automation Technical Support at these numbers:

Brooks Location	GUTS® Contact Number
North America	1-800-FOR-GUTS (1-800-367-4887) US/Canada +1-978-262-2900
Europe	+49 1804 CALL GUTS (+49 1804 2255 4887)
Japan	+81-45-477-5980
China	+86-21-5131-7066
Taiwan	+886-3-552-5225
Korea	+82-31-288-2500
Singapore	+65-6464-1481

For additional contact information, please go to the Brooks Automation web site at www.brooks.com or send an E-mail to techsupport@brooks.com.

The Quality Report (QR) shipped with each robot contains a list of all the factory default settings for the robot, aligner and LPM. Refer to the QR to reset to the default.

Appendix B: Station Identification

The G2 system is customized at the factory to the user's specified parameters. Accompanying the G2 system is a Brooks Automation Acceptance Test (AT) which lists all factory assigned parameters.

If user replaces any modules within or re-configures the G2 system, the new parameters should be recorded in the tables provided in this section. Tables are provided for the stations accessed by the robot in the Atmospheric Front End and by the MagnaTran robot in the Vacuum Back End.

Table 9-1: System Assignments Log - Atmospheric Front End

Stn	Station Name	F/V	R	T	W	Z (BTO)	Lower	Slots	Pitch
1	Load Lock B	Final							
		Via							
2	Load Lock A	Final							
		Via							
3	Load Port Module 1	Final							
		Via							
4	Load Port Module 2	Final							
		Via							
5	Load Port Module 3	Final							
		Via							
6	Load Port Module 4	Final							
		Via							
7	Aligner	Final							
		Via							
		Final							
		Via							
		Final							
		Via							

Table 9-2: System Assignments Log - Vacuum Back End

Stn	Station Name	R	T	W	Z (BTO)	Lower	Slots	Pitch
1	LL B - Arm ‘A’							
	LL B - Arm ‘B’							
2	LL A - Arm ‘A’							
	LL A - Arm ‘B’							
3	PM 1 - Arm ‘A’							
	PM 1 - Arm ‘B’							
4	PM 2 - Arm ‘A’							
	PM 2 - Arm ‘B’							
5	PM 3 - Arm ‘A’							
	PM 3 - Arm ‘B’							
6	PM 4 - Arm ‘A’							
	PM 4 - Arm ‘B’							
7	PM 5 - Arm ‘A’							
	PM 5 - Arm ‘B’							

Appendix C: Document Abbreviations

The abbreviations provided in this table are used with Brooks documentation.

Table 9-3: Documentation Abbreviations

AIR	Air, pressurized	FN	Facet Node board	PN	Pneumatic manifold
AL	Load Lock ‘A’	FDP	Front Buffer Defeat Plug	PP	Poppet valve
AR	Argon gas	FM	Foreline Manifold	PR	Pressure Relief valve
AS	Atmospheric Switch	FS	Flow Switch	PS	Pressure Switch
ASA	Atmospheric Switch Adapter	FV	Fast Vent	PU	Purge valve
BL	Load Lock ‘B’	GP	Gas Panel	PV	Profiled Vent valve
BV	Bleed valve	H2O	Water	RM	Rough Manifold
C2	Communications board RS-232	HP	Heater Power Supply	RV	Rough Valve
C4	Communications board RS-422	HT	Heater cartridge	S	Sensor
CC	Cold Cathode	IG	Ion Gauge	SP	Wafer Lift Spider (Z-Lift)
CG	Convectron Gauge	IL	Inligner (TopLigner)	SR	Slow Rough
CL	Cooling valve	IO	System I/O distribution board	SS	Substrate Sensor
CM	Capacitance Manome-ter	IV	Isolation Valve	SV	Slot Valve
CP	Cryo Pump	LF	Lower Facilities	T/C	Thermocouple
CS	Cool Station	LL	Load Lock	T5	T5X system controller
CT	Temperature controller	LN	Load Lock Node	TB	Turbo Backing valve
CV	Charge Valve or Cryo Vent	Mx	MagnaTran robot	TC	Transport Chamber
DB	D-subminiature connec-tor	MCC	Motion Control Card	TMC	Transport Module Con-troller
DC	DC power supply	MP	Mechanical Pump	TP	Turbo Pump
DP	Differential Pump	N2	Nitrogen gas	TS	Thermal Switch
DR	Atmospheric Door	NMA	Null Modem Adapter	TV	Turbo Vent valve
EFEM	Equipment Front End Module	P#	Process Module *num-ber*	VS	Vacuum Switch
FB	Front Buffer	PDP	Process Module Defeat Plug	WP	Water Pump

Appendix D: Consumables

Call Brooks Automation technical support to obtain consumables for the Gemini 2 Vacuum Back End. Refer to the individual User Manuals, such as the JET User manual and the Vision User manual, for lists of the consumable items to be stocked for the components of the Gemini 2 system. Refer to the System Manual Addendum, if provided, for a list of all consumable items for that specific configuration.

