
Brooks Automation

Atmospheric Pre-aligner User's Manual



For the Single-Axis **PRE-050** Pre-aligner,
Three-Axis **PRE-200** and **PRE-201** Pre-aligners,
Three-Axis **PRE-300** and **PRE-301** Pre-aligners
and the Single-Axis **PRE-350** Pre-aligner

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Changes

Overview

Changes may be made to this manual to ensure that it will continue to provide the most complete documentation possible for the Brooks Automation Atmospheric Pre-aligner. This section provides a brief description of each change.

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.

Revision 1

This manual was previously released as Equipe/PRI Automation Atmospheric Pre-aligner Manual, December 1998, Part Number 4000-0015 Revision 1. The manual was transferred to the Brooks Automation format.

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1

Introduction

Overview

This Introduction provides a brief overview of Brooks Automation Atmospheric Pre-aligner, highlighting its features, operation, and specifications. Additionally, the chapter organization and a description of each chapter's contents is presented, and notation conventions are explained.

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Atmospheric Pre-aligner Overview

The Pre-aligner determines the center of the wafer and the orientation of the fiducial and positions the wafer for handling. A wafer handling system requires a Pre-aligner if:

- The fiducial must be oriented to a specific axis in the tool.
- The wafer must be placed in the process or measurement tool with greater precision than the cassette tolerance allows.
- The wafer must be placed in the process or measurement tool within the field of view of a pattern recognition camera.



Figure 1-1: Atmospheric Pre-aligner

This manual is intended for Brooks Automation customers who have purchased an atmospheric wafer Pre-aligner. This manual describes the installation, operation, and troubleshooting of the Equipe PRE-050, PRE-200, PRE-201, PRE-300, PRE-301 and PRE-350 Pre-aligners.

The Pre-aligner is an optional component in a robotic system, which includes a robot, either single-arm or dual-arm, a Brooks Automation Controller and, optionally, a track, a flipper, laser scanner, or front-end loader. In addition, the robotic system might include one or more customer components.

The example instructions in this manual cannot be specific to your specialized system. Instead, the instructions assume a Pre-aligner only system. That is, if your system includes more components than a Pre-aligner and a Controller, refer to the other component manuals to coordinate the installation and operation of your system.

Features

Brooks Automation atmospheric Pre-aligners combine high resolution optical sensing with Charged Couple Device (CCD) pixel resolution of 10.7 microns. High-precision mechanics and chuck-encoder resolution of 0.018° ensure consistent performance and repeatability. A uniform light source provides optimal illumination of the CCD sensors.

Atmospheric Pre-aligner Models

Brooks Automation builds Three-Axis and Single-Axis Pre-aligners.

Three-Axis Pre-aligner

A three-axis Pre-aligner can independently align a wafer while the robot is processing another wafer. The chuck spins the wafer between the LED array and CCD array and the three pins lift and shift the wafer. A Pre-aligner Amplifier Board in the Controller amplifies the PWM motor-driven signals to drive the three motors in the Pre-aligner. Three servo axes move in three directions during alignment:

- The vertical axis raises and lowers the wafer using the pins.
- The theta axis rotates the wafer chuck to align the flat or notch to the programmed orientation. The Pre-aligner automatically detects if the wafer being aligned has a notch or a flat.
- The radial axis shifts the wafer laterally to center the wafer.

Single-Axis Pre-aligner

A Single-Axis Pre-aligner has no pins and relies on the robot radius (R) and vertical (Z) axes to lift and translate the wafer. The Controller for a single-axis Pre-aligner does not have a Pre-aligner Amplifier Board as a single AMC driver unit is used.

Pin Loading and Chuck Loading

Pin length and type of robot end effector determine whether a Pre-aligner is pin loading or chuck loading. Brooks Automation Pre-aligners work with either a Horseshoe End-Effector or a Blade End-Effector:

- With a Horseshoe End-Effector, the wafer is loaded directly onto the wafer chuck. Using a Horseshoe End-Effector is faster because time is not required to raise and lower the transfer pins while loading. If the Pre-aligner has pins, they are short pins.
- With a Blade End-Effector, the wafer is loaded on the pins. The end effector

then retracts and the pins lower until the wafer is on the chuck. Blade End Effectors are durable and have a low relative mass, but are slower than the Horseshoe End Effector. The pins are long pins.

The type of loading for the PRE-300 and PRE-301 is determined by a software setting. That is, if you have a chuck loading PRE-300, you can change it to a pin loader by resetting the pin length with the SWL command. Changing wafer size requires only that you enter the new size with the SWS software command. No mechanical modifications or adjustments are required.

Summary of Brooks Automation Pre-aligners

The Single-Axis **PRE-050 Pre-aligner** has one axis and no pin assembly to move the wafer in the r- and z-directions. The t axis rotates the wafer and the robot lifts the wafer and centers it on the chuck. The PRE-050 is used for applications where throughput is not a critical issue.

The Three-Axis **PRE-200** and **PRE-201** have three axes to center and align the wafer. A difference in hardware makes the PRE-200 a chuck loader and the PRE-201 a pin loader.

The Three-Axis **PRE-300** and **PRE-301** have three axes to center and align the wafer. The physical dimensions are larger than those of a PRE-200 or PRE-201 Pre-aligner to accommodate 12-in (300-mm) wafers. A difference in software settings makes the PRE-300 a chuck loader and the PRE-301 a pin loader. You can reset the software to change the load type by using the RWL and SWL commands. Refer to Chapter 8: Commands, for information about using these commands.

The Single-Axis **PRE-350** has one axis, the t axis, to center and align the wafer. The physical dimensions are larger than those of a PRE-050 to accommodate 12-in (300-mm) wafers.

Table 1-1: Atmospheric Pre-aligner Models

Model	Number of Axes	Wafer Sizes	Load Type	End Effector
PRE-050	1	3 to 8 in (76 to 200 mm)	Chuck	Horseshoe
PRE-200	3	3 to 8 in (76 to 200 mm)	Chuck	Horseshoe
PRE-201	3	3 to 8 in (76 to 200 mm)	Pin	Blade
PRE-300	3	200 and 300 mm with optional 150 mm	Chuck	Horseshoe

Table 1-1: Atmospheric Pre-aligner Models

Model	Number of Axes	Wafer Sizes	Load Type	End Effector
PRE-301	3	200 and 300 mm with optional 150 mm	Pin	Blade
PRE-350	1	200 and 300 mm with optional 150 mm	Chuck	Horseshoe

Operation Overview

Either a Brooks Automation Smart Controller (ESC) for single-arm robots or an Brooks Automation Dual Controller (EDC) for dual-arm robots can control a Pre-aligner. The number of axes in your system determines the specific ESC/EDC model.

The Controller contains the Pre-aligner input/output board. For a three-axis Pre-aligner, a Pre-aligner Amplifier Board amplifies the PWM motor-driver signals to drive the three motors in the Pre-aligner. For a Single-axis Pre-aligner, a single AMC driver unit is used rather than an amplifier board.

The CPU Board has on-board Non-Volatile Static Random Access Memory (NVS-RAM) to store macros and critical files. Firmware is loaded on EPROMs on the CPU board.

The Controller processes the wafer-edge image data from the Pre-aligner Charged Couple Device (CCD). The CCD/LED pairs monitor the edge of the wafer during wafer alignment. The Controller CPU board is equipped with an on-board Math Coprocessor for processing the image data.

You can use a hand-held Teach Pendant with LCD display or a personal computer (PC) to control your Pre-aligner.

- The Teach Pendant communicates through an RS-232C serial link from the COM 2 port on the Controller and executes macros written by the user that reside in the Controller. Information on using the Teach Pendant is located in the *Smart Controller User's Manual*.
- You can use any standard personal computer using serial communications. Brooks Automation provides the EQT32 graphical user interface for controlling your system or you can incorporate your own interface in your host system. Information for creating your own interface is given in the *Smart Controller User's Manual*.

Alignment Overview

The three-axis Pre-aligners have servo-driven mechanisms to rotate the incoming wafer between the linear array CCD sensor and the LED array. The single-axis Pre-aligner moves the wafer in the theta direction only; the robot moves the wafer in the r and z directions. Except for the difference, the aligning process is the same.

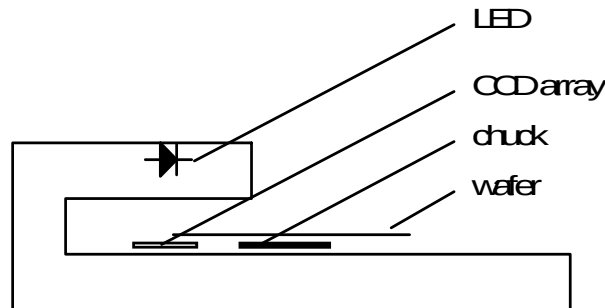


Figure 1-2: Side View of the Atmospheric Pre-aligner

1. When you execute your alignment macro (ALIGN, AL, BAL, or PRL), the Controller opens the wafer chuck vacuum valve and checks the status of the sensor. If it senses that a wafer is present on the chuck, the alignment continues. If no vacuum is sensed, alignment stops.
2. Data from the CCD sensor is sent to the Pre-aligner I/O board over a separate Data Cable. The CPU board plots the encoder count in relation to the CCD count. A perfectly centered wafer would appear as a straight line, while an offset wafer would appear as a sinusoidal waveform. The flat or notch appears as a discontinuity in the data.
3. The CPU board analyzes the data and computes a correction vector and a flat/notch rotation position. The wafer is then centered:
 - A three-axis Pre-aligner has three vacuum pins spaced around the rotating wafer chuck. These pins shift the wafer to the center position by aligning the offset with the r (horizontal) axis and then lifting and shifting the wafer using the r axis and the z (vertical) axis.
 - A single-axis Pre-aligner uses the robot radial and vertical axes to center the wafer.
4. With the wafer centered in the r direction on the wafer chuck, the Pre-aligner moves the primary flat or notch to the user-specified position.

5. The Controller sends a message to the host computer giving the status of the alignment attempt.

Fast Align Option

To further increase the throughput of three-axis chuck-loading Pre-aligners, Brooks Automation offers the Fast Align Option. A combination of faster hardware movement, faster collection of CCD data, and firmware algorithms speed up the overall alignment process.

Information for using the Fast Align Option in conjunction with the robot is given in [Chapter 4: Operation](#).

Documentation Overview

The documentation provided with the Atmospheric Pre-aligner includes this manual, which provides a complete documentation package for selection, installation, operation, maintenance, and repair of the product.

Changes: An overview of the changes to this manual since its initial release.

Chapter 1: *Introduction*: An overview of the product.

Chapter 2: *Safety*: Safety concerns and requirements for the product.

Chapter 3: *Installation*: Site preparation, unpacking, and installation information for the product, including all setup procedures, initial check-out, and alignment.

Chapter 4: *Subsystems*: Detailed information on the various subsystems of the product.

Chapter 5: *Operational Interfaces*: Detailed information on the interfaces to the product.

Chapter 4: *Operation*: Operating procedures for the product, including an overview of all controls and indicators.

Chapter 5: *Adjustments and Calibration*: Standard adjustments and calibrations required for proper operation of the product.

Chapter 6: *Command Reference*: Software control features for the product, including a complete Command Reference and Error Reference.

Chapter 7: *Maintenance*: Preventive maintenance schedules and procedures and basic repair procedures for the standard maintenance of the product.

Chapter 8: *Troubleshooting*: Troubleshooting guidelines for the product.

Glossary: Definitions of terms used within this manual.

Using this Manual

This User's Manual provides documentation for operation and maintenance of the Brooks Automation Atmospheric Pre-aligner. While this document covers specific information and adjustments for the Atmospheric Pre-aligner, there is information in other manuals which affect the settings or operating mode of the Atmospheric Pre-aligner.

Additional Reference Materials

The *Atmospheric Pre-aligner Manual* may refer the reader to these manuals for additional information.

- *Smart Controller User's Manual*
- *Atmospheric Single-Arm Robot User's Manual*
- *Atmospheric Dual-Arm Robot User's Manual*

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

Note, Hazards, and Pictograms

Notes and hazards used within this manual have very specific meanings and formats. A description of the meanings of these terms is provided below.

NOTE: *A note provides additional or explanatory information.*



A CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices or the potential for equipment damage.



A WARNING indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.



A DANGER indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.

Specifications

This section includes the environmental, mechanical, electrical, and vacuum requirements your facility must have before installing a Pre-aligner.

The Pre-aligner is designed for cleanroom environments. It is not intended for use in environments of explosive mixtures, corrosive conditions, high humidity, or dust. Specifications for operation and storage are as follows:

Operating Temperature:

59° F to 89° F (15° C to 32.5° C)

Shipping Temperature:

-4° F to 104° F (-20° C to 40° C)

Storage Temperature:

-13° F to 131° F (-25° C to 55° C), up to 149° F (65° C) for 24 hrs

Humidity: 10% to 80% (relative, non-condensing)

Lighting: Standard lighting provided in the cleanroom environment where the Atmospheric Pre-aligner is installed is sufficient for proper operation and maintenance.

Electrical Specifications

The Atmospheric Pre-aligner requires the use of the Brooks Automation Smart Controller that provides power for operation. The actual power being drawn will depend upon operations being performed, however all power wiring must be capable of carrying the full load. Internal power converters produce the different voltages required by the different subsystems of the Atmospheric Pre-aligner.

NOTE: *The facility is responsible for the main disconnect device between the Atmospheric Pre-aligner and the facilities' power source, ensuring it complies with the correct electric codes. Service to the Atmospheric Pre-aligner should have the appropriate fuse or circuit breaker rating.*

The Pre-aligner receives its power from the Controller. Electrical specifications are as follows:.

Table 1-2: Controller Electrical Specifications

Operating Specifications	Voltage
100/120 VAC@ 5 amps	Voltage 92 VAC to 260 VAC Frequency: 47 Hz to 63 Hz
220/240 VAC @ 2.5 amps	

The two signal cables connecting the Pre-aligner and the Controller are isolated from the power cable that is connected from the Pre-aligner and the Controller.

Vacuum Specifications

The pre-aligner requires an external vacuum source. The pre-aligner has a vacuum switch for the wafer chuck vacuum and a vacuum switch for the pin vacuum. There is a vacuum sensor for the wafer chuck vacuum, but no vacuum sensor for the pin vacuum.

It is recommended that the vacuum pressure you supply to the fitting is between -20 and -25 in Hg (67728 to 84660 Pa).

The vacuum fitting is sized to accommodate 1/8 in OD hose, unless customized.

Mechanical Specifications

Before installing a pre-aligner, make sure you have a baseplate made of either 0.500+ in thick aluminum or 0.375+ in thick stainless steel.

Seismic Requirements

Bolt the Pre-aligner to the system.

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Safety

Overview

This chapter describes safety guidelines for the Brooks Automation Atmospheric Pre-aligner. All personnel involved in the operation or maintenance of the product 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 Atmospheric Pre-aligner is installed has additional safety guidelines they should be followed as well, along with the applicable national and international safety codes.

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Regulatory Compliance

The regulatory compliance information and safety requirements in this chapter are intended for CE-compliant and SEMI S2-ready Pre-aligners only.

To determine if the Atmospheric Pre-aligner is CE compliant, check for the CE mark on the Atmospheric Pre-aligner. If necessary, request the official Declaration of Conformity (DOC) from Brooks Automation. The Atmospheric Pre-aligner is also S2 compliant. If necessary, request a copy of the Third Party Certificate of Compliance (COC) from Brooks Automation.

In addition to this section, other sections may include regulatory information.

Table 2-1: Safety Agencies

Approval of Safety Agencies	This equipment has been examined for user safety and complies with the regulations set by the following organizations:
CE (Conformité Européenne) - The European safety requirements	• Machinery Directive • LVD Directive • EMC Directive
Semiconductor Equipment and Materials International (SEMI)	Safety Guidelines for Semiconductor Manufacturing Equipment (the SEMI S2 Guidelines).

Safety Features

A Pre-aligner is a low-inertia mechanism and turns off servo motors quickly when an obstruction is encountered. Low mass and inertia allow the following error to be set low, even when high speeds are required. Mechanical stops are placed at the positive and negative limits of the r and z axes to prevent the Pre-aligner from over travel and possible damage.

The following conditions result in an internally generated signal that disables the amplifiers:

- The Controller bus power fails
- A servo amplifier fails
- Motor power fails inside the Pre-aligner
- The signal cable connection is broken
- The servo motor control fails.

Cable Connectors

Cable connectors for the CCD data cable, motor signal cable, and power cable are heavy-duty locking D-type connectors. If you disconnect the signal cable, the amplifier is disabled.



WARNING

Be sure the connector locking screws are locked down during installation and operation!

Safety Considerations

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



WARNING

Only qualified personnel are permitted to operate or maintain the Atmospheric Pre-aligner. Properly qualified personnel are those who have received certified training and have the appropriate qualifications for their jobs.

Personnel Safety Guidelines

The Brooks Automation Atmospheric Pre-aligner may provide several direct safety hazards to personnel if not properly installed or operated.

- Persons operating the Atmospheric Pre-aligner should be properly trained.
- Possible injury can result from the automatic operation of the Atmospheric Pre-aligner.
- Know the location of the following:
 - Fire extinguisher
 - First Aid Station
 - Emergency eyewash and/or shower
 - Emergency exit
- Be aware of sharp edges while working around the Atmospheric Pre-aligner.
- The following safety equipment should be donned prior to operating or servicing the Atmospheric Pre-aligner:
 - Eye protection
 - Hard hat
 - Safety Shoes
- Observe the facility guidelines pertaining to loose clothing while working around or operating the Atmospheric Pre-aligner.
- Perform a complete review of the Material Safety Data Sheets (MSDS) for each material used with the Atmospheric Pre-aligner. These individual sheets are provided by the suppliers of the materials.

- It may be recommended that the use of hazardous materials, such as cleaning fluids, be used during routine maintenance procedures. Perform a complete review of the Safety Information Sheet provided at the end of this chapter for each recommended substance.
- There are no ergonomic or human factor requirements for the Pre-aligner.

Equipment Safety Guidelines

The Atmospheric Pre-aligner user is accountable for the following safety concepts:

- If hazardous materials are to be present, users must take responsibility to observe the proper safety precautions and insure that the material used is compatible with those from which the Atmospheric Pre-aligner is fabricated.
- Users are responsible for the detection of unwanted chemical or gaseous releases.
- The user shall determine if the Atmospheric Pre-aligner will be employed in an earthquake prone environment and rectify equipment installation accordingly.



