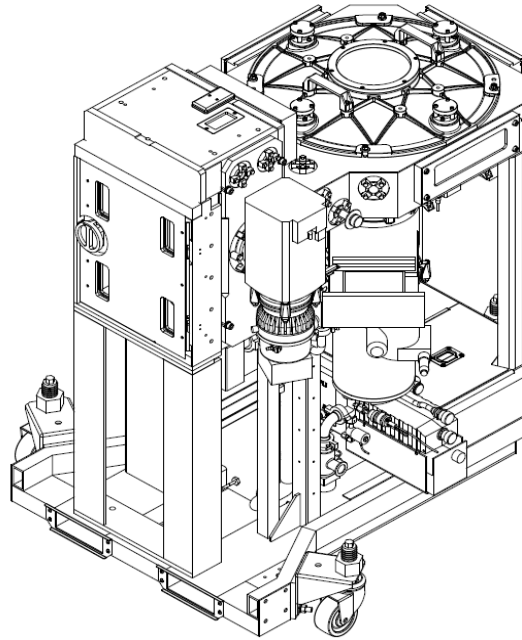




Marathon Express 400

User Manual

Part Number 607865 Rev. A



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Table of Contents

1. Introduction	13
System Overview	13
Features	14
Options	14
Subsystems	14
Supplementary and Related Documentation	17
Manual Notation	18
Specifications	18
Operating Specifications	18
Environmental Specifications	19
Mechanical Specifications	20
Chamber Heating and Cooling	21
Facilities Specifications	22
Center of Gravity and Floor Loading	26
Site Requirements for Moving the Marathon Express 400	26
Process Module Space Allocation	26
Service and Exclusion Zones	26
2. Safety	28
General Safety Considerations	29
Explanation of Hazards and Alerts	32
Safety Text	32
Safety Icons	32
Signal Words and Color	32
Alert Example	33
Safety and Identification Labels	34
Illustration of Hazard Locations	38
Interlocks	41
Mechanical Hazards	41
Lockout/Tagout Procedure	42
Ergonomics Hazards	47
Tip Hazard	47
Electrical Hazards	48
Disconnect Devices	48
ESD Protection	49
ESD/EMI Precautions	49
ESD Specification	50
Laser Hazards	50
Gas Hazards	52
Chemical Hazards	54
Thermal Hazards	55
Vacuum Hazards	55
Fire and Explosion Hazards	57
Environmental Information	58

Noise Emission	58
Vibration	58
Recycling and Hazardous Materials	58
Material Safety Information	60
3. Installation	61
Site Requirements	61
Floor Space and Loading	61
Environmental	62
Facilities	62
Unpacking and Inspection	62
Procedure Category	65
Required Tools and Equipment	65
Unpacking Instructions	65
Installation Procedure	68
Procedure Category	69
Required Tools and Equipment	69
Remove Protective Packaging	69
Removing Shipping Brackets	70
Installing the Marathon Express 400	71
Mounting the Process Modules to the MX System	73
Intermodule Connections	74
Facilities Connections	74
Electrical	75
EMO Circuit	76
Communications Connections	80
Power-up Sequence	80
4. Subsystems	84
System Overview	84
Description	86
Transport Chamber	87
Transport Chamber Lid Assembly	87
Frame Assembly	88
Service Access	89
Power Distribution	89
AC Power Distribution	90
Circuit Protection	91
Vacuum System Operation	91
Initial Conditions	91
Chamber Bakeout	91
Start-up	92
Exchange Wafers in the Load Locks	92
Shut Down from High Vacuum	92
Pneumatic System	93
Gas System	94
Water System	96
Transport Chamber Heating System	96

Heater Power Supply	97
Heaters	98
Temperature Controller	99
Thermal Blankets	99
Transport Chamber Cooling System	100
Electrical System	101
Interlocks	102
Ethernet to Serial Gateway	102
TopCooler	103
Material Presence Sensors	103
Outputs	104
Vacuum Robot	105
Wafer Buffer Module	105
VCE	106
Internal Software	106
5. Operational Interfaces	107
Interface Overview	107
Vacuum Aligner	107
Vacuum Robot	107
Heat Power Supply	107
Communications Node	108
BrooksNet Module	109
Ethernet to Serial Gateway Module	109
AC Power Distribution	110
Power Connections	110
AC Power Distribution Cable	111
Heater Power Supply Cable	113
Turbo Pumps and Cryogenic Compressor	114
Ethernet Communications	114
Network Interface Connections	114
DeviceNet Communications	115
Network Interface Connections	115
Serial Communications	115
Serial Interface Connection	116
Heater Power Supply Remote	117
E-Stop Connection	118
6. Operation	120
Theory of Operation	120
Station Coordinate System	121
Marathon Express 400 Frames of Reference	123
Robot's Frame of Reference	124
System Operation Overview	125
Determining Material Locations	126
Pick and Place Commands	126
Wafer Presence Sensing	126
Wafer Mapping	127

Radial Motion Sensors	127
Controls and Indicators	127
External Controls and Indicators	127
Internal Controls and Indicators	127
Pressure Switch	128
Temperature Controller	129
AC Power Distribution	130
Heater Power Supply	131
Ethernet to Serial Gateway Module	132
Safety Interlocks	133
Ethernet Communication	134
Ethernet Serial Gateway	134
Robot Ethernet Operation	136
DeviceNet Communication	137
The EVENT System	137
Control/Display Module (CDM) Operation	137
Heating System	137
Power Supply	138
Operation	139
Standard Operation	140
Temperature Controller	140
Watlow Temperature Controller Overview	141
Watlow 96 Setup	142
Watlow SD6 Setup	147
Heating Modes	151
Heating Control	151
Water Cooling Systems	153
Chamber Cooling System	154
Pump Cooling System	154
Wafer Cooling System	154
Pneumatic (Air Distribution) System	155
Gas Facilities Operation	156
Controls and Indicators	156
TopCooler Operation	157
Vacuum Aligner Operation	157
Pressure Switch	157
Vacuum System Operation	158
Initial Conditions	158
Chamber Bakeout	158
Start-up	160
Exchange Wafers in the Load Locks	160
Shut Down from High Vacuum	160
Start-up	161
Normal Running	162
Typical Operating Sequences	163
Shut-down	164

Emergency Procedures	166
Issuing a HALT Command in Background Mode	166
Issuing an Emergency Off (EMO)	166
Issuing an EMER_STOP in DIO Mode	167
Issuing a STOP in CDM Mode	167
Issuing an EMERGENCY STOP on the CDM	167
Power Failure	167
7. System Alignment	168
Overview	168
Procedure Category	169
Required Tools and Test Equipment	169
Alignment Strategy	169
Alignment Overview	170
Alignment Process	171
Level the VCE Platforms	173
Level the Process Modules and Dock to the Marathon Express	174
Adjust the Robot's End Effectors	174
System Preparation	176
Initializing the Vacuum Cassette Elevators	177
Initializing the Vacuum Aligner	177
Initializing the TopCooler	177
Initiating the CDM	177
Removing the Chamber Lid	178
Alignment Procedures	178
Setting the Options for the Vacuum Robot	178
Teach the Robot to the Vacuum Aligner	178
Procedure Category	179
Required Tools and Test Equipment	179
Configuration and Alignment Strategy	179
Teach the Robot the Aligner Station	180
Teach the Robot with the TopCooler	182
Teach the Robot the Cooler Station	183
Vacuum Cassette Elevator Configuration and Alignment	184
Configuration and Alignment Strategy	185
Set the Robot to the VCE WTP	186
Adjust the Load Lock Platform	189
Set the Load Lock T and R Coordinates	191
Align the Load Lock's SPS	193
Teach the Robot the Process Modules	193
Procedure	194
Teaching Pan 'B' on a Dual End-Effector Arm Set	195
Fine-Tuning the Station Assignment	196
Using the Aligner as a True Position Reference	196
Using Physical Location as a True Position Reference	197
System Alignment Check-out	197
Alignment Procedure	198

8. Command Reference	200
9. Maintenance and Repair	201
Preventative Maintenance	201
Parts	202
Preventive Maintenance Schedule and Procedures	202
Material Support (Pad) Inspection	203
Inspection Procedure	204
Pad Cleaning Procedure	204
Maintenance Procedure	206
Cleaning Procedure	206
Maintenance Procedure	207
TopCooler Cool Chuck Cleaning	208
Maintenance Procedure	209
O-Ring Removal/Replacement/Cleaning	210
Maintenance Procedure	211
Material Presence Sensor Adjustment	212
Verifying Flatness of Robot's End Effector	214
Measurement Procedure	215
Adjusting the Robot's End Effector(s)	216
Adjustment Procedure	217
Repair Philosophy	218
Repair Procedures	218
Wafer Change-Over Procedure	219
Maintenance Procedure	220
Removing/Replacing Lid	220
Removing/Replacing Viewports	223
Pad Removal/Replacement	226
Heater Cartridge Replacement	228
Isolation Valve Replacement	229
10. Troubleshooting	230
Initial Troubleshooting	230
Material Transport	231
Heating System	231
Pressure/Indicator Switch	232
Vacuum System	232
Contact Brooks Automation Technical Support	234
11. Appendices	235
Appendix A: Factory Default Settings	236
Default Robot Settings	236
Default VCE Drive Settings	236
Default Vacuum Aligner Drive Settings	236
Appendix B: Station Identification	237
Appendix C: Document Abbreviations	238
Appendix D: Consumables	239
Appendix E: Tooling	240

Appendix F: Packing and Shipping Instructions	242
Packing Procedure	244
12. Field Replaceable Units	247
Marathon Express 400	248

1. Introduction

This Introduction provides a brief overview of the Brooks Automation Marathon Express™ 400 Cluster Tool Integration Platform highlighting its features, components, operation, and specifications. Additionally, the chapter organization and a description of each chapter's contents is presented, and notation conventions are explained.

System Overview

The Brooks Automation Marathon Express 400 (MX 400) Cluster Tool Integration Platform transfers 100 mm to 200 mm wafers or 100 mm to 150 mm square substrates from a Vacuum Cassette Elevator Load Lock into a vacuum transport system for access to multiple Process Modules for multi-step processing without leaving the vacuum environment. The MX 400 system may also be used as an atmospheric-to-vacuum front end for a single process module. The MX 400 system provides SEMI standard compatible process module and material carrier interface systems, with a full set of options, to meet factory interface requirements.

The Brooks Automation MX 400 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 Marathon Express 400 system includes the cluster tool platform that accommodates up to 3 Process Modules, one vacuum cassette elevator, one integrated vacuum aligner, and one vacuum robot.

The SEMI S2 and CE regulatory compliant Marathon Express 400 Cluster Tool Integration Platform offers integral support for all system structures. The integrated frame architecture of the MX 400 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 Marathon Express 400 a superior platform for integration.

The MX 400 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 cleanroom 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

- Small footprint in the clean room and in the service area
- 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
- Brook Automation vacuum robot - performs material handling within the vacuum tool platform
- Brook Automation VCE load lock - provides batch loading of up to 25 wafers
- Rack mountable electronics
 - Heater Power Supply

Options

- TopCooler (available as a facet-mounted module)
- Vacuum Aligner
- High speed heating/cooling of the Transport Chamber
- Complete slot valve/process module/robot hardware interlocking depending on System Integration Level

Subsystems

The Marathon Express 400 is made up of several functional subsystems designed for ease of use, maintenance, and repair. These subsystems are modular in design to allow ease of maintenance and to minimize Mean Time To Repair (MTTR). The individual modules that make up the MX 400 system are described briefly below and in detail in "[Subsystems](#)".

Marathon Express™ 400 Vacuum Transport System

The Brooks Automation Marathon Express 400 Vacuum Back End is a multi-faceted Cluster Tool Integration Platform utilizing proven Brooks components such as the VCE vacuum cassette elevator and vacuum robot.

VCE Vacuum Cassette Elevator

The Brooks Automation VCE allows SEMI standard H-bar wafer cassettes to be introduced into, and removed from, the high-vacuum environment of the Transport Module without disturbing that vacuum environment. The VCE consists of a sealed wafer cassette elevating mechanism housed in an aluminum vacuum load lock chamber. The elevator raises or lowers a cassette so that individual slots are aligned with the system Wafer Transport Plane for material transport by the vacuum robot. A wafer sensor is used to determine wafer presence or absence, eliminating lost time searching for a wafer, and preventing wafer breakage caused by double loading. See the *VCE User Manual* for more information on the VCE.

Vacuum Robot

The Brooks Automation vacuum robot is capable of 3-axes of motion to provide complete material transport between the facets of the Transport Module. The drive mechanisms for the robot are isolated from the vacuum environment to minimize contamination. The robot accepts a variety of arms and end effectors, including single and dual end effector arms and arms capable of handling heavy loads. The robot is supplied with a Control Display Module for setup and monitoring.

Vacuum Aligners

The Brooks Automation Vacuum Aligner Modules utilize sensing techniques and underside wafer contact to provide rotational and translational positioning of a wafer. The vacuum aligners accept randomly-oriented wafers and rotates them while scanning for fiducial location and eccentricity. Using the eccentricity information provided the robot can then pick up the wafer using an offset to center the wafer on the end effector.

Wafer Cool Station

The Brooks Automation TopCooler is designed to cool wafers in SEMI standard 100 mm through 200 mm sizes prior to further processing or reinsertion into a cassette. The cooling cycle involves discharging gas into the closed cool chamber, which provides conductive heat transfer between the gas and a chill plate to cool the wafer.

Controls

The Marathon Express 400 is available with several different control configurations for the distribution of various control signals. See the related controls manuals and Block Diagram shipped with the system for more information.

Operation

The Marathon Express 400 is designed for batch processing where a 25-wafer cassette is placed into the Vacuum Cassette Elevator (VCE), which is then pumped down to the same vacuum level as the Transport Chamber (TC), which maintains a constant high vacuum environment. The wafers are then transferred from the VCE, one at a time, to one of three OEM Process Modules docked to the Transport Chamber. Wafers may also be transported between PMs for multi-stage processing where the wafer can not leave the vacuum environment. Once the wafer is processed it is returned to the VCE. When all wafers within the cassette have been processed the VCE is vented to atmospheric pressure, the processed cassette is removed, a new cassette of unprocessed wafers is placed into the VCE, and the processing cycle restarts.

Configuration

The configuration of the Marathon Express 400 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 Marathon Express 400 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's 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 Marathon Express 400 and the software used through the Level 2.5 integrated systems.

Level 1 - Marathon Express 400 Components:

This is the base Marathon Express 400 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 locks with manual door
- Vacuum wafer handling robot drive, transfer arm, and end effector(s)
- System documentation

Level 2 - Marathon Express 400 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 - Marathon Express 400 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

Supplementary and Related Documentation

This User Manual provides documentation for operation and maintenance of the Brooks Automation Marathon Express 400 Cluster Tool Integration Platform. While this document covers specific information and adjustments for the Marathon Express 400, there may be information in other manuals which affect the settings or operating mode of the MX 400 system and attached components.

The Marathon Express 400 is set to system specifications and acceptance tested at Brooks Automation. Before adjusting or changing settings on a MX 400 system, consult the following documentation:

- Brooks Automation vacuum robot manuals
- Brooks Automation *VCE User Manual*
- OEM Components Manuals (supplied with this manual)
- Brooks Automation Marathon Express 400 Block Diagram
- Controls manual (if equipped)

NOTE: All documents cited should be the latest revision. This manual is intended to provide information about a wide variety of Marathon Express 400 configurations and options. It may contain references to items not installed on a specific system.

The commands for controlling the robot and other components used in the Marathon Express 400 are defined in their User Manuals. The Marathon Express 400 User Manuals may refer the reader to these manuals for additional information.

This manual contains, as addendums and attachments, customized documents for a specific build of the Marathon Express 400. These documents are provided to allow service personnel to identify specific parts within the system and aid in maintenance and troubleshooting.

NOTICE

This manual and all addendums and attachments are not controlled. Changes may have been made or additional documents or drawings added to the system documentation at any time. To identify the current revisions or to obtain a current set of drawings and documents, contact Brooks Automation Customer Support.

Manual Notation

This manual uses a standard notation system to provide consistent descriptions of all items and functions associated with all Brooks Automation devices. These standards include; hardware notation, software notation, and descriptive warnings. These notation standards identify tasks to be performed by the user during a service, installation, or operation procedure, or as a specific input to the Marathon Express 400.

In applications where “should” or “shall” is used, conformance to this application is required. Where “may”, “suggested”, or “preferred” is used, conformance is not required.

Specifications

The Brooks Automation Marathon Express 400 is a high reliability integration platform supporting up to 6 Process Modules and 2 Load Lock Modules. The specifications for the Marathon Express 400 and its subsystems are detailed below.

NOTE: All specifications are for the standard MX 400 configuration, specifications can vary for customized configurations.

Operating Specifications

Table 1-1: Operating Specifications

Specification	Value
Range of Motion	665.0 mm (26.18 in) nominal end effector extension beyond tool at center of all process module facets (305 mm past slot valve) These dimensions are for standard MX 400 system configurations, dimensions can vary for customized configurations
Maximum Noise Level	NC55
Transport Plane	900 mm at VCE platform (SEMI standard) 1100 mm (43.31 in) per SEMI E21 at Process Module side (3.78 mm (0.15 in) above slot centerline)
Material Sizes (wafers)	100 mm 125 mm 150 mm 200 mm with or without notched fiducial per SEMI M1.9

Specification	Value
Material Sizes (substrates)	100 mm square 125 mm square 150 mm square
Material Weight	400 g maximum
Material Thickness	8 mm maximum
Material Transparency	0 to 96%
Vacuum Chamber Volume	MX 400: Approximately 49.2 liters (3,000 in ³) VCE: Approximately 50.0 liters (3,051 in ³) (each) SVL: Approximately 12.0 liters (732 in ³) (each)
Base Vacuum	5 x 10 ⁻⁸ Torr with cryo/turbo pumping system 5 x 10 ⁻⁷ Torr with turbo pumping system
Leak Rate	1.0 x 10 ⁻⁸ Torr-l/sec He max.
Working Pressure	-15 psi vacuum +1 psi overpressure
Relief Pressure	1-3 psi
Cassette map Period	20 seconds (typical)
Laser Light	Class 1 Laser (used in wafer mappers)
Wafer Sensing	Sensors: Polar-reflective beam break, bottom mount Sensor radius: 250.0 mm (9.84 in)
Vacuum Aligner Modules	Mounting: Integrated into chamber Alignment mode: Rotary
Wafer Cooler Module	Mounting: Facet mount without slot valve Cool Time: 550° C to 70° C in 60 sec (silicon)

Environmental Specifications

ISO 14644-1 Class ISO 6 or better cleanroom ambient.

Table 1-2: Environmental Specifications

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)

Specification	Value
Lighting	Standard lighting provided in the cleanroom environment where the Marathon Express 400 is installed is sufficient for proper operation. Maintenance may require a user-supplied service light (i.e., flashlight).

Mechanical Specifications

NOTICE

All drawings within this manual are generic and may not reflect specific builds of the Marathon Express 400. To obtain a complete and current set of drawings and documents contact Brooks' Customer Support.

Table 1-3: Mechanical Specifications

Specification	Value
Dimensions	Refer to Figure 1-1 on page 25 and Table 1-6 for typical physical dimensions, for the actual dimensions of the specific system, including foot and seismic tie-down locations refer to the Mechanical Layout Drawing supplied with this manual.
Weight	Refer to Table 1-6 for typical system weights, for the actual weight of the specific system, including Floor Loading and Center of Gravity refer to the Mechanical Layout Drawing supplied with this manual.
Exposed Materials (Atmosphere)	Anodized Aluminum, 6061 T6 Aluminum, 5080R Aluminum, 316 Stainless Steel, AM350 Stainless Steel, Cold Rolled Steel, Baked Powder Coated Epoxy, 7740 Pyrex®, 7056 Glass, Viton®, Lexan®
Exposed Materials (Vacuum)	6061 T6 Aluminum, 5080R Aluminum, 316 Stainless Steel, AM350 Stainless Steel, Sintered Nickel, Electroless Nickel Plate, 7740 Pyrex, 7056 Glass, BK7 Glass, Teflon®, Viton, Kalrez®, Tinned Copper Wire, Quartz (TopCooler option)
Cassette Type	100 mm, 125 mm, 150 mm, and 200 mm SEMI standard cassettes 25 or 26 wafer cassette configurations
Vacuum Ports (Rough)	NW 40

Specification	Value
Vacuum Ports	At VCE interface panel As specified by user
	At Marathon Express Vacuum 400 Transport System ISO 160 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	1/4 inch VCR fitting at Nitrogen Facilities Connection To support venting capacity, a minimum of a 3/8 inch O.D. line is required with a reducer to connect to the 1/4 inch VCR fitting.
Argon Port	1/4 inch VCR fitting at TopCooler Facilities Connection
Pneumatic Port	10 mm Quick Connect
Water	1/2 inch OD tubing, Swagelok interface
Exhaust Port	12 mm Quick Connect
Water Return	1/2 inch OD tubing, Swagelok interface
Ground Clearance	At nominal height, 0.4 inch under fork tubes
Leveling Provision	Adjustable feet to meet WTP -0.4/+1.0 inch range
Rolling Provision	3 casters, removable
Lifting Provision	Built-in fork tubes, one-side access
Hold-down Provisions	User supplied and installed brackets

Chamber Heating and Cooling

Table 1-4: Chamber Heating and Cooling

Category	Description
Bakeout Temperature	120° C $\pm$ 10° C max, programmable using controller
Temperature Control	Single zone, tool mounted PID controller, RS-485 interface
Over-temp Protection	Thermal switch

Category	Description
Heater	750 W, 4 places
Heat-up time	20° C to 120° C in 3 hours (for base system as supplied by Brooks Automation only, does not include any user attached modules)
Cool-down time	120° C to 40° C in 2 hours (with water cooling option) (for base system as supplied by Brooks Automation only, does not include any user attached modules)

Facilities Specifications

Table 1-5: Facilities Specifications

Specification	Value
Pneumatic	Typical configurations require the following supply of clean, dry (unfiltered), oil free air: 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 40 psig $\pm$ 5 psig at 100 slm nominal, 300 slm maximum
Argon	Configurations using a facet mounted TopCooler may require the following supply of clean, dry argon: <1 ppm contamination 20 psig -5/+0 psig at 10 sccm
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

Specification	Value
Electrical System	Japan, USA: 200 - 208V AC @ 50/60 Hz, two phase (phase to phase or phase to neutral), 8 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, UL489/IEC60947-2 compliant branch circuit breaker (circuit breaker supplied with Gen 5 EN system ACPD is 5,000 AIC). Europe, Korea, Israel: 220 - 240V AC @ 50/60 Hz, single phase (phase to neutral), 8 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 user-supplied 10,000 AIC rated, UL489/IEC60947-2 compliant branch circuit breaker (circuit breaker supplied with Gen 5 EN system ACPD is 5,000 AIC).
Electrical Heater	Three phase star (Y) connection: 50/60 Hz (Europe, Korea, Israel) 220 VAC @ 9.45 A per phase, total power 5.7 kVA 230 VAC @ 9.88 A per phase, total power 6.2 kVA 240 VAC @ 10.31 A per phase, total power 6.8 kVA Heater Power Supply incorporates a 10,000 AIC rated, UL489/IEC60947-2 compliant, branch curcuit breaker. Delta connection: 50/60 Hz (Japan, USA) 200 VAC @ 15.58 A per phase, total power 5.7 kVA 208 VAC @ 16.85 A per phase, total power 6.2 kVA Heater Power Supply incorporates a 10,000 AIC rated, UL489/IEC60947-2 compliant, branch curcuit breaker.

Specification	Value
Water	Facilities chilled water must be supplied for cool modules and some pumps. Supply Pressure: 50 psig nominal, 70 psig maximum 30 psig minimum delta p between inlet and outlet 40 psig if equipped with turbo pumps (or manufacturers listed cooling requirements) 20 psi min is required to avoid boiling chamber cooling water during the system cartridge heater 120° C bake out Flow Rate: 15 l/m (4 gpm) Filtration: 200 um (0.5 mm Filter pre-installed) Temperature: 15° C ± 5° C (59° F ± 9° F) Acidity: 6.0 to 8.0 Ph Conductivity: 2000 µmhos/cm Dissolved Solids: < 75 ppm as calcium carbonate Corrosion Inhibitor: 300 - 600 ppm nitrite borate, 450 - 900 ppm sodium nitrite Organics, Intermittent Chlorination or Biocide application as required Open Systems: based on visual inspection (Do Not use algicides containing ethyl alcohol as it may degrade any seals it contacts) Organics, Closed Systems: Standard filter test count < 100
Exhaust	Sufficient to support return from air lines and exhaust from vacuum pumps
Water Return	Sufficient to handle water flow. Nominal 20 psi, 70 psi max.

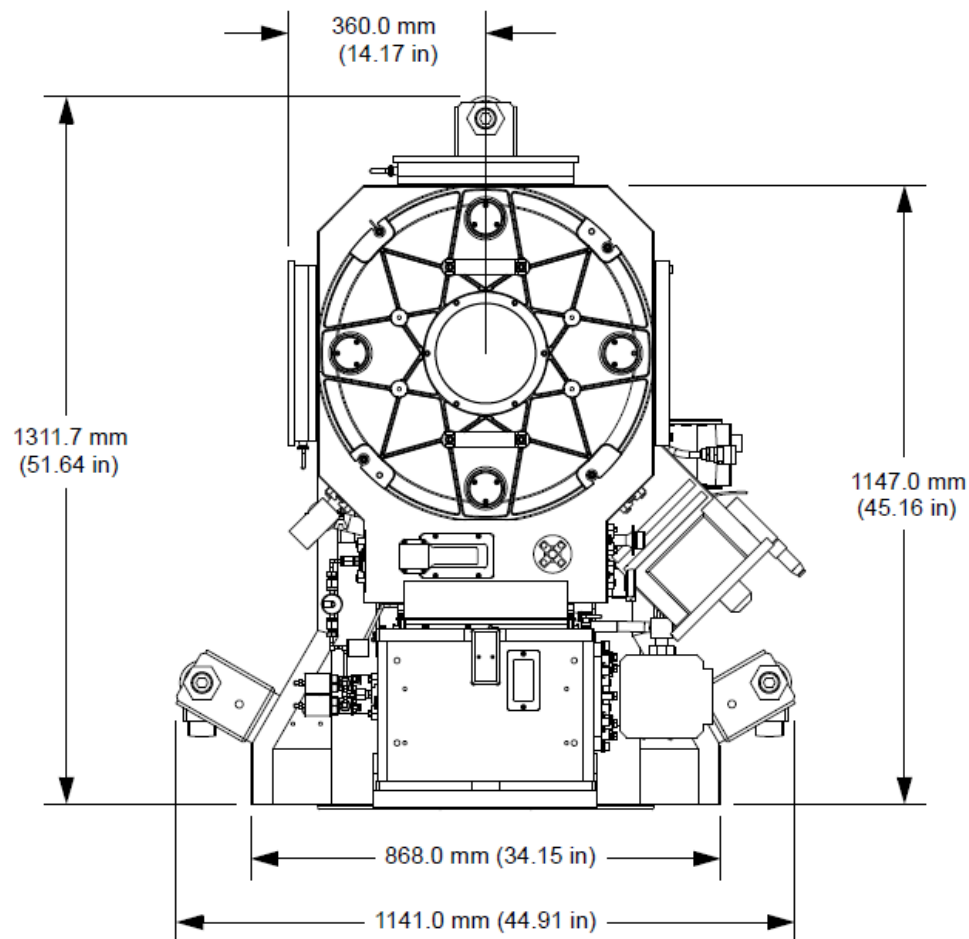


Figure 1-1: Marathon Express Space Requirements - Typical

Table 1-6: MX 400 Space Specifications - Typical

Width	Depth	Height	Weight
868.0 mm (34.15 in)	1147.0 mm (45.16 in)	1392.5 mm (54.82 in)	708.5 kg (1562 lb)

Center of Gravity and Floor Loading

Center Of Gravity and Floor Loading information for the Marathon Express 400 varies based on the configuration of the Transport Chamber. For the Center of Gravity and Floor Loading of the specific system refer to the Mechanical Layout Drawing supplied with this manual.

Overturning Moment: 100 ft.lbs. applied at any PM facet

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

Site Requirements for Moving the Marathon Express 400

Various locations within the site where the Marathon Express 400 will be installed must meet the following minimum requirements to ensure proper handling of the MX 400 system:

- **Door Openings:** The Marathon Express 400 has been designed to fit through standard door openings.
- **People:** A minimum of four people are required for moving the Marathon Express 400 within the facility.
- **Floor:** The Marathon Express 400 system has been designed to roll easily across smooth interior floors only. The floor where the Marathon Express will be installed must be capable of supporting the weight of the MX system as shown in [Table 1-6](#). The weight information provided is maximum weight, including VCEs, specific MX systems may weigh less

Process Module Space Allocation

The Marathon Express accepts Semi Standard compatible Process Modules as defined by SEMI E26. The MX system is also capable of accepting non-standard Process Modules, contact Brooks Automation for details.

Service and Exclusion Zones

The Marathon Express 400 system requires adequate space for service access as specified in SEMI E26 and for proper operation. The service space required for the MX 400 system is shown in [Figure 1-2](#) and [Figure 1-3](#). Refer to the Mechanical Layout Drawing supplied with this manual for system dimensions.

Ensure that installation of the Marathon Express 400 system is such that it provides access to items required for service after installation, such as the lid handles and connection panels.

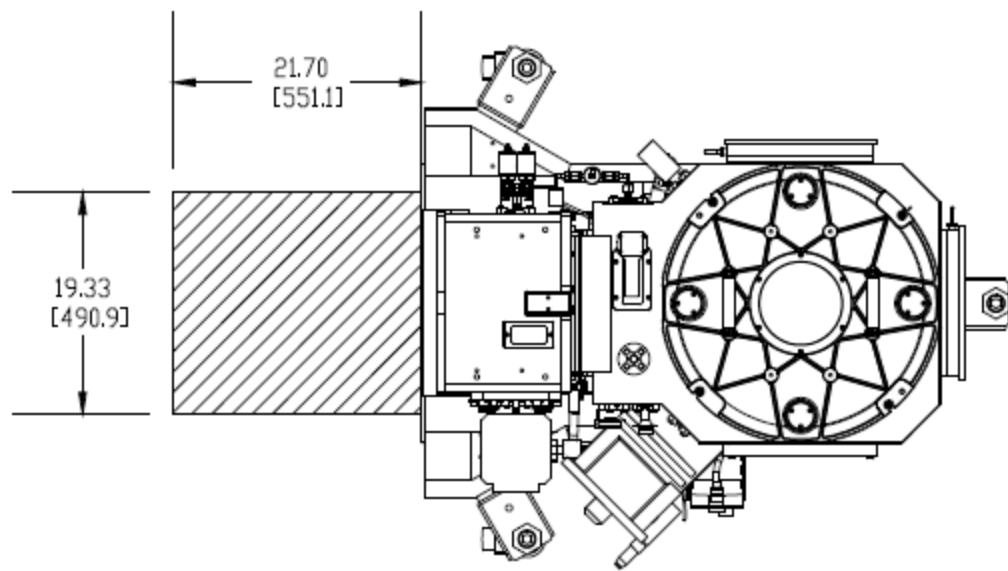


Figure 1-2: Service and Exclusion Zones - Horizontal

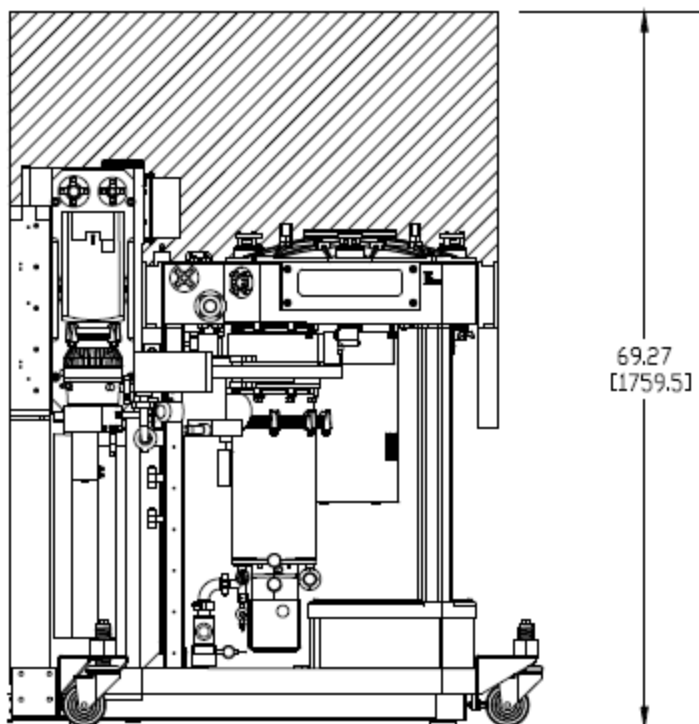


Figure 1-3: Service and Exclusion Zones - Vertical

2. Safety

This chapter describes safety guidelines for the Brooks Automation Marathon Express 400. All personnel involved in the operation or maintenance of the MX 400 system should be familiar with the safety precautions outlined in this chapter.

NOTE: This manual is not a controlled copy. Updates to this manual may be made as Technical Support Bulletins or as a new revision. To verify this manual is the current revision, call Brooks Automation Customer Support.

These safety recommendations are basic guidelines. If the facility where the Marathon Express 400 is installed has additional safety guidelines they should be followed as well, along with the applicable national and international safety codes.



DANGER

Read the Safety Chapter

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

- All personnel involved with the operation or maintenance of 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.

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.

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.

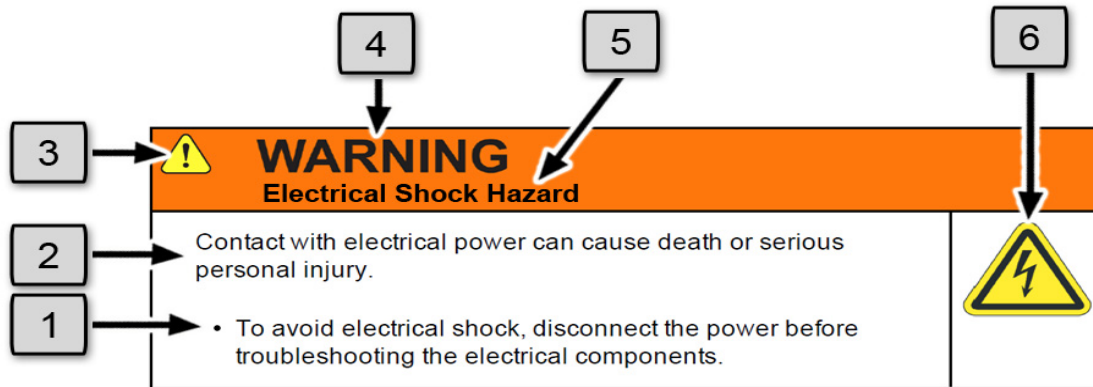


Figure 2-1: Components of a Safety Alert

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)

Safety and Identification Labels

Safety labels are placed on the Marathon Express 400 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.

NOTICE

Do not change or remove the safety or equipment identification labels.

To replace a lost or damaged label call Brooks Technical Support.

