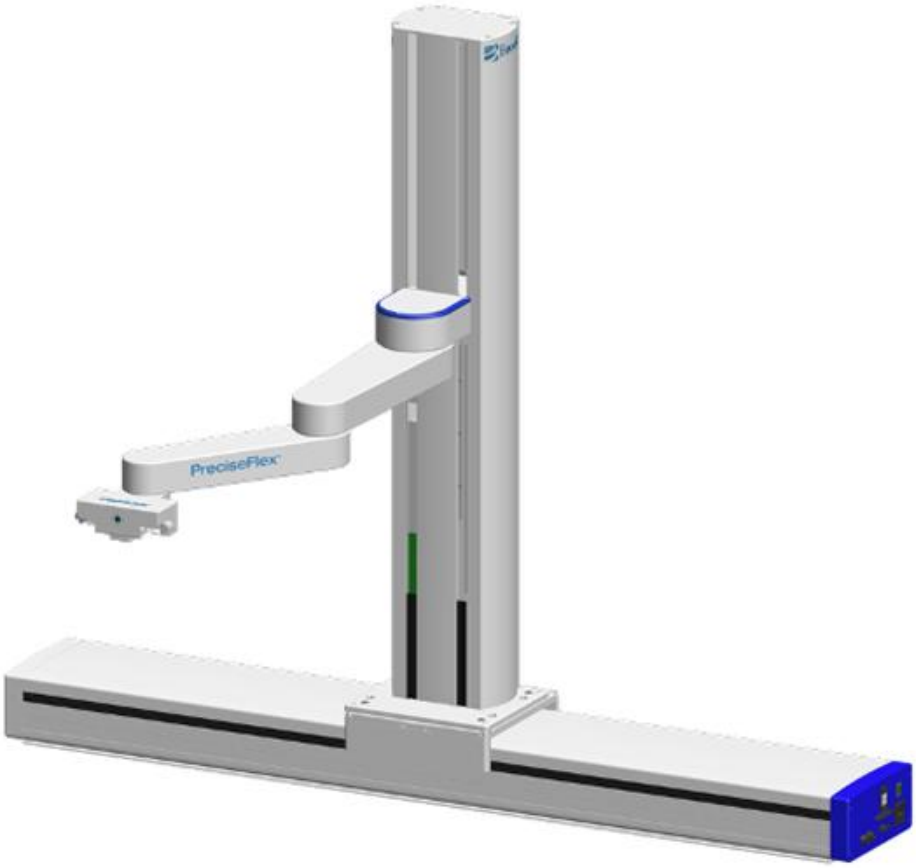

PreciseFlex™ Linear Rail

User Manual

Product Revision A

Document Version A, #663245

Brooks Automation

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Brooks Automation
15 Elizabeth Drive
Chelmsford, MA
01824-2400
Tel: +1 978-262-2400
Fax: +1 978-262-2500

Brooks Automation, PreciseFlex Collaborative Robots
201 Lindbergh Avenue
Livermore, CA
94551
Tel: +1-408-224-2838

Worldwide Headquarters
15 Elizabeth Drive
Chelmsford, MA 01824 U.S.A.

Brooks Automation,
PreciseFlex Collaborative Robots
201 Lindbergh Avenue
Livermore, CA 94551 U.S.A

Technical Support

Location	Contact	Website
North America	+1-800-447-5007 (Toll-Free) +1-978-262-2900 (Local) +1-408-224-2838 (PreciseFlex)	http://www.brooks.com/
Europe	support_preciseflex@brooksautomation.com	
Japan	+81 120-255-390 (Toll Free) +81 45-330-9005 (Local)	
China	+86 21-5131-7066	
Taiwan	+886 080-003-5556 (Toll Free) +886 3-5525258 (Local)	
Korea	1800-5116 (Toll Free)	
Singapore	+65 1-800-4-276657 (Toll Free) +65 6309 0701 (Local)	

General Emails

Division	Email Address
Sales	sales_preciseflex@brooksautomation.com
Technical Support	support_preciseflex@brooksautomation.com
Technical Publications	Technical.Publications@brooksautomation.com

Brooks Automation
15 Elizabeth Drive
Chelmsford, MA
01824-2400
Tel: +1 978-262-2400
Fax: +1 978-262-2500
www.brooks.com

Brooks Locations Worldwide:

Brooks Automation
46702 Bayside Parkway
Fremont,CA 94538
Tel: +1-510-661-5000
Fax: +1-510-661-5166

Brooks Automation
AIM Servicios Administrativos
S de RL de CV
Carretera Huinalá km 2.8
Parque Industrial Las Américas
66640 Apodaca, NL Mexico
Tel: +52 81 8863-6363

Brooks Automation (Germany) GmbH
Ernst-Ruska-Ring 11
07745 Jena, Germany
Tel: +49 3641 4821 100
Fax: +49 3641 4821 4100

Brooks Automation (Germany) GmbH
Daimler-Straße 7
78256 Steißlingen, Germany
Tel: +49-7732-9409-0
Fax: +49-7732-9409-200

Brooks Automation
9601 Dessau Road, Suite 301
Austin, TX 78754
Tel: +1 512-912-2840
Toll-Free: +1 800-367-4887

Brooks Automation (Israel) Ltd.
Mevo Yerach 5
Kiryat-Gat 82000
Israel
Tel: +972 8672 2988
Fax: +972 8672 2966

Brooks Technology (Shanghai) Limited
2nd Floor, No. 72,
887 Zuchongzhi Road
Zhangjiang Hi-Tech
Park Pudong, Shanghai
China 201203
Tel: +86-21-5131-7070
Fax: +86-21-5131-7068

Brooks Japan K.K.
HEADQUARTERS
Nisso Bldg. No 16, 9F
3-8-8 ShinYokohama, Kohoku-ku
Yokohama, Kanagawa 222-0033
Tel: +81-45-477-5570
Fax: +81-45-477-5571

Brooks Japan K.K.
YOKOHAMA TECHNICAL CENTER
852-1 Kawamuko-cho, Tsuzuki-ku
Yokohama, Kanagawa 224-0044
Tel: +81-45-477-5250
Fax: +81-45-470-6800

Brooks Japan K.K.
KUMAMOTO SERVICE OFFICE
202 Mirai Office II
312-1 Tatsudamachi Yuge
Tatsuda, Kumamoto 861-8002
Tel: +81-96-327-9720
Fax: +81-96-327-9721

Brooks CCS Japan K.K.
CONTAMINATION CONTROL SOLUTIONS
Nisso Bldg. No 16, 9F
3-8-8 ShinYokohama, Kohoku-ku
Yokohama, Kanagawa 222-0033
Tel: +81-45-477-5570
Fax: +81-45-477-5571

Brooks Automation Ltd.
TAIWANHEADQUARTERS
5F-5, No.32, Tai-Yuen Street
Chu-Pei City
Hsinchu County 302, Taiwan, R.O.C.
Tel: +886-3-552 5258
Fax (G&A): +886-3-552 5255
Fax (Sales): +886-3-552 5200

Brooks Automation Korea, Inc.
#35 Giheungdanji-Ro 121Beon-Gil
Giheung-Gu, Yongin-Si
Gyeonggi-Do, 17086
Korea
Tel : +82-31-288-2500
Fax: +82-31-287-2111

Brooks Automation CCS RS AG
Lohstampfestrasse 11
CH-8274 Tagerwilen, Switzerland
Tel: + 41 71-666-72-10
Fax: + 41 71-666-72-11

Brooks Automation Korea
#35 Giheungdanji-Ro 121Beon-Gil
Giheung-Gu, Yongin-Si
Gyeonggi-Do, 17086
Korea
Tel : +82-31-288-2500
Fax: +82-31-287-2111

Brooks Automation (S) Pte Ltd
51-18-C1 Menara BHL,
57 Jalan Ahmad Shah,
10050, Penang,
Malaysia
Tel: +60 4 3701012
Fax: +60 4 3701015

Brooks Automation (Singapore) Pte Ltd
Blk 5008 Ang Mo Kio Avenue 5
#05-08, Techplace II
Singapore 569874
Tel: +65-6836-3168
Fax: +65-6836-3177

Brooks Automation Ltd.
TAINAN OFFICE
3F., No.11, Nanke 3rd Rd., Xinshi Dist.
Tainan Science Park
Tainan City 74147, Taiwan (R.O.C.)
TEL: +886-6-505-0268
FAX: +886-6-505-5228

Brooks Automation Precise Collaborative Robotics
201 Lindbergh Drive
Livermore, CA 94551
Tel: +1-978-262-2400

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Documentation Version	ECO	Date	Action	Author
A	EC166511	August 18, 2025	Released manual at Rev. A to follow standard Brooks technical publication styles.	M. Ashenfelder

Table of Contents

1. Safety

Safety Setup

Brooks uses caution, warning, and danger labels to convey critical information required for the safe and proper operation of the hardware and software. Read and comply with all labels to prevent personal injury and damage to the equipment.

DANGER

Read the Safety Chapter

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

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

Explanation of Hazards and Alerts

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

Safety Text

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

- Identify the hazard
- State the consequences if the hazard is not avoided

- State how to avoid the hazard.

Safety Icons

- Hazard alerts contain safety icons that graphically identify the hazard.
- The safety icons in this manual conform to ISO 3864-1:2011 *Graphical symbols — Safety colours and safety signs* and ANSI Z535 standards.

Safety Icon Examples	
	Warning
	Two-Person Lift
	Electric Shock

Signal Words and Colors

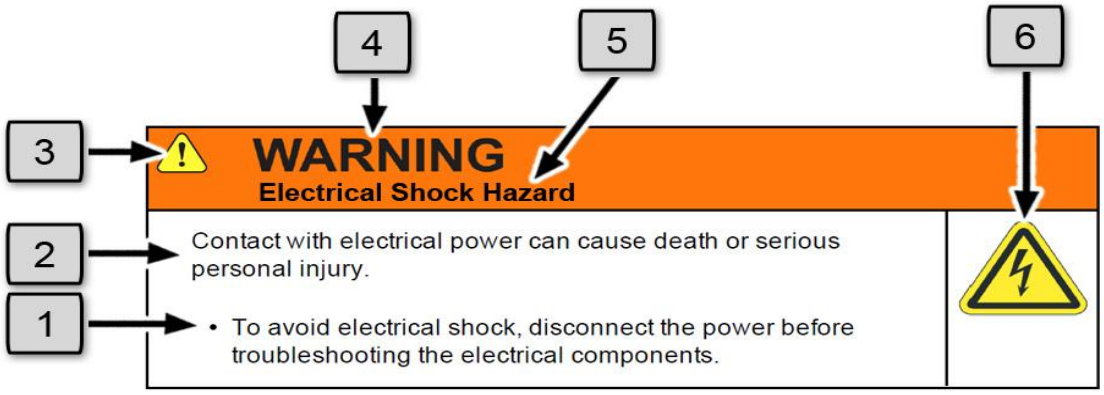
Signal words and colors inform of the level of hazard.

	Danger indicates a hazardous situation which, if not avoided, **will result in serious injury or death**. The Danger signal word is white on a red background with an exclamation point inside a yellow triangle with black border.

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

Alert Example

The following is an example of a Warning hazard alert.



Number	Description
1.	How to Avoid the Hazard
2.	Source of Hazard and Severity
3.	General Alert Icon

Number	Description
4.	Signal Word
5.	Type of Hazard
6.	Hazard Symbol(s)

General Safety Considerations

WARNING

Software

Software is not safety rated. Unplanned motion can occur as long as power is supplied to the motors. Maximum torque could be momentarily applied that may cause equipment damage or personal injury.

- Only operate the robot with its covers installed.
- Guarantee that safety controller features are in place (for example, an emergency stop button and protective stop).
- Regularly test safety components to prove that they function correctly.

WARNING

Robot Mounting

Before applying power, the robot must be mounted on a rigid test stand, secure surface, or system application. Improperly mounted robots can cause excessive vibration and uncontrolled movement that may cause equipment damage or personal injury.

- Always mount the robot on a secure test stand, surface, or system before applying power.

WARNING

Do Not Use Unauthorized Parts

Using parts with different inertial properties with the same robot application can cause the robot's performance to decrease and potentially cause unplanned robot motion that could result in serious personal injury.