CAUTION

The Atmospheric Pre-aligner is not provided with an Emergency Machine Off (EMO) device. The user is accountable for the EMO circuit.

The following safety considerations are provided to aid in the placement and use of the Atmospheric Pre-aligner.



TRIP HAZARD

- Do not place the Atmospheric Pre-aligner's facilities connections (power and communications cables) where they could cause a safety hazard.
- Do not place the Atmospheric Pre-aligner in a location where it may be subject to physical damage.
- Ensure that all power connections to the Atmospheric Pre-aligner are properly grounded.
- Ensure that the Atmospheric Pre-aligner receives proper air flow for cooling.
- Do not remove any Warning, Hazard, or Equipment Identification labels.

- Turn OFF power before inserting or removing power cables.
- Be aware of the hazardous points of the Atmospheric Pre-aligner as described in this section.



CAUTION

Use of the Atmospheric Pre-aligner for any purpose other than as an atmospheric wafer aligner is not recommended and may cause damage to the Atmospheric Pre-aligner or the system.

Some moving mechanisms have no obstruction sensors and can cause personal injury.

Whenever power is applied, the possibility of automatic movement of the components within the Atmospheric Pre-aligner exists, which could result in personal injury.

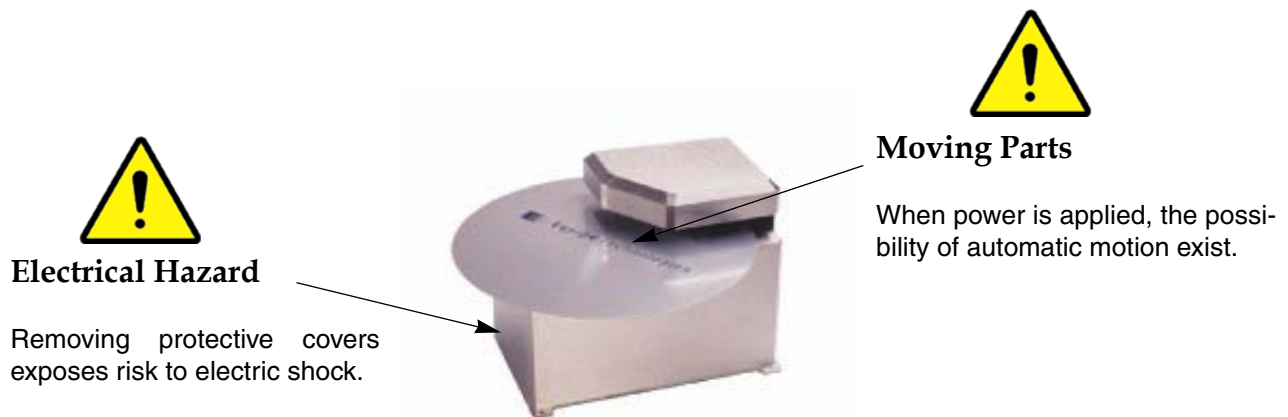


Figure 2-1: Safety Hazard Location on the Pre-aligner

EMC and ESD Protection

A third party has tested the Atmospheric Pre-aligner to ensure electromagnetic compatibility for both emissions and immunity. The Atmospheric Pre-aligner complies with the EMC Directive.

For protection against Electromagnetic Interference (EMI), it is strongly recommended that you mount the Pre-aligner directly to equipment ground, forming a metal-to-metal contact.

Protection against electrostatic discharge (ESD) is designed into the Pre-aligner. The Pre-aligner complies with the ESD requirement of the EMC Directive.

Safety Labels

Hazards to personnel include electric shock or burns.

Damage to equipment may result from faulty installation, improper operation, inadequate or incorrect maintenance, and other forms of misuse or abuse. Safety labels are attached to both the Pre-aligner and Controller.



WARNING

Ignoring information about potential hazards can lead to serious harm to personnel and/or damage to equipment, and may result in the nullification of the manufacturer's equipment warranty.

High Voltage Label

The high voltage-warning label is attached to the Pre-aligner:

Figure 2-2, shows the label that is affixed to the Brooks Automation Atmospheric Pre-aligner. These labels are used to alert personnel to hazards on or within the Atmospheric Pre-aligner and to provide information about the Atmospheric Pre-aligner. To replace a lost or damaged label, call Brooks Automation Technical Support.

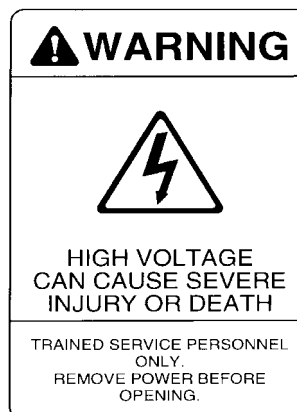


Figure 2-2: High Voltage Warning Label

Mechanical Hazards

Provide a baseplate made of either 0.500+ in. thick aluminum or 0.375 in. thick stainless steel.

Only persons with the proper training should service or operate the Atmospheric Pre-aligner.

All facilities to the Atmospheric Pre-aligner must be disconnected as outlined in the facilities' lockout/tagout procedure before servicing, or injury may result from the automatic operation of the equipment. The proper precautions for operating and servicing remotely controlled electro-mechanical equipment must be observed. These precautions include wearing safety glasses, steel toe shoes, and any other precautions specified within the facility where the Atmospheric Pre-aligner is being used.



WARNING

Moving mechanisms have no obstruction sensors. Do not operate the Atmospheric Pre-aligner without the protective covers in place or personal injury could result in the squeezing or compression of fingers or hands between moving parts. When servicing the Atmospheric Pre-aligner, ensure that all equipment connected to it is also shut down using lockout/tagout to prevent automatic movement within that equipment.



TIP HAZARD

Tip hazard exists when moving the Atmospheric Pre-aligner or when it is not attached to the user's process tool.



TRIP HAZARD

Trip hazard exists if the facilities connections (power and communications cables, gas and vacuum lines) for the Atmospheric Pre-aligner are not routed to ensure they don't cause a safety hazard.

Electrical Hazards

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 Atmospheric Pre-aligner is being used.

The Pre-aligner receives its power from the Brooks Automation Atmospheric Pre-aligner Controller. Electrical specifications for the Controller are as follows:

Table 2-2: Controller Specifications

Operating Specifications	Tolerances
100/120 VAC @ 5 amps	Voltage: 92 VAC to 260 VAC Frequency: 47 Hz to 63 Hz
220/240 VAC @ 2.5 amps	

Lockout/Tagout

Per standard industry practices, lockout/tagout procedures must be followed when service/maintenance is performed on the Atmospheric Pre-aligner to prevent personal injury or equipment damage. Local or company procedures must be followed; but where no procedures exist, follow the guidelines below.

If a service lock and/or tag is installed, DO NOT remove the lock, tag, or engage the circuit breaker without proper authorization.



WARNING

All power to the Atmospheric Pre-aligner must be disconnected per the facilities' lockout/tagout procedure. Potentially hazardous conditions or actions may exist that may result in personal injury.

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

- Use LOCKOUT/TAGOUT for high voltage electrical circuit repair.
- Use TAGOUT for low voltage (below 30 volts) electrical circuit repair.
- Use LOCKOUT/TAGOUT for maintenance, cleaning, or lubricating moving parts if the Atmospheric Pre-aligner is used with in an environment with a robot or high voltage (over 30 volts).

Tagout

When using tagout procedures, a written warning is attached to the switches/circuit breakers that are placed in a SAFE or OFF position. The SAME person 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-releasable and attached by hand. A nylon cable tie is recommended.

Tagout Procedure

1. Notify all affected personnel that a tagout is required.
2. Set the system circuit breaker or main disconnect switch to the off position.
3. Place a warning tag on the circuit breaker handle bar or main disconnect switch.

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

4. Using a voltmeter, electrically verify that the associated circuitry is de-energized.

Lockout/Tagout

When using lockout procedures, a lock is attached to switches/circuit breakers to keep equipment from being set in motion and endangering service personnel. One key is to be provided for each lock and must be kept by the person or persons doing the work. Each person doing the work must attach their own lock and tag.

Lockout/Tagout Procedure

Perform Tagout procedure above, but also disconnect AC to the End Tool and lockout per local Lockout/Tagout procedures.

Electrical Hazard Classifications

The following table describes the four types of electrical hazard classifications as per

SEMI S2-0200. Brooks Automation has designed the Atmospheric Pre-aligner to require minimum need to conduct testing or maintenance. Calibrations and adjustments are performed with the power on and live circuits covered. **No equipment should ever be repaired or replaced with the power on.**

Table 2-3: Electrical Hazard Classifications

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

Chemical Hazards

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



WARNING

Some chemicals may leave a flammable or toxic residue.

When a chemical is used during servicing the Atmospheric Pre-aligner, 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 Atmospheric Pre-aligner is being used.



WARNING

Whenever any cleaning fluid is used during service of the Atmospheric Pre-aligner, the facilities' environmental procedures must be followed regarding the storage, handling, and disposal of that fluid along with any affected apparatus.



WARNING

Allow the Atmospheric Pre-aligner to completely cool before performing maintenance involving volatile chemicals.

Thermal Hazards

The Atmospheric Pre-aligner does not use thermal heat during operation. However, the product may become hot during usage. Be aware of these areas during servicing of the robot.



DANGER

Heating during use could cause burns when in contact with skin.
Allow time for them to cool before servicing the robot.



WARNING

Allow the system chamber and robot to completely cool before performing maintenance involving volatile chemicals.

Vacuum Hazards

The Brooks Automation Atmospheric Pre-aligner is designed for use in vacuum applications.

The Pre-aligner requires an external vacuum source. The Pre-aligner has a vacuum switch for the wafer chuck vacuum and a vacuum switch for the pin vacuum. There is a vacuum sensor for the wafer chuck vacuum, but no vacuum sensor for the pin vacuum.

It is recommended that the vacuum pressure you supply to the fitting is between -20 and -25 in Hg (67728 to 84660 Pa).



WARNING

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

The standard vacuum safety measures for the application in which the Atmospheric Pre-aligner is being used should be applied.



DANGER

Implosion may result from equipment damage. It is essential that a complete inspection of the equipment be performed prior to use.



CAUTION

Uncontrolled venting such as opening an unequalized slot valve may result in severe damage to the equipment.



CAUTION

The Brooks Automation Atmospheric Pre-aligner is designed specifically for vacuum and has no overpressure protection. Internal pres-

ures must never exceed normal atmospheric pressure, as damage to the Atmospheric Pre-aligner could result.

Fire and Explosion Hazards

The Brooks Automation Atmospheric Pre-aligner provides no direct fire or explosion hazard. However, the use of Isopropyl alcohol or other flammable solvents around the Atmospheric Pre-aligner 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 Atmospheric Pre-aligner, the proper precautions for use of those fluids must be observed.



WARNING

Never use isopropyl alcohol to clean hot parts due to the risk of fire or explosion. Allow the Atmospheric Pre-aligner to completely cool before performing maintenance involving flammable cleaning fluids.



CAUTION

Whenever any cleaning fluid is used during service of the Atmospheric Pre-aligner, all power to the Atmospheric Pre-aligner should be disconnected and the standard precautions for use of that fluid must be employed.

Environmental Hazards

Noise

The Brooks Automation Atmospheric Pre-aligner provides no direct noise hazard.

Vibration

The Brooks Automation Atmospheric Pre-aligner provides no direct vibration hazard. Any vibrations produced are minimal and cause no hazardous conditions.

Matrix of Emergency and Corrective Response Actions

The following matrix provides emergency and corrective actions for safety issues that may arise regarding the Atmospheric Pre-aligner only. Emergency and corrective actions required for the equipment that the Atmospheric Pre-aligner is installed in should be provided with that equipment.

Table 2-4: Emergency Action Matrix

Emergency	Corrective Response
Electric Shock 	Disconnect from power source.
Fire 	Use a non-conductive fire extinguisher (Class C).
Mechanical Pinch 	Perform one of the following: • Press EMO button (user accountable circuit) • Turn off power from source

Material Safety Information

Hazardous materials may be present during the operation of the Atmospheric Pre-aligner or during maintenance. Hazardous material distributors provide a Material Safety Data Sheet (MSDS) for all materials they supply. These sheets provide crucial information pertaining to the hazardous material used in the equipment.

Isopropyl alcohol may be recommended for use with the Atmospheric Pre-aligner. The following material safety information is provided as a guideline for proper conduct when working with alcohol and corrective action if exposed.

Isopropyl Alcohol Safety Information

Isopropyl Alcohol (IPA) is a clear, colorless, mobile flammable liquid with the chemical formula C_3H_7OH . Short term exposure to IPA is irritating to skin, eyes, and mucous membranes. Long term exposure may cause drying, cracking, or burning of the skin. A person working with IPA must be thoroughly familiar with MSDS precautions and corrective action to take in the event of exposure.

Pre-existing medical conditions may be aggravated by IPA. Isopropyl alcohol should not be used with aluminum equipment at temperatures above 120° F. Isopropyl Alcohol is incompatible with strong oxidizing agents, acids, chlorine, acetaldehyde, ethylene, and isocyanates. IPA decomposes into hazardous carbon monoxide and carbon dioxide.

Hazard	Emergency Action
Fire 	• Flammable/combustible material; may be ignited by heat, sparks, or flames. • Vapors may travel to a source of ignition and flash back. • Container may explode in heat of fire. • Fire may produce irritating or poisonous gases. • Small fires may be put out with a CO₂ or dry chemical type extinguisher. • Large fires may be extinguished with water spray, fog, or foam. • Move the container from fire area if this can be performed without risk.
Leak	• Shut off ignition sources. No flames or smoking in hazard area. • Stop leak if possible. • For small spills, take up with sand or other noncombustible absorbent material and dispose of properly.
Inhalation	• May be poisonous if inhaled. • Vapors may cause dizziness or suffocation. • Move victim to fresh air and call emergency medical care. If victim is not breathing perform artificial respiration.
Skin Contact	• May be poisonous if absorbed through the skin. • Contact may irritate or burn skin and eyes. • In case of contact with eyes, flush eyes with running water for at least 15 minutes. • In case of contact with skin, wash skin with soap and water. Remove and isolate clothing and shoes at the site.

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3

Installation

Overview

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

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Unpacking and Inspection 3-2

Installation Procedure 3-4

Initial Power-up Sequence 3-9

Installing the EQT 32 Interface.....3-11

Preliminary Teaching 3-13

Alignment and Calibration.....3-14

Unpacking and Inspection

The Atmospheric Pre-aligner is shipped individually sealed to maintain cleanroom conformance. Inspect and verify its contents against the checklist provided on the front page of the QR. Report any damage immediately to the shipper and to Brooks Automation.

The contents of the shipping crates will depend on the items purchased. Refer to the QR for the exact contents.

The Quality Report (QR) is a permanent record of the Atmospheric Pre-aligner as it was manufactured by Brooks Automation. In addition to providing information about serial number, model number, etc., it also provides critical data about load port designations, system assignments, station numbers, etc. Make copies of the form and keep a copy close to the Atmospheric Pre-aligner. Should maintenance be required, data from the QR will be needed.

This chapter gives instructions for installing a Pre-aligner only. If you are installing an integrated system, use the instructions from your *Robot Manual* and any other component manuals to coordinate the installation of all components.

To install a Pre-aligner, you will:

- Unpack the Pre-aligner and the Controller
- Position the Pre-aligner and Controller
- Level the Pre-aligner
- Connect the Pre-aligner to the Controller
- Connect the vacuum source to the Pre-aligner
- Access a user interface (EQT or a Teach Pendant)
- Verify connections
- Teach and operate the Pre-aligner

Unpacking Instructions

NOTE: *The Atmospheric Pre-aligner was assembled and bagged in plastic in a cleanroom environment. To ensure the cleanliness of the Atmospheric Pre-aligner, only unbag it in a cleanroom environment.*

1. Remove the Pre-aligner from its shipping box. Remove the anti-static plastic bag(s).

2. If the Pre-aligner was shipped with a Smart Controller, unpack it also from the shipping box. Remove the anti-static plastic bag.
3. Remove cables, floppy disk, and manuals from the shipping box.
4. Remove the bag from the Atmospheric Pre-aligner and carefully inspect the product for signs of damage that may have occurred during shipping.



CAUTION

Do not handle a nickel-plated Pre-aligner with bare hands. Use clean latex barrier gloves or similar gloves. Fingerprints will stain finish unless removed immediately with Windex™.



RECYCLE

Recycle all packaging materials according to local regulations.

Installation Procedure

The Atmospheric Pre-aligner is typically supplied in a standard configuration. The information required to install the standard configuration of the Atmospheric Pre-aligner is provided in the following procedures:

- [Mounting on page 3-4](#)
- For the facilities connections refer to [Specifications on page 1-10](#)

Mounting

The Atmospheric Pre-aligner is supplied in a standard configuration. The following procedure provides the information required to install the Atmospheric Pre-aligner.

1. Before installing a Pre-aligner, prepare a baseplate made of either 0.500+ in thick aluminum or 0.375+ in thick stainless steel.
2. Position the Pre-aligner to allow the robot end effector to pick and place wafers.
 - For a pin-loading Pre-aligner, orient the Pre-aligner so the Blade End Effector clears the pins.
 - For a chuck-loading Pre-aligner, make sure the Horseshoe End Effector will not hit the CCD sensors!
3. Verify that the Pre-aligner is co-planar to the robot end-effector. The end effector must be parallel with the wafer surface. If the robot Z column is not perpendicular to the baseplate, use a leveling plate to level the Pre-aligner chuck surface.
4. Use the four mounting tabs at the corners of the Pre-aligner to bolt the Pre-aligner to a mounting baseplate or other frame.

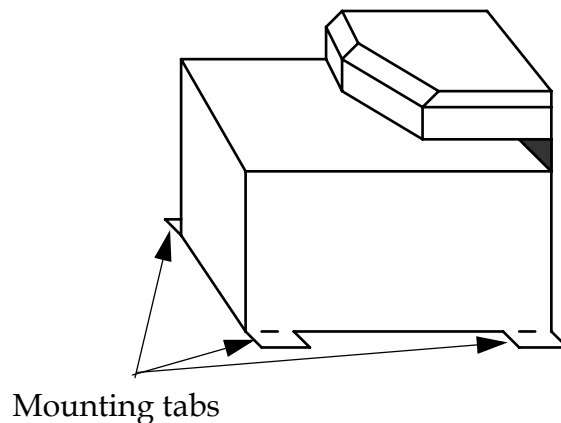


Figure 3-1: Atmospheric Pre-aligner Mounting Tabs

Connections

The standard configuration of the Atmospheric Pre-aligner requires a signal cable, data cable, power cable and a vacuum connection. The following procedures provide the information required to make all connections. Safety glasses should be worn at all times when working around the Atmospheric Pre-aligner.

