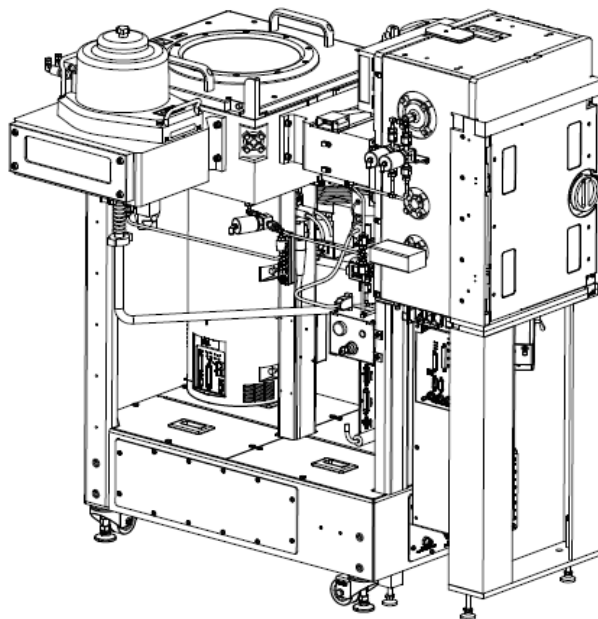




Micro Marathon Express™ (MMX)

User Manual

Part Number 606137 Rev. B



Brooks Automation, Inc.

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1. Introduction

Micro Marathon Express™ System Overview

The Micro Marathon Express (MMX) Cluster Tool Integration Platform transfers 100 mm to 200 mm wafers or 100 mm to 150 mm square substrates from a Vacuum Cassette Elevator (VCE) Load Lock into a vacuum transport system for access to multiple Process Modules for multi-step processing without leaving the vacuum environment. The MMX system may also be used as an atmospheric-to-vacuum front end for a single process module. The MMX system provides SEMI standard compatible process module and material carrier interface systems, with a set of options designed to meet factory interface requirements.

The MMX system is designed for use in a vacuum transport cluster tool system with hot or cold processing. This system provides material transfer between multiple user-installed Process Modules in a clean, controlled, high vacuum environment with simple user integration into fabs and easy mobility within and between fabs.

The full MMX system includes the cluster tool platform that accommodates up to three Process Modules, one vacuum cassette elevator, one integrated vacuum aligner, and one vacuum robot. [Figure 1-1](#) shows a MMX Cluster Tool Integration Platform with all Brooks Automation components.

The MMX 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.

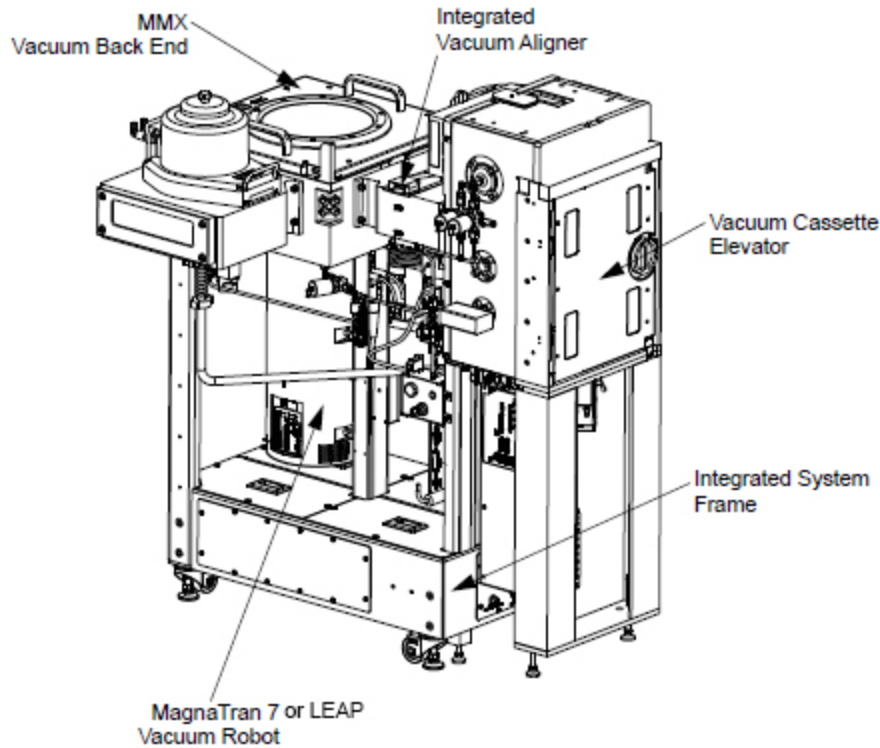


Figure 1-1: Micro Marathon Express

The SEMI S2 and CE regulatory compliant MMX Cluster Tool Integration Platform offers integral support for all system structures. The integrated frame architecture of the MMX system supports standard OEM SEMI roll up style Process Modules with standard interfacing to frame and facet and MESC bolt on style process chambers. Uniform hardware interlock capability, modularity, and expandability of electronics makes the MMX a superior platform for integration.

Brooks Automation continues to demonstrate proven expertise in producing the MMX as a maintenance free, high reliability, ultra clean system backed by Brooks' worldwide support. Brooks Automation drop-in components are easily installed from the top of the transport chamber for fast integration and minimal down time.

The MMX system is designed as a low cost, four-sided platform for Etch, Ashing, MR Head Deposition (PVD and CVD), RTP and other applications. The vacuum system connections allow configuration changes to support different vacuum system configurations. The MMX system is a 200 mm platform with a smaller footprint than most standard systems.

The MMX system is designed for batch processing. During processing, the system is maintained at vacuum while the load lock cycles between vacuum and atmosphere. The Transport Chamber is used to interface Process Modules to a clean room interface or a load lock. No processing is performed within the Transport Chamber. Brooks Automation provides the user with complete flexibility in the design of the material routing throughout the tool.

Features

- Modular design
- Small footprint
- Transport Chamber and Load Lock on integrated steel frame
- Port for Vacuum Cassette Elevator Module
- Transfer isolation valve located between the Transport Chamber and the Vacuum Cassette Elevator Module
- Blankoffs, or optional transfer isolation valves, located at each Process Module facet
- Vacuum, Vent, and Pneumatic Systems
- Facilities distribution interface provides centralized access
- Readily transitions to network communication
- Easy access to all electronics
- Brook Automation MagnaTran 7 or LEAP vacuum robot - performs material handling within the vacuum tool platform
- Brook Automation VCE load lock - provides batch loading of up to 25 wafers

Options

- Vacuum Aligner (InLigner or VX Aligner)
- Complete slot valve/process module/robot hardware interlocking depending on System Integration Level
- TopCooler

Configuration

The configuration of the MMX is determined by the user and is based on the Basic Configuration needed and the System Integration Level required.

Basic Configuration

The Basic Configuration of the MMX is determined by the material size and the number of Process Modules (PMs) accommodated.

System Integration Level

The System Integration Level is determined by the user requirements for system integration and controls and is available in Levels as described below. This manual provides complete coverage for the hardware used in all integration levels of the MMX and the software used through the Level 2.5 integrated systems.

Level 1 - Micro Marathon Express Components

This is the base MMX system providing only the automation components and mechanical integration. This system includes the Transport Chamber, Frame, and Full Automation Component Set as detailed below.

- Transport chamber and frame
- VCE vacuum load lock with manual door
- MagnaTran 7 or LEAP vacuum wafer handling robot drive, transfer arm, and end effector(s)
- System documentation

Level 2 - Micro Marathon Express with Vacuum System

This level of integration provides a Vacuum Pumping System, including Venting and Facilities. This system includes all components, integration, and testing for a complete Mechanical solution. Level 2 includes the complete component set from Level 1 and facilities plumbing as detailed below.

- All Level 1 items
- 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)

Level 2.5 - Micro Marathon Express 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 provides a complete component set including all cabling and complete Power Distribution as detailed below.

- All Level 2 items
- Connector panel with internal wiring and power distribution

Specifications

The MMX is an integration platform supporting up to three Process Modules and one Load Lock Module, or two Process Modules and two Load Lock Modules.

The specifications for the MMX system and its subsystems are detailed below. All specifications are for the MMX standard configuration. Specifications for customized configurations can vary.

Operating Specifications

Specification	Value
Maximum Noise Level	Less than 65 dB
Transport Plane	900 mm (35.43 inches) at VCE platform (SEMI std) 1100 mm (43.31 inches) per SEMI E21 at Process Module side 9.4 mm (0.37 inch) above slot centerline
Material Sizes (Wafers)	100 mm 125 mm 150 mm 200 mm with or without notched fiducial per SEMI M1.9
Material Weight	400 g (14.12 oz) maximum
Material Thickness	8 mm (0.32 inch) maximum
Material Transparency	0 to 96%

Specification	Value
Base Vacuum	5 x 10 ⁻⁶ Torr with turbo pumping system
Leak Rate	1.0 x 10 ⁻⁸ Torr-l/sec He max.
Working Pressure	-103.4 kPa (-15 psi) vacuum +6.9 kPa (+1 psi) overpressure
Maximum Air Pressure	689kPa (100 psi)
Relief Pressure	6.9 - 20.7 kPa (1 - 3 psi)
Cassette Map Period	20 seconds (typical)
Laser Light	Class 1 Laser (used in wafer mappers)
Material Sensing (Sensors)	Polarized-reflective beam break, bottom mount
Vacuum Aligner Modules	Mounting: Located between the chamber and the VCE Alignment Mode: Rotary

Environmental Specifications

ISO 14644-1 Class ISO 6 or better cleanroom ambient

Specification	Value
Temperature	Operating: 20° C to 30° C (68° F to 86° F) Shipping: -25° C to 55° C (-13° F to 131° F), up to 65° C (149° F) for 24 hrs. max Storage: -25° C to 55° C (-13° F to 131° F), up to 65° C (149° F) for 24 hrs. max Safety Hub Operating: 10° C to 40° C (50° F to 104° F) Keyswitch Operating: 10° C to 40° C (50° F to 104° F)
Humidity	30% to 55% (relative, non-condensing)
Lighting	Standard lighting provided in the clean room environment where the MMX is installed is sufficient for proper operation. Maintenance may require a user-supplied service light (that is, flashlight).

Decommissioning

Decommissioning MMX must be handled following all federal, state, local, and facility procedures for recycling of PC Boards, power supplies, connectors, and metal housings.

Mechanical Specifications

NOTICE

Drawings within this manual are generic and may not reflect a specific configuration of the MMX.
To obtain a set of drawings for a specific configuration, contact Brooks Automation Customer Support.

Specification	Value
Dimensions	Refer to Figure 1-2 and Table 1-1 for typical physical dimensions; for the actual dimensions of a specific system, including foot and seismic tie-down locations, refer to the Mechanical Layout Drawing supplied with the system.
Weight	Refer to Table 1-1 for typical system weight; for the actual weight of a specific system, including Floor Loading and Center of Gravity, refer to the Mechanical Layout Drawing supplied with the system.
Exposed Material	Atmosphere: Anodized Aluminum, VAPORE 6 Aluminum, 316 Stainless Steel, AM350 Stainless Steel, Cold Rolled Steel, Baked Powder Coated Epoxy, 7740 Pyrex®, 7056 Glass, Viton®, Lexan® Vacuum: VAPORE 6 Aluminum, 316 Stainless Steel, AM350 Stainless Steel, Sintered Nickel, Electroless Nickel Plate, 7740 Pyrex, Inconel®, 7056 Glass, BK7 Glass, Teflon®, Viton, Kalrez®, Quartz
Cassette Type	100 mm, 125 mm, 150 mm, and 200 mm SEMI standard cassettes 25 or 26 wafer cassette configurations
Vacuum Port (Rough)	NW 40
Vacuum Ports	At VCE interface panel As specified by user At MMX Vacuum Transport System ISO 100 Port for High Vacuum Pump KF 50 Port for Venting KF 40 Port for Rough Pump KF 25 Port for Material Sensor (x 4) KF 25 Port for Vacuum Gauging (x 4) KF 16 Port for Vacuum Gauging (x 2) KF 16 Port for Pressure Relief
Nitrogen Port	6.35 mm (1/4-inch) VCR fitting at Nitrogen Facilities Connection To support venting capacity, a minimum of a 9.525 mm (3/8-inch) O.D. line is required with a reducer to connect to the 6.35 mm (1/4-inch) VCR fitting.
Pneumatic Port	10 mm (0.39 inch) Quick Connect
Exhaust Port	12 mm (0.47 inch) Quick Connect

Specification	Value
Ground Clearance	At nominal height, 10.16 mm (0.4 inch) under fork tubes
Leveling Position	Adjustable feet to meet WTP -10.16 /+ 25.4 mm (-0.4/+1.0 inch) range
Rolling Provision	Casters
Hold-down Provision	User-supplied and user-installed brackets

Facilities Specifications

Specification	Value
Pneumatic Port	Typical configurations require the following supply of clean, dry (unfiltered), oil free air: 620.5 kPa $\pm$ 68.9 kPa (90 psig $\pm$ 10 psig) at 50 slm nominal, 200 slm maximum
Nitrogen	Typical configurations require the following supply of clean, dry nitrogen: <1 ppm contamination 275.8 kPa $\pm$ 34.5 kPa (40 psig $\pm$ 5 psig) at 100 slm nominal, 300 slm maximum
Vacuum, Backing	Typical configurations require the following differential vacuum supply (input to vacuum aligner seals) 635 mm Hg at 50 cc/sec (25 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	Japan, USA: 200 - 208V AC @ 50/60 Hz, two phase (phase to phase or phase to neutral), 6 A, based on configuration and operating mode. Inrush current < 38 A max for 1/2 to 1 cycle Overvoltage Category II The system must be installed on the load side of a usersupplied 10,000 AIC rated circuit breaker (circuit breaker supplied with Gen 5 EN system ACPDU is 5,000 AIC). Europe, Korea, and Israel: 220 - 240V AC @ 50/60 Hz, single phase (phase to neutral), 6 A, based on configuration and operating mode. Inrush current < 38 A max for 1/2 to 1 cycle Overvoltage Category II The system must be installed on the load side of a usersupplied 10,000 AIC rated circuit breaker (circuit breaker supplied with Gen 5 EN system ACPDU is 5,000 AIC).
Exhaust	Sufficient to support return from air lines and exhaust from vacuum pumps

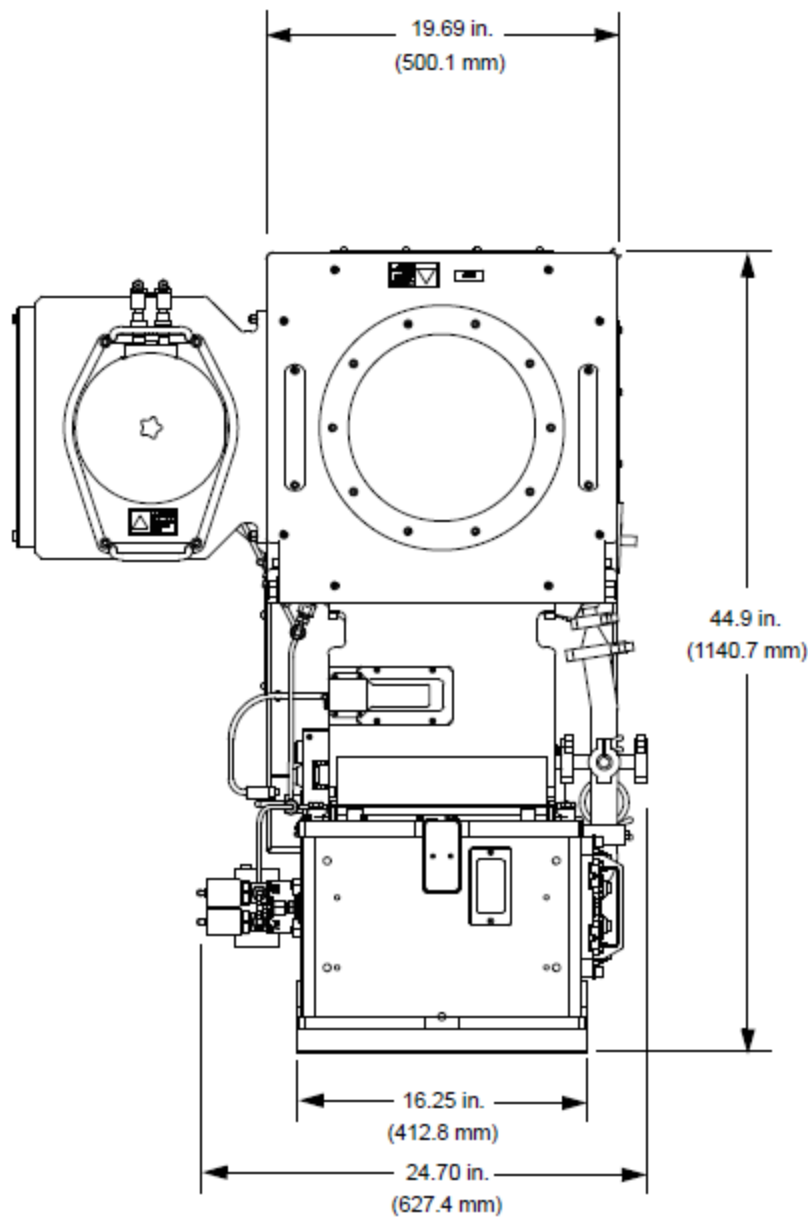


Figure 1-2: MMX Space Requirements

Table 1-1: MMX Dimensions

System	Width	Length	Height	Weight
MMX	599.9 mm (23.62 in)	1140.7 mm (44.9 in)	1392.5 mm (54.82 in)	364 kg (800 lb)
Safety Hub	203 mm (8 in)	304.8 mm (12 in)	101.6 mm (4 in)	7 kg (15.4 lb)
Keyswitch Box	31.7 mm (1.25 in)	130 mm (5.1 in)	104 mm (4.1 in)	2 kg (4.4 lb)

Communications Specifications

Reference the controls manual and system block diagram for more information.

Specification	Value
Serial	RS-232
Discretel/O	Mapped to DeviceNet bus
Network	Ethernet (10/100 Mbps) DeviceNet, requires external Master Node

Center of Gravity and Floor Loading

Floor loading and Center Of Gravity information for the MMX varies, based on the configuration of the Transport Chamber. Information for specific Transport Chambers is available on request.

Overturning Moment: 100 ft-lbs. applied to any PM facet

PM Weight Supported: 100 kg (220.5 lb) maximum per PM

Site Requirements for Moving the Micro Marathon Express

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

Specification	Description
Door Openings	The MMX has been designed to fit through standard door openings.
People	A minimum of two people are required for moving the MMX within the facility.
Floor	The MMX system has been designed to roll easily across smooth interior floors only. The floor where the MMX will be installed must be capable of supporting the weight of the MMX system as shown in Table 1-1 . The weight information provided is maximum weight, including VCE; specific MMX systems may weigh less.

Process Module Space Allocation

The MMX accepts SEMI standard compatible Process Modules as defined by SEMI E26. The MMX system is also capable of accepting non-standard Process Modules. Contact Brooks Automation for details. See [Contact Us](#) for more information.

Service and Exclusion Zones

The MMX system requires adequate space for service access as specified in SEMI E26 and for proper operation. The service space required for the MMX is shown in [Figure 1-3](#) and [Figure 1-4](#). Refer to the Mechanical Layout Drawing supplied with the system for system dimensions.

Ensure that installation of the MMX system is such that it provides access to components requiring service after installation, such as the lid handles and connection panels.

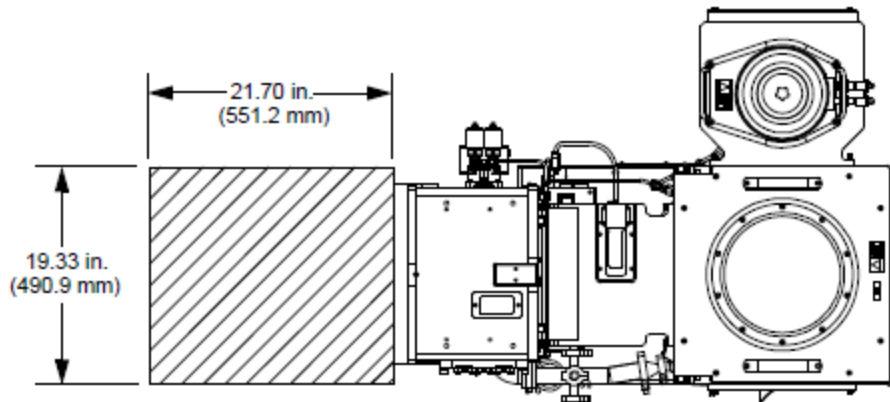


Figure 1-3: Service and Exclusion Zones - Horizontal

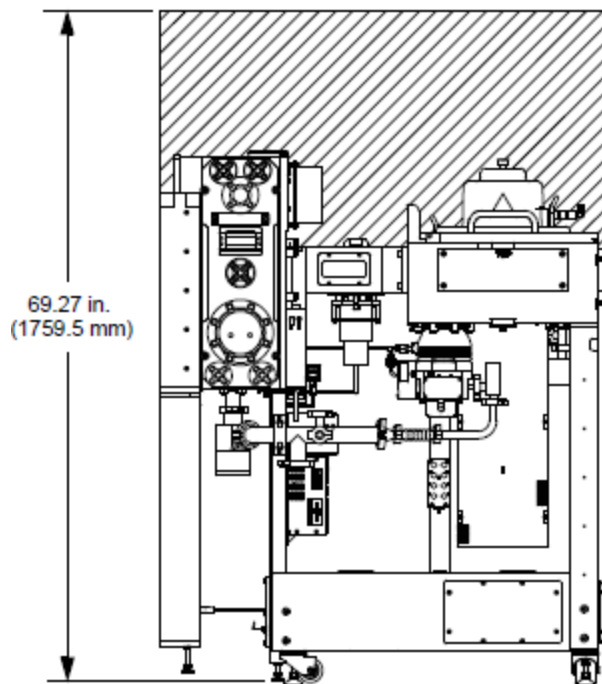


Figure 1-4: Service and Exclusion Zones - Vertical

Supplementary and Related Documentation

This User Manual provides documentation for operation and maintenance of the MMX Cluster Tool Integration Platform. While this document covers specific information and adjustments for the MMX, there may be information in other manuals which affect the settings or operating mode of the MMX system and attached components.

The MMX is set to system specifications and acceptance tested at Brooks Automation. Before adjusting or changing settings on a MMX system, consult the following documentation:

- Brooks Automation robot user manual
- Brooks Automation VCE manual
- Brooks Automation Micro Marathon Express Wiring Diagrams
- OEM Components Manuals (supplied with this manual)
- Transport, Process Module, and System Controller User Manuals
- See FRU list supplied with tool

The commands for controlling the robot and other components used in the MMX are defined in the applicable user manuals. Changes may have been made or additional documents or drawings added to the MMX system documentation. To obtain a current set of drawings and documents for a specific configuration of the MMX, contact Brooks Automation Customer Support. See [Contact Us](#) for more information.

2. Safety

 DANGER Read the Safety Chapter	
Failure to review the <i>Safety</i> chapter and follow the safety warnings can result in death or serious injury. • All personnel involved with the operation or maintenance of this product 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. • Know the facility safety procedures, safety equipment, and contact information. • Read and understand each procedure before performing it.	

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

Brooks Automation Technical Support Group notifies users of record if additional safety-related upgrades or new hazards associated with the MMX are identified.

Regulatory Compliance and Declaration of Incorporation

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

The MMX 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 MMX is enclosed inside a plastic documentation packet accompanying the MMX.

	Declaration of Incorporation of Partly Completed Machinery For the European Union	Document #: 204213 Rev.: C
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Description: Micro Marathon Express (MMX)
Function: Vacuum Cluster Tool
Part Number: 181600-XXXX series with Level 2.5 Gen5 EN controls
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, Im Wiesengrund 14, 78315 Radolfzell am Bodensee, Germany

The manufacturer declares:

- That the following essential requirements of Machinery Directive 2006/42/EC are applied and fulfilled and that the relevant technical documentation is compiled in accordance with part B of Annex VII:
 - Annex I sections: 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, 1.3.8, 1.3.9, 1.4.1, 1.4.2, 1.4.3, 1.5.1, 1.5.2, 1.5.3, 1.5.5, 1.5.6, 1.5.7, 1.5.8, 1.5.9, 1.5.11, 1.5.12, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.6.5, 1.7.1, 1.7.2, 1.7.3
 - EN 60204-1
 - EN ISO 12100
 - ISO 13849-1
- That this partly completed machinery conforms with the provisions of Electromagnetic Compatibility Directive 2014/30/EU.
 - EN61000-6-4
 - EN61000-6-2
- 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



David Jarzynka
Vice President and General Manager - Automation

10-March-2017
Chelmsford, Massachusetts

Form: QMS100362 Rev D

Explanation of Hazards and Alerts

This manual and this product use industry standard hazard alerts to notify the user of personal or equipment safety hazards. Hazard alerts contain safety text, safety icons, signal words, and color.

Safety Text

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

- Identify the hazard,
- State 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.
- The safety icons in this manual conform to ISO 3864 and ANSI Z535 standards.

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.

Alert Example

The following is an example of a *Warning* hazard alert.

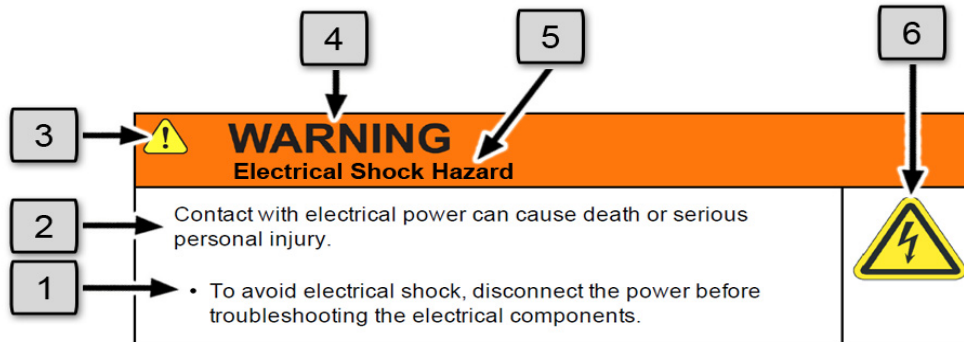


Figure 2-1: Components of a Safety Alert

Number	Description
1.	How to Avoid the Hazard
2.	Source of Hazard and Severity
3.	General Alert Icon
4.	Signal Word
5.	Type of Hazard
6.	Hazard Symbol(s)

General Safety Considerations

 WARNING Emergency Off (EMO)	
This device is not equipped with an EMO disconnect device. Using this product without an Emergency Off (EMO) circuit may cause death or personal injury. • The integrator and user are responsible for installation of the EMO disconnect device that complies with the mandated safety codes. • Personnel servicing this product are responsible for disconnecting power as specified by the facility Lockout/Tagout procedures.	 

 CAUTION Unauthorized Service	
Personal injury or damage to equipment may result if this product is operated or serviced by unauthorized personnel. • Only qualified personnel are allowed to transport, assemble, operate, or maintain the Product. • Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.	

 CAUTION Training and Unauthorized Service	
Personal injury or damage to equipment may result if this product is operated or serviced by untrained or unauthorized personnel. • Only qualified personnel who have received certified training and have the proper qualifications for their jobs are allowed to transport, assemble, operate, or maintain the product.	

 CAUTION Personal Protective Equipment	
This product contains heavy objects that may cause personal injury. • Use safety shoes and head protection when installing or maintaining the product. • Wear protective eyewear when setting up or testing the system.	

 CAUTION Seismic Restraint	
The use of this product in an earthquake prone environment may cause equipment damage or personal injury. The user is responsible for determining whether the product is used in an earthquake prone environment and installing the appropriate seismic restraints in accordance with local regulations.	

 CAUTION Inappropriate Use	
Use of this product in a manner or for purposes other than for what it is intended may cause equipment damage or personal injury. • Only use the product for its intended application. • Do not modify this product beyond its original design. • Always operate this product with the covers in place.	

 CAUTION Damaged Components	
The use of this product when components or cables appear to be damaged may cause equipment malfunction or personal injury. • Do not use this product if components or cables appear to be damaged. • Place the product 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.	

NOTICE

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

NOTICE

Please follow all facility and local wiring regulations before operating or servicing the product.

Illustration of Hazard Locations

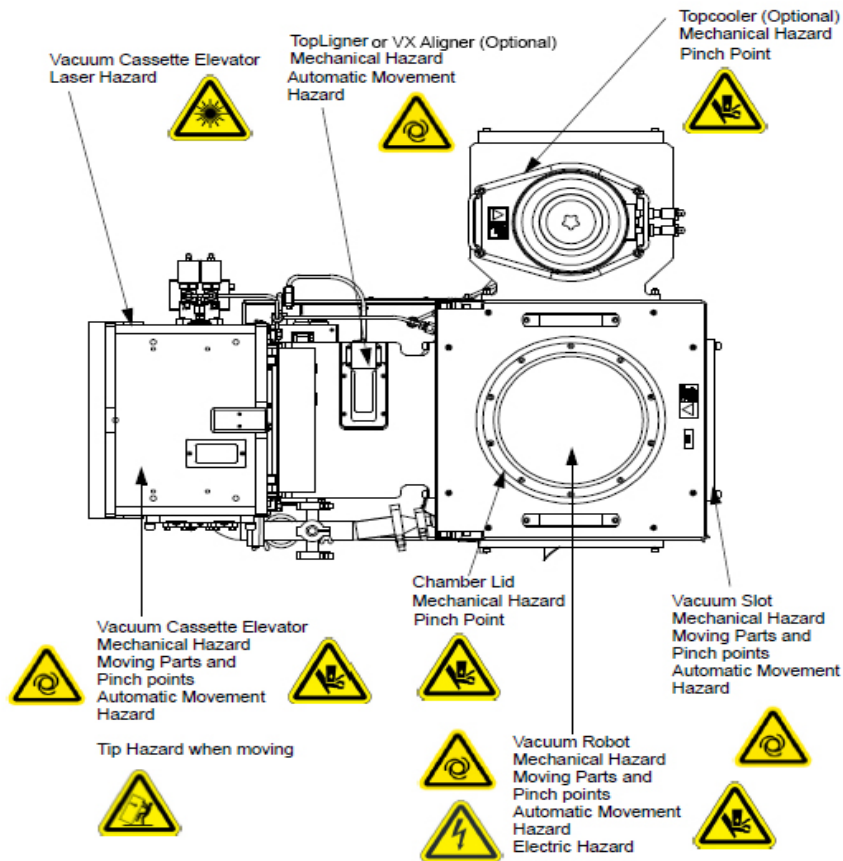


Figure 2-2: Location of Hazardous Points

Safety and Identification Labels

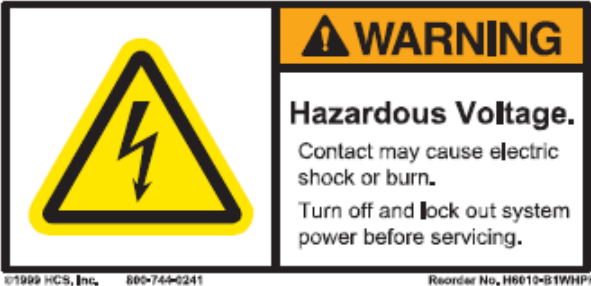
Safety labels are placed on the MMX system to identify hazards. Identification labels provide information about the product.