- Do not use unauthorized parts.
- Confirm that the correct robot application is being used.

WARNING

Magnetic Field Hazard

This product contains magnetic motors that can be hazardous to implanted medical devices, such as pacemakers, and cause personal harm or severe injury.

- Maintain a safe working distance of 30 cm from the motor when with an energized robot if you use a cardiac rhythm management device.

CAUTION

Unauthorized Service

Personal injury or damage to equipment may result if this product is operated or serviced by untrained or unauthorized personnel.

- Only qualified personnel who have received certified training and have the proper job qualifications are allowed to transport, assemble, operate, or maintain the product.

CAUTION

Damaged Components

The use of this product when components or cables appear to be damaged may cause equipment malfunction or personal injury.

- Do not use this product if components or cables appear to be damaged.
- Place the product in a location where it will not get damaged.
- Route cables and tubing so that they do not become damaged and do not present a personal safety hazard.

CAUTION

Inappropriate Use

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

- Only use the product for its intended application.
- Do not modify this product beyond its original design.
- Always operate this product with the covers in place.

CAUTION

Seismic Restraint

The use of this product in an earthquake-prone environment may cause equipment damage or personal injury.

- The user is responsible for determining whether the product is used in an earthquake prone environment and installing the appropriate seismic restraints in accordance with local regulations.

Electrical Hazards

Refer to the specifications of the *Guidance Controller Quick Start Guide* for the electrical power.

DANGER

Electrical Shock Hazard

Contact with electrical power can cause personal harm and serious injury.

- To avoid electrical shock, disconnect the power before troubleshooting the electrical components.
- Check the unit's specifications for the actual system power requirements and use appropriate precautions.
- Never operate this product without its protection covers on.

WARNING

Electrical Burn

Improper electrical connection or connection to an improper electrical supply can result in electrical burns resulting in equipment damage, serious injury, or death.

- Always provide the robot with the proper power supply connectors and ground that are compliant with appropriate electrical codes.

WARNING

Electrical Fire Hazard

All energized electrical equipment poses the risk of fire, which may result in severe injury or death. Fires in wiring, fuse boxes, energized electrical equipment, computers, and other electrical sources require a Class C extinguisher.

- Use a fire extinguisher designed for electrical fires (Class C in the US and Class E in Asia).
- It is the facility's responsibility to determine if any other fire extinguishers are needed for the system that the robot is in.

NOTICE

Improper handling of the power source or connecting devices may cause component damage or equipment fire.

- Connect the system to an appropriate electrical supply.
- Turn off the power before servicing the unit.
- Turn off the power before disconnecting the cables.

Ergonomic Hazards

CAUTION

Heavy Lift Hazard

Failure to take the proper precautions before moving the robot could result in back injury and muscle strain.

- Use a lifting device and cart rated for the weight of the drive or arm.
- Only persons certified in operating the lifting device should be moving the product.

CAUTION

Tipover Hazard

This product has a high center of gravity which may cause the product to tip over and cause serious injury.

- Always properly restrain the product when moving it.
- Never operate the robot unless it is rigidly mounted.

CAUTION

Trip Hazard

Cables for power and communication and facilities create trip hazards which may cause serious injury.

- Always route the cables where they are not in the way of traffic.

Emergency Stop Circuit (E-Stop)

The integrator of the robot must provide an external emergency stop switch.

WARNING

Emergency Stop Circuit

Using this product without an emergency stop circuit may cause personal injury.

- Customer is responsible for integrating an emergency stop circuit into their system.
- Do not override or bypass the emergency stop circuit.

Recycling and Hazardous Materials

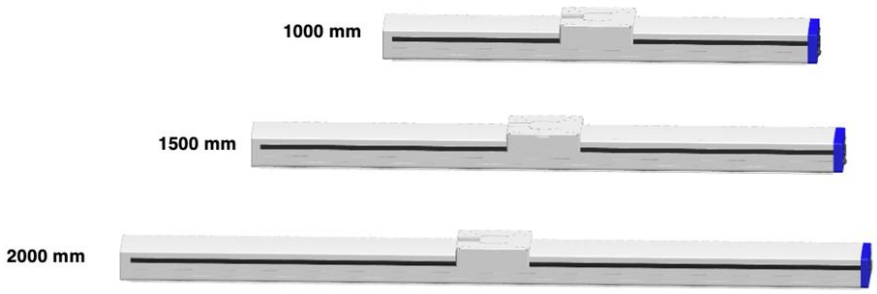
Brooks Automation complies with the EU Directive 2002/96/EU Waste Electrical and Electronic Equipment (WEEE).

The end user must responsibly dispose of the product and its components when disposal is required. The initial cost of the equipment does not include the cost of disposal. For further information and assistance in disposal, email Brooks Automation Technical Support at support_preciseflex@brooksautomation.com.

2. Overview

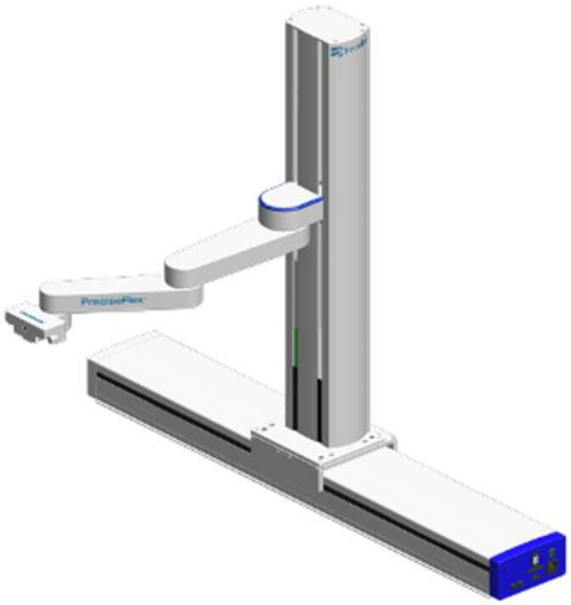
PreciseFlex robots can be ordered with an optional linear rail to extend the horizontal reach of the robot. Linear rails are available in 1000, 1500, and 2000 mm travel distances and can be ordered with PreciseFlex 400, PreciseFlex 3400, PreciseFlex c3, and PreciseFlex c5 robots.

The length of the linear rail is about 380 mm longer than the travel distance. All cables and controls are contained inside the linear rail, which is equipped with drip proof covers and tape seals. The power, E-stop, and Ethernet connectors are extended from the base of the robot to the end cap of the linear rail.



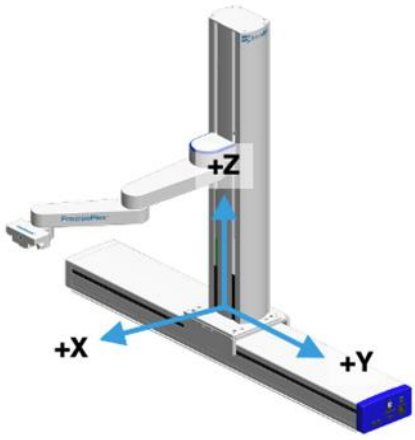
The linear rail is driven by a servo amplifier located under the carriage. This servo amp gets both power and commands from the controller located inside the robot.. The linear rail must be used in combination with a PreciseFlex robot. It does not operate as a stand-alone axis.

The graphic below shows a PreciseFlex c3x robot mounted to a 1000 mm linear rail. The linear rail carriage (and robot) is positioned in the middle of travel, which is defined as the zero position for the linear rail travel. The robot may be mounted in the default orientation, thereby the linear rail moves along the Y-axis in the robot's coordinate system, extending the robot's Y-axis by plus or minus 500 mm. The Y-axis robot travel will increase accordingly when a 1500 or 2000 mm linear rail is used.

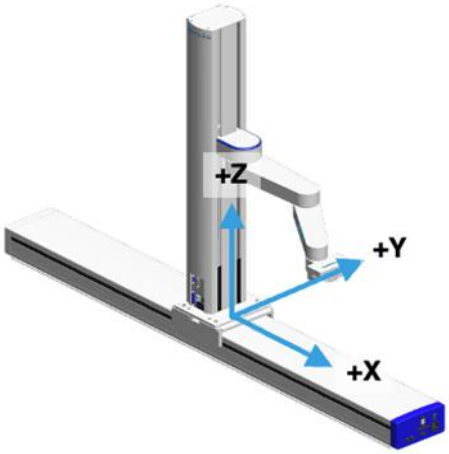


The robot may also be rotated 90° counterclockwise, as shown below, so that the robot X-axis travel is in line with the linear rail. In this case, the linear rail extends the robot's X-axis travel, when the appropriate software parameter is changed.

> ***NOTE:*** The PreciseFlex c3, PreciseFlex 400, and PreciseFlex 3400 have the same mounting configurations.

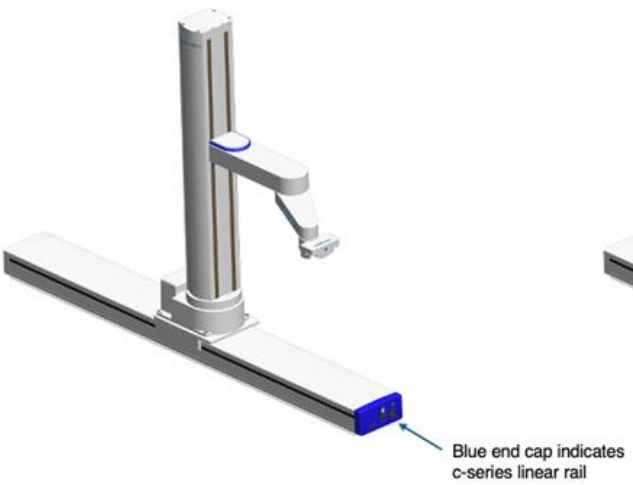


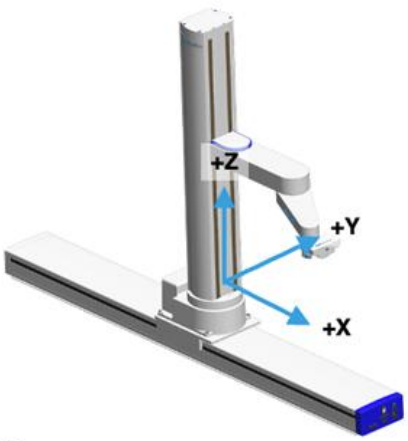
Default Mounting Configuration



90° Mounting Configuration

Since the PreciseFlex c5 robot has a rotary base, only one mounting orientation is provided.





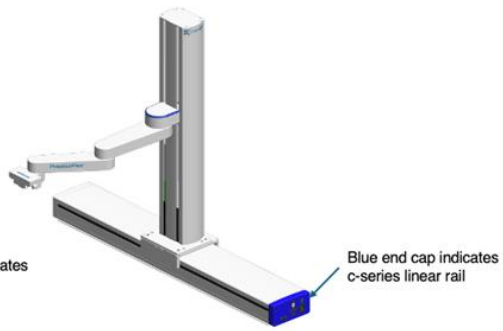
Robot Compatibility

PreciseFlex 400 and 3400 robots are compatible with legacy linear rails. PreciseFlex c3 and c5 robots are compatible with the new c-series linear rails. It is important not to install PreciseFlex 400 or 3400 robots on *the new c-series linear rails*. It is equally important not to install PreciseFlex c3 or c5 robots on *legacy linear rails*. C-series linear rails are identifiable by the blue end cap on the power end of the linear rail.