Connecting the Atmospheric Pre-aligner to the Controller

Brooks Automation provides an RS-232C connection for host control. The system host transmits ASCII commands to the Controller through a DB-25 male connector. The RS-232 serial port is located on the CPU board at the back of the Controller box.

The RS-232 cable provides these connections: RX/TX, RTS/CTS, Signal GND, and Shield. The shield is either soldered to the D shell connectors at each end, or connected to the chassis of the host and Controller by pigtail leads.

The default baud rate (bits per second) is 9600, but you can configure this to 19200, 4800, or 2400.

A block diagram of the connections is shown in [Figure 3-2 on page 3-6](#).



CAUTION

Never connect or disconnect the communications lines with power applied to the Atmospheric Pre-aligner as damage to internal components may result.

Do not connect the Atmospheric Pre-aligner's power supply to facility power until all installation procedures have been completed.

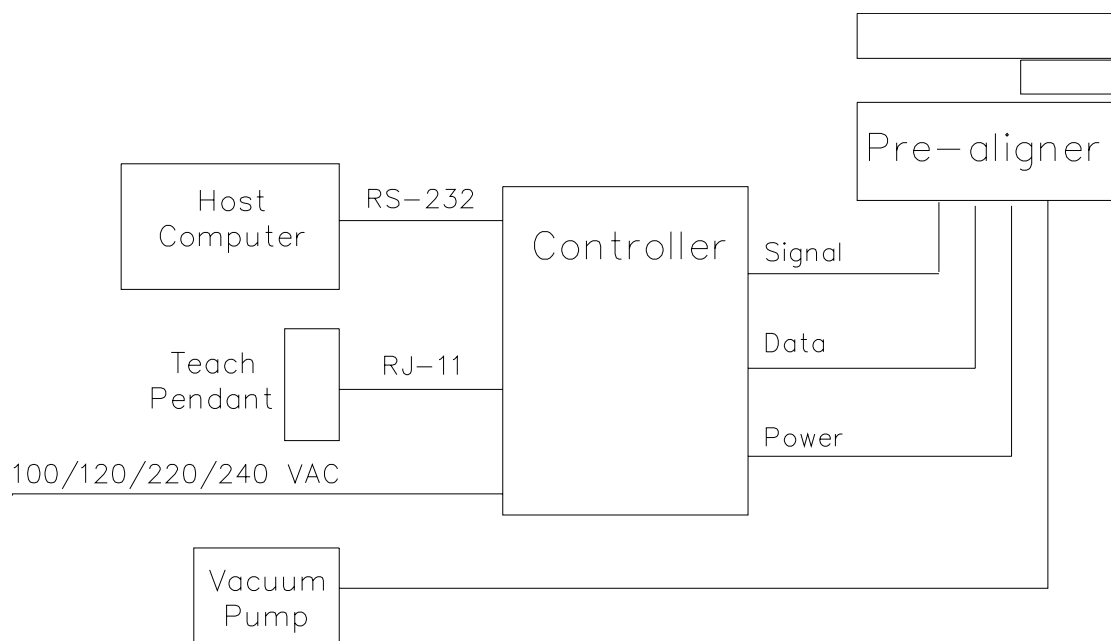


Figure 3-2: Atmospheric Pre-aligner Wiring Diagram

Your configuration might be side-connected or bottom-connected, as shown in [Figure 3-3](#).

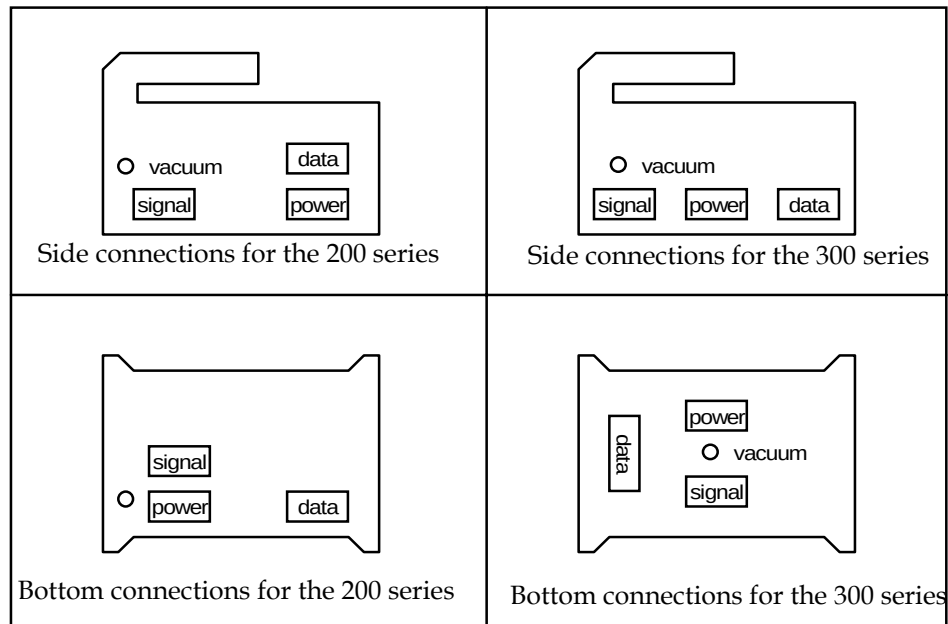


Figure 3-3: Atmospheric Pre-aligner Connections for different Models



CAUTION

Do not connect the power until all Pre-aligner connections are made.

1. Connect three Pre-aligner cables to the Controller:
 - Motor power cable with eight-pin connector
 - Motor signal cable with 50-pin connector
 - Pre-aligner signal cable with CCD data connector.

Tighten the cable-locking screws to prevent accidental disconnection.

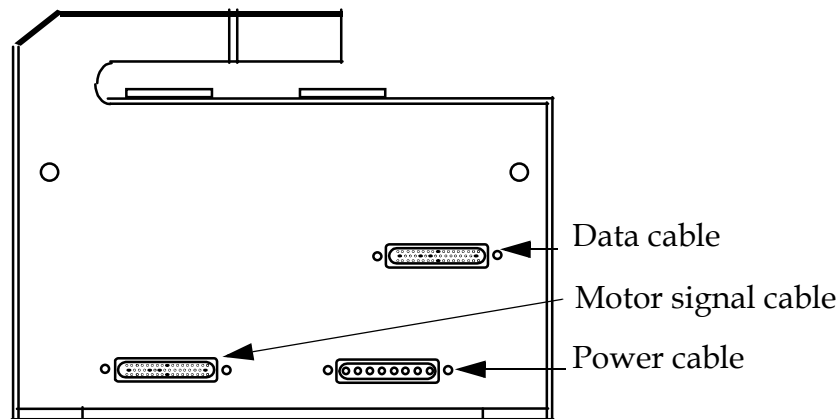


Figure 3-4: Atmospheric Pre-aligner Cable Connections

2. Verify that the power source is properly grounded. Adherence to National Electrical Code is required.
3. Confirm the AC power setting on the voltage selector. Unless otherwise requested, the Controller voltage is set to 120 VAC when shipped. Your Controller is factory set according to your Certificate of Compliance (COC).



CAUTION

Setting voltage incorrectly can damage the robotic system.

4. With system power OFF, connect the Controller AC power cable to an AC outlet connected to the host system EMO circuit. The Controller does not have a power switch.

Connecting the Vacuum Line

For an integrated system, connect the vacuum line to a vacuum source that is separate from the robot vacuum system. The robot can move wafers while the Pre-aligner is aligning wafers. In normal operation, both Pre-aligner and robot vacuum valves should not open simultaneously, but this can happen when the throughput is very fast.

1. Locate the quick-connect vacuum fitting near the Pre-aligner connections. Connect the hose to the vacuum source. [Vacuum Specifications on page 1-11.](#)

Initial Power-up Sequence

Brooks Automation recommends that each operator control station that can initiate robot motion, has a readily accessible EMERGENCY STOP or EMO device. This includes the Teach Pendant; the SEMI S2 compliant TTR 200 has a red EMS button. Or, use the EQT 32 interface on a personal computer.

Refer to the *Smart Controller User's Manual* for details about using the EQT 32 interface and the Teach Pendant. You cannot use the EQT 32 interface and the Teach Pendant simultaneously. To use EQT with the Teach Pendant connected, return to the Brooks Automation logo screen on the Teach Pendant.

Before connecting a Teach Pendant or installing the EQT 32 interface, follow these instructions to ready the Controller.

1. Connect the RS-232 cable to the host computer and Controller.
2. Verify that all cables are plugged into the correct connectors in the correct orientation. Make sure they are securely fastened, using the integral jack screws supplied with the cables as needed.
3. Exit the restricted envelope before you apply power.
4. Power up the Controller. The Controller automatically resets, which takes about 4 to 10 seconds, depending on the quantity and length of macros stored in NVSRAM.
5. After boot-up, check the indicator LEDs located at the front of the Controller. The following conditions indicate a "normal" condition:
 - The green LED is on.
 - The yellow LED is flashing.
 - The red LED remains on until the amplifiers are enabled.

Connecting the Teach Pendant

Connect the Teach Pendant cable to the bottom RJ-11 connector next to the DB-25 connector on the Controller. This is the COM2 port.

The Teach Pendant emits a sound and displays the logo screen when you are connected.

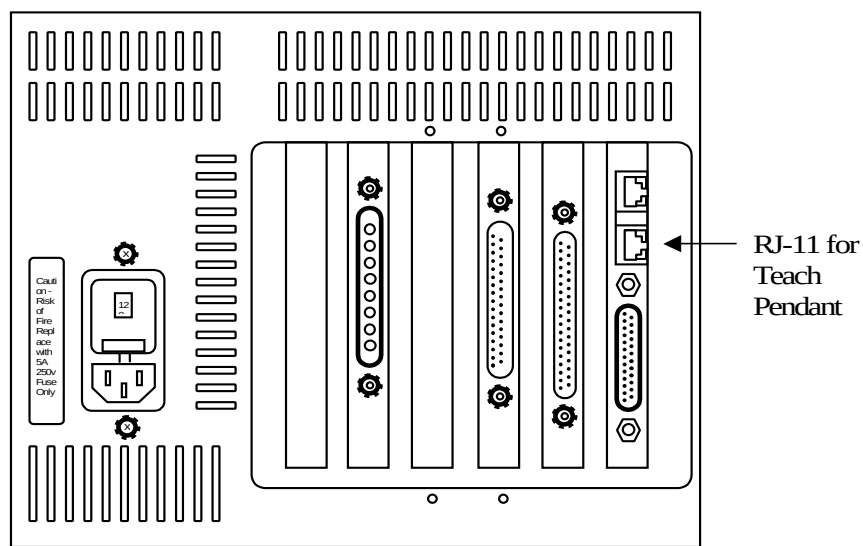


Figure 3-5: Back of the Controller Used with the Atmospheric Pre-aligner

Installing the EQT 32 Interface

You can install the EQT 32 interface to be used with Microsoft Windows 95[®] or Microsoft Windows NT[®] 3.51 or later. Follow these steps to install the EQT 32 interface.

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

1. With Windows 95 or Windows NT running, insert the EQT 32 Setup Disk into your floppy drive.
2. Open the Windows Control Panel dialog box.
3. Open the Add/Remove Programs dialog box and click on Install.
4. Follow the instructions displayed on the window.

You will be prompted for the previous location of your Eqt32 configuration file (Eq32.ini). If you have parameters from a previous installation that you want to save, access the directory location of the existing Eq32.ini file. Your existing parameters will be combined with the new parameters.

5. To execute EQT 32, click the EQT icon. The Terminal Mode window opens ([Figure 3-6 on page 3-11](#)).

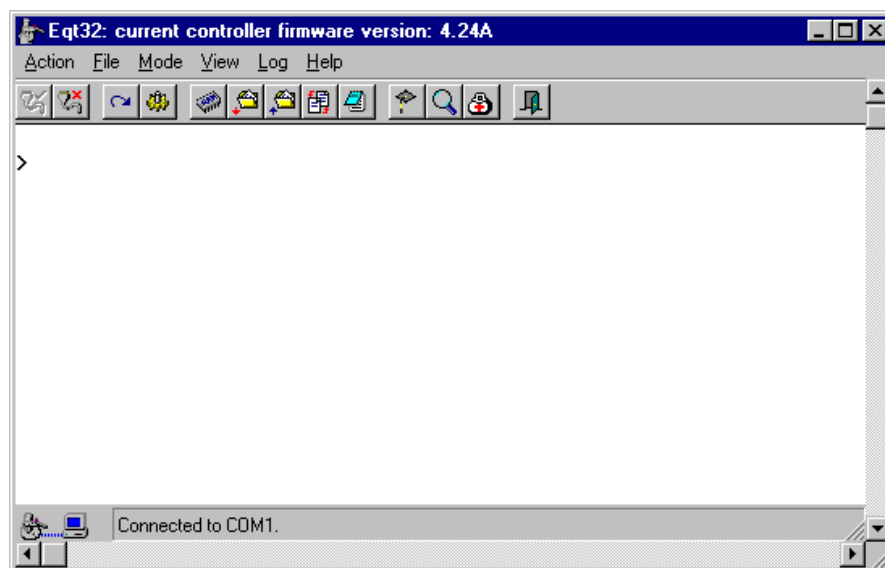


Figure 3-6: Terminal Mode Window

6. At the cursor, type **SVON** and press Enter. This turns on all servo motors on the Atmospheric Pre-aligner.
7. Type **HOM** and press Enter to execute your **HOM** macro. This homes all axes of the Pre-aligner. When all axes are homed, EQT displays a status message. A status message or code of 1000 or 1008 indicates all devices are working. Refer to the Brooks Automation *User Interface Manual* (4000-0017) for more information on EQT 32 displays of command responses.
8. Use the Vacuum Valve and Sensor Test of the Pre-aligner Diagnostics to verify that the vacuum source is correctly connected.
9. Send the **SVON** command. All servo motors in the system should turn on. **SVON** also checks internal and external connections, such as signal cable and power cable connections. If there is a problem, **SVON** sends the '?' prompt. In that case, send the **STAT** and **ALST** commands to find the cause and solution for the problem.
10. Send the **HOME** command.
 - For a Pre-aligner only system, send **HOME A** to home the Pre-aligner axes. This works for both a single-axis Pre-aligner or a three-axis Pre-aligner.
 - For an integrated system, send **HOME A** to home the robot axes and then **HOME a** to home the Pre-aligner axes.

Preliminary Teaching

With the Pre-aligner initialized and homed, teach the desired angular positioning of the flat or notch of the wafers.

1. Use the **RWS** and **SWS** commands to read and set the wafer size.
2. Use the **RFAA** and **SFAA** commands to read the current flat/notch orientation setting, and set the desired flat/notch orientation setting.

In the following teaching example, the wafer size is set to 200 mm and the angular orientation is set to 45.15 degrees.

>RFAA	Read Flatfinder Alignment Angle
9000	Angle is currently set at 90°
>RWS	Read Wafer Size
150	Current Wafer Size setting is 150 mm or 6 in
>SWS 200	Set Wafer Size to 200mm
>SFAA 4515	Set Flatfinder Alignment Angle to 45.15°
>SAV	SAVe new values to NVSRAM

Alignment and Calibration

The Brooks Automation Atmospheric Pre-aligner must be aligned with the system that it will be operating in to prevent damage to wafers. Note that even a small misalignment can interfere with proper Atmospheric Pre-aligner operation and may cause wafer breakage or damage to the system.

The user must perform a complete alignment as part of installing the Atmospheric Pre-aligner in a system. Additionally, proper alignment should be verified after servicing the Atmospheric Pre-aligner. Refer to [Chapter 5: *Adjustments and Calibration*](#) for the required adjustment procedures.



CAUTION

Do not attempt to use the Atmospheric Pre-aligner until the alignment procedures have been completed.

4

Operation

Overview

This chapter provides complete operation directions for the Brooks Automation Atmospheric Pre-aligner. The operation of the Atmospheric Pre-aligner is covered for both normal conditions and emergency conditions.

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Theory of Operation 4-2

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Wafer Calibration File.....4-7

Verifying Correct Files 4-8

Copying Files from the Diskette 4-9

Using the Fast Align Option.....4-10

Shut-down.....4-11

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Theory of Operation

In normal operating mode, you use macros to control the Pre-aligner. Use either a PC with EQT software or the Teach Pendant to send commands and macros. For information on using EQT32 or the Teach Pendant, refer to the *Smart Controller User's Manual*.

This chapter reviews commands and macros and when to use them. Follow the instructions in this chapter to verify the loading, chuck (waiting), and unloading positions before you use the Pre-aligner with your system.

Pre-aligner Files

Parameters that determine the Pre-aligner behavior are stored in the Pre-aligner Parameter File, Wafer Calibration File, and Wafer Parameter File.

Table 4-1: Atmospheric Pre-aligner Files

File Type	Extension	Description
Macro	.mac	This file contains one or more macros.
Pre-aligner Parameter	.par	This file contains servo parameters, speed and acceleration for homing, and other parameters needed for operating the Pre-aligner.
Wafer Calibration	.cal	Pre-aligners are factory-calibrated to optimize accuracy. The data is stored in the Wafer Calibration file.
Wafer Parameter	.waf	The Wafer Parameter File contains information about the Flat-finder and speeds and accelerations used during alignment.

Pre-aligner Parameter File

The Pre-aligner parameters are stored in the PRE*.par file. This file defines the Pre-aligner parameters for the Controller. Below is an example parameter file, annotated to show the line locations of the parameters. Your parameter file might have different values.

Most parameters have three positions. The first position is the T-axis value, the second position is the R-axis value, and the last position is the Z-axis value. For example, when the T axis is homed, a speed of 1000 is used, but when the Z axis is homed, a speed of 200 is used.