Table 2-1: Safety Labels placed on the Product

	Caution Label - Do Not Step P/N: 103948 Qty: 2 Location: On the Safety Node (Gen 5 Controls only) Hazard Type: Surface not for support Possible injuries: Fall How to avoid the hazard: Do not stand or step on the indicated surface
	Caution Label - Hot Surfaces P/N: 144444 Qty: Varies by configuration Location: On Chamber Hazard Type: Hot Surfaces (Heater option only) Possible injuries: Burn How to avoid the hazard: Ensure all surfaces are cool before touching
	China Environmental Label P/N: 145038 Qty: 2 Location: On Chamber and Frame next to Product Information Label

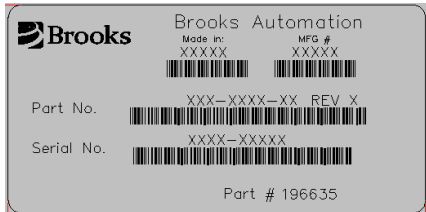
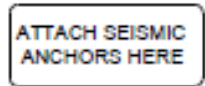
 Brooks Automation Made in: XXXXX MFG # XXXXX Part No. XXX-XXXX-XX REV. X Serial No. XXXX-XXXXX Part # 196635	Product Information Label P/N: 002-5271-01 Qty: 2 Location: On the Chamber and Frame
 ATTACH SEISMIC ANCHORS HERE	Seismic Tie Down Point Label P/N: PB37521 Qty: 3 Location: On the Chamber and Frame

Table 2-2: Labels Used on the Safety Node

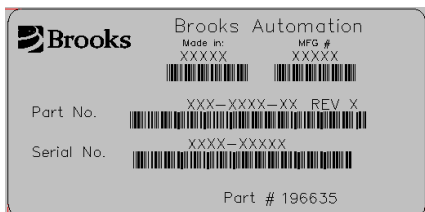
 ©1999 HCS, Inc. 800-744-0241 Reorder No. H6010-B1WHPK	Warning Label - Hazardous Voltage P/N: 70020026 Qty: 1 Location: On the top of the Safety Node Hazard Type: Hazardous voltage Possible injuries: Electric shock or burn How to avoid the hazard: Do not service while the Load Lock Node is energized
 ©1999 HCS, Inc. 800-748-0241 Reorder No. H6014-RGCHPK	Caution Label - Heavy Object P/N: 70025562 Qty: 1 Location: On the top of the Safety Node Hazard Type: Heavy Object Possible injuries: Muscle strain or back injury How to avoid the hazard: Use proper lifting techniques when moving
 Brooks Automation Made in: XXXXX MFG # XXXXX Part No. XXX-XXXX-XX REV. X Serial No. XXXX-XXXXX Part # 196635	Product Information Label P/N: 002-5271-01 Qty: 2 Location: On the rear of the Safety Node
FIELD REPLACEABLE UNIT NO USER SERVICEABLE PARTS INSIDE	Label - Field Replaceable Unit P/N: 130165 Qty: 1 Location: On the top of the Safety Node

Table 2-3: Labels Used on the ACPDU

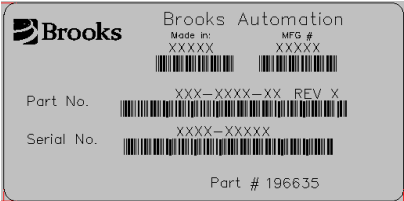
 WARNING ELECTRICAL SHOCK HAZARD. Circuit breaker does not remove all power inside enclosure. Turn off circuit breaker AND remove power input before servicing. SMITH PULS, LLC 200021 801-401-0000	Warning Label - Shock Hazard P/N: 130166 Qty: 1 Location: On the front of the AC Power Distribution Unit Hazard Type: Hazardous voltage Possible injuries: Electric shock or burn How to avoid the hazard: Do not service while the ACPDU is energized
 WARNING Power Requirements 200-240 Vac 50-60 Hz 20 Amps SMITH PULS, LLC 801-401-0000 www.smithpuls.com 200021 801-401-0000	Warning Label - Power Requirements P/N: 119221 Qty: 1 Location: On the top of the AC Power Distribution Unit Hazard Type: Hazardous voltage Possible injuries: Electric shock or burn How to avoid the hazard: Do not connect incorrect power to ACPDU
 DO NOT SERVICE	Label - Protective Earth Ground P/N: 106413 Qty: 1 Location: On the bottom of the AC Power Distribution Unit next to the Ground Terminal
 DO NOT USE	Label - Do Not Use P/N: 70060555 Qty: A/R Location: On all unused AC Outlets on the ACPDU
 Brooks Automation Made in: XXXXX MFG # XXXXX Part No. XXX-XXXX-XX REV X Serial No. XXXX-XXXX Part # 196635	Product Information Label P/N: 002-5271-01 Qty: 2 Location: On the side of the AC Power Distribution Unit
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

Table 2-4: Labels Used on the Mini Hub

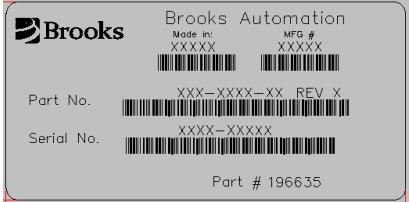
	Warning Label - Hazardous Voltage P/N: 70020026 Qty: 1 Location: On the top of the Mini Hub Hazard Type: Hazardous voltage Possible injuries: Electric shock or burn How to avoid the hazard: Do not service while the Mini Hub is energized
	Product Information Label P/N: 002-5271-01 Qty: 2 Location: On the side of the Mini Hub
FIELD REPLACEABLE UNIT NO USER SERVICEABLE PARTS INSIDE	Label - Field Replaceable Unit P/N: 130165 Qty: 1 Location: On the top of the Mini Hub

Illustration of Hazard Locations

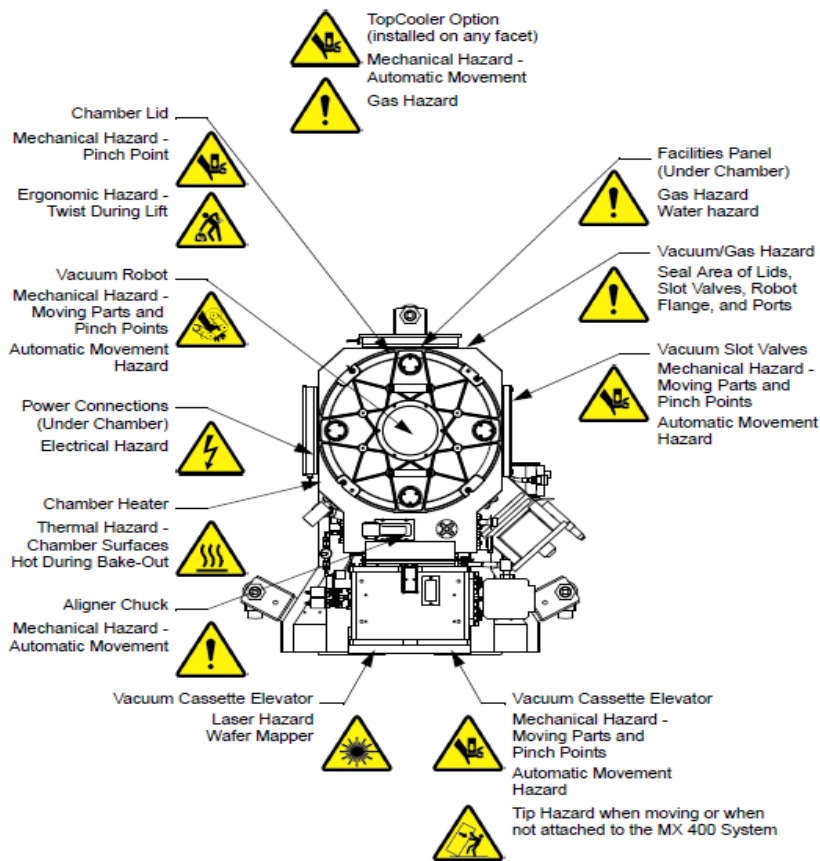


Figure 2-2: Location of Hazardous Points

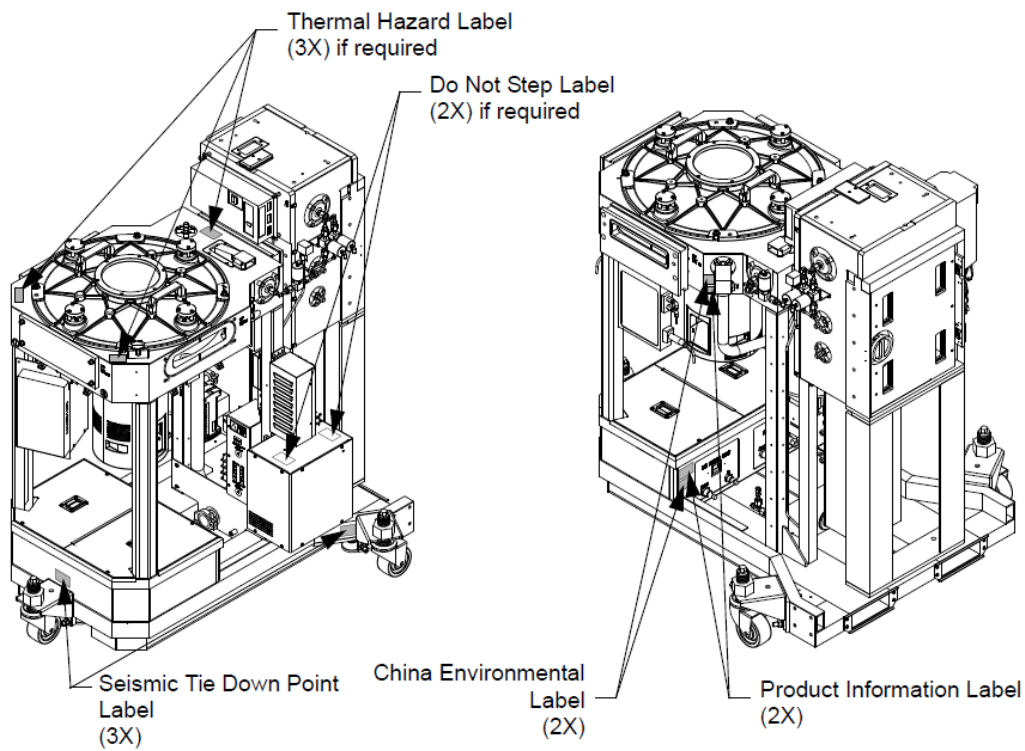


Figure 2-3: Label Locations on the MX 400 System

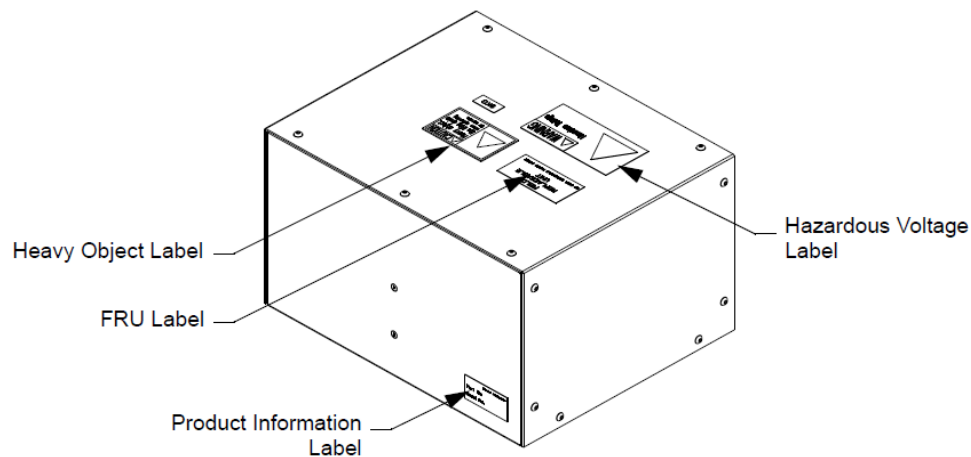
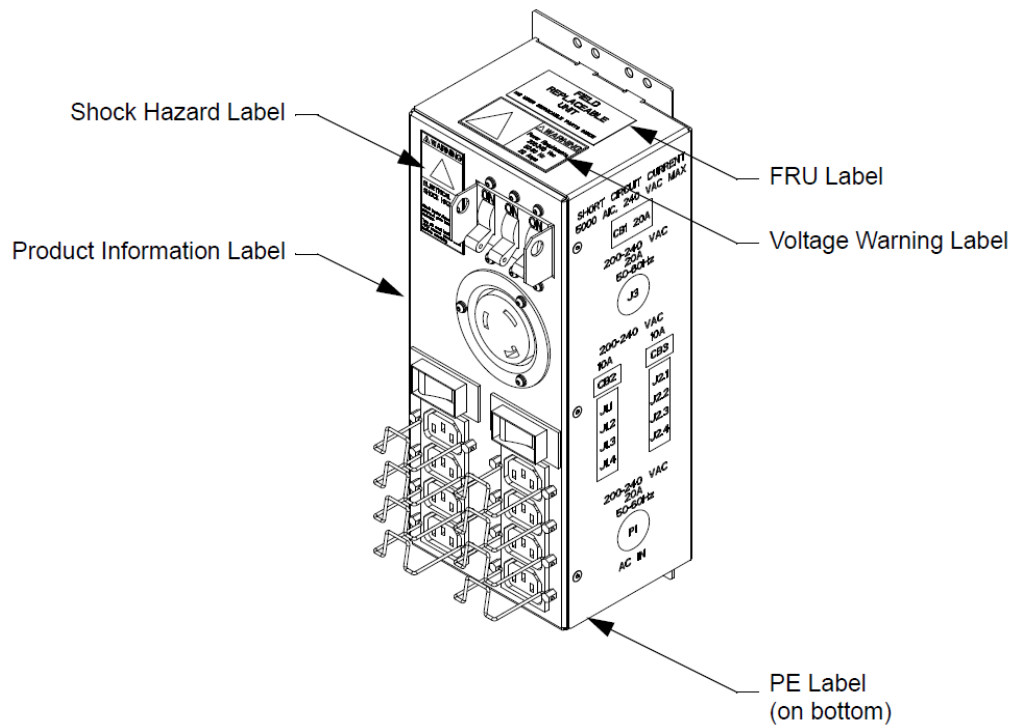
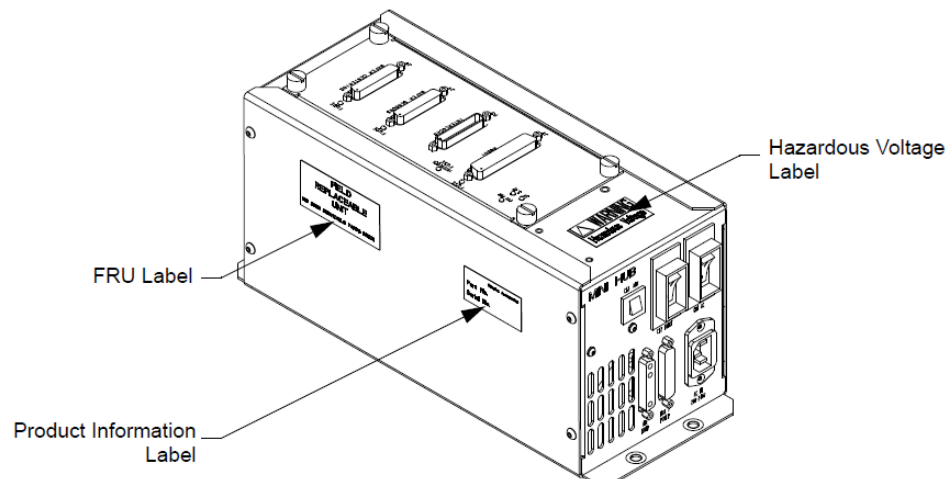


Figure 2-4: Label Locations on the Safety Node

**Figure 2-5: Label Locations on the ACPDU****Figure 2-6: Label Locations on the Mini Hub**

Interlocks

Safety interlocking capabilities exist for user safety and operational interlocks exist to protect the Marathon Express 400 and the material moving through it.

Refer to the controls manual and specific block diagram for more information on safety interlocks.

 WARNING Safety Interlocks	
Overriding the safety interlocks could cause personal injury or death. • Always use the safety interlocks.	

The following Safety Interlocks may exist on the Marathon Express 400:

- Emergency Off
- Emergency Stop
- Lid Open

Mechanical Hazards

The Brooks Automation Marathon Express 400 is a complex electromechanical device. Only persons with the proper training should attempt to service or operate the any part of the material transfer tool.

All facilities to the Marathon Express 400 must be disconnected as outlined in the facility's lockout/tagout procedures before servicing, or injury may result from the automatic operation of the equipment. If no such procedures exist, follow the guidelines provided in "[Laser Hazards](#)" on page 50. The proper precautions for operating and servicing remotely controlled electromechanical equipment must be observed. These precautions include wearing a hard hat, safety glasses, safety shoes, and any other precautions specified within the facility where the Marathon Express 400 is being used.

 WARNING Automatic Movement / Crush hazard	
Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include: - Robot - Aligner - Cool Module Poppet - Load Lock Module(s) (AutoDoor, Arm, Platform) - Atmospheric Doors - Vacuum Slot Valves - Isolation Valves - Pumps Moving mechanisms do not have obstruction sensors and can cause serious personal injury or death. Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled. Do not operate the robot without the protective covers in place. Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.	 

 CAUTION Heavy Object	
The Marathon Express 400 weighs approximately 708.5 kg (1562 lb). The Vacuum Cassette Elevator weighs at least 111 kg (245 lb) without the vacuum pump attached. The robot drive weighs 29.5 kg (65 lb) 3-axis or 21 kg (46.5 lb) 2-axis. Failure to take the proper precautions before moving any of these items could result in personal injury. Use a properly rated fork lift to lift the Marathon Express 400 or a minimum of four people to roll the MX 400 system and a minimum of two people to move any other modules.	

Lockout/Tagout Procedure

Per standard industry practices, lockout/tagout procedures must be followed when service or maintenance is performed on the MX 400 system to prevent personal injury or equipment damage. Local or company procedures must also be followed; but where no procedures exist, follow the

guidelines below. 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 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.	 

The following are general recommendations for LOCKOUT or TAGOUT for systems manufactured by Brooks Automation.

- Use LOCKOUT for all power sources (high voltage electrical, air, nitrogen, water, etc.)
- Use TAGOUT for low voltage (below 30 volts) electrical circuit repair.
- Use TAGOUT for maintenance, cleaning, or lubricating moving parts.
- Use TAGOUT for clearing jammed parts or mechanisms.

When using tagout procedures, a written warning is attached to the valves/switches/circuit breakers that are placed in a SAFE or OFF position. The SAME person that installed the tag shall remove the tag once the work has been completed. Tags and their attachments shall be substantial enough to avoid accidental removal. The tag and attachment shall be non-reusable, self-locking, non-releaseable, and attached by hand. A nylon cable tie is recommended.

Tagout Procedure

Step	Action
1.	Notify all affected personnel that a tagout is required.
2.	Turn off all power supplied to the MX 400 system and all devices connected to it by setting the system circuit breaker to the Off position.
3.	Place a warning tag on the circuit breaker handle bar. The tag must have the following information: • Date of maintenance/service action • Names of the persons performing the service procedure • Short description of the service/maintenance action • Signatures of the service supervisor and production supervisor

Step	Action
4.	Using a voltmeter, electrically verify that the associated circuitry is de-energized.
5.	As soon as the lockout/tagout device is removed, close and secure the lid.

Lockout/Tagout Procedure

When using lockout/tagout procedures, a lock and a tag with a written warning are attached to switches/circuit breakers that are placed in a SAFE or OFF position to keep equipment from being set in motion and endangering service personnel. The SAME person that installed the lock and tag shall remove the lock and tag once the work has been completed. One key is to be provided for each lock and must be kept by the person doing the work. The tag and its attachment shall be substantial enough to avoid accidental removal. The tag and attachment shall be non-reusable, self-locking, non-releaseable, and attached by hand. A nylon cable tie is recommended.

Step	Action
1.	Notify all affected personnel that a lockout/tagout is required.
2.	Turn off all power supplied to the MX 400 system and all devices connected to it by setting the system circuit breaker to the Off position and lock it as described below. a. If the circuit breaker can be locked in the Off position, place a lock with a warning tag on the circuit breaker handle such that the circuit breaker cannot be turned on without removing the lock. The tag on the lock must have the following information: • Date of maintenance/service action • Names of the persons performing the service procedure • Short description of the service/maintenance action • Signatures of the service supervisor and production supervisor
3.	If the circuit breaker cannot be locked in the Off position, disconnect all power cables from the equipment and lock plug shields with tags over the plugs on the ends of all power cables. The tag must have the following information: • Date of maintenance/service action • Names of the persons performing the service procedure • Short description of the service/maintenance action • Signatures of the service supervisor and production supervisor

Step	Action
4.	Turn off the air, nitrogen (vent gas), vacuum, and optionally cooling water and argon (cool gas) supplies to the MX 400 system and all devices connected to it by setting the supply valves to the Off position and lock them as described below. a. If the valves can be locked in the Off position, place a lock with a warning tag on the valve handle such that the valve cannot be turned on without removing the lock. The tag on the lock must have the following information: • Date of maintenance/service action • Names of the persons performing the service procedure • Short description of the service/maintenance action • Signatures of the service supervisor and production supervisor
5.	If the valves cannot be locked in the Off position, disconnect all vacuum and gas lines from the equipment and lock shields with tags over the ends of all the supply lines. The tag must have the following information: • Date of maintenance/service action • Names of the persons performing the service procedure • Short description of the service/maintenance action • Signatures of the service supervisor and production supervisor
6.	Using a voltmeter, electrically verify that the associated circuitry is de-energized.

Removal of Locks and Tags

Before lockout/tagout devices are removed and energy is restored to the equipment, the authorized employee must take the following actions or observe the following procedures:

Step	Action
1.	Inspect the work area to ensure that non-essential items have been removed and that components are intact and capable of operating properly.
2.	Check the area around the equipment to ensure that all employees have been safely positioned or removed.
3.	Locks and tags should only be removed by those employees who attached them. Notify affected employees immediately after removing locks and tags and before starting equipment.

Ergonomics Hazards

 CAUTION Heavy Object	
The MX 400 chamber lid weighs at least 8.2 kg (18 lb) and requires a twisting motion to remove. Precautions should be taken when removing the lid. Refer to "Removing/Replacing Lid" on page 220.	

Tip Hazard

 WARNING Tip Hazard	
The Vacuum Cassette Elevator may tip and fall when they are not attached to the Marathon Express 400 which may cause serious injury or death. Do not attempt to move the Vacuum Cassette Elevator without the use of a fork lift or a hoist. Moving it without a hoist could cause a tip hazard. Move on smooth floors only.	 

NOTICE

The Slot Valves and Atmospheric Doors may drift to an indeterminate position if pneumatic pressure is lost.

Electrical Hazards

At maximum load the Marathon Express 400 is capable of drawing 8 Amps at 200 - 240 VAC. The minimum overcurrent ratings for the MX 400 system disconnects requires a 200 - 240 VAC, 10 A, slow blow circuit breaker that meets, or exceeds, the minimum AIC rating specified by SEMI S2. The minimum overcurrent ratings for the Heating System disconnects requires a 3-phase 200 - 208 VAC, 20 A, slow blow circuit breaker that meets, or exceeds, the minimum AIC rating specified by SEMI S2.

The proper precautions for operating and servicing electrical equipment must be observed. These precautions include following facility lockout/tagout procedures, and any other specified action within the facility where the Marathon Express 400 is being used.

 DANGER Electrical Shock	
Maximum power consumption for the Marathon Express 400 during normal operation is 200 - 240 VAC at 8 Amps. Improper handling of the power source or connecting devices may induce electrical shock or burn resulting in serious injury or death or cause an equipment fire. Always provide the MX 400 system with the proper electrical code compliant connections. Maximum power consumption for the optional MX 400 Heating System during bake-out operations is 200 - 240 VAC at 17 Amps. Approximately 750 watts at 220 volts is present at each heating element. Improper handling of the power source or connecting devices may induce electrical shock or burn resulting in serious injury or death or cause an equipment fire. Always provide the MX 400 system with the proper electrical code compliant connections.	 

Disconnect Devices

The integrator and end user are responsible for the Marathon Express 400 system's main disconnect device, ensuring that it is readily accessible and complies with the correct electric codes. The main user installed disconnect device must meet, or exceed, the minimum AIC rating specified by SEMI S2. Personnel servicing the MX 400 system and any equipment connected to it are responsible for the status of the system's main disconnect device as specified by the facilities' lockout/tagout procedure.

NOTICE

Before disconnecting main power to the Marathon Express 400, ensure all circuit breakers on the MX 400 system and any related equipment are in the OFF position.

Overvoltage Category

Table 2-5 describes electrical overvoltage categories. Brooks Automation has designed the Marathon Express as an Overvoltage Category II device.

Table 2-5: Overvoltage Category

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

ESD Protection

A third party has tested the Marathon Express 400 to ensure electromagnetic compatibility for both emissions and immunity. The MX 400 systems comply with the EMC Directive.

Brooks Automation recommends that the Marathon Express 400 is RF-bonded to a common ground with other equipment in the system to ensure maximum EMI and ESD protection.

ESD/EMI Precautions

To ensure that ESD and EMI are kept to an absolute minimum, it is important to note the following requirements:

a.

Brooks recommends the Marathon Express 400 be grounded to the User's Tool or End-Tool by metal-to-metal connection. If this is not possible, a braided copper ground wire with ring-lug connectors must be provided between the MX 400 system's ground connection and the User's Tool or End-Tool ground connection. The wire should be as short as possible to minimize impedance at

high RF.

- b. Communications cables should be constructed using shielded cable and metal connector backshells to provide proper protection. The shield cable should be terminated 360-degrees to the backshell. Drain wire or pig-tail grounding are not acceptable.

ESD Specification

The MX 400 system complies with the EMC directives and can withstand 4 kV contact and 8 kV air discharge.

For Robot

The vacuum robot complies with the EMC directives and can withstand 4 kV contact and 8 kV air discharge.

For Vacuum Cassette Elevator

The VCE load locks comply with the EMC directives and can withstand 4 kV contact and 8 kV air discharge.

Laser Hazards

The Brooks Automation Marathon Express 400 uses low power laser light for mapping of wafers and to ensure all wafers are properly seated in the cassette in the VCE 6 Vacuum Cassette Elevator. These lasers produce low power invisible infrared light. They are Class II laser diodes (see laser class descriptions below). These lasers are Class I as implemented because they are not visible during normal operation.

The proper precautions for operating and servicing lasers must be observed. Any precautions specified within the facility where the MX 400 system is being used must also be observed.

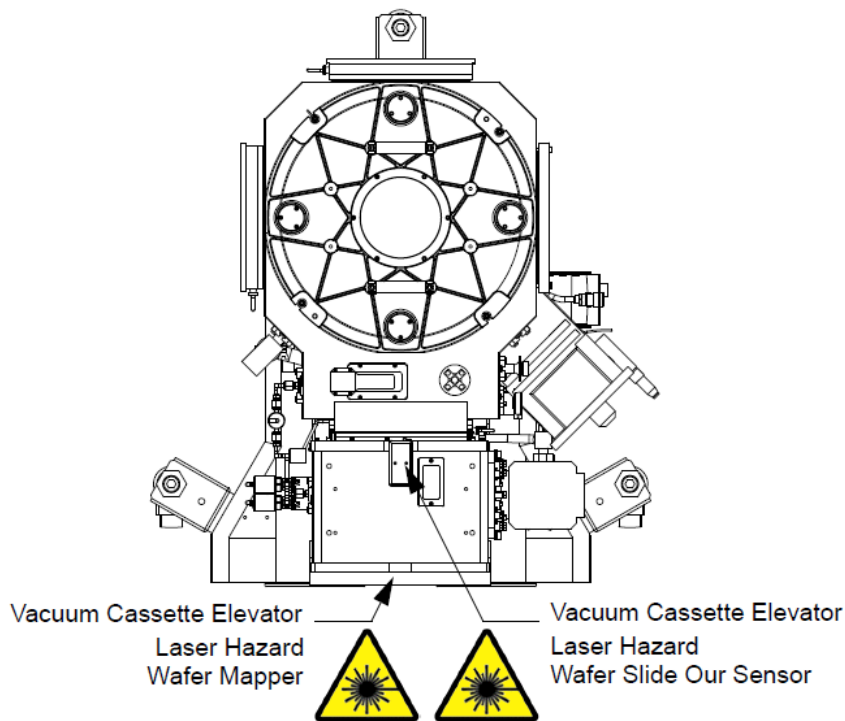


Figure 2-7: Laser Locations

 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.	

The following describes laser classifications, general safety issues and laser handling precautions. Laser diodes have three properties that distinguish them from standard light emitting diodes. First, they can produce much brighter beams of light (by a factor of 1000 or more). Second, the beam from a laser can be very narrow (where the spot of light is almost the same size whether projected a few inches or many feet). Third, laser light is a very pure color with a single wavelength, which makes the spot look speckled and shimmery.

National and international standards classify low power laser systems as the following:

Table 2-6: Laser Hazard Classifications

Classification	Description
Class I	Very low power (4×10^{-7} Watt) - safe for continuous viewing.
Class II	Low power visible lasers (4×10^{-6}) Watt - safe for 15 minutes of continuous viewing.
Class III	Low power visible lasers only (1×10^{-3} Watt) - safe for brief viewing: do not stare into the beam.

Gas Hazards

The Brooks Automation Marathon Express 400 uses compressed air for pneumatic functions of the system, nitrogen gas for venting, and may use argon gas for wafer cooling. Ensure all gases used are vented as specified by the facility's local environmental regulations.

All gas supplied to the Marathon Express 400 system must be disconnected as outlined in the facility's lockout/tagout procedures before servicing, or injury may result from the automatic operation of the equipment.

 WARNING Lockout / Tagout	
All gas connections to the Marathon Express 400 must be disconnected per the facility's lockout/tagout procedure before servicing to prevent risks associated with these gases.	 

 WARNING Explosion Hazard	
The Marathon Express 400 system requires compressed air for normal operation. Do not remove any pneumatic tubes as long as pressure is applied. Pneumatic systems on the Marathon Express 400 may contain check-valves or compressed air accumulators, which will cause compressed air to be stored in the Marathon Express 400 even after disconnecting the MX 400 system from the facility's pneumatic supply. Before performing any service ensure Lockout/Tagout is used for all pneumatic systems and that all pneumatics are depressurized.	

 CAUTION Chemical Gas Hazard	
Opening the refrigerant circuit or changing valve settings without following the instructions in this manual could result in release of refrigerant gas that is considered a green house gas. • Avoid release of green house gas to the environment. • Keep the gas line couplings aligned when making or breaking coupling connections to prevent leaks. • Review this manual before performing any procedure including routine operation. Exposure to nitrogen or argon gas may cause dizziness or suffocation in unventilated areas. Whenever any gases are vented, the facility's environmental procedures must be followed regarding the storage, handling, and disposal of gases.	

 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.	

It may be recommended that nitrogen gas be used for cleaning sections of the Marathon Express 400 system by “blowing out” any accumulated particles during routine maintenance procedures. When handling compressed gases, such as nitrogen, eye protection should be worn. Any other precautions specified for compressed gases within the facility where the Marathon Express 400 is being used should be followed. Whenever any compressed gas is used during service of the MX 400 system, the facility's standard precautions for use of that gas must be employed.

The Marathon Express 400 system Transport Chamber and Load Locks are supplied with Overpressure Relief Valves. The exhaust from these valves must be vented as specified by the facility's local environmental regulations.

Chemical Hazards

The Brooks Automation Marathon Express 400 does not make use of any hazardous chemicals. However, it may be recommended that Isopropyl alcohol be used for cleaning sections of the Marathon Express 400 during routine maintenance procedures.

 WARNING Lockout / Tagout	
All power to the Marathon Express 400 must be disconnected per the facility's lock-out/tagout procedure before using any cleaning solutions to prevent the risk of electrical shock.	 

 CAUTION Chemical Hazard	
Some chemicals may leave a flammable or toxic residue. The robot arm and surfaces inside the vacuum chamber could have very hazardous contamination as a result of exposure to process gases. Decontamination certification should be obtained prior to performing a repair on or near these surfaces. Personal protective equipment such as gloves, eye wear, respirators, self-contained breathing apparatus, etc. may also be required. Whenever any cleaning fluid is used during service of the Marathon Express 400, the facility's environmental procedures must be followed regarding the storage, handling, and disposal of that fluid along with any affected apparatus.	

When a chemical is used during servicing the MX 400 system, the standard precautions for use of that chemical must be observed. These safeguards include sufficient ventilation, proper disposal of excess chemical and wipes and any other precautions specified for use of hazardous chemicals within the facility where the system is being used.

CAUTION

The Marathon Express 400 may be used in a high temperature environment (121 °C (250 °F)). Allow the system to completely cool before performing maintenance involving volatile chemicals.

Thermal Hazards

Heating elements may exist on the Marathon Express 400 vacuum transport chamber. Be aware of hot surfaces on the transport chamber during servicing and operation. Brooks recommends placing barriers around the MX 400 system while bake-out is in process to ensure facility personnel do not come into contact with any hot surfaces.

WARNING Extreme Temperature

Surfaces heated during system bake-out can reach temperatures of 121° C (250° F), which could cause burns when in contact with skin.

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

Allow time for the Marathon Express 400 to cool before servicing or operating and before performing maintenance involving volatile chemicals.



Vacuum Hazards

The Brooks Automation Marathon Express 400 is designed for use as an atmospheric- to-vacuum equipment transport system. Vacuum pumps are used within the vacuum side of the MX 400 system to provide a high vacuum environment. These vacuum pumps may be exposed to hazardous chemicals left on the material after processing.

All vacuum supplied to the MX 400 system must be disconnected as outlined in the facility's lockout/tagout procedures before servicing, or injury may result from the automatic operation of the equipment.

NOTICE

Whenever any vacuum pump exhaust is vented, the facility's environmental procedures must be followed regarding the venting of gases.



WARNING

Implosion Hazard

Implosion may result from equipment damage, which could result in personal injury or death. Opening an unequalized vacuum slot valve or atmospheric door may result in severe damage to the equipment or Marathon Express in process or cause personal injury.

It is essential that a complete inspection of the equipment be performed prior to use.



The standard vacuum safety measures for the application in which the Marathon Express 400 is being used should be applied.



WARNING

Explosion Hazard

The vacuum back end of the Brooks Automation Marathon Express 400 is designed specifically for vacuum. Internal pressures should never exceed normal atmospheric pressure, as damage to the system or personal injury due to unexpected popping of the Pressure Relief Valve could result.

It is essential that a complete inspection of the equipment be performed prior to use.



Fire and Explosion Hazards

The Brooks Automation Marathon Express 400 provides no direct fire or explosion hazard. However, the use of Isopropyl alcohol or other flammable solvents around the Marathon Express 400 while power is applied does present the possibility of fire or explosion. Cleaning fluids may leave a flammable residue. If they are being used during servicing of the MX 400 system, the proper precautions for use of those fluids must be observed.

 DANGER Fire Hazard	
Improper handling of the power source or connecting devices may cause electric arcing, creating a fire hazard. Never use Isopropyl alcohol to clean hot parts due to the risk of fire or explosion. Allow the Marathon Express 400 to completely cool before performing maintenance involving flammable cleaning fluids.	

 CAUTION
Whenever any cleaning fluid is used during service of the Marathon Express 400, all power to the MX 400 system should be disconnected and the standard precautions for use of that fluid must be employed.

Environmental Information

Noise Emission

The Brooks Automation Marathon Express 400 provides no direct noise hazard during operation. When operating normally the Maximum Sound Pressure is NC55 (does not include pumps) and causes no hazardous conditions.

Vibration

The Brooks Automation Marathon Express 400 provides no direct vibration hazard during operation. Any vibrations produced during normal operation are minimal and cause no hazardous conditions.

Recycling and Hazardous Materials

The Brooks Automation Marathon Express 400 contains, or uses for maintenance, the following items that may require special handling for disposal or recycling.

Lithium Batteries

A Lithium Battery is located on the Processor Board within the vacuum robot to maintain data when power is removed.

A Lithium Battery is located on the Aligner Controller Board to maintain data when power is removed.

If any of these batteries are being removed or replaced they must be handled in the following manner:

- Follow all Federal, State, Local, and Facility procedures for the disposal of hazardous materials.

NOTICE

Lithium Battery Disposal



A lithium battery is located on the controller, Processor Board, and optional T5X Processor Board.

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

Lead Acid Battery

A Lead-Acid Battery is located on the optional MAG 7 PowerPak to provide power for robot shut-down when system power is removed. If this battery is being removed or replaced it must be handled in the following manner:

NOTICE

Lead Acid Battery Disposal



A Lead-Acid battery is located on the optional MAG 7 PowerPak. If it is being removed or replaced, it must be handled following all Federal, State, Local, and Facility's procedures for the disposal of hazardous material.

IPA Wipes Used During Maintenance

IPA Wipes are used in maintenance. Approximately 20 wipes required per cleaning, each containing approximately 3 mL of 10% IPA / 90% DI Water solution (6 mL IPA total).

NOTICE



Follow all facility and government regulations regarding recycling and disposal when discarding Marathon Express 400 components that have been replaced.

Material Safety Information

Hazardous materials may be present during the operation or maintenance of the Marathon Express 400. [Table 2-7](#) identifies the materials that are contained or shipped with the MX 400 system. Read and understand the Material Safety Data Sheet (MSDS) for each material. These sheets provide crucial information pertaining to the hazardous materials used in the Marathon Express 400 system. The facility where the Marathon Express 400 is to be used is responsible for the maintenance and distribution of each MSDS. Ensure that there is a copy in each workplace for all hazardous materials involved in the operation and maintenance of the Marathon Express 400 system.

Other gases, cleaners, and lubricants may be recommended for use with the Marathon Express 400. Obtain the MSDS for these materials from the supplier.

Table 2-7: Hazardous Material Used in the Marathon Express 400

Material	Description	Location in MX System
Krytox® LVP	White, waxy grease	Lubrication within vacuum chambers, if required

3. Installation

The Brooks Automation Marathon Express 400 has been designed for quick and easy mounting to the user's Process Modules. This chapter provides complete installation procedures for the Brooks Automation Marathon Express 400 including: unpacking, assembly, initial setup, and initial check-out.

Site Requirements

Before the Brooks Automation Marathon Express 400 may be installed, the site where the MX 400 system will be located must be properly prepared. This preparation includes ensuring that the proper facilities, including electrical and communications connections, are available and are properly prepared for connection to the Marathon Express 400.

Floor Space and Loading

The site for the Marathon Express 400 must meet the minimum space requirements specified in "[Mechanical Specifications](#)" on page 20 and [Figure 1-2 on page 27](#) and [Figure 1-3 on page 27](#) to ensure proper clearance for installation, operation, and servicing of the MX 400 system. Note that the dimensions given are for the MX 400 system only. It is the user's responsibility to ensure adequate space around the Process Modules for operation and service based on their needs.

NOTICE

All drawings within this manual are generic and may not reflect specific builds of the Marathon Express 400. To obtain a complete and current set of drawings and documents contact Brooks.

Environmental

The site for the Marathon Express 400 must meet the minimum environmental requirements specified in ["Environmental Specifications"](#) to ensure proper operation of the MX 400 system.

Facilities

The user is responsible for providing the facilities specified in ["Facilities Specifications" on page 22](#) for the Marathon Express 400 to ensure proper operation of the MX 400 system. Refer to ["Facilities Specifications" on page 22](#) for the connection of all facilities to the MX 400 system. Refer to ["Operational Interfaces"](#) for the wiring of all electrical connections.

The user is responsible for the main disconnect device between the Marathon Express 400 and the facility's power source, ensuring it complies with the correct 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 MX 400 system should have the appropriate fuse or circuit breaker rating.

Unpacking and Inspection

The Brooks Automation Marathon Express 400 is shipped in separate packages which are individually sealed to maintain cleanroom conformance. Unpack each crate carefully following the steps provided in ["Unpacking and Inspection" on page 62](#); inspect and verify the contents against the checklist provided on the front page of the ATP. Report any damage immediately to the shipper and to Brooks Automation.

One set of shipping documents will be attached to the outside of the main shipping crate for easy access. An additional set of the same documents will be attached to the equipment inside the shipping crate.

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

Table 3-1: Packing Checklist Reference

Package	Typical Contents
Marathon Express 400	Chamber mounted on frame with wheels with installed options that may include: the robot, VCE load locks, custom end effector, aligner, etc.
Electronics	- Heater Controller - Controller Computer - Pump controllers, etc.

Package	Typical Contents
Installation Kit	• System cables • User Manuals

The Marathon Express 400 was assembled in a cleanroom environment. The system is double-bagged for shipping in a Class 100 cleanroom. Before bagging the modules of the MX 400 system, they are cleaned and then completely wrapped in plastic that covers the top and bottom of all modules to ensure cleanliness. The plastic wrap is then cleaned, and the first bag is placed around each module. The bag is then cleaned and a second bag is placed around it.

When the Marathon Express 400 is being prepared for shipping, the outer bag is cleaned and a foil bag is placed around each module of the MX 400 system. The foil bag is then sealed and evacuated and the system is 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 Marathon Express 400 weighs approximately 708.5 kg (1562 lb). The Vacuum Cassette Elevator modules of the Marathon Express 400 weigh 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 properly rated fork lift to lift the Marathon Express 400 or a minimum of four people to roll the MX 400 system and a minimum of two people to move any other modules.	 

 CAUTION Tip Hazard	
Tip hazard exists when moving the Marathon Express 400. Ensure that all the force exerted on the Marathon Express modules when moving them is below the center of the gravity. Failure to take the proper precautions before moving any module, especially while moving it out of the shipping crate, could result in personal injury.	 

 CAUTION Personal Protective Equipment	
Safety glasses should be worn at all times when installing the Marathon Express 400.	

NOTICE
When rolling the Marathon Express 400 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 MX 400 system and could be damaged if pushed against.

NOTE: Save the shipping crates for possible future use. If any of the modules of the Marathon Express 400 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 242](#).

The Brooks Automation Marathon Express 400 was assembled and bagged in plastic in a cleanroom environment. To ensure the cleanliness of the MX 400 system, unbag it only in a cleanroom depack environment.

Procedure Category

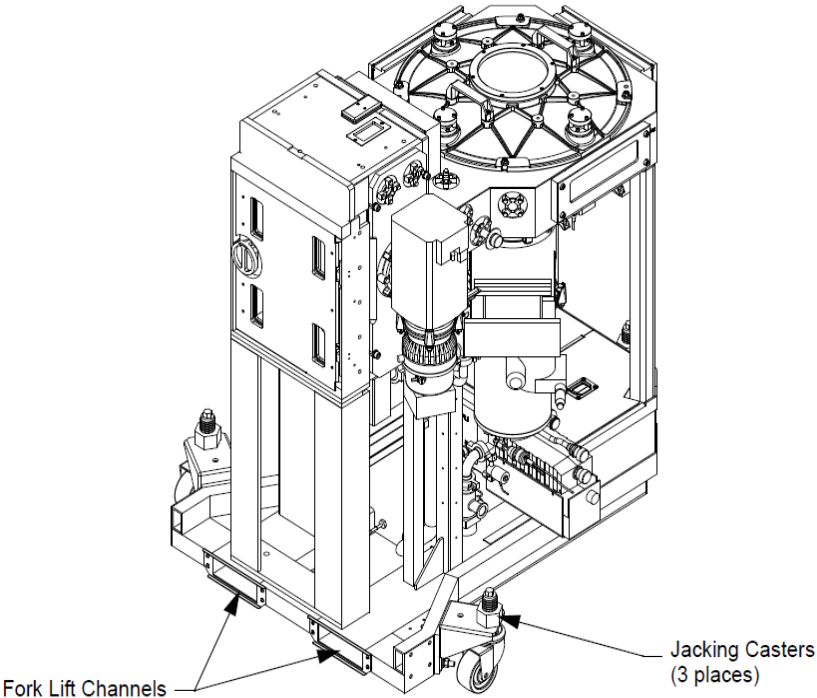
Type 1 Procedure: Equipment is fully de-energized.

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 Marathon Express 400 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 ATP may be needed.
3.	Remove the crate walls of the Transport Chamber.
4.	Unbolt the caster brackets from the pallet floor (3 places). NOTE: Save the shipping crate for possible future use. If the Marathon Express 400 is returned to Brooks for service or shipped to another location, the original shipping crate and brackets must be used.

Step	Action
5.	Using the fork lift, pick the Transport Chamber up only enough to clear the shipping skid. The fork lift channels are located below the VCE as shown in Figure 3-1. NOTE: The Marathon Express 400 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.  Figure 3-1: Fork Lift Channel Locations
6.	Slide out the shipping skid and lower the MX 400 system jacking casters as shown in Figure 3-1 by turning the threaded rods clockwise. Gradually transfer the weight of the system from the fork-lift channels to the casters.
7.	Remove the fork lift. NOTE: The individual modules of the Marathon Express 400 are top heavy. Failure to take the proper precautions before moving any module could result in personal injury.
8.	Cut open and remove the foil bag the MX 400 system is shipped in and roll the system into the Depack area. NOTE: Inspect the travel route of the Marathon Express 400 to ensure that it is level and clear of all debris and obstacles. Cover dips, thresholds, or any uneven floor transitions with plates.
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.

Step	Action
11.	Remove all outer bags and vacuum and wipe down all inner bags. NOTE: The Brooks Automation Marathon Express 400 was assembled and bagged in plastic in a cleanroom environment. To ensure the cleanliness of the MX 400 system, remove only the outer bags in the Depack area. NOTE: Recycle all packaging materials.
12.	Carefully inspect the Marathon Express for signs of damage that may have occurred during shipping.
13.	Roll the system into the cleanroom and position it at its final location. NOTE: When pushing the Marathon Express 400 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 Marathon Express 400 and could be damaged if pushed against.
14.	Remove all inner bags and any additional wrapping.
15.	Carefully inspect the MX400 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 Marathon Express are provided in [Appendix F: "Packing and Shipping Instructions" on page 242](#).

Installation Procedure

The Marathon Express 400 is typically supplied in one of several standard configurations and arrives as a set of modules ready to install.

 CAUTION Heavy Object	
The Marathon Express 400 weighs 708.5 kg (1562 lb). The Vacuum Cassette Elevator modules of the Marathon Express weigh 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 properly rated fork lift to lift the Marathon Express 400 or a minimum of four people to roll the MX 400 system and a minimum of two people to move any other modules.	 

 CAUTION Tip Hazard	
Tip hazard exists when moving the VCE modules or when they are not connected together as part of the Marathon Express 400.	 

 CAUTION	
Personal Protective Equipment	
Safety glasses and steel toe shoes should be worn at all times when installing the Marathon Express 400.	

Procedure Category

Type 1 Procedure: Equipment is fully de-energized.