WARNING

Incompatibility Damage

Damage to robots and linear rails may occur if robots are connected to incompatible linear rails



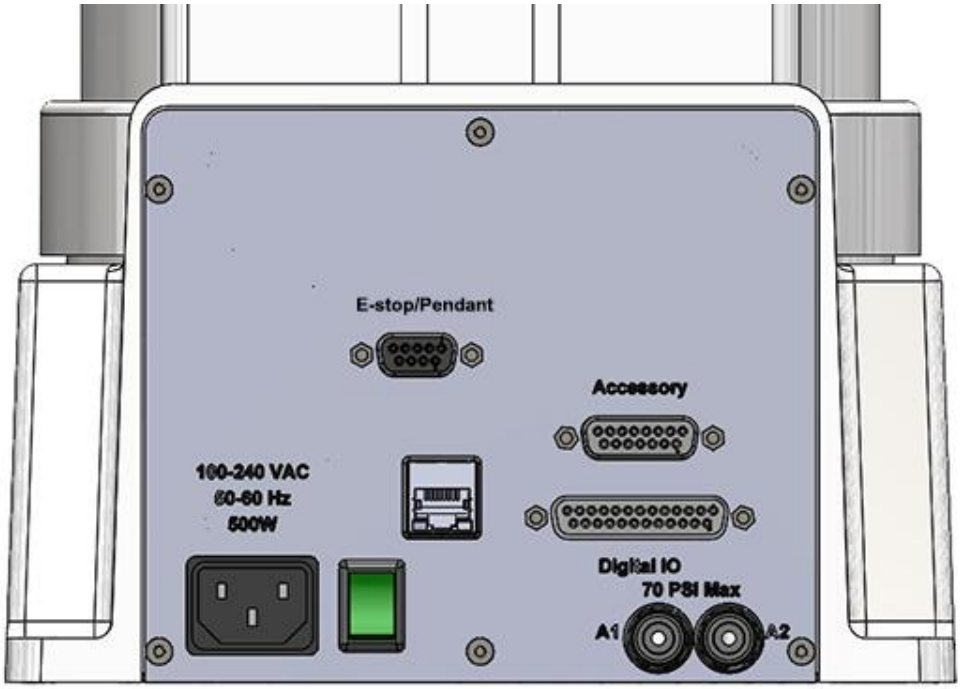
The following table shows which PreciseFlex robots the PreciseFlex linear rails are compatible with.

Robot Model	Legacy Linear Rails (1.0, 1.5, or 2.0 M)	C-Series Linear Rails (1.0, 1.5, or 2.0M)
PreciseFlex 400	Yes	Not compatible
PreciseFlex 3400	Yes	Not compatible
PreciseFlex c3/c3X	Not compatible	Yes
PreciseFlex c5	Not compatible	Yes
PreciseFlex c10	Not compatible	Not compatible
PreciseFlex c8A	Not compatible	Not compatible

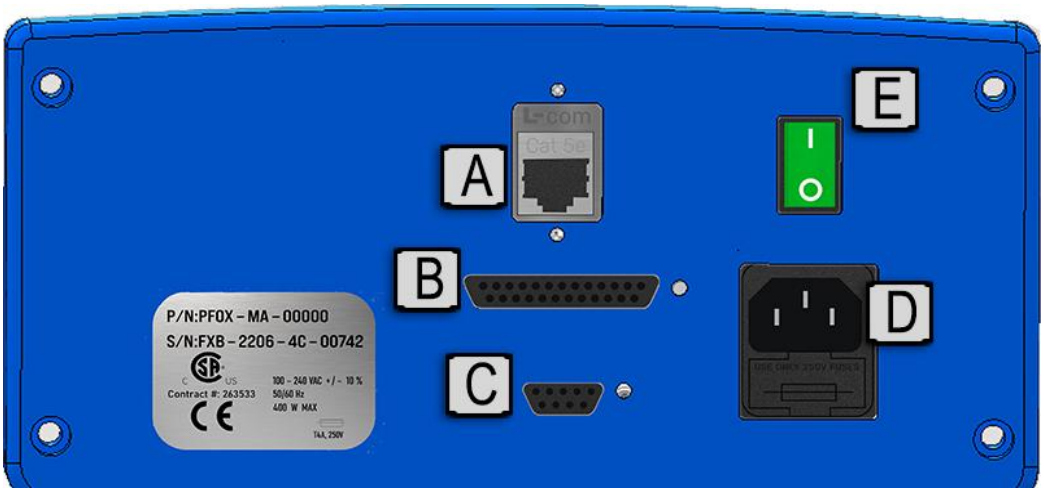
NOTE: The PreciseFlex c3 and c3X use the same adaptor plate and mounting configurations are the PreciseFlex 400 and 3400 robots. The PreciseFlex c5 robot base has a different bolt patten. Therefore, it requires a different mounting plate adapter.

Linear Rail Facilities Panel

Plug all required peripheral devices and interface connectors from the robot into the linear rail facilities panel.



Robot facilities panel, example from a c5 robot



Linear rail facilities panel, example for a c5 robot

Number	Name	Description
A	Ethernet connector	For Ethernet-to-computer cable. Required for communicating with robot via Guidance Development Studio (GDS).
B	Digital I/O	25-pin D-sub connector for GIO Module for connecting general digital inputs and outputs. See the robot manual for details.

Number	Name	Description
C	E-stop/Pendant	9-pin D-sub connector for external E-stop, RS-232 serial port.
D	Power entry module	For IEC plug. Contains dual fuse drawer. 100-240 VAC, 50-60 Hz.
E	Power switch	Lighted power switch. Turns on power to the robot and the linear module. Switch on only after all connections are made and installation complete.

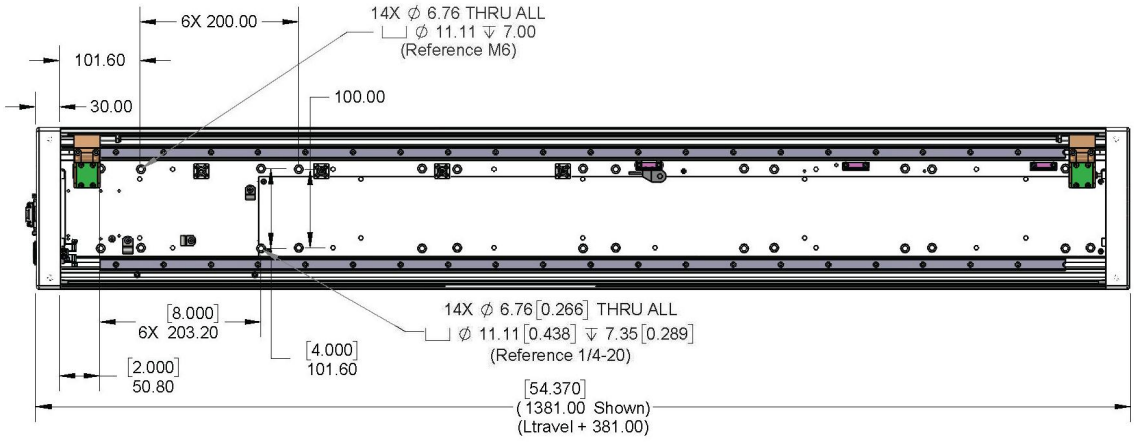
3. Installation

Rail Mounting

The PreciseFlex linear axis must be attached to a rigid surface that can withstand lateral forces of 200 Newtons without the mounting surface moving or vibrating. The linear rail supports both M6 and ¼-20 hole patterns.

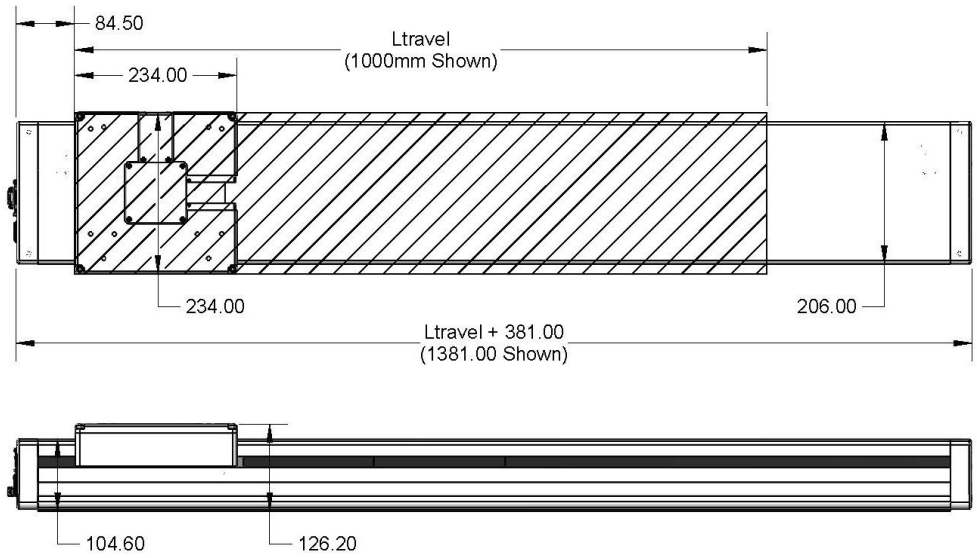
Remove the top two screws on each end plate, then lift and slide out the top cover to access all mounting holes.

NOTE: Be careful to not damage the electronics in the carriage assembly and to not damage the tape seals.



PreciseFlex linear rail mounting holes

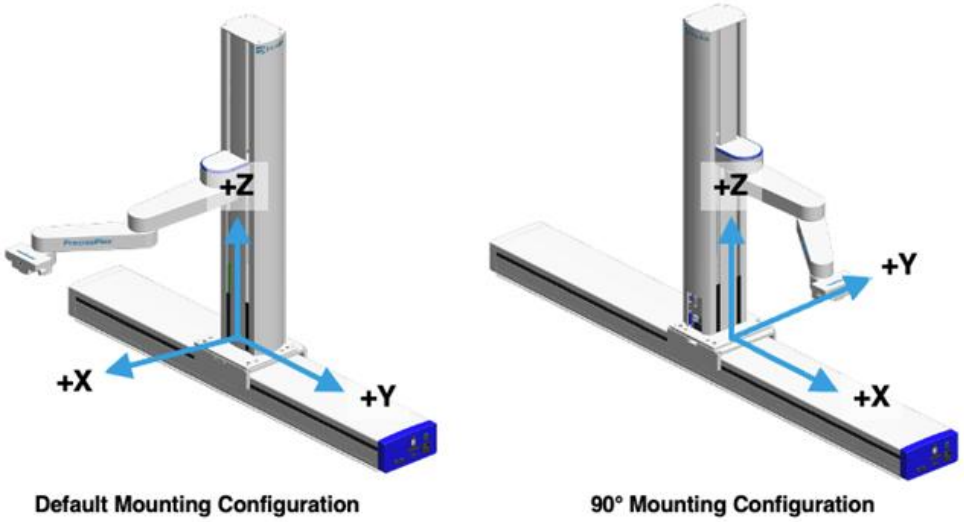
When replacing the top cover, be sure the tape seals are inside the slot in the top cover and not pinched or crushed. Move the carriage back and forth across the range of travel to ensure the cover and tape seals are installed properly.



PreciseFlex linear rail travel dimensions

PreciseFlex 400, 3400, and c3/c3X Robots

PreciseFlex 400, 3400 and c3/c3X robots can be mounted in one of two configurations. The default configuration is with the robot Y-axis moving in the direction of the linear rail travel. The robots can also be rotated counterclockwise 90° so that the robot X-axis moves along the linear rail travel.