Table 4-2: Atmospheric Pre-aligner Parameter File

PRE-3880	Serial number of the Pre-aligner
9600	Baud rate
1000,500,200	Home speed
10000,10000,500	Home acceleration
0,0,0	Encoder resolution
0,0,0	Reserved - Not used
2997,9997,15000	Operational speed

Table 4-2: Atmospheric Pre-aligner Parameter File

61563,20339,31027	Operational acceleration
300,300,400	Error limit or following error
250,15,35	GN, Proportional gain
0,0,0	Servo acceleration forward
50,10,10	KI, Integral gain or Response to error
9999,9999,9999	TL - Torque limit
1000,120,150	ZR, Derivative gain or Damping element
4352,768,768	Ramp value, controls radius of the S-curve
0,0,-3000	Customized home position
0,-20227,-2025	Home offset in encoder counts
180000,39370,100000	Mechanical ratio used in scaling
0,1,0	Second number is used in encoder counts.
0,0,0	Reserved-Not used
61655,20369,10957	Operational deceleration
-66000,-6000,-6000	Negative software motion limit
300000,6000,6000	Positive software motion limit
0,0,0	Reserved-Not used
0,0,0	Reserved - Not used

You can reset some parameters, such as speed and acceleration, with commands. You can also change parameters by editing the parameter file; refer to the *Smart Controller User's Manual*.

Wafer Parameter File

The wafer parameters are stored in the PRE*.waf file, which defines the wafer parameters for Controller calculations. The *Fast* parameters are for the Fast Align option. If you do not have the Fast Align option, the *Standard* parameters determine the alignment speed and acceleration.

The second column in the table contains example values. The values set by Brooks Automation differ among various Pre-aligner models. Your Wafer Parameter File might have different values than the example.

Table 4-3: Wafer Parameter Files

Line Number	Example File	Description
1	PRE-3880	Serial number. Use DUMPW command to read.
2 3	4000 20000	Constants used for centering
4 5	200 20000	Constants used for finding flat
6	3	Chuck dead band
7 8	6000 5000	Constants used for Fast centering
9	0	Reserved
10 11 12 13 14 15	15000 10000 50001 5000 10000 5000	Constants used for speeds and accelerations for Standard align wafer rotation and movement.
16 17 18 19 20 21	15000 10000 50001 50000 10000 5000	Constants used for speeds and accelerations for Fast align wafer rotation and movement.
22	9000	Flat angle
23	0	Measurement type
24	0	Wafer type

Table 4-3: Wafer Parameter Files

Line Number	Example File	Description
25	-3000	Pin loading position. Use RWL and SWL commands to read and set.
26	200	Pin unloading or lift position. Use RWU and SWU commands to read and set.
27 28	300 200	Constants for Fast align
29-37		Lines 29 through 37 are Reserved
38	2588	CCD1 first pixel
39	22520	CCD1 angle
40		Reserved
41	6215	CCD2 first pixel
42	17950	CCD2 angle
43-46		Lines 43 through 46 are Reserved
47	200	Default wafer size
48	0	Default flat type
49	0	Default wafer type
50-56		Lines 50 through 56 are Reserved

Wafer Calibration File

The wafer calibration factors for alignment are stored in the PRE*.cal file. Calibration factors include wafer size and type, CCD locations, and offsets. The file contains several sets of factors, one for each size wafer.

Brooks Automation sets the values during calibration; do not edit this file or modify the values.

Table 4-4: Wafer Calibration Files

Index	Wafer Calibration File	Description
	PRE-2636	Serial number
	76	Wafer size
	0	Wafer type
0	76	Wafer size
1	0	Wafer type
2	1	CCD number
3	3	Number of repetitions
4	3500	Maximum offset
5	0	Reserved
6	0	Reserved
7	0	Reserved
8	2501	CCD position
9	22467	CCD angle
10	1000	Offset correction for Window 0
11	997	Offset correction for Window 1
12	997	Offset correction for Window 2
13	1001	Offset correction for Window 3
14	1060	Offset correction for Window 4
15	1070	Offset correction for Window 5
The above items are repeated for other sizes.		

Use the **RCT** command to Read the Calibration Table. Refer to the Brooks Automation *Software Manual* (4000-0012) for details.

Verifying Correct Files

The correct files for your Pre-aligner must be resident on the Controller NVSRAM. Each unit is delivered with the corresponding files on a diskette. If the Controller is delivered with the unit, the correct files are already downloaded to the Controller.

If you are not sure you have the correct files loaded for your unit, compare the serial number on the unit with the serial number in each file as instructed in the following steps:

1. Access Terminal mode in EQT or on the Teach Pendant.
2. Enter the command to return the serial number for a Pre-aligner. For an integrated system, enter **RSRN 1**. For Pre-aligner only system, enter **RSRN**.
3. The serial number from the Pre-aligner Parameter File is displayed. Compare it to the number on the Pre-aligner manufacturing label. If the numbers match, you have the correct Pre-aligner Parameter File. If the numbers do not match, follow the instructions in the section [Copying Files from the Diskette on page 4-9](#) to copy the correct file from your diskette.
4. To verify the correct Wafer Parameter File, enter the command **DUMPW**. The serial number from the Wafer Parameter File is displayed. As you press Enter, and the file is displayed one line at a time. If the serial number is not correct, follow the instruction in the section [Copying Files from the Diskette on page 4-9](#) and follow the instructions to copy the correct file from your diskette.
5. To verify the correct Wafer Calibration File, enter the command **DUMPC**. The serial number from the Wafer Calibration File is displayed. As you press Enter, the file is displayed one line at a time. If the serial number is not correct, follow the instruction in the section [Copying Files from the Diskette on page 4-9](#) and follow the instructions to copy the correct file from your diskette.

Copying Files from the Diskette

If any of your files are not correct for your Pre-aligner, follow these instructions to use EQT to download the correct file(s) from the diskette.

1. Load the diskette into the diskette drive.
2. Access the main EQT window.
3. To download a file, press the Download button on the Terminal-mode window to access the Download dialog.
4. On the Download dialog, specify the file type to download from the host computer to the Controller. When you select a file type, such as parameter, the available files for that type are displayed. To display your file on the diskette, select the disk drive location in the same way you select it elsewhere on an NT or Windows '95 system.
5. Double-click on the file to select it or select the file and press the Open button. Then press the Download button on the Download dialog.

Using the Fast Align Option

During initialization, the firmware detects the Pre-aligner type and sets the default speed mode based on the Pre-aligner type. Speed and acceleration for all Pre-aligner axes are set based on the mode of speed.

To use the Fast Align Option, verify the following:

1. Your Pre-aligner has the Fast Align Option.
RPTY
2. The speed mode is set to Fast.
SPMO 1
RPMO
3. If you are using a PUTA macro, it is in the currently active macro file.
4. The settings in your Wafer Parameter File are correct for Fast Aligning.

For information regarding macros and the Wafer Parameter Files refer to Chapter 8: [*Command Reference*](#).

Shut-down

The following shut-down procedure is used to remove power from the Atmospheric Pre-aligner in an orderly manner and place the components within the product in safe conditions. This procedure is used to prepare the Atmospheric Pre-aligner for repair, removal, or maintenance.



CAUTION

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

1. All wafer transfers should be completed.
2. Shut down the host system.

Emergency Conditions

To actuate the EMO circuit, press the EMO button. An Emergency Off may cause the following effects:

- If an action is in progress when the EMO is received, an error is generated.
- After an EMO, the error may need to be reset.



CAUTION

The Atmospheric Pre-aligner is not provided with an Emergency Off (EMO) device. The user is accountable for the EMO circuit.

5 Adjustments and Calibration

Overview

This chapter provides directions for the alignment of the Brooks Automation Atmospheric Pre-aligner and for aligning a wafer on the product.

Chapter Contents

Atmospheric Pre-aligner Alignment.....	5-2
Alignment Strategy	5-2
Level the Atmospheric Pre-aligner	5-3
Wafer Alignment Procedures.....	5-4
Aligning a wafer.....	5-4

Atmospheric Pre-aligner Alignment

The Brooks Automation Atmospheric Pre-aligner must be aligned with the system that it will be operating in to prevent misplacement of wafers or collision with the robot. Note that even a small misalignment can interfere with proper system operation.

The user must perform the following alignment procedure as part of installing the Atmospheric Pre-aligner in a system, during routine maintenance, whenever the Pre-aligner is moved or replacement is required. Brooks Automation recommends an alignment check under the following circumstances:

- A complete alignment when the Atmospheric Pre-aligner is first setup at the user's site.
- A complete check when the Atmospheric Pre-aligner is replaced.
- A complete check if the Atmospheric Pre-aligner was involved in a wafer transfer error.

Alignment Strategy

The alignment is performed to ensure proper equipment operation and precise wafer handling within the user's system. The teach pendant or a host computer and the command set described in [Chapter 6: Command Reference](#) will be used during the performance of the Alignment Procedure.



CAUTION

A thorough alignment protects against equipment damage and mis-aligned or sliding wafers.

Prior to beginning the alignment procedure, verify the following:

1. Read this chapter and the Alignment Procedures before doing any alignments.
2. Read and understand [Chapter 2: Safety](#).
3. Become familiar with the safety warnings and the procedures to ensure safety while performing the procedures.
4. Become familiar with the host computer or teach pendant.
5. Power up and initialize the Atmospheric Pre-aligner.

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

Level the Atmospheric Pre-aligner

Adjustable feet are provided on the Atmospheric Pre-aligner. These feet are used to support the Atmospheric Pre-aligner, to compensate for an uneven mounting location. Refer to [Mounting on page 3-4](#) for complete installation information.

NOTE: *It should not be necessary to level the Atmospheric Pre-aligner unless this is a new installation or if the aligner has been removed and replaced or re-installed.*

During the mounting procedure you align the aligner to the robot end effector and also level the Atmospheric Pre-aligner chuck surface.

Wafer Alignment Procedures

The following alignment procedure provides the information required for standard wafer alignment of the Brooks Automation Atmospheric Pre-aligner.

Aligning a wafer

The three-axis Pre-aligners have servo-driven mechanisms to rotate the incoming wafer between the linear array CCD sensor and the LED array. The single-axis Pre-aligner moves the wafer in the theta direction only; the robot moves the wafer in the r and z directions. Except for the difference, the aligning process is the same.

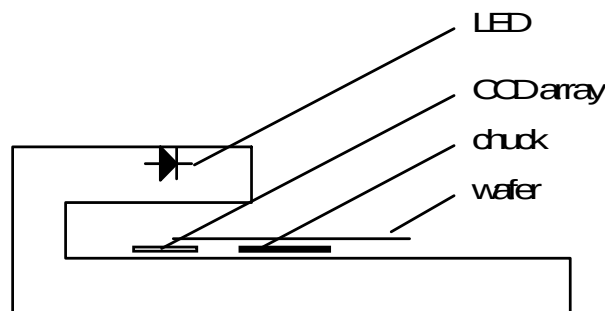


Figure 5-1: Side View of the Atmospheric Pre-aligner

1. When you execute your alignment macro (ALIGN, AL, BAL, or PRL), the Controller opens the wafer chuck vacuum valve and checks the status of the sensor. If it senses that a wafer is present on the chuck, the alignment continues. If no vacuum is sensed, alignment stops.
2. Data from the CCD sensor is sent to the Pre-aligner I/O board over a separate Data Cable. The CPU board plots the encoder count in relation to the CCD count. A perfectly centered wafer would appear as a straight line, while an off-set wafer would appear as a sinusoidal waveform. The flat or notch appears as a discontinuity in the data.
3. The CPU board analyzes the data and computes a correction vector and a flat/notch rotation position. The wafer is then centered:
 - A three-axis Pre-aligner has three vacuum pins spaced around the rotating wafer chuck. These pins shift the wafer to the center position by aligning the offset with the r (horizontal) axis and then lifting and shifting the wafer using the r axis and the z (vertical) axis.
 - A single-axis Pre-aligner uses the robot radial and vertical axes to center the wafer.

4. With the wafer centered in the r direction on the wafer chuck, the Pre-aligner moves the primary flat or notch to the user-specified position.
5. The Controller sends a message to the host computer giving the status of the alignment attempt.

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6

Command Reference

Overview

This chapter provides an overview of the embedded control software for the Brooks Automation Atmospheric Pre-aligner. The control software provides a broad range of command options, including a number of sophisticated, integrated command sequences. Communications between the Atmospheric Pre-aligner and the host Controller uses standard EtherNet communications for normal operation or RS-232 communications for setup and test to access all Atmospheric Pre-aligner software commands.

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Commands	6-2
Pre-aligner Macros.....	6-3
Macro for Aligning	6-3
Robot Macro for Fast Align Option.....	6-6
Using the Macros to Verify Positions	6-8
Loading Position	6-8
Chuck Position	6-8
Unloading or Up Position.....	6-9

Commands

The most often-used Pre-aligner commands are listed here. For a complete listing of commands, refer to the *Smart Controller User's Manual*.

NOTE: For axes, use *t*, *r*, *z*; for a system with only a Pre-aligner use *T*, *R*, *Z*, and *A*. The "A" or "a" indicates all Pre-aligner axes. For position parameters, list the value in mils.

Table 6-1: Common Commands

Command	Example	Comment
HOME axis	HOME r	HOME the radial axis.
LMCR	LMCR	List all MaCRos in NVSRAM.
LMCR name	LMCR HOM	List all lines in one MaCRo.
MOVA axis, position	MOVA z, 3000	MOVE Absolute. This moves the Pre-aligner z axis.3 inch from the zero (0) position.
MOVR axis, position	MOVR t, 36000	MOVE Relative. Completes one revolution or 360°.
RES	RES	RESet the Controller.
RFAA	RFAA	Read Flat Angle Alignment.
RLS	RLS	Read Limit Switch.
RPMO	RPMO	Read Pre-aligner MOf speed. 0 is Standard and 1 is Fast.
RPTY	RPTY	Read the Pre-aligner TYpe, which is either Standard or Fast.
RWL	RWL	Read Wafer-Load position.
RWS	RWS	Read the Wafer Size.
RWU	RWU	Read the Wafer-Up position
SAV	SAV	SAVe parameters, coordinate, and calibration data in NVSRAM.
SFAA	SFAA 9000	Set Flat Angle Alignment to 90°
SPMO	SPMO 1	Set Pre-aligner MOf speed to Fast align speed.
SVON	SVON a	Turn ON all Pre-aligner SerVo motors.
SVOF	SVOF a	Turn OFF all Pre-aligner SerVo motors.
SWL	SWL -3000	Set Wafer-Load position to 0.3 in below the Home position.
SWS	SWS 200	Set Wafer Size to 200 mm.
SWU	SWU 200	Set Wafer-Up position to 0.02 in above the Home position.

Pre-aligner Macros

The most commonly used Pre-aligner macros include **ALIGN**, **CVON**, **CVOF**, **HOM**, and **PINL**. For an integrated system, the **HOM** macro typically sends all axes in the system to the HOME position.

Your alignment macro might be named AL or some name other than **ALIGN**.

Table 6-2: Common Macros

ALIGN	Align the wafer on the wafer chuck with vacuum source on.
CVON	Wafer Chuck Vacuum ON
CVOF	Wafer Chuck Vacuum OFF
HOM	Send to home position for r and z axes. The t axis does not have a Home Sensor.
PINC	Move PINs to Chuck position where wafer rests on wafer chuck with pins approximately 0.04 in (1 mm) below wafer.
PINL	Move PINs to wafer Loading position
PVOF	Pin Vacuum OFF
PVON	Pin Vacuum ON
PINU	Move PINs to Unloading position until wafer is slightly above the wafer chuck, about 0.03 in (0.75 mm). At this position, the radial axis can center the wafer.

Macro for Aligning

The **ALIGN** (or AL, BAL, or PRL) macro performs the steps to align the wafer to the previously user-defined angular offset position. It calls a series of macros that are listed in the table on the next page. This example **ALIGN** macro might be different than your **ALIGN** macro.

MACRO ALIGN

R20 = 1;	Set a flag for multi-tasking.
TSKM 0;	Define a task for multi-tasking.
RESP a, 15;	Verify that conditions are correct to proceed.
IPINC;	Move pin to the chuck position
ICVON;	Turn on the chuck vacuum.
R87 = 271;	Set R87 to 271 decimal.
BCOR 0, [R87];	Begin correction of offset and flat.

WMO a	Wait for Pre-aligner movement to end.
R87 = R87 & 271	
CMP [R87], 0;	Compare for error condition.
JPZ 100	
IPINC;	Move pin to the chuck position.
ICVON;	Turn on the chuck vacuum.
R87 = 271	
BCOR 0, [R87]	
WMO a	
LABEL 100	
WAIT 50	
ICVOF;	Turn off the chuck vacuum.
IPINL;	Move pin to the loading position.
TSKK 0;	Kill the defined task.
R20 = 0;	Turn off the multi-tasking flag.
ISTAR "A";	Send status prefixed with the letter A.
ENDM	

The macros in the first column of the table call the corresponding macros listed in the third column. Notice that the “calling macro” contains the **RESP** command. When you send the macro from the command line, you want the prompt and use the “calling macro.” But you do not want prompts sent to the command line if you are executing from the macro. The “called macro” does not use the **RESP** command and is used in the **ALIGN** macro.

Table 6-3: Calling Macros

Calling Macro	Purpose	Called Macro
MACRO CVOF ICVOF RESP ENDM	Turn off the chuck vacuum. Use this macro to turn off the chuck vacuum just prior to picking up the wafer.	MACRO ICVOF INPUT L, [R15] R15 = R15 & 254 OUTP L, [R15] ENDM
MACRO CVON ICVON RESP ENDM	Turn on the chuck vacuum.	MACRO ICVON INPUT L, [R15] R15 = R15 1 OUTP L, [R15] ENDM
MACRO PINC IPINC RESP ENDM	Move Pin to the home position.	MACRO IPINC IPVOF MOVA z, 0 WMO a ENDM
MACRO PINL IPINL RESP ENDM	Move pin to loading position. (SWL RWL). This moves the pins that raise and lower the wafer into the proper position for the robot to pick or place a wafer.	MACRO IPINL IPVOF RWL [R49] MOVA z, [R49] WMO a ENDM
MACRO PINU IPINU RESP ENDM	Move pin up to the ready or lifted position (wafer on pins).	MACRO IPINU ICVOF RWU [R49] MOVA z, [R49] WMO a ENDM
MACRO PVOF IPVOF RESP ENDM	Turn off the pin vacuum.	MACRO IPVOF INPUT L, [R15] R15 = R15 & 253 OUTP L, [R15] ENDM

Robot Macro for Fast Align Option

The robot macro, **PUTA**, starts the aligning process when a wafer is put on the Pre-aligner and the robot arm is retracted only to the point where the Pre-aligner can start motion.