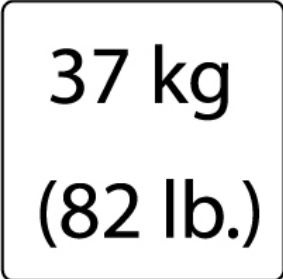
- Safety labels provide instructions on how to avoid the hazard.
- Items that weigh over 4.5 kg (10 lb) and that may be removed for service have a mass label attached.

[Table 2-1](#) lists the labels that are affixed to the MMX and the components within it.

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

Table 2-1: Safety Labels on the MMX

	Label name: Hazardous Voltage Qty: 2 Locations: Safety Hub, Robot 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.
FIELD REPLACEABLE UNIT NO USER SERVICEABLE PARTS INSIDE	Label name: FRU label Qty: 2 Location: Safety Hub, Robot No user serviceable parts inside
	Label name: Crush Hazard Qty: 2 Location: Above Door of VCE, Robot Hazard Type: Warning Possible injuries: Crush hands and/or fingers How to avoid the hazard: Keep hands clear.
	Label name: Laser Hazard Qty: 2 Location: Above VCE Door, On top of VCE Hazard Type: Caution Possible injuries: Eye damage How to avoid the hazard: Do not stare into beam. Class 1 laser product.

	Caution Label - Heavy Object P/N: 70025562 Qty: 4 Location: Transfer Chamber Lid, Top of VCE, VCE Connections Box, Robot Hazard Type: Warning Possible injuries: Muscle strain or back injury How to avoid the hazard: Use proper lifting techniques when moving
	Label name: 16 Kg Weight Label Qty: 1 Location: Transfer Chamber Lid
	Label name: 37 Kg Weight Label Qty: 1 Location: Robot
	Label name: 20 Kg Weight Label Qty: 1 Location: VCE Connections Box
	Label name: 111 Kg Weight Label Qty: 1 Location: Top of VCE

		SERIAL #	ABCDEFGHIJKL
15 ELIZABETH DRIVE CHELMSFORD, MA USA		01824	
THIS EQUIPMENT IS SUPPLIED BY ONE SOURCE OF POWER			
ELECTRICAL DIAGRAM	181600-BX	MODEL #	181600-ABCD
SCCR	300	AMPERES RMS	
AIC RATING*	10000	AMPERES RMS	
FREQUENCY	50/60	HERTZ	
VOLTAGE	200-240	VOLTS	
* = RATING OF CUSTOMER SUPPLIED CIRCUIT BREAKER			
SINGLE PHASE POWER			
# OF PHASES	1-PH / 3-WIRE		
CURRENT	10 AMPS		
LARGEST LOAD	6 AMPS		
P/N 184060 REV C			

Label name: Serial Name Plate

Qty: 2

Location: Transfer Chamber, Frame to the Right of the Facilities Interface Panel



Label name: Seismic Anchor

Qty: 4

Location: One at each corner of the Frame



Label name: Moving Parts Present

Qty: 1

Location: VCE Connections Box

Hazard Type: Warning

Possible injuries: Serious injury to hands and/or fingers

How to avoid the hazard: Keep hands away from moving parts. Disconnect and lock out power before servicing.

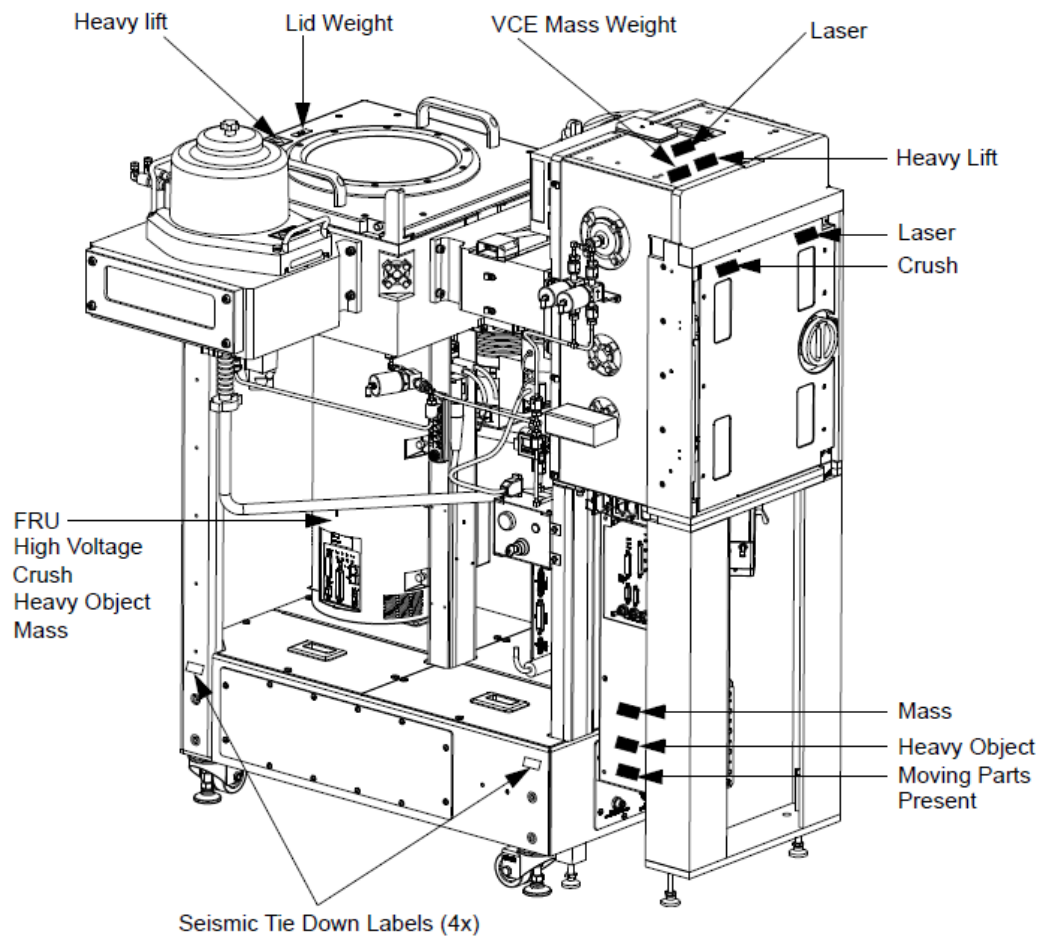


Figure 2-3: Label Locations on the MMX

Table 2-2: Labels Used on the Safety Hub

 WARNING Hazardous Voltage. Contact may cause electric shock or burn. Turn off and lock out system power before servicing. ©1999 HCS, Inc. 800-744-0241 Reorder No. H6610-B1WHPK	Label name: Hazardous Voltage Part Number: 70022616 Qty: 1 Locations: Safety Hub, Robot 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.
FIELD REPLACEABLE UNIT NO USER SERVICEABLE PARTS INSIDE	Label - Field Replaceable Unit P/N: 130165 Qty: 1 Location: On the top of the AC Power Distribution Unit

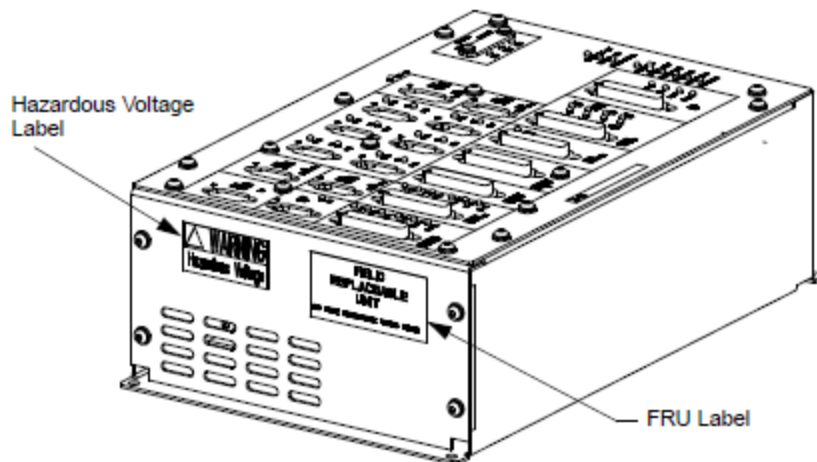


Figure 2-4: Label Locations on the Safety Hub

Table 2-3: Labels Used on the Robot Power Supply

	Warning Label - Hazardous Voltage P/N: 70022616 Qty: 1 Location: On the top of the Robot Power Supply Hazard Type: Hazardous voltage Possible injuries: Electric shock or burn How to avoid the hazard: Do not service while the Robot Power Supply is energized
FIELD REPLACEABLE UNIT NO USER SERVICEABLE PARTS INSIDE	Label - Field Replaceable Unit P/N: 130165 Qty: 1 Location: On the side of the Robot Power Supply

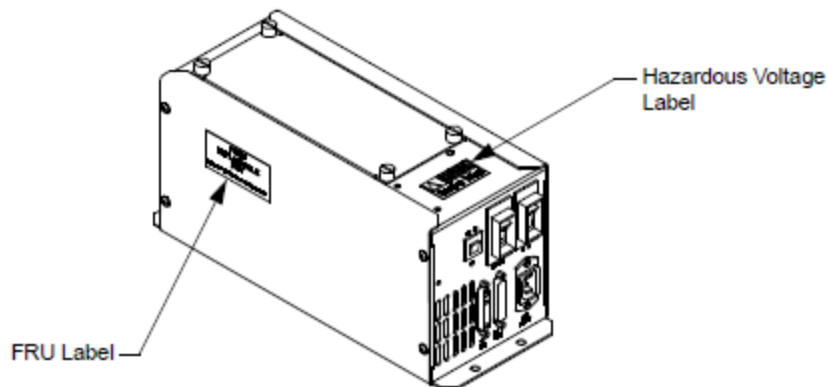


Figure 2-5: Label Locations on the Robot Power Supply

Disconnect Devices

The facility is responsible for the MMX System's main disconnect device. Be sure it complies with the correct electric codes. The main user installed disconnect device must meet, or exceed, the minimum SCCR rating specified by SEMI S2. Personnel servicing the product and any equipment connected to it are responsible for the status of the product's main disconnect device as specified by the facility's lockout/tagout procedure.

Interlocks

Safety interlocks exist for the Safety of personnel while operational interlocks protect the equipment and the material it transports. For additional information, refer to ["Safety Interlocks" on page 104](#).

Safety interlocks act differently depending on whether the MMX is in AUTO (Automatic Mode), OFF/RESET Mode, MAN (Manual) Mode, or Teach Mode.

The MMX System is in Teach Mode when the vacuum robot teach pendant (CDM) is plugged into the facilities panel and the CDM is turned on. Interlocks in Teach Mode vary between AUTO, OFF/RESET, and MAN Modes.

A keyswitch on the MMX System facilities panel is used to change the modes of the tool between AUTO, OFF/RESET, and MAN Modes. Keep the key in a safe location. Do not leave the key in the keyswitch. The key left in the keyswitch allows access to unqualified personnel for changing the mode.

Emergency Machine Off (EMO)

Emergency Machine Off (EMO) Safety interlocks must be installed by the user at the facility where the MMX System is installed. The EMO button(s) and circuits are the responsibility of the facility. The EMO button and circuits must comply with all Safety standards for the use of the EMO.

Refer to the controls manual for more information.

Lockout/Tagout

According to standard industry practices, lockout/tagout procedures must be performed before performing service or maintenance on the MMX. Local, federal, and factory standard procedures must also be followed to remove hazardous energy of any type.

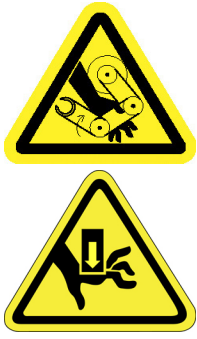
If a service lock or tag is installed, DO NOT remove the tag or energize the circuit without proper authorization.

 WARNING Lockout / Tagout	
Working with energized equipment may cause sudden movement or electrical shock and may result in death or serious injury. All power to the Marathon Express must be disconnected per the facilities Lockout/Tagout procedure before servicing. • All energy must be removed from the equipment per the facility's	

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

Mechanical Hazards

 WARNING Potential Robot Movement	
The product has the potential for automatic motion that may cause death or serious injury. • Avoid working inside the movement path or under extended components. • Use physical barriers to prevent injury when working in the movement path.	

 WARNING Moving Mechanisms	
Moving mechanisms do not have obstruction sensors and can cause death or serious injury. • Be aware of the potential movement area of the product whenever power is applied. • Never place any part of your body between the robot arms and fixed surfaces. • Do not operate the robot without the guards and protective covers in place and all safety interlocks enabled.	

 CAUTION Pinch Point	
Moving parts of the MMX system may cause squeezing or compression of fingers or hands resulting in personal injury. Do not operate the MMX system without the protective covers in place	

Electrical Hazards

Refer to the specifications of the MMX for the electrical power.

 DANGER 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.	 

Grounding

The power source to which the MMX 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.

Laser Hazards

The MMX system uses low power laser light for mapping of wafers in the Automatic Wafer Centering system. The laser emitter produces low power invisible infrared light. This laser is located on the VCE and is not visible during normal operation, so it is a Class I as implemented.

The proper precautions for operating and servicing lasers must be observed. Any precautions specified within the facility where the MMX is being used must also be observed.

 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.	

Ergonomics Hazards

 CAUTION Heavy Object	
The MMX weighs approximately 364 kg (800 lb). Failure to take the proper precautions when lifting or moving any of these items could result in personal injury. Use a fork lift or a hoist to move the MMX. Use a minimum of four people to move the MMX and a minimum of two people to move all other modules.	  

Tip Hazard

 WARNING Tip Hazard	
Moving this VCE without a hoist could cause a tip hazard which may cause death or serious injury. • Do not attempt to move the VCE without the use of a fork lift or a hoist. • Roll on smooth floors only.	 

 CAUTION Trip Hazard	
Cables for power and communication and facilities create trip hazards which may cause serious injury. • Always route the cables where they are not in the way of traffic.	

Environmental Information

Recycling and Hazardous Materials

NOTICE	
	IPA Wipes are used in maintenance for cleaning. These wipes contain approximately 3 ml of 10% IPA / 90% DI Water solution. Follow all Federal, State, Local, and Facility procedures for the disposal of hazardous materials.

NOTICE	
	Decommissioning modules must be handled following all federal, state, local, and facility procedures for recycling of PC Boards, power supplies, connectors, and metal housings.

NOTICE



Hazardous lubrication material 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 Facility procedures for the disposal of hazardous materials.

NOTICE

Lithium Battery Disposal



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's 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.

3. Installation

Site Requirements

Floor Space and Loading Floor space and loading site requirements for the MMX are listed in the "[Mechanical Specifications](#)" on page 19 and shown in [Figure 1-3](#) and [Figure 1-4](#). Note that the dimensions given are for the MMX system only. It is the responsibility of the facility where the system is installed to ensure adequate space around the Process Modules.

NOTICE

Drawings within this manual may not reflect a specific configuration of the MMX. To obtain a complete and current set of drawings and documents for a specific configuration, contact Brooks Automation Customer Support. See [Contact Us](#) for more information.

Environmental

Environmental site requirements for the MMX are specified in "[Environmental Specifications](#)" on page 18.

Facilities

The user is responsible for providing the facilities specified in "[Facilities Specifications](#)" on page 20. Refer to "[Facilities Specifications](#)" on page 20 for the connection of all facilities to the MMX system. Refer to "[Operational Interfaces](#)" for the wiring of all electrical connections. The user is responsible for the main disconnect device between the MMX system and the facility's power source, and for ensuring the device complies with the relevant electric codes. The main user installed disconnect device must meet, or exceed, the minimum AIC rating specified by SEMI S2 (10,000 AIC minimum). Service to the MMX system should have the appropriate fuse or circuit breaker rating.

Unpacking and Inspection

The MMX is shipped in separate crates that are individually sealed to maintain clean room conformance.

- Carefully unpack each crate, following the "Unpacking Instructions".
- Verify the contents of each crate against the checklist provided on the front page of the ATP (Acceptance Test).
- Inspect the contents of each crate for damage.
- Immediately report to the shipper and to Brooks Automation any damage found. One set of shipping documents is attached to the outside of the main shipping crate for easy access. A duplicate set of these documents is attached to the equipment inside the shipping crate.

NOTE: The number and contents of the shipping crates depends upon the items purchased. Refer to the ATP for the exact contents. [Table 3-1](#) is provided for reference only.

Table 3-1: Packing Checklist Reference

Package	Typical Contents
Micro Marathon Express	Chamber mounted on frame with wheels with installed options that may include: robot, VCE load lock, custom end effector, vacuum aligner, etc.
Electronics	AC Power Supply
Installation Kit	• Connector for power cable • System cables • Mounting Hardware • User manuals

The MMX system is both assembled and double-bagged for shipping in a Class 100 clean room. Before bagging, the entire system is cleaned and then completely wrapped in plastic (except for the bottom).

When the MMX is being prepared for shipping, shipping brackets are bolted to the bagged MMX frame. The shipping brackets are then bolted to the crate bottom before the crate is closed and bolted together. Tip indicators, shock indicators, and moisture indicators are attached to each crate.

 CAUTION Heavy Object	
The MMX weighs approximately 364 kg (800 lb). Failure to take the proper precautions when lifting or moving any of these items could result in personal injury. Use a fork lift or a hoist to move the MMX. Use a minimum of four people to move the MMX and a minimum of two people to move all other modules.	

 WARNING Tip Hazard	
Failure to take the proper precautions before moving any module, especially while moving it out of the shipping crate, could result in personal injury. Ensure that all force exerted on the modules of the MMX when moving them is below the center of gravity. Roll on smooth floors only.	

NOTICE
When rolling the MMX on its casters, place hands on the dummy process modules or on the process module blankoffs. Gauges and sensors are located in other areas of the MMX and could be damaged if pushed against.

NOTE: Save the shipping crates for possible future use. If any of the modules of the MMX are returned to Brooks for service or shipped to another location, the original shipping crates must be used. If the original crates have become lost or damaged, contact Brooks Automation for replacements. Refer to [Appendix F: "Packing and Shipping Instructions" on page 194](#).

The MMX was assembled and bagged in plastic in a clean room environment. To

ensure the cleanliness of the MMX system, unbag it only in a clean room depack environment.

Procedure Category

Equipment is fully de-energized.

Required Tools and Equipment

- Fork truck or appropriate lift with bumper stops
- Open end wrenches, adjustable or size 19 mm, 3/4 in, and 1 1/8 in
- Metric hex wrenches

Unpacking Instructions

Step	Action
1.	Upon receiving the crate, inspect the indicators for disturbance. Also, visually verify crate is not damaged. Inform freight carrier and Brooks Automation of any inspection discrepancy.
2.	Remove the cover of each shipping crate. Inspect and verify contents. The MMX Acceptance Test (ATP) is included in the shipment and is a permanent record of the system as it was manufactured by Brooks Automation. In addition to providing information about serial number, model number, and robot station assignments, it also provides critical data. Make copies of the form and keep a copy close to the system. Should maintenance be required, data from the AT may be needed.
3.	Remove the crate walls of the Transport Chamber.
4.	Unbolt the shipping brackets from the pallet floor (4 places). NOTE: Save the shipping crate for possible future use. If the MMX is returned to Brooks for service or shipped to another location, the original shipping crate and brackets must be used.
5.	Using the fork lift, pick the Transport Chamber up only enough to clear the shipping skid. NOTE: The MMX system must be lifted from the VCE side only. Bumper stops must be present on the fork lift to prevent the lift from contacting the frame.
6.	Slide out the shipping skid and screw the VCE support feet and the MMX system leveling feet so that they are fully retracted into the frame. Gradually transfer the weight of the system from the fork-lift channels to the casters.
7.	Remove the fork lift.
8.	Cut open and remove the foil bag the MMX system is shipped in and roll the system into the depack area.
9.	Move the contents of all other crates into the depack area.
10.	Vacuum and wipe down the bags for all items while in depack.
11.	Remove all outer bags and vacuum and wipe down all inner bags.

Step	Action
	NOTE: The MMX was assembled and bagged in plastic in a clean room environment. To ensure the cleanliness of the MMX system, remove only the outer bags in the Depack area. Recycle all packaging materials.
12.	Roll the system into the clean room and position it at its final location.
13.	Remove all inner bags and any additional wrapping.
14.	Carefully inspect the MMX system and all additional items for signs of damage that may have occurred during shipping. Inform the freight carrier and Brooks Automation of any inspection discrepancy.

Procedures for re-packaging the MMX are provided in [Appendix F: "Packing and Shipping Instructions" on page 194](#).

Installation Procedure

All modules are controlled on the MMX. The information required to install the MMX is provided in the following procedures.

 CAUTION Heavy Object	
The MMX weighs approximately 364 kg (800 lb). Failure to take the proper precautions when lifting or moving any of these items could result in personal injury. Use a fork lift or a hoist to move the MMX. Use a minimum of four people to move the MMX and a minimum of two people to move all other modules.	

 WARNING Tip Hazard	
Failure to take the proper precautions before moving any module, especially while moving it out of the shipping crate, could result in personal injury. Ensure that all force exerted on the modules of the MMX when moving them is below the center of gravity. Roll on smooth floors only.	

Procedure Category

Equipment is fully de-energized.

Required Tools and Equipment

The following tools and materials are required during the installation of the MMX:

- Metric Hex Wrenches
- Standard Hex Wrenches
- Scale (ruler)
- I-beam Level
- Bubble Level
- 1/2-inch Bolt (or Threaded Rod), Qty 3, for MMX system tie-down

Remove Protective Packaging

The modules of the MMX are shipped with their internal components (robot, aligner, etc.) covered in protective packaging. This packaging must be removed before installation can be started.

Micro Marathon Express Module

Remove protective wrapping from any loose cable ends or connectors.

Removing Shipping Brackets

The modules of the MMX are shipped with shipping brackets attached to them, and these shipping brackets must be removed before installing the MMX system.



Figure 3-1: Shipping Bracket on Frame

Save the shipping brackets for possible future use. If any of the modules of the MMX are returned to Brooks for service or shipped to another location, the original shipping brackets must be used. Refer to [Appendix F: "Packing and Shipping Instructions" on page 194](#).

Micro Marathon Express Vacuum Back End

Step	Action
1.	The robot arms are secured in place with shipping brackets for protection during shipment, and these brackets must be removed before attempting to operate the robot.
2.	Open the chamber lid.
3.	Unscrew the arm shipping brackets. Remove the brackets and save for future use. If the MMX Vacuum Back End is shipped, the brackets must be replaced before shipping.
4.	Close the chamber lid.

VCE Module

The door and the cassette platform of the VCE is secured in place for protection during shipment. These shipping brackets must be removed before attempting to operate the VCE. Refer to the *VCE User Manual* for detailed instructions on removing the shipping brackets.

Step	Action
1.	Remove the brackets securing the door to the frame of the VCE.
2.	Remove the bracket securing the cassette elevator platform to the back wall of the VCE chamber.

Installing the Micro Marathon Express

The MMX must be positioned within the facility to ensure proper handoff between the facility wafer carriers and the Vacuum Cassette Elevator.

Once the MMX system is positioned, the Wafer Transfer Plane must be adjusted to the proper height and the system must be leveled.

After these preliminary adjustments are complete, the MMX system may be bolted to the floor using the tie-down points provided.

Leveling the Micro Marathon Express and Setting the Wafer Transfer Plane

Adjustable feet are provided on the frame of the MMX.

These feet are used for the following:

- To support the MMX Vacuum Back End and VCE
- To set the Wafer Transport Plane (WTP)
- To compensate for an uneven floor

Step	Action
1.	Move the tool to its installation location.
2.	Lower each of the four leveling feet (on the back of each wheel) on the VBE until it just touches the floor and then hand tighten it. Refer to Figure 3-2 .
3.	Open the chamber lid and set it in the support slots.
4.	The correct height of the tool is 1153.16 mm (45.4 inches), measured from the top of the chamber to the floor. Refer to Figure 3-3. This will establish the Wafer Transport Plane (WTP) at the SEMI MESC height of 1100.0 mm (43.31 in) per SEMI E21. Refer to Figure 3-4. Beginning with the leveling foot located at position 1, adjust the foot until the height of the tool from the top of the chamber to the floor is 1153.16 mm (45.4 inches). Refer to Figure 3-5.
5.	Place a spot level (or bubble level) on the corner of leveling foot at position 1 (Refer to Figure 3-5) and jack leveling feet at positions 2, 3, and 4 until the system is level all around.
6.	Confirm the system is level by checking leveling at all four leveling feet locations and adjust the height of each foot as necessary. NOTE: The system must be level and at the required height or components in the system and/or product will be at risk.
7.	Hand tighten each leveling foot and then tighten the locking nut on each leveling foot against the bottom of its caster.

Step	Action
8.	Lower the 2 VCE feet to the floor. Hand tighten each foot and then tighten each one further with a quarter turn with a wrench. Snug each foot to the floor, but do not over constrain. Refer to Figure 3-6 .

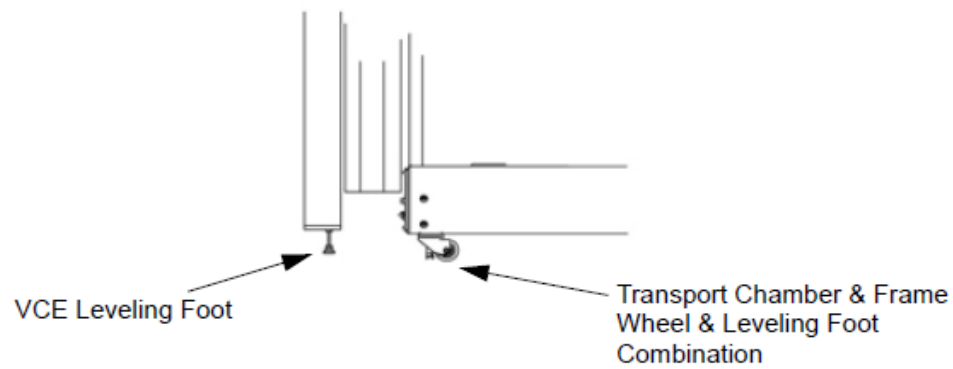


Figure 3-2: Lowering the Combination Leveling Feet

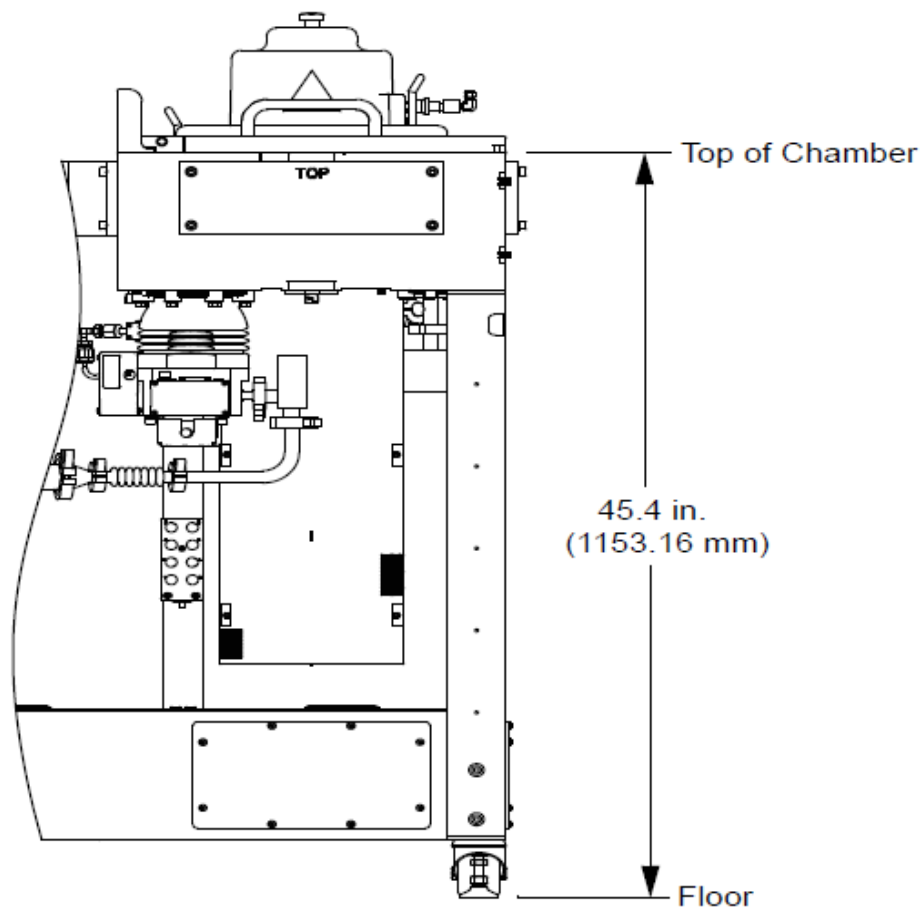


Figure 3-3: Height of Tool for Leveling

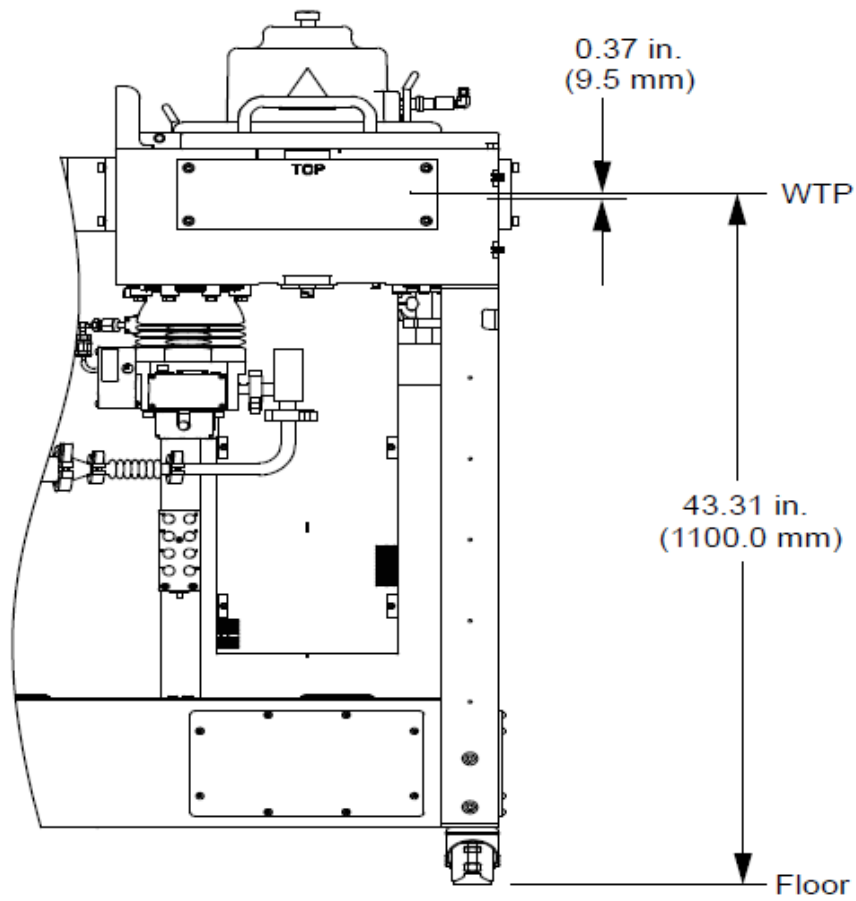


Figure 3-4: Wafer Transfer Plane

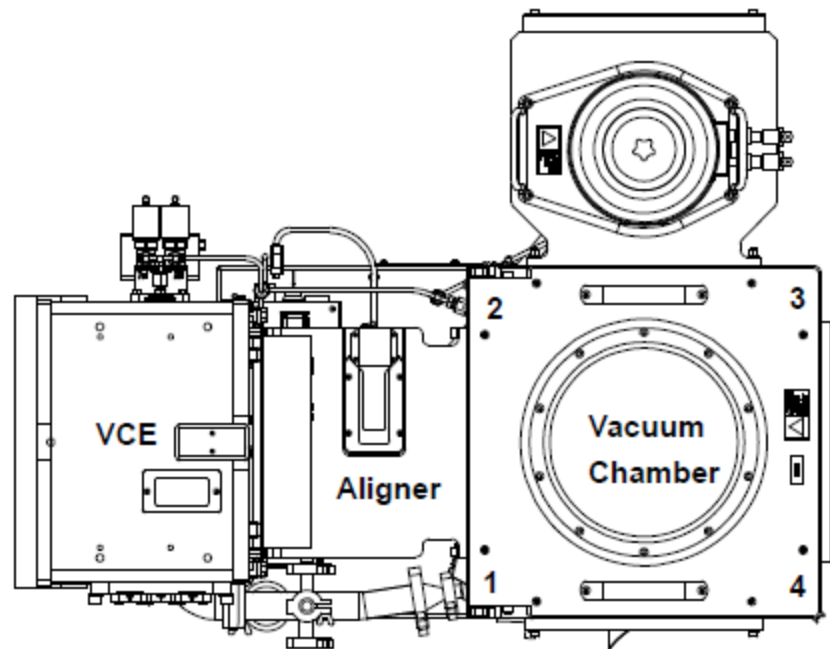


Figure 3-5: Location Positions of Leveling Feet (procedure reference only)