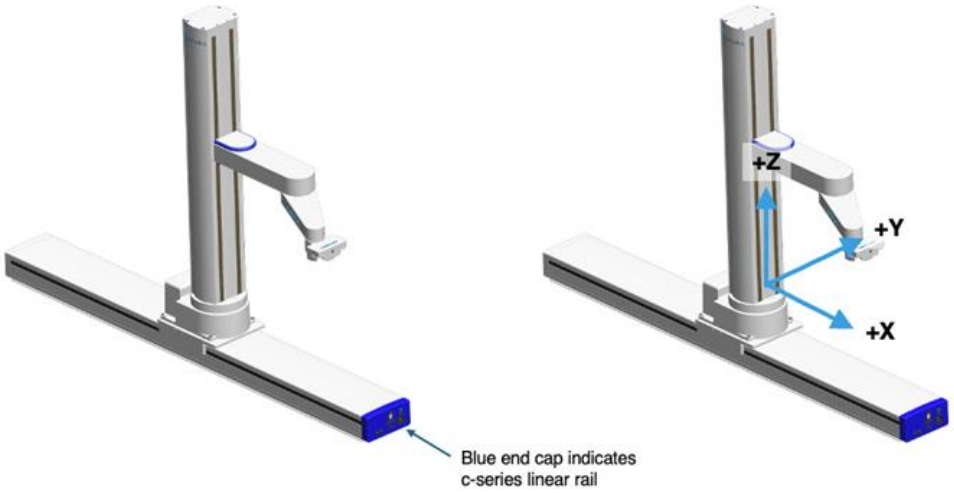


Default Mounting Configuration **90° Mounting Configuration**

PreciseFlex c3X on Linear Rail

PreciseFlex c5 Robots

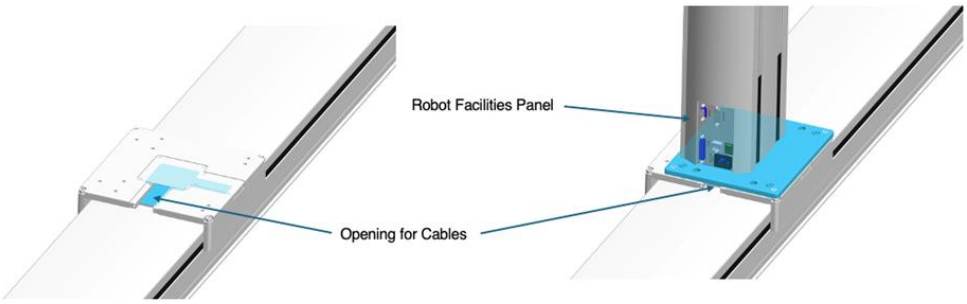
As mentioned in Chapter 2, with the rotary base of the PreciseFlex c5 robot, there is only one mounting configuration. The robot X-axis moves in the direction of the linear rail travel.



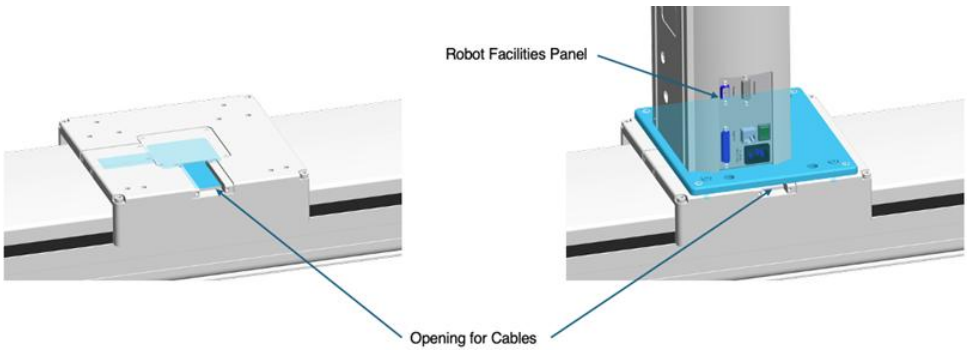
PreciseFlex c5 on Linear Rail

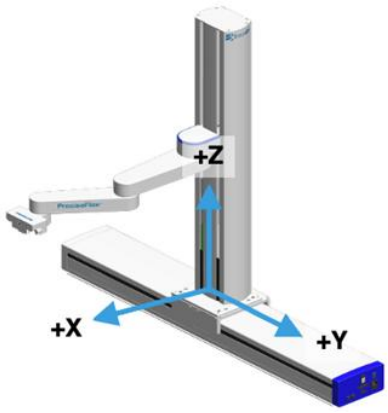
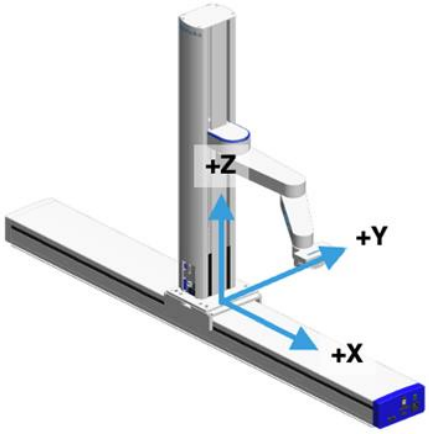
Mounting the PreciseFlex 400, 3400, or c3/c3x Robot

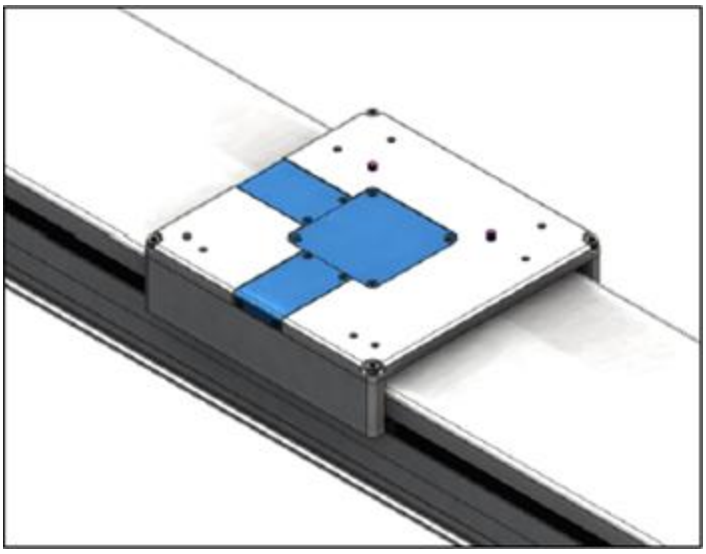
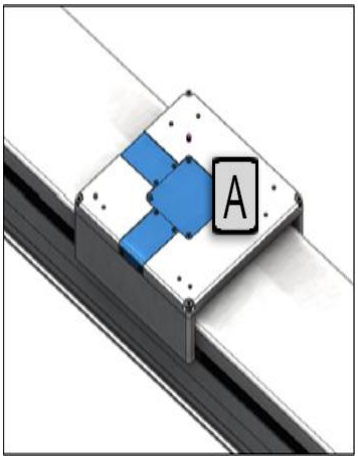
The opening in the linear rail carriage should align with the position of the cables attaching to the robot facilities panel. If the default configuration is desired, there should be no need to adjust the mounting plate.

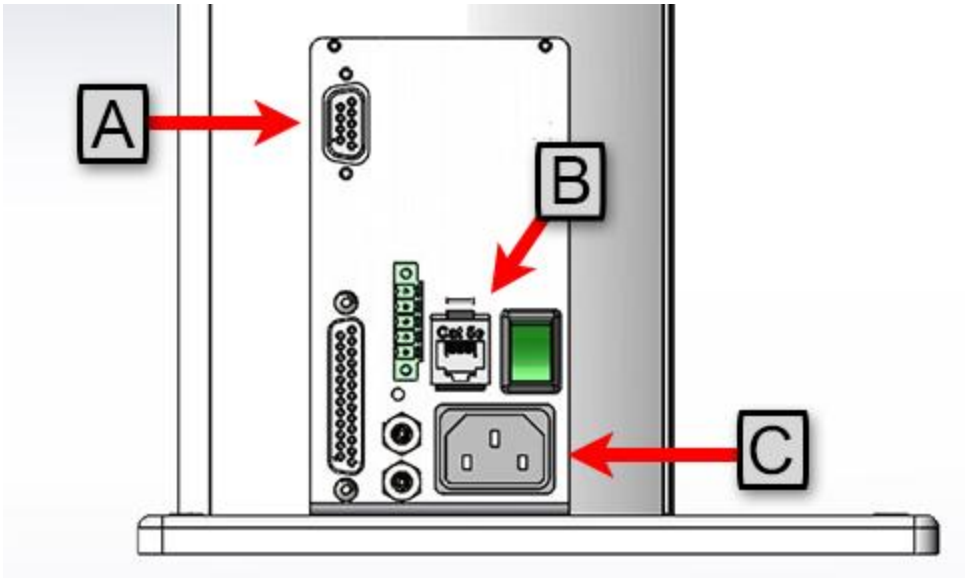
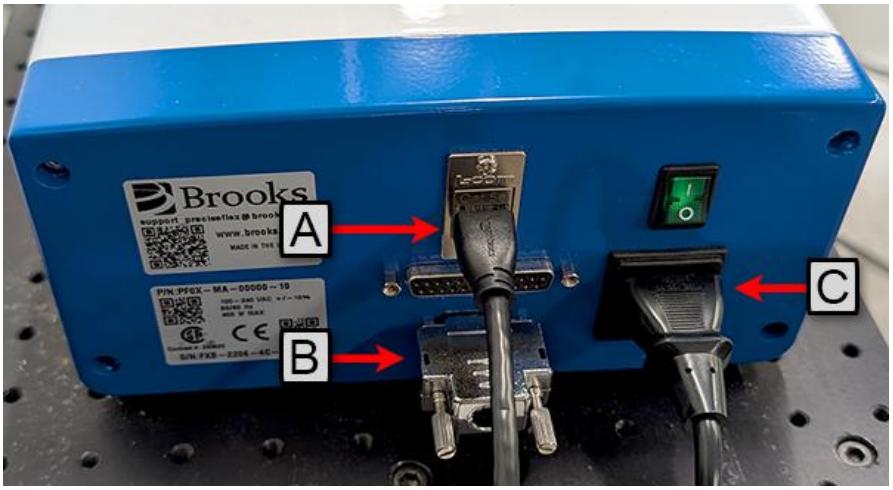


If the 90° mounting configuration is desired, it is necessary to move the cable opening cover so the opening aligns with the robot facilities panel.

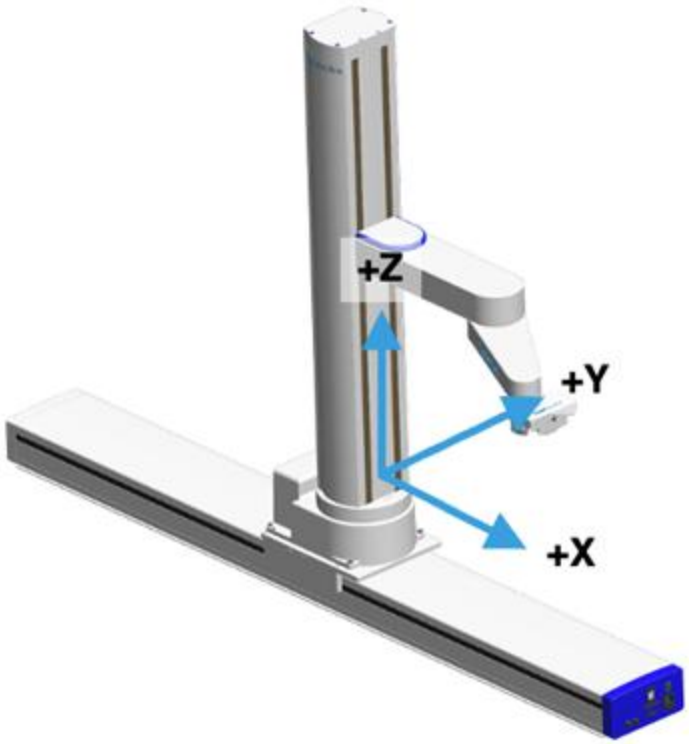
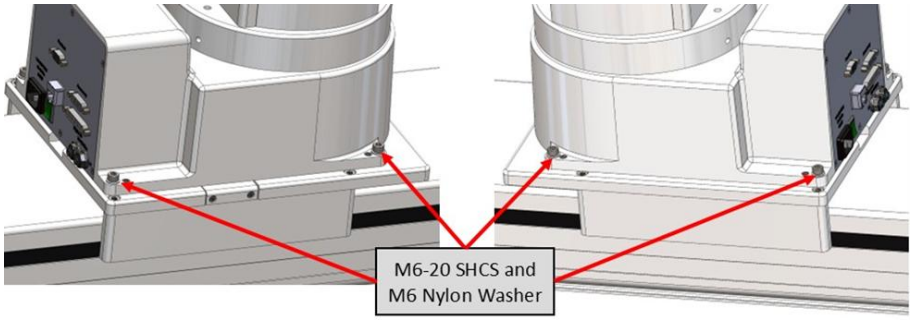