Required Tools and Equipment

The following tools and materials are required during the installation of the Marathon Express 400:

- Metric Hex Wrenches
- Standard Hex Wrenches
- Scale (ruler)
- I-beam Level
- Bubble Level
- 1/2 inch Bolt (or Threaded Rod), Qty 3, for MX 400 system tie-down

Remove Protective Packaging

The modules of the Marathon Express 400 are shipped with their internal components (robot, aligner, etc.) covered in protective packaging. This packaging must be removed before installation can be started.

Marathon Express 400 Module

Remove protective wrapping from any loose cable ends or connectors.

VCE Module(s)

Remove protective wrapping from any loose cable ends or connectors.

Rack Mountable Equipment

Remove protective wrapping from any loose cable ends or connectors.

Removing Shipping Brackets

The modules of the Marathon Express 400 are shipped with shipping brackets attached to them, which protect their moving parts and provide ease of movement of the modules. These shipping brackets must be removed before the MX 400 system may be installed or used.

NOTE: Save the shipping brackets for possible future use. If any of the modules of the Marathon Express 400 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 242](#).

Marathon Express 400 Vacuum Back End

The robot arms are secured in place for protection during shipment. These shipping brackets must be removed before attempting to operate the robot.

Step	Action
1.	Remove the lid from the chamber. Refer to "Removing/Replacing Lid" on page 220 .
2.	Unscrew the arm shipping brackets. Remove the brackets and save for future use. If the Marathon Express 400 Vacuum Back End is shipped, the brackets must be replaced before shipping.
3.	Replace the lid on the chamber. Refer to "Removing/Replacing Lid" on page 220 .

VCE Module

The door and the cassette platform of each VCE are 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 Marathon Express 400

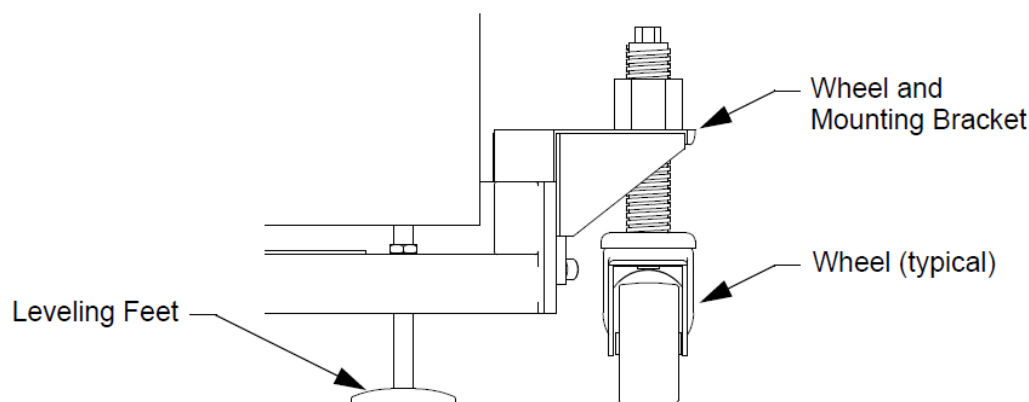
The Marathon Express 400 must be positioned within the facility to ensure proper handoff between the facility wafer carriers and the Vacuum Cassette Elevators. Once the MX system is positioned it must be leveled and the Wafer Transport Plane must be adjusted to the proper height. After these preliminary adjustments are complete the MX 400 system may be bolted to the floor using the tie-down points provided.

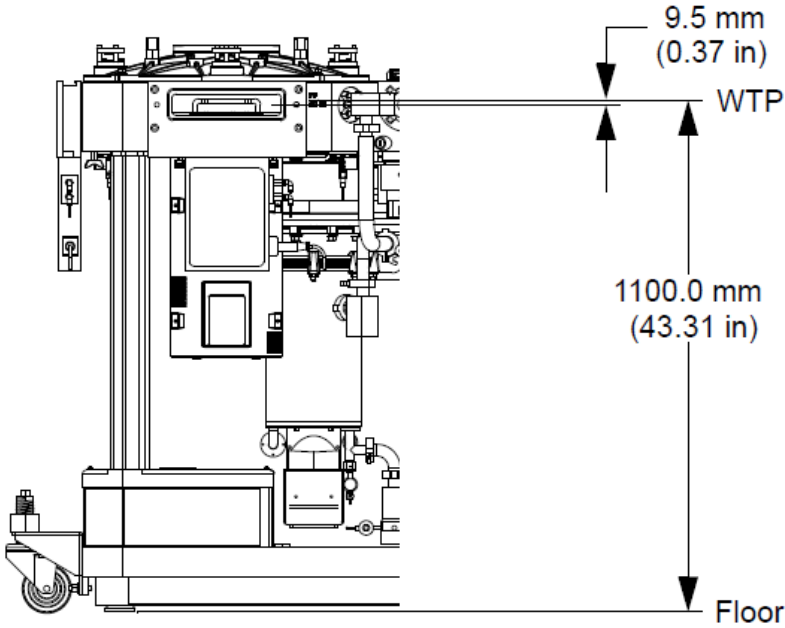
Leveling the Marathon Express and Setting the Wafer Transport Plane

Adjustable feet are provided on the frame of the Marathon Express 400. These feet are used to support the Marathon Express 400 Vacuum Back End and VCEs, to set the Wafer Transport Plane (WTP), and to compensate for an uneven floor.

NOTICE

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

Step	Action
1.	Lower the leveling feet, shown in Figure 3-2, until the feet are fully supporting the module's weight.  Figure 3-2: Lowering the Leveling Feet
2.	Raise the wheels and remove the casters. Retain the casters for future use. NOTE: The casters must be saved for future use in moving the Marathon Express 400.

Step	Action
3.	The Wafer Transport Plane (WTP) can be established at the SEMI MESC height of 1100 mm (43.31 in) per SEMI E21 by setting the distance from the scribe mark on the side of the chamber to the floor at 1100 mm as shown in Figure 3-3. Alternately, set the center of a material transfer slot to the floor at 1090.5 mm, which will set the MTP at 1100.0 mm.  Figure 3-3: Setting the Wafer Transport Plane
4.	Level the MX 400 system using an I-beam level placed along the chamber by adjusting each foot as necessary. NOTE: When adjusting the height of the transport chamber or leveling the chamber, ensure that it is not allowed to “twist”. This could damage the chamber or frame.
5.	Verify the WTP height from the floor to the center of each vacuum facet alignment pin.

Installing the Tie-down Brackets

Seismic brackets must be provided to secure the Marathon Express 400 to the floor to eliminate movement and for earthquake protection. The caster brackets must be removed from the system and the system secured with angle brackets (not supplied) using the tapped holes in the side of the frame as shown in Figure 3-4.

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

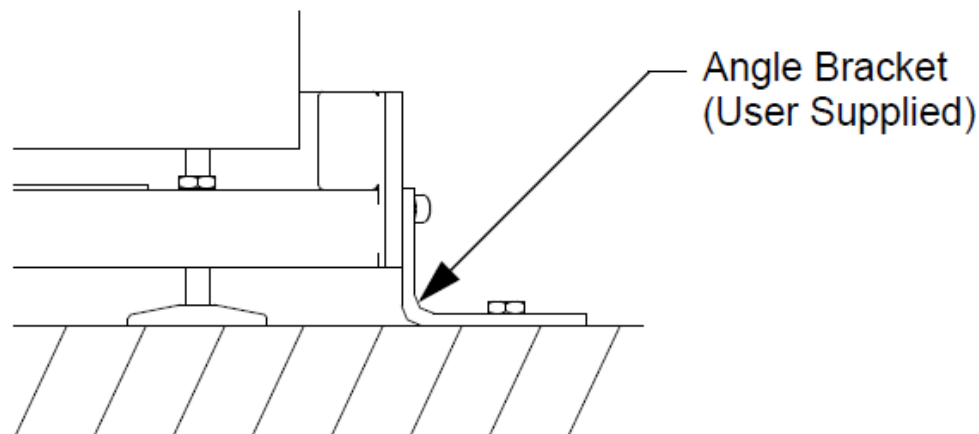


Figure 3-4: Typical Seismic Bracket Mounting

Step	Action
1.	Locate the Seismic Brackets at the points the casters were attached to the frame as shown in Figure 3-4 .
2.	Position the brackets so that the seismic mounting holes are against the floor.
3.	Replace the (4) bolts and washers to secure the bracket to the frame.
4.	Install appropriately sized bolts (not supplied) through the bracket and into the floor.

Mounting the Process Modules to the MX System

Any components that will be mounted to the Marathon Express 400 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 Marathon Express Vacuum Back End.
2.	Adjust the Process Module so that its Material Transport Plane is at 1100 mm (refer to the <i>Process Module's User Manual</i>). Ensure that the Process Module remains level while making any adjustments to the height.

Step	Action
3.	Mate the Process Module to the vacuum facet of the Marathon Express 400 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 Marathon Express 400 does not require any connections be made between the Marathon Express 400 Vacuum Transport System and the VCE modules during installation.

Most cables in the Marathon Express 400 are shipped from the factory already connected to the tool. However, individual subsystems such as any rack mountable components must be connected during installation.

Block diagram, 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 Marathon Express 400 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 Marathon Express 400 requires compressed air, nitrogen (vent gas), vacuum, exhaust, electrical power, communications connections, and optionally cooling water, water return, and argon (cool gas). Refer to the ["Facilities Specifications" on page 22](#) for detailed descriptions of the required user-supplied facilities.

All Marathon Express 400 Cluster Tool Integration Platforms come with the required connectors to facilitate interfacing the system, along with connectors for the vacuum sources. The MX 400 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.	 

 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.	

Electrical

Electrical power is connected to the Marathon Express 400 for operation of the robot, elevators, sensors, and other subsystems. A 200 - 240 VAC electrical connection is provided on the Marathon Express 400 for AC power from the facility. Refer to "[Facilities Specifications](#)" on page 22 for electrical requirements. Ensure that the electrical connection is for the appropriate voltage.

 DANGER Electrical Shock	
Turn on the electrical supply before connecting the facilities to the Marathon Express 400 can cause personal injury or death. Do not turn on the electrical supply from the facility until all connections to the Marathon Express 400 and all installation procedures have been completed.	

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 Marathon Express 400 for operation of the Vacuum Cassette Elevators, Slot Valves, Atmospheric Doors, and optional TopCooler. Quick connect air ports are provided on the Marathon Express 400 system's Pneumatic Facilities Panel. Refer to ["Facilities Specifications" on page 22](#) for pneumatic requirements. Ensure that the pneumatic connection is for the appropriate pressure.

NOTICE

Do not turn on the pneumatic supply until all connections to the Marathon Express 400 and all installation procedures have been completed.

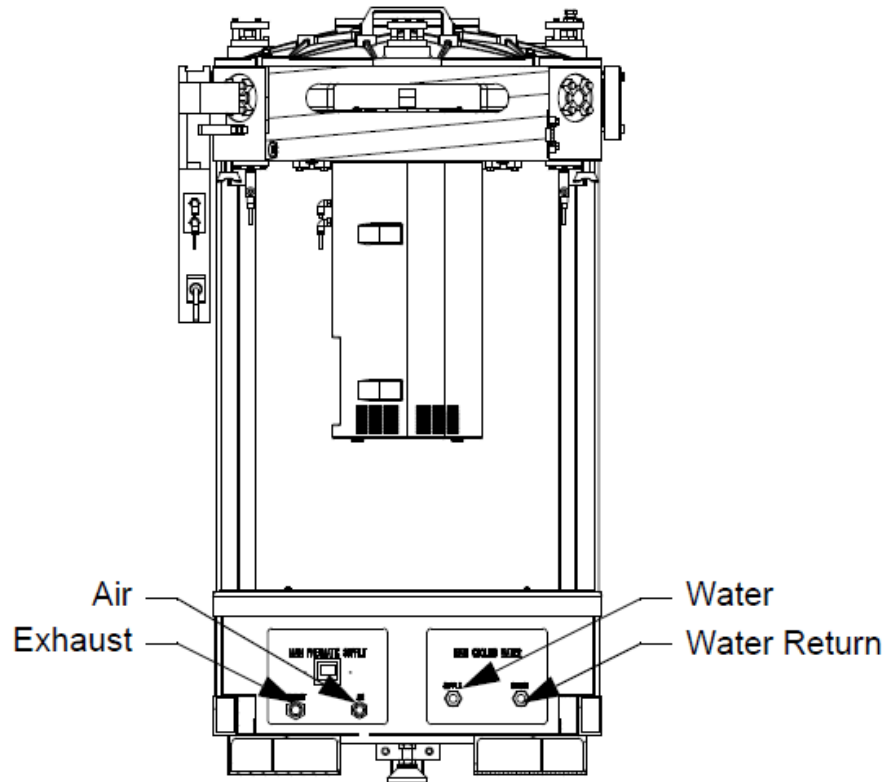


Figure 3-5: Pneumatic and Water Connections

Step	Action
1.	Connect the compressed air line from the facility to the 10 mm quick connect air connection on the Marathon Express 400 system's Pneumatic Facilities Panel.

Nitrogen

Nitrogen is connected to the Marathon Express 400 for venting the Vacuum Cassette Elevators and the Marathon Express 400 Vacuum Back End and, depending on the configuration, nitrogen may be used as the thermal transfer gas in the TopCooler. A 1/4 inch VCR connection is provided on the MX 400 system on the Gas Facilities Panel. Refer to "[Facilities Specifications](#)" on page 22 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 Marathon Express 400 and all installation procedures have been completed.

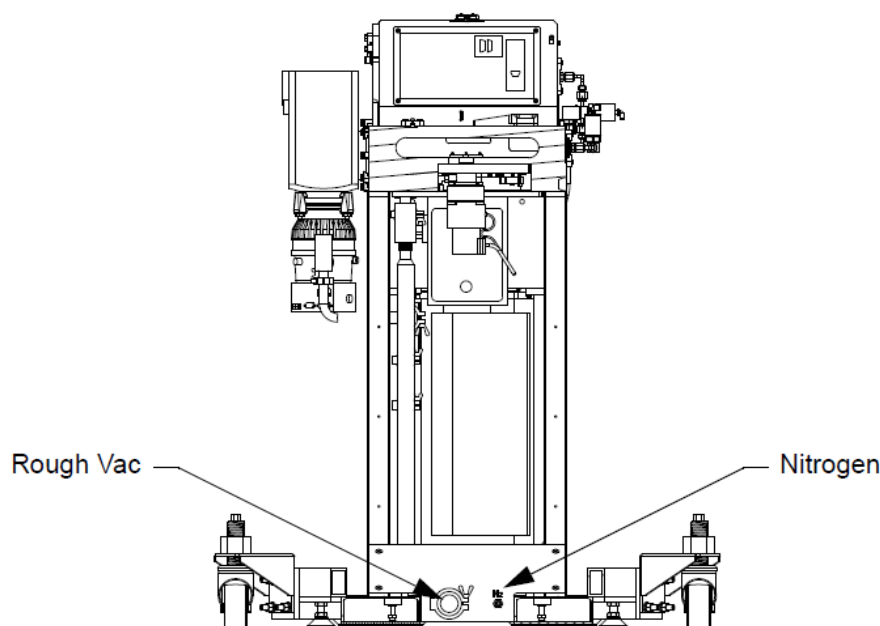


Figure 3-6: Gas and Vacuum Connections

Step	Action
1.	Connect the nitrogen line from the facility to the nitrogen connection on the MX 400 system.

Argon

Argon may be connected to the Marathon Express 400 in the optional TopCooler. A 1/4 inch VCR connection may be provided on the MX 400 system on the Gas Facilities Panel, or it may be provided on the TopCooler. Refer to "[Facilities Specifications](#)" on page 22 for argon gas requirements. Ensure that the argon connection is for the appropriate pressure.

NOTICE

Do not turn on the argon supply until all connections to the Marathon Express 400 and all installation procedures have been completed.

Step	Action
1.	Connect the argon line from the facility to the argon connection on the MX 400 system's TopCooler as shown in .

Vacuum

An appropriate user supplied vacuum system must be connected to the Marathon Express 400 Vacuum Back End to provide the desired pump-down times for the vacuum chambers. Refer to ["Facilities Specifications" on page 22](#) for vacuum requirements.

Depending upon the configuration of the Marathon Express 400, differential vacuum may need to be supplied to various seals including the TopLigner vacuum aligner and the Vacuum Cassette Elevators 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.

NOTICE

Do not turn on the vacuum connection until all connections to the Marathon Express 400 and all installation procedures have been completed.

Step	Action
1.	Connect the facility's rough-vacuum system to the Marathon Express 400, as shown in Figure 3-6 .

Exhaust

A line to receive exhaust from operation of the Marathon Express 400 is connected to the Vacuum Cassette Elevators and Marathon Express 400 Vacuum Back End. One 8 mm quick connect exhaust port is provided on the Marathon Express 400 system's Pneumatic Facilities Panel. Refer to ["Facilities Specifications" on page 22](#) for exhaust requirements.

Step	Action
1.	Connect the exhaust line from the facility to the 10 mm quick connect EXH connection on the Marathon Express 400 system's Pneumatic Manifold.

Water and Water Return

Depending upon the configuration of the Marathon Express 400, water may need to be supplied to the MX 400 system for cooling of components attached to the chamber, such as pumps, or for the cooling of the vacuum chamber. Refer to ["Facilities Specifications" on page 22](#) for water and water

return requirements. Ensure that the water connection is for the appropriate pressure and temperature and is maintained to avoid corrosion.

NOTICE

Do not turn on the water connection until all connections to the Marathon Express 400 and all installation procedures have been completed.

These connections are only required if the system requires cooling water for the Transport Chamber or modules attached to the system.

Step	Action
1.	Run a 1/2 inch O.D. Teflon line from the facility water supply to the WATER connection on the Marathon Express 400 system's Facilities Interface Panel as shown in Figure 3-5 .
2.	Run a 1/2 inch O.D. Teflon line from the facility water drain to the RETURN connection on the Marathon Express 400 system's Facilities Interface Panel as shown in Figure 3-5 .

Communications Connections

The modules within the Marathon Express 400 typically use RS-232, RS-422, RS-485, Discrete I/O, Ethernet, and DeviceNet for communications with the host controller. Some modules, such as the vacuum robot, are capable of Ethernet communication as an option. The type of connections used depends on the generation of the control system implemented on the MX 400 system.

Power-up Sequence

The following procedure describes the steps to safely apply power to the Marathon Express 400 system and verify that it is ready for operation.



WARNING

Automatic Movement / Crush hazard

Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include:

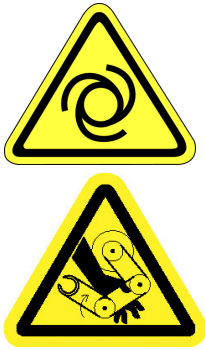
- Robot
- Aligner
- Cool Module Poppet
- Load Lock Module(s) (AutoDoor, Arm, Platform)
- Atmospheric Doors
- Vacuum Slot Valves
- Isolation Valves
- Pumps

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

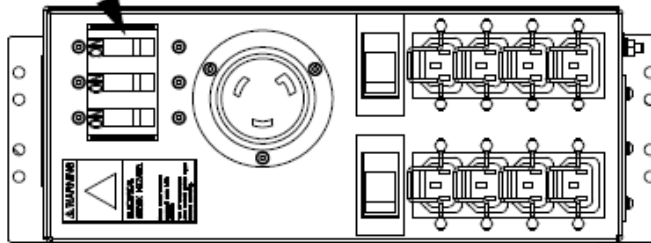
Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled.

Do not operate the robot without the protective covers in place.

Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.



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 Marathon Express 400 vacuum chamber and load lock lids are closed and secured.
3.	Mechanical Checks: - Verify that all shipping brackets have been removed. - Ensure that the VCE modules are properly and securely mounted to the Marathon Express 400. - Ensure that the Marathon Express 400 has been properly secured within the facility. - Ensure that the OEM Process Module(s) are properly and securely mounted to the Marathon Express 400 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.

Step	Action
4.	Facility Checks: - Ensure that all facilities are capable of meeting, or exceeding, the requirements as described in the "Facilities Specifications" on page 22. - Ensure that the power, communications, air, exhaust, nitrogen, vacuum, optional water, and any other connections have been completed. - Check all cables. Verify that the connectors are fully seated and screws/ locks are secured to ensure good continuity. - Verify all internal cables are routed in a safe place and away from any internal movement. - Verify all external cables are routed in a safe place and away from any travel areas. - Inspect all cables and tubing for restricting bend radii or excessive tension.
5.	Pre-operation Checks: Ensure that there are no obstructions in the travel path of the robot and its end effectors within Marathon Express 400. NOTE: Some of the internal components of the Marathon Express 400 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.
6.	Connect the Marathon Express 400 to the facility's electrical services. NOTE: HIGH VOLTAGE: 200 - 240 VAC at 15 Amps. The AC circuit must be properly protected.
7.	If supplied, connect the Marathon Express 400 system's heater power supply to the facility's electrical services. NOTE: HIGH VOLTAGE: 200 - 240 VAC at 15 Amps. The AC circuit must be properly protected.
8.	Turn on vacuum, air, nitrogen, argon if used, and water supply if used.
9.	Turn on the AC power from the facility to the Marathon Express 400.
10.	Turn on the power within the Marathon Express 400 system.
11.	Turn on the Main Breaker for the AC Power Distribution Unit, located on the front of the unit. Main Breaker  The diagram shows the front panel of the Marathon Express 400. On the left side, there is a vertical row of four circuit breakers. An arrow points to the top one of these breakers, which is labeled 'Main Breaker'. To the right of these breakers is a large circular port. Further right, there are two rows of terminal blocks, each with multiple screw terminals for wiring.
12.	Perform a Ground Continuity check from the surfaces of the MX 400 system and all rack mountable equipment to a known good ground.

Step	Action
13.	The modules will power up when the Main Breaker on the ACPD is turned on and the following sounds and indicators should be observed, refer to Table 3-2 for an overview of the indicators that should be on. Audible sounds: fans in robot drive If the initialization sequence executes without error, then the Brooks Automation Marathon Express 400 has been properly installed, all the components are communicating successfully, and the system is ready for operation. NOTE: The Host Controller initiates all motion control to the Marathon Express 400. If bits are high at start-up, motion will take place. It is the user's responsibility to initiate a safe start-up of the Marathon Express system. NOTE: If start-up was successful, the Marathon Express 400 is ready to accept commands. If, however, the start-up sequence was unsuccessful, refer to "Initial Troubleshooting".
14.	Return the Marathon Express 400 system to operation or teach the MX 400 system as required.

The Brooks Automation Marathon Express 400 system must be aligned with the system that it will be operating in to prevent misplacement of the material being moved through the system or collision of the robot with other parts of the system. Note that even a small misalignment can interfere with proper MX 400 system operation and may cause material breakage or MX 400 system damage.

The user must perform a complete alignment as part of installing the MX 400 system.

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

Table 3-2: Start-up Indicators

Component	Indicator	Status
Vacuum Robot	24V Power	Green
Safety Controller	24V Power	Green
Mini Hub	24V Power	Green
Air Inlet	Pressure Sensor Status LED	Green
Nitrogen Inlet	Pressure Sensor Status LED	Green
TopCooler (optional)	Pressure Sensor Status LED	Green-

NOTICE

Do not attempt to operate the Marathon Express 400 until it has been properly aligned. The alignment procedure in this manual must be completed prior to commanding motion.

4. Subsystems

This chapter provides an overview of all major subsystems within the Brooks Automation Marathon Express 400 Cluster Tool Integration Platform. This system has been designed as a set of major field replaceable modules. These field replaceable modules and other components of the MX 400 system are described in this section.

System Overview

The Marathon Express 400 (MX 400) provides a controlled, ultra-clean environment for material transfer between the factory and the process equipment. The MX 400 system is composed of Brooks Automation components and additional subsystems creating a complete system. Each subsystem is discussed in this chapter, many of these subsystems are available as FRUs. The symmetry and architectural design of the Marathon Express 400 focuses on commonality of parts and accessibility to all serviceable items. The subsystems are modular in design and designed for ease of use, maintenance, and repair minimizing Mean Time To Repair (MTTR).

Depending on system configuration (refer to ["Configuration" on page 15](#)), 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 Marathon Express 400 systems and may contain references to items not installed on a specific system.

Material transfer between these modules occurs across a single horizontal plane called the Wafer Transport 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.

Table 4-1: Typical Marathon Express 400 Control Configuration

System Type	System Configuration
ETCH	Turbo Controller (for the chamber), DC Power Supply

System Type	System Configuration
CVD	2 Turbo Controllers (one for the VCE and one for the chamber), DC Power Supply
PVD	1 Turbo Controller (for the VCE), 1 Cryopump Controllers (for chamber), Heater Controller, DC Power Supply

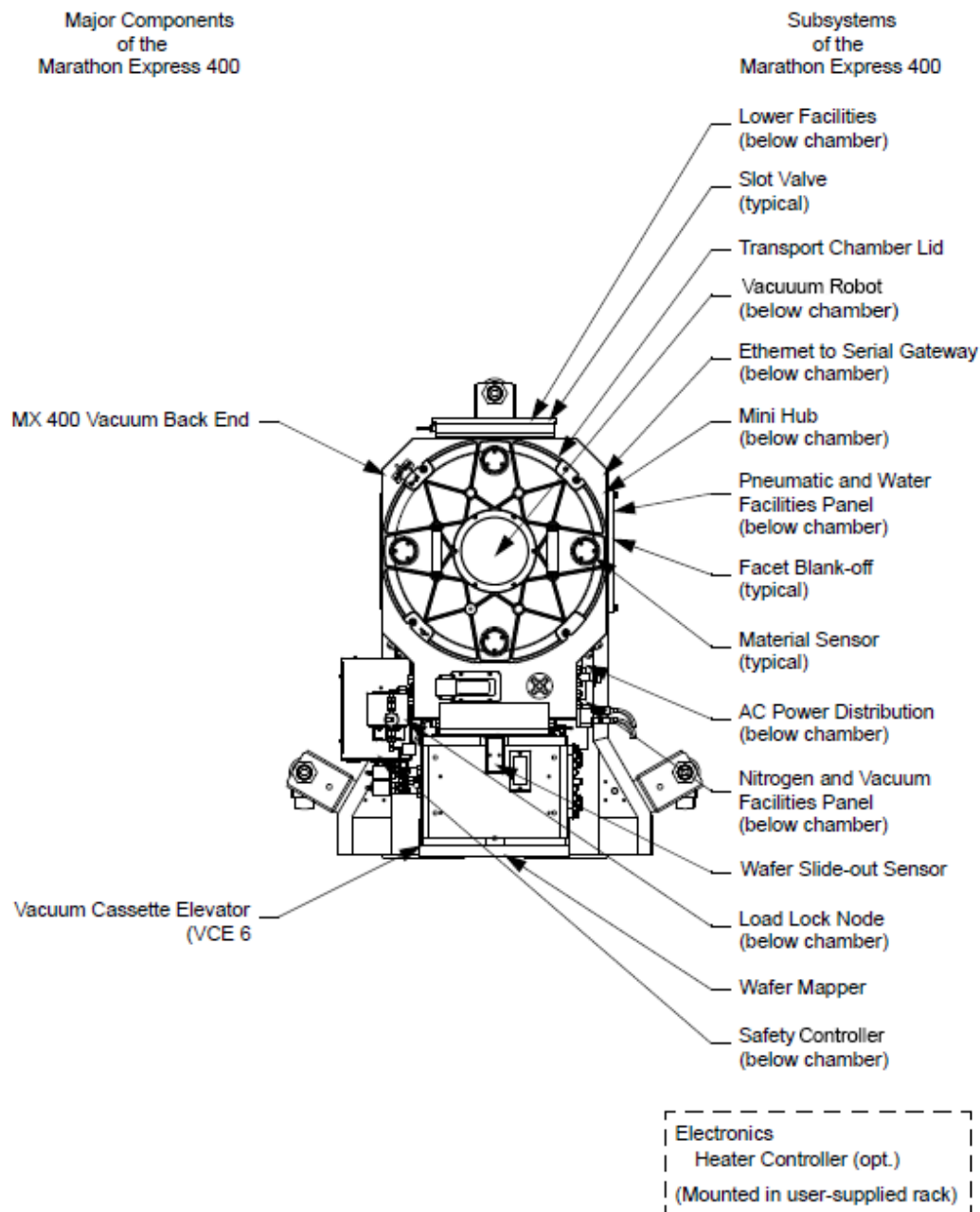


Figure 4-1: Typical Marathon Express 400 Subsystems

Description

A supported wafer carrier is placed in the VCE Load Lock. The MX 400 system then pumps down the Load Lock to the appropriate vacuum and the vacuum robot removes a wafer from the cassette and transfers it into the Transport Module's vacuum chamber. Once in the Transport Module the wafer is aligned and transferred into the appropriate Process Module. After processing, the robot

removes the wafer from the Process Module, places another wafer in the Process Module, and either passes the wafer to another Process Module or returns it to the Load Lock. If a hot process was used the wafer is first cooled before being returned to the VCE. Refer to "[System Operation Overview](#)" on page 125 for a detailed description of the system's operation.

The Marathon Express 400 uses the controller supplied as part of the vacuum robot to control the functions of the Marathon Express 400 Vacuum Back End it is installed in. The controller can provide system monitoring and interlocks. The robot in the MX 400 system is independently controlled by the host controller.

Transport Chamber

The Brooks Automation Marathon Express 400 Vacuum Back End is designed to provide three facets for the attachment of Process Modules and one facet for the attachment of a VCE Load Lock with the vacuum robot being used for material transfer within the chamber. This design provides the smallest footprint available for atmospheric- to-vacuum material transfer.

Transport Chamber Lid Assembly

The Marathon Express 400 lid is located on the top of the transport chamber, sealing the chamber and providing access into the chamber for service. The lid assembly consists of the lid with observation ports. The lid meets all S2-93 and EU safety standards.

The lid can weigh up to 8.2 kg (18 lb). This lid provides a 100 mm (4 in) diameter viewport located in the center of the lid and a 16 mm (0.62 in) diameter viewport for each material sensor. There is one material sensor reflector mounted above each material sensor viewport. The o-ring on the bottom edge of the lid mates with the vacuum sealing surface on the vacuum chamber. No locking provisions are required.

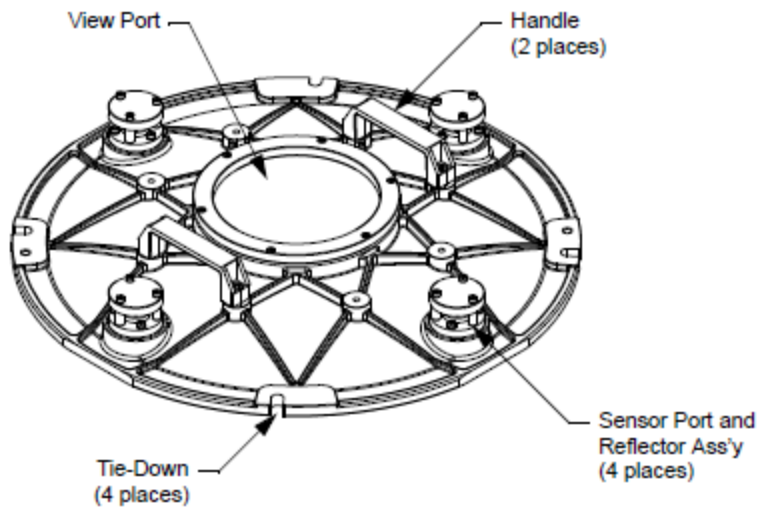


Figure 4-2: Marathon Express 400 Lid

The lid is secured to the top of the Transport Chamber using four bolts and has two handles for easy removal.

Frame Assembly

The frame consists of a welded, tubular construction, steel structure that meets SEMI E21 requirements.

The height of the frame is such that the height of the chamber's WTP above the facility floor when mounted on the frame conforms to the SEMI MESC cluster tool specification (1100 mm/42.9 in.).

NOTICE

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

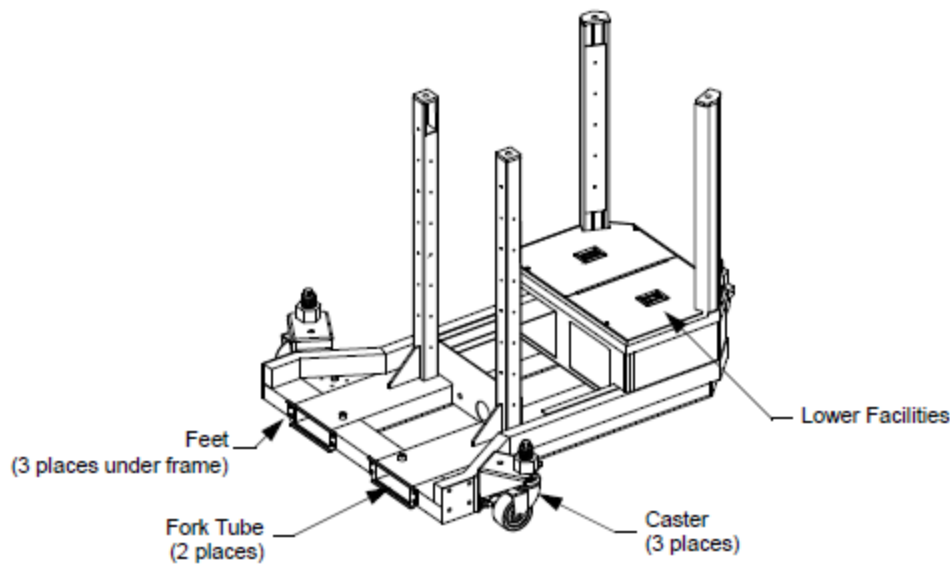


Figure 4-3: Typical Marathon Express 400 Frame

The Marathon Express 400 frame is provided with 3 removable casters for rolling the chamber and frame to its destination. Built-in fork tubes allow moving the frame with a fork lift. The system design allows access to the fork tubes for positioning.

The frame is also equipped with adjustable feet allowing adjusting and leveling of the Vacuum Transport Chamber. Tie-downs using the caster brackets 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. See ["Installing the Tie-down Brackets" on page 72](#). Service access is provided under the chamber behind the VCE and between the Process Modules, refer to [Figure 1-2 on page 27](#) and [Figure 1-3 on page 27](#).

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

Power from the main facility connection is distributed to the various modules of the Marathon Express 400. This provides a single point of connection to minimize wiring.

Refer to System Block Diagram and controls manual for more information.

AC Power Distribution

AC power within the MMX is distributed throughout the tool from the AC Power Distribution Unit (ACPDU), which also provides circuit protection. [Figure 4-4](#) shows the location of the controls and indicators on the ACPDU. [Table 4-2](#) shows the functions associated with each of them.

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

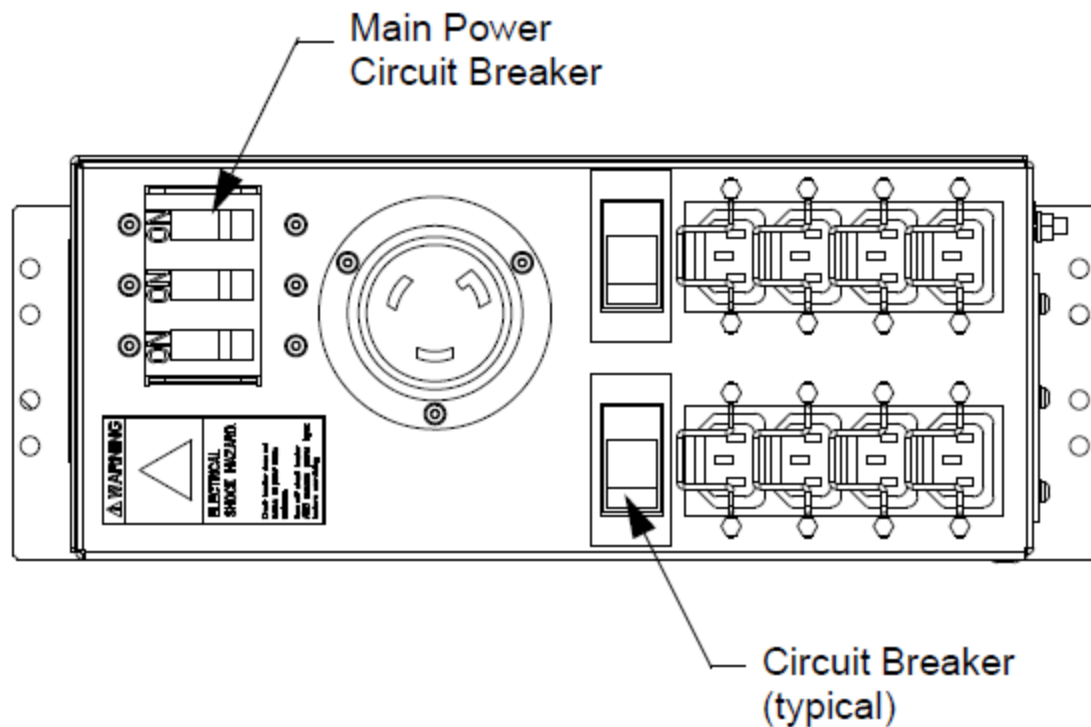


Figure 4-4: AC Power Distribution Unit - Controls and Indicators

Table 4-2: AC Power Distribution Unit - Controls and Indicators

Name	Type	Function
CB1	Circuit Breaker, 20 A	Main Circuit Breaker ON: Power on OFF: Power off
CB1	Circuit Breaker, 10 A	Output Circuit Breaker 1 ON: Power on OFF: Power off
CB2	Circuit Breaker, 10 A	Output Circuit Breaker 2 ON: Power on OFF: Power off

Circuit Protection

The main power line is protected through a 20 Amp multipolar magnetic circuit breaker. The breaker is a current-limiting device which disconnects the Marathon Express 400 from the utility in the case of a fault (short circuit).

Vacuum System Operation

The following vacuum system operation example is for a PVD system configuration containing turbo pumped load locks and cryopump and cryopanel on the Transport Chamber.

Initial Conditions

- System is vented with all chambers at atmospheric pressure.
- Rough and foreline pumps are operating with manifold pressure of < 100 mT
- Cooling water supplied to the system is within specification
- DC/AC power supply is available to all system loads
- Host Controller is booted and ready
- Helium compressor is ready and operating, cryogenic pumps are at room temperature
- All system valves are shut

Chamber Bakeout

- a. Stop cooling water to Transport Chamber.
- b. Energize TC Cartridge Heaters.
- c. Rough out the Transport Chamber.
 - a. Open slow rough.
 - b. At crossover (80 Torr) open fast rough and shut slow rough.
- d. Rough load lock.
 - a. Open turbo pump foreline isolation valve and start turbo pump.
 - b. Open slow rough.
 - c. At crossover (80 Torr) open fast rough and shut slow rough.
 - d. When turbo is at full speed, open turbo isolation and energize the high vacuum gauge.
- e. Repeat for second Load Lock.
- f. Rough cryopump and begin cool down.
- g. When cool down is complete, open cryopump isolation valve and energize high vacuum gauge.
- h. After chamber bakeout is complete, secure Cartridge Heaters and initiate cooling water flow to chamber.

Start-up

- a. Begin cool down of cryopanel.
- b. When cryopanel is at operating temperature and chamber pressure is $< 1 \times 10^{-7}$, system is ready for processing.

Exchange Wafers in the Load Locks

- a. Vent the Load Lock
 - a. Close Load Lock slot valve.
 - b. Close turbo pump isolation valve.
 - c. De-energize the high vacuum gauge.
 - d. Initiate profiled vent.
 - e. Initiate fast vent when pressure > 80 Torr.
 - f. When Digital Pressure Switch indicates pressure is equal to outside pressure, secure vent.
- b. Exchange wafers.
 - a. Open Load Lock door.
 - b. Exchange cassette.
 - c. Close Load Lock door.
- c. Pump down Load Lock.
 - a. Open slow rough.
 - b. Open fast rough at crossover (80 Torr).
 - c. Shut slow and fast rough valves.
 - d. Open cryo pump isolation valve and energize high vacuum gauge.
- d. When Load Lock chamber pressure is $< 1 \times 10^{-5}$ Torr, Load Lock is ready for processing.

Shut Down from High Vacuum

- a. Turn off high vacuum gauge.
- b. Turn off turbo pump.
- c. When turbo pump has stopped, shut turbo pump foreline valve.
- d. Shut cryo pump isolation valve.
- e. Shut down cryo panel (cryo pump regeneration must occur when chamber is under vacuum, if cryo pump is not going to be regenerated, use rough vacuum).

Vent Transport Chamber

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

Vent Load Locks

- a. Shut turbo pump foreline valve.
- b. Secure turbo pump.
- c. De-energize high vacuum gauge.

- d. Initiate profiled vent When pressure >80 Torr, open fast vent valve.
- e. 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.

- a. Close Isolation valve.
- b. 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.

Pneumatic System

Compressed air is used to power various valves within the Marathon Express 400 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 vacuum robot, the Pneumatic Facilities Interface is easily accessible for service.