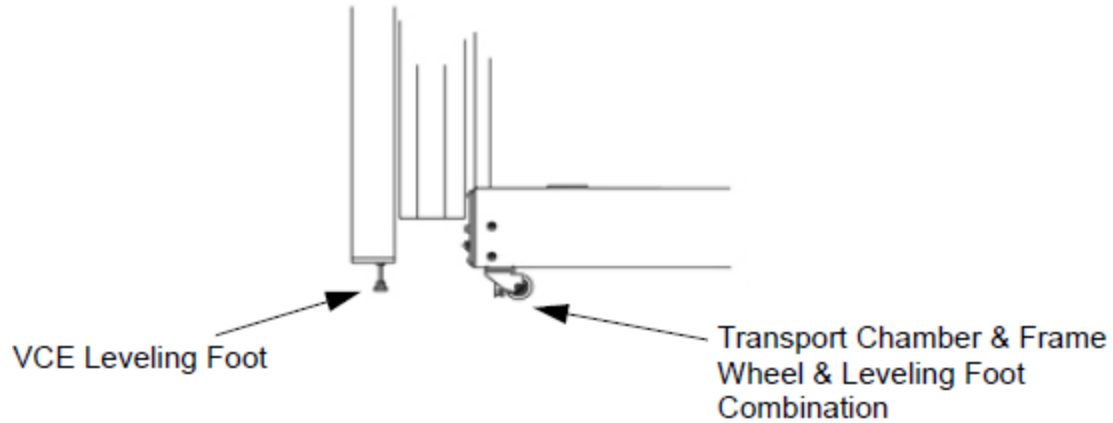


Figure 3-6: Lowering the VCE Leveling Feet

Mounting the Process Modules to the MMX System

Any components that will be mounted to the MMX Transport Chamber are assumed to conform with SEMI MESC standards.

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

Step	Action
1.	Remove the blankoffs from the vacuum facets of the MMX Vacuum Back End.
2.	Adjust the Process Module so that its Wafer Transfer 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 MMX by inserting the pins on the Process Module into the holes on the Vacuum Slot Valve of the facet. NOTE: <i>It may be necessary to re-adjust the height of the module(s) to align them to the Transport Chamber. If a height re-adjustment is required, take care to ensure that the module remains level.</i>
4.	Once the Process Module is mated, clamp the flanges of the Process Module and the Slot Valve together using the ISO clamps provided.

Intermodule Connections

The standard configuration of the MMX does not require any connections be made between the MMX Vacuum Transport System and the VCE module during installation. If the VCE was not installed on the Transport System, or a VCE was replaced, refer to the ["VCE Replacement Procedure" on page 175](#) section for connection information.

Most cables in the MMX are shipped from the factory already connected to the tool. However, individual subsystems such as any rack mountable components must be connected during installation.

Wiring, vacuum, and vent system diagrams for the specific system configuration are supplied with this manual. Refer to these diagrams while installing the system to verify correct connections. The configuration of the MMX 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 MMX requires compressed air, nitrogen (vent gas), vacuum, exhaust, electrical power, and communications connections. Refer to ["Facilities Specifications" on page 20](#) for detailed descriptions of the required user-supplied facilities.

All MMX Cluster Tool Integration Platforms come with the required connectors to facilitate interfacing the system, along with connectors for the vacuum sources. The MMX system is supplied with Facilities and Interface Panels. All the connectors on the facilities interfaces are labeled for easy identification. Refer to the electrical and mechanical drawings supplied with the System Manual and to ["Operational Interfaces"](#) 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.	 

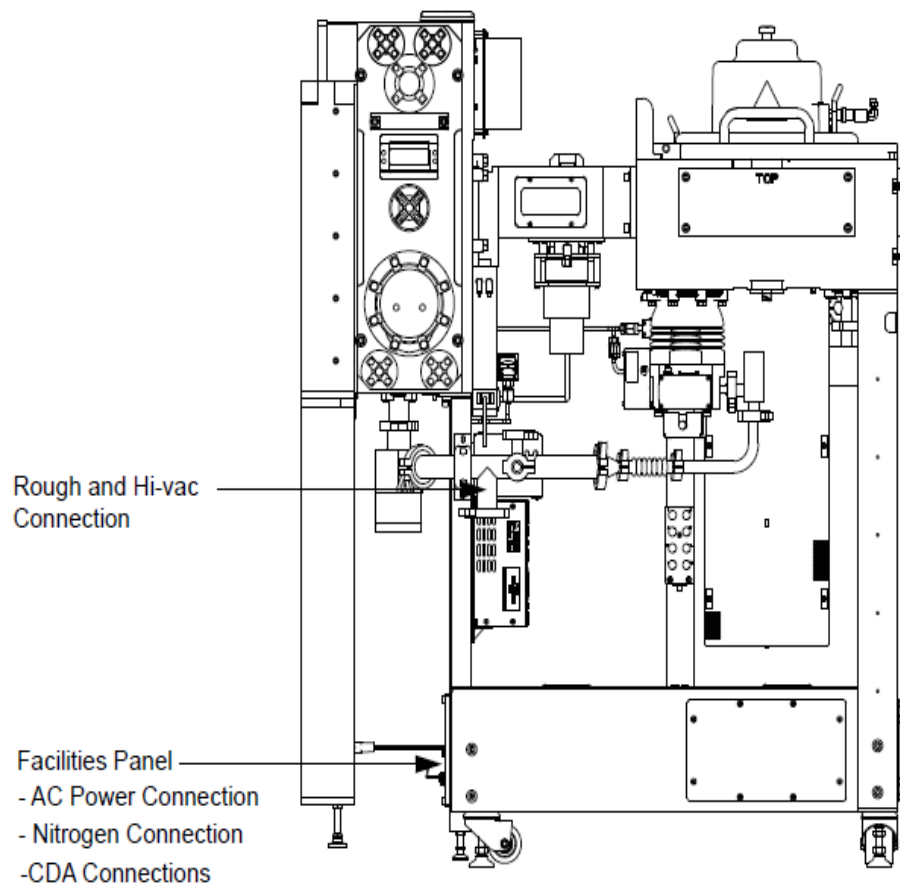


Figure 3-7: Micro Marathon Express Interface Locations

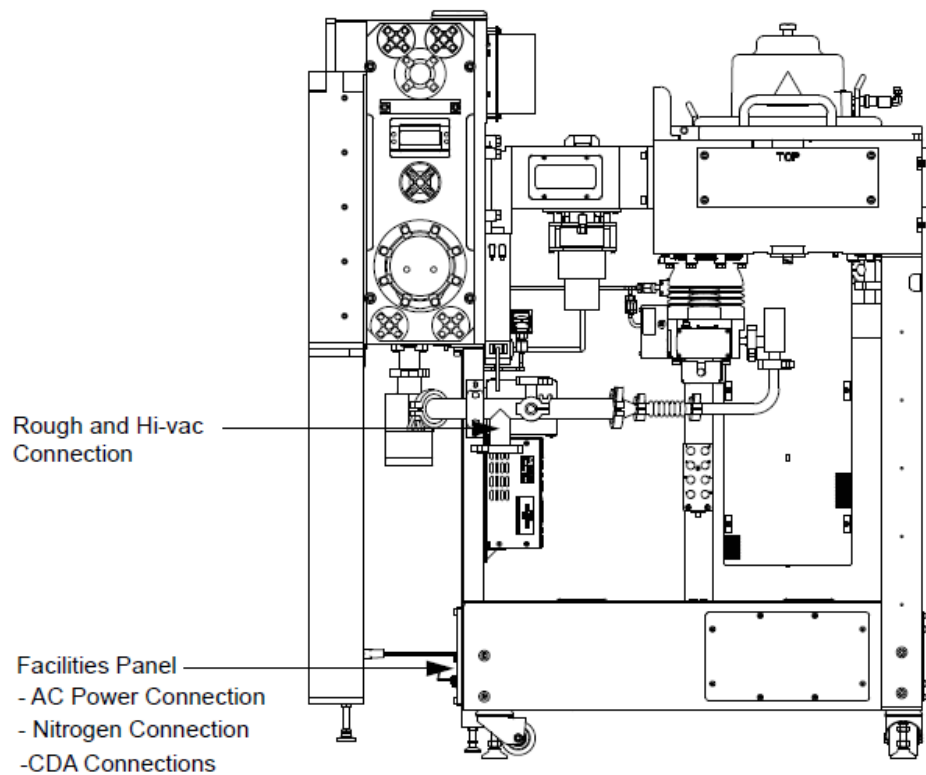


Figure 3-8: Micro Marathon Express Interface Locations

Electrical

Electrical power is connected to the MMX for operation of the robot, elevators, sensors, and other subsystems. A 200 - 240 VAC electrical connection is provided on the MMX for AC power from the facility. Refer to "[Facilities Specifications](#)" on [page 20](#) 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 MMX and all installation procedures have been completed.

Gen5 EN Controls

Connect an AC power cable from the facility's main power disconnect to the power connector on the AC Power Distribution Unit.

EMO Circuit

Step	Action
1.	The EMO circuit is the responsibility of the user. An optional EMO button may be supplied with the system for the user's convenience.
2.	Once the EMO circuit is wired and tested, remove the Warning label from the optional EMO button.

Pneumatic

Air is connected to the MMX for operation of the Vacuum Cassette Elevators, Slot Valves, and Atmospheric Doors. Quick connect air ports are provided on the MMX system's Pneumatic Facilities Panel. Refer to "[Facilities Specifications](#)" on [page 20](#) for pneumatic requirements. Ensure that the pneumatic connection is for the appropriate pressure.

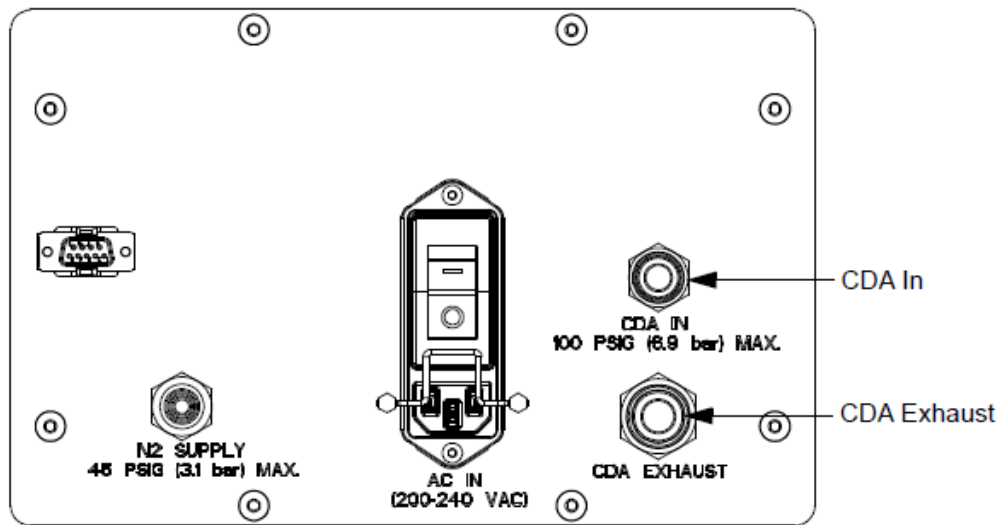


Figure 3-9: Pneumatic Connections

Step	Action
1.	Connect the compressed air line from the facility to the 10 mm "CDA in" air connection on the MMX system's Pneumatic Facilities Panel as shown in Figure 3-9 .

Nitrogen

Nitrogen is connected to the MMX for venting the Vacuum Cassette Elevators and the MMX Vacuum Back End. A 1/4-inch VCR connection is provided on the MMX system on the Gas Facilities Panel. Refer to "[Facilities Specifications](#)" on [page 20](#) 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 MMX and all installation procedures have been completed.

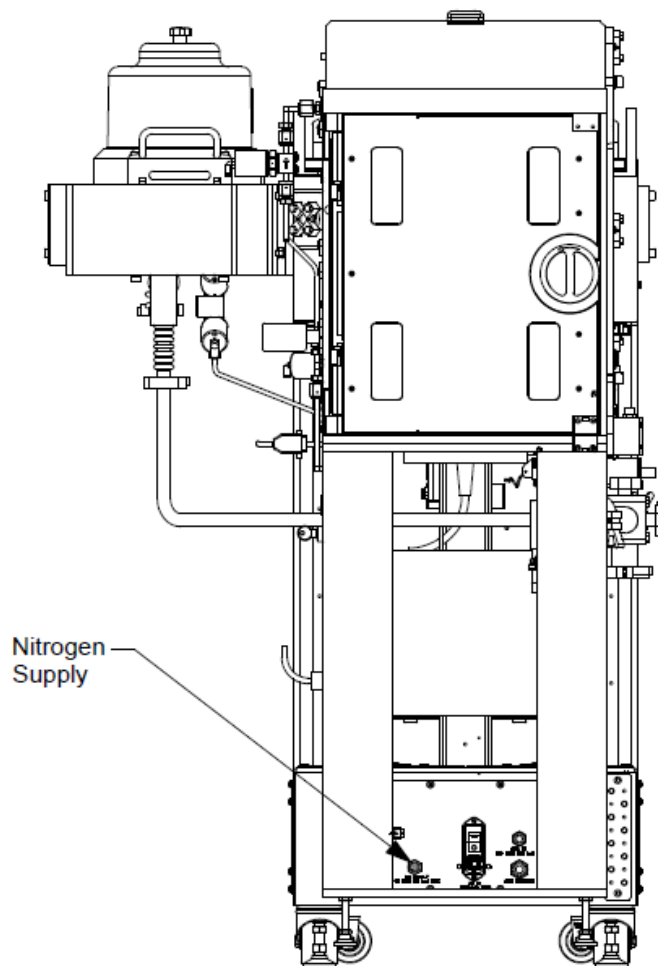


Figure 3-10: Gas and Vacuum Connections

Step	Action
1.	Connect the nitrogen line from the facility to the Nitrogen connection on the MMX system as shown in Figure 3-8 and Figure 3-10 .

Vacuum

An appropriate user supplied vacuum system must be connected to the MMX Vacuum Back End to provide the desired pump-down times for the vacuum chambers. Refer to "[Facilities Specifications](#)" on page 20 for vacuum requirements and [Figure 3-8](#) and [Figure 3-10](#) for vacuum system connections.

Depending upon the configuration of the MMX, differential vacuum may need to be supplied to various seals including the vacuum aligner and the vacuum cassette elevator for proper operation of these units. If differential vacuum is required it is taken directly off of the roughing vacuum line, no user connection is required.

Step	Action
1.	Connect the facility's rough-vacuum system to the MMX as shown in Figure 3-10 . NOTE: Do not turn on the vacuum connection until all connections to the MMX and all installation procedures have been completed.

Exhaust

A line to receive exhaust from operation of the MMX is connected to the Vacuum Cassette Elevator and MMX Vacuum Back End. One 8 mm quick connect exhaust port is provided on the MMX system's Pneumatic Facilities Panel. Refer to "[Facilities Specifications](#)" on page 20 for exhaust requirements.

Step	Action
1.	Connect the exhaust line from the facility to the 10 mm quick connect EXH connection on the MMX system's Pneumatic Manifold as shown in Figure 3-9 .

Communications Connections

The modules within the MMX typically use Ethernet.

 WARNING Automatic Movement	
Unexpected automatic motion can result in personal injury. Never connect or disconnect the communications lines with power applied to the MMX as unexpected motion may result.	

NOTICE

Never connect or disconnect the communications lines with power applied to the MMX as damage to internal components may result.

Ethernet

The standard configuration of the MMX supports Ethernet communication between the host controller and the robot.

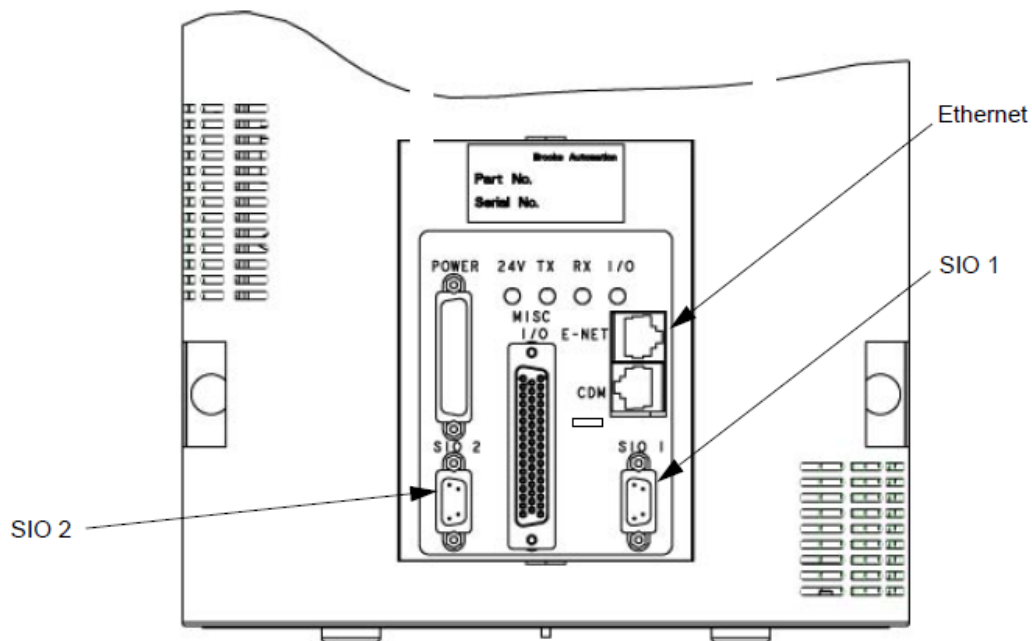


Figure 3-11: Ethernet Communications Connections

Step	Action
1.	Connect the Ethernet cable for communications from the host controller to the Channel 1 Ethernet connection on the "Safety Hub" on page 95 . Pinouts for this connection are provided in "Operational Interfaces" .

Generation 5 EN Controls

The control system provides a single Ethernet connection from the host controller to the MMX.

Ethernet

The standard Gen 5 EN Controls configuration of the MMX system supports Ethernet communication between the host controller and the MMX system.

Step	Action
1.	Connect the Ethernet cable for communications from the host controller to the robot.

DeviceNet

The Controls configuration of the MMX supports DeviceNet communication between the host controller and the MMX system. Make the DeviceNet communications connection to the MMX system as detailed below.

Step	Action
1.	Connect the DeviceNet cable for communications from the host controller to the DeviceNet Junction block.

Software Installation

The MMX requires no software installation in any of its modules. All MMX system control software is loaded on the VCE, the robot, and the vacuum aligner at the factory.

Upgrades to the software can be downloaded through the serial I/O port or through the optional network communications link. Refer to the Upgrade Procedure in the Release Notes supplied with the software upgrade.

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 MMX system and verify that it is ready for operation.

Step	Action
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 VCE's doors are closed. • Ensure that the MMX vacuum chamber and load lock lids are closed and secured.
3.	Mechanical Checks: • Verify all shipping brackets have been removed. • Ensure that the VCE modules are properly and securely mounted to the MMX. • Ensure that the MMX has been properly secured within the facility. • Ensure that the OEM Process Module(s) are properly and securely mounted to the MMX Vacuum Back End. • Ensure that all hardware is secure. • Verify all protective covers are in place. • If the optional EMO button was supplied, ensure that it is functional, and remove the Warning label from the EMO button. • Perform chamber leak test if required.
4.	Facility Checks: • Ensure that all facilities are capable of meeting, or exceeding, the requirements as described in "Facilities Specifications" on page 20. • Ensure that the power, communications, air, exhaust, nitrogen, vacuum, 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.

Step	Action
5.	Pre-operation Checks: Ensure that there are no obstructions in the travel path of the robot and its end effectors within MMX. NOTE: <i>Some of the internal components of the MMX may present travel obstructions to robot end effectors in certain cases. It is the user's responsibility to control the robot such that the robot, and any material in transport, do not come into contact with these components.</i>
6.	Connect the MMX to the facility's electrical services. NOTE: <i>HIGH VOLTAGE - 200 - 240 VAC at 10 Amps. The AC circuit must be properly protected.</i>
7.	Turn on vacuum, air, and nitrogen.
8.	Turn on the AC power from the facility to the MMX.
9.	Turn on the power within the MMX system. The following may be observed: • Audible sounds: fans in product • Visual indicators: Power On indicator will light • Pneumatic system pressurization. If the initialization sequence executes without error, then the MMX Vacuum System is properly installed and all the components are communicating successfully.
10.	Verify proper operation of all interlocks (refer to "Disconnect Devices" on page 37). The MMX System must be aligned and taught to the system in which it is to operate. Even a small misalignment can interfere with proper product operation and may cause material breakage or product damage.

The MMX System must be aligned and taught to the system in which it is to operate. Even a small misalignment can interfere with proper product operation and may cause material breakage or product damage.

Refer to ["System Alignment"](#) for the alignment and teach procedures.

NOTE: Do not attempt to operate the MMX System until it has been properly leveled and the robot pick and place operation is verified.

4. Subsystems

The Micro Marathon Express (MMX) provides a controlled, ultra-clean environment for material transfer between the factory and the process equipment. The MMX system is composed of Brooks Automation components and additional subsystems creating a complete system.

Depending on system configuration (refer to ["Configuration" on page 16](#)), some components discussed in this section may not be present on a particular system.

NOTE: This manual is intended to provide information about a wide variety of MMX systems and may contain references to items not installed on a specific system.

The MMX system consists of a vacuum chamber with an integrated Load Lock, material-handling robot, material sensors for each station, and environmental controls. The MMX system is designed to transfer materials among standard SEMI MESC compatible material-handling or processing modules in an ultra clean, vacuum environment. These modules include all Brooks-supplied modules and all user-supplied Process Modules. The vacuum environment within the Cluster Tool is maintained by a controller in conjunction with the Cassette Module and the user's Process Modules connected to the chamber.

Material transfer between these modules occurs across a single horizontal plane called the Wafer Transfer Plane (WTP). The robot end effector and all access ports in the chamber walls are aligned to the WTP. This configuration permits attachment of material-handling or processing modules to each facet of the chamber.

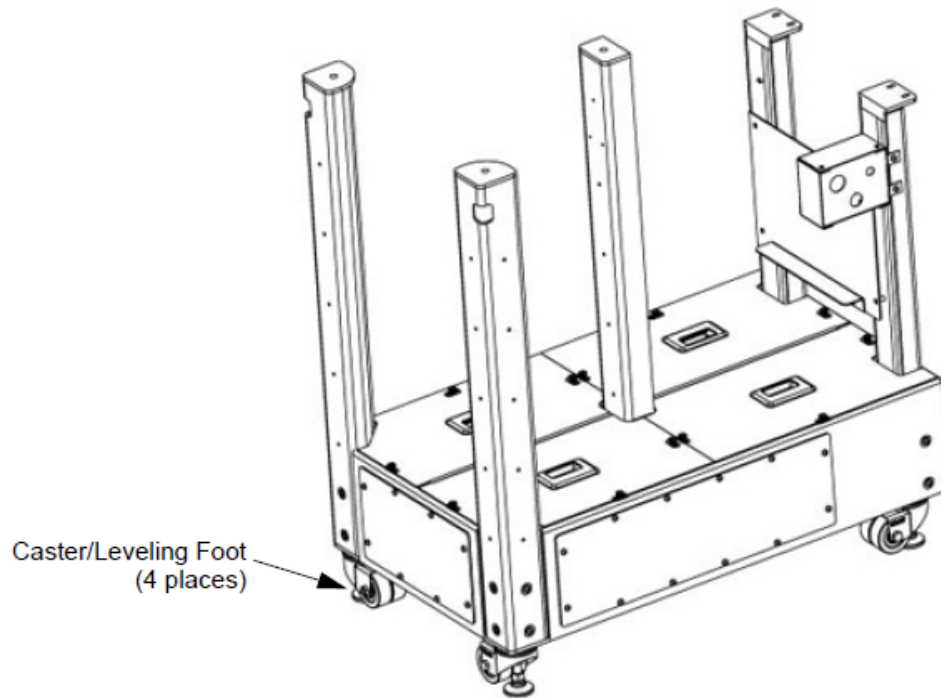


Figure 4-1: Micro Marathon Express Frame

NOTICE

The minimum overturning moment is 100 ft-lbs applied to any Process Module facet.

The MMX frame is provided with 4 casters for rolling the chamber and frame to its destination. The frame is also equipped with adjustable feet allowing adjusting and leveling of the Vacuum Transport Chamber. Tie-down mounting holes are provided for facilities that want to eliminate movement of the system. Seismic hold-down for facilities requiring earthquake protection are the responsibility of the user. The tapped holes for the seismic tie down hardware are threaded for a M10 X 5.5 X 14 mm hardware.

Service access is provided under the chamber behind the VCE and between the Process Modules, refer to [Figure 1-3](#) and [Figure 1-4 on page 24](#).

Service Access

Service access is provided under the chamber behind the VCE. The chamber lid is removable for full access to the robot arms.

Power Distribution

AC Power Distribution

The frame mounted AC Power Outlet Strip is used in the control systems and provides a single point of connection to the MMX system. The AC Power Outlet Strip supplies AC power to the robot, the VCE load lock, the aligner, and any additional devices. All devices provide their own conversion from AC power to DC power.

NOTE: The Outlet Strip is not intended to supply power to user installed modules.

Circuit Protection

The main power line is protected through a 10 Amp multipolar magnetic circuit breaker. The breaker is a current-limiting device which disconnects the MMX from the utility in the case of a fault (short circuit).

Vacuum Systems

The modular design of the MMX allows for configuration changes to support different vacuum system packages. To the extent possible, the individual vacuum system packages feature the same components to reduce the number of required spare parts and to simplify maintenance and repair.

The MMX systems are supplied with vacuum system packages to provide environmental control for the Transport Chamber, the Load Lock, 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 cycles by using profiled pump downs and profiled vent ups where required. The complete MMX system provides integrated management of all vacuum system packages supplied with the system.

Each vacuum system package has five elements: a pumping system, a vacuum measurement system, chamber isolation valves, a venting system, and a vacuum control system. Each of these systems is described below.

Refer to the System Block Diagram and Schematics and Vacuum and Vent Diagrams supplied with this manual.

Pumping System

The pumping system is designed to bring modules from atmospheric pressure to high vacuum with minimum introduction of contaminants and turbulence. Each module to be evacuated generally incorporates a main pump, a backing pump, a pump vent valve, and a pump controller. Roughing vacuum is required and can be provided by a Brooks Automation supplied backing pump or from a user-provided source.

Main Pump

Main pumps, which are normally turbomolecular (turbo) pumps, are used to evacuate the Transport Chamber and VCE chambers. Main pumps are selected on the basis of the following features:

- High reliability with minimum vibration and contamination
- Capability to pump from atmosphere to pressures below 10^{-5} Torr

High Vacuum System

The modular design of the vacuum system accommodates several different brands of pumps for high vacuum systems. The plumbing manifold is terminated at a single KF-40 connection. The MMX system's design will accommodate several different SEMI compatible isolation valves (SMC, VAT).

Backing Pump

High vacuum pumps require backing vacuum pumps to operate properly. The MMX systems normally require a user-supplied dry diaphragm or scroll pump to provide the backing vacuum. This is a pump with dry working chambers, i.e., the gases being pumped from the pump chamber do not come into contact with any lubricant. Backing pumps are placed where convenient by the user.

Pump Vent Valve

The pumping system includes valves to permit automatic 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.

Pump Controller

Individual pump controllers supervise the operation of each main pump. Each pump controller accepts and executes pumping system on/off commands from the host controller.

Some main pumps require remote control, which typically comes from the user's host controller. Other main pumps (some turbo pumps) lack integral pump controllers. Their individual controllers are rack mountable.

Roughing Pump

The MMX systems use a single mechanical dry pump. A two-stage, slow/fast roughing process is used on the Load Lock, and a single-stage fast rough process is used in the Transport Chamber. When high vacuum pumps are installed on the system, the same dry pump may sometimes be used as a backing pump.