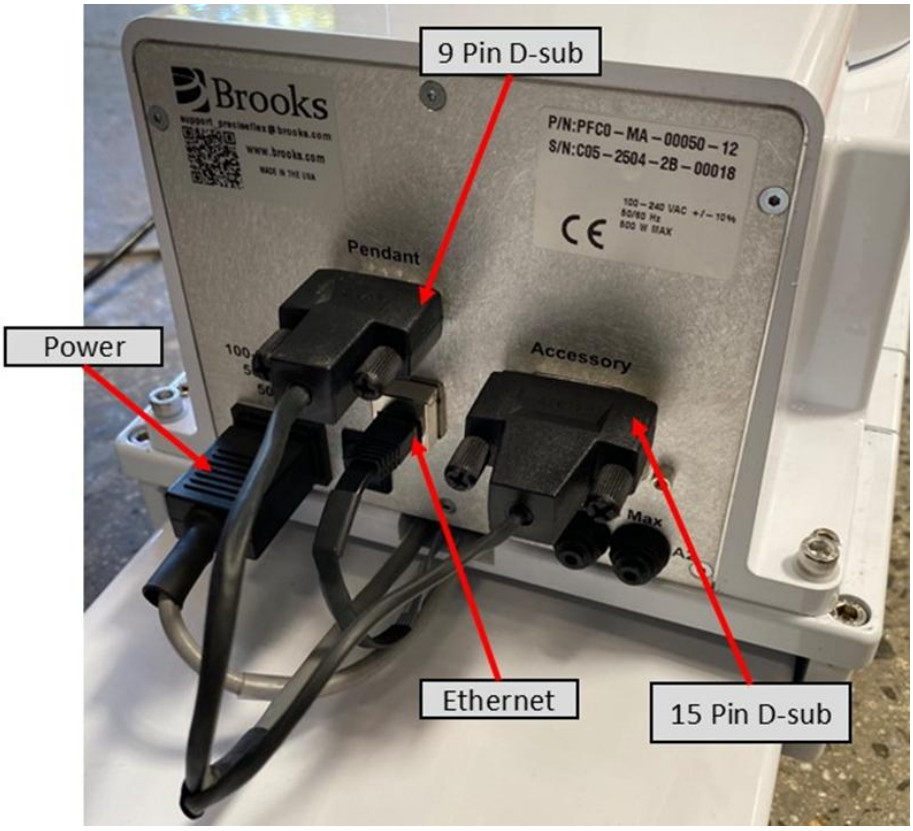
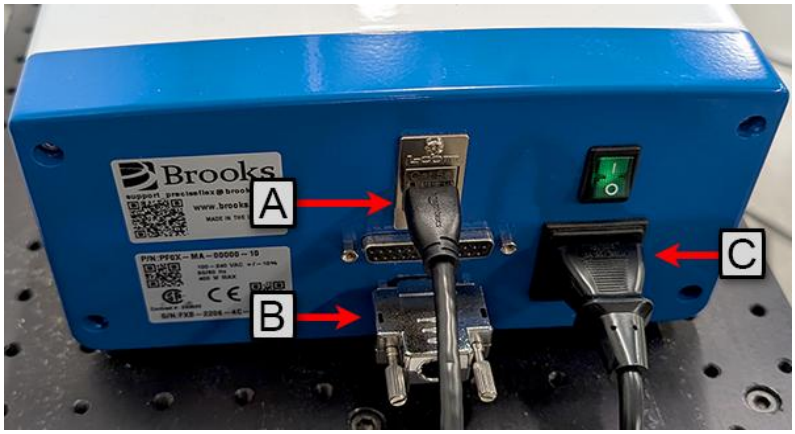
Step	Action
1.	Select an orientation for PreciseFlex 400, 3400 and c3/c3x.  0 Degrees: Robot Y-axis aligns with rail travel (moves "sideways")  -90 Degrees: Robot X-axis aligns with rail travel (moves "forward" and "backward")

Step	Action
2.	Route cables. If necessary, unscrew the M3 X 6 FHCS screws from the covers on the carriage, remove the covers, and re-route the cabling so the connectors can reach the Linear Rail Facilities Panel. Minimize excess cables as much as possible. Put the covers back on after rerouting the cables. 
3.	Secure the robot with the four (4) M6 x 20 screws and torque the screws to…  **0 Degrees**  **-90 Degrees**

Step	Action
4.	Connect the E-stop (A), Ethernet (B), and power (C) cables from the linear rail to the robot's facilities panel.  **PreciseFlex 400**
5.	Connect Ethernet (A), E-stop (B), power (C) and other peripherals to the linear rail facilities panel. 
6.	Install new PAC files, and calibrate the robot. See Updating Robot Configuration (PAC) Files after Linear Rail Installation

Mounting the PreciseFlex c5 Robot

Step	Action
1.	Mount the PreciseFlex c5 robot to the linear rail. ***NOTE:*** *The PreciseFlex c5 robot can be mounted in only one mounting orientation.* 
2.	Secure the robot using 4X M6-20 screws with M6 nylon flat washer. 

Step	Action
3.	Connect the E-stop, Ethernet, and power cables. 
4.	Install new PAC files, and calibrate the robot. See Updating Robot Configuration (PAC) Files after Linear Rail Installation
5.	Connect Ethernet (A), E-stop (B), power (C), and other peripherals into the linear rail facilities panel. 

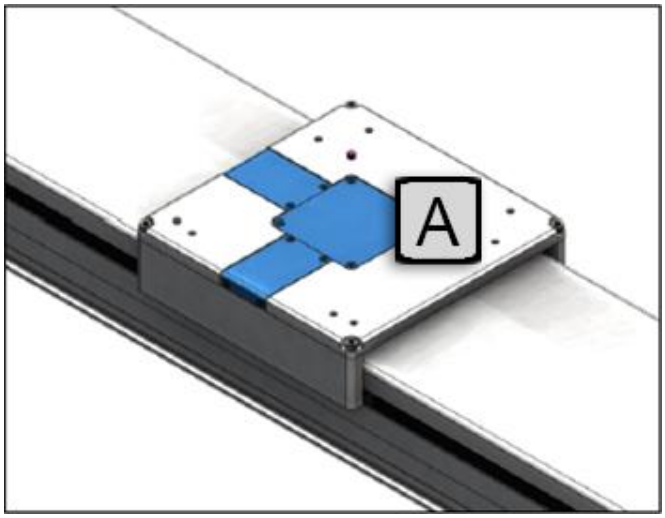
Robot Mounting Orientation

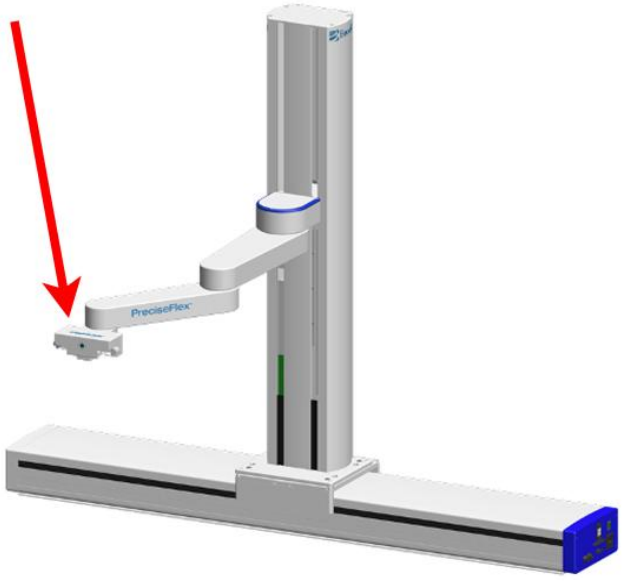
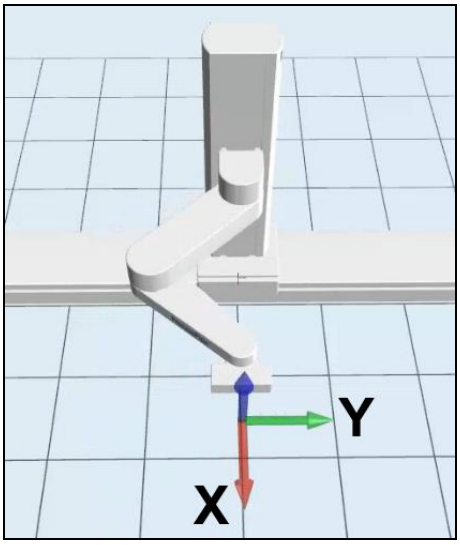
Correct robot mounting orientation is critical for ensuring accurate motion and reachability along the linear rail. Improper orientation, such as mounting the robot 180° reversed or misconfiguring its rotation, can lead to:

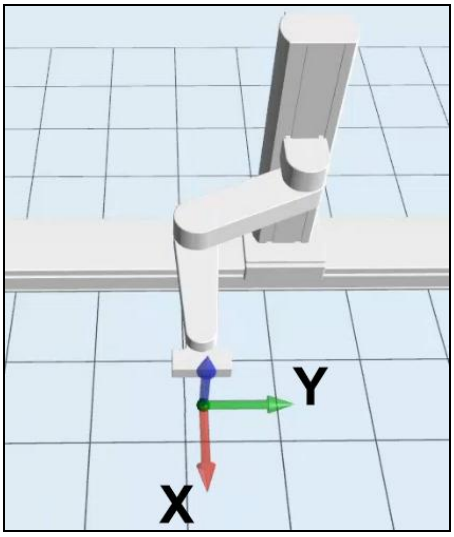
- Inaccurate coordinate reporting
- Limited reachability (for example., “dead zones” on one side of the rail)
- Collisions or unreachable positions
- Confusion during calibration and programming

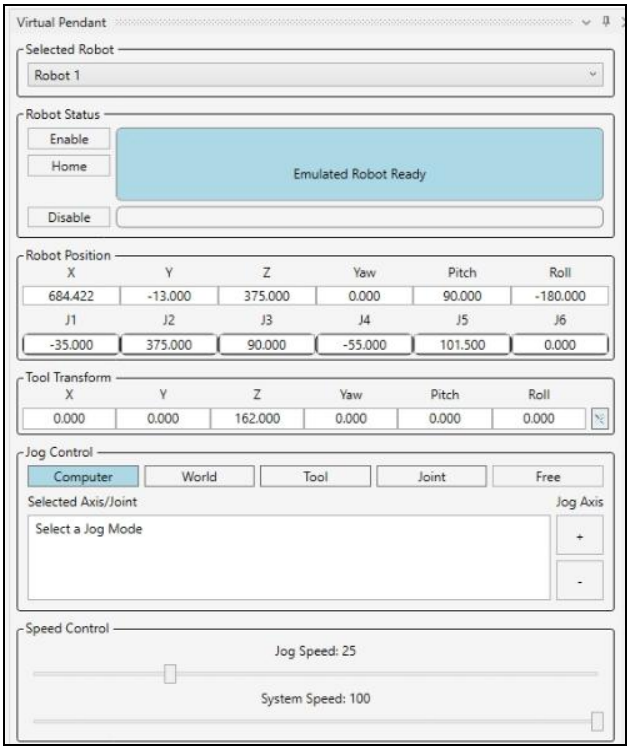
This verification procedure helps ensure the robot is mounted and configured correctly before operation. For the procedure, hold the gripper in place and move the carriage. If X and Y values change significantly, the robot is misconfigured. This simple manual test can save hours of troubleshooting and remounting. Always perform it before finalizing your setup.

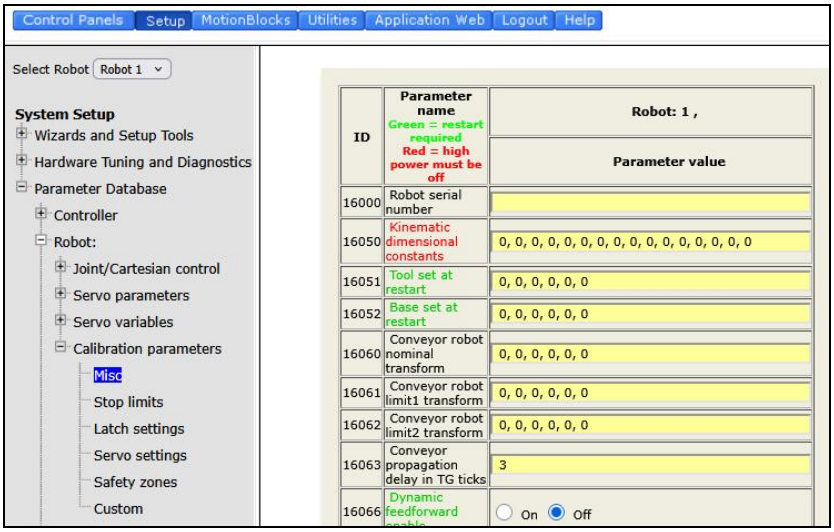
The power can be off for this procedure.