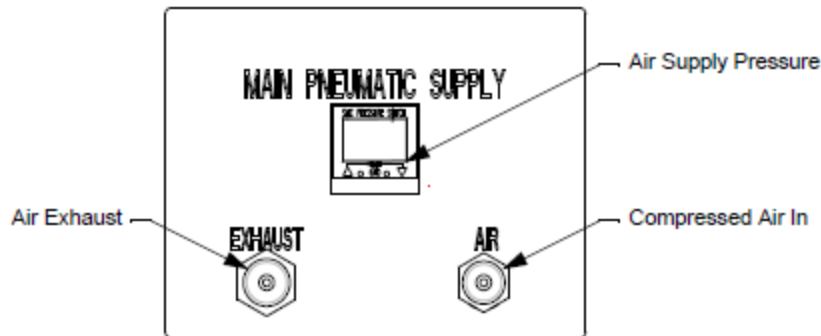


Figure 4-5: Pneumatic Facilities Connection Panel

One pneumatic manifold is used on the Marathon Express 400 system.

Pneumatic Manifold PMAN.TC: located on the leg of the frame behind the VCE, 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.

Two pneumatic manifolds are used on the Marathon Express 400 system with Gen 5 Controls.

Pneumatic Manifold PMAN.LLA: located on the leg of the frame behind the VCE, operates all pneumatically controlled devices related to the load lock. This includes the Isolation Valves, Rough Valves, Slow Rough Valves, Fast Vent Valves, Profiled Vent Valves, and if used, the Cryo Pump Rough and Regen Valves.

Pneumatic Manifold PMAN.TC: located on the leg of the frame behind the VCE, operates all pneumatically controlled devices related to the transport chamber. This includes the Slot Valves, the Isolation Valves, Rough Valves, Slow Rough Valves, Fast Vent Valves, Profiled Vent Valves, and if used, the Cryo Pump Rough and Regen Valves.

Brooks Automation 4-20 MN-002-8500-00 Revision D 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. See ["Pressure Switch" on page 157](#) for operation.

See System Block Diagram and the controls manual for more information.

Gas System

The Marathon Express 400 frame assembly includes a gas facilities interface. This provides a centralized connection for the Cluster Tool to nitrogen and argon supplied by the facility. Located on

the frame, below the chamber near the Load Locks, the Facilities Interface is easily accessible for service.

The Gas Facilities Panel uses one Digital Pressure Switch for monitoring the flow and indicating the pressure of the facility supplied nitrogen and another Digital Pressure Switch for monitoring the flow and indicating the pressure of the facility supplied argon.

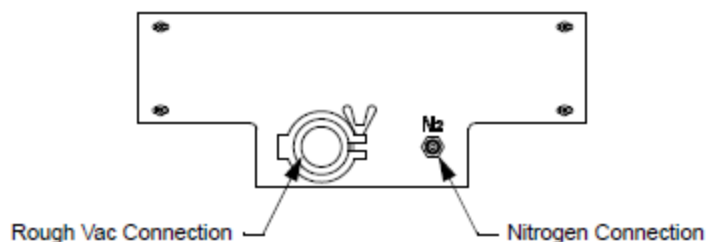


Figure 4-6: Gas Distribution Panel

A Digital Pressure Switch, shown in [Figure 4-6](#), is used for monitoring the flow and indicating the pressure of the facility supplied nitrogen. See ["Pressure Switch" on page 157](#) for operation of the switch.

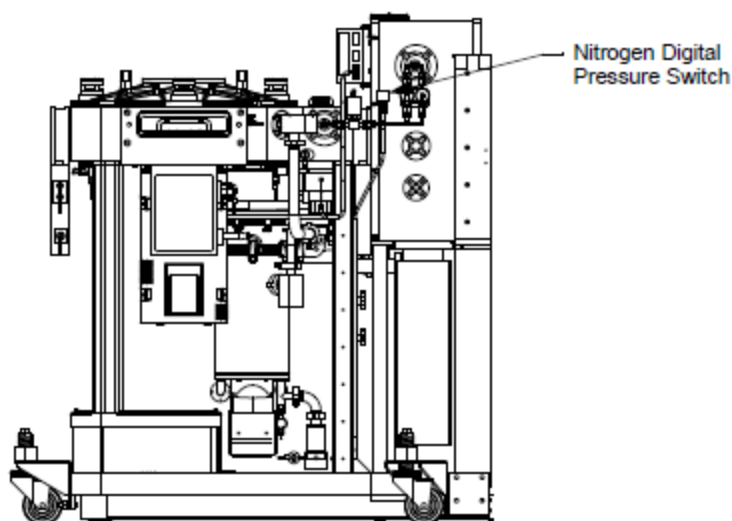


Figure 4-7: Gas Pressure Monitoring

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

Water System

The Marathon Express 400 frame assembly includes an optional water facilities interface. This provides a connection for the Cluster Tool to water supplied by the facility for cooling of the chamber, pumps, and any other system components that require cooling water, such as the TopCooler. Located in the frame below the robot, the Water Facilities Interface is easily accessible for service.

The water cooling system requires a closed loop cooling source capable of supplying chilled water as specified in ["Facilities Specifications" on page 22](#). The minimum pressure of 20 psi is required to ensure that the water inside the Transport Chamber does not boil when the chamber is heated to 120° C. The supply pressure must be 30 psi greater than return pressure to achieve required flow rate during chamber cool down after bakeout.

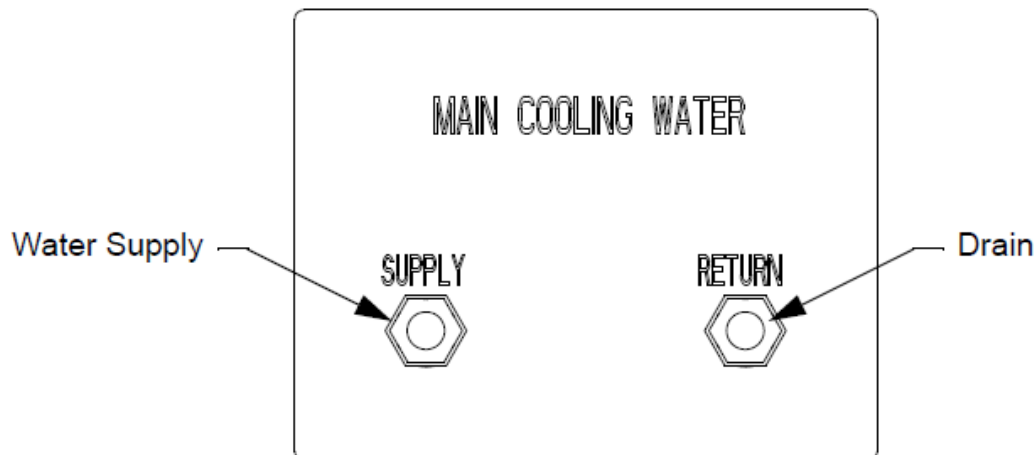


Figure 4-8: Water Facilities Connection Panel

Refer to the System Block Diagram and Water Diagram supplied with this manual.

Transport Chamber Heating System

An optional single zone vacuum chamber heating system may be provided with the Marathon Express 400. Heating the Transport Chamber removes free water molecules attached to the chamber walls allowing a lower base vacuum to be obtained. Thermal Blankets are provided to minimize heat loss providing a faster bakeout cycle.

The Electric Heating System consists of a Heater Power Supply, Heater Cartridge assemblies mounted in the Transport Chamber, a Temperature Controller, a Thermal Switch, and a Thermocouple. This system heats the Transport Chamber while monitoring the temperature of the chamber.

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

Heater Power Supply

The Heater Power Supply, shown in [Figure 4-9](#), is rack mountable. The power supply provides power distribution to the Heater Cartridge assemblies, the Temperature Controller, the Thermal Switch, and the Thermocouple. The Heater Power Supply contains power control, switching, and over temperature cutout circuits; maximum Bakeout temperature is fixed by a safety thermo-switch on the chamber.

The Heater Power Supply, designed by Brooks Automation, uses a Watlow Temperature Controller to regulate the Transport Chamber temperature. The 24V controller controls operation of the heater system via communications from the host controller. The Temperature Controller is mounted in the Lower Facilities Bay on the MX 400 system's frame.

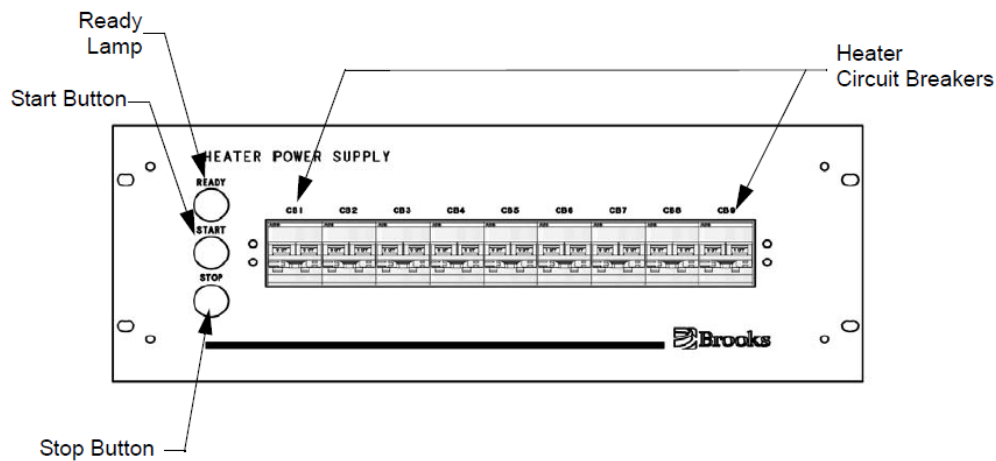


Figure 4-9: Heater Power Supply

Heaters

Four 750 Watt Heater Cartridge assemblies, shown in [Figure 4-11](#), are positioned around the bottom of the Transport Chamber as shown in [Figure 4-10](#). Each Heater Cartridge is made into a sub-assembly for quick replacement. A Thermocouple attached to the Transport Chamber monitors the TC temperature and a Thermal Switch provides over-temperature protection..

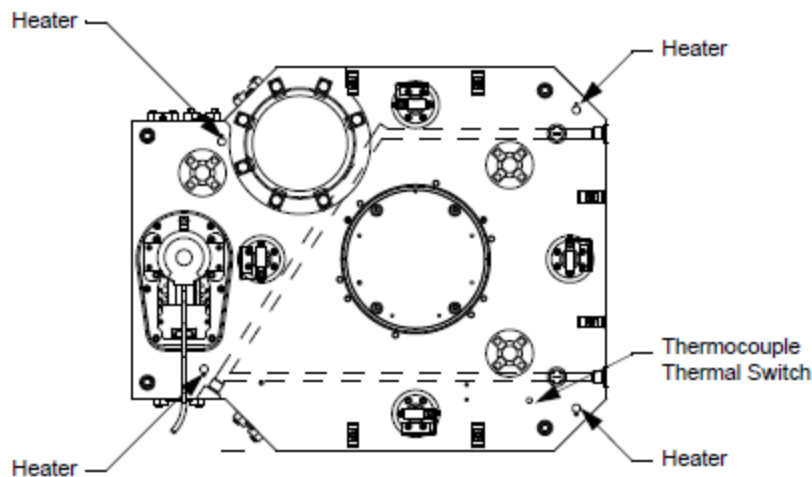


Figure 4-10: Chamber Heating System

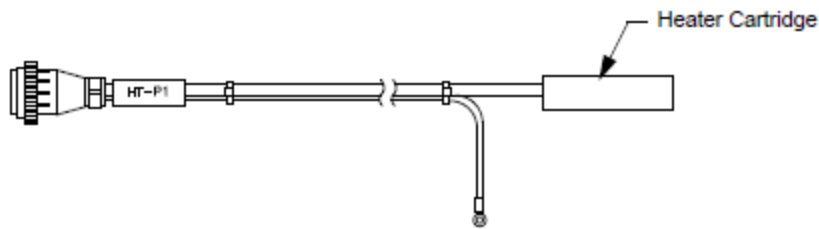


Figure 4-11: Cartridge Heater Assembly

Temperature Controller

The Temperature Controller, shown in , provides a single-channel dual display controller for use with DeviceNet that offers many advanced functions. There is one universal sensor input, a second auxiliary input, and two outputs. The controller provides 10 Hz sampling, variable time base burst firing outputs, NEMA 4X front panel and 0.1% calibration accuracy.

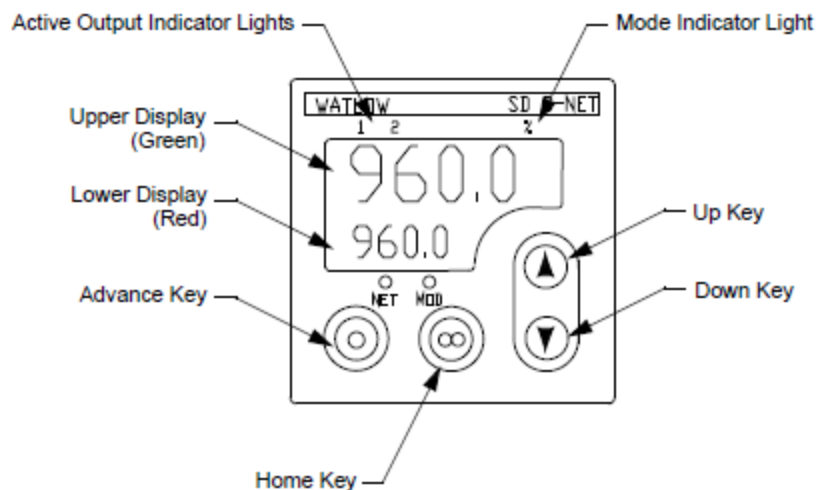


Figure 4-12: Temperature Controller

See ["Heating System" on page 137](#), ["Temperature Controller" on page 140](#), and the Heater Subsystem drawings and System Block Diagram supplied with this manual.

Thermal Blankets

To ensure rapid heating with minimal heat loss, and to provide some thermal protection to service personnel, Thermal Blankets are created that provide a custom fit around the top and sides of the MX 400 system's chamber and lid. These blankets must be in place before a bake-out process is begun. The blankets may be left in place during normal operation of the MX 400 system as they are designed such that they will not interfere with normal operation.

Transport Chamber Cooling System

Cooling water is supplied to the Marathon Express 400 for various cooling tasks including chamber cooling, wafer cooling, and module (pumps, etc.) cooling. Each of the cooling tasks is optional and may not be installed on a specific system. Refer to [Figure 4-13](#) for a cooling water system schematic showing all options.

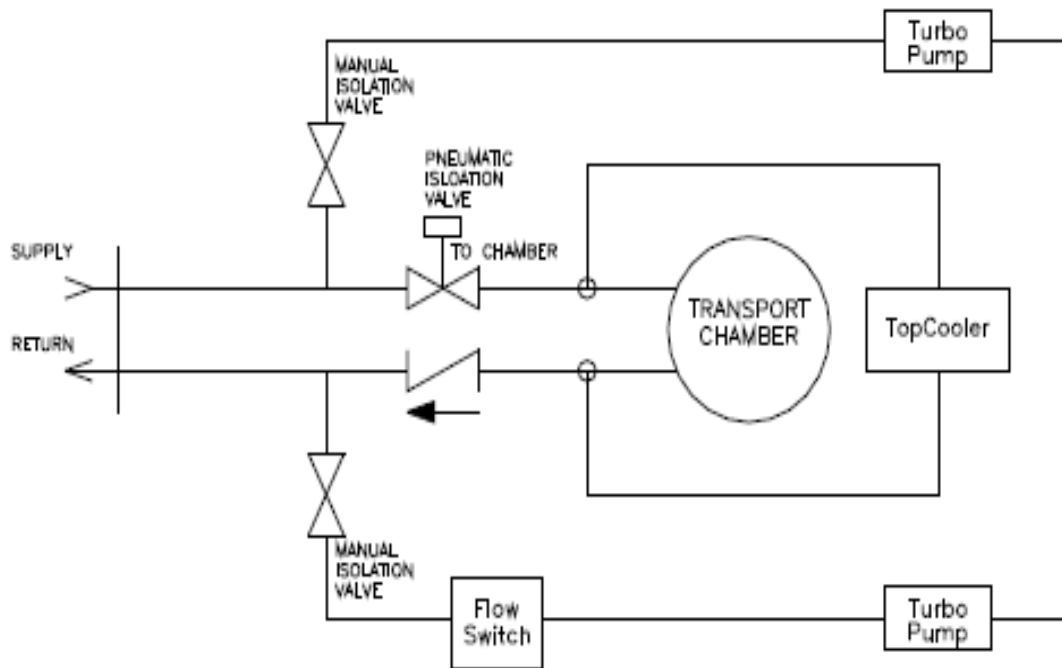


Figure 4-13: Cooling Water Schematic

For MX 400 systems that have the optional Chamber Heating System installed an optional Chamber Cooling System may be installed on the MX 400 Transport Chamber to assist in recovery from bakeout. The design of the water channels within the chamber allows water flow in either direction allowing the user to determine the preferred connection points for water flowing in and water return. Cooling water is circulated through channels drilled into the Transport Chamber to provide a rapid cool-down after bakeout. See [Figure 4-14](#) for the routing of the water path for systems using the Electric Heating option.

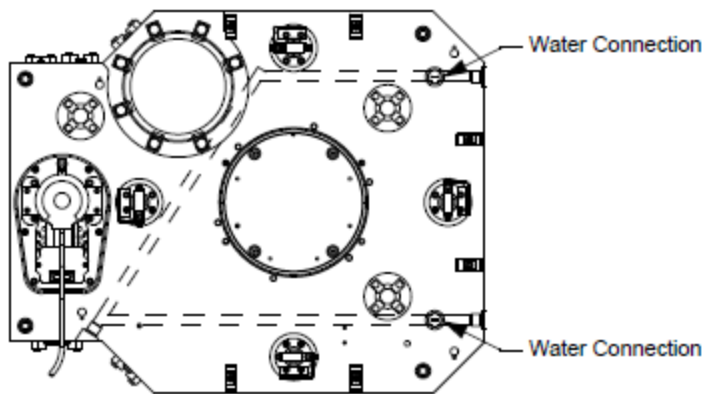


Figure 4-14: Chamber Cooling System

For MX 400 systems that have the optional TopCooler wafer cooler installed cooling water is routed to the Cool Tray to provide wafer cooling. Refer to ["TopCooler" on page 103](#) for detailed information about the TopCooler.

For MX 400 systems that require cooling for modules such as pumps the cooling water is routed from the water facilities panel to the modules requiring cooling.

The water cooling system requires a closed loop cooling source capable of supplying chilled water at a minimum pressure of 20 psi. This minimum pressure is required to ensure that the water inside the Transport Chamber does not boil when the chamber is heated to 120° C during bakeout by the Electric Heating system. The supply pressure must be 30 psi greater than return pressure to achieve the required flow rate during chamber cool down after bakeout.

The Marathon Express 400 system's water cooling system utilizes the same equipment in all MX 400 systems with the only difference being the different cooling loads associated with the various cooling options.

Electrical System

The modular architecture of the electrical system readily supports configuration changes. The design of the electrical system was driven by serviceability and manufacturability. Cabling schemes and controller interfaces are readily adaptable to accommodate the process driven requirements.

Standard, off-the-shelf cables comprise 70% of the electrical system, thereby eliminating customized cabling. Refer to the System Block Diagram and the Schematic drawings supplied with this manual for the specific system.

Interlocks

The Safety Node provides a set of hard-wired interlocks between all automation components (robot, VCE, and valves) within the MX 400 system. These interlocks prevent any action from taking place if the E-Stop is active. These interlocks also prevent certain actions under certain conditions (i.e., extending robot to a station if the slot valve is closed).

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

Coded Magnetic Switches are provided on all load lock doors and on the transport module chamber lid. These switches must be closed to allow motion within the chamber they are associated with. Using a coded magnetic switch prevents the use of a basic magnet to override the interlock, a key with a matching code must be used. Brooks provides a Service Key to allow service operation while the door is opened.

NOTE: The Service Key is only to be used by trained personnel and is only meant to be used while performing service on the Marathon Express 400. The MX 400 system should never be run with the Service Key.

The Emergency Off (EMO) circuit is the user's responsibility and is typically used to remove all power to the Marathon Express 400 and the modules connected to it. The AC Power Distribution Unit provides a single point for connecting the facility's power to the MX 400 allowing the user to easily integrate an EMO circuit.

Ethernet to Serial Gateway

The Ethernet to Serial Gateway provides an RS-232 communications interface through the Ethernet. The gateway is mounted on the Transport Chamber frame under the chamber and the serial communications cables are routed to the appropriate devices. Distribution includes the robot, aligner, load lock and other devices using serial communications.

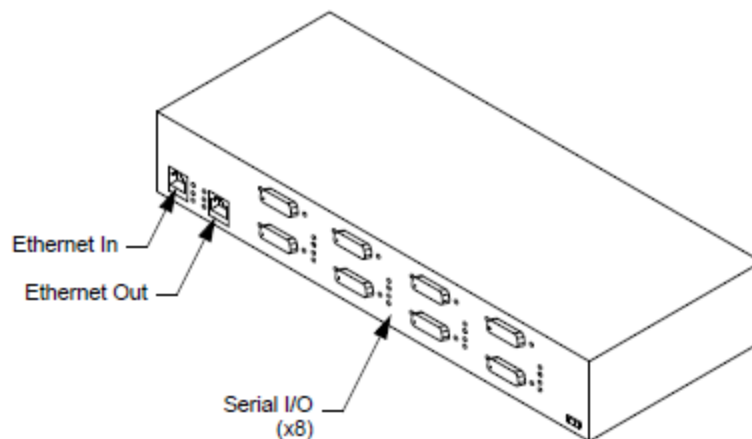


Figure 4-15: Ethernet to Serial Gateway

The Ethernet Serial Gateways are used to interface peripheral devices using serial communication to the Ethernet network within the MX 400 system. The serial data stream is internally buffered allowing the gateway to send and receive data using the standard software commands for the devices with a gateway header to direct the command to the appropriate serial communications channel, refer to ["Ethernet Serial Gateway " on page 134](#).

LEDs on the serial gateway indicate the status of each RS-232 channel. The serial gateway is powered from a remote AC Adapter module. Refer to the assembly drawings supplied at the back of this manual for mounting locations.

NOTE: If more than one Ethernet Serial Gateway is installed on the Marathon Express 400, the IP address settings cannot be the same for each node.

Refer to the System Block Diagram and Schematics supplied with this manual, ["Ethernet to Serial Gateway Module " on page 109](#) for pinouts, and ["Ethernet to Serial Gateway Module" on page 132](#) for controls and indicators.

TopCooler

Refer to the *TopCooler User Manual* for more information.

Material Presence Sensors

To safeguard against material-handling mishaps, the Marathon Express 400 Transport Chamber contains optical material sensors at each station. The Marathon Express 400 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.

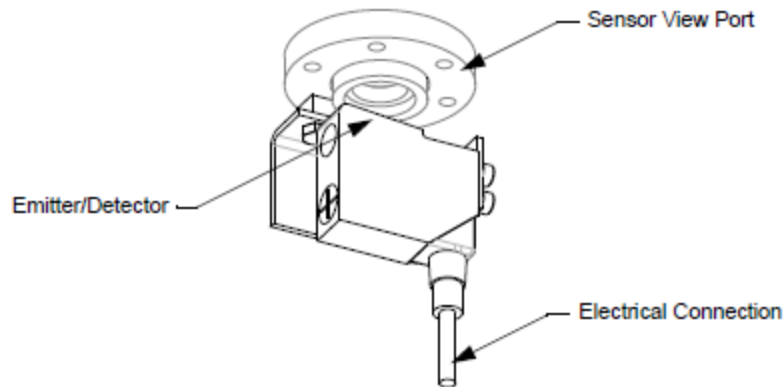


Figure 4-16: Material Sensor

Each material sensor consists of a polarized visible light emitter/detector pair capable of detecting clear substrates. The sensor detects material presence by bouncing a beam of light from the emitter off of a reflector mounted on the lid and back to the detector. If there is no material on the end effector the beam will be detected; if material is on the end effector the material will interrupt, or disturb the polarization, of the beam and no light will be detected.

The material sensor feature is designed to determine material presence on the end effector for the Brooks Automation patented Single Arm, the BiSymmetrik™ Dual Arm, and the Leapfrog™ Dual Arm. In the case of the Leapfrog™ Arm set with one end effector over the other, one end effector must be extended over the sensor to determine if material is present on the specific end effector.

Outputs

NPN and PNP outputs are both available from the sensor. Both outputs produce the same signal, which may be configured as either Light Active or Dark Active.

- Light Active (default): signals are active when sensor beam is reflected.
- Dark Active: signals are active when sensor beam is blocked.

To configure the LIGHT/DARK mode, pin 5 (L-D) on the sensor must be set to GND or to +24V. Refer to ["Material Presence Sensor Adjustment" on page 212](#) for adjustments.

Vacuum Robot

Refer to the appropriate robot user manual for more information.

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 in) 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.

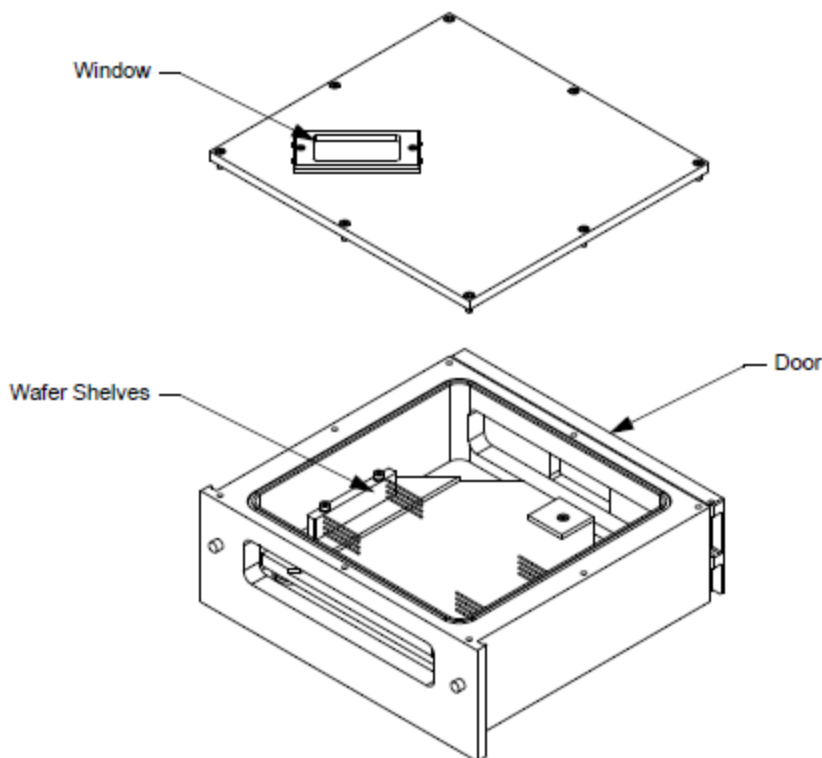


Figure 4-17: Wafer Buffer Module

VCE

The Brooks Automation Vacuum Cassette Elevators are SEMI compatible interfaces designed for manual or automated loading of substrate carriers waiting horizontal wafer transfer. These elevators provide cassette indexing to place wafers at the Wafer Transport Plane. The VCE provides an interface between the atmospheric environment of the manufacturing facility and the vacuum environment of the cluster tool. The VCEs may be provided with their own vacuum systems including pumps and monitoring to allow them to function fully as Vacuum Cassette Modules.

The VCE Load Lock is a CE/S2 compliant load lock designed to handle SEMI standard cassettes of 25 or 26 wafers up to 200 mm. The VCE is fabricated from aluminum and weighs 111 kg (245 lb). It is designed to be a low cost, corrosion resistant, and serviceable component.

See the *VCE User Manual* for more information.

Internal Software

The software supplied with the Marathon Express 400 is in the form of internal control programs that reside on the related components within the system. Please refer to the appropriate component manual for any software information.

5. Operational Interfaces

This chapter provides a detailed description of all operational interfaces to the Brooks Automation Marathon Express 400. These interfaces provide power to the MX 400 system and communications from the Marathon Express 400 system to the host controller to allow it to monitor and control all components.

Interface Overview

This section provides a description of the Marathon Express 400 system's operational interfaces. Interfaces for all MX 400 system options are covered, however if an option is not installed, those connections are not present.

Vacuum Aligner

Refer to the Aligner User Manual and System Block Diagram for more information.

Vacuum Robot

Refer to the Vacuum Robot Manual and System Block Diagram for more information.

Heat Power Supply

The Marathon Express 400 uses a Heater Power Supply to power the chamber heaters. [Figure 5-1](#) shows the location of all connections found on the Heater Power Supply. [Table 5-1](#) lists the connections, and shows which type of connectors are used.

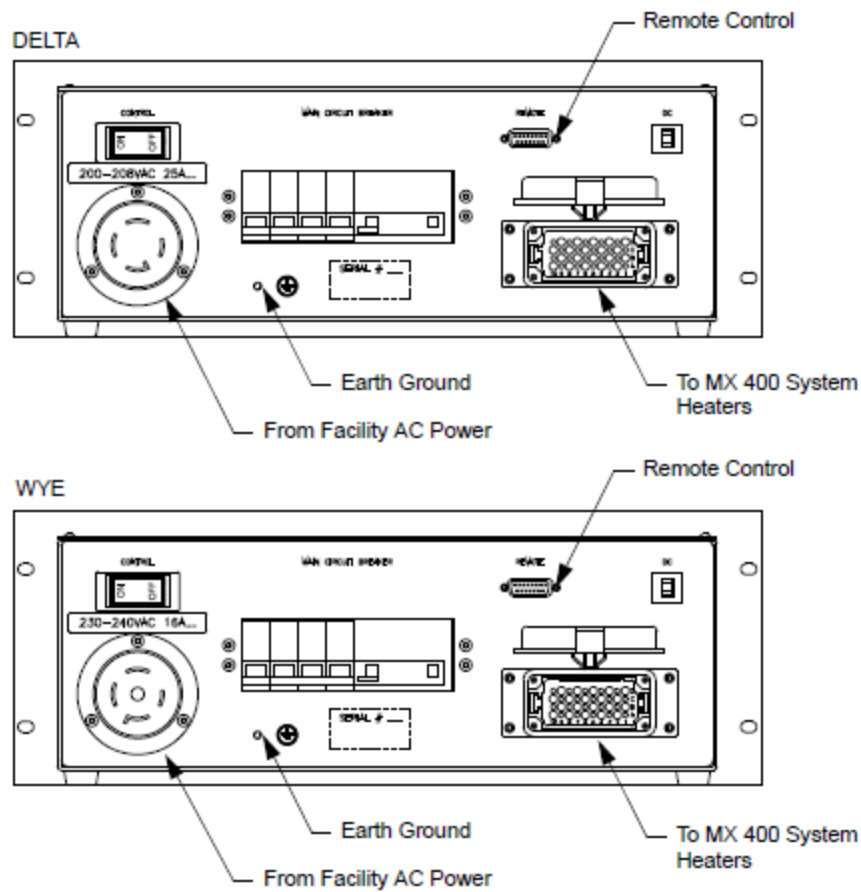


Figure 5-1: Heater Power Supply - Connections

Table 5-1: Heater Power Supply - Connections

Label	Description	Connector Type
200-240V 20A	AC In, 200 - 208V, 20A, 3 phase	Hubbell 2425
Power Distribution	Power connection to heaters on the MX 400 system	Harting 09-30-016-0306 Harting 09-21-040-3101
Remote	Remote Control Interface	Female DB-15
GROUND	Earth Ground connection	Stud, M4-16

Communications Node

Refer to the Controls Manual for more information.

BrooksNet Module

Refer to the Controls Manual for more information.

Ethernet to Serial Gateway Module

The Ethernet to Serial Gateway used with the Gen 5 controls provides an RS-232 communications interface through the Ethernet. [Figure 5-2](#) shows the location of the connections on the Ethernet to Serial Gateway. [Table 5-2](#) shows which type of connectors are used for each of them.

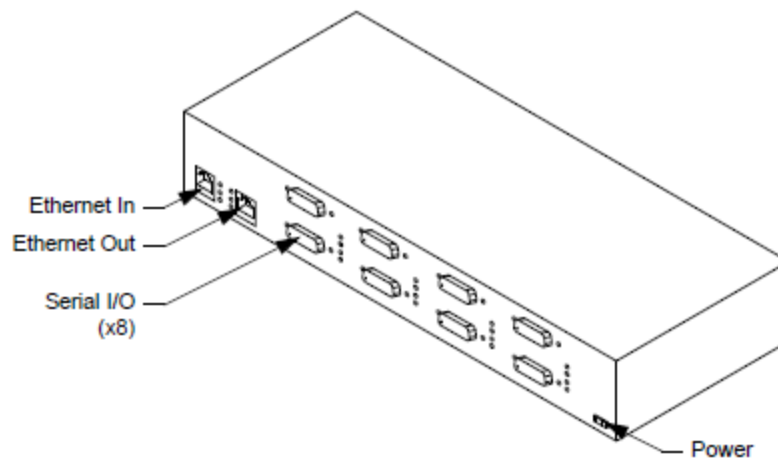


Figure 5-2: Ethernet to Serial Gateway

Table 5-2: Ethernet to Serial Gateway Connections

Label	Description	Connector Type
Up	Ethernet In	RJ-45
Down	Ethernet Out	RJ-45
1 - 8	Serial I/O	Male DB-9
PWR	24VDC	Molex 3-pin

AC Power Distribution

The Marathon Express 400 uses an AC Power Distribution Unit (ACPDU) to distribute AC power throughout the tool. The ACPDU also provides circuit protection. [Table 5-3](#) shows the location of all connections found on the ACPDU. [Table 5-3](#) lists the connections, and shows which type of connectors are used.

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

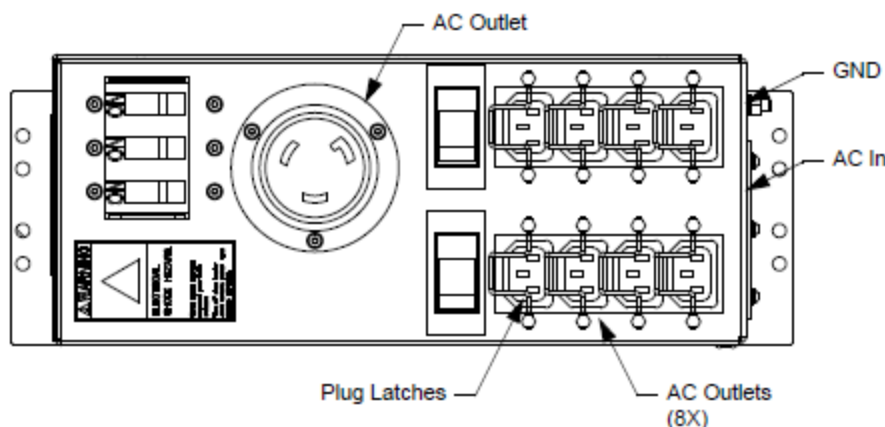


Figure 5-3: AC Power Distribution Unit - Connections

Table 5-3: 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 Marathon Express 400 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 22](#).

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

NOTE: The facility is responsible for the main disconnect device between the Marathon Express 400 and the facility's power source, ensuring it complies with the correct electric codes. Service to the MX 400 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 Marathon Express 400.

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 Marathon Express 400 and the facility's power source, ensuring it complies with the correct electric codes. Service to the MX 400 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 Marathon Express 400. Refer to the ["Facilities Specifications" on page 22](#) for power requirements.

NOTE: Before connecting or disconnecting main power to the Marathon Express 400, ensure all circuit breakers on the MX 400 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 MX 400 system's frame and provides power to the MX 400 system's modules. The pin-out for the ACPDU's 200 - 240 VAC cable is provided in [Table 5-4](#). The power cable connectors are shown in [Table 5-5](#).

Table 5-4: 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 5-5: 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

Heater Power Supply Cable

If the optional Electric Chamber Heater will be used, the user must fabricate the power cable carrying facility power to the power supply. The Heater Power Supply is typically mounted in a 19" equipment rack and provides power to the Marathon Express 400 system's heating units. The pin-out for the Heater Power Supply 200 - 240 VAC cable is provided in [Table 5-6](#). The power cable plugs into the rear panel of the Heater Power Supply module using the connectors shown in [Table 5-7](#). Refer to the owners manual for installation.

Table 5-6: Heater Power Supply Cable

WYE 220 - 240 VAC, 16 A, 3 phase		DELTA 200 - 208 VAC, 25 A, 3 phase	
Pin ID	Signal	Pin ID	Signal
X	phase A	X	phase A
Y	phase B	Y	phase B
Z	phase C	G	Earth Ground
W	NEUTRAL	Z	phase C
G	Earth Ground		

Table 5-7: Heater Power Supply Connectors

DELTA	
Connector located on Heater Power Supply Panel	Connector bagged for facility's power cable
Hubbell 2725 Flanged inlet connector 250 V, 30 A, male, 4-wire Brooks Automation P/N 211-0063-24	Hubbell 2723 Insulated Grip, nylon connector 250 V, 30 A, female, 4-wire Brooks Automation P/N 210-0068-17
WYE	
Hubbell 2525 Flanged inlet connector 480 V, 20 A, male, 5-wire Brooks Automation P/N 211-0063-16	Hubbell 2523 Insulated Grip, nylon connector 480 V, 20 A, female, 5-wire Brooks Automation P/N 210-0068-19
Terminations: Harting type Han D, 40, 250~/300 V crimp	

Turbo Pumps and Cryogenic Compressor

The turbo pumps are AC powered and typically carry an on-board controller. The user must fabricate the power cables carrying facility AC power for all user-supplied pumps.

For most other turbo pumps and the Cryogenic Compressors, the user will need to create cables that bring power to their rack mountable controllers. Refer to the owners manual for installation.

Ethernet Communications

Network communications using the Ethernet communications protocol provides the ability to connect a number of different devices to a Host Controller using a single communications cable. Each device connected to the cable has a unique network device address. Only communications addressed to a specific device through the network will be received by that device. The configuration for the various devices using Ethernet is described in ["Operation"](#).

Network communications allows the Host Controller to communicate with the Marathon Express 400 using the commands detailed in the *WAVE II Software User Manual*. In situations where the host controller is unavailable, a personal computer running a network communications application may be connected to the MX 400 system's network port using the same cable and commands to communicate with the system as the host controller.

Network Interface Connections

The Ethernet connection to the Marathon Express 400 from the host controller uses standard Ethernet network communications protocols and wiring. The Ethernet cables used are standard network cable (UTP-CAT5) with an 8-pin "RJ-45" connector. The pin-out for this connection is provided in [Table 5-8](#). Note that pins not identified with a signal name are to be left unconnected. Refer to [Figure 5-2 on page 109](#) for the location of this connection.

Table 5-8: Standard Ethernet Network Connector Pin Assignments

Pin ID	Signal Name
1	Tx+
2	Tx-
3	Rc+
4	
5	
6	Rc-
7	
8	

To establish a direct communications link to the modules within the MX 400 system either a crossover cable or a hub is needed. Refer to ["Ethernet Communication" on page 134](#).

DeviceNet Communications

Network communications using the DeviceNet tool network allows the System Controller to communicate with the various subsystems of the Marathon Express 400 over a single internal network cable. Each device connected to the cable has a unique network device address. Only communications addressed to a specific device through the network will be received by that device.

DeviceNet is a low-cost industrial network 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 MX 400 system. Network termination is typically provided by the DeviceNet Master Node.

Network Interface Connections

The DeviceNet connections within the MX 400 system use standard DeviceNet network communications protocols and wiring. The DeviceNet cables use standard Thick Cable with M12 connectors. The pin-out for this connection is provided in [Table 5-9](#).

Table 5-9: 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

Serial Communications

Serial communications allows the host controller to communicate with the Marathon Express 400 using the commands detailed in the *WAVE II Software User Manual*. No additional control, or

“handshaking”, wires are used. The Baud Rate (see [Table 5-10](#)) indicates the speed of the connection in bits-per-second.

In situations where the Command Display Module and the host controller are unavailable, a personal computer running a serial communications application may be connected to the robot's serial communication port using the same cable and commands to communicate with the robot as the host controller.

Serial Interface Connection

The connection to the Marathon Express 400 from the host controller uses standard RS-232 or RS-422 serial communications. The configuration for the MX 400 system's serial communications protocol is described in [Table 5-10](#).

Table 5-10: 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

The serial communications cables used within the Marathon Express 400 use a standard 9-pin “D” connectors. Note that pins not identified with a signal name are to be left unconnected.

Table 5-11: Standard RS-232 and RS-422 Connector Pin Assignments

Pin ID	Standard RS-232 Signal Name	Optional RS-422 Signal Name
1		
2	TXD	RXD-
3	RXD	RXD+
4		
5	GND	TXD-
6		
7		

Pin ID	Standard RS-232 Signal Name	Optional RS-422 Signal Name
8		TXD+
9		

The Gen 4 RS-422 serial communications cable for the Marathon Express 400 Vacuum Back End uses a standard 3-row 44-pin Male “D” connector that plugs into the MX 400 Vacuum Back End at the Communications Node on the Facilities Panel.