Rough Vacuum System (High Speed Rough/Base Configuration)

The high performance two-stage rough vacuum system achieves a fast rough (Load Locks and Transport Chamber) at 2 minutes/100 mTorr. The rough plumbing manifold for the Load Locks is terminated at a single point KF-40 connection under the Load Locks. The rough plumbing manifold for the Transport Chamber is terminated at a KF-40 connection under the chamber.

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. For an overview of the isolation valve cabling and control, refer to the System Block Diagram.

Vacuum Isolation Valves

The Load Locks vacuum system include a valve located between the Load Lock chamber and the main pump. This valve is used to isolate the chamber from the module's vacuum system during chamber vent cycles and when the vacuum system is not operating. On the Transport Chamber, the main pump is mounted directly on the chamber.

Transfer Isolation Valves

The MMX is supplied with Transfer Isolation Valves (Slot Valves) located between the Transport Chamber, the Load Locks, and the Process Modules. These valves are used to isolate the Transport Chamber from the Load Lock chambers during vent cycles (load and unload operations) and to isolate the Transport Chamber from the environmentally controlled Process Modules during material processing. Slot valves permit the chamber to remain at vacuum while hostile environmental conditions occur within Process Modules during material processing. Slot Valves are controlled by the host controller.

External vacuum slot valves are located between the Process Modules and the Vacuum Transport Chamber. This isolates the process gases with the Process Module to prevent contamination of the environment within the Vacuum Transport Chamber. These slot valves are mounted to the Vacuum Transport Chamber with the seat side against the chamber. The seat side has a seal and is indicated by the pointing of the triangle stamped on the flange.

External vacuum slot valves are also located between the Load Lock or VCE and the Vacuum Transport Chamber. This allows the Vacuum Transport Chamber to maintain a vacuum while the Load Lock is vented for material transfer.

Venting System

The MMX uses two stage venting through a filter and a diffuser. The Transport Chamber uses a fixed orifice vent valve, which is either open or closed, as material should not be present during venting, therefore particulate redistribution is not a concern. The Load Lock uses two-stage fixed orifice venting because of possible material presence. However, fully controllable soft-venting is available in the Load Lock chambers if desired.

To minimize particulate redistribution during the Load Lock chamber vent cycle, both the two-stage fixed orifice and the variable flow venting subsystems employ a controlled flow of nitrogen to vent the evacuated chamber. The initial rate of flow of nitrogen into the chamber remains low (molecular pressure regime, no boundary layer to restrict particle movement) until the chamber pressure reaches a pre-determined set point. After reaching the set point, venting proceeds at a higher rate (viscous pressure regime, boundary layer suppresses particle movement) until the chamber reaches atmospheric pressure.

Vent System

The MMX high volume vent system provides less than one minute vent cycling. A 0.012 um high purity 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.

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 evacuated chamber, the system consists of a vacuum measurement controller, one or two low-vacuum gauge heads and a high-vacuum gauge head.

Vacuum Measurement Controller

The vacuum measurement system includes Vacuum Measurement Controllers located in the smart gauges that interpret signals from the gauge heads 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 5×10^{-8} Torr region. Two types of vacuum gauges are used on the MMX system: MicroIon and MiniConvectron. MiniConvectron gauges are heat transfer based and have a pressure range from atmospheric level down to 1 mTorr (1×10^{-3} Torr).

MicroIon gauges are hot cathode ion gauges which cover the pressure range from 50 mTorr down to 5×10^{-8} Torr. The ranges of both gauges overlap so that the Micro-Ion 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 a single cable for +24VDC power and RS-485 multidrop communication and set-point relay signals.

Low-vacuum gauges permit monitoring of chamber pressures under low-vacuum conditions, such as at the start of an evacuation cycle. The high-vacuum gauge permits monitoring of chamber pressures at high vacuum, i.e., less than 10^{-3} mbar of pressure. Some hot ion gauges will require periodic adjustments of the control unit and calibration against a known gauge. Refer to the specific gauge manual for this procedure.

Vacuum System Control

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

Pneumatic System

Compressed air is used to power various valves within the MMX system's vacuum systems. The Pneumatic System also provides control and routing of compressed air for control of all pneumatically operated subsystems. Located in the frame below the robot, the Pneumatic Facilities Interface is easily accessible for service.

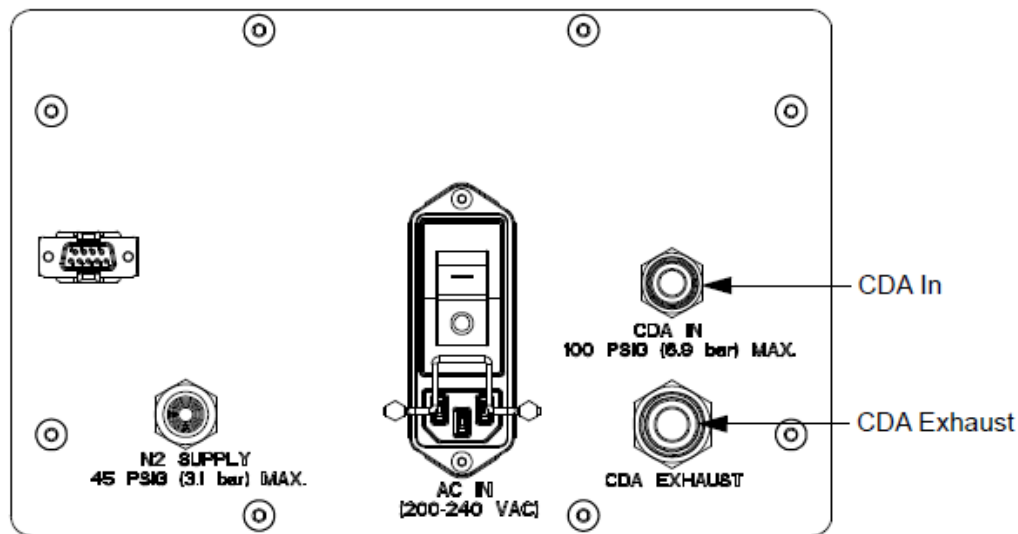


Figure 4-2: Pneumatic Facilities Connection Panel

One pneumatic manifold is used on the MMX system.

Pneumatic Manifold PMAN.TC: Located in the sub-floor of the unit, operates all pneumatically controlled devices. This includes the Slot Valves, the Isolation Valves, Rough Valves, Slow Rough Valves, Fast Vent Valves, Profiled Vent Valves, and the Cryo Pump Rough and Regen Valves.

With the proper sizing of air lines and exhaust lines, minimal supply sag and exhaust back pressure is achieved. The tubing for the pneumatics is color coded for easy tracing and routed separately from the electrical cables through the middle trough of the wireway. The air pressure is monitored by the Digital Pressure Switch located on the Main Pneumatic Supply panel. Refer to the System Block Diagram, Pneumatic Diagram, and Vacuum and Vent Diagrams supplied with this manual.

Gas System

The MMX frame assembly includes a gas facilities interface, shown in [Figure 4-3](#). This provides a centralized connection for the Cluster Tool to nitrogen and rough vacuum supplied by the facility. Located on the frame, below the chamber near the Load Locks, the Facilities Interface is easily accessible for service.

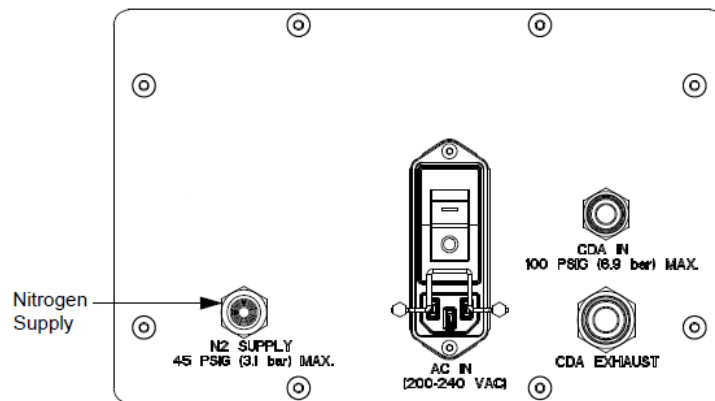


Figure 4-3: Nitrogen Facilities Connection

A Digital Pressure Switch, shown in [Figure 4-4](#), is used for monitoring the flow and indicating the pressure of the facility supplied nitrogen.

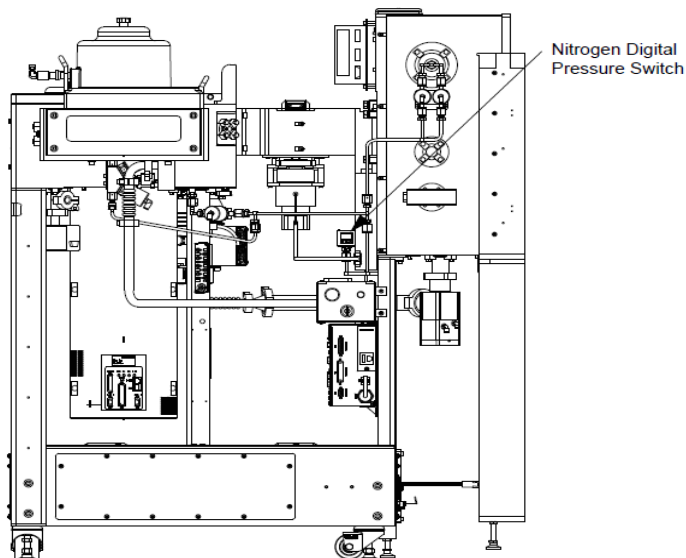


Figure 4-4: Gas Pressure Monitoring

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

Electrical System

On a minimal system (a system without turbo pumps), power goes from the main inlet to the VCE, where it is then distributed to the Safety Hub and the robot controller.

On a system with turbo pumps, a power strip that distributes 200 - 240 VAC Single Phase at 50/60 Hz supplies AC power to the MMX System. The power strip has a double pole circuit breaker and 4 outlet plugs. The VCE is plugged into the first outlet. The turbo pump controllers are connected to the 2nd and 3rd outlet. The 4th plug position is reserved. The input to the power strip connects to the facilities panel.

All circuits in the MMX System are grounded for both safety and low noise. The grounding system improves tool communications through better noise suppression. A grounding strip is located below the Buffer.

Electrical, System: 200 - 240 VAC @ 50/60 Hz, 10 A single phase
based on configuration and operating mode.

SCCR: 300 A

Inrush current: 50 A

Overvoltage Category: Category II.

System must be installed on the load side of a user supplied 10 A circuit breaker.

The actual power being drawn depends upon operations being performed, however all power wiring must be capable of carrying the full load.

NOTE: The facility is responsible for the main disconnect device between the Product and the facility's power source. It must comply with the correct electric codes. Service to the product must have the appropriate fuse or circuit breaker rating. The main user installed disconnect device must meet, or exceed, the minimum SCCR rating specified by SEMI S2. All current requirements shown are maximum values, the actual current drawn depends upon the use of the MMX.

Power Cable

The power cable plugs into the product at the MMX interface panel.

Generation 5 EN Controls

The Generation 5 EN (Gen 5 EN) control system, provides Ethernet and DeviceNet connection from the TMC to the MMX. These connections provide communications for all controlled and monitored devices on the MMX system including: robots, aligners, load locks, pumps, valves, and gauges.

Robot Power Supply

The Robot Power supply is mounted on the Transport Chamber frame under the chamber. The Robot Power supply provides the DC power supply for the robot and aligner. The robot power supplies are stand alone units that replace the Minihub in Vacuum Systems that use a robot. The Power Supplies do not have the interconnect PC Board that is on the top of the Minihub. The board is replaced by the interconnect board on the top of the Safety Hub.

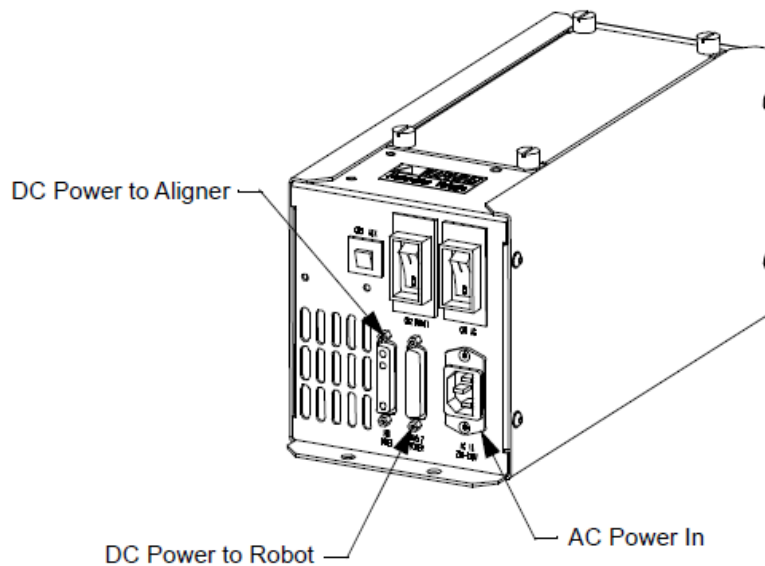


Figure 4-5: Robot Power Supply

Refer to the System Block Diagram supplied with this manual and ["Robot Power Supply" on page 90](#) for pinouts.

Key Switch on Facilities Panel

The key switch on the Facilities Panel sets the working mode of the MMX System. There are three settings:

- AUTO (Automatic)
- OFF/RESET
- MAN (Manual)

See the controls manual for more information.

Micro Marathon Express Vacuum System Controls in the Sub-Panel

The controls for the MMX System are located in the sub-panel in the bottom of the frame. The controls

the sub-panel contains include the following:

- Safety Hub
- Robot controller
- Pneumatic Manifold
- 8 port DeviceNet input block
- Devicenet Junction Block
- Cool Dry Air (CDA) pressure switch with Lockout/Tagout

Safety Hub

The Safety Hub is a multi-function module that connects to and/or controls other intelligent modules within the system. The Safety Hub replaces the Minihub or Microhub on previous systems.

The Safety Hub contains a power supply that provides up to 8A of 24V DC power for the DeviceNet network and all modules connected to the network, as well as supplying power to internal components of the Safety Hub.

The Safety Hub has a DeviceNet Slave Module that interfaces the customer's host system software with pneumatic controls and status monitoring. It also has a number of other control and status functions that are detailed in the controls manual. Errors reported by the Safety Hub diagnostic I/O must be handled by the tools host software to alert the operator.

For more information, see the controls manual.

DeviceNet

The DeviceNet tool communications network allows the host controller to communicate with the various subsystems of the MMX over a single internal network cable. Additionally, power can be provided over the DeviceNet network cable to low power modules. Each DeviceNet module has a dedicated DeviceNet Node with a unique address.

See the controls manual and system block diagrams for more information.

Theory of Operation

DeviceNet is a cost-effective industrial network consisting of one master controlling one or more slaves and is used to connect devices such as limit switches, photoelectric cells, valve manifolds, motor starters, drives, and operator displays to PLCs and PCs. It eliminates expensive hard-wiring and provides enhanced device-level diagnostics. Any DeviceNet modules can be connected to the network within the MMX system. Network termination is supplied by the DeviceNet Master Node, making network wiring very simple as no additional termination is required.

Each device on the network has a unique node address known as a MAC ID (Media Access Control ID).

The MAC ID (network address) is typically set using two rotary switches. There may be up to 64 devices (including the controller) on a DeviceNet network. For this reason, the MAC ID and BAUD RATE of the Network Modules must be specified in software to exactly match that selected by the switches on the actual Network Modules.

Baud rate for each network connection is typically set at the node. The baud rate of all nodes must be the same and is typically set to 500.

Both power and communications signals are provided through the DeviceNet cable. In some cases the power provided through the cable is enough to power the device connected to the DeviceNet network, in other cases the device draws power from an external supply.

TopCooler

The Brooks Automation TopCooler™ offers maximum performance with minimum complexity through a drop-in interface into the Transport Chamber.

Refer to the TopCooler manual for more information.

Vacuum Aligner

Systems that requires precise alignment of wafers are equipped with a Vacuum Aligner Module. Typically the aligner module is an integrated version of the InLigner, installed at the front of the Transport Chamber, which is used to align wafers coming into the system from the VCE Load Lock.

See the VX Aligner manual for more information.

Material Presence Sensors

To safeguard against material-handling mishaps, the MMX Transport Chamber contains optical material sensors at each station. The MMX system's design has four radial motion material present sensors.

Each sensor is located under the chamber, with the sensor's reflector mounted on the chamber's lid, at a radius outside the retracted position of the robot. The robot senses the material on-the-fly during PICK, PLACE, GOTO, and XFER operations. Each sensor is capable of being associated to any station and configured as active or inactive during material transfer. The robot firmware will monitor these sensor inputs and use them to verify material presence status and determine the success of any material transfer operations.

Wafer Buffer Module

The optional External Wafer Buffer Module may be located on any facet of the transport chamber. This module is completely passive containing four closely spaced slots (6.0 mm (0.236-inch) pitch) for wafer storage. The robot's Z-axis motion is sufficient to access the individual wafers.

In normal operation, the wafer buffer module is used to store clean wafers for modules that require periodic clean cycles between production wafers. The module may also be used as a manual load lock by opening the door to insert or remove wafers. The design allows easy installation and service, weighing only 19.1 kg (42 lb).

The host controller tracks the placement history of the wafers within the Wafer Buffer Station. The wafer sensors at the facet will detect if a wafer has been picked up or placed to the wafer buffer station.

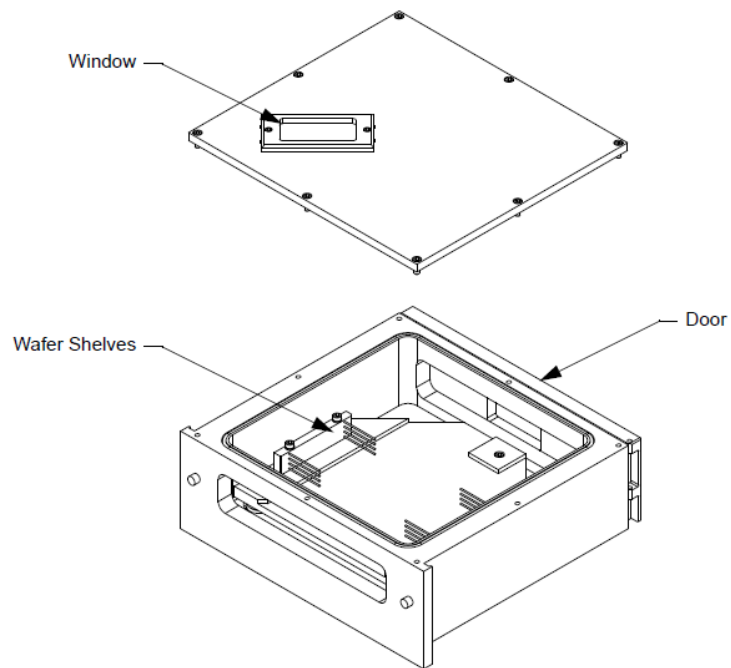


Figure 4-6: Wafer Buffer Module

Vacuum Load Locks

The MMX system can only support one vacuum load lock: a Vacuum Cassette Elevator (VCE) which, when installed with a slot-valve, functions as a load lock allowing cassettes to be changed without disturbing the environment within the chamber. On the MMX system, all plumbing for the load lock vacuum system is integrated into the plumbing on the chamber frame.

Refer to the *VCE User Manual* for complete information on the load lock.

Internal Software

The software supplied with the MMX is in the form of internal control programs that reside on the robot, the vacuum aligner, and the VCE load locks in the MMX. The user interface to this software is through either the Serial Communications Port or an Ethernet connection using software commands. Refer to the appropriate controls manuals for detailed command information.

Descriptions

The command set supplied with the robot is designed for vacuum material transfer by the robot.

The command set supplied with the vacuum aligner is designed to be used by a host controllers for wafer alignment operations using the system robot.

The command set supplied with the VCE load locks is designed for vertical positioning of wafer cassettes and mapping of the wafers within the cassettes.

Operational Interlocks

The robot software provides commands for setting up interlocks between the robot and the components in the robot's environment. These interlocks can be used to ensure the robot does not extend into a station if that station is not ready (door closed, material present, etc.). Additional interlocks can be configured to exclude certain areas within the robot's reach from access by the robot.

Refer to the robot user manual for complete information.

5. Operational Interfaces

This chapter provides a detailed description of operational interfaces to the MMX. These interfaces provide power to the MMX system and communications from the MMX system to the host controller to allow it to monitor and control all components.

Power Specifications

Electrical, System:

- 200 - 240 VAC @ 50/60 Hz, 10 A single phase based on configuration and operating mode.
- SCCR: 300 A
- Inrush current: 50 A
- Overvoltage Category: Category II. System must be installed on the load side of a user supplied 10 A circuit breaker

The actual power being drawn depends upon operations being performed, however all power wiring must be capable of carrying the full load.

NOTE: The facility is responsible for the main disconnect device between the Product and the facility's power source. It must comply with the correct electric codes. Service to the product must have the appropriate fuse or circuit breaker rating. The main user installed disconnect device must meet, or exceed, the minimum SCCR rating specified by SEMI S2. All current requirements shown are maximum values, the actual current drawn depends upon the use of the MMX.

Power Cable

The power cable plugs into the product at the MMX interface panel.

AC Power Distribution

The MMX uses an AC Power Distribution Unit (ACPDU) to distribute AC power throughout the tool. The ACPDU also provides circuit protection. [Table 5-1](#) shows the location of all connections found on the ACPDU. [Table 5-1](#) lists the connections, and shows which type of connectors are used.

NOTE: The ACPDU is not intended to supply power to user installed modules.

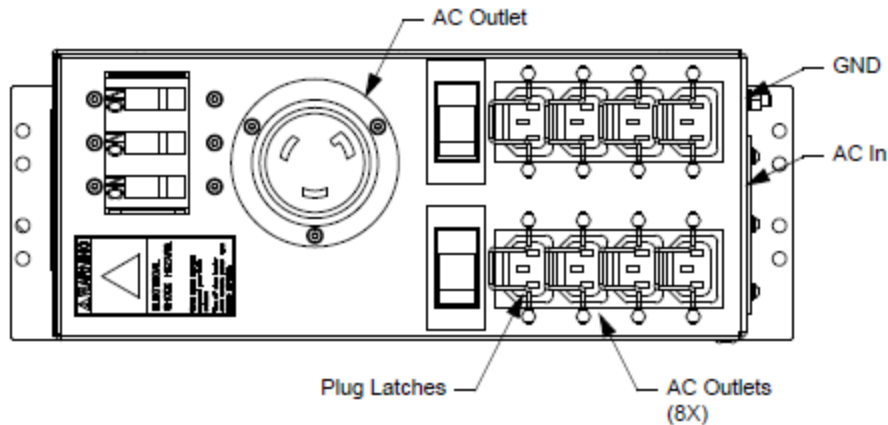


Figure 5-1: AC Power Distribution Unit - Connections

Table 5-1: AC Power Distribution Unit - Connections

Label	Description	Connector Type
RECPT 1	200 - 240 VAC @ 20 A, In	NEMA L15-30P
Earth Ground	Earth Ground	Stud, M5
RECPT 2	200 - 240 VAC @ 20 A, Outlet	NEMA L6-20R
J1.1, J1.2, J1.3, J1.4 J2.1, J2.2, J2.3, J2.4	200 - 240 VAC, 4 Total 10 A (max) Outlets (2X)	Female IEC 320

Power Connections

The MMX requires 200 - 240 VAC at 15 Amps (max) 50-60 Hz single phase (phase-to-phase or phase-to-neutral) for standard operation. The electric chamber heating option requires 200 - 240 VAC at 15 Amps (max) 50-60 Hz (phase-to-phase or phase-to-neutral). The actual power being drawn will depend upon operations being performed, however all power wiring must be capable of carrying the full load, refer to ["Facilities Specifications" on page 20](#).

See the Controls Manual and System Block Diagram for more information.

NOTE: The facility is responsible for the main disconnect device between the MMX and the facility's power source, ensuring it complies with the correct electric codes. Service to the MMX system should have the appropriate fuse or circuit breaker rating. The main user-installed disconnect device must be rated at 10,000 AIC minimum. All current requirements shown are maximum values, the actual current drawn will depend upon the use of the MMX.

The proper distribution of power is determined by the user. Brooks Automation recommends circuit breakers, ground-fault protection, contactors, and/or EMO circuitry for equipment and personal safety.

The facility is responsible for the main disconnect device between the MMX and the facility's power source, ensuring it complies with the correct electric codes. Service to the MX system should have the appropriate fuse or circuit breaker rating. All current requirements shown are maximum values, the actual current drawn will depend upon the use of the MMX. Refer to the ["Facilities Specifications" on page 20](#) for power requirements.

NOTE: Before connecting or disconnecting main power to the MMX, ensure all circuit breakers on the MMX system and any related equipment are in the OFF position. Damage to internal components may result if circuit breakers are left in the ON position.

AC Power Distribution Cable

For Gen 5 systems, the user must fabricate the power cable carrying facilities power to the AC Power Distribution Unit (ACPDU). The ACPDU is typically mounted on the MMX system's frame and provides power to the MMX system's modules. The pin-out for the ACPDU's 200 - 240 VAC cable is provided in [Table 5-2](#). The power cable connectors are shown in [Table 5-3](#).

Table 5-2: AC Power Distribution Unit Cable

AC INPUT, 200-240 VAC @ 20 A		
Pin ID	2 Phase	3 Phase
X	-	L3
Y	L2/N	L2/N
Z	L1	L1
G	GND	GND

Table 5-3: AC Power Distribution Unit Connectors

Connector Located on AC Power Distribution Unit	Connector Bagged for Facilities Power Cable
Hubbell 2425 Flanged inlet connector 250 VAC, 20A, 3 Phase, male Brooks P/N 211-0063-16	Hubbell 2423 Connector body 250 VAC, 20A, 3 Phase, male Brooks P/N 211-0068-14

Robot Power Supply

The Robot Power Supply used in Gen 5 EN Controls provides the DC Power Supply for the robot and aligner. [Figure 5-2](#) shows the location of all connections found on the Robot Power Supply. [Figure 5-2](#) lists the connections found on the Robot Power Supply, and shows which type of connectors are used.

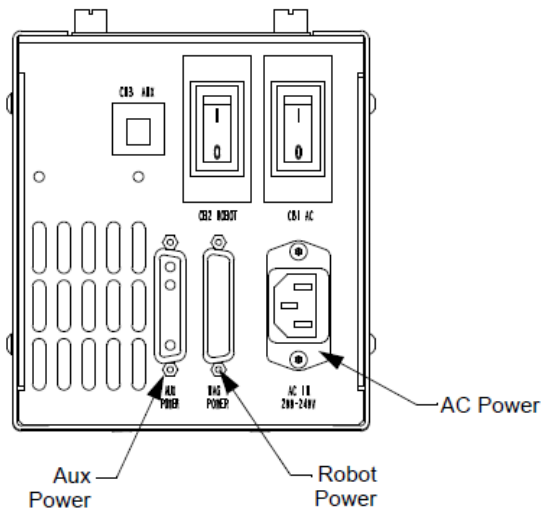


Figure 5-2: Robot Power Supply Connections

Table 5-4: Robot Power Supply Connections

Label	Description	Connector Type
AUX POWER	24V Power to Aligner	D-Type 13W3 - Female
MAG 7 POWE	24V Power to Robot	D-Type 9W4- Female
AC IN	A/C Power input	IEC 320 - C14

Facilities Specifications

Specification	Value
Nitrogen	40psig $\pm$ 5psig at 100 SLM nominal, 300 SLM maximum 1/4-inch VCR, Male
Pneumatic (Air)	90 psig $\pm$ 10psig at 50 SLM nominal, 200 SLM maximum 8 mm one touch
Exhaust	10 mm one touch
Vacuum, Rough	KF40 Flange

Communications Connections

DeviceNet Interface Connection

The DeviceNet connections within the MMX system use standard DeviceNet network communications protocols and wiring. The DeviceNet cables use standard Thin Cable with Eurofast connectors.

Table 5-5: Standard DeviceNet Network Connector Pin Assignments

Pin ID	Signal Name	Wire Color
1	Drain	Bare
2	V+	Red
3	V-	Black
4	CAN_H	White
5	CAN_L	Blue

Ethernet Network

Speeds: 10/100 Mbps

The connection to the product from the host controller uses standard UTP-Cat5 with an 8 pin RJ-45 connector, network communications protocols, and wiring.

Table 5-6: Standard Ethernet Connector Pin Assignments

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

Serial Connection

If the user is using a Turbo Pump, RS-232 communications is provided from the Safety Hub to the Turbo Pump. The configuration for the product's serial communications protocol is described in [Table 5-7](#).

Table 5-7: Serial Communications Protocol

Port Configuration	RS-232 or RS-422
Baud Rate	1200/9600
Data Bits	8
Parity	None
Stop Bits	1
Optional Parameters	
Handshake	No
RTS/CTS	No
XON/XOFF	No

These parameters may be changed as needed by the user through the internal web server of the Lantronix Ethernet to Serial device. This is accessed using any standard web browser and navigating to IP Address 20.20.249.5 The serial communications cable uses a standard DB-9 connector that plugs into the Turbo Pump, if used. The pin-out for this connection is provided in [Table 5-8](#). Pins not identified with a signal name are to be left unconnected.

Table 5-8: Standard RS-232 Connector Pin Assignments

Port Configuration	RS-232 or RS-422
1	
2	TXD
3	RXD
4	
5	GND
6	
7	
8	
9	

Environmental Requirements

ISO 14644-1 Class ISO 6 or better clean room ambient.

Specification	Value
Temperature	Operating: 20° C to 30° C (68° F to 86° F) Shipping: -25° C to 55° C (-13° F to 131° F), up to 65° C (149° F) for 24 hrs. max Storage: -25° C to 55° C (-13° F to 131° F), up to 65° C (149° F) for 24 hrs. max
Humidity	30% to 55% (relative, non-condensing)
Lighting	Standard lighting provided in the clean room environment where the Product is installed is sufficient for proper operation. Maintenance may require a user supplied service lamp (i.e., flashlight).

Service Access

The Product requires adequate space for service access and for proper operation. Refer to the Mechanical Layout Drawing supplied with this manual for system dimensions.

Ensure that installation of the MMX System is such that it provides access to items required for service after installation, such as the lid, Load Lock, Buffer, and connection panels.

Keyswitch Connection

The Keyswitch sets the working mode of the system. There are three settings.

- AUTO (Automatic)
- OFF/RESET
- MAN (Manual/Service)

Robot

The MMX uses a MagnaTran 7 or LEAP robot for all internal material transfers. [Table 5-9](#) lists the connections found on the robot, and shows which type of connectors are used.