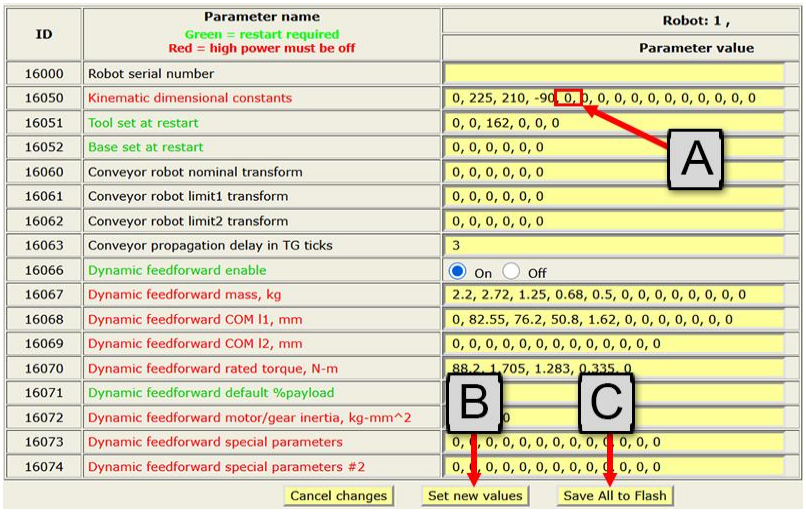
Step	Action
Initial Setup	
1.	Make sure the robot is securely mounted to the carriage (A). 

Step	Action
2.	Make sure the gripper is accessible and safe to hold manually. 
Hold the Gripper	
3.	With one hand, hold the gripper still. Maintain the gripper and the X axis position in a fixed point in space. Do not allow the gripper to move 
Slide the Carriage	

Step	Action
4.	With your other hand, slide the carriage along the linear rail (Y axis). Move it a significant distance (for example, 300 mm) to observe coordinate changes. 
5.	Monitor the robot's X and Y positions via the browser interface's Virtual Pendant.  **Browser Virtual Pendant**

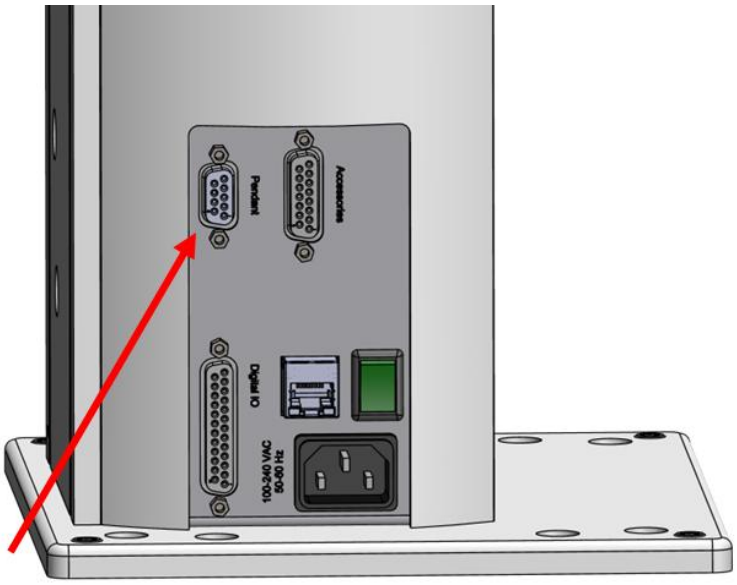
Step	Action
6.	Or monitor positions in the GDS Virtual Pendant. .  **GDS Virtual Pendant**
7.	**If the robot is correctly configured**, only the rail should show significant motion. **If the robot is misconfigured**, you will see large changes (e.g., 300 mm) in X or Y values. This indicates the robot is facing the wrong direction or has incorrect rotation settings.
Verify the Software Configuration	
8.	Verify that the software matches the physical orientation of the robot. ***NOTE:*** *A common mistake is to enter +90° instead of -90° in the robot's orientation settings.*
9.	Verify that J6 increased as the rail carriage is moved to the right, and decreases as it moves to the left. If J6 did not increase, the rail was calibrated at the wrong end

Step	Action
10.	Verify that the Cartesian X and Y positions remain constant within about 10 mm. • If both the X and Y change is larger than 10 mm, then the robot rotation is off by +/- 90° • If only one of the two axes change by more than 10 mm, then the robot orientation is off by 180° • If neither X nor Y change more than 10 mm, then the robot is configured correctly
To Update the Robot Orientation	
11.	In the browser interface, select **Admin > Setup > System Setup > Parameter Database > Robot > Calibration Parameters > Misc**. 

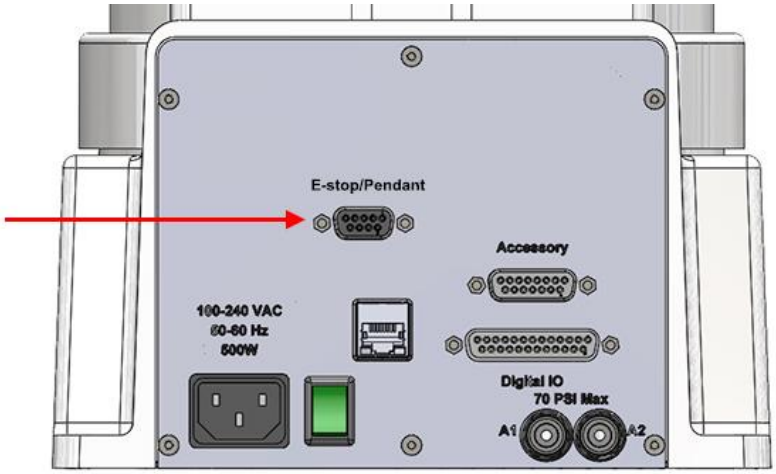
Step	Action
12.	• (A) Set the 5th value of parameter 16050 to the chosen orientation (0 or -90). • (B) Click "Set new values" • (C) Click "Save all to flash" 
13.	• Wait for the "Writing to Flash" banner to disappear • Wait an additional 10 seconds for all controller write operations to complete • Power cycle the robot. The linear rail configuration changes should take effect.
Verification	
14.	Verify J6 increases as the rail carriage is moved to the right and decreases as it moves to the left. If not the rail was calibrated at the wrong end.
15.	Verify the Cartesian X and Y position remains constant within about 10 mm • If X and Y changes are larger than 10 mm, then the robot rotation is off by +/- 90° • If only one of the two axes change by more than 10 mm, then the robot orientation is off by 180° • If neither X nor Y change more than 10 mm the robot is configured correctly.

External Emergency Stops (E-stops) for PreciseFlex c-Series Robots

PreciseFlex c3 and c5 robots have a dual-channel E-stop input on the 9-pin D-sub connector in the robot facilities panel.

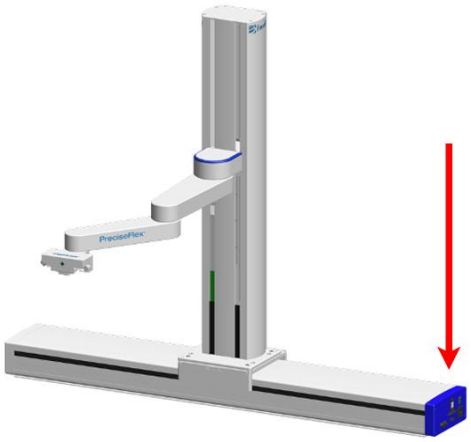


E-stop connector on a PreciseFlex c3 facilities panel



E-stop connector on a c5 facilities panel

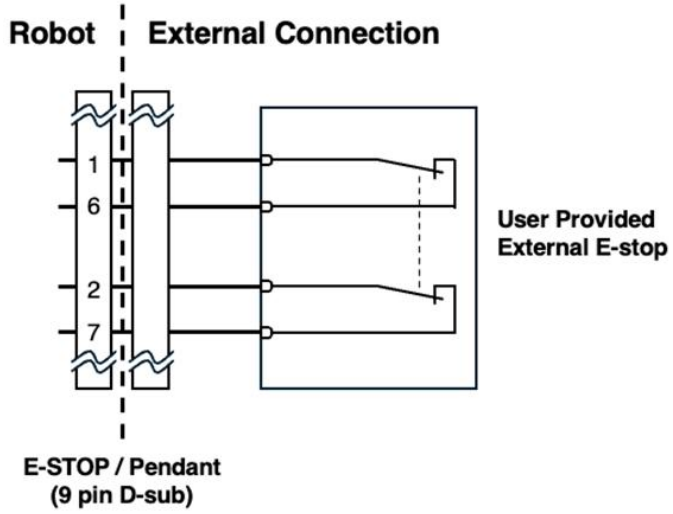
A cable from the linear rail connects to this 9-pin D-sub connector and extends the E-stop through the linear rail to the rail facilities.



This enables users to connect external E-stops with the following methods:

- A user-provided external E-stop
- An optional Brooks-provided E-stop box
- An optional Brooks-provided manual control pendant, which contains an E-stop button.

The E-stop circuit connects from Pin 1 (E-stop 1) to Pin 6 (FE Out 1) and from Pin 2 (E-stop 2) to Pin 7 (FE Out2). The Force E-stop (FE) Out signals allow each E-stop circuit to be toggled during the CAT3 startup sequence. If this circuit is not closed, robot motor power cannot be enabled.



c-Series linear rails ship with an E-stop loopback jumper (see the PreciseFlex Linear Rail Spare Parts List) in the 9-pin D-sub connector. Brooks recommends this plug be replaced with an external mechanism for triggering E-stop. Retain the loopback jumper for running the robot when it is not in production.

The connector on the linear rail is a female 9-pin D-sub (DB9) connector (AMP p/n 5747150-7). For External E-stops Brooks recommends the following connector components:

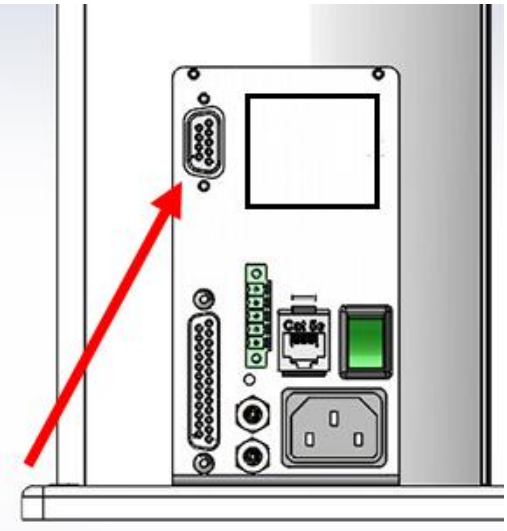
- DB9 Male Plug - Amp p/n 1658655-1 - User plug
- Pins - Amp p/n 22-26AWG 745254-6 - Pins

> ***NOTE:*** c-Series linear rails are only compatible with the E-stop loopback jumper, as described above. Connecting a different loopback jumper may result in an “E-Stop” error or potential damage to the equipment.

For full details of robot-specific external E-stop circuits, refer to the robot user manual.