Table 9-4: Consumables

Description	Frequency
O-ring removal/replacement kit (contains all 14 Transport Chamber o-rings)	As Required
Batch Load Lock Drive Belt	12 months

Appendix E: Tooling and Fixtures

Table 9-5 provides a list of the specialized tools and fixtures supplied with the Gemini 2 system, including shipping brackets and teach fixture kits used for servicing the G2 system.

Table 9-5: Tools and Fixtures Supplied with the Gemini 2

Tool	Description and Use	Part Number
Robot Shipping Brackets	Used to secure the robot arm to the robot flange during shipment.	Depends upon configuration
LPM Shipping Brackets	Used to secure the paddle to the LPM frame during shipment.	Depends upon configuration
Controller Shipping Brackets	Used to secure the controller to the UI Panel during shipment.	Depends upon configuration
Teach Fixtures	Used to align the robot to specific stations.	Depends upon configuration

Appendix F: Packing and Shipping Instructions

If the Gemini 2 system is to be shipped, for return to Brooks or to another location, it must be properly packaged to ensure it arrives undamaged. The Gemini 2 system was originally assembled and packaged in a cleanroom environment. Care should be taken to ensure that it is repackaged in the same type of environment. The following procedure provides the correct method of handling and packaging the system for shipment.

NOTE: *The original shipping crates must be used when shipping the Gemini 2 system. If the original crates have become lost or damaged, contact Brooks Automation for replacements.*

NOTICE

Before beginning this procedure:

The Gemini 2 system must be shut down following the procedure provided in Safe Shutdown on page 5-33.

Perform Lockout/Tagout procedures per facility's requirements.

CAUTION

Lift Aid Required

The Equipment Front End Module weighs at least 756.6 kg (1668 lb).The Vacuum Back End weighs at least 580.6 kg (1280 lb). Improper lifting may result in personal injury.

Do not attempt to move or lift the Equipment Front End Module and Vacuum Back End without a lift aid such as a forklift or a hoist.

WARNING

Tip Hazard

The Gemini 2 may tip and fall which may cause serious injury or death.

- Do not attempt to lift the Gemini 2 without the use of a fork lift.
- Roll on smooth floors only.

Required Tools and Equipment

- Fork truck or appropriate lift
- Open End Wrench, Adjustable or size 19 mm, $^{1}/_{2}$ in, $^{3}/_{4}$ in, and 1 $^{1}/_{8}$ in
- Metric Hex wrenches
- Phillips screwdriver

EFEM Packing Procedure

1. Remove the bolts securing the Atmospheric Front End to the Vacuum Back End.
2. Refer to the Atmospheric Front End User Manual for removal, crating, and shipping information.

NOTICE

Inspect the travel route of the Atmospheric Front End and the Load Port Modules. Cover dips, thresholds, or any uneven floor transitions with plates.

VBE Packing Procedure

1. Disconnect all external wiring and facilities connections.
2. Remove the tie-downs from the frame.
3. Release the clamps securing the Vacuum Back End to the Process Module(s).
4. Reattach the wheels to the Vacuum Back End's frame using the hardware that was supplied with the wheels.
5. Lower the wheels until the feet are raised off the floor.
6. Screw in the system leveling feet so that they are fully retracted into the frame.
7. Lower the wheels until the feet just clear the floor.
8. Secure the MagnaTran 7 robot's arms in the Vacuum Back End to prevent movement and damage during shipment, using the shipping brackets supplied with the Vacuum Back End when it was received.
9. Roll the Vacuum Back End away from the Process Modules.
10. Attach blankoffs to the atmospheric doors and vacuum slot valves on the Vacuum Back End module as required.
11. Secure any loose cables in the Vacuum Back End and protect all cable ends and connectors.
12. The entire Vacuum Back End should be wrapped, bagged, and packed following standard packing procedures for a cleanroom environment. Ensure that all wrapping/bagging covers the bottom of the frame to ensure cleanliness.
13. Lower the system by raising the casters until the system is resting on the feet inside of the bag.

NOTICE

Always adjust each caster the same amount. Do not allow the frame of the chamber to twist.

14. Remove the casters. Replace them on the outside of the bag.

15. Remove the fork tube gasket seal plates. Replace them on the outside of the bag.

16. Evacuate and seal the inner and outer poly-bags using a heat sealer.

17. Lower the jacking casters.

18. Roll the system to the shipping area.

NOTICE

Inspect the travel route of the Vacuum Back End. Cover dips, thresholds, or any uneven floor transitions with plates.

19. Using the fork lift, lift the Transport Chamber just enough to clear the shipping skid.

20. Raise the casters until the wheels are up to the frame.

21. Using the crate the Vacuum Back End was originally shipped in, slide the shipping skid under the system.

22. Secure the system to the shipping skid using 5/8 in. or 1/2 in. threaded rod through each of the caster brackets.

    Additional blocking should be added as required to ensure that the system is adequately secured to the pallet.

23. Add tip indicators, shock indicators and moisture indicators to the outside of the crate as desired, to verify proper handling during shipment.