The **PUTA** macro works only for Pre-aligners with the required hardware upgrade. To determine if your Pre-aligner is set for Fast Align, enter the command **RPTY** to read the Pre-aligner type. If a **1** is returned, the Pre-aligner is a Fast Pre-aligner.

Your customized **PUT** macro is the basis for the **PUTA** macro. The difference between your **PUT** macro and your **PUTA** macro are the following lines:

RWS [R90];	Get the wafer size
R91 = -30 * R90;	Calculate r-axis length for the Partial Retract
MOVR R, [R91];	Do partial retract
WMO R;	Wait for r axis to complete movement
TSKM 2;	Define ALIGN as task 2
ALIGN;	Start alignment process
TSKK 2;	End task 2

The Partial Retract of the end effector allows the aligning process to begin sooner than if a Full Retract (RETH) is required.

Note that the computation of the r-axis length requires that the wafer size be expressed in millimeter units.

Here is an example of an entire **PUTA** macro.

MACRO PUTA #C60,	
#R1	
TSKM 1;	Set this macro as task #1
R21 = 1;	Set R21 to 1
RESP A,15;	Check if condition allows moving robot axes
INDEX [C60], [R1];	Set Index
MTCR [C60], 1, 0;	Move axes to in front of station and extend
RSEE [C60], [R35];	Read EE#
WMO A;	Wait for all robot motion to complete
SSP Z, 300;	Set speed to slow
SAD Z, 300	
SDL Z, 300	
STROK [C60], 1;	Stroke Z down
OUTP [R35], 1;	Turn off vacuum
WMO Z;	Wait until Z stops
RSA Z;	Restore Z speed
WVAC [R35], 1, 5;	Wait
RWS [R90];	Get the wafer size
R91 = -30 * R90;	Calculate r-axis length for the Partial Retract
MOVR R, [R91];	Do partial retract
WMO R;	Wait for r axis to complete movement
TSKM 2;	Define ALIGN as task 2
ALIGN;	Start alignment process
TSKK 2;	Kill task 2
RETH;	Retract R axis
WMO R;	Wait
TSKK 1;	Kill task 1
R21 = 0;	Set flag to 0
? D, "P";	Send status
ISTAR	
ENDM	

Using the Macros to Verify Positions

Before operating the Pre-aligner, verify that the pin heights for loading, chuck (waiting), and unloading are correct. You use your **PINL**, **PINC**, and **PINU** macros in the following instructions.

The PRE-300 and PRE-301 can be either pin-loading or chuck-loading. To change from one to the other, simply reset the pin height for the loading position and install the correct end effector.

Loading Position

The loading position varies between pin-loading and chuck-loading Pre-aligners:

- For pin-loading Pre-aligners, the loading position determines how high the wafer is lifted. The pins should lift the wafer above the chuck about 4.83 mm (0.19 in) for a PRE-201 or about 7.1 mm (0.28 in) for a PRE-301.
- For chuck-loading Pre-aligners, the loading position hides the pins completely under the top cover.

To verify that the loading position of the pins is correct, execute the **PINL** macro. From the command line in Terminal mode, enter:

PINL

If the pins are not set correctly, follow these instructions to adjust them.

1. Access Terminal mode on the Teach Pendant or in EQT.
2. To read the current setting, send the command **RWL**.
3. Approximate the correct setting and enter that value using the **SWL** command.
4. To restore the speed and acceleration for all axes, use the **RSA** command, either **RSA a** for an integrated system or **RSA A** for a Pre-aligner only system.
5. To save the new setting, send the command **SAV**.
6. Repeat your test using the **PINL** macro. Adjust the setting as necessary to correct the loading position.

Chuck Position

To verify that the chuck or waiting position of the pins is correct, execute the **PINC** macro. From the command line in Terminal mode, enter:

PINC

The pins should be about 1 mm (0.04 in) below the wafer in this position. If they are not, follow the instructions in the “r and z Home Offset” Diagnostic that begins on page 44.

Unloading or Up Position

To verify that the unloading (aligning) position of the pins is correct, execute your **PINU** macro. From the command line in Terminal mode, enter:

PINU

The pins should lift the wafer above the chuck so that the wafer does not scrape the chuck. If the wafer is not being lifted high enough, change the wafer lifting position in the Wafer Parameter File by following these instructions.

1. Access Terminal mode on the Teach Pendant or in EQT.
2. To read the current setting, send the command **RWU**.
3. Add 50 to the number from the previous step. Enter this new value using the **SWU** command.
4. Execute the **PINU** macro. If the pin position is good, proceed to the next step. If the new number is not large enough, repeat Step 3.
5. To restore the speed and acceleration to all axes, enter either **RSA a** for an integrated system or **RSA A** for a Pre-aligner only system.
6. To save the new setting, send the command **SAV**.

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7 Maintenance

Overview

This chapter provides maintenance schedules and procedures for the Brooks Automation Manual I/O (Reticle Monopods and SMIF Pods). 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.

Chapter Contents

Preventive Maintenance	7-2
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Cleaning the CCDs	7-4
Cleaning the LEDs	7-5
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Starting Diagnostics	7-8
NVSRAM Test	7-9
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Vacuum Valve Sensor	7-22
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CCD and Chuck Test	7-25

Preventive Maintenance

This section provides cleaning procedures for routine preventive maintenance of the Atmospheric Pre-aligner to reduce unscheduled downtime. The Atmospheric Pre-aligner 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 Atmospheric Pre-aligner 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 Atmospheric Pre-aligner 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 Preventive Maintenance Schedule as appropriate to account for any deviations from this environment.

If your environment is Class 10,000 or more, you will need to regularly clean the CCDs and possibly the LED.

To determine whether or not the CCDs need to be cleaned, run the CCD and Chuck Diagnostic Step. When a wafer completely covers the CCD, the number should be as high as 2720. When the CCD is not covered, the number should be very low, about 36.

NOTE: *For models built before October 1998, the numbers might be different.*

Before cleaning the CCDs, disconnect the Pre-aligner. To clean the CCDs, use one of the methods described in the next section of this manual.

Preventive Maintenance Schedule and Procedures

The Pre-aligner has no user-serviceable parts and maintenance is minimal. When maintenance occurs, the equipment is fully de-energized, which results in a Type 1 task hazard rating. Work defined as Type 1 is considered safe. The Preventive maintenance, which is cleaning and a five point checklist, are Type 1 procedures. Diagnostic tests are Type 2 procedures. The operator uses the teach pendant.

Use the Brooks Automation Diagnostic software to verify any hardware problems. Although the diagnostic steps are presented here in numerical order, you do not need to use them consecutively. For example, if you suspect that the z axis needs to be adjusted, you would use only the r & z Home Offset Diagnostic Step to check the home offset.

The following maintenance schedule provides the information required for standard user maintenance of the Brooks Automation Atmospheric Pre-aligner. [Table 7-1](#) is provided as a quick reference to all scheduled maintenance.

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.*



WARNING

Cleaning the Brooks Automation Atmospheric Pre-aligner requires that the power is off and power is secured per facilities lockout/tagout procedure. This is a Type 1 category procedure.

Table 7-1: Preventive Maintenance Schedule

Procedure	Page #	Frequency
Cleaning	7-4	As required

Cleaning

If your environment is Class 10,000 or more, you will need to regularly clean the CCDs and possibly the LED.

Required Tools and Test Equipment

- Isopropyl Alcohol (100%)
- DI Water
- Cleanroom Wipes
- Cotton swab

Cleaning the CCDs

To determine whether or not the CCDs need to be cleaned, run the CCD and Chuck Diagnostic Step. When a wafer completely covers the CCD, the number should be as high as 2720. When the CCD is not covered, the number should be very low, about 36.

NOTE: *For models built before October 1998, the numbers might be different.*

Before cleaning the CCDs, disconnect the Pre-aligner. To clean the CCDs, use one of these steps:

1. Tip the Pre-aligner on its side and blow compressed dry air against the three CCDs.
2. Wet a cotton swab with isopropyl alcohol and lightly brush the tops and sides of the three CCDs.
3. Blow compressed dry air on the CCDs to dry them.



CAUTION

Dispose of cleaning cloths and cotton swabs per facilities procedures and local regulations.

Cleaning the LEDs

Cleaning the LED is more difficult, and unless the environment is extremely harsh, is not necessary.



CAUTION

To maintain the extreme cleanliness achieved at the factory, wear gloves when handling any of the Atmospheric Pre-aligner components that will enter the vacuum environment.

Cleaning the LEDs

1. Locate the LED on the underside of the Pre-aligner top.
2. Dampen a lint-free cloth with isopropyl alcohol.
3. With the Pre-aligner tipped up on its side, drop the cloth through the opening so that the ends of the cloth extend through each side.
4. Set the Pre-aligner down on a flat surface.
5. Pull the cloth back and forth gently across the LED.

Diagnostic Testing

Brooks Automation provides Diagnostic tests to troubleshoot the Pre-aligner. Pre-aligner Diagnostics are available only with the Teach Pendant, not with EQT. Refer to the *Smart Controller User's Manual* for detailed information about using the Teach Pendant.

The Diagnostics Menu displays the current step and its title. Use the >>> or <<< buttons to select the next or previous step. When the desired step is displayed, press HERE (ENTER). After each step, press HERE to return to the Diagnostics Menu.

The Pre-aligner Diagnostic Mode has 10 or 11 steps:

- For a system with only a Pre-aligner, you have Steps 1 to 11 without Steps 5 and 6, as shown in the first column in the table below.
- If you have an integrated system with both robot and Pre-aligner, you have Steps 14 to 24, as shown in the second column below.

NOTE: *The diagnostic tests are presented in numerical order in this chapter, but you can run any test by itself as needed.*

Table 7-2: Diagnostic Tests

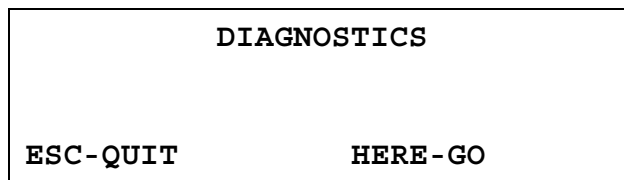
PRE	INT	Test	Purpose	Warnings and Cautions	Page
1	14	NVSRAM	Verify that NVSRAM is correctly formatted and all required files are available.		7-9
2	15	Galil and I/O	Verify that the Galil board and I/O ports are functioning correctly. Do not use to test external I/O.	If this test fails, you cannot run any other steps.	7-10
3	16	Encoder Read	Verify that the Controller receives the correct encoder feedback from the Pre-aligner	Ensure the Pre-aligner signal cable is securely connected.	7-12
4	17	Limit & Home	Test the limit and home switches.	Ensure the Pre-aligner signal cable is securely connected.	7-13
7	18	Servo	Check servo motors for all three axes of 200 and 300 series. For the PRE-050 and PRE-350, checks t axis servo motor.	Run only if Encoder Read test passed.	7-14

Table 7-2: Diagnostic Tests

PRE	INT	Test	Purpose	Warnings and Cautions	Page
8	19	Home Test and Set	Use if belt slipping is suspected or after replacing robot parts that require detaching belts.	Ensure all belts, pulleys, motors, and so on are securely attached.	7-16
9	20	r and z Home Offset	Sets the physical Home for pins with z axes.	Ensure no limit switch is triggered.	7-18
10	21	Scaling Factor	Check mechanical ratio.	Ensure the Pre-aligner signal cable is securely connected.	7-21
11	22	Vacuum Valve/Sensor	Check vacuum sensor adjustment.	Ensure vacuum source is connected.	7-22
NA	23	Pre-aligner I/Os	Check vacuum valves and sensors.	Ensure all cables and hoses are connected.	7-24
12	24	CCD and Chuck	Verify the Video Board functions.	Ensure all cables are connected.	7-25

Starting Diagnostics

To enter Diagnostics mode on the Teach Pendant, at the main display screen, press CTRL+ D. The Teach Pendant displays the following:



If your system has both a robot and Pre-aligner, you are prompted to select Pre-aligner Diagnostics or Robot Diagnostics. Select Pre-aligner Diagnostics.

In Diagnostics mode, the following keys are recognized.

Table 7-3: Active Teach Pendant Keys

Key	Action
HERE	Continues or accepts, similar to Enter
ESC	Quits, cancels or aborts
>>>	Increments the step or current value
<<<	Decrements the step or current value
Q ON/OFF	Toggles the theta servo
R ON/OFF	Toggles the r servo
Z ON/OFF	Toggles the z servo
Either Theta Jog Key	Selects the theta Axis
Either Radial Jog Key	Selects the r axis
Either Z Jog Key	Selects the z axis
A	Selects all axes
Y	Yes
N	No

NVSRAM Test

NVSRAM Test first checks the Non-Volatile Static RAM (NVSRAM) and then checks the files.

If the NVSRAM is *not* correctly formatted, the message NVSRAM NOT READY is displayed. Refer to the FRMT 313 command for formatting information. After you format the NVSRAM, download the required files. These files were delivered on a diskette with your system.

If the NVSRAM is OK, the parameter, wafer parameter, and wafer calibration files are checked. Messages report the status of each file:

- **Check-Sum OK** indicates the space allocation for file is not corrupt.
- **File Not Open** indicates there is no file. Download the specified file.
- **Check-Sum Bad** indicates the file is damaged. Download the file again. For the macro file, download the file and send the **SMCR** command to save the macro file to NVSRAM.

Galil and I/O Test

To test the Galil board, the diagnostics software attempts to communicate with the Galil board. During this step, a message indicates whether Galil passed or Galil failed.

If the test fails, there is an error in communication between the Galil board and the CPU board. Contact Brooks Automation Customer Support for further instructions.

Testing Ports A and B

The I/O Board Test verifies communication for each I/O port. If the port communications work, the message Port A, B OK is displayed and the tests continue.

If a port communication fails, the message Port X,,, BAD is displayed, where X is the port designator. Ensure that all cables are correctly connected. The Main Menu is displayed. Repeat the test. If the test fails a second time, check the internal cable connections and jumper settings. If the jumper settings are correct, replace the I/O board.

Testing Input G

In the display, the order of XXXXXXXX, Bit 0 to Bit 7, is left to right.

Bit 0 —————> XXXXXXXX <————— Bit 7

That is, the left-most digit is the least significant bit (LSB) and the right-most digit is the most significant bit (MSB).

```
Testing Input G
VALUE:
XXXXXXXX
Generate Error
```

Port G is an internal 8-bit port on the Pre-aligner I/O Board. Port G constantly monitors the status of eight subsystems within the Controller. In normal operating mode, Input Port G should be set to all zeros if there are no problems.

The following table describes each bit when it is set to 1 (high) and how to correct the problem.

Table 7-4: Port G Bits

Bit	Description	Corrective Action
0	Internal amplifier connections or Pre-aligner signal cable.	Check I/O to Galil cable, I/O to amplifier board, and the signal cable. If all cables are OK, replace the I/O board. If a problem persists, contact Customer Support.
1	Motor off.	Check the interlock switch (EMS/MOFF) to ensure it is in the correct state.
2	Stop input.	Check stop input.
3	Amplifier Board Under Power indicator	Check green LED on amplifier board. - If ON (board under power), check I/O to amplifier board cable and I/O board. - If OFF (board has no power), and there is voltage to the amplifier board (P3 pin # 2 and 3 should be 41V to 46V), replace the amplifier board. If no voltage, check motor power supply (torroidal transformer) and relay.
4	Motor Power Supply indicator	Check I/O to power supply cable and I/O board.
5	Robot Interface Board Power Supply indicator. Usually accompanied by bit 3.	Check the Power interface board (located above the switching power supply). - If the LED lights, check I/O to power supply cable and I/O board. - If LED is not ON, check relay input for 5V.
6	Switching Power Supply indicator	None. This condition occurs approximately 30 ms before the Controller shuts down.
7	Bus Power Good indicator	N/A. Does not occur during diagnostics.

Encoder Read Test

Use this test to verify that the Controller receives the correct feedback from the Pre-aligner. Before you move an axis as requested, make sure the Pre-aligner signal cable is securely connected.

t: XXXXXXXX
r: XXXXXXXX
z: XXXXXXXX
Move Axes

As you manually move each axis, observe whether the encoder number counts up or down:

- As the t axis moves in the positive (clockwise) direction, the number should count up and as it moves in a negative direction, the number should count down smoothly.
- As the r axis moves in the positive (counter-clockwise) direction, the number should count up and as it moves in a negative direction, the number should count down smoothly.
- As the z axis moves up, the number should count up and as the z axis moves down, the number should count down.

If this test fails for an axis, replace the signal cable. If the test continues to fail, contact Brooks Automation Customer Support for further instructions.

Limit & Home Test

Before you move the axes to activate the switch indicators, make sure the Pre-aligner signal cable is securely connected.

In the display, the square brackets indicate the characters inside might not appear on the screen. The symbols [-], [H], and [+] respectively indicate that the negative limit switch, home switch, and positive limit switch are activated.

```
t:
r: [-] [H] [+]
z: [-] [H]
Act. Limit Switches
```

When you move the axes to their limits (negative or positive), the display changes to indicate activation of the limit switches. Activating the negative limit switch on an axis triggers the Home switch for that axis.

- If the Limit switches remain *off* at all times, verify that the signal cable and Pre-aligner interface board are securely connected.
- If the Limit switches remain *on* at all times, unplug the signal cable. If the limit switch then turns off, replace the limit switch assembly. If the limit switch remains on, replace the signal cable or Galil board.

Servo Test

Run the Servo Test *only* after you pass the Encoder Read Test. This tests the continuous action of the amplifier modules and the closed-loop servo system. It automatically increases the Following Error to infinity so that moving an axis manually does not cause the axis to servo off. You can also use this test to decrease Torque Limit so that each axis can be easily moved manually.

Before you move an axis, make sure the Pre-aligner signal cable is securely connected. You will test the t axis only for a PRE-050 or PRE-350 or test all three axes for a PRE-200s or PRE-300s.