External Emergency Stops (E-stops) for PreciseFlex 400/3400 Robots

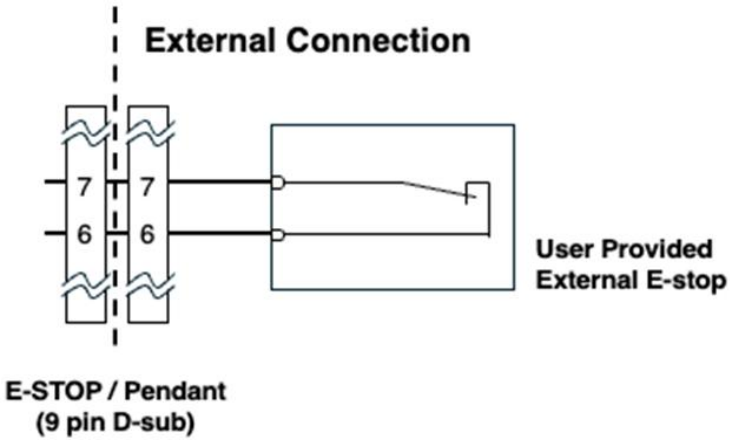
For PreciseFlex 400 and 3400 robots (Rev C and Rev D), the external E-stop is extended from the robot's 9-pin E-stop connector, through the linear rail to the linear rail facilities panel.



9-pin E-stop connector in a PreciseFlex 400 facilities panel

9-pin E-stop connector in a linear rail facilities panel

A user-provided external E-stop can be connected to pins 6 and 7 of the 9-pin D-sub connector on the linear rail facilities panel.



An external E-stop can be connected in the following ways:

- A user-provided external E-stop connected to the 9-pin D-sub connector
- An optional Brooks-provided E-stop box can be connected to the 9-pin D-sub connector
- An optional Brooks-provided manual control pendant, which contains an E-stop switch, can be connected to the 9-pin D-sub connector.

The E-stop circuit must be closed for robot power to be enabled. If open, robot motor power cannot be enabled, and an “E-stop” is reported. If open during operation, robot motor power is disabled, and the robot will stop.

Legacy linear rails ship with an E-stop loopback jumper plug (see the PreciseFlex Linear Rail Spare Parts List) in the 9-pin D-sub connector. Brooks recommends this plug be replaced with an external mechanism for triggering E-stop. Retain the loopback jumper for running the robot when it is not in production.

The connector on the linear rail is a female 9-pin D-sub (DB9) connector (AMP p/n 5747150-7). For External D-stops, Brooks recommends the following connector components.

- DB9 Male Plug - Amp p/n 1658655-1 - User plug
- Pins - Amp p/n 22-26AWG 745254-6 - Pins

NOTE: Legacy linear rails are only compatible with the E-stop loopback jumper as described above. Connecting a different loopback jumper may result in an “E-Stop” error or potential damage to the equipment.

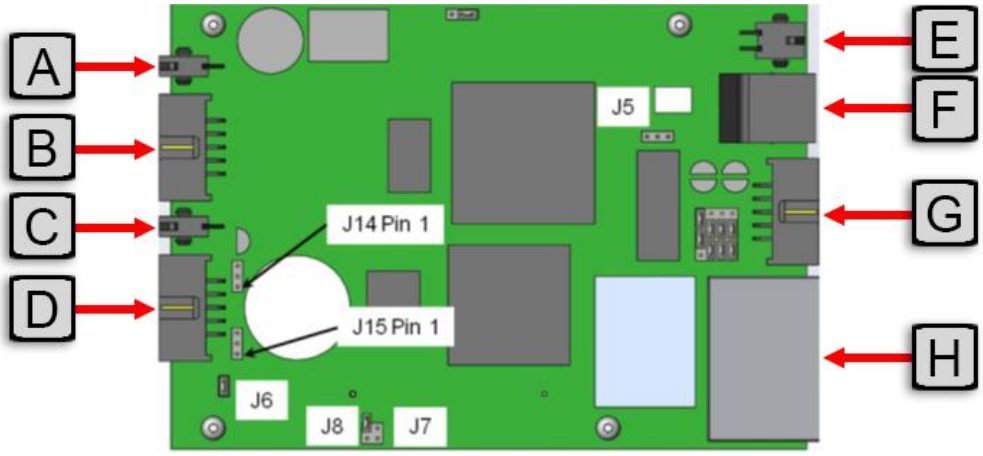
For full details of robot-specific external E-stop circuits, refer to the robot user manual.

Removing the RS-485

When adding a robot to a PreciseFlex linear rail for the first time, the J6 RS-485 termination jumper on the robot controller in the robot's inner link must be removed, because the RS-485 bus will extend to the end of the linear rail where an RS-485 jumper is installed. Failing to remove the jumper can result in RS-485 communication errors as there will be too many loads on the RS-485 bus.

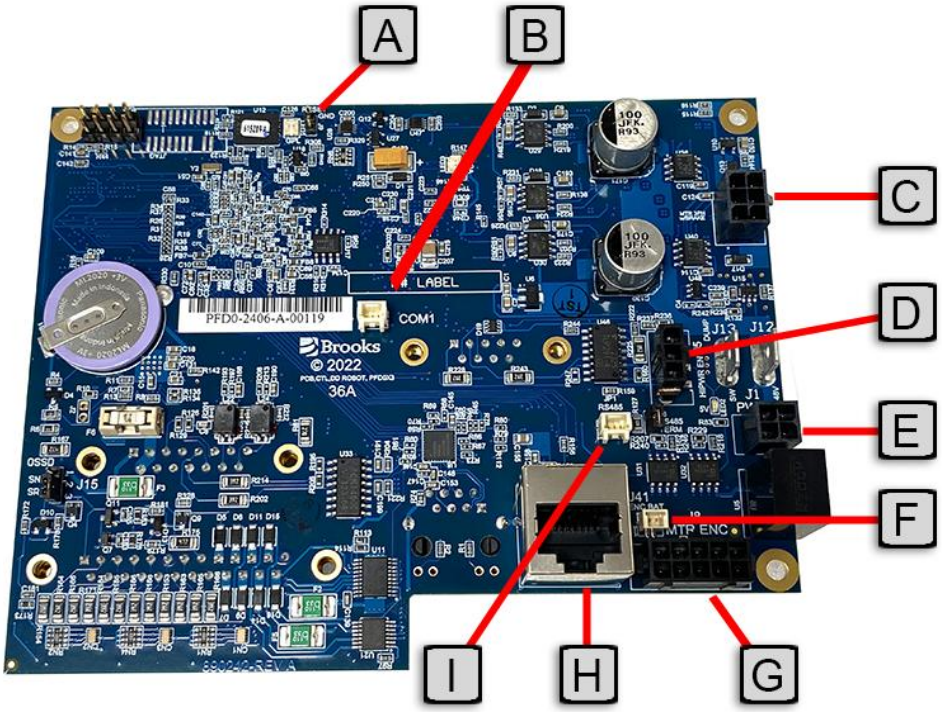
NOTE: For robots with a pneumatic gripper, this jumper should not be removed because the controller will form one end of the RS-485 chain, and the GSB controller in the PreciseFlex linear rail or the GIO I/O board in the end of the PreciseFlex linear rail should provide the second termination.

If the GIO is installed, J6 should be installed on the GIO, and J6 should be removed from the GSB on the linear rail carriage. (Refer to the Appendices titled Replacing the Controller and Installing the Optional GIO Board (Legacy Linear Rails Only).)



PreciseFlex 400/3400 controller

Letter	Description
A	Regeneration
B	Pendant/E-stop
C	LED
D	RS-485/RS-232
E	Power in
F	RS-232
G	Digital I/O
H	Dual Ethernet



PreciseFlex c5 controller

Letter	Description
A	System reset
B	RS-232 (optional wiring if no Ethernet)
C	J1 motor

Letter	Description
D	HIPWREN 3-pin connector
E	24 VDC and 48 VDC
F	Optional battery
G	J1 encoder
H	Ethernet port
I	RS-485

Verifying Installation Steps are Complete

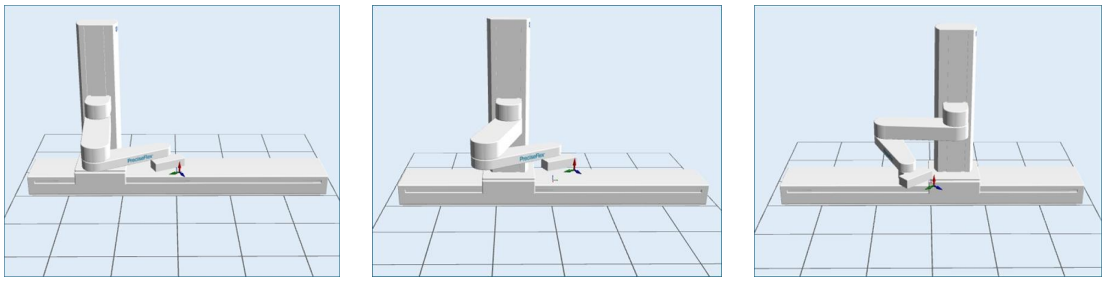
Confirm that you have completed the following steps.

1. The linear rail is mounted and covers secured.
2. The robot is mounted to the linear rail.
3. Interface cables between the linear rail and robot are attached.
4. Power and combination cables are attached to the linear rail.
5. The external E-stop is connected to the linear rail (or the E-stop jumper is in place).

4. Operation

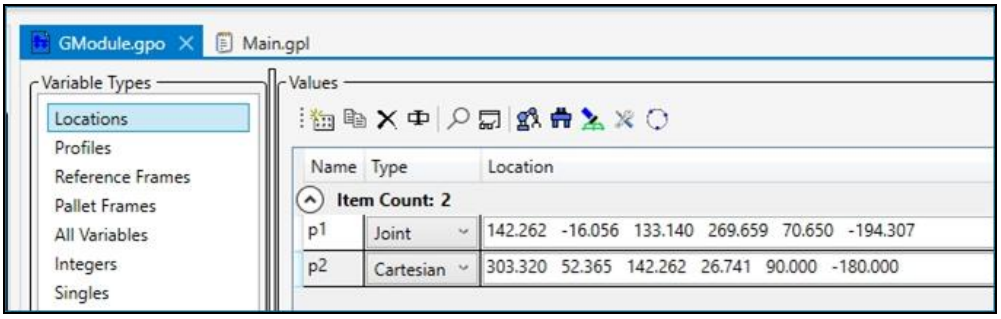
Linear Rail Programming Considerations

When programming a robot with a linear rail, it is important to be aware of the differences between Cartesian and Joint positions. Linear rails have singularity due to three axes being in the same plane.



Notice that the robot can reach the same Cartesian location via three different joint locations without changing from Righty to Lefty. When commanding a Cartesian location, the linear rail is ignored, and the robot attempts to reach the position. A Cartesian location at one end of the linear rail will not be reachable from the other end.

When recording Joint Locations, all axis positions of the robot are saved, including the gripper axis position and linear rail axis position.



When using Cartesian location and linear rails, it is sometimes optimal to use the GPL command `Move.OneAxis()`. Pass in the desired axis, desired position, and a flag for Relative or Absolute.

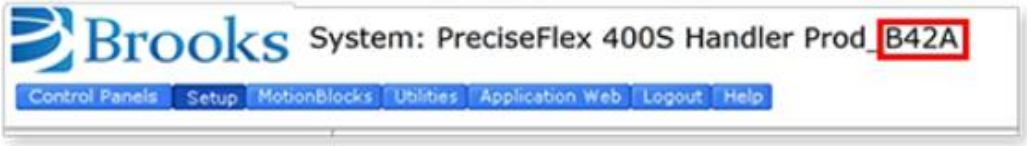
On the website brooks.com, see the PreciseFlex Library or Online Help for more information.