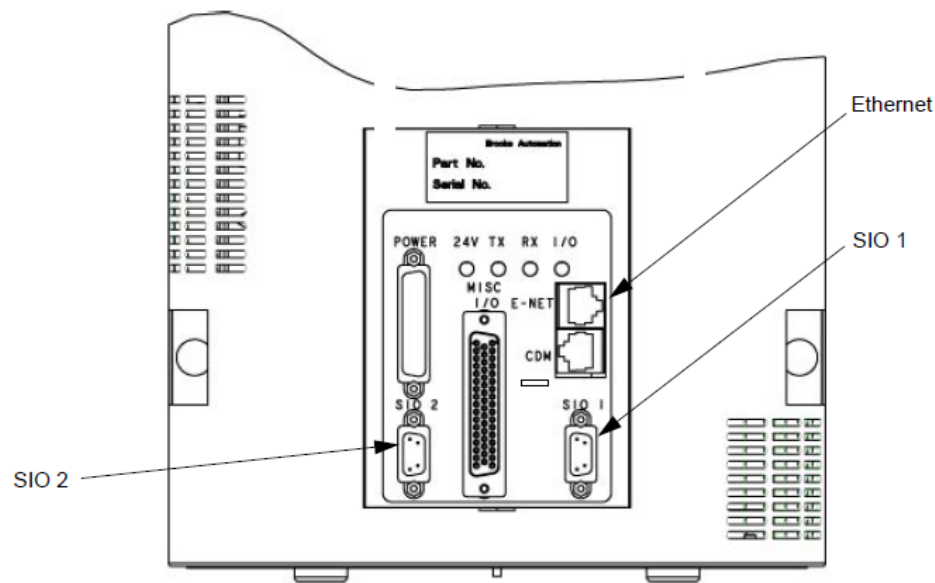


Figure 5-3: MagnaTran 7 Robot Connections

Table 5-9: MagnaTran 7 Robot Connections

Label	Description	Connector Type
POWER	Power to robot	Cannon DBM9W4PK87
SIO 1	RS-232 Comm., host/robot	Female DB-9
SIO 2	RS-232 Comm., robot/external device (e.g., aligner)	Female DB-9
CDM	Control/Display Module	RJ-45
MISC IO	Robot Misc. I/O	Male DB-50
Interlock	Robot motion safety Interlock	Female 2-pin
ETHERNET	Ethernet Comm., host/robot	RJ-45

Safety Hub

The Safety Hub used in Gen 5 EN Controls provides interlocking between the robot, load locks, valves, and the pump/vent system. The Safety Hub contains a power supply that provides up to 8A of 24VDC power for the DeviceNet network and all modules connected to the network, as well as supplying power to internal components of the Safety Hub.

See controls manual and system block diagram for more information.

6. Operation

Theory of Operation

The Micro Marathon Express (MMX) is designed to transport material among standard SEMI MESC compatible material-handling or processing modules in an ultra clean, vacuum environment with minimal contamination of the material. Transport of the material is accomplished using the Brooks Automation vacuum cassette elevator and vacuum robot. This chapter is intended to give users of the MMX systems information on how to operate the MMX system. It is not intended to be a complete reference for developing the associated software and hardware necessary for MMX system operation. The details of operation are configured by the user for their specific application.

Wafers are introduced into the MMX through the Vacuum Cassette Elevators (VCE). These modules allow up to 25 substrates to be loaded at one time into the vacuum environment using SEMI standard wafer carriers, ready for single wafer processing through the MMX.

Once a wafer carrier is placed into the VCE, the VCE is closed and pumped down to the vacuum set point. The VCE then maps the wafers in the carrier and provides the information to the host controller. This ensures picking of properly placed wafers only.

The slot valve is opened and the robot takes one wafer from the VCE, places it on the vacuum aligner, and the slot valve is closed. The wafer is aligned and the fiducial is positioned. The robot picks the wafer from the aligner using the offset specified by the host controller to center the wafer on the end effector and places it into a Process Module.

While the wafer is being processed the robot picks the next wafer from the VCE and places it on the vacuum aligner. When wafer processing is complete the host controller instructs the robot to remove the wafer from the Process Module and transfer it into the VCE.

While the wafer processing is running additional wafers are processed as described above. This cycle continues until all wafers are processed. Refer to ["System Operation Overview" on page 102](#) for detailed information.

Station Coordinate System

The robot software uses a station coordinate system for identifying specific locations within the MMX as shown in [Figure 6-1](#). Each station is identified by its Theta position, its Radial position (amount of arm extension), and its Z position (vertical distance from Home). Some MMX systems may have additional parameters specified for a station, based on additional functions provided by the robot, such as Wrist position and Traverser position.

Station numbers are assigned to represent each module connected to the MMX and each material transfer point within the MMX system. All station number assignments are dependent upon the specific system configuration. By identifying the stations in this manner, it is only necessary 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.

Brooks Automation will configure the stations on the MMX as shown unless different station assignments are specifically requested.

See System Block Diagram for station assignments.

NOTE: The stations referenced here are for a standard configuration. Actual station assignments may vary based on the 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 reconfiguration of all station options.

All numbering of stations within the Transport Chamber for the robot is done in a clockwise direction starting with the Load Lock on the left when looking at the MMX system from the top, see [Figure 6-1](#). The aligner is always Station # 5.

The R (radial extension), T (rotational), and Z (vertical) values for each station should be recorded for each type of material that will be used with the system. Note that these values will be different for different size wafers and for different systems.

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 Wafer Transfer Plane (WTP). The Lower parameter provides the distance from the WTP that the robot must move down to deposit material, which also defines the height that the robot must enter a module to pick up material.

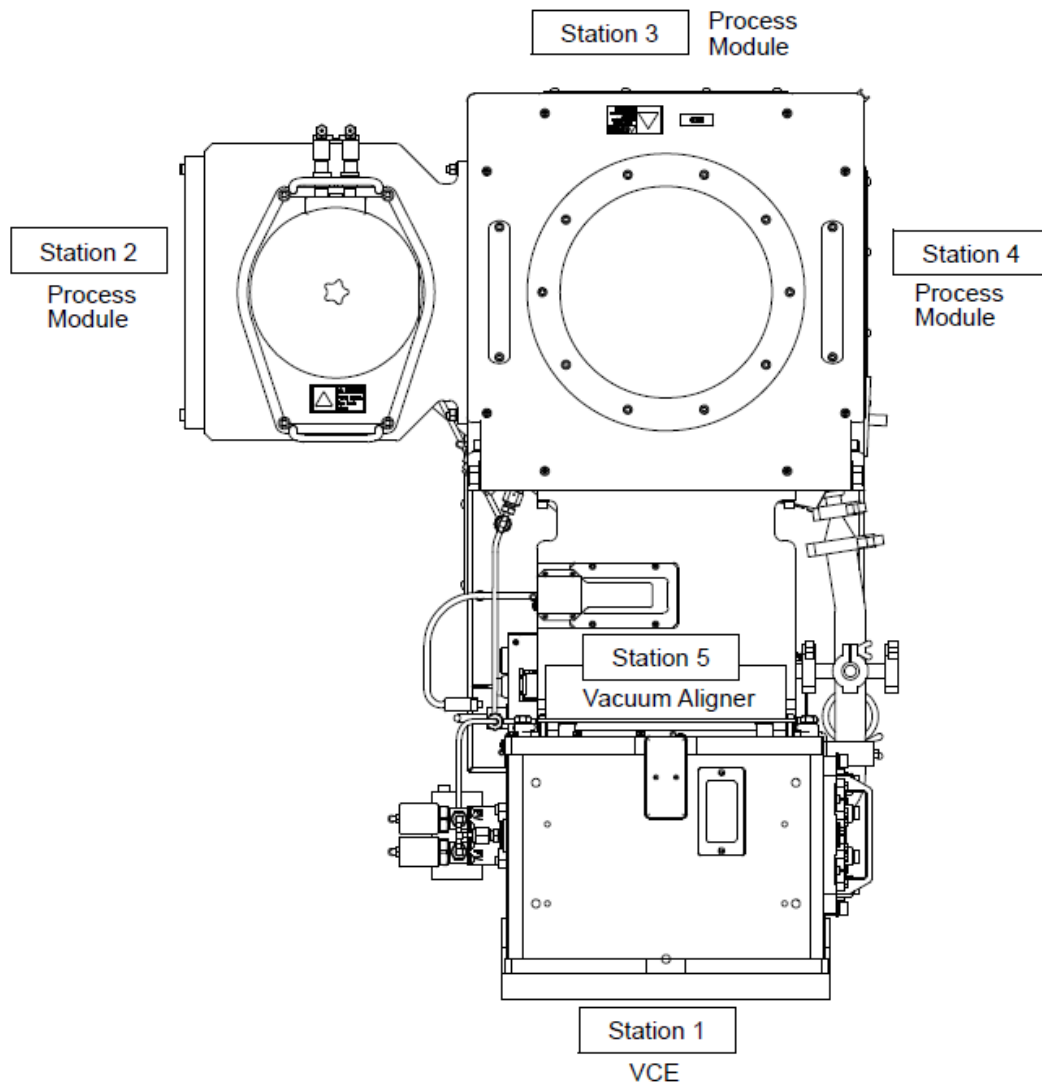


Figure 6-1: MMX Station Assignment Examples

The Slot parameter is used to define the number of slots in a station (the default is one) and to specify the slot the robot's operation will be performed on (if none is specified the default 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.

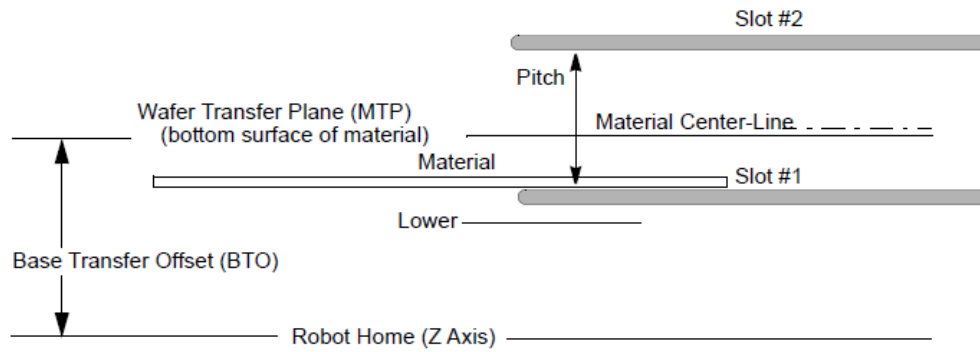


Figure 6-2: Robot Z-axis

Table 6-1: 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 °.
Z	The vertical position in increments of 0.001 mm.
BTO	The Z-axis location, in microns, of the Wafer Transfer Plane, which is also the Up position of the robot arm in the station.
LOWER	The distance in microns below the Wafer Transfer 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.

Micro Marathon Express Frames of Reference

Before setting stations or using the MMX Cluster Tool Integration Platform, 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 robot. 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, which 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.

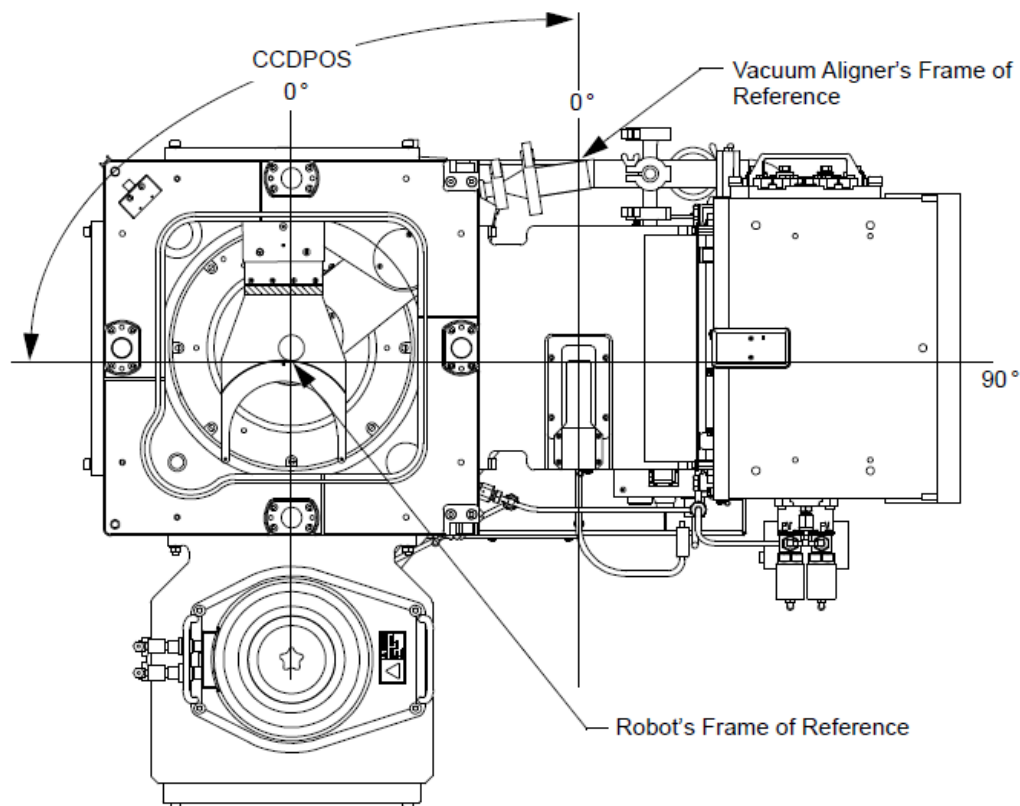


Figure 6-3: Frames of Reference

Robot 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 6-3](#) is a horizontal x-y plane, and each position within this plane is defined using a polar coordinate notation for the robot.

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.

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

The third axis in the robot'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.

Aligner Frame of Reference

Another frame of reference that is used within the MMX Vacuum Transport System is the aligner's Frame of Reference. The aligner is installed on all systems requiring precision wafer placement. When a wafer is placed into the aligner, the aligner reports both the magnitude and the direction of the wafers eccentricity. These values are expressed as polar coordinates based on the aligner's internal frame of reference.

The aligner's Frame of Reference has its origin at the aligner's center of rotation with its 0° axis defined as the line between the center of the aligner and the center of the CCD array, as shown in [Figure 6-3](#).

Looking at the top view of the aligner, the aligner will report a rotational, or T (theta), position value to indicate the direction of the wafer's eccentricity, which increases from 0° in a clockwise direction. The aligner's radial, or R, axis is measured from the center-line of the aligner radially outward in millimeters and is used to describe the amount of the wafer's eccentricity.

The aligner's Frame of Reference can be adjusted to bring it into line with the robot as shown in [Figure 6-3](#) by using the CCDPOS command.

The T and R eccentricity values obtained by the aligner are sent to the system controller, which then commands the robot to execute a "Delta Pick" of the wafer. The delta pick performed by the robot is based on the wafer eccentricity values obtained by the aligner, which the system controller then uses to calculate a new R and T position for the aligner.

The newly calculated R and T values for the aligner are only used once (during the "Pick" of the wafer), which results in the wafer being centered on the robot's end effector.

System Operation Overview

The material transfer operation of the MMX consists of the communication between the VCE load locks, the robot, and the vacuum aligner in the MMX system and the host controller. The detailed operation of these components is described in their respective user manuals. This operation section provides unique information in relation to these components as part of a MMX system. In the case of any contradiction, this manual will take precedence.

The following sequence demonstrates the normal wafer transfer operation of the MMX. The sequence shown is for a MMX system with one VCE Load Lock, and one Process Module. The MMX system chamber also provides an integrated vacuum aligner (InLigner) for wafer alignment.

Step	Action
1.	Load material to be processed into the system. • A wafer carrier is placed in the VCE Load Lock. • The host controller initiates a pump down of the Load Lock. • Once the VCE is at the vacuum set point the host controller initiates a mapping of the wafers in the carrier and retrieves the wafer map when it is completed.
2.	Pick wafer from carrier and align. • The host controller opens the slot valve to the Load Lock. • The host controller instructs the robot to remove a wafer from the VCE and place it on the InLigner within the MMX system. • The host controller closes the slot valve to the Load Lock.
3.	Align wafer and place into the Process Module. • The host controller instructs the InLigner to orient the fiducial of the wafer and the robot to pick the wafer from the aligner. The aligner measures the eccentricity if required and communicates the position of the wafer to the host controller. The host controller may instruct the robot to center the wafer on the end effector if necessary during the pick. • The host controller opens the slot valve to the Process Module. • The host controller instructs the robot to place the centered and oriented wafer into the Process Module. • The host controller closes the slot valve to the Process Module.
4.	Pick next wafer from carrier and align. Transfer wafer to next processing stage. • The host controller opens the slot valve to the Load Lock. • The host controller instructs the robot to remove a wafer from the VCE and place it on the InLigner within the MMX system. • The host controller closes the slot valve to the Load Lock.
5.	Align wafer and place into the Process Module. Transfer wafer from Process Module back to carrier. • The host controller instructs the InLigner to orient the fiducial of the wafer and the robot to pick the wafer from the aligner. The aligner measures the eccentricity if required and communicates the position of the wafer to the host controller. The host controller may instruct the robot to center the wafer on the end effector if necessary during the pick. • The host controller opens the slot valve to the Process Module. • The host controller instructs the robot to pick the wafer from the Process Module.

Step	Action
	• The host controller instructs the robot to place the centered and oriented wafer into the Process Module. • The host controller closes the slot valve to the Process Module. • The host controller opens the slot valve to the Load Lock. • The host controller instructs the robot to place the wafer into the Load Lock. • The host controller closes the slot valve to the Load Lock.
6.	The cycle (Step 4 and Step 5) repeats until all wafers in the carrier have been processed.
7.	Once all of the wafers within the wafer carrier have been processed, the wafer carrier is removed. • The host controller initiates a vent of the Load Lock. • The wafer carrier is removed from the VCE Load Lock.
8.	The process (Step 1 through Step 7) repeats for each wafer carrier.

Determining Material Locations

There are several ways to determine material presence within the MMX as described below.

Pick and Place Commands

The robot will assume it has material on the end effector(s) after power-up. The robot will assume it has material after a PICK command at a station without sensors. The robot will assume it does not have material after a PLACE command at a station without sensors. For stations with sensors the robot will check the station sensor to verify that the PICK/PLACE was successful.

Use the RQ LOAD command to request the robot's assumption. To reset the load flag, use the SET LOAD command. The robot's knowledge of material presence is used to regulate the speed of the robot.

Wafer Presence Sensing

The aligner can use the CCD to determine wafer presence by looking for the shadow of a wafer on the chuck. To use the aligner WPS, enter RQWPRS.

Wafer Mapping

The Vacuum Cassette Elevators have an Optical Wafer Mapper used to map cassettes and report the presence of wafers in particular slots. To map a cassette, ensure the VCE door is closed and the chamber is pumped down to the operating vacuum, then enter A, MP to map the cassette and R, MI to request the map information.

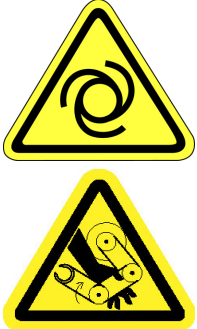
Radial Motion Sensors

There are material sensors in the MMX Vacuum Back End's chamber, positioned according to the robot manual as an R_MT (Radial Motion) material sensor. The vacuum robot can be commanded to do a CHECK LOAD to determine material presence. This command causes the robot to move the material such that the edge of the material present on the end effector would trigger the sensor.

The robot automatically checks the R_MT sensor before and after a Pick or a Place. If the material present state does not match the expected state the robot will generate an error.

Safety Interlocks

The MMX is provided with safety interlocks to ensure the safety of the operators and service personnel. The location and function of each of these interlocks is identified below.

 WARNING Automatic Motion/Crush Hazard	
Whenever power is applied, the possibility of automatic movement of the components within the MMX exists. These systems have no obstruction sensors and movement could result in personal injury or death. These components include the following: • Robot • Aligner • Cool Module Poppet • Load Lock Module (AutoDoor, Platform) • Vacuum Slot Valves • Isolation Valves • Pumps Do not operate the MMX without the protective covers in place and all safety interlocks enabled. Do not operate the Vacuum Slot Valves when the chamber lid is open.	

Identification

All user safety interlocks are located as shown in [Table 6-2](#).

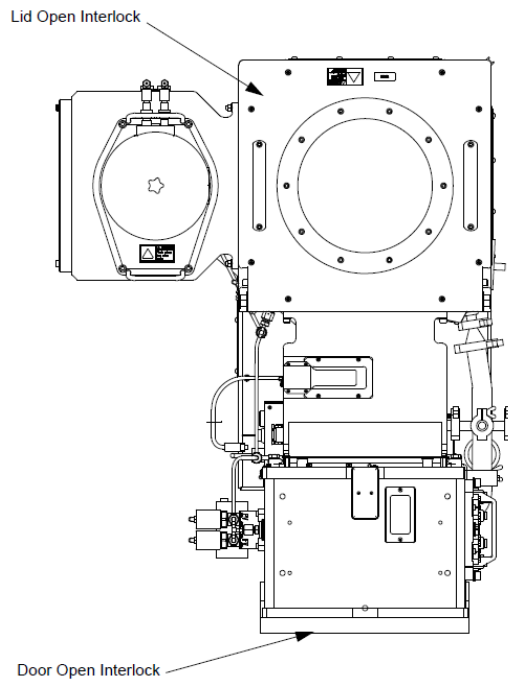


Figure 6-4: Safety Interlocks

Function

Table 6-2: Safety Interlocks

Name	Type	Function
Lid Open	Coded Magnetic Switch	Robot and valve motion is not allowed if the lid is open.
Emergency Stop (E-Stop) Circuit	User supplied switch	Input to Safety Hub

Lid Open

The Lid Open and Door Open Interlocks use a coded magnetic switch to detect the presence of the transport chamber lid and the VCE door in the closed position.

Emergency Stop (E-Stop) Circuit

The MMX provides the ability for a user supplied E-Stop button to be installed on the tool where the MMX system is installed by connecting it to the Safety Node. The function of the E-Stop within the MMX system is detailed in the Interlocks section. Once the emergency is resolved, which can include determining the reason for the emergency and checking the station involved during the emergency, the E-Stop may be removed. With the E-Stop cleared some motion commands may need to be cleared and reset.

NOTE: The E-Stop requires a user supplied E-Stop push button connected to the Safety Hub.

If a user supplied E-Stop button will not be used the supplied E-Stop Jumper Plug must be installed to override the E-Stop function.

The E-Stop function may be bypassed when servicing the MMX system by inserting the E-Stop Jumper Plug into the E-Stop connector on the Safety Node. If the E-Stop function has been bypassed for service it must be restored by removing the E-Stop Jumper Plug and reconnecting the E-Stop button before returning the MMX system to operation.

Gas Facilities Operation

The Gas Facilities connections are located underneath the chamber in back of the load lock. Access to the panel is provided behind the load lock. The Gas Facilities Panel provides a single point interface for facility supplied gas (nitrogen).

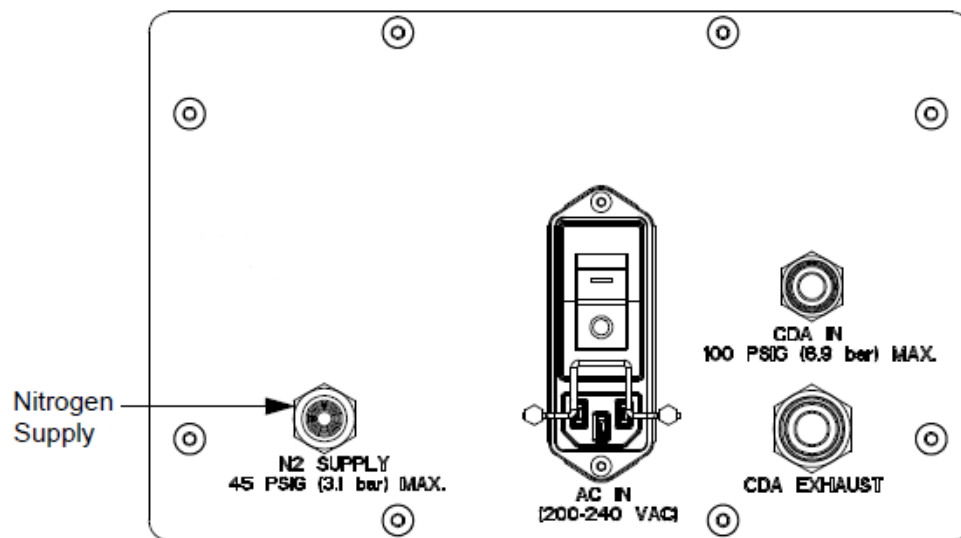


Figure 6-5: Nitrogen Facilities Connection

Controls and Indicators

One Digital Pressure Switch, shown in [Figure 6-6](#), indicates the pressure of the facility supplied nitrogen.

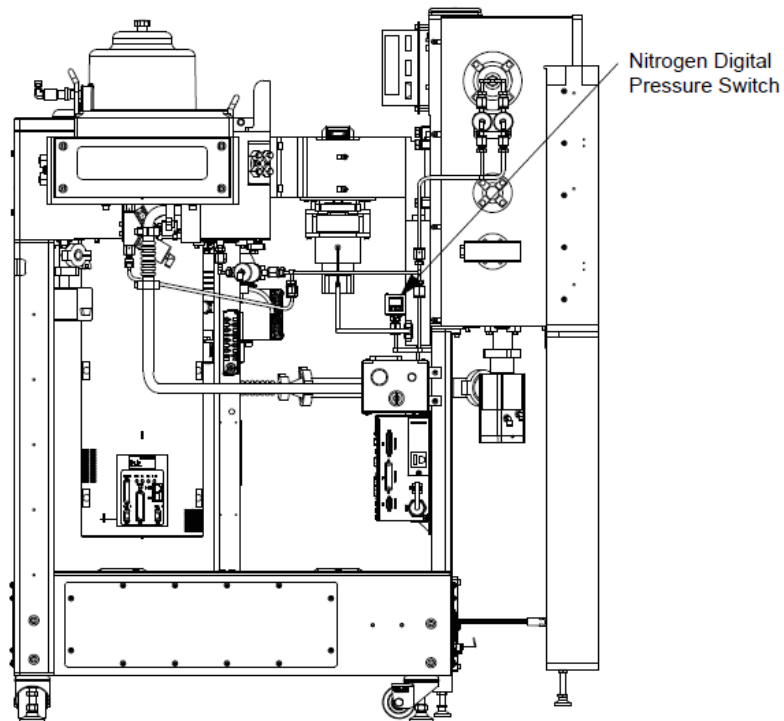


Figure 6-6: Gas Pressure Monitoring

Refer to the System Block Diagram and Schematics and Vacuum and Vent Diagrams supplied with this manual.

TopCooler Operation

The TopCooler is directly controlled by the TMC through discrete inputs and outputs. The system software running on the TMC is also responsible for all interlocking and error handling.

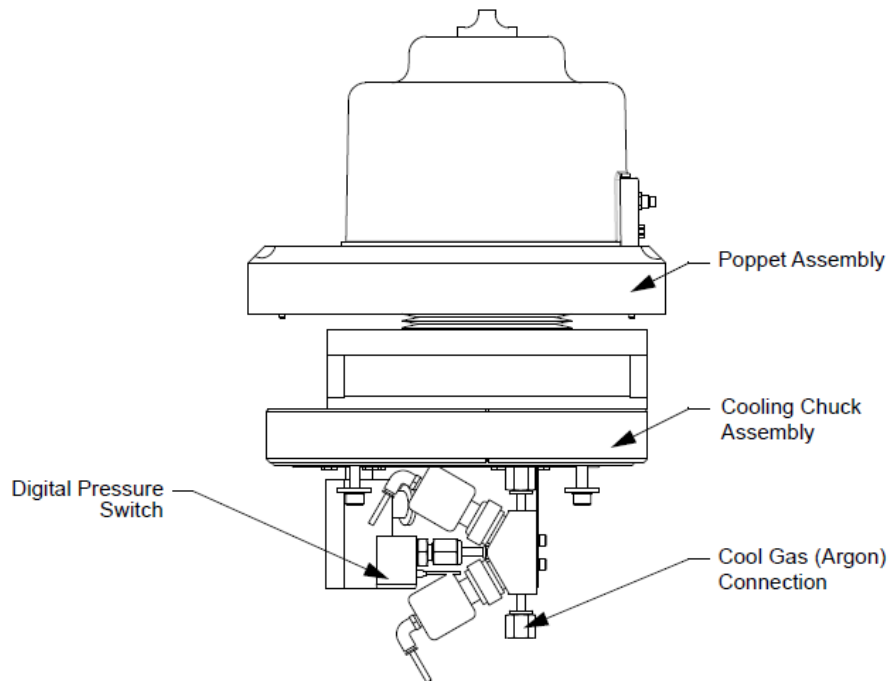


Figure 6-7: Drop-in TopCooler

During normal operation the TopCooler remains closed until a wafer cool cycle is required. To cool a wafer, the Poppet is opened and a hot wafer is placed on the wafer shelf of the poppet. The poppet is closed, lowering the wafer onto the chill plate and a fixed quantity of gas is discharged into the closed cool chamber. After a fixed period of time, the gas is removed and the poppet is opened allowing removal of the cool wafer. Pressure sensing of the TopCooler is performed by the TMC monitoring the pressure switch, which indicates the pressure states inside of the cooler. This gauge has two outputs, LOW and HI, that indicate low and high pressure.

There is no wafer sensor in this module. Also, there is no position indication on the valves so their position is verified by the system response as indicated by the pressure switch's high and low programmed bits.

The TopCooler poppet is located directly below the Lift Bar. To raise the poppet, the POPPET RAISE pneumatic control is asserted until the POPPET UP signal transitions from 0 to 1. To lower the poppet, the POPPET LOWER pneumatic control is asserted until the POPPET DOWN

signal becomes true. Both operations should be subject to a time-out condition for error checking.

The Charging Valve and the Backfill Initiation Valve are diaphragm valves which open when the signal is asserted and closed when the signal is released.

The Rough Out Valve is a NW-16 poppet valve and tracks the single open/closed state.

See the *TopCooler User Manual* for more information.

Vacuum Aligner Operation

Wafers are placed in the vacuum aligner by the system robot, which then withdraws, leaving the wafer supported by the Rotate Chuck.

After being placed on the Rotate Chuck, the wafer is rotated. While rotating, the edge of the wafer is illuminated by an LED, which casts a shadow covering a varying percentage of a CCD sensor. The wafer turns 360° while being scanned in this manner. After a single rotation, the degree of eccentricity, the phase of the eccentricity, and the position of the fiducial are determined. This position information is provided to the host controller which calculates an offset for the robot to use when picking the wafer, thereby causing the wafer to be centered on the end effector.

After rotating, the robot lifts the wafer from the Rotate Chuck using a “Delta Pick” and moves it to the next Process Module.

See the *VX Aligner User Manual* for more information.

Material Presence Sensors

The Photoelectric Reflex Switch used in the detection of material within the chamber has an indicator that will be on when no material is detected and turn off when material is present.