In the display, XXXX TL is the torque limit being sent to the corresponding motor, and YYY is the current *setting* for the maximum torque limit.

t: XXXX	
r: XXXX	TL
z: XXXX	YYY
Move Axes	

You need cleanroom gloves and a large slotted screwdriver to follow this procedure:

1. Set the torque limit (TL) for each axis to 3333 by pressing the >>> and <<< buttons as needed.
2. To test the t axis, toggle on the t-axis servo motor.
3. With cleanroom gloves on, *carefully* grasp the wafer chuck and rotate it about 1/8 of a revolution. You should feel the motor apply a smooth and continuous counterforce. When you release the chuck, the axis should spring back to the original position.
4. Increase Torque Limit by using the arrow keys and repeat the preceding step.
5. To test the r and z axes, remove the Pre-aligner End Cover ([Figure 7-1](#)), which is opposite the CCDs.

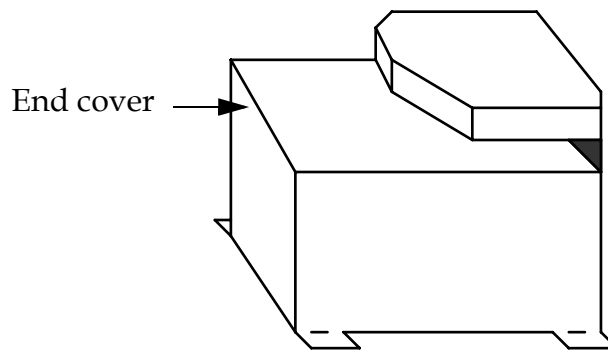


Figure 7-1: Atmospheric Pre-aligner Showing End Cover

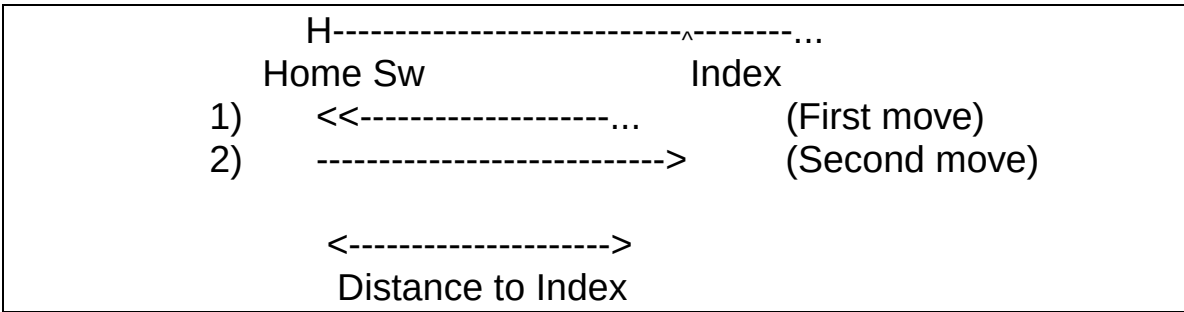
6. Notice the large gear pulley. This is part of the z-axis drive assembly. With cleanroom gloves on, *carefully* grasp the gear and rotate it about 1/8 of a revolution. You should feel the same smooth and continuous counterforce as generated by the t-axis motor. Again, the axis should spring back to the original position when you release it.
7. Notice the lead screw at the upper left corner. This is part of the r-axis drive assembly. With a large slotted screwdriver, rotate the leadscrew approximately 1/8 of a revolution. You should feel the same smooth and continuous counterforce as generated by the t and z motors. The axis should spring back to the original position when you release the screw.
8. Increase the Torque Limit for r or z and repeat until you feel a much stronger resistance.

Home Test and Set

Each Pre-aligner motor is factory set such that the distance between the Home switch and the encoder index is always between 1/3 and 2/3 of a motor revolution away. This is critical for maintaining repeatability of the Home position of each axis at a given mechanical calibration.

This diagnostic step measures and displays the Distance to Index of the r and z axes. Note that the t axis does not have a Home Switch.

The homing procedure moves an axis to its Home switch and then moves in the opposite direction to find the encoder index. (The encoder index is one encoder revolution mark).



If the Distance to Index is too short, the Controller can miss the first occurrence of index signal because it occurs too soon after the Home switch signal. Thus, the motor is required to move one more revolution to generate the signal. At a particular distance, this doesn't happen every time and thus creates two different home positions, where the second home is too far.

This test determines the Distance to Index, evaluates it, and assists in making the correction. Use these instructions only if you have replaced a pulley, belt or motor, or if the belt slips.

1. Press Enter. The Amplifier board initializes. If there is no closed loop, the test stops. If this happens, check the connection.
2. You are prompted to select an axis to home. Use the toggle buttons to select the axis.
3. The axis homes, stopping at the home switch and then at the index mark. The Distance to Index is displayed in encoder counts.

```
T:
R: XXXXXXXX
Z:
Distance to Index
```

(One revolution is four times the encoder pulses per channel.)

4. If the Distance to Index is bad, you are prompted to move the axis to a GOOD position. This is the position where you can release the belt directly attached to the z-axis motor or r-axis limit switch flag. Press ESC to start over or Enter to continue.
5. You are prompted to lock the axis so it cannot move. Release the belt or limit switch flag. When you are finished, press ESC to start over or Enter to continue.
6. While the motor is moving to position, the display reads **MAKING CORRECTION...**
7. When the correction is done, you are prompted to replace the belt or tighten the limit switch flag. After the belt is replaced, press Enter.

r & z Home Offset

This test is for the z axis of three-axis Pre-aligners only. Ignore the r Home Offset test. The r-axis diagnostic is no longer used.

The z-axis diagnostic performs standard HOMing on the z axis with the pin high.

Use this step to calibrate the Pin Chuck Position, or z-axis Home Offset, of the z-axis pins. The correct Pin Chuck Position (**PINC**) is 1 mm (0.04 in) below the underside of the wafer when the wafer is on the wafer chuck.

1. The first screen prompts you to select r or z. Press the <Z, On/Off> key to select the z axis.

PRESS R TOGGLE

OR

PRESS Z TOGGLE

2. After the z axis moves to its calibrated position, the screen displays:

HOMING Z AXIS

OFFSET CORRECT

Y-YES N-NO

3. The correct offset for pins is about 1 mm (0.40 in) below the underside of the wafer, as shown in [Figure 7-2 on page 7-18](#).

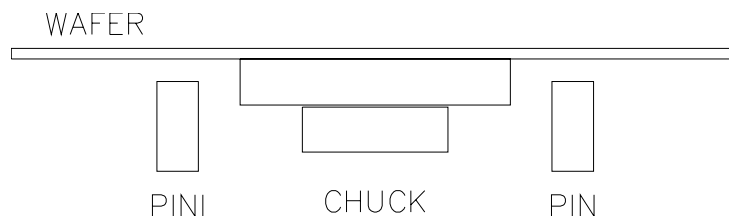


Figure 7-2: Pins and Chuck Below the Surface of the Wafer

4. If the position is correct, press Y and Enter to return to the main menu. If the position is incorrect and you have a PRE-200 or PRE-201 Pre-aligner, proceed to the following steps. If your model is a PRE-300, 301, 350, or 050, you cannot access the pulley; report the problem to Brooks Automation Customer Support.
5. Remove the Pre-aligner end cover, which is opposite the CCDs. Refer to [Figure 7-3 on page 7-19](#).
6. Press N to indicate the position is incorrect. The following message is displayed:

SWITCHING OFF SERVO

Move Z axis to 0

and Here or Esc

7. Set the position by moving the big pulley manually by hand until the pins are approximately 1 mm (0.04 in) below the underside of the wafer. Hold the pulley, and then press the Enter key.

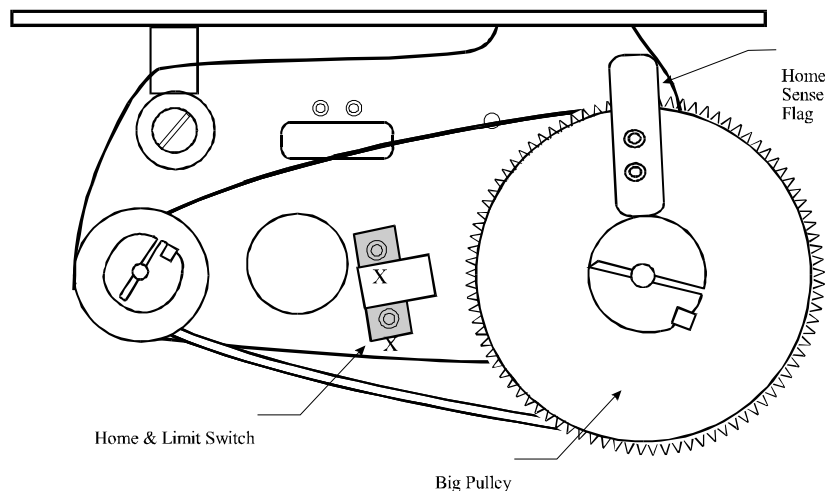


Figure 7-3: Inside the Atmospheric Pre-aligner End Cover

8. The screen prompts Home set. Press 'Enter'. Press Enter

9. Exit Diagnostics mode by pressing `Shift/Esc`.
10. Activate Terminal Mode by pressing `Ctrl + T` and then `T` again.
11. To restore operational speed and acceleration, use the **RSA** command and then the **SAV** command.
12. Enter **SVON** and **HOM** to turn on servos and home the Pre-aligner.
13. Check and set the Pin Load Position by using the **RWU** and **SWU** commands, as described in Unloading or Up Position on page 33.
14. In Terminal Mode, use the **SWL** and **RWL** commands to read the current value, which should be about:
 - -2000 for a chuck-loaded PRE-200 Pre-aligner
 - 2000 for a pin-loaded PRE-201 Pre-aligner
 - -3000 for a chuck-loaded PRE-300 Pre-aligner
 - 3000 for a pin-loaded PRE-301 Pre-aligner
15. To restore speed and acceleration, use the **RSA** command and then the **SAV** command.

Scaling Factor Test

Use the Scaling Factor Test to verify the scaling factor on each axis or to verify that the Mechanical Ratio parameter in the Pre-aligner Parameter file is correct. You need a measuring device.

The display reads:

```
t: ttttttt  
r: rrrrrrr  
z:  
Move Axes
```

where tttttt is the theta position in 0.01° and rrrrrr is the radial position expressed in 0.001-in.

Manually move the axis you want to check. Measure the physical movement, that is, the displacement of the axis, not the absolute position. Compare the result with the reading on the Teach Pendant.

Vacuum Valve Sensor

The Vacuum Sensor indicates the presence or absence of a wafer on the chuck. A sensor switch prevents a signal from being sent to the Controller until the magnitude pressure of the vacuum has crossed a preset threshold setting. The vacuum sensor is preset at a level that works correctly and accurately; it is preset to -8 in. Hg (27091 Pa).

The vacuum sensor has the following characteristics:

- Functions within a pressure range from 0 to -30 in. Hg (0 to 101592 Pa).
- Has a pressure set-point hysteresis of $\pm 3\%$ over the full pressure range. The drift of the threshold setting over time does not exceed this hysteresis.
- Performs to a full-scale accuracy of $\pm 3\%$ from 40 to 100°F and $\pm 5\%$ outside of those temperature parameters from 0.0 to 60°C (32 to 140°F).

The next figure simulates a vacuum pump and a vacuum gauge. The sensor is set to a threshold value of -8 in Hg (27091 Pa). The tolerance is ± 1 in. Hg (3386 Pa). If there is no leak from pump to chuck and the entire vacuum pathway is plugged, any part of the pathway exhibits a pressure value equal to the pump pressure. However, no system is completely leak-tight and pressure values depend on the pump capacity, cross-sectional flow areas, and the total volume to be evacuated.

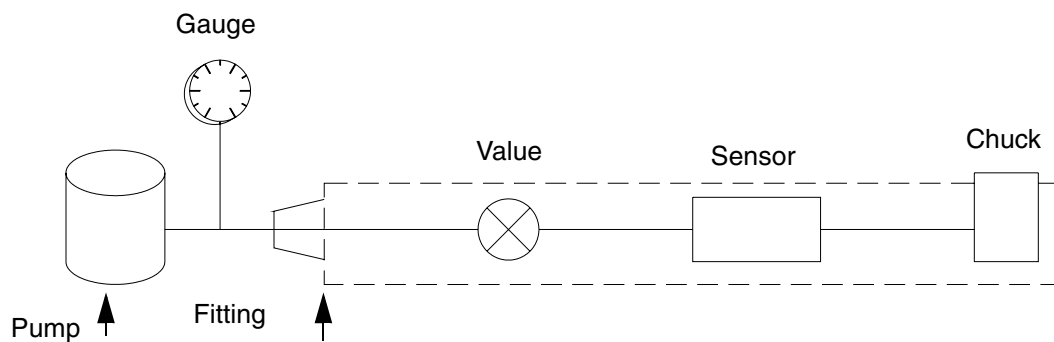


Figure 7-4: Vacuum Pump and Vacuum Gauge

With the recommended pressure of -20 in. to -25 in. Hg (67728 to 84660 Pa) at the fitting, it takes about 30 ms for the sensor to trigger with a wafer on the chuck.

- If the pressure is less than -20 in. Hg (67728 Pa), the lag time increases, which has a direct impact on throughput.
- If the pressure is more than -25 in. Hg (84660 Pa), the pressure may be enough to trigger the sensor when there is no wafer on the chuck, known as a false positive.

If the sensor does not trigger the signal during a set time, the firmware sets Bit # 7 of the STAT response to indicate an error, usually that no wafer is present.

The recommended pressure values to the fitting are required in order to validate the warranty.

This diagnostic tests the vacuum valve(s) and vacuum sensor(s) attached to the Pre-aligner:

- The vacuum to the wafer chuck is controlled by Vacuum Valve #1 and sensed by the Vacuum Sensor. On the PRE-200 Pre-aligners, the sensor is visible through the end cover near the CCDs.
- The vacuum to the pins is controlled by Vacuum Valve #2 but does *not* have a vacuum sensor.

	#1	#2	
Vac Sensor	On/Off	On/Off	(Vacuum Sensors)
Vac Valve	On/Off	On/Off	(Vacuum Valves)
Press '1' or '2'			

When you toggle the switches, the valve and sensor have opposite indicators. That is, when the vacuum valve is on, the sensor is off, and so on.

- With Vacuum Valve #1 in the Off state (valve open) and an appropriate vacuum source connected to the Pre-aligner, repeatedly place and remove a wafer on the Wafer Chuck and watch Vacuum Sensor #1.

Turn the vacuum valve off (open the valve) by using number key 1 for valve one and then pressing the 2 key for the second valve. Place and remove a wafer on the chuck. The vacuum valve should indicate On and Off respectively. If it does not, verify that the correct vacuum pressure is present at the fitting.

Pre-aligner I/Os (for Integrated Systems only)

This step tests the input/output connections for an integrated system. Robot I/O ports are Port A and Port G. Pre-aligner connections are on Port L and input is read from Port K. The two Pre-aligner output bits and the one input bit are described in the table.

Table 7-5: Input and Output Bits for Port L and Port K

Port	Port Type	Bit Assignments	I/O Number
L	Output	Bit 0 - Chuck vacuum valve. High to open. Bit 1 - Pin vacuum valve. High to open. Bits 2 through 7 - Not connected.	40 41 42 to 47
K	Input	Bit 0 - Chuck vacuum sensor. Low if activated. Bits 1 through 7 - Not Connected.	40 41 to 47

BYTE #: 01234567

OUT 00111111

IN 11111111

Use the number keys, 0 and 1, to toggle the two output bits. The first two bits should toggle, indicating that the *robot* connections are working. The third and fourth bits should toggle to indicate the Pre-aligner connections are working. The remaining bits do not toggle.

CCD and Chuck Test

Use this test to verify that the CCDs and the wafer chuck are functioning correctly.

CCD	ANGLE	E	R	N
cccc	aaaaa	0	0	0
R-Reset	S-Servo			
1,2 or 3 CCD				

The CCD number displayed on the first line is 1, 2, or 3, which indicates the size of the wafer. The table below summarizes the CCD numbers for various Pre-aligners and wafer sizes.

Table 7-6: Number of CCDs for Various Atmospheric Pre-aligners

Pre-aligner	Wafer Size	CCD #
PRE -300 or PRE-350	6 in (optional)	1
PRE -300 or PRE-350	8 in	2
PRE -300 or PRE-350	12 in	3
PRE -200, PRE-100, or PRE -050	3 or 4 in	1
PRE -200, PRE-100, or PRE -050	5 or 6 in	2
PRE -200, PRE-100, or PRE -050	8 in	3
PRE-100 built before March 1995	3, 4, or 5-inch 6 or 8 in	1 2

The remaining display items are defined as follows:

CCD Scanning range in CCD pixels, from 36 (no wafer on the
cccc chuck) to 2720 (wafer completely covers the CCD).

For models built before October 1998, the numbers may be different. The scanning range should be 285 when there is no wafer on the chuck and 3328 when the wafer blocks the CCD.

ANGLE aaaaa	Chuck position in encoder counts from 0 to 65,536. By turning the chuck, the chuck position can be increased or decreased.
N N	Number of the working CCDs.
E and R	When there is a communication error between the Pre-Aligner and the Controller, the E will be 1 instead of 0. If R =1, then a reset is necessary to set it back to 0.
R-Reset S-Servo	There are two parameters that can be adjusted while running this test. Pressing R will reset the Pre-Aligner while pressing S toggles the Servo on or off.

To verify that the CCD is working, try the following tests. At any time during your tests, you can press R to reset the Pre-aligner or press S to toggle the Servo on or off.

1. Manually turn the chuck. The chuck position or angle should increase as you turn the chuck clockwise and decrease as you turn the chuck counterclockwise.
2. Place a wafer on the chuck so that the chuck is completely covered. Slowly move the wafer off the chuck. As you move the wafer, the ccccc number should decrease. Make sure the CCD number increases as you gradually cover the CCD.

Another useful test is to use the SWS (Set Wafer Size) command in terminal mode. You can check the wafer size with the command RWS and set the appropriate wafer size using the command SWS. For example, SWS 300 will set the wafer size to 300 mm or 12 inches. Changing the wafer size will activate the corresponding CCD.

8

Troubleshooting

Overview

This chapter gives information on using these commands, interpreting the responses, and taking recovery actions.