Heater Power Supply Remote

The optional Heater Control Power Supply is capable of two modes of operation: Standard, where it will operate only from its Front Panel, and Remote, where basic controls and indicators for the power supply are available from a remote location. Refer to [Table 5-12](#) for the connector pinout and [Figure 5-4](#) for connection diagrams. Note that pins not identified with a signal name are to be left unconnected.

NOTICE

The Remote Control circuit is the responsibility of the user.

Table 5-12: Heater Remote Control Connector Pinout

Pin	Signal
1	+24VDC
2	User Interlock
3	Remote On 1
4	Remote On 2
5	Remote Off 1
6	Remote Off 2
7	On Sense Relay
8	24VDC Return
9	
10	
11	
12	

Pin	Signal
13	
14	Ready Relay
15	

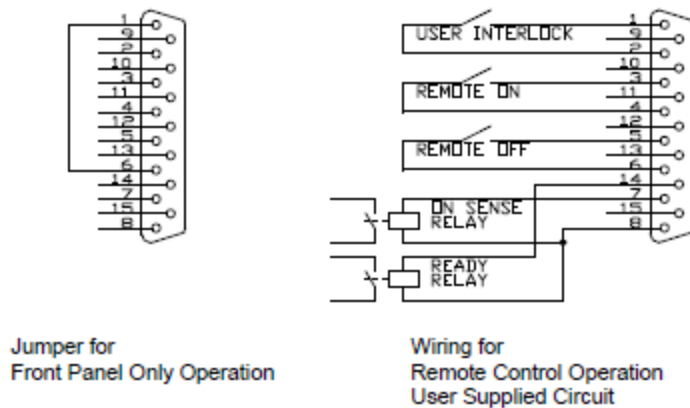


Figure 5-4: Heater Remote Control Connector Wiring

Refer to the System Block Diagram and Vacuum and Vent Diagrams supplied with this manual and to ["Remote Operation" on page 140](#) for operation.

E-Stop Connection

On MX 400 systems the connection to the Safety Node for the E-Stop must be made by the user. The E-Stop circuit provides two normally closed relay inputs. If either of these inputs is open the E-Stop is considered active.

Refer to [Table 5-13](#) for the connector pinout and [Figure 5-5](#) for connection diagrams. Note that pins not identified with a signal name are to be left unconnected.

NOTICE

The E-Stop circuit is the responsibility of the user.

Table 5-13: E-Stop Connector Pinout

Pin	Signal
1	ES_NC_1A
2	ES_NC_2A
3	ES_NC_1B
4	ES_NC_2B
5	



Figure 5-5: E-Stop Connector Wiring

Refer to the System Block Diagram and Schematics supplied with this manual for operation.

6. Operation

This chapter provides complete operation instructions for the Brooks Automation Marathon Express 400. The operation of the MX 400 system is covered for both normal conditions and emergency conditions.

NOTE: This chapter provides operation instructions for the Marathon Express 400 platform only. For operation instructions related to the components of the system, refer to the appropriate user manuals.

Theory of Operation

The Marathon Express 400 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 Marathon Express 400 systems information on how to operate the MX 400 system. It is not intended to be a complete reference for developing the associated software and hardware necessary for MX 400 system operation. The details of operation are configured by the user for their specific application.

Material is introduced into the Marathon Express 400 through the VCE Vacuum Cassette Elevators. 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 Marathon Express 400.

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 Rotate Chuck of the Vacuum Aligner, and the slot valve is closed. The wafer is aligned and the fiducial is positioned. The MagnaTran 7 robot picks the wafer from the aligner using the host controller specified offset to center the wafer on the end effector and places it into a Process Module.

While the wafer is being processed the vacuum 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 place it into the TopCooler.

The host controller then closes the TopCooler Poppet and injects the appropriate process gas (typically argon) into the Cool Chamber. After the cycle time has elapsed the host controller pumps down the Cool Chamber, opens it, and instructs the robot to transfer the wafer 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 125](#) for detailed information.

Station Coordinate System

The robot software uses a station coordinate system for identifying specific locations within the Marathon Express 400 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 MX 400 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 Marathon Express 400 and each material transfer point within the MX 400 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 Marathon Express 400 as shown unless different station assignments are specifically requested. All references to setting stations in this manual will reflect the standard Brooks MX 400 station assignments shown in [Figure 6-1](#).

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 Marathon Express 400 system from the top, see [Figure 6-1](#). Any intermodule stations are numbered on a second clockwise circuit of the Transport Chamber.

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 material 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.

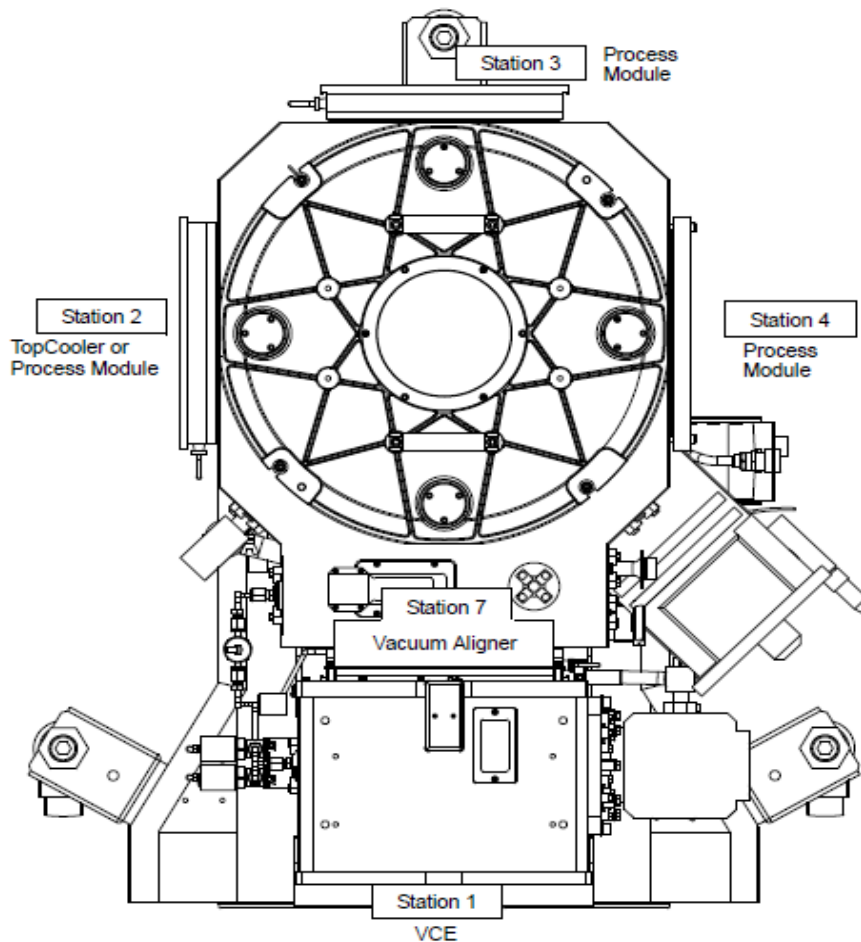


Figure 6-1: MX 400 Station Assignment Examples

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.

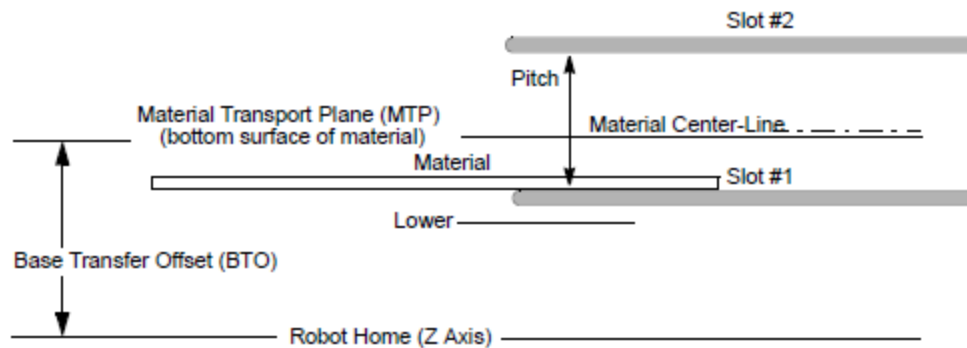


Figure 6-2: Robot Z-axis

Table 6-1: Station Parameters

Station Parameter	Description
R	The full radial extension in increments of 0.001 mm.
S	The rotational position, Theta, in increments of 0.001 ° over a range of 360 °.
W WA/WB FastSwap	The end effector flipping position in increments of 0.001 ° over a range of +10° to -190°
Z	The vertical position in increments of 0.001 mm
S	The horizontal axis of the traverser in microns.
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.

Marathon Express 400 Frames of Reference

Before setting stations or using the Marathon Express 400 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.

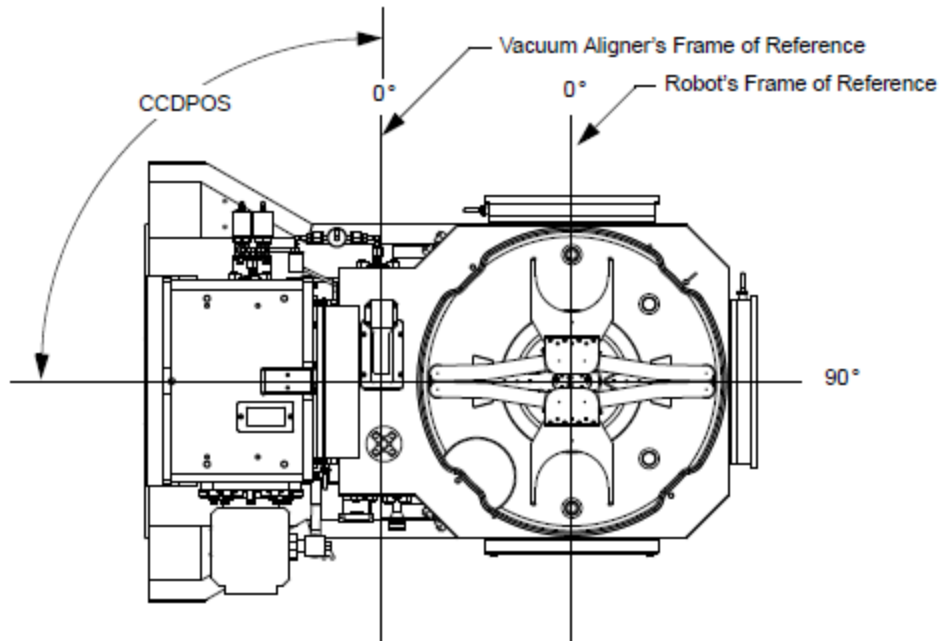


Figure 6-3: Frames of Reference

Robot's Frame of Reference

The typical frame of reference for the Transport Chamber is defined by the robot's coordinate system. The top view shown in [Figure 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.

System Operation Overview

The material transfer operation of the Marathon Express 400 consists of the communication between the VCE load locks, vacuum robot, and the vacuum aligner in the Marathon Express 400 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 Marathon Express 400 system. In the case of any contradiction, this manual will take precedence.

The following sequence demonstrates the normal wafer transfer operation of the Marathon Express 400. The sequence shown is for a Marathon Express 400 system with one VCE Load Lock, and one Process Module. The MX 400 system chamber also provides an integrated vacuum aligner (InLigner) for wafer alignment.

Step	Action
1.	Load the 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 the wafer from carrier and align. - The host controller opens the slot valve to the Load Lock. - The host controller instructs the vacuum robot to remove a wafer from the VCE and place it on the InLigner within the MX 400 system. - The host controller closes the slot valve to the Load Lock.
3.	Align the wafer and place into the Process Module. - The host controller instructs the InLigner to orient the fiducial of the wafer and the vacuum 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 vacuum 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 vacuum 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 the next wafer from the carrier and align. Transfer the wafer to the next processing stage. - The host controller opens the slot valve to the Load Lock. - The host controller instructs the vacuum robot to remove a wafer from the VCE and place it on the InLigner within the MX 400 system. - The host controller closes the slot valve to the Load Lock.

Step	Action
5.	Align the wafer and place it into the Process Module. Transfer the wafer from the Process Module back to the carrier. - The host controller instructs the InLigner to orient the fiducial of the wafer and the vacuum 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 vacuum 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 vacuum robot to pick the wafer from the Process Module. - The host controller instructs the vacuum 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 vacuum 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 Marathon Express 400 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 VCE has 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 Marathon Express 400 Vacuum Back End's chamber, positioned according to the Robot User 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 vacuum 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.

Controls and Indicators

This section provides a description of the Marathon Express 400 controls and indicators. Controls for all MX 400 system options are listed, however if an option is not installed, those controls and indicators are not present. Marathon Express 400 controls include manually operated switches, interlocks, and push buttons. Marathon Express 400 indicators include all lamps, LEDs, and gauges.

The descriptions of the controls and indicators are broken into three sections: the Marathon Vacuum Transport System module, the Vacuum Cassette Elevators, and the Rack Mountable Equipment. All external (user accessible during normal operation) and internal (user accessible during service operation) controls and indicators are covered.

See related component manuals and controls manual for more information.

External Controls and Indicators

The only external controls and indicators used during normal operation of the Marathon Express 400 are on the Rack Mountable Equipment. There are no controls or indicators on the cluster tool platform.

Internal Controls and Indicators

Most of the controls and indicators within the Marathon Express 400 are provided to assist service personnel while performing service operations. This section provides an overview of those controls

and indicators; refer to the specific product UserManuals for detailed information.

The internal controls and indicators on the Vacuum Transport System are detailed in the following figures and tables.

Pressure Switch

The Marathon Express 400 uses a Digital Pressure Switch for controlling the flow and indicating the pressure of facility supplied gases. [Figure 6-4](#) shows the location of the controls and indicators on the Pressure Switch. [Table 6-2](#) shows the function associated with each of them.

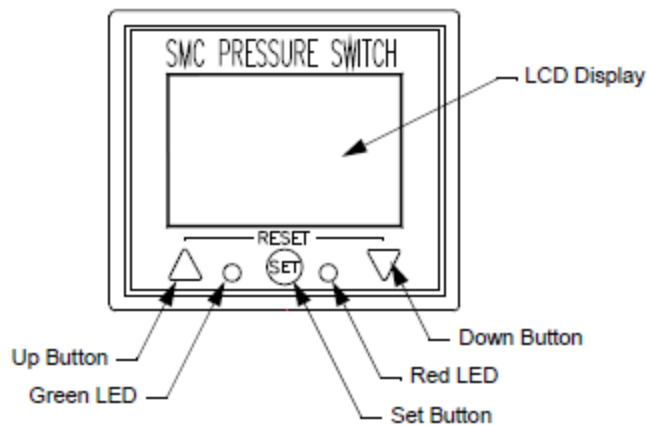


Figure 6-4: Pressure Switch - Controls and Indicators

Table 6-2: Pressure Switch - Controls and Indicators

Name	Type	Function
LCD Display	LCD Display	Monitors nitrogen pressure to the vent valves. For setting the switch, see "Pressure Switch" on page 157 .
Green LED	Green Lamp	Switch status Normal condition: ON
Red LED	Red Lamp	Fault indicator: Normal condition: OFF Fault condition: Blinking - error code displayed on LCD Display
Up Button	Momentary Push-button Switch	Increases display units
Set Button	Momentary Push-button Switch	Enters user set configuration information
Down Button	Momentary Push-button Switch	Decreases display units

Temperature Controller

The Marathon Express uses a Temperature Controller for controlling the power to the chamber heaters during bakeout. Figure 6-5 shows the location of the controls and indicators on the Temperature Controller. Table 6-3 shows the function associated with each of them.

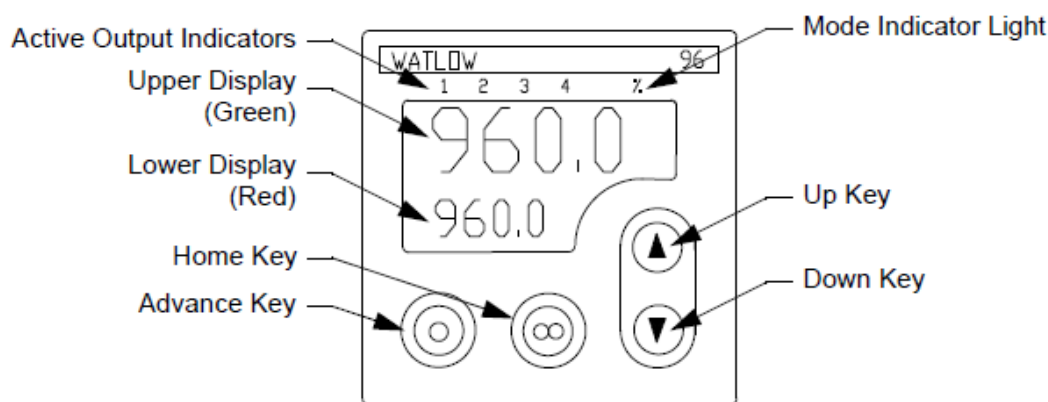


Figure 6-5: Temperature Controller

Table 6-3: Temperature Controller - Controls and Indicators

Name	Type	Function
Active Output Indicators	Lamp	Lit when corresponding output is active
Upper Display	LED Display	Displays actual process values or value for parameter in Lower Display
Lower Display	LED Display	Displays set point value or configuration parameters
Advance Key	Momentary Push-button Switch	Advances lower display through configuration parameters
Home Key	Momentary Push-button Switch	Resets display to actual process values, resets alarms and errors
Up Key	Momentary Push-button Switch	Increases the value in the Upper Display, increases the set point value in the Lower Display
Down Key	Momentary Push-button Switch	Decreases the value in the Upper Display, decreases the set point value in the Lower Display
Mode Indicators	Lamp	ON = Manual Mode OFF = Auto Mode

AC Power Distribution

AC power within the Marathon Express is distributed throughout the tool from the AC Power Distribution Unit (ACPDU), which also provides circuit protection. [Figure 6-6](#) shows the location of the controls and indicators on the ACPDU. [Table 6-4](#) shows the functions associated with each of them.

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

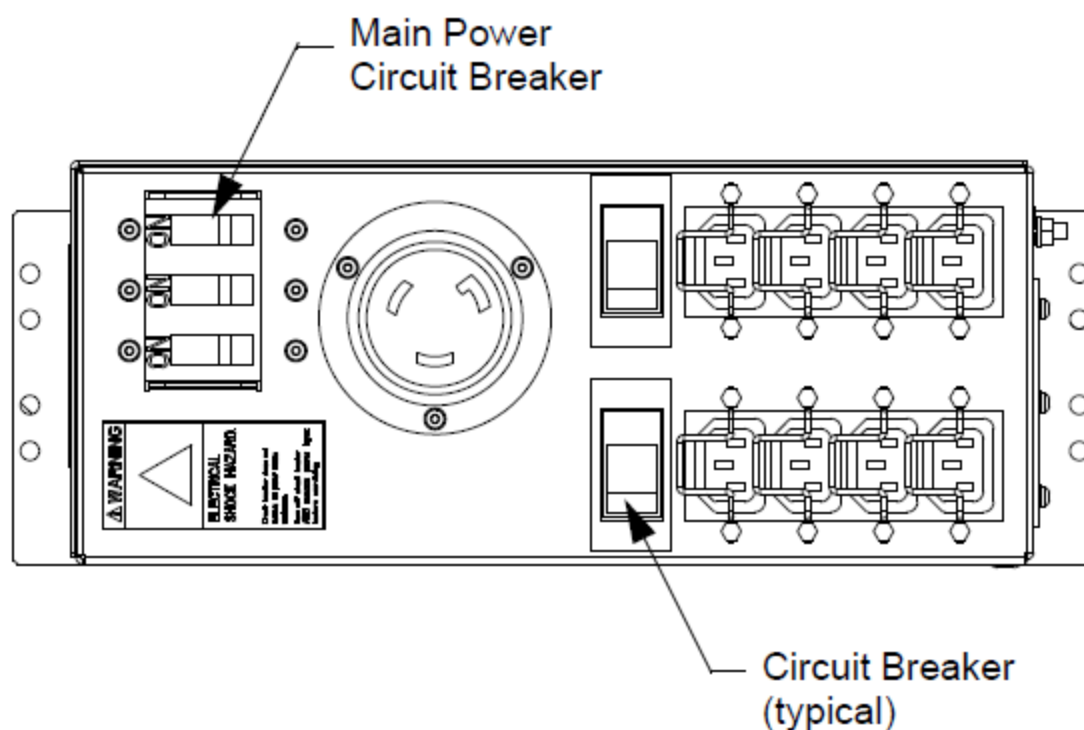


Figure 6-6: AC Power Distribution Unit - Controls and Indicators

Table 6-4: AC Power Distribution Unit - Controls and Indicators

Name	Type	Function
CB1	Circuit Breaker, 20 A	Main Circuit Breaker ON: Power on OFF: Power off
CB1	Circuit Breaker, 10 A	Output Circuit Breaker 1 ON: Power on OFF: Power off

Name	Type	Function
CB2	Circuit Breaker, 10 A	Output Circuit Breaker 2 ON: Power on OFF: Power off

Heater Power Supply

The Marathon Express 400 uses a Heater Power Supply to power the chamber heaters. [Figure 6-7](#) shows the location of the controls and indicators on the Heater Power Supply. [Table 6-5](#) shows the function associated with each of them.

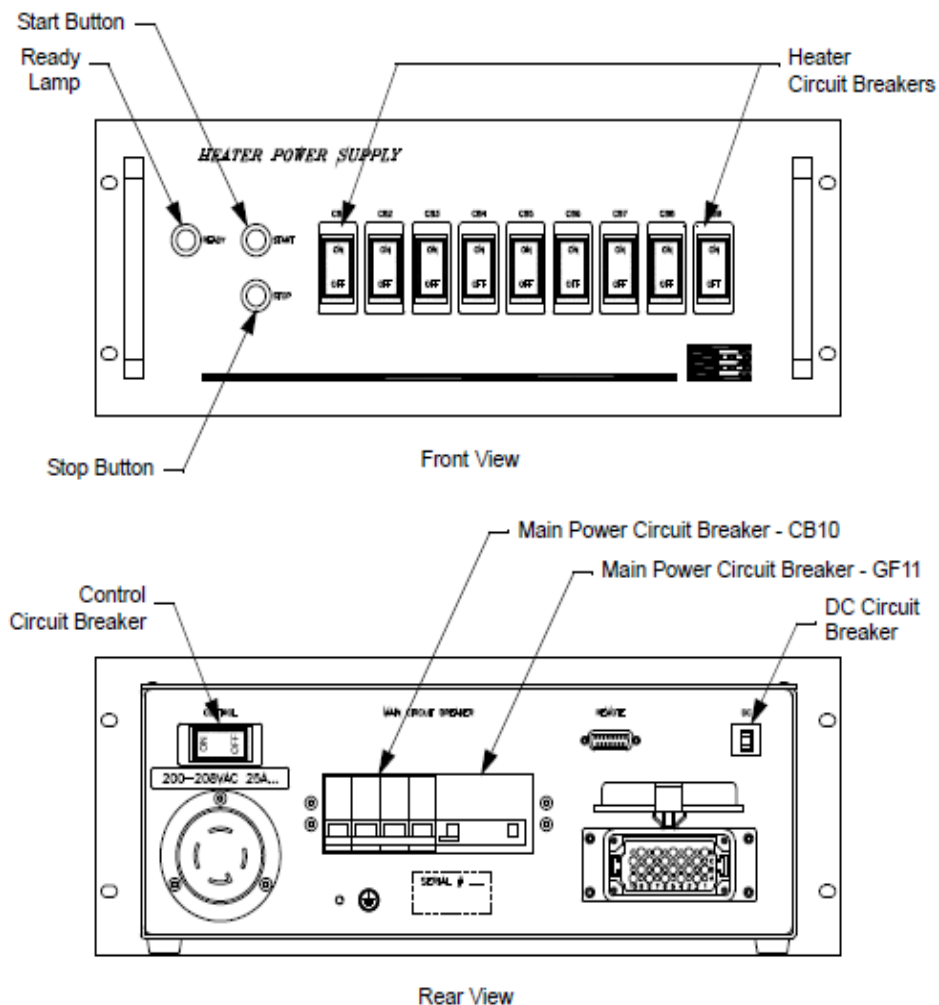


Figure 6-7: Heater Power Supply - Controls and Indicators

Table 6-5: Heater Power Supply - Controls and Indicators

Name	Description	Function
Front		
READY	Green lamp	Indicates heater is ready to accept commands
START	Momentary Push-button Switch with Green Lamp	Closes main contactor Initiates heat cycle
STOP	Momentary Push-button Switch	Opens main contactor Heating operation stops
CB1-9	Circuit Breaker 2-Pole, thermal, 10 A with Green Lamp	Controls the voltage to the Heater Cartridge assemblies in the chamber (CB1 protects Heater Cartridge 1, CB2 protects Heater Cartridge 2, etc.) ON: Power on OFF: Power off
Rear		
Control	Circuit Breaker 2-Pole, thermal, 10 A with Green Lamp	Protects internal DC Power Supply ON: Power on OFF: Power off
Main Circuit Breaker	Circuit Breaker (GFI1) 4-Pole, GFI, 30 mA with Test Button	Provides Ground Fault protection ON: Power on OFF: Power off
	Circuit Breaker (CB10) 4-Pole, 25 A, C-Curve	Protects AC circuit at Main Contactor ON: Power on OFF: Power off
DC	Circuit Breaker thermal, 3 A	Protects the 24VDC circuit ON: Power on OFF: Power off

Ethernet to Serial Gateway Module

The Ethernet to Serial Gateway provides an RS-232 communications interface through the Ethernet. [Figure 6-8](#) shows the location of the indicators on the Ethernet to Serial Gateway Module. [Table 6-6](#) shows the function associated with each of them.

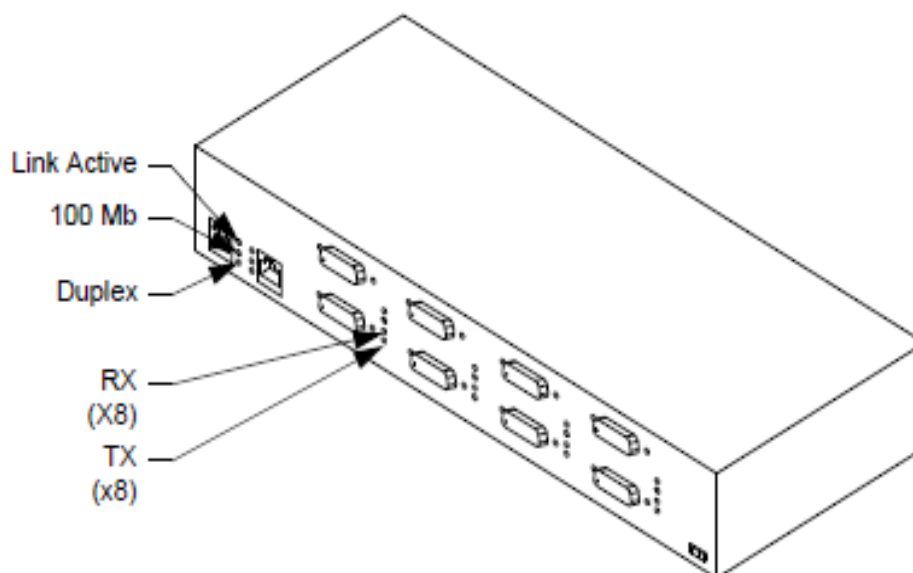


Figure 6-8: Ethernet to Serial Gateway Module - Controls and Indicators

Table 6-6: Ethernet to Serial Gateway Module - Controls and Indicators

Name	Type	Function
LNK ACT	Red Lamp	Indicates working EtherNet connection
100 MB	Red Lamp	Connection speed ON: 100 Mbps OFF: 10 Mbps
DUP	Red Lamp	Indicates full duplex mode
RX	Green Lamp	Serial communications receive Normal condition: Flickering
TX	Green Lamp	Serial communications transmit Normal condition: Flickering

Safety Interlocks

The Marathon Express 400 is provided with safety interlocks to ensure the safety of the operators and service personnel. Refer to the Controls Manual for more information on interlocking.

Ethernet Communication

Ethernet communication allows the Marathon Express 400 to send and receive data faster than with a serial communication connection. Additionally, when using Ethernet multiple devices can communicate over the same cable through the use of a network hub.

Ethernet Serial Gateway

Support for devices using serial communication is provided in the Marathon Express 400 with Gen 5 controls by using an Ethernet to Serial Gateway. The User's host controller must establish a connection with the Serial Gateway to exchange data between the host and the serial devices. Each device connected to the serial gateway is identified by the gateway's IP address and each I/O channel, for the serial I/O devices, is identified by user assigned Link and Port Numbers.

The Ethernet Serial Gateway provides web-based configuration of all operating parameters. The Ethernet address and serial I/O ports are user configurable. I/O types (RS-232, RS-422, RS-485) and serial communications settings for each channel are also user configurable.

Serial Gateway Configuration

The Ethernet Serial Gateway is configured by accessing the gateway's web-based configuration page.

Step	Action
1.	Connect a PC with a web browser to the network the gateway is connected to.
2.	Change the IP address on the host computer to 192.168.250.249 and the Mask to 255.255.0.0.
3.	Open an internet browser and enter the IP address of the gateway into the browser (Factory default = 192.168.250.250, Brooks default = 20.20.249.14, or refer to the AT for the address).
4.	Once the gateway is communicating, click on the link for Configure Network.
5.	Set any configuration parameters required, typical settings, as shown in Table 6-7 .
6.	After making any changes, click the SAVE button.
7.	If the gateway's IP address was changed, reboot (cycle power) the gateway. NOTE: If the IP Address was changed, change the address in the browser to the new address to reconnect to the gateway.
8.	Set up the communication mode for each port as shown in Table 6-8 . Click the Save button after changing each port. NOTE: Each serial I/O channel must have a unique Port Number.

Table 6-7: Ethernet Serial Gateway Ethernet Parameters

Parameter	Setting
IP Address	20.20.249.14
Netmask	255.0.0.0
Gateway Configuration	0.0.0.0
TCP Keepalive Timeout	5

Table 6-8: Ethernet Serial Gateway Parameters

	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
	VCE A					Robot1		
Mode	RS232	-	-	-	-	RS232	-	-
Baud	9600	-	-	-	-	9600	-	-
Parity	Even	-	-	-	-	None	-	-
Data Bits	7	-	-	-	-	8	-	-
Stop Bits	1	-	-	-	-	1	-	-
Flow	None	-	-	-	-	None	-	-
DTR	Off	-	-	-	-	Off	-	-
EOL	Disable	-	-	-	-	Disable	-	-
Input Timeout	5	-	-	-	-	5	-	-
Enable	Yes	-	-	-	-	Yes	-	-
Listen	1102	-	-	-	-	1107	-	-
Connect to Addr/Port	0.0.0.0/0	-	-	-	-	0.0.0.0/0	-	-
Connect on	Always	-	-	-	-	Always	-	-
Disconnet on	None	-	-	-	-	None	-	-
Idle Timer	300	-	-	-	-	300	-	-

¹Robot can be controlled directly through an Ethernet connection or through the Ethernet Serial Gateway.

Serial Gateway Operation

The devices connected to the Ethernet Serial Gateway are accessed through standard Ethernet communications to the specified IP Address and Port for each device connected to the gateway.

Robot Ethernet Operation

In all controls configurations the robot provides an option for Ethernet communication. If this option is installed the robot may be controlled using either Serial or Ethernet communications.

Vacuum Robot Configuration

The CDM must be used to enable the primary Ethernet link to the vacuum robot. Enter the following on the CDM to cause the controller to reset and activate the Ethernet interface:

```
SETUP -> CONFIG ROBOT -> COMM SETTINGS -> CHANGE CONTROL -> RESET TO  
ETHERNET
```

This will cause the robot to reset and activate the Ethernet interface.

The primary connection port is 1102 and the host will open a connection on that port. The factory settings for the robot's IP address is given in [Table 6-9](#). Note that if more than one MX 400 system will be connected to the same network the IP Address of each additional system will have to be changed to avoid IP conflicts.

Table 6-9: Vacuum Robot Ethernet Parameters

Parameter	Setting
IP Address	20.20.249.10
Netmask	255.0.0.0

The IP address for the robot can be changed with the following command:

```
CONFIG ENET IP ipAddress MASK mask
```

This command will take place immediately. If the command was issued through the Ethernet, the host will have to re-establish contact. It is recommended that the robot be reset after issuing this command. The current Ethernet settings can be requested using the following command:

```
RQ ENET IP
```

DeviceNet Communication

Within a Marathon Express 400 using Gen 4 Controls a DeviceNet Master Node is required. This is typically the user-supplied host controller.

All nodes on the DeviceNet network are assigned a Media Access Control ID (MAC ID). Typically, the DeviceNet Master Node resides at MAC ID 1.

The EVENT System

Refer to the Vacuum Robot Manual for more information.

Control/Display Module (CDM) Operation

Refer to the appropriate robot user manual for more information.

Heating System

The Marathon Express 400 offers an Electric Heating System option for systems that require chamber heating. The Electric Heating System is built into the MX 400 system chamber with the Heater Power Supply and Controller dedicated to that system.

The heating system is used in the rapid heating of the chamber after service. The Marathon Express 400 heater system option offers two modes of heating operation: Bakeout and Continuous. Refer to ["Bakeout Heating" on page 151](#) and ["Continuous Heating" on page 151](#) in this section for detailed information.

The heater system may be controlled by the host controller through the Facet Node Breakout box at Process Module 2 using general purpose RS-232/RS-422 input MISC INPUTS J6.

 WARNING Extreme Temperature	
Surfaces heated during system bake-out can reach temperatures of 121 °C (250 °F), which could cause burns when in contact with skin. Once system heating has been started, all personnel must keep away from the system to avoid possible burn injury due to high temperatures. Allow time for the Marathon Express 400 to cool before servicing or operating. Do NOT operate the robot, vacuum aligner, or any other components in the Marathon Express System during bakeout.	 

NOTICE
Minimum ramp time for heating or cooling is 3 hours. Heating or cooling the Transport Module faster may cause the chamber to distort.

Power Supply

The Heater Power Supply is rack mountable and requires user-supplied power. The Heater Power Supply is available in two AC input versions: 200-208V or 220-240V. Refer to ["Facilities Specifications" on page 22](#) for detailed power requirements.

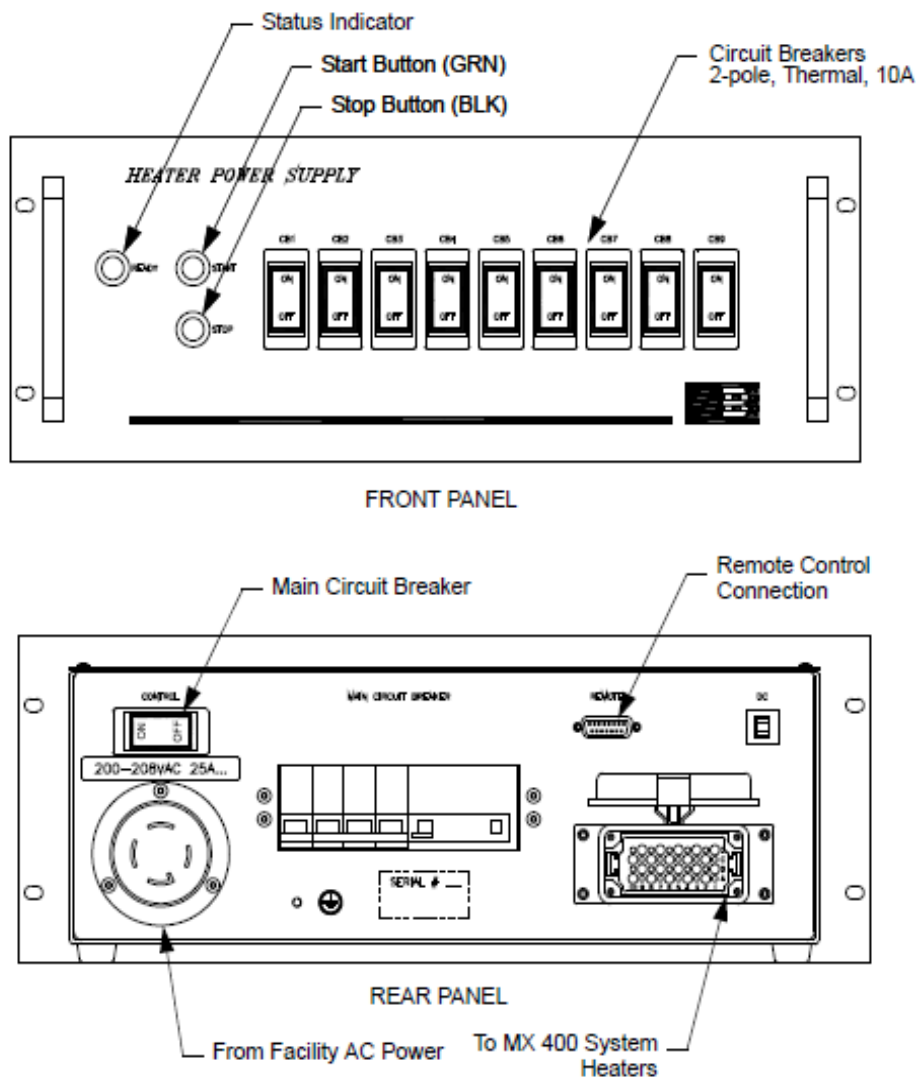


Figure 6-9: Heater Power Supply Controls

Operation

The Heater system may be manually controlled from the front panel of the Heater Power Supply with the temperature monitored visually on the Temperature Controller. The Temperature Controller can also communicate with the host controller to provide monitoring of temperature control parameters, set points, etc. In this way, the host controller can turn off the heaters by changing the temperature set point below the current value thereby causing the over temp alarm to shut the power off.

The Main Heater Cable connects the Heater Power Supply to the Main Heater Harness located on the chamber. The Heater Harness branches power to the Heater Cartridge assemblies, the Temperature Controller, the Thermal Switch, and the Thermocouple.

The Heater Control Power Supply is capable of two modes of operation: Standard, where it will operate from the Front Panel only, and Remote, where basic controls and indicators for the power supply are available both from a remote location and from the Front Panel.

Standard Operation

Ensure that the supplied jumper plug is installed in the REMOTE connector on the rear of the power supply.

Remote Operation

A Remote Control Interface and Cable must be created and connected to the REMOTE connector on the rear of the power supply with the appropriate remote switches and indicators by following the wiring diagram provided in [Figure 5-4 on page 118](#).

Mount the remote control interface where required. The power supply can now be turned on or off and monitored from either the remote location or from the front panel of the power supply.

Table 6-10: Heater Power Supply Remote Operation Conditions

Function	Condition
Manual Stop	Always works
Manual Start	Works only when the Remote Off circuit (pins 1 & 6) is closed.

For more information on operating the heater system, refer to ["Temperature Controller" on page 140](#) and the Heater Controller Wiring Diagram, System Block Diagram, and Vacuum and Vent Diagrams supplied with this manual.

Temperature Controller

The Temperature Controller monitors the set-points programmed into it, monitors the temperature of the Transport Chamber during the heating operation, and commands the Heater Power Supply to control power to Cartridge Heaters during the heating operation.

The Temperature Controller (Watlow Series SD6, shown in [Figure 6-10](#)) is located in the Lower Facilities of the Transport Chamber frame. The Temperature Controller is a dual display controller. There is one universal sensor input, a second auxiliary input, and two outputs. The controller provides 10 Hz sampling, variable time base burst firing outputs, NEMA 4X front panel and 0.1% calibration accuracy. Refer to the *Watlow Temperature Controllers User Manual* supplied with this manual.

The Gen 5 Temperature Controller (Watlow Series SD6, shown in Figure 6-22) is located in the Lower Facilities of the Transport Chamber frame. The Temperature Controller is a dual display controller. There is one universal sensor input, a second auxiliary input, and two outputs. The controller provides 6.5 Hz sampling, variable time base burst firing outputs, NEMA 4X front panel and 0.1% calibration accuracy. Refer to the Watlow Temperature Controllers User Manual supplied with this manual. Refer to ["Watlow SD6 Setup" on page 147](#) to configure the controller for use with the MX 400 system.