The material present sensor uses a polarized reflective beam-break sensor with a retroreflector. The sensor is mounted on the bottom of the transfer chamber, the retroreflectors are mounted on the lid at each facet. The light from the sensor is guided by a polarizing filter. When the beam is unobstructed, it reaches the polarization active reflector surface and returns to the sensor. When the beam is obstructed by material, which is not a polarization active surface, the beam is unable to reflect back to the sensor.

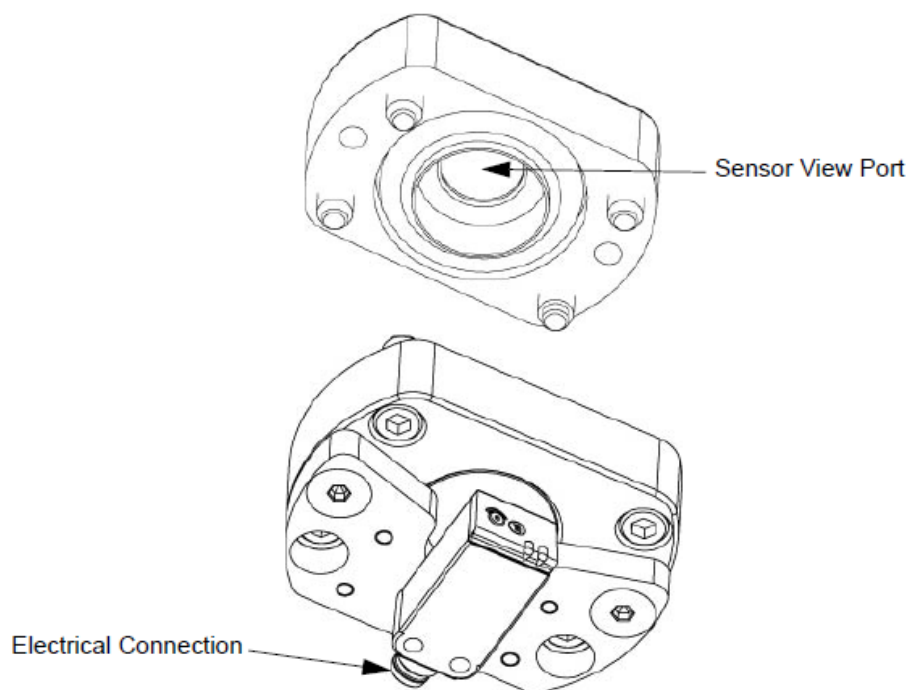


Figure 6-8: Material Sensor

The robot firmware reads the radial motion sensor state in each PICK, PLACE, GOTO, and XFER operation. If the operation is successful, the robot returns a ready signal to the host controller. The host controller does not directly read the I/O bits for the material presence sensors. If the operation is not successful, the robot returns an error code to the host controller.

The Radial Motion Material Present Sensor feature applies to passive material hand-off commands (PICK, PLACE, XFER) as the arm extends and retracts and to active material hand-offs (GOTO). No material sensors are active during a MOVE operation.

The material present status can only be checked when the end effector is in motion. This applies to all arm types. A material present query will return the state of the map. The host controller

communicates directly with the robot rather than the sensors. The robot returns an error when sensor detection does not agree with the map.

The shape of the end effector is not important to the proper performance of the Radial Motion material presence sensors.

During normal operation, the switch indicator will be lit. This indicates that the beam is sent to the retroreflector and enough light is being received back. If the indicator is out or if it is blinking, the switch needs to be adjusted. Refer to ["Material Presence Sensor Adjustment" on page 160](#).

Vacuum System Operation

The following vacuum system operation example is for a rough only system configuration.

Initial Conditions

- System is vented with all chambers at atmospheric pressure.
- Rough and foreline pumps are operating with manifold pressure of < 100 mT.
- Power supply is available to all system loads.
- Host Controller is booted and ready.
- All system valves are shut.

To Exchange Wafers in the Load Locks

- Vent the Load Lock.
 - Close Load Lock slot valve.
 - Close turbo pump isolation valve.
 - De-energize the high vacuum gauge.
 - Initiate profiled vent.
 - Initiate fast vent when pressure > 80 Torr.
 - When Digital Pressure Switch indicates pressure is equal to outside pressure, secure vent.
- Exchange wafers.
 - Open Load Lock door.
 - Exchange cassette.
 - Close Load Lock door.
- Pump down Load Lock.
 - Open slow rough.
 - Open fast rough at crossover (80 Torr).
 - Shut slow and fast rough valves.
 - Load Lock is ready.

Vent Transport Chamber

- Open fast vent valve.
- Close vent when chamber pressure switch indicates pressure is equal to outside pressure.

Vent Load Locks

- Initiate profiled vent.
- When pressure >80 Torr, open fast vent valve.
- Close vent when chamber pressure switch indicates pressure is equal to outside pressure.

Venting the Chambers - Profiled Vent

The following example of a vent sequence applies to Load Lock and Transport Chambers having fast vent and profile vent valves. The profile vent valve uses time to determine crossover point to fast vent. Both valves are open at crossover. An atmospheric switch determines when atmospheric pressure has been reached.

- Close Isolation valve.
- Close all Rough valves.

- c. Close all Vent valves.
- d. Check if pressure is less than vent crossover set point.
- e. Initiate Profile vent
 - a. If nitrogen is not present: raise exception, post alarm.
 - b. Open profile vent valve.
 - c. Wait for profile vent time.
 - d. If pressure is less than or equal to crossover: raise exception, post alarm.
- f. Initiate Fast vent
 - a. If nitrogen is not present: raise exception, post alarm.
 - b. Open Fast vent valve.
 - c. Close profiled vent valve.
 - d. Vent chamber to atmosphere.
 - e. If switch not at atmosphere and time has expired: raise exception, post alarm.
- g. Close Fast vent valve.

Start-up

The MMX is started by applying power and plant facilities as previously specified. Once this is done, the MMX is ready to operate and will accept 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 Brooks Automation MMX under normal circumstances.

Step	Action
1.	Verify that all of the installation procedures previously outlined have been completed.
2.	Ensure that all switch settings are set according to the instructions.
3.	Turn on the circuit breakers. The status lights should come on as indicated in "Power-up Sequence" on page 68 .
4.	If the initialization sequence executes without error, then all the components are referenced, the Cassette Modules are at slot #0, the host controller has not detected any substrates on the end effector(s), and all the components are communicating successfully.

Normal operation of the Brooks Automation MMX is controlled by the user's host controller. Normal operation would typically proceed as follows:

Step	Action
1.	Power up the MMX as previously described.

Step	Action
2.	Power up the host controller as directed.
3.	Once all systems are up and running properly the host controller will typically instruct the MMX to begin pumping down the Transport Module chamber.
4.	Once the Transport Module chamber has been pumped down, proceed as directed by the host controller.

Normal Running

Normal operation of an MMX system is controlled by the user's host controller. Normal operation would typically proceed as follows:

Step	Action
1.	Power up the MMX as previously described in "Power-up Sequence" on page 68 .
2.	Power up the host controller as directed by its user manual. Once all systems are up and running properly the host controller will typically instruct the MMX to begin pumping down the Transport Module chamber. The exact usage of the MMX 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 individual processes.
3.	Once the Transport Module chamber has been pumped down, proceed as directed by the host controller.

Typical Operating Sequences

Pick

The robot will pick a wafer from the specified slot in the specified station. If no slot is specified Slot 1 is assumed.

- a. The station checks to verify that there is a wafer present in the slot.
- b. The robot rotates to the specified station.
- c. The host controller checks the station wafer sensor to verify that there is no wafer on the end effector.
- d. The host controller opens the slot valve after checking that the pressures are equal between the two chambers.
- e. The robot extends, picks the wafer, and retracts.
- f. The host controller checks the station wafer sensor to verify that there is a wafer present on the end effector.
- g. The station checks to verify that there is no wafer in the slot.
- h. The slot valve closes.

Align

If a vacuum aligner is installed, the robot places a wafer on the aligner chuck, aligns it, and performs an automatic delta pick (delta is the adjusted radial and theta position at which the robot picks a wafer after a wafer alignment) in the following manner:

- a. The aligner moves to the home position and checks for the absence of a wafer on the chuck.
- b. The robot rotates to the aligner station.
- c. The host controller checks the wafer sensor at the aligner station for a wafer present on the end effector.
- d. The robot extends, places the wafer on the aligner chuck, and retracts. 5. The aligner checks for the presence of a wafer.
- e. The aligner rotates the wafer collecting eccentricity and fiducial location information and places the fiducial in the post position.
- f. Using the eccentricity information the host controller calculates a Delta Pick location. 8. The robot extends, performs a delta pick of the wafer, and retracts.
- g. The aligner checks for the absence of a wafer on the chuck.
- h. The system controller checks the wafer sensor at the aligner station for a wafer present on the end effector.

Place

The robot will place a wafer to the specified slot in the specified station. If no slot is specified Slot 1 is assumed.

- a. The station checks to verify there is no wafer in the slot.
- b. The robot rotates to the specified station.
- c. The host controller checks the station wafer sensor to verify that there is a wafer present on the end effector.
- d. The host controller opens the slot valve after checking that the pressures are equal between the two chambers.
- e. The robot extends, places the wafer, and retracts.
- f. The host controller checks the station wafer sensor to verify that there is no wafer on the end effector.
- g. The station checks to verify that there is a wafer present in the slot.
- h. The slot valve closes.

Shut-down

The following shut-down procedure is used to remove power from the MMX in an orderly manner and place the robot and all other components within the system in safe conditions. This procedure is used to prepare the system for repair, removal, or maintenance.

NOTE: When the host controller is to be shut down, the MMX system should be shut down first.

NOTICE

The shut-down procedure is used in the normal shut-down of the MMX. This procedure completely removes the power source and all other facilities from the MMX system and provides guidelines for lockout/tagout. This procedure is NOT the same as an EMO circuit or other safety interlock.

Step	Action
1.	All material transfers should be completed. All material should be in the VCE Modules only. If this is not possible, at least ensure that no material is left on the end effectors.
2.	If permanent storage of values is desired, STORE values using appropriate STORE commands for the robot, elevators, and aligner. NOTE: Set commands only load parameter values into RAM and will be reset to default values if power is removed
3.	The robot should be in the Home position (arm(s) retracted).
4.	The elevators should be in the Home position (platform down and retracted).
5.	All other material handling modules should be in the Home position.
6.	All chambers of the system should be at atmospheric pressure.
7.	Turn off power to the robot and all other material handling modules by turning off the appropriate circuit breakers.
8.	Turn off the air supply from the facility to the MMX system.
9.	Turn off the nitrogen supply from the facility to the MMX system.
10.	Turn off the vacuum supply from the facility to the MMX system.
11.	Turn off the main power disconnect for the MMX system.

Step	Action
12.	Remove the power cable from the source and disconnect it from the MMX system.
13.	Disconnect the communication cables to the MMX system.
14.	Secure the MMX system using Tagout procedures 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 tagout and the person responsible.
15.	Secure all gas and vacuum supply lines using 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 tagout and the person responsible. NOTE: <i>This procedure only shuts down facilities to the MMX system and its subsystems. Any user Process Modules or other equipment will remain powered up.</i>

7. System Alignment

The components within the Brooks Automation Micro Marathon Express (MMX) must be aligned to each other to prevent misplacement of material or collision of the robot 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 for use with a specific material type and size at the factory prior to shipment. However, if the user reconfigures the system for a different material type or size the system may need to be retaught.

Brooks Automation recommends an alignment check under the following circumstances:

- A complete alignment when the MMX is first set up at the user's site
- A complete alignment when any of the robot's end effectors, arms, or drive is replaced
- A check of the aligner station whenever an aligner is replaced
- A complete preventive maintenance check of all stations every three months
- A complete check of all stations when the robot end effector or the robot arms hit any part of the chamber or any of the attached modules
- A complete check when the MMX is involved in a material transfer error
- A complete check when the MMX is involved in an Emergency Off (EMO) event Before attempting to align the MMX, be familiar with the subsystems attached to the MMX system.
- Be prepared to use the robot's hand-held Control/Display Module (see the robot user manual)
- Understand the operation of the Vacuum Cassette Elevators (see the *VCE User Manual*)
- Understand the operation of the Vacuum Aligner and Wafer Cooler
- Read through the entire alignment procedure before beginning
- Record the Station coordinates for the robot in the worksheet provided in ["Station Identification" on page 191](#).

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

Performing the alignment procedure requires the following tools and materials:

- The parameter sheet for the MMX system's stations from the System Acceptance Test (ATP) shipped with the system
- A computer running a terminal emulator with a RS-232 Serial communications connection or an Ethernet connection.
- A Serial Communication cable
- An Ethernet cable

- A set of Hex wrenches in inch sizes
- A set of Hex wrenches in metric sizes
- 15/16-inch open end or socket wrench
- Small screwdriver
- A 150 mm (6-inch) steel ruler graduated in hundredths
- The Control/Display Module (CDM) for the robot
- 2 process cassettes of the type used in normal processing
- MicroTool Dummy Wafers or test material of the size for which the system is being set up (minimum of 10)
- MicroTool Electronic level or equivalent (bubble level)
- A 1 m (3 ft) bubble level or equivalent
- System teach fixtures
- Magnetic Safety Sensor Interlock Override Switch
- The user manuals for all components within the MMX
- The user manuals for any devices interfacing with the MMX

Alignment Strategy

The MMX is an Atmospheric to Vacuum Cluster Tool Integration Platform for Process Modules. To properly align the MMX system it must be attached to the Process Modules it will be used with.

The robot within the MMX system does not have leveling adjustments. The robot is mounted directly to the chamber of the MMX Vacuum Back End. Adjustment of the MMX system's modules is part of the alignment of the MMX during installation. All components of the MMX system must be leveled relative to the reference plane of the MMX.

The procedures provided here are for a basic system alignment. Refer to the appropriate user manuals for detailed alignment information.

NOTE: A thorough alignment protects against equipment damage and misaligned or sliding material, which could lead to personal injury.

Alignment Overview

Typical system alignment starts with setting the height and leveling the MMX and then docking the Process Module(s) to the MMX system. The major steps of the alignment process are detailed below.

The Process Module(s) can be aligned to the Wafer Transfer Plane (WTP) using the end effector and a MicroTool Electronic level or test material and bubble level.

Step	Action
1.	Level the MMX ensuring the rotation axis of the robot is perpendicular to the reference plane of the chamber and that the Wafer Transfer Plane is set to 1100 mm.
2.	Verify the that the end effector is level. Refer to "End Effector Levelness Verification and Adjustment" on page 164.

Step	Action
3.	Level the Process Module(s) ensuring the material stage is parallel to the reference plane of the MMX and that the Wafer Transfer Plane is set to 1100 mm per SEMI E21, and attach to the MMX system.
4.	Attach the Load Lock Modules to the MMX system if required and level to ensure the material carrier plane is parallel to the reference plane of the system.
5.	Configure the robot for operation within the MMX.
6.	Teach the handoff positions (aligner, load locks, process modules, etc.) in the MMX for the robot.
7.	Test the system alignment by running a series of test material to ensure proper material transport throughout the MMX system.

System Alignment - Mechanical Alignment

The first phase of the system alignment procedure, called the Mechanical Alignment Phase, is performed to ensure mechanical integrity between the motion of the robot arm and the stations it serves. This phase 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 (e.g., Cassette Elevator's platform), and programming actual station values (R, T, and Z) into the robot. These procedures are generally performed using fixtures (supplied with the system) and measuring instruments (e.g., scales, dial indicators, etc.). Another very useful tool is the robot's Control Display Module (CDM), which provides very precise local control of the robot.

System Alignment - Wafer Alignment Phase

Once station values have been defined that ensure mechanical integrity during wafer transport operation to and from each station within a system, a second phase of system alignment is performed. This second alignment phase, called the Wafer Alignment Phase, utilizes an absolute true position reference to position the wafer on the robot's end effector to optimize the accuracy of wafer transfer from one location within the system to any other location within the system.

Having a "true position" means that the wafer can be "centered" on the robot's end effector at the same position in a reliable and repeatable fashion. However, this does not mean that the wafer must be physically centered on the end effector; it means that the wafer can be consistently located in exactly the same position on the robot's end effector every time a "Pick" from a station, or a delta "Pick" from an aligner, is performed.

Alignment Process

A complete and accurate alignment ensures that no part of the robot or of any material contacts any of the system's interior surfaces and that no sliding motions occur between the material and any support surfaces. The alignment will be done using the robot's Control/Display Module (CDM) and a serial communications program such as Procomm™.

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 Automatic Motion/Crush Hazard	
Whenever power is applied, the possibility of automatic movement of the components within the MMX exists. These systems have no obstruction sensors and movement could result in personal injury or death. These components include the following: • Robot • Aligner • Cool Module Poppet • Load Lock Module (AutoDoor, Platform) • Vacuum Slot Valves • Isolation Valves • Pumps Do not operate the MMX without the protective covers in place and all safety interlocks enabled. Do not operate the Vacuum Slot Valves when the chamber lid is open.	

NOTE: To ensure accuracy and repeatability, do not "home" the robot during the alignment procedure unless specifically directed to do so.

It is crucial that the alignment is performed in the sequence shown in this section for maximum operating performance of the MMX system. Those individual procedures that do not apply to a specific system (i.e., alignment to a Cool Module when there is no Cool Module installed) may be skipped. Many of the adjustments will be made using the robot's Control/Display Module (CDM) or a computer. Prior to beginning the alignment procedure, ensure the following steps have been completed.

Step	Action
1.	Read and understand "Safety" so that you are familiar with the safety concerns involved with performing these procedures.
2.	Become familiar with all attached subsystems, including the CDM, and the command set to be used.
3.	Ensure the MMX, the Process Module(s), and all associated components are at room temperature.
4.	Power up and initialize the MMX and all devices that interface with the MMX system. The system must be in the following state: • All chambers must be at atmosphere • All slot valves and atmospheric doors must be open
5.	Read the "Alignment Overview" on page 120 and the Alignment Procedures.
6.	Perform the alignment procedures in the order presented. Note that this section provides a detailed overview of the alignment process, which will reference the actual procedures as required.

Prepare the Micro Marathon Express System for Alignment

Before the System Alignment can begin the system must be properly prepared. This includes ensuring the system is level and that the modules of the system are properly initialized. Refer to ["System Preparation" on page 126](#) for instructions on getting the system ready for alignment.

Locate and Level the Micro Marathon Express

Adjustable feet are provided on the frame of the MMX. These feet are used to support the MMX, to compensate for an uneven floor, and to relieve the wheels. The MMX system must be located to ensure proper hand-off of the material with the facility. Refer to the ["Installation Procedure" on page 50](#). It should not be necessary to level the MMX unless this is a new installation or if the MMX has been moved after initial installation.

Install the Vacuum Cassette Elevators to the Micro Marathon Express

The MMX is typically shipped with the VCEs installed to the Vacuum Back End.

- If the VCEs are installed, confirm all shipping brackets are removed.

Level the VCE Platform

It should not be necessary to level the VCE platform unless a VCE is being replaced.

Adjust the Robot's End Effector

Open the lid to gain access to the robot arm and end effector.

The condition of the end effector must be verified to ensure proper material handoff. The pitch and roll are added together to determine the TIR (Total Indicated Runout), which should be less than 0.001-inch maximum for each inch of wafer diameter.

It should not be necessary to adjust the end effector unless it is a new installation, an End Effector is being replaced, or the robot has been involved in a material transfer error.

Step	Action
1.	Verify the end effector is flat. Refer to "Verifying Flatness of End Effector" on page 162.
2.	Remove the shipping brackets from the robot arm.
3.	necessary corrections or adjustments. Refer to "End Effector Levelness Verification and Adjustment" on page 164.

Level and Dock the Process Modules to the Micro Marathon Express

Follow the manufacturers directions for leveling the Process Modules that are connected to the MMX. Ensure that the Wafer Transfer Plane is set to 1100 mm. It should not be necessary to level the Process Modules unless it is a new module or significant changes have been made to it.

Configure the Robot

Configure the robot, by setting up the operating parameters, for proper operation within the MMX. Compare the settings to the CX document.

Teach the Micro Marathon Express Stations for Material Transfer

The robot's software uses a station coordinate system for identifying specific locations. By identifying physical locations in this manner, it is only necessary 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 assigned to a single physical location for logistical purposes.

Teach the Robot the Vacuum Aligner Location

The vacuum aligner acts as the center point of wafer transfers through the MMX Vacuum Transport System. It is used to orient the fiducial of all wafers, and 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 ["Teach the Robot the Vacuum Aligner" on page 129](#) for instructions on teaching the vacuum aligner station.

Teach the Robot the Load Lock Location

The VCE Load Lock provides the interface for material transfer from the atmospheric environment. To ensure proper handoff of the material between the robot and the cassettes in the Load Lock, the VCE must be configured and the LL stations must be taught to the robot. Refer to ["Vacuum Cassette Elevator Configuration and Alignment" on page 132](#) for instructions on teaching the LL stations.

It should not be necessary to level the VCE platform unless this is a new installation, a VCE is being replaced, or the material type or size is being changed.

Teach the Robot the Process Module Locations

The Process Modules attached to the MMX 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 robot and the Process Modules the PM stations must be taught to the robot. Refer to ["Teach the Robot the Process Modules" on page 1](#) for instructions on teaching the PM stations.

Verify Proper Operation of the Material Presence Sensors

Once the modules of the MMX have been aligned, the sensors within the system must be aligned.

Verify proper operation of the Material Presence Sensors. Refer to ["Material Presence Sensor Adjustment" on page 160](#).

Verify Proper Operation of the Micro Marathon Express

Once the modules of the MMX have been aligned, verify proper material transfer between all stations within the MMX. Refer to ["System Alignment Check-out" on page 140](#).

System Preparation

When preparing for alignment after installation, power up and initialize the MMX as specified in ["Installation"](#).

When preparing for an alignment after replacing a component or performing an alignment check, first ensure that the Transport Chamber, the Vacuum Cassette Elevator, and any Process Module chambers are vented.

NOTE: Prior to performing this procedure, ensure that all Load Locks and Process Modules are connected to the Transport Chamber and that preliminary leveling of each component and the Transport Chamber have been completed.

NOTICE

Do not proceed to the next step until all chambers within the system are at atmospheric pressure. Damage to the system could result.

Step	Action
1.	Open each slot valve.
2.	Shut off the vacuum and venting subsystems and perform lockout/tagout procedures as defined by the facility where the equipment is installed on those subsystems to ensure that the Slot Valves and other associated valves do not move unexpectedly.

Safety

- Read, understand, and follow the safety advise in ["Safety"](#).
- During the teaching procedure, the system is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.
- Breaking material can cause flying shards. Always wear eye protection when teaching the robot and using test material.
- Read and understand ["Emergency Procedures"](#) on page 1.

Level the Chamber and Set the WTP Height

The height of the MMX must be properly set and the entire tool must be level before any other system alignments are performed. The system Wafer Transfer Plane (WTP) must be set to the SEMI MESC standard height and the entire system must be level. This procedure should only need to be performed during initial system installation or whenever the system is moved. Refer to ["Installation"](#).

Initializing the Vacuum Cassette Elevators

Verify that the VCE CF settings are the same as the VCE shipped QR. Customer may require customized configuration and those parameters may be changed using the *VCE User Manual*.

The alignment procedure requires moving the elevator platform to various positions, including the positions it must travel to when moving a wafer cassette. To respond correctly to motion commands, the Vacuum Cassette Elevator controller needs to know certain information about the type of cassettes the facility will be using to process wafers. Refer to the *VCE User Manual*.

NOTE: This procedure assumes that both load locks are connected to the Transport Chamber prior to adjustment and that preliminary leveling of each component and the Transport Chamber have been completed.

Initializing the Vacuum Aligner

The mechanical portion of the system alignment is not directly affected by the vacuum aligner. However, the robot will need to be taught the location of the aligner Chuck to allow placing wafers for alignment. Note that use of an aligner during the Wafer Alignment Phase of system alignment allows the alignment to be “fine tuned” for improved accuracy. Setup procedures for the aligner are covered in the system alignment procedures later in this chapter.

Initiating the CDM

Verify that all setup procedures in the robot 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 MMX requires moving the robot arm and setting and storing the station coordinates 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 robot user manual.

Removing the Chamber Lid

If the vacuum robot has not been taught, the Transfer Chamber Lid may be opened to allow access to the end effector and allow visual verification of the station assignments. Opening the Lid will set the Magnetic Safety Sensor Interlock. To override the interlock, place the Override Switch over the matched magnet on the chamber.



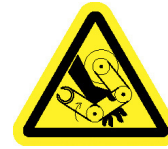
WARNING

Crush Hazard

Overriding the Magnetic Safety Sensor Interlock or operating the vacuum robot with the Transfer Chamber Lid removed exposes the user to moving hazards.

Do not climb into the chamber or leave tools on the floor of the chamber.

Do not put hands into the chamber when motion is in progress.



Alignment Procedures

See the robot manual for any additional information.

Teach the Robot the Vacuum Aligner

If the MMX is equipped with the optional Brooks Automation vacuum aligner, it is necessary to teach the robot the station location of the aligner chuck. This station should be set-up before any Process Modules as it will be used to fine-tune their set-up.

NOTE: The stations referenced here are for a standard configuration. Actual station assignments may vary based on the system configuration.

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

The vacuum aligner station must be taught prior to teaching any other stations.

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

- CDM (Control/Display Module)
- A computer running a terminal emulator or a dumb terminal and a serial I/O cable
- MicroTool Dummy Wafer or test wafer of the appropriate size
- Brooks Robot/Aligner alignment fixture

Configuration and Alignment Strategy

Configuring the system requires configuring the robot to work with the vacuum aligner and teaching the robot the aligner's location. Once taught, the vacuum aligner becomes the reference point for all other alignments within the MMX. Refer to the robot user manual for detailed information on using the CDM and teaching stations.

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

- Vacuum aligner is Station 7 for the robot

Teach the Robot the Aligner Station

 WARNING Automatic Motion/Crush Hazard	
Whenever power is applied, the possibility of automatic movement of the components within the MMX exists. These systems have no obstruction sensors and movement could result in personal injury or death. These components include the following: - Robot - Aligner - Cool Module Poppet - Load Lock Module (AutoDoor, Platform) - Vacuum Slot Valves - Isolation Valves - Pumps Do not operate the MMX without the protective covers in place and all safety interlocks enabled. Do not operate the Vacuum Slot Valves when the chamber lid is open.	

Within the MMX the default station assignment for the vacuum aligner is Station 5. Refer to ["Station Coordinate System" on page 97](#) for a detailed description of the station assignments.

Step	Action
1.	Home the vacuum aligner. HOME
2.	Place the alignment fixture over the vacuum aligner's chuck, fitting the wafer support pins on the chuck into the mating holes on the bottom of the fixture. Ensure that the cutouts on the bottom of the fixture seat fully on the wafer supports.  Figure 7-1: Vacuum Aligner Alignment Fixture
3.	Using the robot's CDM, teach the robot the R and T values for the vacuum aligner.

Step	Action
	SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE - Manually move the robot's end effector until the end effector's U-shaped slot fits around the Alignment Fixture and the bottom of the "U" is close to, but not touching, the fixture. - Inspect the clearance of the end effector slot around the Alignment Fixture. The clearance should be equal on all sides (approximately +.002 in.). If not, move the robot in the R and T axes until the end effector is centered around the alignment cylinder with the proper spacing. - Once the end effector is positioned correctly save the R and T values for the robot using the CDM. ESCAPE -> STORE -> R -> T -> QUIT
4.	Using the robot's CDM, move the robot's arm out of the vacuum aligner. SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE Move the robot's arm out of the vacuum aligner and exit use of the robot using the CDM. QUIT
5.	Remove the Robot/Aligner Centering Fixture from the vacuum aligner.
6.	Center a wafer on the end effector and, using the robot's CDM, teach the robot the BTO value for the vacuum aligner. SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE - Manually move the robot's end effector into the vacuum aligner, adjusting Z as necessary so the wafer clears the aligner pins (1.5 mm (0.06 in.) minimum). Note that this BTO value will be different from the BTO for the Load Locks and Process Modules. - Once the wafer is positioned correctly save the BTO value for the vacuum robot using the CDM. ESCAPE -> STORE -> BTO -> QUIT
7.	Teach the robot the amount it must travel down to deposit the wafer and provide the end effector clearance while moving under the wafer. SETUP -> STATIONS -> 7 -> CR -> LEARN LOWER -> JOG - Jog the wafer down into position and continue jogging down so the end effector is equally spaced between the wafer and the rotate chuck. - Once the wafer and end effector are positioned correctly save the Lower value using the CDM. ESCAPE -> STORE -> L -> QUIT
8.	Using the robot's CDM, move the robot's arm out of the vacuum aligner. SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE Move the robot's arm with the wafer out of the vacuum aligner and exit use of the vacuum robot using the CDM. QUIT
9.	Record the Station coordinates in the appropriate worksheet provided in Appendix C: "Station Identification" on page 191 .

Vacuum Cassette Elevator Configuration and Alignment

The following procedure will teach the robot the Vacuum Cassette Elevator station values.

NOTE: The stations referenced here are for a standard configuration. Actual station assignments may vary based on the system configuration.

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

The vacuum aligner station must be taught prior to teaching the Vacuum Cassette Elevators.

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

- The specific Vacuum Cassette Elevator user manual
- CDM (Control/Display Module)
- MicroTool Dummy Wafer or test wafer of the appropriate size
- Cassette of the appropriate size with unbreakable wafers
- A computer running a terminal emulator or a dumb terminal and a serial I/O cable
- Brooks VCE gauge block

Configuration and Alignment Strategy

Configuring the system requires teaching the robot the location of the Vacuum Cassette Elevators, and opening the interface with the VCEs. Refer to the robot user manual for instructions on using the CDM and teaching stations.

Prior to teaching the Load Lock stations, the VCEs must be level.

NOTE: For this procedure, the wafer is assumed to be aligned. Should anything happen to jar the wafer on the end effector, repeat the alignment portion of the aligner teaching procedure to re-align the wafer.

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

- Vacuum Cassette Elevator is VCE A
- VCE A is Station 1

Set the Robot to the VCE WTP

 WARNING Automatic Motion/Crush Hazard	
Whenever power is applied, the possibility of automatic movement of the components within the MMX exists. These systems have no obstruction sensors and movement could result in personal injury or death. These components include the following: • Robot • Aligner • Cool Module Poppet • Load Lock Module (AutoDoor, Platform) • Vacuum Slot Valves • Isolation Valves • Pumps Do not operate the MMX without the protective covers in place and all safety interlocks enabled. Do not operate the Vacuum Slot Valves when the chamber lid is open.	

A robot controller parameter, called the Base Transfer Offset (BTO), sets the height of the robot's transport plane to the height of the system's Wafer Transport Plane (WTP). The BTO is the vertical distance from the robot's home position to its UP (wafer transport) position. The MMX is designed to operate with the WTP at the SEMI MESC standard height. The procedure outlined below utilizes a special gauge block provided with the system so that the robot's WTP can be set correctly and quickly.