For problems you cannot solve, gather information and contact Brooks Automation Technical Support. Use the last page of this chapter's form to provide information to Technical Support so that they can better assist you.

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Introduction

This chapter describes how to troubleshoot Pre-aligner problems. Typically, you verify what does work and what does not work by running the diagnostics described in Chapter 9: Maintenance. To access the Controller information on the functioning of various components, use the EQT Information Request or send various information commands:

- Use the **STAT** command to check general Controller status.
- Use the **ALST** command to further specify an alignment error.
- Use the **RLS** command to check limit switch status.
- Use the **GLST** command to check for errors in movement.

As you follow the instructions, you might be asked to perform one or more Diagnostic steps. Instructions for using the Teach Pendant to perform diagnostics are described in the chapter 9, Maintenance. General instructions for using the Teach Pendant and EQT 32 are given in the Brooks Automation *Smart Controller User's Manual*, Document number 4000-0017.

Checking Pre-aligner Status

You can check various connections by sending information request commands to the Controller or by using EQT 32 Information Request. The firmware recognizes the current axes and returns information for those axes.

Table 8-1: Information Commands

Command	Purpose
STAT	Send status word
AST 1	Check error status on communications port 1 (COM1)
AST 2	Check error status on communications port 2 (COM2)
GLST	Check status of the Galil motion control board
INPUT G	Read input port G
RLS	Read limit switches
RNCS	Read NVSRAM check-sum
ALST	Check Alignment status when STAT bit 7 is set to 1
VER	Read firmware version number

In EQT 32, select the Troubleshooting button. The Troubleshooting dialog is displayed. Select Information Request and press the Run button. Nine commands are executed and the results are displayed as text messages. Problems are highlighted with a red box.

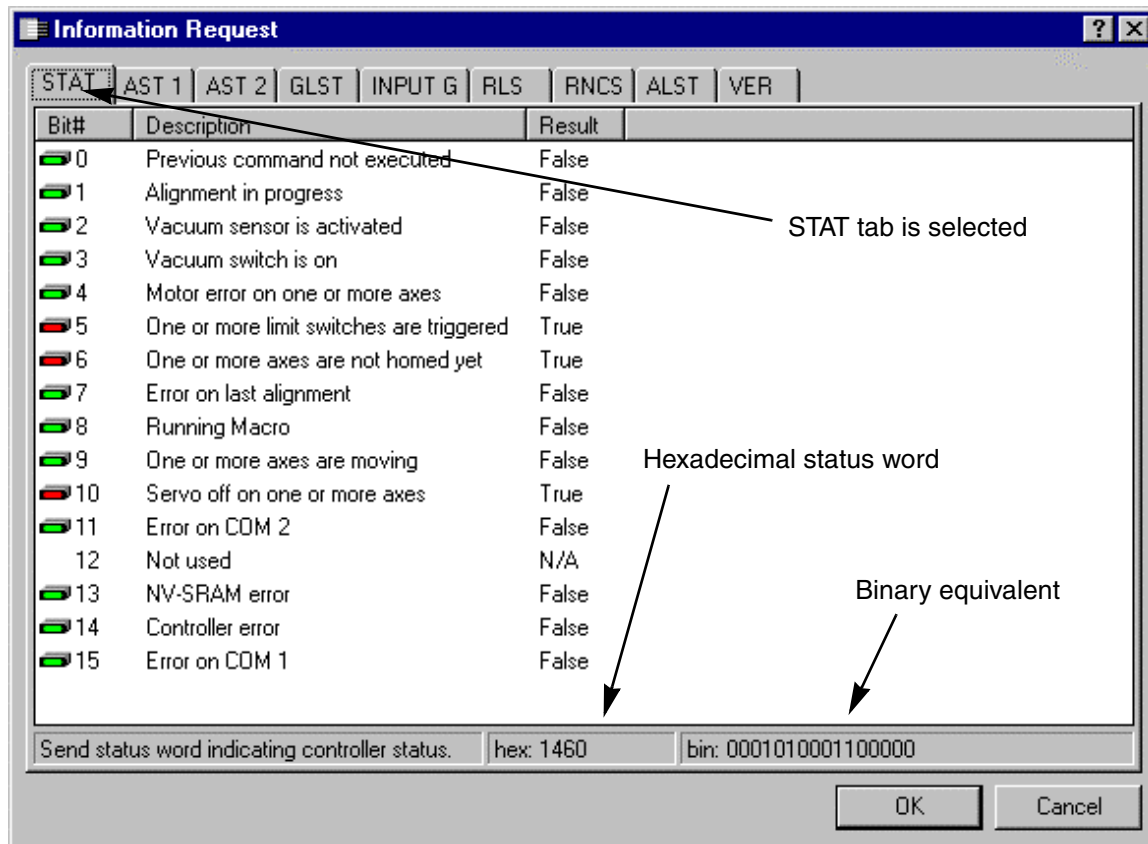


Figure 8-1: Information Request Screen

Alternatively, you can send commands in Terminal mode from either a Teach Pendant or EQT 32.

Cause and Recovery for STAT Messages

The setting of each status bit is caused by one or more reasons. Sometimes the cause is fatal and needs immediate action to recover, and sometimes the cause is harmless and does not require any direct action. The following table lists the probable cause of the problem and suggested recovery for each of the 16 status bits.

Table 8-2: Status Bit Error Messages with Cause and Recovery

Bit	Message	Cause	Recovery
0	Previous command not executed	The command cannot be executed for the current condition. For example, a SVON command cannot execute while axes are moving. Also see Bit 2.	Review the command and the conditions.
1	Previous command invalid	The command is unknown or has invalid syntax. When Bit 1 is set to 1, Bit 0 is also set to 1.	Check command syntax.
2	Robot vacuum sensor is activated	Vacuum sensor is on; an object is detected. When Bit 2 is set to 1, Bit 3 should be 1 (vacuum switch is on). If Bit 2 is 1 regardless of presence of object or status of Bit 3, the vacuum sensor is too sensitive.	Adjust the vacuum sensor on the robot. (For Pre-aligner vacuum testing, use the Pre-aligner Diagnostics.
3	Vacuum switch is ON	A normal condition. For example, a GET or PUT command turns Bit 3 on.	None.
4	Motor error on one or more axes	One or more axes have a position error condition. Excessive force has been applied to the force generated by the motor. An obstacle might be in the path. Or, the Servo Error Limit (ER) is too small. See also Bit 10.	Clear the obstacle, send the SVON command, and continue. If ER is too small (usually about 100-200), change the setup and increase.
5	One or more limit switches are triggered	A limit switch can be positive or negative. Use the RLS command to display detailed information on limit switches.	Send the RLS command to determine which limit switches are on or triggered and move away from them.

Table 8-2: Status Bit Error Messages with Cause and Recovery

Bit	Message	Cause	Recovery
6	One or more axes are not homed yet	With this condition, the Controller will not allow a Move command on the axes. Power up or disconnection of the signal cable sets this bit to 1.	Get Controller ready to Home and then HOME the Pre-aligner.
7	Pre-Aligner error on last alignment	This indicates a general error in alignment. Send the ALST command to determine the specific error.	See ALST command.
8	A macro is running	The bit is set to 0 after the macro executes the last ENDM command.	Send the STOP command.
9	One or more axes are moving	Any Move command causes Bit 9 to be set to 1.	Send the STOP command.
10	Servo OFF on one or more axes	Bit 10 is set to 1 when SVOF is issued or a motor error condition is generated.	Send SVON command.
11	Error on COM2	There are several possible causes. Use AST 2 command for more information.	Sending AST 2 usually clears Bit 11.
12	Not used	Not used. Bit 12 is always set to 1.	None
13	NVSRAM error	Refer to the Software Manual.	
14	Controller error	Internal motion Controller communication error. The Galil board might be damaged or the jumper configuration is wrong.	Send another STAT . If it does not clear Bit 14, send RES command.
15	Error on COM1	There are several possible causes. Use AST 1 command for more information.	Sending AST 1 usually clears the bit.

Checking Alignment Status with the ALST Command

When Bit 7 of the STAT response is set to 1, use the **ALST** command to determine the specific problem. Use the following table to interpret the response to **ALST**.

Table 8-3: ALST Command Error Bits

Bit	Meaning when set to 1
0	Wafer is not found on chuck
1	Alignment has been repeated maximum tries and failed
2	No flat or notch found
3	No offset vector found
4	Home not performed
5	Servo motor is off (use SVON or see STAT bit 10)
6	Arithmetic calculation error; attempted to divide by zero
7	Alignment used two or more cycles and failed
8	Wrong wafer size or type specification
9	Not used
10	Not used
11	Not used
12-15	Not used

Checking Limit Switch Status with the RLS Command

Limit switches prevent over-travel of the Pre-aligner into the hard stops of each axis of motion, and are normally activated just prior to contact with the hard stops. The limit switches signal the Galil board to kill power to the motor and stop the motion. In normal operation, the Pre-aligner should not move into the limit switch area. Limit switches are also used to *home* the axes.

Limit switch problems can be caused by software, mechanical position setup, or hardware. To determine if limit switch hardware is functional, perform Diagnostic Step 4, the Limit & Home Test.

If the Pre-aligner fails because a limit switch was triggered (Bit 5 in the response to the **STAT** command), use the **RLS** command to determine which limit switch was activated. The response to **RLS** has the following bit assignments:

Table 8-4: Limit Switch Activation Using the RLS Command

Bit	Meaning when set to 1
0	Robot positive theta
1	Robot positive radial
2	Robot positive Z
3	Track positive t in four-axis system
4	Pre-aligner positive theta
5	Pre-aligner positive radial
6	Pre-aligner positive Z
7	Track positive w in eight-axis system
8	Robot negative theta
9	Robot negative radial
10	Robot negative Z
11	Track negative t in a four-axis system
12	Pre-aligner negative theta
13	Pre-aligner negative radial
14	Pre-aligner negative Z
15	Track negative w in eight-axis system
16	Robot positive theta triggered
17	Robot positive radial triggered
18	Robot positive Z triggered
19	Track positive t in a four-axis system triggered
20	Pre-aligner positive theta triggered
21	Pre-aligner positive radial triggered
22	Pre-aligner positive Z triggered
23	Track positive w in eight-axis system triggered

Table 8-4: Limit Switch Activation Using the RLS Command

Bit	Meaning when set to 1
24	Robot negative theta triggered
25	Robot negative radial triggered
26	Robot negative Z triggered
27	Track negative t in a four-axis system triggered
28	Pre-aligner negative theta triggered
29	Pre-aligner negative radial triggered
30	Pre-aligner negative Z triggered
31	Track negative w in eight-axis system triggered

When a limit switch is triggered during Pre-aligner operation, the Pre-aligner stops and the Controller returns an error message. In this situation you should:

1. Send the **RLS** command to determine which switch was triggered.
2. Send the **RLS** command again to determine if the switch is still active.
3. If the limit switch remains on after the second **RLS** command, the Pre-aligner is probably at its travel limit. Manually move it away from this limit. Send the **RLS** command again. If it clears, it is likely that the Pre-aligner was instructed by software to go too close to the limit.

This can occur even during teaching, if the position taught is beyond the limit. In this case, change the taught position.

Also, if the Pre-aligner goes slightly beyond its taught position as it decelerates at the end of a motion in a given axis and then returns to its designated position. To avoid this, decrease the speeds and accelerations.

If the **RLS** command you sent after changing the Pre-aligner position cleared all bits, this indicates a problem in the limit switch assembly. The Pre-aligner might need to be serviced. Call Brooks Automation Customer Support for assistance.

Using the GLST Command

The Galil motion control board status is given in a 32-bit double word. For a four-axis system, bits 12 to 15, 20 to 23, and 28 to 31 are zeros.

Table 8-5: Galil Motion Control Board Status Bits

Bit	Meaning when set to 1
0	Write or read time out
1	Responds with the "?" prompt
2	Board is in debug mode
3	Galil command error
4	Integrator output exceeds torque limit (TL)
5-7	Always 0
8	Position error on robot theta axis
9	Position error on robot R-axis
10	Position error on robot Z-axis
11	Position error on or track t axis in four-axis system
12	Position error on Pre-aligner theta axis
13	Position error on Pre-aligner R-axis
14	Position error on Pre-aligner Z-axis
15	Position error on or track w in eight-axis system
16	Robot theta axis idle
17	Robot R-axis idle
18	Robot Z-axis idle
19	Track t axis in four-axis system is idle
20	Pre-aligner theta axis idle
21	Pre-aligner R-axis idle
22	Pre-aligner Z-axis idle
23	Track w in eight-axis system is idle
24	Servo off robot theta axis
25	Servo off robot R-axis
26	Servo off robot Z-axis
27	Servo off on track t axis in four-axis system
28	Servo off Pre-aligner theta axis
29	Servo off Pre-aligner R-axis
30	Servo off Pre-aligner Z-axis
31	Servo off on track w in eight-axis system

Contact Brooks Automation Technical Support

Even the most reliable Atmospheric Pre-aligners require service and support. To help you receive the most value from our Specialists, have the following information ready before you contact Brooks Automation Technical Support.

1. Record the serial numbers from the following components:
Controller
Pre-aligner
Robot
2. Provide the location of the Atmospheric Pre-aligner.
3. Provide the name of the person to contact, e-mail address, and telephone number.
4. List any error codes received during the failure.
5. Prepare a detailed description of the events leading up to the error.

How long has the equipment been in operation?

Was any work done on the equipment prior to the error?

What command was the equipment performing when the error occurred?

List all actions taken after the error was performed. What were the results of those actions?

Is there any other information that may assist our Specialist?

6. Contact Brooks Automation Technical Support:

Tel: +1 (978) 262-2900

Fax: +1 (978) 262-2515

e-mail: tscallcenter@brooks.com

Glossary

This Glossary provides a list of common terms and acronyms used in this document and their definitions.

μm (micron):	Micrometer (0.001 mm).
Abort Command:	A command to the Atmospheric Pre-aligner which causes any action in progress to halt, and resets any error condition. The Atmospheric Pre-aligner is left unreferenced after an abort command.
Absolute Coordinates:	The distance from Home (the reference position) in millimeters or degrees as appropriate. For a robot this is the location of the arm along the three axes, R (radial), T (rotational) and Z (vertical). For an elevator this is the location of the platform along Z (vertical), and depending upon the options installed along R (radial).
Action Commands:	All commands that cause the Atmospheric Pre-aligner to execute physical actions.
AGV:	Automated Guided Vehicle. A computer controlled, unmanned transport vehicle.
Aligner:	A device used to ensure the proper centering and alignment of a wafer. Mechanical contact aligners use pins or other fixtures to ensure proper wafer position by mechanically moving a wafer placed into them. Non-contact aligners scan the wafer and pass information regarding the wafer's position to the host Controller, which then directs the system wafer handler on how to pick up the wafer to ensure that it will be properly positioned.
ALPM:	AGV Load Port Module. A Load Port Module designed for automated loading and unloading by an Automated Guided Vehicle.
AMHS:	Automated Material Handling System. Automated carrier transfer to and from Production equipment, including stockers, interbay transport, and intrabay transport systems.
API:	Application Programming Interface. Provides an interface for an application program to access the operating system and other services.
ASCII:	American Standard Code for Information Interchange. An assignment of alphanumeric characters to 8-bit data byte values. Used by many communication protocols, including RS-232.

Assign Commands:	All commands that both set a parameter in RAM and EEPROM.
Atmosphere:	The average pressure exerted on the earth's surface.
ATR:	Atmospheric Transfer Robot.
Backing Pump:	The mechanical pump used to discharge gases at atmospheric pressure from a turbo pump or other pump.
Bakeout:	The degassing process by which a vacuum system is heated during the pump down process.
Base Transfer Offset:	A dimension used by robots, it is the distance between Z Axis Home and the Substrate Transfer Plane.
Batch Transfer Arm:	A robotic arm designed with a set of multi-level end effectors (or "tines") used for transporting entire batches of substrates into and out of an elevator.
BCR:	Bar Code Reader. A device used for optical recognition of bar codes.
Bellows:	A flexible tube that can expand and contract lengthwise while withstanding pressure radially.
BOLTS:	Box Opener, Loader and Tool-interface Standards. Refers to SEMI E15.1 standard interface for 300mm substrates.
BTA:	See Batch Transfer Arm .
BTO:	See Base Transfer Offset .
BiSymmetrik:	Brooks Automation's patented dual end effector frog leg arm system.
Cassette Elevator:	See Elevator .
Cassette Present Sensor:	A sensor that detects the presence of a cassette in an elevator.
Cassette Type Offset:	The distance downward from the Home position the elevator platform must move a particular type of cassette to position the bottom-most wafer slot (slot #1) for transport.
Category:	In the context of the Atmospheric Pre-aligner, within a record type, a category is used to identify a specific command.
CDM:	See Control/Display Module .
Command Response:	A transmission from the Atmospheric Pre-aligner to the host Controller.
Configuration Files:	In addition to the software file, the robot includes a Configuration File (CF). The CF file contains servo, application-specific, parameters. The release of a new CF files occurs when a new hardware configuration is added or when a known application specific issue is being corrected. CF files receive a part number and a revision number which is changed upon subsequent releases of new CF files.If you request a change to a specific application, you will see this change on all updated future CF files. If new applications are added, your application remains the same.

Control/Display Module:	A small hand-held local Controller for the robot. It provides access to all robot functions required for setup and testing of the robot.
Convectron Gauge:	A thermal conductivity vacuum gauge that is gas dependant (i.e., the gauge must be calibrated for the type of gas being used). These gauges are used to measure vacuum to 1 millitorr.
Cooler:	A device used to cool wafers placed into it. This is typically done after processing in a "hot" process to prevent damage to the wafer cassette.
CLPM:	Cassette Load Port Module. A Load Port Module designed to accept standard wafer cassettes.
CORBA:	Common Object Request Broker Architecture. Provides an interface that supports interoperability of software application regardless of platform, operating system, programming language, and network hardware and software
CPS:	See Cassette Present Sensor .
Crossover:	The pressure point in a vacuum system when the rough vacuum is switched to high vacuum.
Cryopump:	Mechanical vacuum pump used to achieve High Vacuum.
Crystal Gauge:	A low/mid vacuum gauge using a quartz crystal oscillator as a pressure-sensing device. It provides a fast response, and accurate, stable, repeatable measurement from 10 ⁻⁴ Torr to Atmosphere. There is no high voltage, high current, or high temperature in the vacuum, ensuring safe operation even in explosive or reactive gases.
CTC:	Cluster Tool Controller.
CTO:	See Cassette Type Offset .
D1:	A SEMI standard dimension: the distance from a cassette's base to the centerline of slot #1.
Degas:	A device used to heat wafers placed into it. This is typically done before processing to "boil off" any contaminants or to pre-heat the wafer to minimize processing time.
Device ID:	An optional identification code in a Atmospheric Pre-aligner transmission which serves to distinguish the Atmospheric Pre-aligner from other devices connected to the same host. This number is only used when the Atmospheric Pre-aligner is using RS-485 communications.
DeviceNet:	A low-cost industrial network used to connect devices such as limit switches, photo-electric cells, valve manifolds, motor starters, drives, and operator displays to PLCs and PCs.
DI Water:	De-ionized water.
Discrete I/O:	Discrete I/O provides monitoring and control of external device functions using individual I/O pins for each function with no additional control, or "handshaking", lines. Typically, if a pin is being used for an input to the Atmospheric Pre-aligner it is not used as an output also.