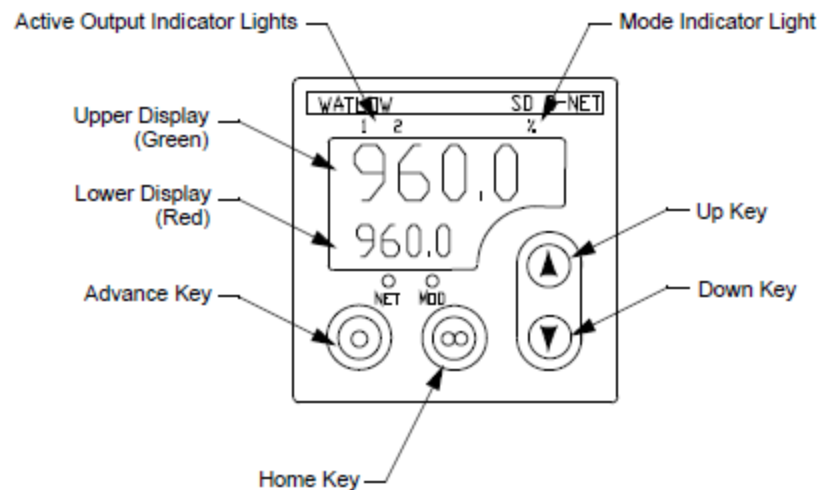


Figure 6-10: Watlow Temperature Controller

Watlow Temperature Controller Overview

The controls and displays on the front panel of the Watlow Temperature Controllers are used to program the correct communication settings and configuration parameters required for proper operation. Refer to or [Figure 6-10](#) to identify the controls and indicators.

Home Page

The HOME PAGE is the Watlow Controller default page, displaying both the actual temperature reading (Upper Display) and the programmed temperature set-point (Lower Display).

Operation Page

The OPERATION PAGE contains five menus that allow the user to program various Alarm set-points, PID parameters and Output set-points.

Setup Page

The SETUP PAGE contains six menus that allow the user to program various Alarm set-points, PID parameters and Output set-points.

Watlow 96 Setup

Set the basic operating parameters for the controller.

Step	Action
1.	Simultaneously depress the two Arrow keys for three seconds or until the OPER heading appears in the Watlow Lower display. Release the arrow keys.
2.	Using the Arrow keys, scroll to the Mon menu (Mon will appear in the Lower Display).
3.	Using the Advance key, scroll to the Pcnt screen (Pcnt will appear in the Lower Display).
4.	Using the Arrow keys, adjust the Pcnt value in the Upper Display to 100.0.
5.	Using the Advance key, scroll back to the Mon menu.
6.	Using the Arrow keys, scroll to the ALM menu (ALM will appear in the Lower Display).
7.	Using the Advance key, scroll to the A3hi screen (A3hi will appear in the Lower Display).
8.	Using the Arrow keys, adjust the A3hi value in the Upper Display to 130.
9.	Using the Advance key, scroll to the A3lo screen (A3lo will appear in the Lower Display).
10.	Using the Arrow keys, adjust the A3lo value in the Upper Display to 0.
11.	Using the Advance key, scroll back to the ALM menu.
12.	Using the Arrow keys, scroll to the PID 2 menu (PID 2 will appear in the Lower Display).
13.	Using the Advance key, scroll to the hys 2 screen (hys 2 will appear in the Lower Display).
14.	Using the Arrow keys, adjust the hys 2 value in the Upper Display to 2.0.
15.	Using the Advance key, scroll back to the PID 2 menu.
16.	Using the Arrow keys, scroll to the PID 1 menu (PID 1 will appear in the Lower Display).
17.	Using the Advance key, scroll to the pb 1 screen (pb 1 will appear in the Lower Display).
18.	Using the Arrow keys, adjust the pb 1 value in the Upper Display to 0.0.
19.	Using the Advance key, scroll to the hys 1 screen (hys 1 will appear in the Lower Display).

Step	Action
20.	Using the Arrow keys, adjust the hys 1 value in the Upper Display to 2.0.
21.	Using the Advance key, scroll back to the PID 1 menu.
22.	Using the Arrow keys, scroll to the User menu (User will appear in the Lower Display).
23.	Using the Advance key, scroll to the A-M screen (A-M will appear in the Lower Display).
24.	Using the Arrow keys, adjust the A-M value in the Upper Display to Auto.
25.	Using the Advance key, scroll to the Aut screen (Aut will appear in the Lower Display).
26.	Using the Arrow keys, adjust the Aut value in the Upper Display to off.
27.	Using the Advance key, scroll to the ATSP screen (ATSP will appear in the Lower Display).
28.	Using the Arrow keys, adjust the ATSP value in the Upper Display to 90.
29.	Using the Advance key, scroll to the SP 2 screen (SP 2 will appear in the Lower Display).
30.	Using the Arrow keys, adjust the SP 2 value in the Upper Display to 24.
31.	Using the Advance key, scroll back to the PID 1 menu.
Set the alarm set points, PID parameters, and output set points.	
32.	Simultaneously depress the two Arrow keys for six seconds or until the SET heading appears in the Watlow Lower display. Release the arrow keys.
33.	Using the Arrow keys, scroll to the InP1 menu (InP1 will appear in the Lower Display).
34.	Using the Advance key, scroll to the Sen 1 screen (Sen 1 will appear in the Lower Display).
35.	Using the Arrow keys, adjust Sen 1 value in Upper Display to tc.
36.	Using the Advance key, scroll to the In 1 screen (In 1 will appear in the Lower Display).
37.	Using the Arrow keys, adjust the In 1 value in the Upper Display to J.
38.	Using the Advance key, scroll to the rL 1 screen (rL 1 will appear in the Lower Display).
39.	Using the Arrow keys, adjust the rL 1 value in the Upper Display to 0.0.
40.	Using the Advance key, scroll to the rh 1 screen (rh 1 will appear in the Lower Display).
41.	Using the Arrow keys, adjust the rh 1 value in the Upper Display to 120.0.
42.	Using the Advance key, scroll to the dEC 1 screen (dEC 1 will appear in the Lower Display).

Step	Action
43.	Using the Arrow keys, adjust the dEC 1 value in the Upper Display to 0.0.
44.	Using the Advance key, scroll to the ft1 screen (ft1 will appear in the Lower Display).
45.	Using the Arrow keys, adjust the ft1 value in the Upper Display to 1.0.
46.	Using the Advance key, scroll to the InP1 menu (Inp1 will appear in Lower Display).
47.	Using the Arrow keys, scroll to the 9LbL menu (9LbL will appear in the Lower Display).
48.	Using the Advance key, scroll to the Unit screen (Unit will appear in the Lower Display).
49.	Using the Arrow keys, adjust Unit value in Upper Display to US.
50.	Using the Advance key, scroll to the C - F screen (C - F will appear in the Lower Display).
51.	Using the Arrow keys, adjust the C - F value in the Upper Display to C.
52.	Using the Advance key, scroll to the err screen (err will appear in the Lower Display).
53.	Using the Arrow keys, adjust the err value in the Upper Display to nLAt.
54.	Using the Advance key, scroll to the FAIL screen (FAIL will appear in the Lower Display).
55.	Using the Arrow keys, adjust the FAIL value in the Upper Display to MAn.
56.	Using the Advance key, scroll to the MAn screen (MAn will appear in the Lower Display).
57.	Using the Arrow keys, adjust the MAn value in the Upper Display to 0.0.
58.	Using the Advance key, scroll to the PLSP screen (PLSP will appear in the Lower Display).
59.	Using the Arrow keys, adjust the PLSP value in the Upper Display to 120.0.
60.	Using the Advance key, scroll to the PL A screen (PL A will appear in the Lower Display).
61.	Using the Arrow keys, adjust PL A value in Upper Display to 100.
62.	Using the Advance key, scroll to the PL b screen (PL b will appear in the Lower Display).
63.	Using the Arrow keys, adjust the PL b value in the Upper Display to 100.
64.	Using the Advance key, scroll to the rp screen (rp will appear in the Lower Display).
65.	Using the Arrow keys, adjust the rp value in the Upper Display to OFF.
66.	Using the Advance key, scroll to the OPLP screen (OPLP will appear in the Lower Display).

Step	Action
67.	Using the Arrow keys, adjust the OPLP value in the Upper Display to OFF.
68.	Using the Advance key, scroll to the 9LbL menu (9LbL will appear in Lower Display).
69.	Using the Arrow keys, scroll to the Out 4 menu (Out 4 will appear in the Lower Display).
70.	Using the Advance key, scroll to the Baud screen (Baud will appear in the Lower Display).
71.	Using the Arrow keys, adjust Baud value in Upper Display to 19.2.
72.	Using the Advance key, scroll to the Addr screen (Addr will appear in the Lower Display).
73.	Using the Arrow key, adjust the Addr value in the Upper Display to 1.
74.	Using the Advance key, scroll to the Out 4 menu (Out 4 will appear in Lower Display).
75.	Using the Arrow keys, scroll to the Out 3 menu (Out 3 will appear in the Lower Display).
76.	Using the Advance key, scroll to the Ot screen (Ot will appear in the Lower Display).
77.	Using the Arrow keys, adjust Ot value in Upper Display to AL.
78.	Using the Advance key, scroll to the AtY3 screen (AtY3 will appear in the Lower Display).
79.	Using the Arrow key, adjust the AtY3 value in the Upper Display to Proc.
80.	Using the Advance key, scroll to the AhY3 screen (AhY3 will appear in the Lower Display).
81.	Using the Arrow key, adjust the AhY3 value in the Upper Display to 2.0.
82.	Using the Advance key, scroll to the Lat3 screen (Lat3 will appear in the Lower Display).
83.	Using the Arrow key, adjust the Lat3 value in the Upper Display to no.
84.	Using the Advance key, scroll to the Sil3 screen (Sil3 will appear in the Lower Display).
85.	Using the Arrow key, adjust the Sil3 value in the Upper Display to no.
86.	Using the Advance key, scroll to the Sid3 screen (Sid3 will appear in the Lower Display).
87.	Using the Arrow key, adjust the Sid3 value in the Upper Display to both.
88.	Using the Advance key, scroll to the L9c3 screen (L9c3 will appear in the Lower Display).
89.	Using the Arrow keys, adjust L9c3 value in Upper Display to AL 0.
90.	Using the Advance key, scroll to the Anu 3 screen (Anu 3 will appear in the Lower Display).

Step	Action
91.	Using the Arrow key, adjust the Anu 3 value in the Upper Display to YES.
92.	Using the Advance key, scroll to the Out 3 menu (Out 3 will appear in Lower Display).
93.	Using the Arrow keys, scroll to the Out 2 menu (Out 2 will appear in the Lower Display).
94.	Using the Advance key, scroll to the Ot 2 screen (Ot 2 will appear in the Lower Display).
95.	Using the Arrow keys, adjust Ot 2 value in Upper Display to Heat.
96.	Using the Advance key, scroll to the Out 2 menu (Out 2 will appear in Lower Display).
97.	Using the Arrow keys, scroll to the Out 1 menu (Out 1 will appear in the Lower Display).
98.	Using the Advance key, scroll to the Ot 1 screen (Ot 1 will appear in the Lower Display).
99.	Using the Arrow keys, adjust Ot 1 value in Upper Display to Heat.
100.	Using the Advance key, scroll to the Out 1 menu (Out 1 will appear in Lower Display).
101.	Press the Infinity key once to exit Setup and return to the Home page.

Watlow SD6 Setup

Set the basic operating parameters for the controller.

Step	Action
1.	Simultaneously depress the two Arrow keys for three seconds or until the SEt heading appears in the Watlow Lower Display and PAgE appears in the Watlow Lower Display. Release the keys.
2.	Using the Advance key, scroll until the Lower Display shows Sensor Type (SEn will be in the Lower Display).
3.	Verify that the Sensor Type is tc. If it is not, use the Arrow keys to scroll through the Thermocouple choices to find TC (tc will appear in the Upper Display).
4.	Using the Advance key, scroll to the Linearity screen (Lin will appear in the Lower Display).
5.	Using the Arrow keys, adjust the thermocouple type to J (J will appear in the Upper Display)
6.	Using the Advance key, scroll to the Temperature Units screen (C-F will appear in the Lower Display).
7.	Using the Arrow keys, adjust the C - F value in the Upper Display to C.
8.	Using the Advance key, scroll to the Temperature Decimal Places screen (S.dEC will appear in the Lower Display).
9.	Using the Arrow keys adjust the S.dEC value in the Upper Display to 0.
10.	Using the Advance key, scroll to the InfoSense screen (IS.En will appear in the Lower Display).
11.	Using the Arrow keys, adjust the IS.En value in the Upper Display to no.
12.	Using the Advance key, scroll to the Set Point Low Limit screen (SP.Lo will appear in the Lower Display).
13.	Using the Arrow keys, adjust the SP.Lo value in the Upper Display to 0.
14.	Using the Advance key, scroll to the Set Point Hi Limit screen (SP.hi will appear in the Lower Display).
15.	Using the Arrow keys, adjust the SP.hi value in the Upper Display to 130.
16.	Using the Advance key, scroll to the Input Filter screen (Ftr.E will appear in the Lower Display).
17.	Using the Arrow keys, adjust the Ftr.E value in the Upper Display to OFF.
18.	Using the Advance key, scroll to the Output 1 Function screen (Ot 1 will appear in the Lower Display).
19.	Using the Arrow keys, adjust the Ot 1 value in the Upper Display to hEAt.

Step	Action
20.	Using the Advance key, scroll to the Fixed Time Base screen (Ftb1 will appear in the Lower Display).
21.	Using the Arrow keys, adjust the Ftb1 value in the Upper Display to 5.0.
22.	Using the Advance key, scroll to the Power Limit 1 screen (PL 1 will appear in the Lower Display).
23.	Using the Arrow keys, adjust the PL 1 value in the Upper Display to 100.
24.	Using the Advance key, scroll to the Output Power Scale Low 1 screen (PSL1 will appear in the Lower Display).
25.	Using the Arrow keys, adjust the PSL1 value in the Upper Display to 0.0. Using the Arrow keys, adjust the PSL1 value in the Upper Display to 0.0.
26.	Using the Advance key, scroll to the Output Power Scale Hi 1 screen (PSh1 will appear in the Lower Display).
27.	Using the Arrow keys, adjust the PSh1 value in the Upper Display to 100.
28.	Using the Advance key, scroll to the Output Power Non-linear Function 1 screen (nLF1 will appear in the Lower Display).
29.	Using the Arrow keys, adjust the nLF1 value in the Upper Display to OFF.
30.	Using the Advance key, scroll to the Output 2 Function screen (Ot 2 will appear in the Lower Display).
31.	Using the Arrow keys, adjust the Ot 2 value in the Upper Display to Pr.AL
32.	Using the Advance key, scroll to the Alarm 2 Hysteresis screen (hyS2 will appear in the Lower Display).
33.	Using the Arrow keys, adjust the hyS2 value in the Upper Display to 5.
34.	Using the Advance key, scroll to the Alarm 2 Logic screen (L9c2 will appear in the Lower Display).
35.	Using the Arrow keys, adjust L9c2 value in Upper Display to AL 0.
36.	Using the Advance key, scroll to the Alarm 2 Latching screen (Lat2 will appear in the Lower Display).
37.	Using the Arrow keys, adjust Lat2 value in Upper Display to nLAt.
38.	Using the Advance key, scroll to the Alarm 2 Silencing screen (SIL2 will appear in the Lower Display).
39.	Using the Arrow keys, adjust Sil2 value in Upper Display to OFF.
40.	Using the Advance key, scroll to the Alarm 2 Message screen (Dsp2 will appear in the Lower Display).

Step	Action
41.	Using the Arrow keys, adjust Dsp2 value in Upper Display to On.
42.	Using the Advance key, scroll to the Units of Measurement screen (Unit will appear in the Lower Display).
43.	Using the Arrow keys, adjust Unit value in Upper Display to US.
44.	Using the Advance key, scroll to the Input Error Latching screen (I.Err will appear in the Lower Display).
45.	Using the Arrow keys, adjust I.Err value in Upper Display to nLAT.
46.	Using the Advance key, scroll to the Input Error Failure Mode screen (FAIL will appear in the Lower Display).
47.	Using the Arrow keys, adjust the FAIL value in the Upper Display to Man.
48.	Using the Advance key, scroll to the Input Error Power screen (Man will appear in the Lower Display).
49.	Using the Arrow keys, adjust Man value in Upper Display to 0.0.
50.	Using the Advance key, scroll to the Active Displays screen (dSP will appear in the Lower Display).
51.	Using the Arrow keys, adjust dSP value in Upper Display to nor. Using the Arrow keys, adjust dSP value in Upper Display to nor.
52.	Using the Advance key, scroll to the Ramping Mode screen (rP will appear in the Lower Display).
53.	Using the Arrow keys, adjust the rP value in the Upper Display to OFF.
54.	Using the Advance key, scroll to the DeviceNet Address screen (Addr will appear in the Lower Display).
55.	Using the Arrow keys, adjust Addr value in Upper Display to match the system (typically 50).
56.	Using the Advance key, scroll to the Baud Rate screen (bAud will appear in the Lower Display).
57.	Using the Arrow keys, adjust Baud value in Upper Display to match the system (typically 500).
58.	Using the Advance key, scroll to the Lock Out screen (LOC will appear in the Lower Display).
59.	Using the Arrow keys, adjust the LOC value in the Upper Display to 0.
60.	Press the Infinity key once to exit Setup and return to the Home page.
Set the alarm set points, PID parameters, and output set points.	
61.	Press the Advance Key from the HOME page to enter the OPERATIONS page (Po.ht will appear in the Lower Display)

Step	Action
62.	Using the Advance key, scroll to the Auto-Manual screen (A-M will appear in the Upper Display).
63.	Using the Arrow keys, adjust the A-M value in the Lower Display to Auto.
64.	Using the Advance key, scroll to the Autotune screen (Aut will appear in the Upper Display).
65.	Using the Arrow keys, adjust the Aut value in the Lower Display to OFF.
66.	Using the Advance key, scroll to the Calibration Offset screen (CAL will appear in the Upper Display).
67.	Using the Arrow keys, adjust the CAL value in the Lower Display to 0.
68.	Using the Advance key, scroll to the Heat Control Method screen (ht.M will appear in the Upper Display).
69.	Using the Arrow keys, adjust the ht.M value in the Lower Display to on.oF.
70.	Using the Advance key, scroll to the Heat Hysteresis screen (h.hys will appear in the Upper Display).
71.	Using the Arrow keys, adjust the h.hys value in the Lower Display to 2.
72.	Using the Advance key, scroll to the Alarm 2 High screen (A2.hi will appear in the Upper Display).
73.	Using the Arrow keys, adjust the A2.hi value in the Lower Display to 130.
74.	Using the Advance key, scroll to the Alarm 2 Low screen (A2.lo will appear in the Upper Display).
75.	Using the Arrow keys, adjust the A2.lo value in the Lower Display to 0.
76.	Press the Infinity key once to exit Operations and return to the Home page.
77.	Using the Arrow keys, scroll to the Out 2 menu (Out 2 will appear in the Lower Display).
78.	Using the Advance key, scroll to the Ot 2 screen (Ot 2 will appear in the Lower Display).
79.	Using the Arrow keys, adjust Ot 2 value in Upper Display to Heat.
80.	Using the Advance key, scroll to the Out 2 menu (Out 2 will appear in Lower Display).
81.	Using the Arrow keys, scroll to the Out 1 menu (Out 1 will appear in the Lower Display).
82.	Using the Advance key, scroll to the Ot 1 screen (Ot 1 will appear in the Lower Display).
83.	Using the Arrow keys, adjust Ot 1 value in Upper Display to Heat.
84.	Using the Advance key, scroll to the Out 1 menu (Out 1 will appear in Lower Display).
85.	Press the Infinity key once to exit Setup and return to the Home page.

Heating Modes

The Marathon Express 400 heater system option offers two modes of heating operation: Bakeout and Continuous.

The single zone temperature at the thermocouple may be monitored and averaged by the host controller. If the set point temperature is not reached in a specified amount of time, an alarm should be posted to indicate the operation has timed out.

Bakeout Heating

Bakeout Heating mode is used after service has been performed on the Transport Chamber. Heating is performed during pumpdown. This mode is used to achieve a low base pressure by liberating water vapor from the chamber surfaces.

During Bakeout Heating the temperature of the Transport Chamber is raised to a given, very high temperature for a fixed amount of time; then the heat is turned off. During Bakeout, the Transport Chamber must be at vacuum. The maximum bakeout temperature is 120° C (248° F).

No material handling or processing is permitted during bakeout (robot must not move).

Continuous Heating

Continuous Heating mode is used to prevent deposition of chamber gases on cold chamber surfaces. Heating is performed continuously.

Whenever the tool is operating the temperature of the Transport Chamber is raised to a high temperature. The tool operates normally during this time, including transferring material to and from cassettes. The maximum continuous heating temperature is 50° C (122° F).

Chamber Cooling

The chamber cooling is by the absence of heat combined with the cooling of the MX Vacuum Back End chamber with forced water. The use of non-corrosive water at 15° C $\pm$ 5° C is recommended for cooling. There is no specific cooling feature associated with the heater itself. See ["Water Cooling Systems" on page 153](#).

Heating Control

Control of the heater is through the user's host controller.

Start a Heating Process

For a bakeout heating process, the heating should be stopped after the userdetermined heating duration. The chamber temperature is then cooled to the cool temperature set point specified by the user (typically 25° C (77° F)) before returning the MX 400 system into service.

NOTE: The chamber should not be vented during a bakeout process.

For a continuous heating process, heating stops only when commanded by the host controller (process abort, EMO, etc.). The chamber is only cooled to the cool temperature set point specified by the user (typically 25° C (77° F)) for servicing the MX 400 system.

 WARNING Extreme Temperature	
Surfaces heated during system bake-out can reach temperatures of 121 °C (250 °F), which could causes burns when in contact with skin. Once system heating has been started, all personnel must keep away from the system to avoid possible burn injury due to high temperatures. Allow time for the Marathon Express 400 to cool before servicing or operating. Do NOT operate the robot, vacuum aligner, or any other components in the Marathon Express System during bakeout.	

Step	Action
1.	Remove all material from the top surface of the system (including the robot's CDM, tools, and paper or plastic parts.
2.	Vent the system.
3.	Remove all material from the VCEs, Transport Chamber, etc.
4.	Remove the TopCooler cosmetic cover and fastener.
5.	Ensure that the top and side surfaces of Transport Chamber including the lid and vacuum aligner assemblies are covered with the custom fit reusable thermal insulation blankets.
6.	Turn on the Heater Power Supply by switching the Main Circuit Breaker (Control) to on. Verify the READY light on the front panel is lit.
7.	Pump down all chambers (VCEs, Transport Chamber, etc.) to high vacuum.

Step	Action
8.	Prepare the TopCooler: a. Pump down the TopCooler by opening the TopCooler Rough Valve. b. After pump down is complete, close the TopCooler Rough Valve. c. Open the TopCooler Poppet Valve. The poppet will stay open for the duration of the bake-out cycle. This condition is necessary to prevent the Cool Chuck o-ring from sticking to the poppet surface.
9.	Set the Bakeout temperature. Brooks Automation recommends 120° C (248° F) for the temperature set point.
10.	Determine the bake time. Brooks Automation recommends 80 hours after initial build, installation, or after service periods when the Transport Chamber is opened to atmosphere for greater than 1 hour.
11.	Start the bakeout cycle.

Abort a Heating Process

The abort process is user configured. It should only be considered complete when the temperature reaches the cool temperature set point.

Water Cooling Systems

There may be up to three water cooling systems within the Marathon Express 400, based on the configuration of the system. One water cooling system is used in the rapid cool-down process of the chamber after chamber heating. Another cooling system is used for the pumps and any other system components that require water cooling. Another cooling system provides cooling of hot wafers before they are returned to the load locks for storage in a cassette.

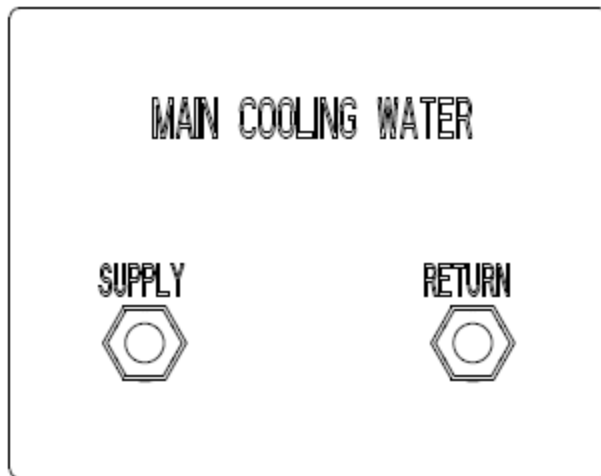


Figure 6-11: Water Distribution Panel

Chamber Cooling System

This cooling system is used in the rapid cool-down process of the chamber and lid after chamber heating. Water cooling is also used for the pumps and is run through the same water cooling system as shown in [Figure 6-12](#).

If the Electric Heater option is used, the cooling flow to the Transport Chamber (TC) is controlled with a separate pneumatically controlled isolation valve. This valve will be open during normal operations to prevent stagnation and minimize corrosion within the cooling channel. Flow to the TC will stop only during the heating portion of the chamber bakeout cycle.

Pump Cooling System

A Flow Switch is mounted on the system cooling outlet in the turbo pump cooling loop to assure that cooling loss does not occur because of poor fluid flow within the MX 400 system's cooling system. The trip point is set by the manufacturer to detect loss of cooling flow to critical heat loads. The Flow Switch will provide a warning to the operator. This cooling loop also contains two manual isolation valves for maintenance.

Wafer Cooling System

Wafer cooling is available as an option using the TopCooler. Wafers must be cooled if the temperature of the wafer is hot enough to melt the plastic cassettes in the Load Locks. In normal operation, unprocessed wafers are placed on the Poppet Shelf, the wafer is then lowered onto the wafer supports on the Cool Platen. During the vent cycle nitrogen, or other gas, conducts heat from the wafer to the platen.

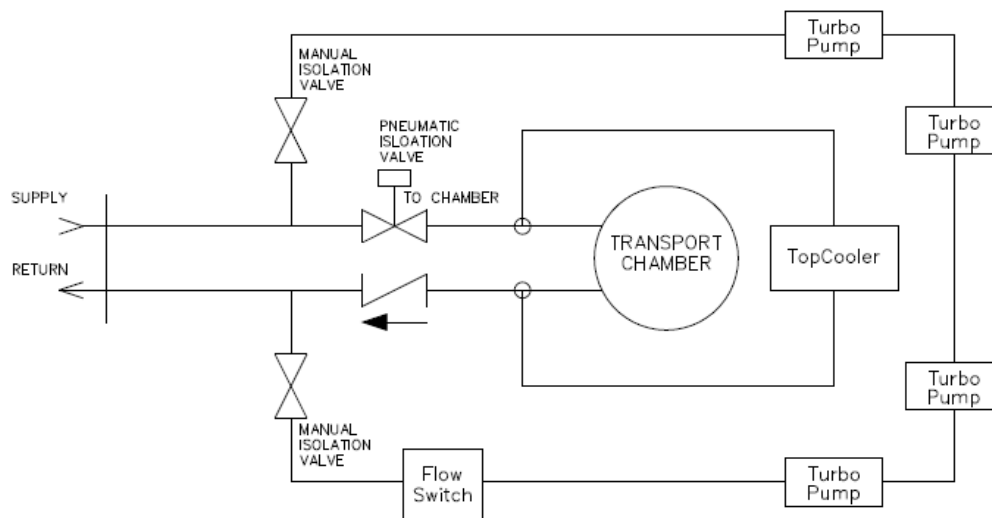


Figure 6-12: Water Cooling Diagram - Chamber, Pumps, TopCooler

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

Pneumatic (Air Distribution) System

The MX 400 system requires compressed air for operation of pneumatic valves and air cylinders.

The pneumatic bank controls the slot valves for the load lock(s) and process modules, as well as the vacuum and vent valves and the optional TopCooler's valves. The pneumatic valves within the bank are controlled electronically from the system controller.

The air pressure is regulated by the Digital Pressure Switch located on the Main Pneumatic Supply panel. See ["Pressure Switch" on page 157](#) for operation.

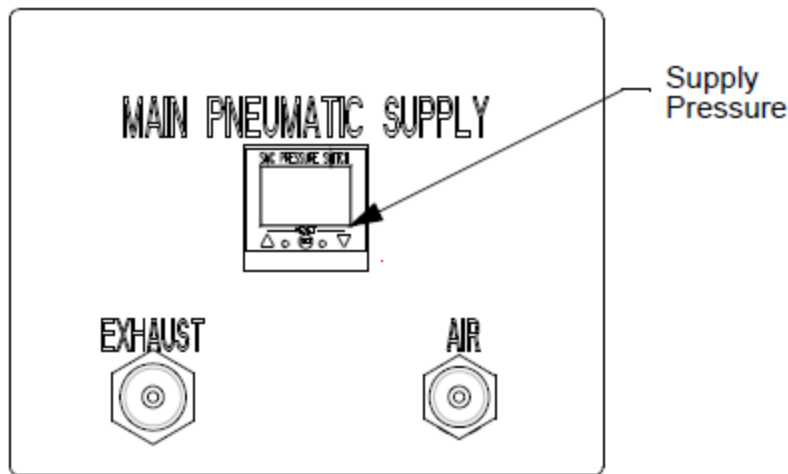


Figure 6-13: Air Distribution Panel

Valve lines are color coded for easy tracing. Refer to the System Block Diagram and Schematics and Vacuum and Vent Diagrams supplied with this manual.

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) and rough vacuum.

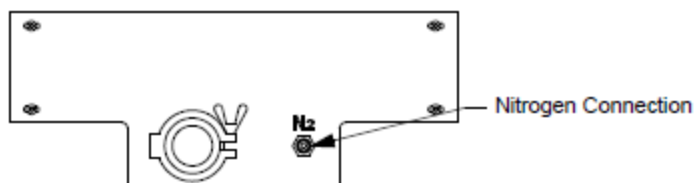


Figure 6-14: Gas Facilities Panel Operation

Controls and Indicators

One Digital Pressure Switch, shown in [Figure 6-15](#), is used for controlling the flow and indicating the pressure of the facility supplied nitrogen. See ["Pressure Switch" on page 157](#) for operation of the switch.

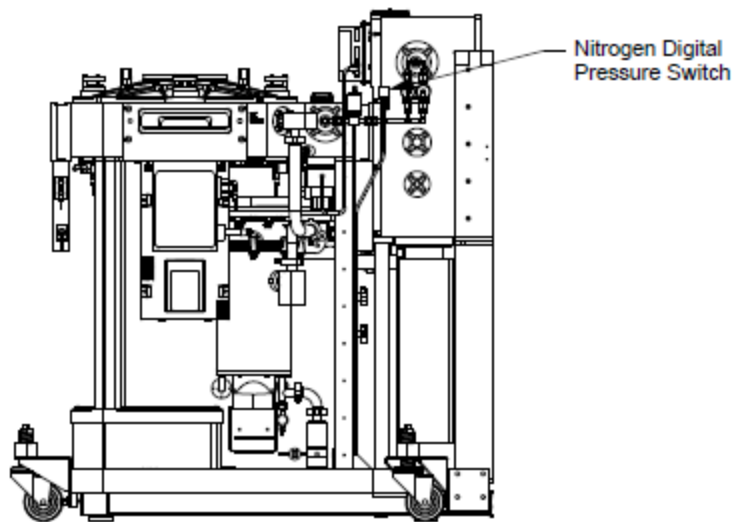


Figure 6-15: Gas Pressure Monitoring

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

TopCooler Operation

Refer to the *TopCooler User Manual* for more information.

Vacuum Aligner Operation

Refer to the *Vacuum Aligner User Manual* for more information.

Pressure Switch

There are Pressure Switches on each Marathon Express 400 used to monitor the pneumatic and nitrogen pressure. The pneumatic Pressure Switch provides 1 output and the nitrogen Pressure Switch provides 2 outputs. These outputs are fed back to the system controller for monitoring the air pressure within the Pneumatic Manifold and the nitrogen pressure within the Vent Manifold.

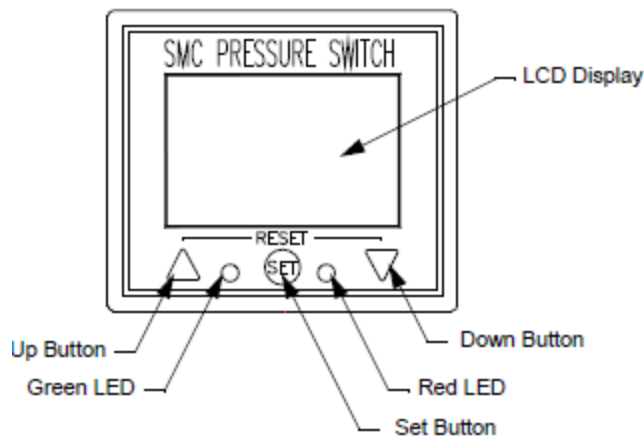


Figure 6-16: Pressure Switch

The Pneumatic Pressure Switch is mounted in the Pneumatic Manifold at the facilities connection for compressed air, refer to [Figure 4-5 on page 94](#). The Nitrogen Pressure Switch is mounted on the Vent Manifold at the facilities connection for nitrogen, refer to [Figure 4-6 on page 95](#).

Refer to "[Pressure/Indicator Switch](#)" and the System Block Diagram, Schematics, and Vacuum and Vent Diagrams supplied with this manual.

Vacuum System Operation

The following vacuum system operation example is for a PVD system configuration containing turbo pumped load locks and cryopump and cryopanel on the Transport Chamber.

Initial Conditions

- System is vented with all chambers at atmospheric pressure.
- Rough and foreline pumps are operating with manifold pressure of < 100 mT
- Cooling water supplied to the system is within specification
- DC/AC power supply is available to all system loads
- Host Controller is booted and ready
- Helium compressor is ready and operating, cryogenic pumps are at room temperature
- All system valves are shut

Chamber Bakeout

- a. Stop cooling water to Transport Chamber.
- b. Energize TC Cartridge Heaters.

- c. Rough out the Transport Chamber.
 - a. Open slow rough.
 - b. At crossover (80 Torr) open fast rough and shut slow rough.
- d. Rough load lock.
 - a. Open turbo pump foreline isolation valve and start turbo pump.
 - b. Open slow rough.
 - c. At crossover (80 Torr) open fast rough and shut slow rough.
 - d. When turbo is at full speed, open turbo isolation and energize the high vacuum gauge.
- e. Repeat for second Load Lock.
- f. Rough cryopump and begin cool down.
- g. When cool down is complete, open cryopump isolation valve and energize high vacuum gauge.
- h. After chamber bakeout is complete, secure Cartridge Heaters and initiate cooling water flow to chamber.

Start-up

- a. Begin cool down of cryopanel.
- b. When cryopanel is at operating temperature and chamber pressure is $< 1 \times 10^{-7}$, system is ready for processing.

Exchange Wafers in the Load Locks

- a. Vent the Load Lock
 - a. Close Load Lock slot valve.
 - b. Close turbo pump isolation valve.
 - c. De-energize the high vacuum gauge.
 - d. Initiate profiled vent.
 - e. Initiate fast vent when pressure > 80 Torr.
 - f. When Digital Pressure Switch indicates pressure is equal to outside pressure, secure vent.
- b. Exchange wafers.
 - a. Open Load Lock door.
 - b. Exchange cassette.
 - c. Close Load Lock door.
- c. Pump down Load Lock.
 - a. Open slow rough.
 - b. Open fast rough at crossover (80 Torr).
 - c. Shut slow and fast rough valves.
 - d. Open cryo pump isolation valve and energize high vacuum gauge.
- d. When Load Lock chamber pressure is $< 1 \times 10^{-5}$ Torr, Load Lock is ready for processing.

Shut Down from High Vacuum

- a. Turn off high vacuum gauge.
- b. Turn off turbo pump.
- c. When turbo pump has stopped, shut turbo pump foreline valve.
- d. Shut cryo pump isolation valve.
- e. Shut down cryo panel (cryo pump regeneration must occur when chamber is under vacuum, if cryo pump is not going to be regenerated, use rough vacuum).

Vent Transport Chamber

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

Vent Load Locks

- a. Shut turbo pump foreline valve.
- b. Secure turbo pump.
- c. De-energize high vacuum gauge.

- d. Initiate profiled vent When pressure >80 Torr, open fast vent valve.
- e. 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.

- a. Close Isolation valve.
- b. 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 Marathon Express 400 Cluster Tool Integration Platform is started by applying power and plant facilities as previously specified. Once this is done, the Marathon Express 400 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 Marathon Express 400 Cluster Tool Integration Platform 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.

Step	Action
3.	Turn on the circuit breakers. The status lights should come on as indicated in "Power-up Sequence" on page 80.
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 Marathon Express 400 is controlled by the user's host controller. Normal operation would typically proceed as follows:

Step	Action
5.	Power up the Marathon Express 400 as previously described.
6.	Power up the host controller as directed.
7.	Once all systems are up and running properly the host controller will typically instruct the Marathon Express 400 to begin pumping down the Transport Module chamber.
8.	Once the Transport Module chamber has been pumped down, proceed as directed by the host controller.

Normal Running

Normal operation of an MX 400 system is controlled by the user's host controller. Normal operation would typically proceed as follows:

Step	Action
1.	Power up the Marathon Express 400 Cluster Tool as previously described in "Power-up Sequence" on page 80.
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 Marathon Express 400 to begin pumping down the Transport Module chamber. The exact usage of the Marathon Express 400 Cluster Tool Integration Platform must be determined by the user. Each component has been described in this manual with the intention of providing the user with the knowledge to use this tool in the most appropriate manner for their individual processes.
3.	Once the Transport Module chamber has been pumped down, proceed as directed by the Cluster Tool 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.

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

Step	Action
1.	The aligner moves to the home position and checks for the absence of a wafer on the chuck.
2.	The robot rotates to the aligner station.
3.	The host controller checks the wafer sensor at the aligner station for a wafer present on the end effector.
4.	The robot extends, places the wafer on the aligner chuck, and retracts.
5.	The aligner checks for the presence of a wafer.
6.	The aligner rotates the wafer collecting eccentricity and fiducial location information and places the fiducial in the post position.

Step	Action
7.	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.
9.	The aligner checks for the absence of a wafer on the chuck.
10.	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 from the specified slot in the specified station. If no slot is specified Slot 1 is assumed.

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

Shut-down

The following shut-down procedure is used to remove power from the Marathon Express 400 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 MX 400 system should be shut down first.

NOTICE

The shut-down procedure is used in the normal shut-down of the Marathon Express 400. This procedure completely removes the power source and all other facilities from the MX 400 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 power to the heaters, if used, by turning off the power switch on the Heater Power Supply.
9.	Turn off the air supply from the facility to the MX 400 system.
10.	Turn off the nitrogen supply from the facility to the MX 400 system.
11.	Turn off the argon supply, if used, from the facility to the MX 400 system.
12.	Turn off the vacuum supply from the facility to the MX 400 system.
13.	Turn off the water supply, if used, from the facility to the MX 400 system.
14.	Turn off the main power disconnect for the MX 400 system.
15.	Remove the power cable from the source and disconnect it from the MX 400 system.
16.	Disconnect the communication cables to the MX 400 system.

Step	Action
17.	Secure the MX 400 system using lockout/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 lockout and the person responsible.
18.	Secure all gas and vacuum supply lines using lockout/tagout procedures defined by the facility. These procedures may include an isolating device to prevent the supply lines from being connected into the facilities supply, along with information about the purpose of the lockout and the person responsible.

NOTE: This procedure only shuts down facilities to the Marathon Express 400 system and its subsystems. Any user Process Modules or other equipment will remain energized.

Emergency Procedures

Issuing a HALT Command in Background Mode

The HALT command causes the robot to immediately stop any action in progress. The HALT command will cause the following effects:

- Controlled stop
- Z-axis brake is applied
- Encoder referencing is maintained

Refer to the HALT command in the *WAVE II Software User Manual*.

Issuing an Emergency Off (EMO)

 WARNING Crush Hazard	
Some equipment relies on electrical braking power and will continue to move during an EMO.	

 CAUTION	
The Marathon Express 400 is not provided with an Emergency Off (EMO) device. The user is accountable for the EMO circuit.	

Issuing an EMER_STOP in DIO Mode

If communicating the with the robot in DIO mode, activating the EMER_STOP pin will immediately cause the following effects:

- A controlled stop
- Z-axis brake is applied
- Encoder referencing is maintained

This pin may be connected to a user supplied Emergency Stop (EMS) button.

Refer to the Operational Interlocks section of the *Robot User Manual*.

Issuing a STOP in CDM Mode

If communicating the with the robot in CDM mode, pressing the **STOP** key will immediately cause the following effects:

- A controlled stop
- Referencing is maintained

Issuing an EMERGENCY STOP on the CDM

During any mode of communication, if the CDM is plugged in, the Emergency Stop button is effective. Pressing the button will immediately cause the following effects:

- Servos will be turned off
- Referencing is maintained

Power Failure

In the event of facility's power failure and the battery backup interlock for the robot has not been used, the following will occur:

- No motion will occur
- Robot must be homed after power-up

7. System Alignment

This chapter provides the alignment instructions for the Brooks Automation Marathon Express 400 and its integrated components.

Overview

The components within the Brooks Automation Marathon Express 400 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.