This procedure uses the floor (i.e., bottom surface) of either Load Lock's access slots as a reference point for determining the BTO to the system's WTP. Assuming that the system has been installed to conform to the SEMI MESC height standards, the SEMI MESC WTP indicated by the WTP scribe mark on the side of the chamber, is located 32.50 mm (1.280 in.) above the floor of the access ports. To facilitate this procedure, the VCE is supplied with a rectangular gauge block having measurements that include 32.49 mm (1.279 in.) as shown in [Figure 7-2](#). The procedure described below uses this gauge block to set the system WTP above the access slot floor. Use the robot's Control/Display Module (CDM) to teach the robot the appropriate Base Transfer Offset (BTO) value as follows:

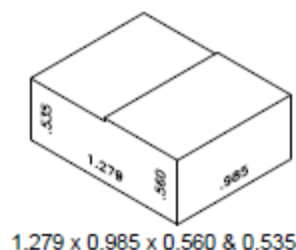
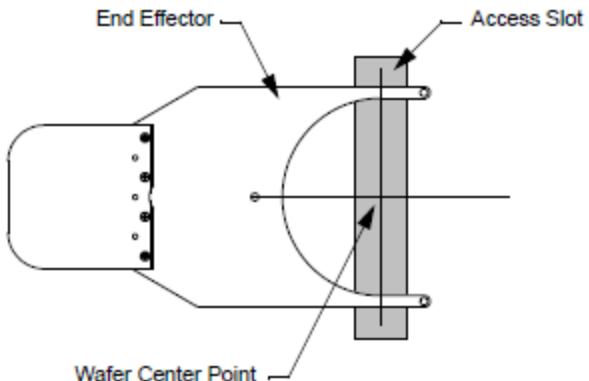
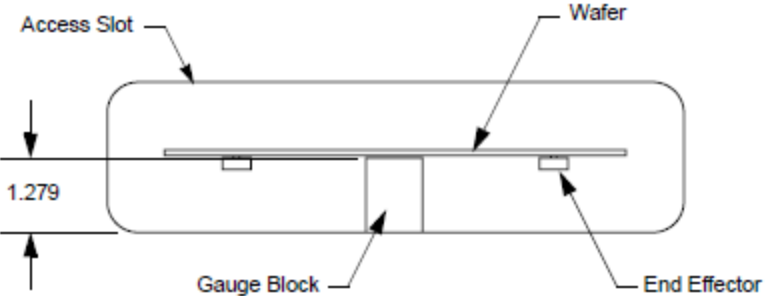


Figure 7-2: Gauge Block

Step	Action
1.	Using the robot's CDM, move the robot's pan 'A' end effector to the appropriate Load Lock's access slot. SETUP -> STATIONS -> 1 -> CR -> LEARN R, T, BTO -> HAND LOCATE
2.	Manually move the robot's end effector until the end effector is located inside the access slot as shown in Figure 7-3.  Figure 7-3: Positioning the End Effector to Set BTO
3.	Place the gauge block in the access slot, adjacent to the robot's end effector with the 1.279 inch dimension vertical, as shown in Figure 7-4.  Figure 7-4: Gauge Block Placement for Setting BTO
4.	Place a wafer on the end effector and sight along the bottom of the wafer. The bottom of the wafer should almost touch the top of the gauge block when resting on the end effector (moving the gauge block should not cause the wafer to move). If the BTO value needs adjustment jog to the appropriate height, and store the corrected BTO value.
5.	Once the end effector is positioned correctly save the BTO value for the robot using the CDM. ESCAPE -> STORE -> BTO -> QUIT
6.	Using the robot's CDM, move the robot's arm out of the Load Lock's access slot. SETUP -> STATIONS -> 1 -> CR -> LEARN R, T, BTO -> HAND LOCATE

Step	Action
	Move the robot's arm with the wafer out of the access slot and exit use of the vacuum robot using the CDM. QUIT
7.	Remove the wafer from the end effector and the gauge block from the access slot.
8.	Refer to Table 7-1 and assign a calculated value for the lift/lower (Z) move to LWR (lower).

Table 7-1: VCE Lower Values

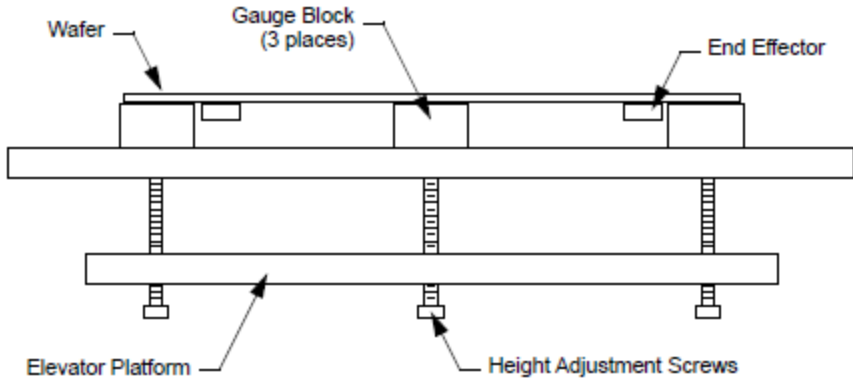
Wafer Size	Lower Value
100 mm, 125 mm, 150 mm (4 in, 5 in, 6 in)	1.82 mm (0.072 in)
200 mm (8 in)	2.25 mm (0.089 in)

Adjust the Load Lock Platform

The platform of each Load Lock attached to the system must be adjusted so that when the robot's end effector is extended, and in the UP position, a wafer on the end effector will be centered vertically in the currently presented cassette slot.

NOTE: All cassettes used within Load Locks attached to the MMX must meet SEMI MESC standards.

Step	Action
1.	Set the platform of the Load Lock to accept the cassette type that will be used (refer to the <i>VCE User Manual</i> for adjustments).
2.	Home the Load Lock. 00, A, HM NOTE: Do not "home" the elevator while the robot's arms or end effector are extended into the Load Lock's chamber because severe damage to the elevator or robot may result.
3.	Select the appropriate Cassette Type Offset (CTO) configuration value from the <i>VCE User Manual</i> and enter it using the Set Cassette Type Offset command, refer to the Command Reference in the <i>VCE User Manual</i>. 00, S, CF, CT, cto NOTE: The CTO is usually set at Brooks with requested dimensions calculated by the cassette size. Before resetting the CTO, request the value first and then change only if necessary.
4.	Command the VCE to Slot 1. 00, A, GO, 1
5.	Raise the end effector to the UP (WTP) position.
6.	Extend (jog) the robot's end effector into the Load Lock and over the platform.
7.	Locate the spring-loaded height-adjustment screws beneath the platform, shown in Figure 7-5 , and place three gauge blocks on the platform over the height-adjustment screws. Refer to the VCE alignment procedures in the <i>VCE User Manual</i> or use the following instructions:

Step	Action
	 The diagram shows a cross-section of the platform assembly. At the bottom is the 'Elevator Platform'. Above it are three 'Height Adjustment Screws'. On top of the platform are three 'Gauge Blocks'. A 'Wafer' is placed on top of the gauge blocks. An 'End Effector' is shown at the top, positioned above the wafer. Arrows point from the labels to the corresponding parts in the diagram. Figure 7-5: Platform Height Adjustment Screws For wafers up to 150mm wafers, place the gauge blocks on the platform with the 0.535 inch dimension oriented vertically. For 200 mm wafers, place the gauge blocks on the platform with the 0.985 inch dimension oriented vertically.
8.	Place an appropriate sized wafer onto the robot's end effector.
9.	Sighting along the bottom surface of the wafer, adjust the platform height-adjustment screws until the tops of the gauge blocks just touch the bottom surface of the wafer.
10.	Sight carefully along the end effector to insure that the wafer has not been lifted off the surface (moving the gauge block should not cause the wafer to move).
11.	Remove the wafer and the gauge blocks and retract the end effector.
12.	Repeat for each Load Lock.

In order to reduce the overall vertical height the platform must travel, this alignment procedure has established the Home position 0.500 inch below the center line of the bottom-most slot. To position the platform for proper operation with different cassette types, the appropriate offset for the cassette type being used in the elevator must be entered. Refer to the VCE User Manual for appropriate CTO values.

Set the Load Lock T and R Coordinates

The exact rotational axis (T) and radial axis (R) coordinates of each Load Lock must be taught to the robot. This procedure consists of rotating and extending the robot arm until the end effector is positioned over the center of the Load Lock elevator platform and then storing this position in the robot memory. The MMX comes with a two-part Robot/VCE Alignment Fixture for the specified end effector, to facilitate this procedure.

NOTICE

Do not "home" the elevator while the robot's arms or end effector are extended into the Load Lock's chamber because severe damage to the elevator or robot may result.

Step	Action
1.	Verify that all elevator parameters are set correctly by using the commands described in the <i>VCE User Manual</i> .
2.	Ensure that the robot's arm is retracted and the elevator door is closed, then move the elevator platform to slot 1.
3.	Using the CDM, move the robot to the initial Load Lock T-axis position using the Move to Station command. Refer to the robot user manual.
4.	Enter the hand locate command on the CDM. This command will cause the robot servos to release, allowing manual positioning of the end effector.
5.	Place the Locating Plate on the platform so that it locks into place. Place the Alignment Puck on the Locating Plate with the handle pointing out and ensure that it can turn freely on the fixture.
6.	Manually position the robot's end effector until the U-shaped slot fits around the Alignment Puck and the bottom of the "U" is close to, but not touching, the puck (approximately +.002 inch).
7.	Once the end effector is properly located around the Puck, use the CDM to view and record the R (radial) and T (rotational) axis locations for this station.
8.	Using the CDM, store the R and T axis locations. Also, record the R and T values in the appropriate worksheet provided in Appendix C: Station Identification on page 12-3.
9.	Retract the robot's arm and remove the Alignment Puck and Locating Plate from the platform.
10.	Record the Station coordinates in the appropriate worksheet provided in Appendix C: "Station Identification" on page 191 .
11.	Repeat for each Load Lock.

Align the Load Lock's SPS

The Substrate Present Sensor (SPS) on each elevator must be adjusted to ensure proper detection of wafers in all slots of the cassettes. This procedure varies slightly depending on the type of sensing and whether the wafer present sensing will be accomplished at the Wafer Transfer Plane or above the Wafer Transfer Plane.

Refer the *VCE User Manual* to adjust the SPS.

NOTE: This adjustment will disturb the factory setting of the Substrate Present Sensor (SPS). Verify that the sensor is out of alignment before performing the following procedure by performing the MAP command and verifying correct wafer count and slot. Refer to the Command Reference in the *VCE User Manual*.

If the robot's end effector is changed after aligning the SPS, re-aligning both the Platform and the SPS may be necessary to ensure accurate wafer detection as the elevator's platform is aligned to the end effector and all elevator systems are aligned to the platform.

Fine-Tuning the Station Assignment

universe" for defining locations within the system. The aligner's ability to precisely measure the offset of a wafer from its center of rotation along with the robot's ability to compensate for this offset by executing a delta pick provides a very powerful tool for both transporting wafers and performing system alignment procedures and checks.

Using the Aligner as a True Position Reference

The following example shows how the wafer alignment phase works using the system aligner.

- The initial station assignment for a Process Module is programmed into the robot. This assignment is a "crude" assignment as it only ensures that the robot will be able to pick and place wafers without any interference or mechanical contact.
- A wafer is then physically placed in the Process Module such that it is optimally located.
- The robot is then instructed to pick the wafer from the Process Module and place it into the aligner.
- The aligner determines the wafer's offset from true position.
- The offset is then used to recalculate and update the Process Module's station assignment stored in the robot.
- The newly calculated and stored station assignment for the Process Module will allow the transfer of wafers from the aligner to the Process Module with essentially zero error.

Using Physical Location as a True Position Reference

For material transport systems that do not have an aligner, there may be other methods or devices available within the system to facilitate material alignment. These are generally of a mechanical nature in which the material is physically moved to a repeatable location through the use of banking pins or tapered shafts. Although this sliding action results in physical contact with the edges of the material and may produce undesirable particles, the objective of repeatedly locating the material is achieved.

For systems that use physical location, it is important to understand that the approach in the wafer alignment phase is essentially similar to the approach used with an aligner. Once the station assignment has been defined with respect to the alignment station, it must not be changed. To position a wafer being delivered to the alignment station in a slightly different location, it is the station assignment values of the Process Module where the wafer is being picked from that must be changed.

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.

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

- The robot's Control/Display Module (CDM)
- MicroTool Dummy Wafers or test material of the appropriate type and size
- Two cassettes of the type that will be used in production
- PC with a communications program such as Procomm™ and a serial I/O cable

Alignment Strategy

Once the 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. 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 the material against cassette walls or other system components.

If there is any material motion or contact with any surfaces within the MMX system while the material is being transferred the station where the motion or contact occurred must be retaught.

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

Observe material transfer from each Process Module, from each cassette slot in the Load Lock, from the Aligner, and from the Cooler.

Alignment Procedure

NOTICE

Breaking wafers may cause flying shards of glass and cause eye injury. When using test material in a set up or test procedure, protective eye wear should be worn at all times to guard against possible eye injuries.

Step	Action
1.	Position cassettes with wafers in slots 1, 12, and 25 into each VCE.
2.	Using the robot's CDM, PICK and then PLACE the wafers in one VCE. During the Pick and Place operations, observe the movement to verify proper placement. NOTE: <i>The wafers should move into and out-of the cassettes without any contact.</i>
3.	Replace one of the cassettes with an empty cassette.
4.	Using the robot's CDM, transfer each of the wafers in the cassette throughout the system. NOTE: <i>Observe the wafer transfer at each station. If any wafer sliding or contact occurs reteach that station.</i> • PICK a wafer from the VCE. • PLACE it into the first Process Module. • PICK it from the Process Module and PLACE it to the next Process Module. • Transfer the wafer through the remaining Process Modules, Aligners, Cool Stations, and Buffers. • PLACE the wafer into the empty cassette. • Continue until all wafers have been transferred successfully.
5.	Repeat the procedure to transfer the wafers back to their original cassette.

8. Command Reference

See the appropriate robot, aligner and controls manuals as well as the System Block Diagram for more information.

9. Maintenance and Repair

Preventive Maintenance This chapter provides the schedule and procedures for routine preventive maintenance of the Micro Marathon Express. Brooks Automation recommends that the preventive maintenance procedures and schedule provided in this section be followed to extend the operating life of the MMX 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 are made with the assumption that the MMX is operating in a clean, dry, inert environment. Any deviation from this basic environment will affect the scheduling of PM and may also require additional PM procedures. The user should adjust the Preventative Maintenance Schedule as appropriate to account for any deviations from this environment.

 CAUTION Unauthorized Service	
Personal injury or damage to equipment may result if this product is operated or serviced by unauthorized personnel. • Only qualified personnel are allowed to transport, assemble, operate, or maintain the Product. • Properly qualified personnel are those who have received certified training and have the proper qualifications for their jobs.	

NOTICE
Due to the possible interference between a 200 mm wafer in the aligner and another on the robot's arm, the robot should not be rotated or moved during maintenance if there is a 200 mm wafer in the Vacuum Aligner.

Parts

Brooks Automation can provide all parts required for Preventive Maintenance. For a list of these parts, contact Brooks Automation Customer Support. To obtain additional information about parts for preventive maintenance, contact the local Brooks sales representative, or call Brooks Automation Customer Support at 978-262-2900 (Monday - Friday, 8:00 am - 5:00 pm Eastern Time).

Preventive Maintenance Schedule and Procedures

[Table 9-1](#) provides a quick reference for all scheduled maintenance of the MMX. If additional procedures are required during the performance of any procedure, they will be provided. Refer to the individual component manuals and any separate preventive maintenance procedures provided with the individual system components for additional maintenance procedures.

The following Preventive Maintenance Schedule is based on a certified clean, dry environment. The user should adjust the Preventative Maintenance Schedule to account for any deviations from this environment.

Table 9-1: Maintenance Schedule

Component	Maintenance Action	Frequency
All Materials Support	"Material Support (Pad) Inspection" on page 145 "Pad Cleaning Procedure" on page 147	3 months
MMX System	"Pad Cleaning Procedure" on page 147	12 months or as required
	"Material Presence Sensor Adjustment" on page 160	6 months
	"Verifying Flatness of End Effector" on page 162	12 months or as required
	"End Effector Levelness Verification and Adjustment" on page 164	12 months or as required
	"Alignment Procedures" on page 129	3 months
Aligner	See aligner manual.	
TopCooler	See TopCooler manual.	
Vacuum Pumps	As specified for pumps being used Refer to Pump User Manual.	
Gauges	As specified for gauges being used Refer to Gauge User Manual.	
Robot	See robot manual.	
Vacuum Load Locks	See VCE manual.	

Material Support (Pad) Inspection

Over time, repeated material transfers will deposit contaminants and wear away the surface of the pads on the end effectors and material shelves, which will decrease their friction. It is necessary to inspect pads to prevent material slippage and loss of repeatability.

Procedure Category

Equipment is fully de-energized.

Required Tools

None

Maintenance Strategy

Visual observation of material supports. Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).

 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.	 

NOTICE	
	The MMX may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. When this is the case, 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.

Inspection Procedure

Step	Action
1.	HOME the robot then turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Vent the Vacuum Chamber and Load Lock.
3.	Open the chamber lid, refer to "Removing/Replacing Lid" on page 169 .
4.	Visually inspect the surface of the pads on the end effector, the vacuum aligner, the cassette support or material support shelves in the load lock, and the wafer support shelves in the cooler for excessive wear or damage.
5.	If any of the above inspection points report a discrepancy, refer to "Pad Cleaning Procedure" on page 147 and "Pad Removal/Replacement" on page 173 for replacement.
6.	Close the chamber lid, refer to "Removing/Replacing Lid" on page 169 .
7.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68 .

Pad Cleaning Procedure

Collection of debris and other contaminants on the material support pad surface may cause material slippage. For optimum robot and system performance, pads should be cleaned as a part of normal servicing to remove contaminants deposited on them from the process or other sources.

Procedure Category

Equipment is fully de-energized.

Required Tools

- Kalrez® pads: use de-ionized water
Stainless Steel pads: use Isopropyl Alcohol
Quartz pads: use Isopropyl Alcohol
- Lint-free, clean room Wipes

Maintenance Strategy

Cleaning procedures depend on the type of pads; Kalrez®, Stainless Steel, or Quartz. Separate procedures are provided for each support type. Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).

 WARNING Lockout / Tagout	
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NOTICE

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

Maintenance Procedure

Step	Action
1.	HOME the robot then turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Cleaning Kalrez® Pads Procedure: - Dampen a cleanroom wipe with de-ionized water. - Clean the entire end effector or support shelf, paying special attention to the Kalrez® pads. Do not apply excessive pressure or force to the pads while cleaning. Excessive force may dislodge or bend the end effector or shelf. - Once all residues have been removed, use dry cleanroom wipes to dry all surfaces. NOTE: Do not use isopropyl alcohol on any material support pads because damage to the pads may occur. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any water to drip. Do not allow water to come in contact with bearings, seals, and so forth.
3.	Cleaning Stainless Steel or Quartz Pads Procedure: - Dampen a cleanroom wipe with isopropyl alcohol. - Clean the entire end effector or support shelf, paying special attention to the pads. Do not apply excessive pressure or force to the pads while cleaning. Excessive force may bend the end effector or shelf. - Once all contaminants have been removed, use cleanroom wipes moistened with DI water to remove any residues. - Once all residues have been removed, use dry cleanroom wipes to dry all surfaces. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any isopropyl alcohol to drip. Do not allow alcohol to come in contact with bearings, seals, and so forth. Alcohol should not be used on the optional perfluoroelastomer (Kalrez) pads. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any water to drip. Do

Step	Action
	<i>not allow water to come in contact with bearings, seals, and so forth.</i>
4.	Ensure the Load Lock door and the Transport Chamber lid are closed.
5.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68.

Cleaning Procedure

Occasionally the MMX will need to be cleaned. This could be done as a part of normal servicing or to remove contaminants deposited on it from the process or other sources.

Procedure Category

Equipment is fully de-energized.

Required Tools

- Isopropyl Alcohol (100%)
- DI Water
- Cleanroom Wipes
- Maintenance Strategy

A general cleaning procedure is provided with specific directions for each of the major components within the system. Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).

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NOTICE	
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NOTICE

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

Maintenance Procedure

Step	Action
1.	HOME the robot then turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Cleaning the Load Lock: - Remove the cassette and all wafers from the load lock chamber. - For a VCE, clean the surface of the Cassette Platform and the interior of the load lock using the General Cleaning Procedure in Step 4. - For an SVL, clean the surfaces of all material shelves and the interior of the load lock using the General Cleaning Procedure in Step 4.
3.	Cleaning the Vacuum Aligner: If a vacuum aligner is installed on the MMX system and contamination enters the aligner chamber, cleaning is necessary. - Remove all wafers from the aligner. - Remove power and disconnect all cables to the vacuum aligner. Refer to "Vacuum Aligner Replacement" on page 176 for disassembly instructions and figures. - Loosen the screws in the top cover and remove the top cover. - Clean the interior of the aligner using the General Cleaning Procedure in Step 4. - Replace the lid, secure the hardware, and reconnect all cables. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any isopropyl alcohol to drip. Do not allow alcohol to come in contact with bearings, seals, and so forth. Alcohol should not be used on the optional perfluoroelastomer (Kalrez) pads. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any water to drip. Do not allow water to come in contact with bearings, seals, and so forth.
4.	General Cleaning Procedure: - Remove any hazardous materials from the MMX system's surfaces following the facility's procedures for those materials. - Clean all exposed surfaces using cleanroom wipes moistened with isopropyl alcohol. - Once all contaminants have been removed, use cleanroom wipes moistened with DI water to remove any residues. - Once all residues have been removed, use dry cleanroom wipes to dry all surfaces. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any isopropyl alcohol to drip. Do not allow alcohol to come in contact with bearings, seals, and so forth. Alcohol should not be used on the optional perfluoroelastomer (Kalrez) end effector pads. NOTE: Wipe must be moistened only; squeezing the wipe should not cause any water to drip. Do not allow water to come in contact with bearings, seals, and so forth.
5.	Ensure the Load Lock door and the Transport Chamber lid are closed.

Step	Action
6.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68 .

TopCooler Cool Chuck Cleaning

The Cool Chuck may be cleaned without removing it from the Transport Chamber.

Required Tools

- Metric Hex Wrenches

Maintenance Strategy

The Cool Chuck is readily accessible after removing the drop-in Poppet Assembly. Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).

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NOTICE	
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Maintenance Procedure

Step	Action
1.	Remove the Poppet Assembly by removing the four M8 screws securing the assembly to the Transport Chamber (refer to "Vacuum Aligner Replacement" on page 176).
2.	The Cool Chuck is now accessible for cleaning. Use the "Pad Cleaning Procedure" on page 147 to thoroughly clean the plate. Do not allow alcohol to permeate the o-ring. It is recommended that the o-ring be removed before cleaning and replaced whenever the plate requires a rigorous cleaning.
3.	Replace the Poppet Assembly and secure the hardware.

O-Ring Removal/Replacement/Cleaning

All O-rings should be inspected periodically to ensure proper operation. Occasionally O-rings will need to be cleaned (if contaminated with particulates) or replaced (if damaged).

Procedure Category

Equipment is fully de-energized.

Required Tools

- Brass or plastic pick
- Isopropyl Alcohol (100%)
- DI Water

Maintenance Strategy

The O-ring replacement procedure requires removal of the existing O-ring, inspection of the seal area, repair of the seal area if necessary, inspection of the O-ring, and replacement of the O-ring if necessary.

Turn off and disconnect all power, communications, and air connections as detailed in "[Shut-down](#)" on page 117.

 WARNING Lockout / Tagout	
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NOTICE



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When this is the case, 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.

NOTICE

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

Maintenance Procedure

Step	Action
1.	HOME the robot then turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Removal Procedure: - Using the pick, pry the old O-ring out of the O-ring groove starting at the plunge hole. - Once a section of the O-ring is free of the groove, gently remove the rest of the O-ring by hand, being careful not to damage or scratch the O-ring or the seal area. NOTE: Use only a tool made of brass, plastic, or similar soft material. The O-ring groove is aluminum and EXTREMELY sensitive to ANY small scratches left in the surface.
3.	Replacement Procedure: - Clean the O-ring seal surface and the O-ring groove with isopropyl alcohol, refer to Step 4 of the "Cleaning Procedure" on page 150. - Clean the O-ring with DI water prior to installation in the system. - Install the O-ring in the groove provided. The O-ring groove is a double dove-tail slot with the narrow portion of the slot at the top. The O-ring has to be compressed in order for it to be placed into the groove. - Once the O-ring has been replaced the seal should be checked for leaks using a leak-checker. The easiest method for placing the O-ring in the groove is: - Insert a small portion of the O-ring into the groove at opposite ends of the ring. - Insert a small portion of the O-ring into the groove at 90° from the points above. - Press the O-ring into the groove evenly in each 90° segment. Do not stretch the O-ring to prevent excessive looping as the balance of the O-ring is inserted. NOTE: Do not allow the O-ring to twist during installation. NOTE: Clean the O-ring by wiping down with DI water only. Do not use alcohol or other solvents, as they may cause the O-ring to become brittle.

Step	Action
4.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68.

Aligner Video Data Check

This procedure provides an easy method for checking the clarity of the video data. Failure to pass this test is often caused by dirt or a film on either the CCD array or the CCD array chamber glass. If not corrected, eventually this condition will result in align and scan errors.

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools

- A computer running a terminal emulator or a dumb terminal
- Test wafer of the appropriate size

Maintenance Strategy

Using a test wafer to determine the quality of the aligner's edge detector. Wafers can be placed on the aligner manually; however, it is recommended that the system controller be used to transfer a wafer into the aligner.

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NOTICE



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When this is the case, 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.

Maintenance Procedure

Step	Action
1.	Place a wafer of the proper size for the current vacuum aligner settings on the chuck.
2.	Issue the following command: FLSH
3.	The aligner will display on the PC the contents of the video RAM. The string of Fs and the string of 0s should be solid, with no random characters within them. There should be a sharp transition from Fs to 0s, with one "transitional character" between.
4.	If any characters appear which are not as described above, remove the CCD array and clean with isopropyl alcohol following Step 4 of the "Cleaning Procedure" on page 150. Also inspect the chamber glass for signs of smudges or dirt and clean if necessary.
5.	Repeat procedure until good data is returned.

Material Presence Sensor Adjustment

The Transport Module's Material Presence Sensors should be checked, and adjusted if necessary, to ensure correct detection of material within the Transport Chamber.

Procedure Category

Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools

- Expendable material of type to be processed
- Small flat-blade screwdriver

Adjustment Strategy

If material is not detected correctly, the material presence sensor needs adjustment. The Photoelectric Switch requires no maintenance. However, it is recommended that the optical interface is cleaned during the scheduled cleaning procedure and that all screws and connections be checked.

Adjustment Procedure

The Photoelectric Reflex Switch sensor is able to detect all material types including clear material. During normal operation, with the beam not being blocked, the switch indicator light will be lit. This indicates that the beam is sent to the reflector and enough reflected light is being received by the sensor. If the indicator is out or if it is blinking, the switch needs to be adjusted.

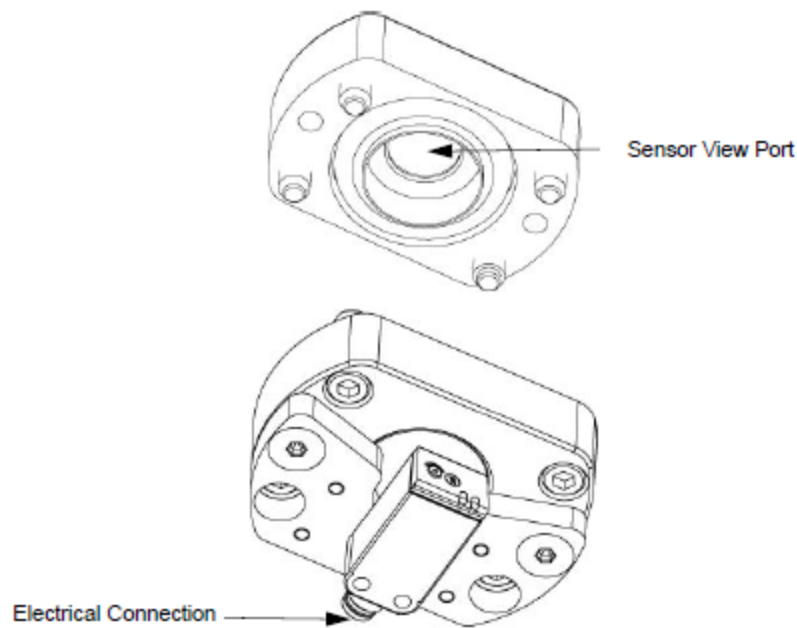


Figure 9-1: Material Sensor

Step	Action
1.	Verify that no object is blocking the sensor. The red beam of the LED should be centered on the reflector.
2.	Adjust signal strength by turning the dial until the indicator lights up.
3.	Verify the object detection function is working correctly. • Move material (i.e., wafer) into the beam; the indicator should turn off. If it stays on or is blinking, reduce the sensitivity using the dial adjustment until the indicator is off. • Remove the material; the indicator should switch on. If it does not, readjust the sensitivity. • Continue this procedure until the sensitivity threshold is set correctly.

The LED in the sensor is safe to look at and allows the lid of the chamber to be opened without optical hazard.

Verifying Flatness of End Effector

The end effector(s) must be flat to ensure proper support of the material being handled by the robot. This procedure checks for the top surfaces of the material supports on the end effector to be within 0.076 mm (0.003 inch) of each other and that no part of the end effector rises above the lowest material support.

This procedure must be performed during initial setup if the end effector is suspected of damage during shipment and at any time that the robot's arms or end effector(s) are damaged, removed and replaced, or changed while in the system. It is also recommended that this procedure be performed as a preventive maintenance practice.

NOTE: To successfully align the robot and to obtain consistent and precise handling of material, the limits and tolerances stated in this verification procedure must be met.

Procedure Category

Equipment is fully de-energized.

Required Tools and Test Equipment

- Granite surface block
- Height gauge

Limits and Tolerances

- Maximum deviation between supports 0.076 mm (0.003 inch)
- No point on the end effector's surface will be higher than the lowest support

Adjustment/Calibration Strategy

This procedure uses the granite surface block as a reference point to determine the height of each material support on the end effector and to ensure that no part of the end effector rises above the material supports. Turn off and disconnect all power, communications, and air connections as detailed in the Measurement Procedure below.