Dog Clamp:	A metal bar with a bolt through one side and a gripping shape on the other side. These are used to attach modules to process chambers.
Dual Pan Arm Set:	The Brooks Automation BiSymmetrik “frog leg” arm set with two end effectors.
E84:	SEMI E84-0302 - Specification for Enhanced Carrier Handoff Parallel I/O Interface. This standard defines the I/O interface used to transfer a carrier to and from one piece of equipment to another. Both pieces of equipment manage this operation without control by the factory.
EEPROM:	Electrically Erasable Programmable Read Only Memory. The EEPROM is the device which stores Atmospheric Pre-aligner configuration information after a store command is issued. The EEPROM retains its memory during power off periods.
EFEM:	Equipment Front End Module.
ELPM:	ERGO Load Port Module. A Load Port Module designed to accept standard wafer cassettes in an ergonomic manner.
Elbow:	The joint on the robot's arms between the inner and outer arm members.
Elevator:	A device used to vertically position a wafer cassette. This is typically done to position cassette slots at a specific location for wafer transport.
Emergency Off:	User-supplied device that disconnects AC power.
Emergency Stop:	Hardware-based safety circuit used by the CDM or by multiple user-supplied devices to interrupt motor power.
EMO:	See Emergency Off .
End Effector:	The mechanical device at the end of the robot's arm that supports the substrate during transport, see Pan .
EPROM:	Erasable Programmable Read Only Memory. The EPROM is a device which is used to store the Atmospheric Pre-aligner's software. The EPROM retains its memory during power off periods. See PROM .
ESD:	Electrostatic Discharge. The transfer of a static charge to, or from, a human being.
EtherNet:	A type of networking technology for local area networks, used to connect computers, servers, and other digital electronics.
EXL:	ExpressLock. A small volume 2-shelf Load Lock used to transfer wafers from an Equipment Front-End Module to a Process Module.
Extend:	Movement outward. For a robot, this is movement of the robot's arm outward (away from the robot's body). For an elevator, this is movement of the platform arm outward (away from the elevator's body).
Facet:	The area on a Transport Module where Process Modules, or other types of modules, can be connected for access by the central wafer handler.
FFU:	Fan Filter Unit. A device supplying filtered air into a minienvironment.

Find Bias:	The distance that the elevator platform must move upward to place a substrate in the substrate present sensor beam for detection.
Flag:	A piece of opaque material that interrupts the beam in an optical sensor when a moving mechanism reaches a defined point in its travel.
Flag Sensor:	An electronic device which emits an optical beam from one side of a notch to a detector on the other side of the notch. When a mechanical flag interrupts the beam, the position of a mechanism is known.
FLPM:	FOUP Load Port Module. A Load Port Module designed to accept standard FOUPs.
Foreline:	The exhaust line of a vacuum pump in a vacuum system.
Frog Leg:	Brooks Automation's patented robot arm system.
FOUP:	Front Opening Unified Pods. Refers to front-opening pods designed to carry 300mm wafers.
FRU:	Field-Replaceable Unit.
Full Step Mode:	An elevator mode in which when commanded to move one step, the platform will increment by a distance equal to the pitch (distance between cassette slots).
FX:	FabExpress. An Equipment Front-End Module used for horizontal wafer transfer between wafer carriers and the process tool.
Gate Valve:	See Slot Valve .
GUI:	Graphical User Interface. An interface for issuing commands to a computer utilizing a pointing device, such as a mouse, that manipulates and activates graphical images on a display.
High Speed:	Usually the highest speed; the speed at which the robot moves when no substrate is on the end effector.
High Vacuum:	Pressure ranges from about 10^{-4} Torr to 10^{-8} Torr.
High Vacuum Pump:	Vacuum pump used to achieve High Vacuum. See also Cryopump .
Home:	The reference position at which the encoders are reset. For a robot, this position is considered to be 0° for T, Home for R (slightly past the retract position for a single end effector robot and equivalent to the mount position for a dual end effector robot), and completely down for Z. For an elevator, this is the position of the platform when it activates the home sensor. This position is near the top of the elevator's travel. The cassette offsets and all Atmospheric Pre-aligner operations, including moves, steps, and partial steps, are referenced to the Home position.
Homing Speed:	Usually the slowest speed; the speed at which the Atmospheric Pre-aligner approaches Home position during a HOME command.

Host Controller:	The user-owned Controller that controls the entire system, including the Atmospheric Pre-aligner.
ICL:	Individual Component Level.
Ion Gauge:	A thermal conductivity vacuum gauge. These gauges are used to measure high vacuum. There are two types of ion gauges: hot cathode and cold cathode.
Illustrated Parts Catalog:	A series of illustrations that shows the locations of parts and subsystems within the component and identifies their part numbers.
InCooler:	In-line cool module designed to be installed in a Cluster Tool between the Transport Module and another module. See Cooler .
InLigner:	In-line aligner module designed to be installed in a Cluster Tool between the Transport Module and another module. See Aligner .
IPC:	See Illustrated Parts Catalog .
IRC:	Individual Replaceable Component.
Isolation Valve:	A large diameter valve used to isolate the vacuum chamber from the pumps.
Jog:	Move incrementally.
Leadscrew:	A precision screw used to move a mechanism.
Leak Rate:	Measurement of mass flow through an orifice in torr-liters per second.
Leapfrog:	Brooks Automation's patented same-side dual end effector robot arm system.
LED:	Light Emitting Diode. LEDs are used to indicate the presence of voltages on the control circuit board, monitor serial communication transmissions, and detect substrate presence in cassette slots or slide-out from the cassette.
Lift:	Movement upwards. For the robot, this is movement of the arm to the Up position. For the elevator this is movement of the platform to the Up position.
Linear Rail:	A precision rail used to provide support and direction to a moving mechanism.
Load Lock:	See Elevator .
Load Port Module:	Factory interface tool meeting SEMI factory interfacing requirements for open cassettes, SMIF pods, or FOUPs delivered manually or via factory automated handling systems.
Low Speed:	Usually slightly faster than Homing speed; the speed at which the robot moves when a substrate is on the end effector. For dual end effector robots, the speed at which the robot moves along the T or Z axis when a substrate is present on either or both end effectors, or along the R axis when a substrate is present on the active arm.
Lower:	Movement downwards. For the robot, this is movement of the arm to the Down position. For the elevator this is movement of the platform to the Down position.

LPM:	See Load Port Module .
MAC ID:	Media Access Control ID. The network address for a component connected to a DeviceNet network.
Medium Speed:	Only dual end effector robots radial motions have a medium speed option. The speed at which the dual end effector robot performs radial motions when the active arm's end effector has no substrate, but the inactive arm's end effector has a substrate.
MTR:	Multi end effector Transport Robot. See Robot .
MTTR:	Mean Time To Repair.
OCP:	Off Center Pick. A feature of Brooks' robots that allows the robot to execute compound move trajectories, which are not limited to pure radial moves.
OCR:	Optical Character Reader. A device used for optical character recognition.
OEM:	Original Equipment Manufacturer.
OHT:	Overhead Hoist Transport. A rail guided vehicle and hoist used to transport material above the factory floor over the heads of factory personnel.
Pan:	See End Effector .
Parallel I/O:	Parallel I/O allows a Host Controller to communicate with the Atmospheric Pre-aligner using the commands detailed in Chapter 8. The characters in each command are converted to sets of binary bits (1s and 0s) and the bits for each character are transmitted down a set of wires as a set (one wire per bit). Additional wires are used for control, or "handshaking", to direct the transfer of data. Typically, Parallel I/O is bidirectional, that is the wires carry data in both directions.
Partial Step Mode:	A mode that requires two steps to move the complete pitch distance. In partial step mode, each slot is divided into an up and down position. The distance between the up and down positions is called the partial step size.
Partial Step Size:	The distance between the up and down positions of a slot.
PC:	Personal Computer. A computer built around a microprocessor for use by an individual, as in an office or manufacturing plant.
Physical Coordinates:	The location along the spatial axes (R, T, and Z as appropriate).
PLC:	Programmable Logic Controller. A dedicated Controller used to automate monitoring and control of industrial equipment. Can be used stand-alone or in conjunction with other systems.
PM:	See Process Module .
Poppet:	The cool chamber cover, designed to raise and lower the wafer.
Post Position:	The position the wafer is placed in after processing.
PPS:	Priority Parts Service.

Process Module:	A user supplied module for processing wafers attached to the Transport Module.
PROM:	Programmable Read Only Memory. The PROM is a device which is used to store the Atmospheric Pre-aligner's software. The PROM retains its memory during power off periods. See EPROM .
PSS:	See Partial Step Size .
R Axis:	The axis of radial movement. For a robot it is the "in and out" of the robot's arms. For an elevator it is the rotation or "in and out" of the platform.
Radial Movement:	Linear movement of the robot's arm in and out of a station.
RAM:	Random Access Memory. Parameters set with set commands are stored in RAM until transferred to the EEPROM with a corresponding store command. Parameters stored in RAM are erased when power is removed.
Ready String:	In the Serial Mode, the string of ASCII characters the Atmospheric Pre-aligner sends when it is ready for the next command.
Record Type:	A single character field in a Atmospheric Pre-aligner transmission which identifies it as either action (A), set (S), store (P), request (R), response (X), or a system abort (E) command.
Release Notes:	Software Release Notes are be distributed to user's requiring new software features.
Request Commands:	A software command, used in serial communications with the Atmospheric Pre-aligner, that requests information from the Atmospheric Pre-aligner.
Reticle:	Glass plate that contains the patterns to be reproduced on the wafer.
Retract:	Movement inward. For a robot, this is movement of the robot's arm inward (towards from the robot's body). For an elevator, this is movement of the platform arm inward (towards from the elevator's body).
RGV:	Remote Guided Vehicle.
Rough Vacuum:	Pressure ranges from atmosphere to 10^{-3} Torr.
Rough Vacuum Pump:	A mechanical vacuum pump used to provide the initial evacuation of a chamber.
Robot:	A device used to move wafers between various stations. Within a Transport Module the robot moves wafers between the modules connected to the facets.
Rotational Movement:	Circular movement of the robot's arm between the various stations.
RS-232:	A serial communications protocol for communications between two devices. This protocol uses one wire for transmitting, one wire for receiving, and a common ground in a shielded cable.
RS-422:	A serial communications protocol for communications between two devices. This protocol uses two "twisted pair" wires; one for transmitting and one for receiving.
RS-485:	A serial communications protocol for communications between multiple devices. This

	protocol uses one “twisted pair” wire for both transmitting and receiving. All devices using this protocol must have an “address” to ensure that information is sent to the right device.
SCARA:	Selectively Compliant Articulated Robot Arm.
SECS I:	SEMI Equipment Communications Standard 1. The SECS-I standard defines the physical connector, signal levels, data rate, and logical protocols required to exchange messages between the host and equipment over a serial point-to-point data path. This employs an RS-232 communication link.
SECS II:	SEMI Equipment Communications Standard 2. The SECS-II standard defines the structure of messages. The messages are organized into categories called streams that are identified by an integer between 0 and 255.
SECS GEM:	Generic Model for Communications and Control of Manufacturing Equipment. The GEM standard defines the behavior of manufacturing equipment as viewed through a communications link. The GEM standard defines which SECS-II messages should be used, in what situations, and what the resulting activity should be.
SEMI:	Semiconductor Equipment and Materials International.
SEMI/MESC:	SEMI Modular Equipment Standards Committee.
Serial I/O:	Serial I/O allows a Host Controller to communicate with the Atmospheric Pre-aligner using the commands detailed in Chapter 6: Command Reference . The characters in each command are converted to sets of binary bits (1s and 0s) and the bits for each character are transmitted down a wire in “single-file”. Typically no additional control, or “hand-shaking”, wires are used.
Servo:	The control loop that governs the motions of the drive motors.
Set Command:	A command which sets a parameter in RAM. In general, set commands can have their status requested with corresponding request commands, and can have their values stored to the EEPROM with corresponding store commands.
Shoulder:	On the robot arm, the joint located at the drive shaft.
Single Pan Arm Set:	The Brooks Automation “frog leg” arm set with one end effector.
Slit Valve:	See Slot Valve .
Slot:	One of the positions on the inside of a substrate cassette that holds substrates. Usually, substrate cassettes have 25 slots.
Slot #0:	The slot number of the home position. See Home .
Slot Valve:	The valve located at a Transport Module facet that isolates the TM from the module connected to the facet.
SLPM:	SMIF Load Port Module. A Load Port Module designed to accept standard SMIF Pods.
SLPM:	Standard Liters Per Minute. 28 SLPM equals 1 CFM.

SMIF:	Standard Mechanical Interface Facility. Refers to sealed environment containers for transporting wafers.
SPS:	See Substrate Present Sensor .
SSO:	See Substrate Slide Out Sensor .
Standard Order:	The default order in which parameters are listed when using the ALL option. The specific standard order is shown in the reference entry for each command that supports the ALL option.
Station:	The robot's identification of a specific set of R, T, and Z coordinates.
Station Coordinates:	The location of the robot's arm relative to station parameters, that is Theta = Station Number, R = Extended or Retracted, and Z = Up or Down and Slot #.
Store Command:	A software command, used in serial communications with the Atmospheric Pre-aligner, that stores a selectable parameter to the EEPROM.
STP:	See Substrate Transport Plane .
Subcategory:	In the context of the Atmospheric Pre-aligner, a subcategory is a variable parameter in a transmission to or from the Atmospheric Pre-aligner. Subcategories often describe a position to be acted upon, or a variable to be set.
Substrate:	A thin quartz glass sheet used for producing Liquid Crystal Displays. Can also refer to a silicon wafer. See Wafer .
Substrate Present Sensor:	An optical sensor that senses substrate presence. See Wafer Present Sensor .
Substrate Slide Out Sensor:	An optical sensor that senses when any substrate is out of a cassette slot. See Wafer Slide Out Detector .
Substrate Transport Plane:	The plane coincident with the bottom surface of the substrate as the substrate is being transported. See Wafer Transport Plane .
T Axis:	The axis of rotational movement of the robot's arms.
T1 Drive:	The lower drive subsystem on a MagnaTran robot, which transmits its power to the arms through the inner drive shaft. Operating with the T2 Drive this axis drives the arms in both the Rotational (T) and Radial (R) axes.
T2 Drive:	The upper drive subsystem on a MagnaTran robot, which transmits its power to the arms through the outer drive shaft. Operating with the T1 Drive this axis drives the arms in both the Rotational (T) and Radial (R) axes.
TCL:	Tool Command Language. An open source scripting language for controlling automated tools.
Technical Support Bulletin:	Brooks Automation Technical Support Bulletins are distributed to user's of Brooks Atmospheric Pre-aligners to notify user's of any additional features, changes to the manual, changes to the software, corrections to the manual, and safety issues.
TM:	See Top Reference Flag .

Top Reference Flag:	See Flag .
Torr:	A unit for pressure measurement. 1 atmosphere (pressure at sea level) is approximately 760 Torr.
Transport Module:	The central hub of a Cluster Tool. Typically a large horizontal chamber with a centrally located wafer handler. All Wafer Transport Systems and Process Modules are attached to the external facets of the chamber.
TSB:	See Technical Support Bulletin .
Turbo pump:	Mechanical vacuum pump used to achieve High Vacuum.
Ultra High Vacuum:	Pressure ranges from about 10^{-8} Torr to less than 10^{-14} Torr.
Uninterruptible Power Supply:	A power supply designed to keep equipment operating without interruption for a short duration allowing proper shut-down of the equipment if utility-supplied power fails.
Universal Cassette Locator:	An elevator platform mounted fixture that facilitates positioning 3-inch through 150mm cassettes.
UPS:	See Uninterruptible Power Supply .
Vacuum Gauge:	A gauge used to measure the vacuum within a chamber. See Convectron Gauge , Crystal Gauge , and Ion Gauge .
Vacuum Pump:	Mechanical pump used to remove gases in an enclosed chamber. Types of pumps: roughing pump, high vacuum pump, ultrahigh vacuum pump.
VCE:	Vacuum Cassette Elevator. See Elevator .
Vent Valve:	Valve used to let atmospheric air or other gas into a vacuum system.
VTR:	Vacuum Transport Robot. See Robot .
Wafer:	A thin silicon disk used for producing semiconductors. See Substrate .
Wafer Present Sensor:	An optical sensor that senses wafer presence. See Substrate Present Sensor .
Wafer Slide Out Detector:	An optical sensor that senses when any wafer is out of a cassette slot. See Substrate Slide Out Sensor .
Wafer Transport Plane:	The plane in which wafers are transported horizontally by a system's transport arm. The plane is established by the surface of the transport arm end effector which supports the wafer. If the robot is capable of vertical motion, the "up" position of the end effector is the wafer transport position. In the VCE, the wafer transport plane is usually established at approximately one-half wafer thickness below the centerline of the first slot. See Substrate Transport Plane .
"with substrate" speed and acceleration:	See Low Speed .
"without substrate" speed and acceleration:	See High Speed .

WPS:	See Wafer Present Sensor .
Wrist:	On the robot arm, the joint (two bearings) located at the attachment to the end effector.
WSO:	See Wafer Slide Out Detector .
WTP:	See Wafer Transport Plane .
Z Axis:	The axis of vertical motion. For a robot it is the “up and down” of the robot’s arms. For an elevator it is the “up and down” of the platform.



Reader's Comments

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