The user must perform the following alignment procedure as part of installing the Marathon Express 400 in a system. This procedure must be performed during routine maintenance and whenever the robot end effector or one of the system modules requires replacement. Brooks Automation recommends an alignment check under the following circumstances:

- A complete alignment when the Marathon Express 400 is first setup at the user's site.
- A complete alignment when any of the controllers are replaced.
- A complete check when any of the robot's end effectors, arms, or drive is replaced.
- A partial alignment at the appropriate station(s) whenever any component is replaced.
- A complete check of all stations whenever an aligner is replaced.
- A complete check of all stations every three months as periodic preventive maintenance.
- A complete check at all stations if the robot end effector or the robot arms hit any part of the chamber or any of the attached modules.
- A complete check if the Marathon Express 400 was involved in a material transfer error.
- A complete check if the Marathon Express 400 was involved when an Emergency Off (EMO) occurred.

Before attempting to align the Marathon Express 400, be familiar with the subsystems attached to the MX 400 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 each robot in the appropriate worksheet provided in [Appendix B: "Station Identification" on page 237](#).

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

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

Performing the alignment procedure requires the following tools and materials:

- The parameter sheet for the Marathon Express 400 system's stations from the System Acceptance Test (ATP) shipped with the system
- A computer running a terminal emulator or a dumb terminal with a RS-232 Serial communications connection
- A Serial Communication 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
- A small screwdriver
- A 150 mm (6 in) 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 (Gen 5)
- The user manuals for all components within the Marathon Express 400
- The user manuals for any devices interfacing with the Marathon Express 400

Alignment Strategy

The Marathon Express 400 is an Atmospheric to Vacuum Cluster Tool Integration Platform for Process Modules. To properly align the MX 400 system it must be attached to the Process Modules it will be used with.

The robot within the MX 400 system does not have leveling adjustments. The robot is mounted directly to the chamber of the Marathon Express 400 Vacuum Back End. Adjustment of the MX 400 system's modules is part of the alignment of the Marathon Express 400 during installation. All components of the MX 400 system must be leveled relative to the robot.

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 Marathon Express 400 and then docking the Process Module(s) to the MX 400 system. The major steps of the alignment process are detailed below.

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

Step	Action
1.	Adjust the end effectors of the robot as required.
2.	Level the Marathon Express 400 ensuring the rotation axis of the robot is perpendicular to the reference plane of the chamber and that the Wafer Transport Plane is set to 1100 mm.
3.	Level the Process Module(s) ensuring the material stage is parallel to the reference plane of the Marathon Express and that the Wafer Transport Plane is set to 1100 mm per SEMI E21, and attach to the MX 400 system.
4.	Attach the Load Lock Modules to the MX 400 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 Marathon Express 400.
6.	Teach the handoff positions (aligner, load locks, process modules, etc.) in the Marathon Express 400 for the robot.
7.	Test the system alignment by running a series of test material to ensure proper material transport throughout the Marathon Express 400 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 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 Movement / Crush hazard

Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include:

- Robot
- Aligner
- Cool Module Poppet
- Load Lock Module(s) (AutoDoor, Arm, Platform)
- Atmospheric Doors
- Vacuum Slot Valves
- Isolation Valves
- Pumps

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

Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled.

Do not operate the robot without the protective covers in place.

Do not operate the Vacuum Slot Valves or Atmospheric Doors 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 Marathon Express 400 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 the "Alignment Overview" on page 170 and the Alignment Procedures.
2.	Read and understand "Safety" .
3.	Become familiar with the safety warnings and the procedures to ensure safety while performing the procedure.
4.	Become familiar with all attached subsystems, including the CDM, and the command set to be used.
5.	Ensure the Marathon Express 400, the Process Module(s), and all associated components are at room temperature.

Step	Action
6.	Power up and initialize the Marathon Express 400 and all devices that interface with the MX 400 system. The system must be in the following state: • All chambers must be at atmosphere • All slot valves must be open
7.	Follow the alignment procedures provided in this section in the order presented. Note that this section provides a detailed overview of the alignment process, which will reference the actual procedures as required.

Prepare the Marathon Express 400 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 176](#) for instructions on getting the system ready for alignment.

Attach the Vacuum Cassette Elevators to the Marathon Express

The Marathon Express 400 is typically shipped with the VCEs attached to the Vacuum Back End.

NOTE: It should not be necessary to attach the Vacuum Cassette Elevators unless this is a new installation or if a VCE is being replaced.

Locate and Level the Marathon Express

Adjustable feet are provided on the frame of the Marathon Express 400. These feet are used to support the Marathon Express 400, to compensate for an uneven floor, and to relieve the wheels. The MX 400 system must be located to ensure proper hand-off of the material with the facility. Refer to ["Installation Procedure" on page 68](#).

NOTE: It should not be necessary to level the Marathon Express 400 unless this is a new installation or if a robot has been replaced.

Level the VCE Platforms

If a VCE is being replaced, refer to ["Adjust the Load Lock Platform" on page 189](#) for instructions on adjusting the VCE platforms.

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

Level the Process Modules and Dock to the Marathon Express

Follow the manufacturers directions for leveling the Process Modules that are connected to the Marathon Express 400. Ensure that the Wafer Transport Plane is set to 1100 mm. Refer to ["Mounting the Process Modules to the MX System" on page 73](#).

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

Adjust the Robot's End Effectors

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

NOTE: It should not be necessary to adjust the end effectors unless they are new or the robot has been involved in a material transfer error.

Step	Action
1.	Verify all end effectors are flat. Refer to "Verifying Flatness of Robot's End Effector" on page 214 .
2.	Verify the dip and twist of all end effectors is within specifications and make any necessary corrections or adjustments. Refer to "Adjusting the Robot's End Effector(s)" on page 216 .

Configure the Robot

Configure the robot, by setting up the operating parameters, for proper operation within the Marathon Express 400.

Teach the Marathon Express 400 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 Marathon Vacuum Transport System. They are 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 to the Vacuum Aligner" on page 178](#) for instructions on teaching the vacuum aligner station.

Teach the Robot the TopCooler Location

The optional TopCooler wafer cooler provides cooling for hot processed wafers within the Marathon Express 400 Vacuum Back End before they are returned to the cassette. To ensure proper handoff of the wafer between the robot and the cooler, the cool station must be taught to the robot. Refer to ["Teach the Robot with the TopCooler" on page 182](#) for instructions on teaching the wafer cooler station.

Teach the Robot the Load Lock Locations

The VCE Load Locks provide 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 Locks 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 184](#) for instructions on teaching the LL stations.

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

Teach the Robot the Process Module Locations

The Process Modules attached to the Marathon Express 400 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 193](#) for instructions on teaching the PM stations.

Verify Proper Operation of the Material Presence Sensors

Once the modules of the Marathon Express 400 have been properly aligned the sensors within the system must be aligned for proper operation.

Step	Action
1.	Verify proper operation of the Material Presence Sensors. Refer to "Material Presence Sensor Adjustment" on page 212 .

Verify Proper Operation of the Marathon Express 400

Once the modules of the Marathon Express 400 have been properly aligned the operation of the system must be verified.

Step	Action
1.	Verify proper material transfer between all stations within the Marathon Express 400. Refer to " System Alignment Check-out " on page 197.

System Preparation

If preparing for alignment after installation, power up and initialize the Marathon Express 400 as specified in "[Installation](#)".

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

NOTE: This procedure assumes that all Load Locks and Process Modules are connected to the Transport Chamber prior to adjustment 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 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 at a Type 2 Electrical Hazard Category.
- Breaking material can cause flying shards. Always wear eye protection when teaching the robot.
- Read and understand "[Emergency Procedures](#)" on page 166.

Level the Chamber and Set the WTP Height

The height of the Marathon Express 400 must be properly set and the entire tool must be level before any other system alignments are performed. The system Wafer Transport Plane (WTP) must be set to the SEMI MESC standard height (see [Figure 3-3 on page 72](#)) and the entire system must be level, refer to "[Leveling the Marathon Express and Setting the Wafer Transport Plane](#)" on [page 71](#). This procedure should only need to be performed during initial system installation or whenever the system is moved.

Initializing the Vacuum Cassette Elevators

Verify that all setup procedures in the *VCE User Manual* have been completed. Some steps may have been performed at the factory.

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.

Initializing the TopCooler

The system alignment procedure is not directly affected by the Brooks Automation TopCooler. However, the robot will need to be taught the wafer placement location within the cooler. Setup procedures for the cooler 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 Marathon Express requires moving the robot arm and entering station coordinates or other robot parameters into the robot's memory. This is most conveniently done using the robot's hand-held Control/Display Module (CDM) supplied with the

robot. Before the robot's CDM can be used, it must be connected to the robot. Follow the procedure for connecting and initiating the CDM in the robot manual.

Removing the Chamber Lid

If the vacuum robot has not been taught, the Transfer Chamber Lid may be removed to allow access to the end effectors and allow visual verification of the station assignments. To remove the Lid, follow the procedure ["Removing/Replacing Lid" on page 220](#). If the system is running Gen 5 controls, removing 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	
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

The following alignment procedures will provide the information required for standard user alignment of the Brooks Automation Marathon Express 400. For a full system alignment follow the ["Alignment Process" on page 171](#).

Setting the Options for the Vacuum Robot

See the appropriate robot user manual for more information.

Teach the Robot to the Vacuum Aligner

If the Marathon Express 400 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

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

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 material of the appropriate size
- Brooks Robot/Aligner alignment fixture

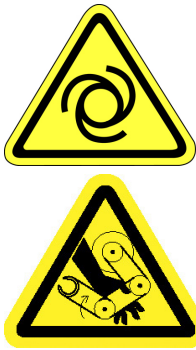
Configuration and Alignment Strategy

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 Marathon Express 400. 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

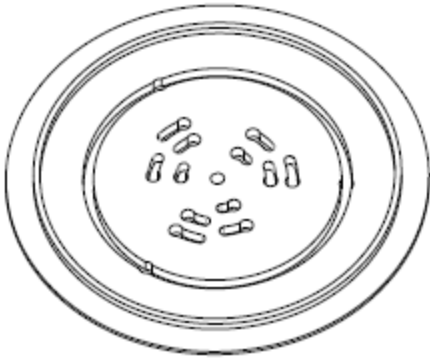
 WARNING Automatic Movement / Crush hazard	
Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include: • Robot • Aligner • Cool Module Poppet • Load Lock Module(s) (AutoDoor, Arm, Platform) • Atmospheric Doors • Vacuum Slot Valves • Isolation Valves • Pumps Moving mechanisms do not have obstruction sensors and can cause serious personal injury or death. Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled. Do not operate the robot without the protective covers in place. Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.	

NOTICE

Always verify proper operation of the CDM E-Stop button before performing any teach procedures by pressing the E-Stop button and verifying that the arm is no longer powered and that while the button is down no motion commands are accepted.

Within the Marathon Express 400 the default station assignment for the Vacuum Aligner is Station 7. Refer to ["Station Coordinate System" on page 121](#) for a detailed description of the station assignments.

Step	Action
1.	Home the vacuum aligner. HOME

Step	Action
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 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. <pre>SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE</pre> - Manually move the robot's end effector until the end effector's Ushaped 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. <pre>ESCAPE -> STORE -> R -> T -> QUIT</pre>
4.	Using the robot's CDM, move the robot's arm out of the vacuum aligner. <pre>SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE</pre> Move the robot's arm out of the vacuum aligner and exit use of the robot using the CDM. <pre>QUIT</pre>
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. <pre>SETUP -> STATIONS -> 7 -> CR -> LEARN R, T, BTO -> HAND LOCATE</pre> - 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. <pre>ESCAPE -> STORE -> BTO -> QUIT</pre>

Step	Action
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 B: "Station Identification" on page 237.

Teach the Robot with the TopCooler

If the Marathon Express 400 is equipped with the optional facet-mounted TopCooler, it is necessary to teach the robot the station location of the wafer position within the cooler. Note that this procedure is for use with Marathon Express 400 systems running WAVE II Software.

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.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

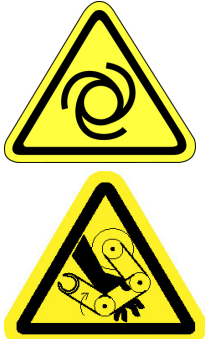
- Robot manual
- MicroTool Dummy Wafer or test wafer of the appropriate size
- CDM (Control/Display Module)

Alignment Strategy

Configuring the system requires configuring the robot to work with the TopCooler, and teaching the robot the cooler's location. Refer to the Robot User Manual for detailed information on using the CDM and teaching stations.

- TopCooler is Station 8 for the robot

Teach the Robot the Cooler Station

 WARNING Automatic Movement / Crush hazard	
Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include: • Robot • Aligner • Cool Module Poppet • Load Lock Module(s) (AutoDoor, Arm, Platform) • Atmospheric Doors • Vacuum Slot Valves • Isolation Valves • Pumps Moving mechanisms do not have obstruction sensors and can cause serious personal injury or death. Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled. Do not operate the robot without the protective covers in place. Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.	

NOTICE

Always verify proper operation of the CDM E-Stop button before performing any teach procedures by pressing the E-Stop button and verifying that the arm is no longer powered and that while the button is down no motion commands are accepted.

Within the Marathon Express 400 the default station assignment for the TopCooler is Station 8. Refer to "[Station Coordinate System](#)" on [page 121](#) for a detailed description of the station assignments.

Step	Action
1.	Using the robot's CDM, teach the robot the R, T, and BTO values for the TopCooler. SETUP -> STATIONS -> 8 -> CR -> LEARN R, T, BTO -> HAND LOCATE - Manually move the robot's end effector with a test wafer properly centered on it (by the aligner) into the cooler poppet, adjusting Z as necessary so the wafer clears the cooler's wafer supports (1.5 mm (0.06 in) minimum). - Once the end effector is positioned correctly save the R, T, and BTO values for the robot using the CDM. ESCAPE -> STORE -> R -> T -> BTO -> QUIT
2.	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 -> 8 -> CR -> LEARN LOWER -> JOG Jog the wafer down into position and continue jogging down so the end effector is 1.85 mm (0.073 in) below the wafer when the wafer is resting on the cooler's wafer supports.
3.	Once the wafer and end effector are positioned correctly save the Lower value using the CDM. ESCAPE -> STORE -> L -> QUIT
4.	Using the robot's CDM, move the robot's arm out of the TopCooler station. SETUP -> STATIONS -> 8 -> CR -> LEARN R, T, BTO -> HAND LOCATE Move the robot's arm with the wafer out of the cooler station and exit use of the vacuum robot using the CDM. QUIT
5.	Record the Station coordinates in the appropriate worksheet provided in Appendix F: "Packing and Shipping Instructions" on page 242.

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

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

- Specific VCE User Manual
- CDM (Control/Display Module)
- MicroTool Dummy Wafer or test material 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 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 manual for instructions on using the CDM and teaching stations.

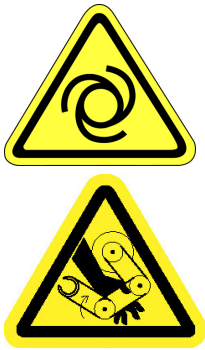
Prior to teaching the Load Lock stations, the VCEs must be level.

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 on left-hand side is VCE A
 - VCE A is Station 1
- Vacuum Cassette Elevator on right-hand side is VCE B
 - VCE B is Station 5

Set the Robot to the VCE WTP

 WARNING Automatic Movement / Crush hazard	
Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include: • Robot • Aligner • Cool Module Poppet • Load Lock Module(s) (AutoDoor, Arm, Platform) • Atmospheric Doors • Vacuum Slot Valves • Isolation Valves • Pumps Moving mechanisms do not have obstruction sensors and can cause serious personal injury or death. Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled. Do not operate the robot without the protective covers in place. Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.	

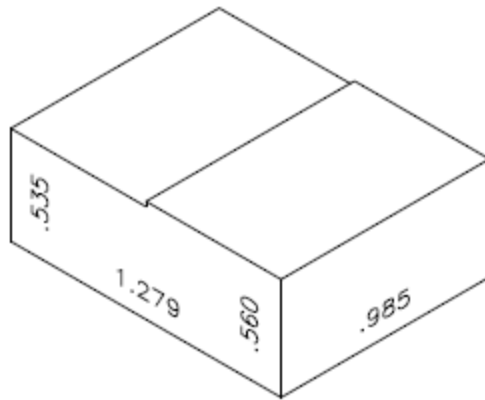
NOTICE

Always verify proper operation of the CDM E-Stop button before performing any teach procedures by pressing the E-Stop button and verifying that the arm is no longer powered and that while the button is down no motion commands are accepted.

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 (material transport) position. The Marathon Express 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.

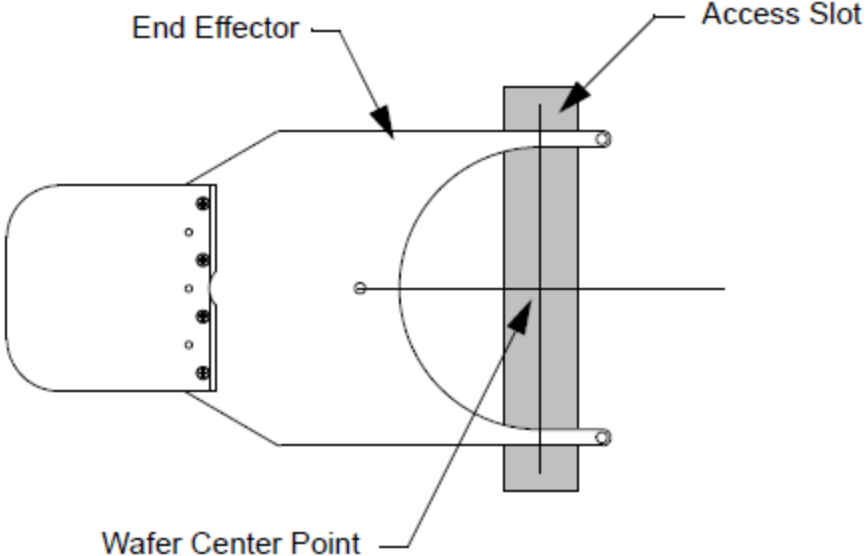
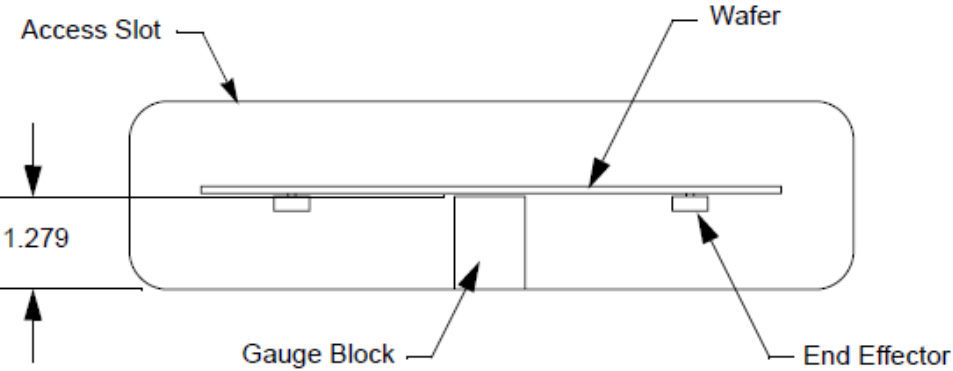
This procedure uses the floor (i.e., bottom surface) of either Load Lock's access slots as a reference point for determining the BTO to the system's WTP. Assuming that the system has been installed to conform to the SEMI MESC height standards, the SEMI MESC MTP indicated by the WTP scribe mark on the side of the chamber, is located 32.50 mm (1.280 in.) above the floor of the access ports. To facilitate this procedure, the Marathon Express 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:



1.279 x 0.985 x 0.560 & 0.535

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 a. Manually move the robot's end effector until the end effector is located inside the access slot as shown.  b. Place the gauge block in the access slot, adjacent to the robot's end effector with the 1.279 inch dimension vertical, as shown.  c. 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. d. Once the end effector is positioned correctly save the BTO value for the robot using the CDM. ESCAPE -> STORE -> BTO -> QUIT

Step	Action
2.	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 a. Move the robot's arm with the wafer out of the access slot and exit use of the vacuum robot using the CDM. QUIT
3.	Remove the wafer from the end effector and the gauge block from the access slot.
4.	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

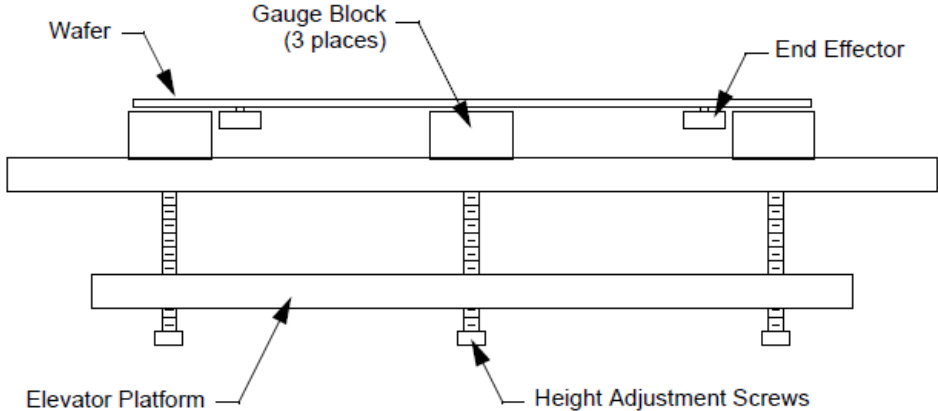
Wafer Size	Lower Value
100 mm, 125 mm, 150 mm (4 in, 5 in, 6 in)	1.82 mm (0.072 in)
200 mm (8 inch)	2.25 mm (0.089 in)

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 Marathon Express 400 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 Brooks Automation <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 as severe damage may result.

Step	Action
3.	Select the appropriate Cassette Type Offset (CTO) configuration value from the Brooks Automation <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 7-3, 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:  Figure 7-3: 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 heightadjustment 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.

Step	Action
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 Marathon Express 400 comes with a two-part Robot/VCE Alignment Fixture for the specified end effector, shown in [Figure 7-4](#), to facilitate this procedure.

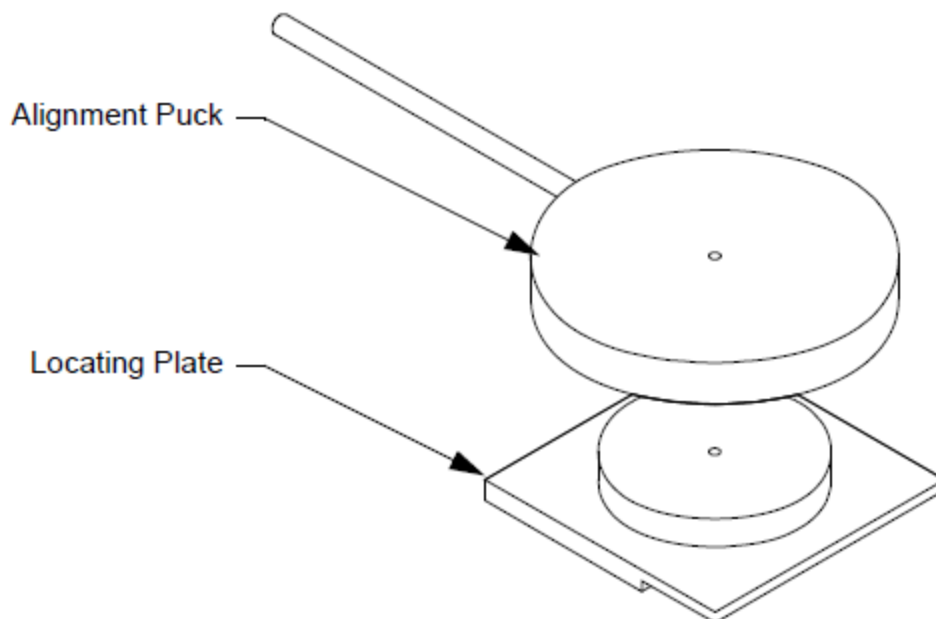
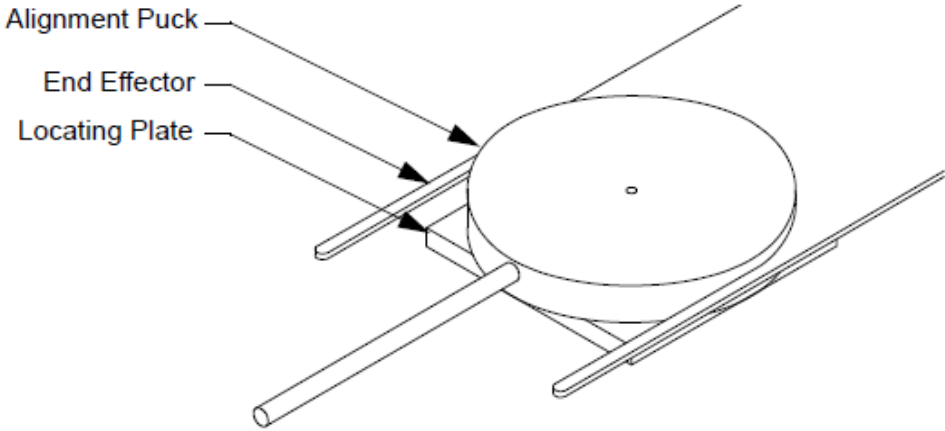


Figure 7-4: Robot/VCE Alignment Fixture

NOTICE

Do not "home" the elevator while the robot's arms or end effector are extended into the Load Lock's chamber as 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 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 as shown in Figure 7-3 and the bottom of the "U" is close to, but not touching, the puck (approximately ± 0.002 inch).  Figure 7-5: Centering End Effector On Alignment Fixture
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 B: "Station Identification" on page 237 .
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 B: "Station Identification" on page 237 .
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.

Teach the Robot the Process Modules

The following procedure teaches the robot the Process Module stations. This procedure is also used for teaching the Wafer Buffer Module. Note that this procedure is for use with Marathon Express 400 systems running WAVE II Software.

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

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.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools

- Control/Display Module
- MicroTool Dummy Wafer or test material of the appropriate size

Alignment Strategy

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

- First Process Module on left-hand side is Station 2 for the robot

Procedure

 WARNING Automatic Movement / Crush hazard	
Whenever power is applied to the Marathon Express 400, the possibility exists of automatic movement that can cause serious injury or death. These components include: • Robot • Aligner • Cool Module Poppet • Load Lock Module(s) (AutoDoor, Arm, Platform) • Atmospheric Doors • Vacuum Slot Valves • Isolation Valves • Pumps Moving mechanisms do not have obstruction sensors and can cause serious personal injury or death. Do not operate the Marathon Express 400 without the protective covers in place and all safety interlocks enabled. Do not operate the robot without the protective covers in place. Do not operate the Vacuum Slot Valves or Atmospheric Doors when the chamber lid is open.	 

NOTICE

Always verify proper operation of the CDM E-Stop button before performing any teach procedures by pressing the E-Stop button and verifying that the arm is no longer powered and that while the button is down no motion commands are accepted.

Refer to "[Station Coordinate System](#)" on page 121 for an illustration of station assignments.

Step	Action
1.	Using the robot's CDM, teach the robot the R, T, and BTO values for the Process Module. SETUP -> STATIONS -> <i>n</i> -> CR -> LEARN R, T, BTO -> HAND LOCATE (where <i>n</i> is the station number for the Process Module) - Manually move the robot's end effector with a test wafer properly centered on it (by the aligner) into the Process Module, adjusting Z as necessary so the wafer clears the module's wafer supports (1.5 mm (0.06 in) minimum). - Once the end effector is positioned correctly save the R, T, and BTO values for the robot using the CDM. ESCAPE -> STORE -> R -> T -> BTO -> QUIT
2.	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 -> <i>n</i> -> CR -> LEARN LOWER -> JOG (where <i>n</i> is the station number for the Process Module) Jog the wafer down into position and continue jogging down so the end effector clears the bottom of the wafer (1.5 mm (0.06 in) minimum).
3.	Once the wafer and end effector are positioned correctly save the Lower value using the CDM. ESCAPE -> STORE -> L -> QUIT
4.	If the station is a multi-slotted station enter number of Slots and the Pitch. A standard Wafer Buffer Module has 4 slots with a pitch of 6.0 mm (0.236 in). SETUP -> STATIONS -> <i>n</i> -> CR -> ASSIGN LOCATION -> SLOT -> 4 -> CR -> P -> 6000 -> CR -> QUIT (where <i>n</i> is the station number)
5.	Record the Station coordinates in the appropriate worksheet provided in Appendix B: "Station Identification" on page 237.
6.	Repeat the procedure for each Process Module using the appropriate station number.

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

Teaching Pan 'B' on a Dual End-Effector Arm Set

When using a dual end effector arm on a robot both end effectors, referred to as pan 'A' and pan 'B' must be taught all stations. The easiest, and most reliable, method for teaching pan 'B' all stations is to simply calculate the pan 'B' values for each station based on the pan 'A' values already obtained.

See the robot manual for instructions on calculating the pan 'B' values.

Record the Station coordinates in the appropriate worksheet provided in [Appendix B: "Station Identification" on page 237](#).

Fine-Tuning the Station Assignment

For material transport systems that have an aligner, the aligner is typically considered the “center of the 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.

After verifying all values, test the pick/place error between the two arms by using the following procedure.

NOTE: Be careful when verifying calculated axes parameters for arm 'B' as these variations could cause the arm or end effector to make physical contact with parts of the system that arm 'A' will not touch.

Step	Action
1.	Pick a wafer from a cassette with pan 'A' and place it on the aligner.
2.	Align the wafer.
3.	Pick the wafer with pan 'A' and place it back into the cassette.
4.	Pick the same wafer with pan 'B' and place it on the aligner.
5.	Align the wafer. The wafer should be < 0.014 off center.
6.	Pick the wafer with pan 'B' and place it back into the cassette.

Step	Action
7.	Repeat the alignment procedure for pan 'B' until the error is within limits.

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. Perform the entire check-out using the robot's pan 'A'; if a dual end effector arm set is being used, perform the entire check-out for pan 'B' also.

Procedure Category

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

Required Tools and Test Equipment

- The robot's Control/Display Module (CDM)
- MicroTool Dummy Wafers or test material of the appropriate 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 material against cassette walls or other system components.

If there is any material motion or contact with any surfaces within the MX 400 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 arms or end effector(s) are damaged, removed and replaced, or changed.

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

Alignment Procedure

 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.	

NOTICE
All cassettes used within Vacuum Cassette Elevators attached to the Marathon Express 400 must meet SEMI MESC standards. Note that it is possible for molded cassettes to “shrink”, shortening the spacing between slots.

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: The wafers should move into and out-of the cassettes without any contact.
3.	Repeat the procedure for the second VCE.
4.	Replace one of the cassettes with an empty cassette.

Step	Action
5.	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.
6.	Repeat the procedure to transfer the wafers back to their original cassette.

8. Command Reference

Refer to the appropriate robot user manuals, vacuum aligner user manuals, and VCE user manuals for command references.

9. Maintenance and Repair

This chapter provides complete maintenance schedules and procedures for the Brooks Automation Marathon Express 400. The first section of this chapter provides preventive maintenance schedules and procedures. The second section of this chapter provides repair procedures for subsystem repair and replacement.

Preventative Maintenance

This section provides the schedule and procedures for routine preventive maintenance of the Marathon Express 400 to reduce unscheduled downtime. The Marathon Express 400 is designed to require very little routine maintenance. However, it is recommended that the preventive maintenance procedures and schedule provided in this section be followed to extend the operating life of the MX 400 system and to minimize unscheduled downtime. If additional procedures are required, they will be supplied along with their maintenance schedules by Brooks Automation.

All Preventive Maintenance procedures and schedules provided here assume that the Brooks Automation Marathon Express 400 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 be performed. The user should adjust the Preventative Maintenance Schedule as appropriate to account for any deviations from this environment.

NOTE: Brooks Automation offers training for troubleshooting and repair of the Marathon Express 400. Only qualified, properly trained persons should perform any maintenance or repair procedures. Damage resulting from improperly performing a procedure is not covered under warranty or service agreements.

 CAUTION Unauthorized Service	
Personal injury or damage to 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.	

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.

Preventive Maintenance Schedule and Procedures

The following maintenance schedule and procedures will provide the information required for standard user maintenance of the Brooks Automation Marathon Express 400. If additional procedures are required during the performance of any procedure, they will be provided. The frequency for performing the procedure is provided and the page number is provided for those procedures in this manual.

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

NOTE: 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 Material Supports	See "Material Support (Pad) Inspection" on page 203	3 months
	See "Pad Cleaning Procedure" on page 204	3 months

Component	Maintenance Action	Frequency
MX 400 System	See "Pad Cleaning Procedure" on page 204	12 months or as required
	Material Presence Sensor Adjustment	6 months
	See "Verifying Flatness of Robot's End Effector" on page 214	12 months or as required
	See "Adjusting the Robot's End Effector(s)" on page 216	12 months or as required
	See "Alignment Procedures" on page 178	3 months
TopCooler	TopCooler Cool Chuck Cleaning	12 months or as required
Vacuum Pumps	As specified for pumps being used Refer to Pump User Manuals	
Gauges	As specified for gauges being used Refer to Gauge User Manuals	
Vacuum Robot	Inspect every 6 months Refer to the Robot User Manual	
Vacuum Load Locks	Inspect every 6 months Refer to the <i>VCE User Manual</i>	

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

Type 1 Procedure: 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 164](#).

 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.	 

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 164 .
2.	Vent the Vacuum Chamber and Load Lock.
3.	Open the chamber lid, refer to "Removing/Replacing Lid" on page 220 .
4.	Visually inspect the surface of the pads on the end effector, the vacuum aligner, and the material 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 204 for cleaning and "Pad Removal/Replacement" on page 226 for replacement.
6.	Close the chamber lid, refer to "Removing/Replacing Lid" on page 220 .
7.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 80 .

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

Type 1 Procedure: 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 164.

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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



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**.



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 164 .
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, 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, etc.,
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 water to drip. Do not allow water to come in contact with bearings, seals, etc. 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, etc.
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 80 .

Cleaning Procedure

Occasionally the Marathon Express 400 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

Type 1 Procedure: 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 164](#).

NOTICE



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



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**.



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 164 .

Step	Action
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 MX 400 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. - 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.
4.	General Cleaning Procedure: - Remove any hazardous materials from the Marathon Express 400 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 water to drip. Do not allow alcohol to come in contact with bearings, seals, etc. 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 alcohol to come in contact with bearings, seals, etc.
5.	Ensure that the Load Lock door and the Transport Chamber lid are closed.
6.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 80 .

TopCooler Cool Chuck Cleaning

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

Procedure Category

Type 1 Procedure: Equipment is fully de-energized.

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 164](#).

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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

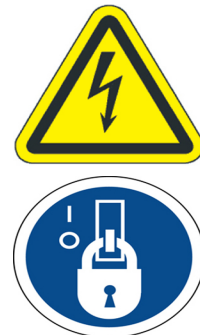


WARNING

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**.



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 164 .
2.	Remove the Poppet Assembly by removing the four M8 screws securing the assembly to the Transport Chamber.

Step	Action
3.	The Cool Chuck is now accessible for cleaning. Use the " Cleaning Procedure " on page 206 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.
4.	Replace the Poppet Assembly and secure the hardware.
5.	Reconnect all power, communications, and air connections, then re-energize the system following the " Power-up Sequence " on page 80.

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

Type 1 Procedure: 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 164.

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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

 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.	 

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 164 .
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 in "Cleaning Procedure" on page 206. - 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: 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. NOTE: Do not allow the o-ring to twist during installation.

Step	Action
4.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 80.

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

Type 2 Procedure: Equipment is energized and all energized circuits are covered or insulated. All work is performed remotely using the CDM or service computer.

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.

NOTE: When performing this service procedure all equipment is on. For this procedure, the Marathon Express 400 system is classified as a Type 2 hazard category (refer to "Electrical Hazards" on page 48).

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.

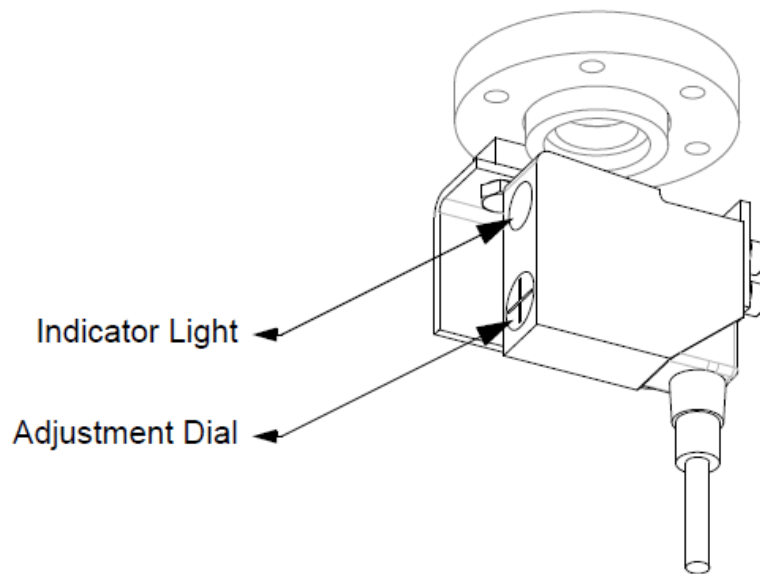


Figure 9-1: Material Presence Sensor

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.

Step	Action
4.	General Cleaning Procedure: - Remove any hazardous materials from the Marathon Express 400 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 water to drip. Do not allow alcohol to come in contact with bearings, seals, etc. 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 alcohol to come in contact with bearings, seals, etc.
5.	Ensure that the Load Lock door and the Transport Chamber lid are closed.
6.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 80.

Verifying Flatness of Robot's 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 in) 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

Type 1 Procedure: 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 in).
- 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.

NOTICE



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



WARNING

Lockout / Tagout

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

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



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 164.

Step	Action
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 in) 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 80.

Adjusting the Robot's End Effector(s)

The end effector of the robot must be adjusted for planar motion within the material delivery zone of any material transfer. This adjustment procedure must be performed at the material delivery zone.

This procedure is performed during initial setup and at any time that the robot's arms or end effector (s) are damaged, removed and replaced, or changed. It is also recommended to perform this procedure as a preventative maintenance procedure.

NOTE: This procedure assumes that the end effector is properly located in the arm, is flat, and that the top surfaces of the material support pads are within 0.076 mm (0.003 in) of each other.

Procedure Category

Type 1 Procedure: Equipment is fully de-energized.

Required Tools and Test Equipment

- Metric hex wrenches
- The robot's Teach Pendant
- MicroTool Wafer Level

Limits and Tolerances

- The end effector must be level within 0.02 degrees

Adjustment Strategy

This procedure uses the bottom surface of a Process Module as a reference point to determine planar movement within the material delivery zone. The arm should be extended to the delivery

zone while measuring the end effector runout. Turn off and disconnect all power, communications, and air connections as detailed in the "[Adjustment Procedure](#)" on page 217.

NOTICE



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

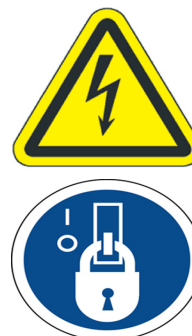


WARNING

Lockout / Tagout

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



Adjustment 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 164.
2.	Place the MicroTool wafer level on the end effector located approximately where a wafer would be located on the end effector. If a bubble level is being used place a test wafer on the end effector and place the bubble level in the middle of the material.
3.	Verify that the end effector is level within 0.02 degrees. a. If the end effector is not level, adjust the end effector as specified in the robot's user manual. Do not over-tighten any of the Adjusting Screws as the end effector may become permanently twisted.

Step	Action
4.	Reconnect all power, communications, and air connections, then re-energize the system following the "Power-up Sequence" on page 80.

Repair Philosophy

If the Marathon Express 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 MX 400 system. Once the failed unit or part has been identified, a Field Replaceable Unit (FRU) can be ordered. The FRU is shipped with directions for removing the failed unit from the Marathon Express and installing the new unit into the MX 400 system. Refer to the appropriate component user manuals for additional troubleshooting and repair procedures.

A series of FRUs, shown in "Field Replaceable Units", has been identified for the Marathon Express 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 Marathon Express 400. 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 Customer support on both a priority and non priority basis

Contact Brooks Automation Technical Support for more information or quotes.

NOTE: Safety and Operations training classes on how to troubleshoot and repair a Marathon Express 400 to a FRU level are available. Contact Brooks Automation for information about these classes.

Repair Procedures

The following repair/replacement procedures will provide the information required for standard user servicing of the Brooks Automation Marathon Express 400. If additional procedures are required during the performance of any procedure, they will be specified.

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

Wafer Change-Over Procedure

The Marathon Express 400 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

Type 1 Procedure: 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 Marathon Express 400 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 164](#).

NOTE: 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"](#).

NOTICE



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

 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.	 

Maintenance Procedure

NOTE: 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"](#).

Vacuum 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

TopCooler:

- Adjust the cooler's wafer clips. See the *TopCooler User Manual* for more information.

System Software:

- Change system software settings (see 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 26.

Procedure Category

Type 1 Procedure: 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 164](#).

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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



WARNING

Lockout / Tagout

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



Removal Procedure

The handle locations on the lid may be moved to provide a better grip and less twisting motion when removing or replacing the lid. Brooks recommends orienting the handles to minimize the handle reach distance and minimize twisting while lifting.