WARNING

Lockout / Tagout

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Measurement Procedure

Step	Action
1.	HOME the robot then turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Remove the end effector from the robot arm as specified in the robot's user manual and place the end effector on a granite surface block with the material supports facing up.
3.	Using the height gauge, measure the height of each material support.
4.	Verify that all supports are within 0.076 mm (0.003 inch) of each other. Replace supports if any are out of specification using the procedures provided in the robot's user manual.
5.	Once all material supports are within specification, measure the height of the top surface of the end effector to ensure that no portion of it exceeds the height of the lowest material support.
6.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68 .

End Effector Levelness Verification and Adjustment

This procedure is only for the 3 wave spring design end effector on the MMX.

Adjust the end effector at initial setup, and at any time that the robot's arms or end effector(s) are damaged, replaced, or changed. Brooks Automation also recommends performing this adjustment as preventative maintenance.

Before performing this procedure, ensure that the end effector is planar. Refer to ["Verifying Flatness of End Effector" on page 162](#).

Procedure Category

Equipment is fully de-energized.

Required Tools and Test Equipment

- Metric hex wrenches
- Torque wrench
- The robot's Teach Pendant
- MicroTool Wafer Level or Bubble Level

Verification and Adjustment Procedure

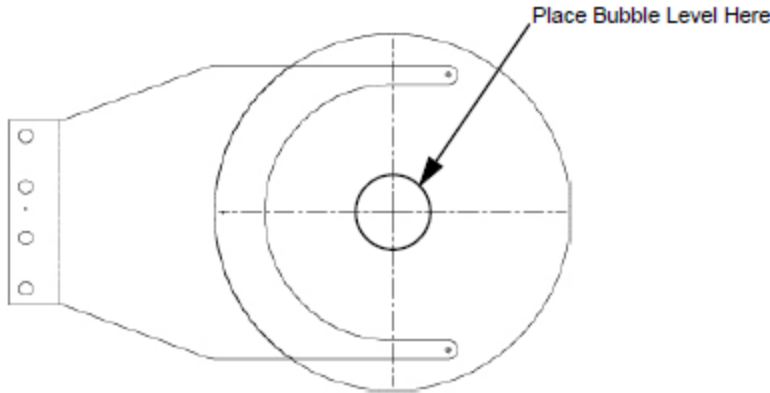
 WARNING Lockout / Tagout	
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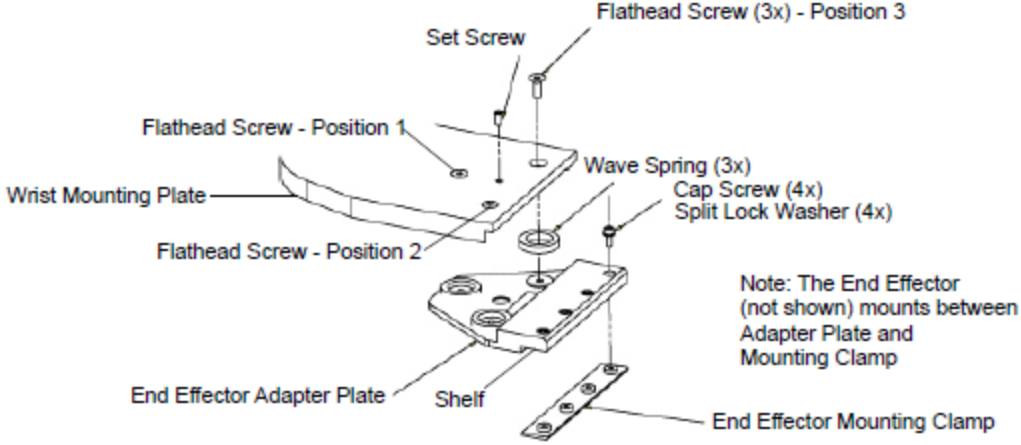
NOTICE



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Step	Action
1.	HOME the robot.
2.	Turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
3.	Open the chamber lid to access the end effector.
4.	If a MicroTool wafer level is being used, place it on the end effector. If a bubble level is being used, place a test wafer on the end effector and place the bubble level at the intersection of the cross hairs as shown in Figure 9-2.  Figure 9-2: Positioning a Bubble Level
5.	Verify that the end effector is level within 0.02 degrees. If the end effector is not level, adjust it as follows. Refer to Figure 9-3. - Loosen the 4 cap screws that hold the end effector adapter plate, the end effector (not shown), and the end effector mounting clamp. If you are replacing the end effector, you must remove the end effector mounting clamp. - Push the end effector back until it is snug against the back wall of the shelf of the end effector adapter plate.

Step	Action
	- Using the torque wrench, tighten each of the 4 cap screws that hold the end effector adapter plate, the end effector (not shown), and the end effector mounting clamp in place. Tighten each screw to 10 inch-lbs. Tighten the 2 inside screws, then tighten the 2 outside screws. If no torque wrench is available, hand-tighten each screw until it is snug. - Back out the set screw on the wrist mounting plate. Leave it in place, but not contacting the end effector adapter plate. - Gradually and sequentially tighten each of the 3 flathead screws until it is snug. Using the torque wrench, tighten each flathead screw to 10 inch-lbs. Back off each flathead screw 1 full turn. If no torque wrench is available, tighten each screw all the way down and then back each one off 1 full turn. - Adjust the flathead screw at position (1) to level for pitch. - Adjust flathead screws at positions (2) and (3) to level for roll. - When the end effector is level all around, tighten the set screw. - Verify the end effector remains level after tightening the set screw. If the end effector is not level, repeat all lettered actions in this step until it is level. If the end effector is level, remove the leveling device (MicroTool or bubble level) and go to the next step. NOTE: Do not over-tighten any of the adjusting screws as the end effector may become permanently twisted.  Figure 9-3: Leveling the End Effector
6.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 68.

Repair Philosophy

If the MMX malfunctions, refer to "[Troubleshooting](#)" in this manual for diagnostic procedures. If these procedures are not adequate to determine the source of the problem, refer to the operational descriptions in "[Subsystems](#)" for in-depth descriptions of the various subsystems of the MMX 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 MMX and installing the new unit into the MMX system. Refer to the appropriate component User Manuals for additional troubleshooting and repair procedures.

A series of FRUs has been identified for the MMX to reduce MTTR and to simplify repair procedures in the field. Some of these FRUs may comprise a complete assembly. A number of alternatives are available for obtaining replacement FRUs and other parts to repair the MMX. The following service options are available:

- Facilitated on-site repair via a Service Sales Order utilizing 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. See [Contact Us](#) for more information.

NOTE: Safety and Operations training classes on how to troubleshoot and repair a MMX to a FRU level are available. Contact Brooks Automation for information about these classes. See [Contact Us](#) for more information.

Repair Procedures

Wafer Change-over Procedure

The MMX is capable of operation with 100 mm through 200 mm wafers. There are minimal changes required to convert from one wafer size to the other.

Procedure Category

Equipment is fully de-energized.

Required Tools

- Metric Hex Wrenches
- A computer running a terminal emulator or a dumb terminal
- The robot's Control/Display Module (CDM)

Maintenance Strategy

The following changes must be made to the MMX system's hardware and software when changing wafer sizes. Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).

After any changes are made to the system (including the size of the wafer), the system should be completely realigned, as described in ["System Alignment"](#).

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Maintenance Procedure

After any changes are made to the system (including the size of the wafer), the system should be completely realigned, as described in "[System Alignment](#)".

Robot:

- Change the robot's end effectors (see the robot user manual)
- Reteach the robot all stations

VCE Load Lock

Adjust the VCE's wafer slide out detector (see the *VCE User Manual*).

Vacuum Aligner

- Change the aligner's chuck
- Change the aligner's CCD position
- Change the system software settings (see the appropriate user manual)

System Software

- Change system software settings (see the appropriate user manual)

Removing/Replacing Lid

The lid may be removed to clean the inside of the chamber and the robot or to remove the robot, the robot arms, or the robot end effector(s). The lid is manually removed. The lid is accessed through the service areas shown in "[Service and Exclusion Zones](#)" on page 23.

Procedure Category

Equipment is fully de-energized.

Required Tools

- Metric Hex Wrenches

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117.



WARNING

Lockout / Tagout

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NOTICE



The MMX may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials.

When this is the case, 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.



CAUTION

Heavy Object

The MMX chamber lid weighs at least 16 kg (35.2 lb). Removing the lid requires a twisting motion that could cause injury.

Use proper lifting technique when removing the lid.



NOTICE

Do not attempt to open the lid if the chamber is under vacuum. The captive hardware is tight, or the O-ring seal has not been released.

Replacing the Vacuum Robot, Arm, or End Effector

The vacuum robot, arm, and end effector are available as FRUs and have no user serviceable parts. These FRUs can be replaced using the following procedure.

Procedure Category

Equipment is fully de-energized.

Required Tools

- A set of Hex wrenches in metric sizes
- Adjustable lift or hoist (optional)

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in "[Shut-down](#)" on [page 117](#). All robot stations must be verified, and retightened if necessary, after making any changes to the robot.

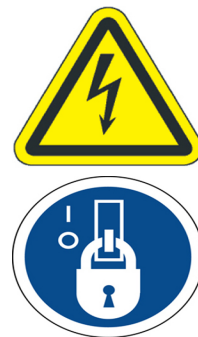


WARNING

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**.



NOTICE



The MMX may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials.

When this is the case, 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.

Replace Robot

The robot is replaced from the top of the MMX vacuum chamber.

Step	Action
1.	Open the chamber lid, refer to "Removing/Replacing Lid" on page 169 .
2.	Access is available to the arms when the robot is in the RETRACT position. Remove the arms using the procedure in the robot user manual.
3.	Remove the robot drive using the procedure in the robot user manual.
4.	Replace the robot drive using the procedure in the robot user manual.
5.	Replace the arms using the procedure in the robot user manual.
6.	Verify, and reattach if necessary, all stations.

Replace Arm Set

The robot arms are replaced from the top of the chamber.

Step	Action
1.	Open the chamber lid, refer to "Removing/Replacing Lid" on page 169 .
2.	Access is available to the arms when the robot is in the RETRACT position. To remove the arms, refer to the robot user manual.
3.	Replace the arms using the procedure in the robot user manual.
4.	Verify, and reattach if necessary, all stations.

Replace End Effectors

The end effectors may be adjusted or replaced from the top of the chamber.

Step	Action
1.	Open the chamber lid, refer to "Removing/Replacing Lid" on page 169 .
2.	Access is available to the end effectors when the robot is in the RETRACT position. To adjust or remove the end effectors, refer to the robot user manual.
3.	Verify, and reattach if necessary, all stations.

Pad Removal/Replacement

Repeated material transfers will eventually wear away the friction pads. In time, the surface of the material may touch the surface of the End Effector or Material Support Shelves resulting in abrasion and particle generation. To prevent this abrasion of the material surface, periodic replacement of the pads according to the maintenance schedule is recommended.

Procedure Category

Equipment is fully de-energized.

Required Tools and Test Equipment

- None

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 117](#).



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**.



NOTICE



The MMX may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials.

When this is the case, 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.

Grommet Style Pad Replacement

Replacing the pads requires no special tools or materials.

Step	Action
1.	Remove the pad by pulling it out of the end effector from the top side.
2.	Press the pad into the holes on the end effector by hand until fully seated.

O-Ring Type Pad Replacement

Replacing the pads requires no special tools or materials.

Step	Action
1.	Remove the pad by pulling out of the shelf tab from the top side.
2.	Hand press the pad over the shelf pins.

VCE Replacement Procedure

The VCE Vacuum Cassette Elevators are supplied in a standard SEMI MESC compatible configuration. Brooks can supply a VCE pre-configured for use in the MMX as long as the appropriate information regarding part number and use is provided at the time of the order.

NOTE: The station coordinates for the VCE must be verified, and corrected if necessary, before using the VCE.

See the VCE FRU procedure for more information.

Safety Hub Replacement

The Safety Hub is provided as a FRU and has no user serviceable parts. The Safety Hub can be replaced using the following procedure.

Required Tools

- A set of Hex wrenches in metric sizes
- Adjustable lift or hoist (optional)

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in "[Shut-down](#)" on page 117.

 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.	 

See the Safety Hub FRU procedure for more information.

TopCooler Replacement

See the TopCooler FRU procedure in the TopCooler manual for more information.

TopCooler Poppet Bellows Replacement

See the TopCooler Poppet Bellows FRU procedure in the TopCooler manual for more information.

TopCooler Chuck O-Ring Replacement

See the TopCooler Chuck O-Ring FRU procedure in the TopCooler manual for more information.

TopCooler Poppet Speed Adjustment

See the appropriate procedure in the TopCooler manual for more information.

TopCooler Poppet Open/Close Sensor Adjustment

See the TopCooler Poppet Open/Close Sensor Adjustment procedure in the TopCooler Manual for more information.

Vacuum Aligner Replacement

The vacuum aligner may be easily removed for servicing by following the directions provided below. No re-alignment is required after replacement.

O-Rings are located in the Top Flange and the Base Flange. It is recommended that these O-rings be replaced whenever the flanges are removed.

Procedure Category

Equipment is fully de-energized.

Required Tools

- Metric Hex Wrenches

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in "[Shut-down](#)" on page 117.

 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.	 

NOTICE	
	The MMX may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. When this is the case, 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.

See the Vacuum Aligner FRU procedure for more information.

Vacuum Aligner Wafer Rotate Module Replacement

See the Vacuum Aligner Wafer Rotate Module FRU procedure for more information.

Vacuum Aligner LED/OPTIC Assembly Replacement

See the Vacuum Aligner LED/OPTIC FRU procedure for more information.

Vacuum Aligner Electronics Module Replacement

See the Vacuum Aligner Electronics Module FRU procedure for more information.

Vacuum Aligner EPROM Replacement

See the Vacuum Aligner EPROM FRU procedure for more information.

Vacuum Aligner Chuck Exchange

See the Vacuum Aligner Chuck Exchange procedure for more information.

Vacuum Aligner CCD Detector Wafer Size Adjustment

See the Vacuum Aligner CCD Detector Wafer Size Adjustment procedure for more information.

Vacuum Aligner Support Pin Replacement

See the Vacuum Aligner Support Pin FRU procedure for more information.

Isolation Valve Replacement

Facet Slot Valve

The facet slot valve gate actuator and the atmospheric door are replaceable units. This actuator is removable from the underside of the valve without having to remove the valve. Refer to the OEM Manual.

10. Troubleshooting

Initial Troubleshooting

This chapter covers the initial determination of the problem area within the Micro Marathon Express (MMX) and provides direction to the second step of the troubleshooting process. If a specific problem is suspected refer to that problem in [Table 10-1](#). If the problem has not been identified review each step of [Table 10-1](#), no matter how trivial, in order to ensure proper determination of the problem area. If the problem encountered 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 10-1: Initial Troubleshooting

Symptom	Possible Problem Area
Power lights do not turn on	"Electrical Systems" on page 180
System powered but no response to Transport Module Controller	
System powered but no response from components within system	
Load Port Modules not operating	"Material Transport" on page 182
Unexpected movement of modules	
Material slipping or left on end effector	
TopCooler leaks	See the TopCooler manual.
Wafer slipping on aligner	"Vacuum Aligner" on page 184
Aligner not working properly	
Chamber not pumping down correctly	"Vacuum System" on page 185
Slot valve/Atmospheric door not working properly	"Isolation Valve Replacement" on page 178

Electrical Systems

Gen 5 EN Control System

If problems are suspected with the Generation 5 EN Controls Modules review [Table 10-2](#).

Table 10-2: Gen 5 EN Controls Troubleshooting

Component	Problem	Corrective Action
ACPDU	Gen 5 EN component will not power up.	- Check that component power switch is ON (Mini-hub, Safety Hub, Ethernet Hub). - Check component AC cord. - Check that ACPDU circuit breaker for Vacuum System is ON. - Check that AC feed to ACPDU is ON.
Ethernet Hub	No Ethernet status lights on host port, or host will not connect.	- Check that Ethernet Hub power adapter is plugged in. - Check for loose Ethernet cable. - Check host network connections setup to ensure host's IP is in correct range (host's IP should be 20.20.245.xx where xx does not interfere with any components IP address). - Check to ensure a second host has not made an active connection to component of interest.
Safety Hub	Robot reports it has halted on interlock or E-stop. Robot reports it has halted because door/SV is not OPEN. Slot valve or door does not OPEN. Slot valve or door does not CLOSE.	- Check for an opened service access (LL lid, TC lid, or EFEM door). Close access or insert interlock bypass, and reset Safety Hub. - The robot may be trying to pass through a door or slot valve that is closed. Check to see if the door/SV is operating correctly. - Check for any service access that maybe opened. - A pneumatic command maybe trying to close a door/slot valve while the robot was extended. The pneumatic command to OPEN the door/slot valve must be sent over DeviceNet, and the Safety Hub must be reset.
Robot Power Supply	Vacuum robot does not have power. Intermittent wafer presence detected or not detected at all.	Check the Robot Power Supply switches (2) to ensure both switches are ON for the robot to receive power.

Component	Problem	Corrective Action
	Interlock event halts vacuum robot.	
Pneumatic Manifold	No status LEDs Valve channel n is ON, but there is no flow. Valve channel n status LED appears to turn ON and OFF, but valve does not operate. Controlled device such as a slot valve or isolation valve fails to complete motion. Controlled device such as a slot valve or isolation valve operates correctly, but another device unexpectedly partially actuates. The power supply in the Safety Hub powers the DeviceNet network and pneumatic manifolds. This Safety Hub power switch must be ON.	- The absence of status LEDs could indicate that no DeviceNet commands have been issued to turn on any of the manifold's pilot valves. - If a valve on the manifold is ON and there is no device actuation then the CDA source could be OFF or the pressure is insufficient. Check the regulator gauge and check the lock-out tag-out CDA shutoff. - If an interlock has been activated the pilot valve for that channel will not activate and actuate the device. - If a controlled device does not actuate completely then check for sufficient CDA supply pressure. - A pinched or obstructed exhaust line can cause back pressure in the manifold, which could lead to unexpected actuation of valve channels not directly commanded. The source of the exhaust line obstruction must be located and removed.

DC Power Supply

If a component does not power up, check the DC Power Supply for open circuit breakers and blown fuses.

Table 10-3: DC Power Supply Troubleshooting

Symptom	System	Circuit Breaker
If no components are on, verify main circuit breaker is in the ON position. The main circuit breaker is located on the rear panel. The PWR ON indicator on the rear panel should be lit red. A 0.5 A fuse is located across the 24V, 24V RTN for all power distribution except the robot (F1).	ON/OFF	15A 2-pole

Symptom	System	Circuit Breaker
If the robot is not receiving power, verify the double pole circuit breaker is thrown on the front panel. The Indicator below the circuit breaker should be lit green. A 0.5 A fuse is located across the 24V, 24V RTN for the robot (F2).	ROBOT	- Check that Ethernet Hub power adapter is plugged in. - Check for loose Ethernet cable. - Check host network connections setup to ensure host's IP is in correct range (host's IP should be 20.20.245.xx where xx does not interfere with any components IP address). - Check to ensure a second host has not made an active connection to component of interest.
Module that has been connected to the I/O Distribution Hub DC PWR OUT is not working.	I/O	10A
Vacuum Aligner will not turn on.	ALIGNER	10A
Component connected to AUX 1 is not working.	AUX 1	10A
Component connected to AUX 2 is not working.	AUX 2	10A
Component connected to AUX 3 is not working.	AUX 3	10A

Material Transport

This section covers determination of problems within the Material Transport Subsystems.

Table 10-4: Material Transport Troubleshooting

Problem	Corrective Action
Material slipping on end effector	a Check that vacuum is connected and meets pressure specifications. b 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.	a Identify cause of the failure that left the material on the end effector. b 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.	a Shut down the system and recover manually. b Remove the vacuum chamber's lid and check all components associated with the failure. Manually remove the material.

TopCooler

This section covers the initial determination of the problem area within the TopCooler II and provides suggested solutions for those problems. If a specific problem is suspected refer to that problem in [Table 10-5](#). If the problem has not been identified review each step of [Table 10-5](#), no matter how trivial, in order to ensure proper determination of the problem area.

Table 10-5: Initial Troubleshooting

Problem	Possible Cause and Suggested Solution	
TopCooler leaks	Bellows or o-ring leak	"TopCooler Poppet Bellows Replacement" on page 176 "TopCooler Chuck O-Ring Replacement" on page 176
Wafer has moved after cool cycle	Poppet speed too high (" 1. Poppet Speed Too High ") Rough poppet motion (" 2. Rough Poppet Motion ") Process gas pressure too high (" 8. Pressure Adjustment ")	
Main chamber pressure rises during cool cycle	Leaky poppet o-ring (" 3. Leaky Poppet O-Ring ")	
Cool chamber pressure does not rise during cool cycle	Insufficient process gas pressure (" 8. Pressure Adjustment ") Leaky poppet o-ring (" 3. Leaky Poppet O-Ring ")	
Valve(s) not responding	Control board problem (" 4. Control Board Problems ") Other valve problems (" 5. Other Causes for Inoperative Gas Valves ")	
Wafer not cooling	Insufficient process gas pressure (" 8. Pressure Adjustment ") Cooling water out of spec. (" 6. Cooling Water Out of Specification ") Main chamber too hot (" 7. Main Chamber Too Hot ")	

Each possible cause in the chart is cross referenced to a numbered procedure in this section. After locating a problem in the chart, refer to the section listed for more detailed information.

1. Poppet Speed Too High

Check that the inlet air pressure is within the values specified in "[Specifications](#)" on page 17 before making any adjustments to the speed control valves. Adjust the speed of the poppet after verifying the pressure is within the range specified.

2. Rough Poppet Motion

One cause of rough poppet motion is the use of a lubricated air supply. Small particles of oil, when passing through the restriction valves, momentarily restrict the air flow and cause a jerky motion. After switching to a dry air supply, the unit should be run through 10 to 20 up/down cycles to clear the oil from the system.

3. Leaky Poppet O-Ring

Refer to ["Maintenance and Repair"](#) for lid o-ring cleaning and replacement information.

4. Control Board Problems

Verify that all connections to the control board are secure and that the daughter board is properly seated on the control board.

5. Other Causes for Inoperative Gas Valves

The operational chain for all gas valves is as follows:

- a. The control board sends power to a solenoid operated valve located on a panel of three valves on the opposite side of the unit.
- b. The solenoid operated valve pressurizes a thin air line which connects to a pneumatic actuator on top of the gas valve.
- c. The pneumatic actuator opens the gas valve.

When diagnosing a malfunctioning valve, this sequence, combined with the electrical schematics and pneumatic diagrams supplied with this manual should allow the troubleshooter to quickly locate a defective component.

6. Cooling Water Out of Specification

Verify that both the flow rate and temperature of the cooling water is within the range specified in ["Specifications" on page 17](#).

7. Main Chamber Too Hot

If the main chamber is running at a very high temperature, the cooling parameters may have to be increased beyond the specified parameters. Contact Brooks Automation for assistance.

8. Pressure Adjustment

Verify that the air or gas pressure is within the range specified in ["Specifications" on page 17](#).

Vacuum Aligner

Refer to the aligner manual for troubleshooting information.

Pressure/Indicator Switch

Errors of the Digital Pressure Switch are displayed on the LCD. After locating and solving the problem, press **RESET** to clear the error.

Table 10-6: Digital Pressure Switch Troubleshooting

Display	Problem	Solution
E1 dE	Data settings have changed.	Press RESET and set all data again.
E2 CE1	Output 1: Load is shorted; overcurrent.	Turn off power. Examine power supply.
E2 CE2	Output 2: Load is shorted; overcurrent.	Turn off power. Examine power supply.
E3 PE	For positive pressure: 1.5 x rated pressure is applied.	Set the pressure less than the rated pressure.

Vacuum System

This section covers determination of problems within the Vacuum System.

Table 10-7: Vacuum System Troubleshooting

Symptom	Possible Problem Area
Vacuum chamber does not pump down in a normal manner (less than 0.0001 torr within five minutes).	Ensure that the vacuum chamber's vacuum gauge is calibrated and is functioning properly. - Check for contaminants on substrates, wafer support assemblies, or in 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 okay). - Check vacuum chamber's slot valve and atmospheric door seals to ensure they are still in place, free of debris, and in working order. - Check the vacuum chamber's backing pump system. - Perform a leak check if all above fails; isolate possible leaks.

Symptom	Possible Problem Area
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 (air pressure is okay). • Check the lid seals to ensure that they are still in place, free of debris, and in working order. • Check the seals on all gate 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; isolate possible leaks.

11. Field Replaceable Units

See the FRU list supplied with the System and associated FRU procedures.

12. Appendices

Appendix A: Contact Brooks Automation Technical Support

Have the following information available when contacting Brooks Automation Technical Support.

- a. Part number and serial number from the product.
- b. Installed location of the product.
- c. Name, e-mail address, and telephone number of the person to contact.
- d. List of error codes received during the failure.
- e. 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
- f. Contact Brooks Automation Technical Support at these numbers:

Location	Contact Number	Website
North America	+1-800-447-5007 (Toll Free) +1-978-262-2900 (Local)	http://www.brooks.com/
Europe	+49 800 000 9347 (Toll Free Germany) +49 364 176 9999 6 (Has Toll)	
Japan	+81 120-255-390 (Toll Free) +81 45-330-9005 (Local)	
China	+86 21-5131-7066	
Taiwan	+886 080-003-5556 (Toll Free) +886 3-5525258 (Local)	
Korea	1800-5116 (Toll Free)	
Singapore	+65 1-800-4-276657 (Toll Free) +65 6309 0701 (Local)	

Technical Support Customer Care: <https://www.brooks.com/services/pathway-connect>

Appendix B: Factory Default Settings

Default Robot Settings

The Quality Report shipped with each robot contains a list of all the factory default settings. Refer to the QR to reset to the default.

Default VCE Drive Settings

The Quality Report shipped with each VCE contains a list of all the factory default setting. Refer to the QR to reset to the default.

Default Vacuum Aligner Drive Settings

The Quality Report shipped with each Vacuum Aligner contains a list of all the factory default setting. Refer to the QR to reset to the default.

Appendix C: Station Identification

The MMX is customized at the factory to the users specified parameters. Accompanying the MMX system is a Brooks Automation Acceptance Test (ATP) which lists all the factory assigned parameters.

In the occurrence that the user replaces any modules within the MMX or re-configures the MMX system, the new parameters should be recorded in the table provided in this section.

Table 12-1: System Assignments Log

[illegible]

Appendix D: Consumables

Consumable items are identified for each unique system based on the demands placed upon that system. No standard consumable items have been identified for the MMX. Refer to the individual user manuals for lists of the consumable items to be stocked for the components of the MMX system.

Appendix E: Tooling

[Table 12-2](#) provides a list of the specialized tools and fixtures supplied with the MMX, including shipping brackets. [Table 12-3](#) through [Table 12-4](#) provides identification of specific teach fixture kits used for servicing the MMX.

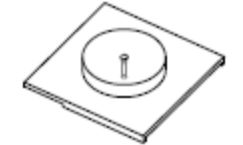
Table 12-2: Tools and Fixtures Supplied with the MMX

Tool	Description and Use
Shipping Bracket	Robot Arm Shipping Clamp

Table 12-3: Optional Tools and Fixtures

Image	Description
Electronic Level	MicroTool EL-5003 Electronic Spot Level, used for leveling during initial installation.
Dummy Wafer	MicroTool CF Series Carbon Fiber Dummy Wafers, used for system set-up and test.

Table 12-4: Teach Fixture Kit

Image	Description
	FIXTURE,ROBOT ALIGNMENT, MX STD END EFFE
	FIXTURE, VCE ALIGNMENT P2
	PIN, DOWEL, 1/4" X 5/8", SST

Appendix F: Packing and Shipping Instructions

If the MMX will be shipped, for return to Brooks or to another location, it must be properly packaged to ensure it arrives undamaged. The modules of the MMX were originally assembled and packaged in a cleanroom environment. Care should be taken to ensure that it is repackaged in the same type of environment.

NOTE: The original shipping crates must be used when shipping the MMX. If the original crates have become lost or damaged, contact Brooks Automation for replacements.

 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 Heavy Object	
The MMX weighs approximately 364 kg (800 lb). The Vacuum Cassette Elevator weighs at least 111 kg (245 lb) without the vacuum pump attached. Failure to take the proper precautions before moving any of these items could result in personal injury. Use a fork lift or a hoist to lift the MMX.	 

 CAUTION Tip Hazard	
Failure to take the proper precautions before moving any module, especially while moving it into the shipping crate, could result in personal injury. Ensure that all force exerted the MMX and the modules of the MMX System when moving them is below the center of gravity.	 

Procedure Category

Type 1 Procedure: Equipment is fully de-energized.

Required Tools and Equipment

The tools and materials required during the removal and shipping of the MMX will vary based on how it was installed. The following tools are recommended as a typical tool set. The user should adjust this list as required based on their specific installation.

- Fork truck or appropriate lift
- Open End Wrench, sizes 19 mm, 3/4 in, 1 1/8 in, or adjustable
- Metric hex wrenches
- All shipping materials used to ship the MMX
- Shipping fixtures
- Double poly-bag
- Desiccant packs
- Moisture, Shock, and Tip indicators as required

Packing Procedure

Step	Action
1.	Turn off and disconnect all power, communications, and air connections as detailed in "Shut-down" on page 117 .
2.	Remove the any tie-downs from the MMX's system frame.
3.	Release the clamps securing the MMX system to the Process Module(s).
4.	Screw in the system leveling feet so that they are fully retracted into the frame.

Step	Action
5.	Roll the MMX away from the Process Module(s).
6.	Secure the robot arms in the MMX Vacuum Back End to prevent movement and damage during shipment by using the shipping brackets supplied with the MMX system when it was received.
7.	Secure the VCE platform and door to prevent movement and damage during shipment by using the shipping brackets supplied with the MMX system when it was received.
8.	Attach blankoffs to the vacuum slot valves on the MMX Vacuum Back End.
9.	Secure any loose cables in the MMX and protect all cable ends and connectors.
10.	Install double poly-bag onto the system from the top in a class 100 packaging cleanroom.
11.	Add desiccant packs as appropriate to ensure the MMX system stays dry.
12.	Trim excess bag material touching the floor.
13.	Secure bottom of bags with shrink wrap.
14.	Secure remaining bag material with shrink wrap until bag is tight all around the system.
15.	Affix "Do Not Push", "Push Here," and "Do Not Top Load" labels where appropriate for shipping area personnel.
16.	Roll the system to the shipping area.
17.	Using the fork lift, pick the frame up only enough to clear the shipping skid. NOTE: <i>If the original crates have become lost or damaged, contact Brooks Automation for replacements.</i>
18.	Slide the shipping skid under the system.
19.	Secure the system to the shipping skid using 1/2-inch threaded rod through each of the shipping brackets. Additional blocking should be added as required to ensure that the system is adequately secured to the pallet.
20.	Attach the sides and top of the crate.
21.	Add tip indicators, shock indicators, moisture indicators, and so forth to the outside of the crate as desired to verify proper handling during shipment.