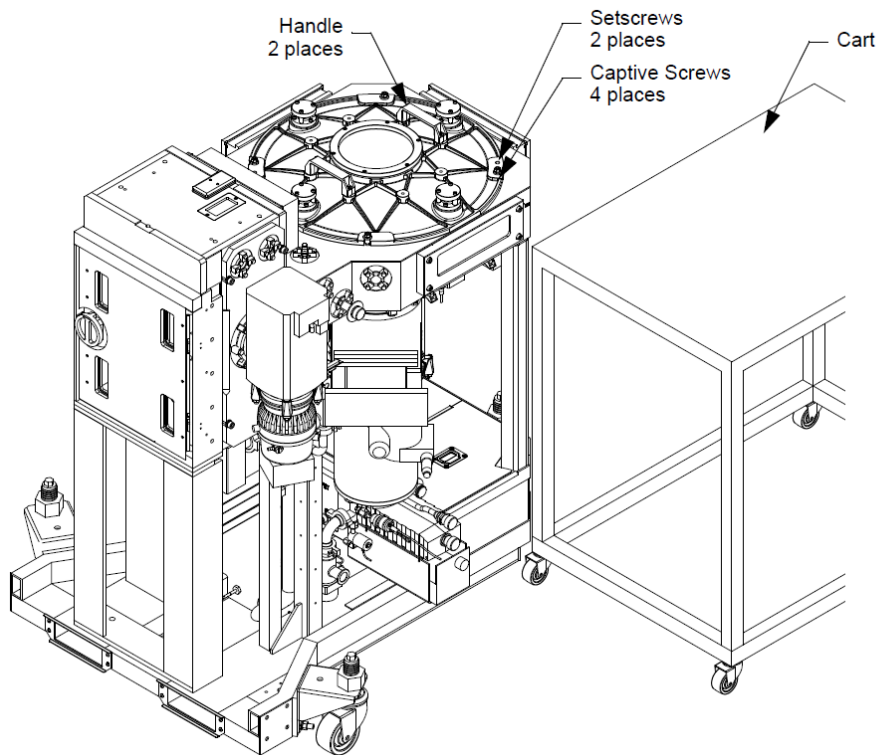


Figure 9-2: Removing Lid

Step	Action
1.	Vent the chamber to atmosphere.
2.	Place a cart as shown in Figure 9-2 .
3.	Loosen each lid mounting screw (4 places).
4.	Tighten the two nylon tip setscrews to break the o-ring seal. NOTE: The nylon tipped setscrews are used to break the o-ring seal after baking the chamber. They should be retracted (unscrewed) right after use so they won't interfere with replacing the lid.
5.	To remove the lid, hold the two handles on top of the lid, lift the lid up to clear the chamber, turn, and place the lid on the cart.

Replacement Procedure

Step	Action
1.	Before replacing the lid, inspect the o-ring for any sign of damage. Replace the o-ring if necessary.

Step	Action
2.	Place the cart holding the lid as shown in Figure 9-2 .
3.	Loosen the two nylon tip setscrews to allow the lid to rest on the o-ring seal. NOTE: <i>The nylon tipped setscrews must be loose to obtain vacuum.</i>
4.	Hold the two handles on top of the lid, lift the lid up off of the cart, turn, and place the lid on the top of the MX 400 chamber.
5.	Tighten each captive screw (4 places). See Figure 9-2 for screw positions. NOTE: <i>DO NOT TIGHTEN the screws after the chamber is at vacuum.</i>

Removing/Replacing Viewports

Many maintenance and repair procedures require removing a view port for access to the component. Additionally, viewports may need to be replaced if they become scratched or broken.

Procedure Category

Type 1 Procedure: 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 164](#).

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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

 WARNING Lockout / Tagout	
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Removal Procedure

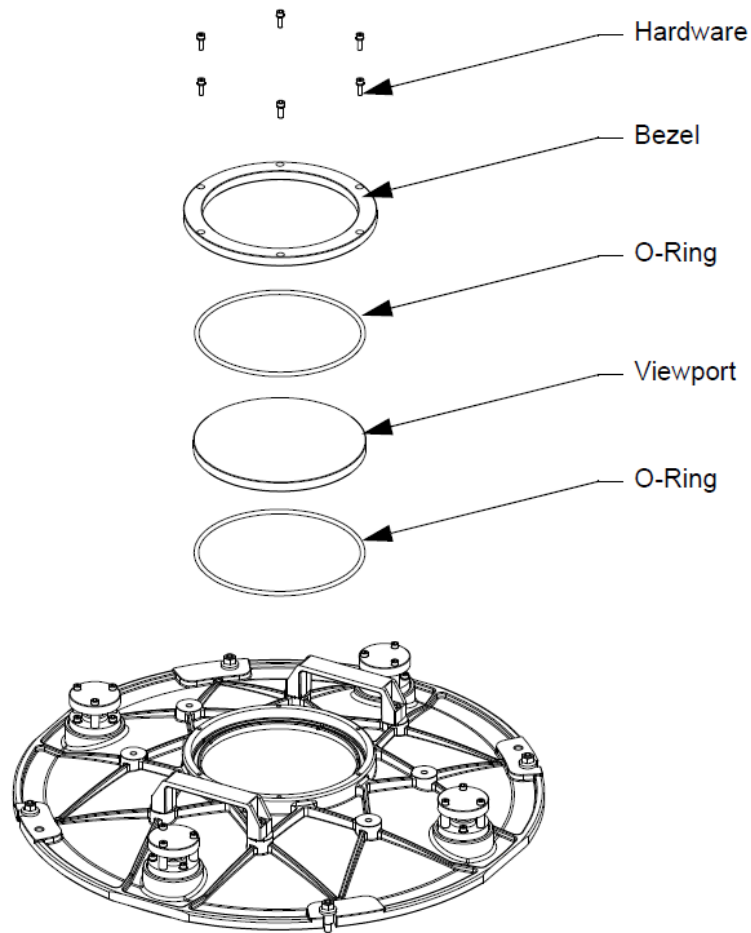


Figure 9-3: Replacing Viewports - Typical

Step	Action
1.	Remove all hardware securing the bezel.
2.	Remove the bezel and viewport assembly, taking care not to scratch the viewport.
3.	The viewport may have become adhered to the o-rings due to heating of the Transport Chamber. Carefully remove the viewport from o-rings. NOTE: If any o-rings have become adhered to the viewport they must be replaced.

Replacement Procedure

Step	Action
1.	Inspect all o-rings for any visible damage that may jeopardize vacuum integrity. Replace any questionable o-rings. Clean or replace the o-ring, refer to "O-Ring Removal/Replacement/Cleaning" on page 210 .
2.	Clean the viewport and the area where the viewport will be replaced by following the "Cleaning Procedure" on page 206 .
3.	Insert the sealing o-ring.
4.	Insert the viewport, taking care not to scratch it.
5.	Insert the seating o-ring.
6.	Insert the bezel, taking care not to scratch the viewport.
7.	Insert the mounting hardware.

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

Type 1 Procedure: Equipment is fully de-energized.

Required Tools

None

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in ["Shut-down" on page 164](#).

NOTICE



The Marathon Express 400 may be used in an environment where hazardous materials are present, and surfaces may be contaminated by those materials. Refer to the facility's Material Safety Data Sheets for those materials to determine proper handling and follow the facility's procedures to certify the environment is safe.

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

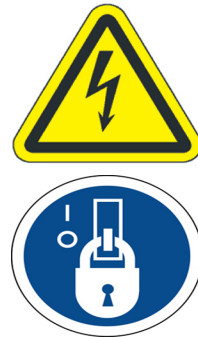


WARNING

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**.



Grommet Style Pad Replacement

Remove the pad by pulling it out of the end effector from the top side.

Replacing the pads requires no special tools or materials. Press the pad into the holes on the end effector by hand until fully seated.

O-Ring Type Pad Replacement

Remove the pad by pulling out of the shelf tab from the top side.

Replacing the pads requires no special tools or materials. Hand press the pad over the shelf pins.

Heater Cartridge Replacement

For Marathon Express 400 systems with the bake-out option, the Cartridge Heaters used to heat the chamber may require replacement if damaged.

Procedure Category

Type 1 Procedure: Equipment is fully de-energized.

Required Tools

- Metric Hex wrench set

Replacement Strategy

Turn off and disconnect all power, communications, and air connections as detailed in "[Shut-down](#)" on page 164.

 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.	 

 WARNING Extreme Temperature	
Contact with hot surfaces can cause serious injury or death from burns. Ensure the Heater Cartridge is cool before attempting replacement to avoid the risk of burning.	

Replacement Procedure

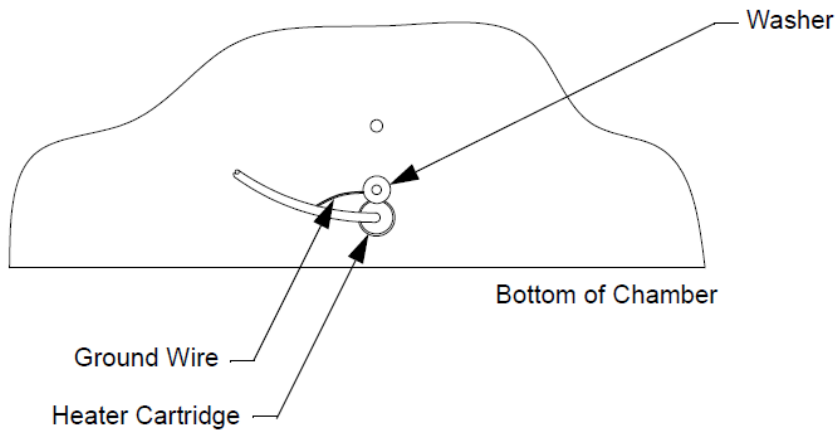


Figure 9-4: Heater Cartridge Replacement

Step	Action
1.	Remove power to the Marathon Express 400 including the Heater Controller.
2.	Remove the washer, shown in Figure 9-4 , securing the ground wire and the heater cartridge to the bottom of the chamber.
3.	Slide the heater cartridge out of the chamber.
4.	Disconnect the Heater Assembly from the wiring harness running below the chamber.
5.	Connect the new Heater Assembly to the wiring harness. Ensure that none of the wires contact the chamber to prevent damage during a heating cycle.
6.	Insert the new heater cartridge into the hole in the bottom of the chamber.
7.	Run the ground wire for the new heater cartridge to the mounting hole next to the heater.
8.	Replace the washer and screw, ensure that the washer extends over the heater cartridge to hold it in place.

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

Troubleshooting problems that might occur with the Brooks Automation Marathon Express 400 is a two step process. The first step is the initial troubleshooting, which is used to determine the general area where the problem exists. The second step is to isolate the problem within the specific area identified during the initial troubleshooting.

Initial Troubleshooting

This section covers the initial determination of the problem area within the Marathon Express 400 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
System powered but no response to Host Controller	
System powered but no response from components within system	
Load Port Modules not operating	"Material Transport"
Unexpected movement of modules	
Material slipping or left on end effector	
Wafer slipping on aligner	Vacuum Aligner
Aligner not working properly	

Symptom	Possible Problem Area
Wafer not cooling	TopCooler
System not heating during bake-out	Heating System
Pressure switch not responding correctly	"Pressure/Indicator Switch"
Chamber not pumping down correctly	"Vacuum System"
Slot valve/Atmospheric door not working properly	"Isolation Valve Replacement"

Material Transport

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

Table 10-2: Material Transport Troubleshooting

Symptom	Corrective Action
Material slipping on end effector	1. Check that vacuum is connected and meets pressure specifications. 2. 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.	1. Identify cause of the failure that left the material on the end effector. 2. 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	1. Shut down the system and recover manually. 2. Remove the vacuum chamber's lid and check all components associated with the failure. Manually remove the material.

Heating System

This section covers determination of problems within the Chamber Heating system.

Table 10-3: Heating System Troubleshooting

Problem	Corrective Action
No indicators on front panel of Heater Power Supply	Check DC CB located on rear panel.
No power to heaters	Check CB10 located on rear panel of Heater Power Supply.

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 10-4: 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 10-5: Vacuum System Troubleshooting

Problem	Corrective Action
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, material support assemblies, or in chamber. • Ensure that the vacuum chamber's pump controller is functioning properly. Reset it if necessary. Refer to the <i>Pump Controller User Manual</i>. • Ensure that the vacuum chamber's pump stack isolation valve is functioning properly (air pressure is okay). • Check vacuum chamber's slot valve 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.

Problem	Corrective Action
Vacuum chamber fails to pump down in set time	• Ensure that 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 <i>Pump Controller User Manual</i>. • 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.

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>

11. Appendices

The following appendices are included to provide the user with a single location for specific information related to the Marathon Express 400.

Appendix A: 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 B: Station Identification

The Brooks Automation Marathon Express 400 is customized at the factory to the users specified parameters. Accompanying the MX 400 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 Marathon Express 400 or re-configures the MX 400 system, the new parameters should be recorded in the table provided in this section.

Table 11-1: System Assignments Log

Stn	Station Name (Position Wafer Size)	R	T	Z (BTO)	Lower	Slots	Pitch
1	Load Lock A - Arm 'A' Load Lock A - Arm 'B'						
2	Process Module 1 - 'A' Process Module 1 - 'B'						
3	Process Module 2 - 'A' Process Module 2 - 'B'						
4	Process Module 3 - 'A' Process Module 3 - 'B'						
7	Vacuum Aligner - 'A' Vacuum Aligner - 'B'						
	TopCooler - 'A' TopCooler - 'B'						

Appendix C: Document Abbreviations

The abbreviations provided in this table are used with Brooks' documentation.

AIR	Air, pressurized	FN	Facet Node board	PN	Pneumatic manifold
AL	Load Lock 'A'	FDP	Front Buffer Defeat Plug	PP	Poppet valve
AR	Argon gas	FM	Foreline Manifold	PR	Pressure Relief valve
AS	Atmospheric Switch	FS	Flow Switch	PS	Pressure Switch
ASA	Atmospheric Switch Adapter	FV	Fast Vent	PU	Purge valve
BL	Load Lock 'B'	GP	Gas Panel	PV	Profiled Vent valve
BV	Bleed valve	H2O	Water	RM	Rough Manifold
C2	Communications board RS-232	HP	Heater Power Supply	RV	Rough Valve
C4	Communications board RS-422	HT	Heater cartridge	S	Sensor
CC	Cold Cathode	IG	Ion Gauge	SP	Wafer Lift Spider
CG	Convection Gauge	IL	Inligner (TopLigner)	SR	Slow Rough
CL	Cooling valve	IO	System I/O distribution board	SS	Substrate Sensor
CM	Capacitance Manometer	IV	Isolation Valve	SV	Slot Valve
CP	Cryo Pump	LF	Lower Facilities	T/C	Thermocouple
CS	Cool Station	LL	Load Lock	T5	T5X system controller
CT	Temperature controller	LN	Load Lock Node	TB	Turbo Backing valve
CV	Charge Valve or Cryo Vent	M7	MagnaTran 7 robot	TC	Transport Chamber
DB	D-subminiature connector	MCC	Motion Control Card	TMC	Transport Module Controller
DC	DC Power Supply	MP	Mechanical Pump	TP	Turbo Pump
DP	Differential Pump	N2	Nitrogen gas	TS	Thermal Switch
DR	Atmospheric Door	NMA	Null Modem Adapter	TV	Turbo Vent valve
F	Filter	P#	Process Module <i>number</i>	VS	Vacuum Switch
FB	Front Buffer	PDP	Process Module Defeat Plug	WP	Water Pump

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 Marathon Express 400, refer to ["Field Replaceable Units"](#) for identification of FRUs. Refer to the individual user manuals for lists of the consumable items to be stocked for the components of the Marathon Express 400 system. Refer to the System Manual Addendum, if provided, for a list of all consumable items for that specific configuration.

Appendix E: Tooling

Table 11-2 provides a list of the specialized tools and fixtures supplied with the Marathon Express 400, including shipping brackets. Table 11-3 provides a list of the optional specialized tools and fixtures used for servicing the Marathon Express 400. Table 11-4 provides identification about teach fixture kits used for servicing the Marathon Express 400.

Table 11-2: Tools and Fixtures Supplied with the Marathon Express 400

Tool	Description and Use
Shipping Bracket	Robot Arm Shipping Clamp
Gauge Block	1.279 x 0.985 x 0.560 x 0.535 Elevator Alignment
Gauge Block	1.279 x 0.985 x 0.500 Elevator Alignment
Gauge Block	0.985 x 0.535 x 0.535 Elevator Alignment
Kit, Override Switch for Gen 5	Overrides the Magnetic Safety Sensor Interlock when the Chamber Lid is open.

Table 11-3: Optional Tools and Fixtures for the Marathon Express 400

Tool	Description and Use
Shipping Bracket	Robot Arm Shipping Clamp
Gauge Block	1.279 x 0.985 x 0.560 x 0.535 Elevator Alignment
Gauge Block	1.279 x 0.985 x 0.500 Elevator Alignment
Gauge Block	0.985 x 0.535 x 0.535 Elevator Alignment
Kit, Override Switch for Gen 5	Overrides the Magnetic Safety Sensor Interlock when the Chamber Lid is open.

Table 11-4: Teach Fixture Kit

Image	Description
	FIXTURE,ROBOT ALIGNMENT, MX STD END EFPE

Image	Description
	FIXTURE, VCE ALIGNMENT P2
	PIN, DOWEL, 1/4" X 5/8", SST

Appendix F: Packing and Shipping Instructions

If the Marathon Express 400 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 Marathon Express 400 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 Marathon Express 400. 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 Marathon Express 400 weighs approximately 708.5 kg (1562 lb.). The Vacuum Cassette Elevator modules of the Marathon Express 400 weigh 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 Marathon Express 400. Use a minimum of four people to move the Marathon Express 400 system. Use a minimum of two people to move any other modules.	  

 CAUTION Tip Hazard	
The Marathon Express 400 may tip and fall which may cause serious injury or death. Ensure that all force exerted on the Marathon Express 400 and the modules of the Marathon Express 400 system when moving them is below their center of gravity. Failure to take the proper precautions before moving any module, especially while moving it into the shipping crate, could result in personal injury. Do not attempt to move the Marathon Express 400 without the use of a fork lift or a hoist.	 

Procedure Category

Type 1 Procedure: Equipment is fully de-energized. Refer to ["Laser Hazards" on page 50](#).

Required Tools and Equipment

The tools and materials required during the removal and shipping of the Marathon Express 400 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 Marathon Express 400
- 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 164 .
2.	Remove the any tie-downs from the Marathon Express 400 system frame.
3.	Release the clamps securing the Marathon Express 400 system to the Process Module(s).
4.	Reattach the casters to the MX 400 system's frame using the hardware that was supplied with them.
5.	Lower the casters until the feet have been raised off of the floor.
6.	Screw in the system leveling feet so that they are fully retracted into the frame.
7.	Roll the Marathon Express 400 system away from the Process Modules. NOTE: <i>Inspect the travel route of the Marathon Express system. Cover dips, thresholds, or any uneven floor transitions with plates.</i>
8.	Secure the robot arms in the Marathon Express 400 Vacuum Back End to prevent movement and damage during shipment by using the shipping brackets supplied with the MX 400 system when it was received.
9.	Secure the VCE platform and door to prevent movement and damage during shipment by using the shipping brackets supplied with the MX system when it was received.
10.	Attach blankoffs to the vacuum slot valves on the Marathon Express 400 Vacuum Back End.
11.	Secure any loose cables in the Marathon Express 400 and protect all cable ends and connectors.
12.	Roll the system into a double poly-bag in a class 100 packaging cleanroom.
13.	Lower the system by turning the casters until the system is resting on the fork lift channels inside of the bag. NOTE: <i>Always adjust each caster the same amount. Do not allow the frame of the chamber to twist.</i>
14.	Remove the casters. Replace them on the outside of the bag.
15.	Remove the fork tube gasket seal plates. Replace them on the outside of the bag.
16.	Add desiccant packs as appropriate to ensure the MX 400 system stays dry.

Step	Action
17.	Evacuate and seal the inner and outer poly-bags using heat sealer.
18.	Lower the jacking casters.
19.	Roll the system to the shipping area. NOTE: <i>Inspect the travel route of the Marathon Express 400 system. Cover dips, thresholds, or any uneven floor transitions with plates.</i>
20.	Using the fork lift, pick the Transport Chamber up only enough to clear the shipping skid. Refer to Figure 11-1 for the location of the fork lift channels. NOTE: <i>If the original crates have become lost or damaged, contact Brooks Automation for replacements.</i>
21.	Raise the casters until the wheels are up to the frame.
22.	Slide the shipping skid under the system.
23.	Secure the system to the shipping skid using 1/2 in threaded rod through each of the caster brackets. Additional blocking should be added as required to ensure that the system is adequately secured to the pallet.
24.	Attach the sides and top of the crate.
25.	Add tip indicators, shock indicators, moisture indicators, etc. to the outside of the crate as desired to verify proper handling during shipment.

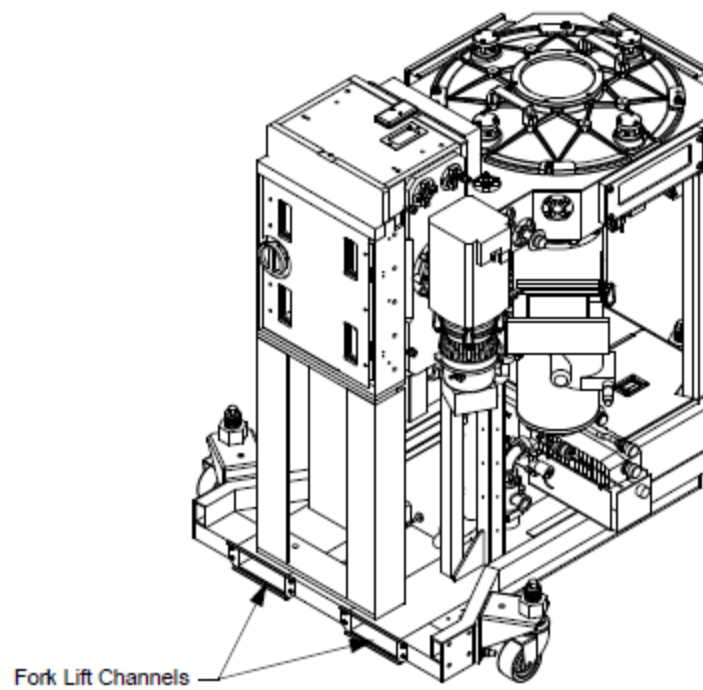


Figure 11-1: Fork Lift Channel Locations

12. Field Replaceable Units

This section identifies those standard items that have been identified as Field Replaceable Units (FRUs) available for user service of the Marathon Express 400 at the system level. FRUs are identified for the Marathon Express 400 based on the demands placed upon the various configurations of the MX 400 system, therefore items may be identified here as FRUs that are not needed for specific configurations. FRUs for individual Brooks Automation components within the system are identified in the component's User Manuals. Refer to the system AT for part and serial numbers. Configuration specific FRUs that are not covered in this section are detailed in the System Manual Addendum.

All Field Replaceable Units identified in this manual are generic and may not reflect specific builds of the MX 400 system. FRUs may be ordered and stocked by the user as Spares at the user's discretion.

Marathon Express 400

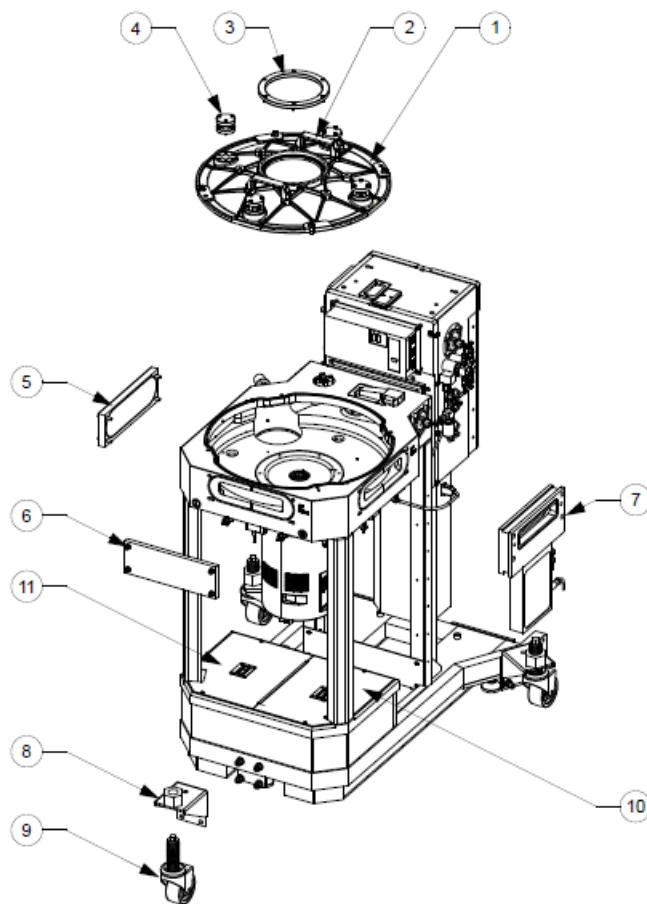
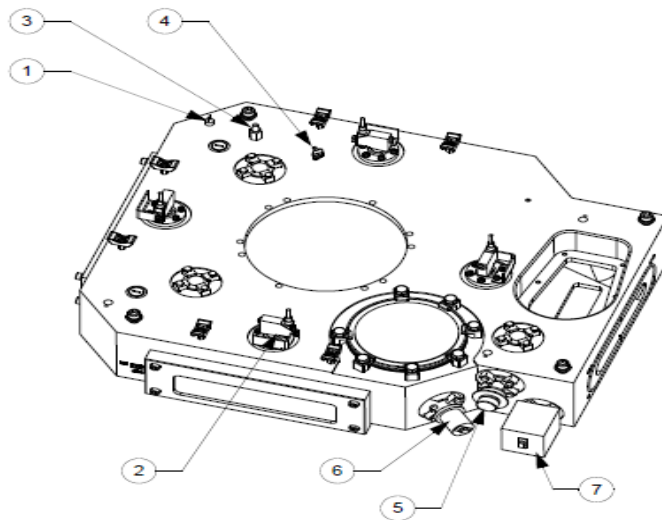


Figure 12-1: Chamber and Frame FRUs

Number	Description
1	ASSY, LID LIFTER,MX400
2	HANDLE, PULL
3	ASSY, WINDOW/BEZEL, CENTER
4	ASSY, SENSOR, RETROREFLECTIVE, KF25
5	ASSY, TRANSPORT VIEWPORT KIT
6	KIT, BLANKOFF, 1/2 MESC FACET
7	VALVE, SLOT, MONOVAT, RECTANGULAR, 200MM, W/DB9 CONN

Number	Description
8	BRACKET, CASTER MOUNT, ATM FRAME
9	CASTER, JACKSCREW, 4" STEM
10	FLOORBOARD, LEFT, FRAME, MX400
11	FLOORBOARD, RIGHT, FRAME, MX400
-	ASSY, BUFFER, CHAMBER, 4 SHELF

**Figure 12-2: Sensor FRUs**

Number	Description
1	ASSY, HEATER W/CONN, 750W, 4" LONG, 240V
2	ASSY, TRANSPARENT WAFER SENSOR, 2.5M CABLE
3	ASSY, THERMOCOUPLE W/ PIGTAIL, 6'
4	SWITCH, THERMAL, 280 DEGREE F, QUICK-CONNECT
5	VALVE, RELIEF, 1 TO 3 PSIG, PRESS
6	SWITCH, PRESSURE, FLANGE SIZE NW25
7	GAUGE, VACUUM, MICRO-ION, RS-485, CE
-	GAUGE, VACUUM, MINI-CONVECTRON, DEVICENET, NW16FKF

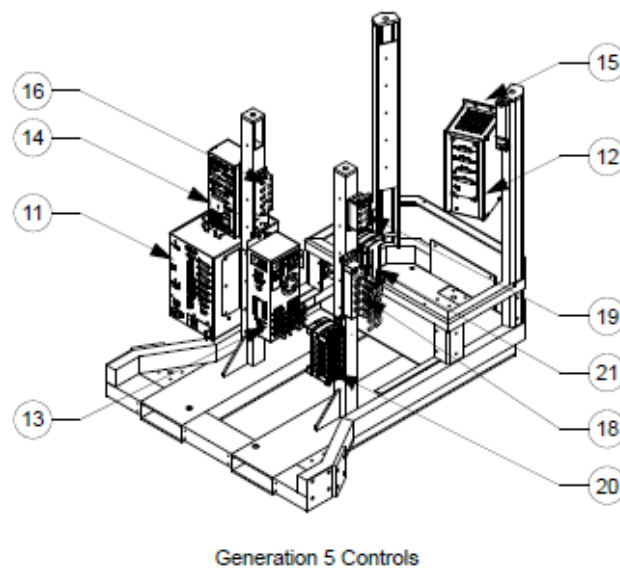
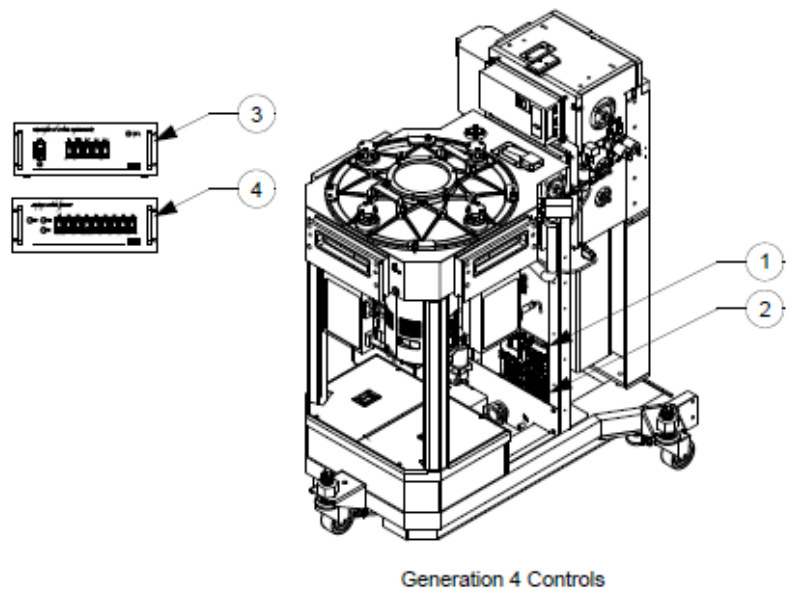


Figure 12-3: Electronics FRUs

Table 12-1: Electronics FRUs

Number	Description
Generation 4 Controls	
1	ASSY, I/O HUB, BROOKSNET, SINGLE MODULE

Number	Description
2	ASSY, COMMUNICATIONS NODE
3	ASSY, DC POWER SUPPLY
-	ASSY, DCPS, MX400, 200-240 V, METRIC MTG FRONT PANEL
4	ASSY, HEATER POWER SUPPLY
Generation 5 Controls	
11	ASSY, SAFETY NODE
12	ASSY, MINI-HUB POWER SUPPLY AND INTERFACE
13	ASSY, AC POWER DIST UNIT, 8 IEC, 20A, 200-240V, GX/FX
14	ASSY, GEN 5 LOAD LOCK NODE
15	SERVER, DEVICE, ETHERNET/SERIAL GATEWAY
16	JUNCTION BLOCK, DNET, 8 PORTS, 16 INPUTS, PNP, M12
18	JUNCTION BLOCK, DNET, 10 PORTS, THICKNET TO M12
19	JUNCTION BLOCK, DEVICENET, 4 PORTS, 8 I/O, M12
20	VALVE ISLAND, 12 STN, DNET, INTRLKD, LL, MX-G5
21	VALVE ISLAND, 12 STN, DNET, INTRLKD, TC, MX-G5

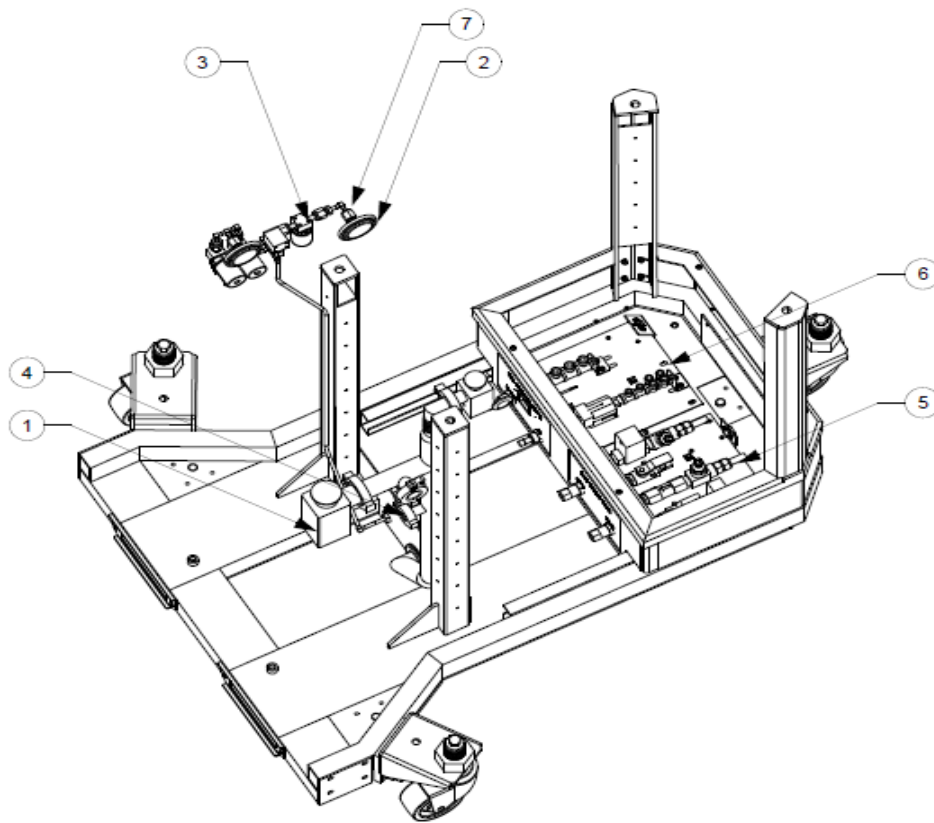
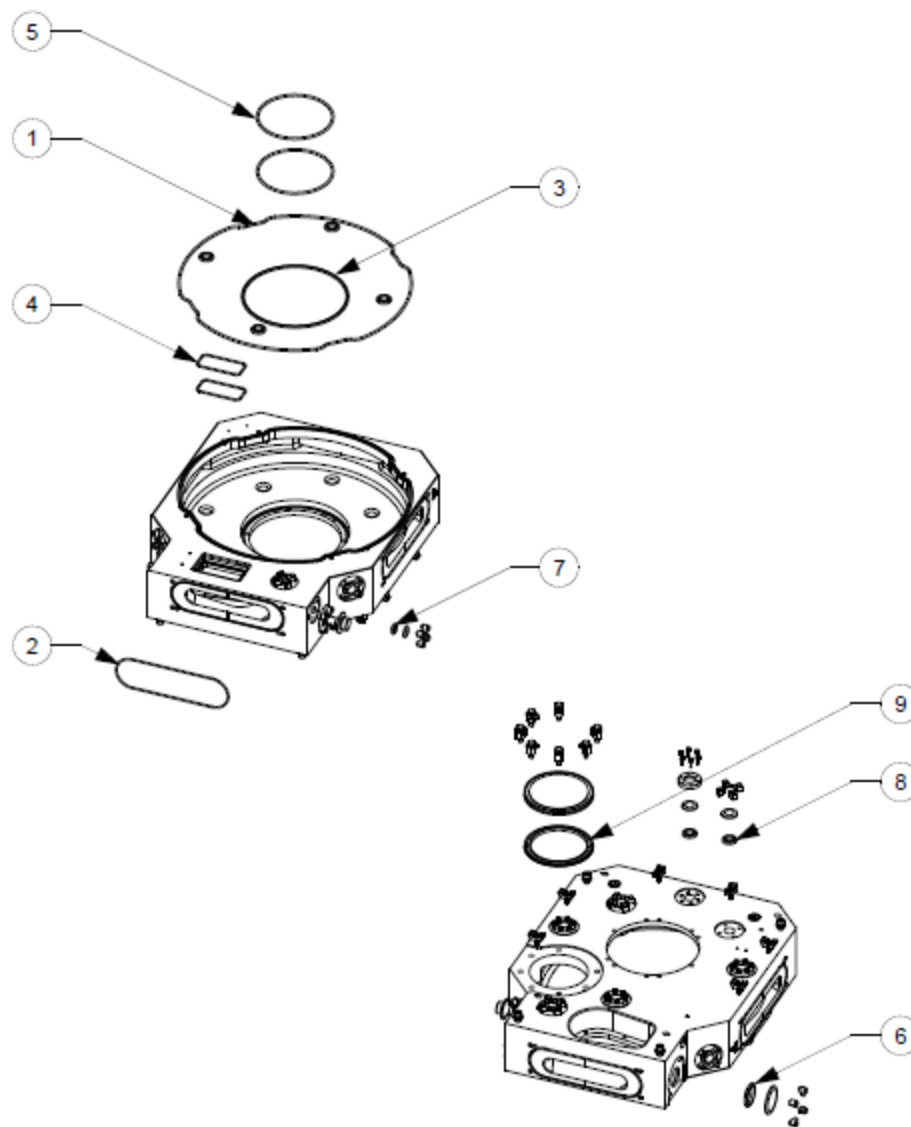


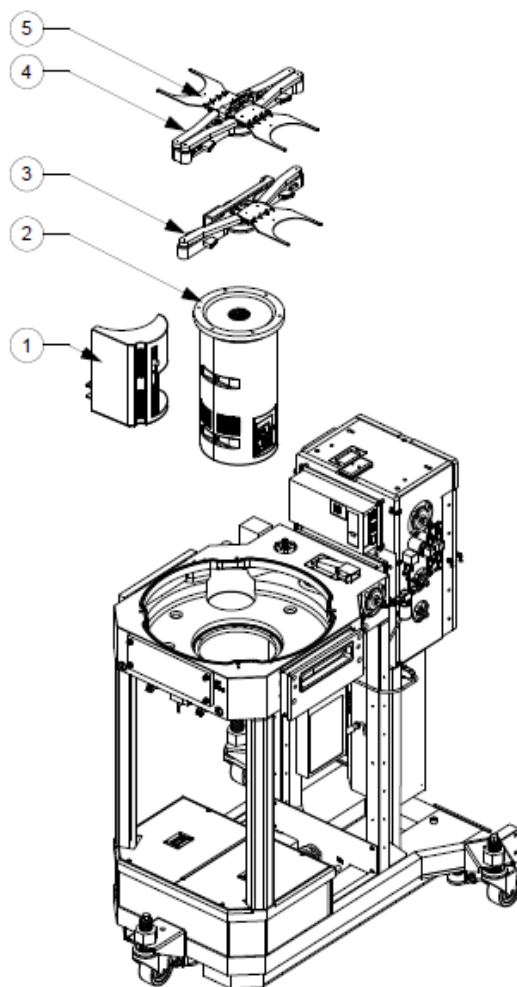
Figure 12-4: Facilities FRUs

Number	Description
1	VALVE, TWO STAGE ANGLE, KF40
2	FILTER/DIFFUSER, KF 50
3	VALVE, AIR OPERATED, NC, 1/4"FACE SEAL, F-F
4	FITTING, CLAMPING RING, DN20-25KF
5	ASSY, WATER FACILITIES
6	KIT, PNEUMATIC AIR/EXHAUST, MX
7	KIT, RETROFIT, VCR GASKET AND ORIFICE, GX

**Figure 12-5: O-Ring Kit**

Number	Description	Qty.
-	KIT, O-RING AND CENTERING RING MX400	-
O-Ring Kit contains the following:		
1	O-RING, VITON, 23.94 ID X 24.36 OD X 3/16 W	1
2	O-RING, VITON, 9"ID X 9 1/4"OD X 1/8"W	4

Number	Description	Qty.
3	O-RING, VITON, 10 1/2"ID X 10 7/8"OD X 3/16"W	1
4	O-RING, VITON, 4"ID X 4 1/4"OD X 1/8"W	2
5	O-RING,VITON,0.210" XSEC DIA,7.50" ID	2
6	FITTING, KF50 CENTERING RING AL/VITON	1
7	FITTING, CENTERING RING, 16 KF, VITON	2
8	FITTING, CENTERING RING, 25 KF, ALUM/VITON	14
9	FITTING, CENTERING RING, 160 ISO, ALUM/VITON	1

**Figure 12-6: Robot FRUs**

Number	Description
1	ASSY, POWERPACK WITH FEET
2	ASSY, MAG7.1, 35Z, 0 DEG, MX, I/O, C5
3	ASSY, SINGLE ARM, MAG7
4	ASSY, DUAL ARM, MAG 7
5 ¹	ASSY, END EFFECTOR

¹Note that changing end effectors to different part numbers requires a new application number for the robot and may require additional changes to the configuration of the Marathon Express 400 to ensure proper operation.