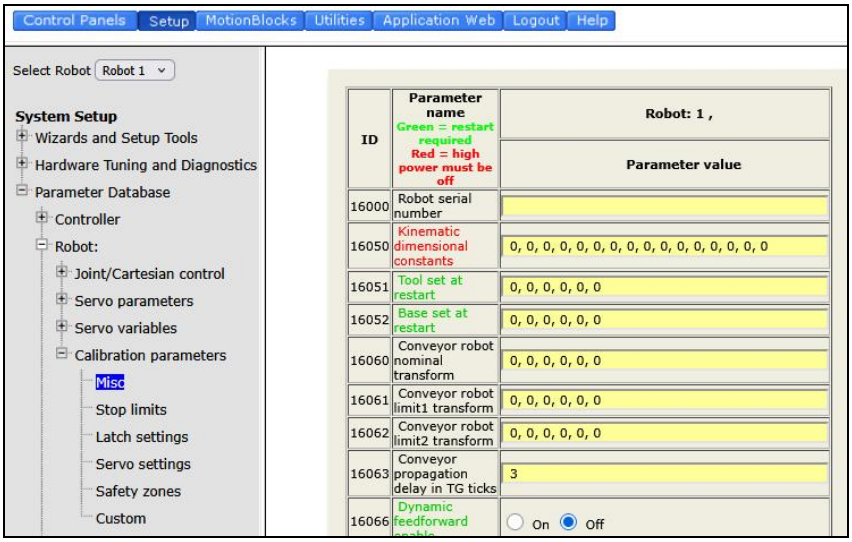
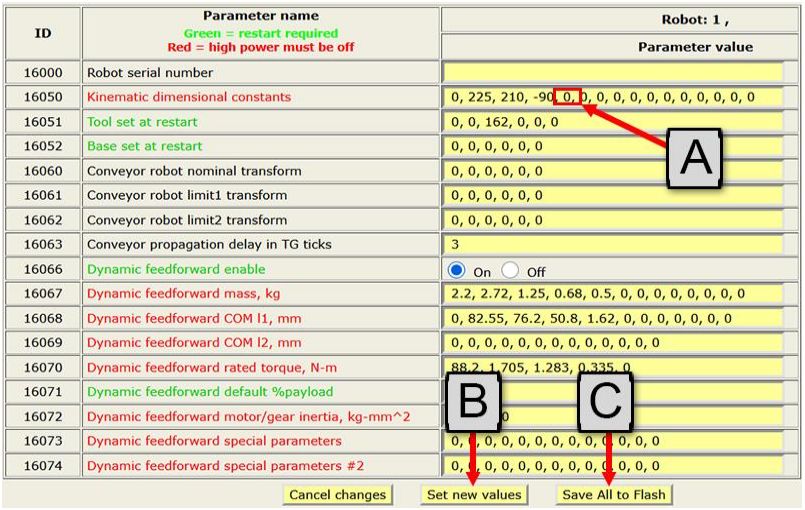
Updating Robot Configuration (PAC) Files after Linear Rail Installation

After the PreciseFlex linear rail installation, the GPL version must be 3.2.H4 or later, and the PAC files must be changed to support the robot. If a robot is installed on, or removed from, a PreciseFlex linear rail, you must get new PAC files from Brooks (support_preciseflex@brooksautomation.com), and install them on the robot controller, and the robot must be re-calibrated using CALPP_Rev21 or later.

There is a configuration parameter in the PAC files that determines whether the PreciseFlex linear rail is configured to add to the robot's Y Cartesian Axis or X Cartesian Axis. The 5th element of the "Kinematic dimension constants" (16050) will specify the orientation of the PreciseFlex linear rail. A value of 0 has the rail moving along +Y. To have the PreciseFlex Linear Rail move along +X, the 5th parameter must be set to -90 (degrees).

Follow this procedure to update the PAC files:

Step	Action
1.	Install new PAC files. Follow standard procedure. Match the version number of the new files to the files currently installed. Reboot the robot after installation. Verify that the virtual pendant now shows the new PreciseFlex linear rail.  **PAC file version number, example from a PreciseFlex 400**
2.	Calibrate the robot. Follow standard procedure according to your robot manual. The rail position is described in Cal_pp dialog.

Step	Action
3.	Set configuration parameter in **Admin > Setup > System Setup > Parameter Database > Robot:> Calibration Parameters > Misc**. 
4.	• (A) Set the 5th value of parameter 16050 to the chosen orientation (0 or -90). • (B) Click "Set new values" • (C) Click "Save all to flash" 

Step	Action
5.	• Wait for the "Writing to Flash" banner to disappear • Wait an additional 10 seconds for all controller write operations to complete • Power cycle the robot. The linear rail configuration changes should take effect.

The PreciseFlex linear rail option is configured so the zero position is in the middle of the range of travel. The software is configured so the PreciseFlex linear rail position is added to either the Y axis or X axis Cartesian position of the gripper. The PreciseFlex linear rail appears as Joint 6 in Joint Coordinates and in the virtual pendant coordinates. The `Move.OneAxis` command can move it by selecting Joint 6.

The factory test program that is shipped with each PreciseFlex robot includes sample code to move the PreciseFlex linear rail.

Recovering from Corrupted PAC Files

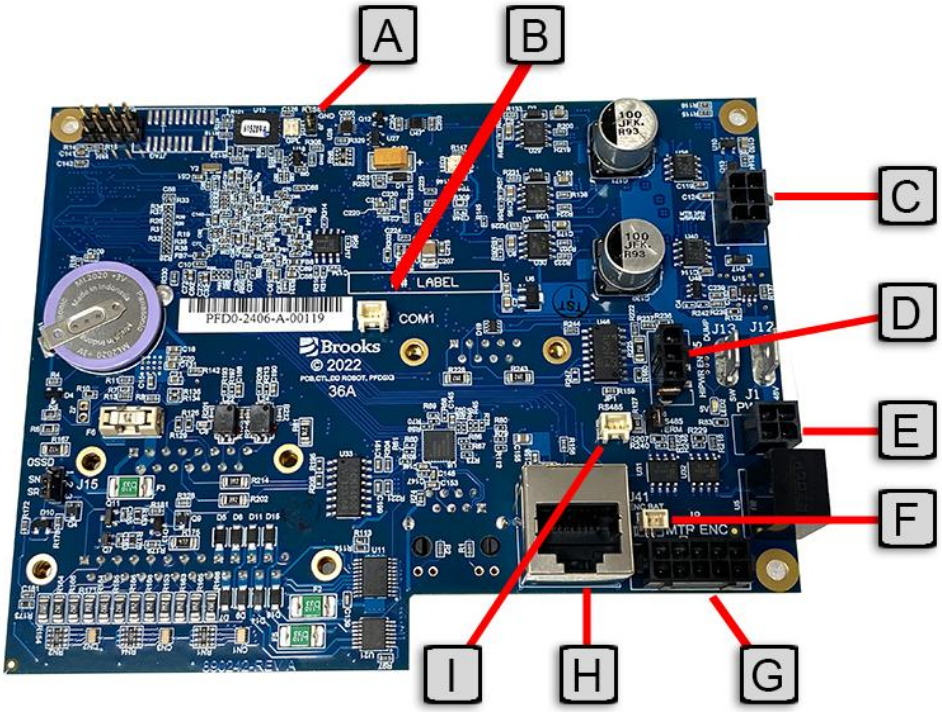
PAC files are configuration files that determine the configuration of the robot for the software, including the robot factory calibration data. These files are stored in Flash RAM.

Flash RAM is also used to store robot programs. The Flash RAM requires some time for a complete write cycle. During the write cycle, the console will display a flashing warning not to turn off robot power. If robot power is turned off during the Flash RAM write cycle, the Flash data may be lost or corrupted. If this happens, it is necessary to reload both the robot PAC files and any user programs that were stored in Flash RAM.

This problem should typically not be encountered by a user unless the user is changing configuration files in the robot and fails to wait a sufficient amount of time for the flash to be saved before turning off power.

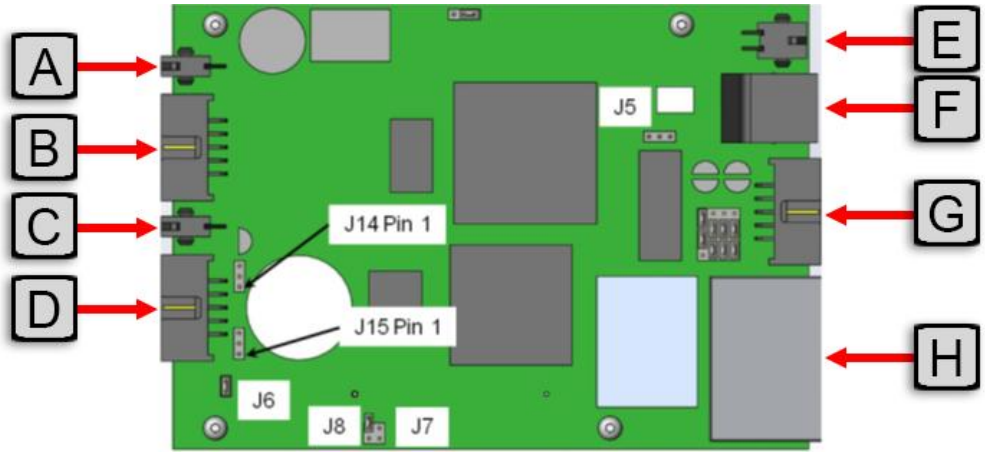
Brooks maintains a record of PAC files shipped with each robot Serial Number. If the PAC files have been corrupted, email support_preciseflex@brooksautomation.com for backup copies. The backup copy will contain the factory configuration and calibration data, but will not contain any changes, including any new calibration data, made after the robot has left the factory.

In order to allow the controller to recover from corrupted PAC files, a set of recovery boot up PAC files is loaded in the system area of the Flash. To configure the controller to boot up in recovery mode, refer to the graphic below, and follow the steps after the graphic.



PreciseFlex c5 controller

Letter	Description
A	System reset
B	RS-232 (optional wiring if no Ethernet)
C	J1 motor
D	HIPWREN 3-pin connector
E	24 VDC and 48 VDC
F	Optional battery
G	J1 encoder
H	Ethernet port
I	RS-485



PreciseFlex 400/3400 controller

Letter	Description
A	Regeneration
B	Pendant/E-stop
C	LED
D	RS-485/RS-232
E	Power in
F	RS-232
G	Digital I/O
H	Dual Ethernet

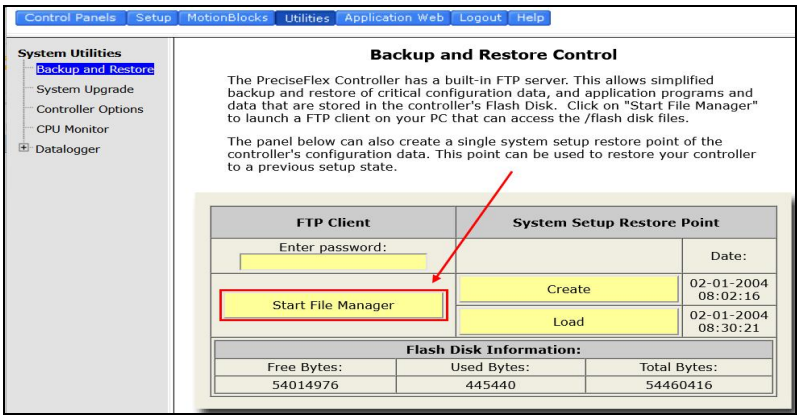
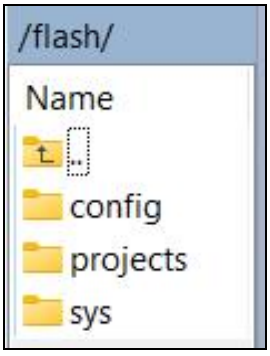
Follow this procedure to configure the controller to boot up in recovery mode.

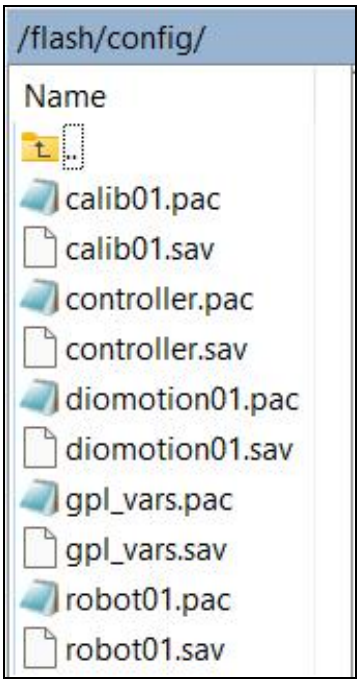
Step	Action
1.	Get a set of backup PAC Files from Brooks (email support_preciseflex@brooksautomation.com) or a local backup.
2.	Access the PCA by removing the screws holding the connector panel in the base of the robot.
3.	Move Jumper J9 (System Reset, letter A above) so it connects the two jumper posts. This will cause the factory default configuration files to be loaded at controller boot up.
4.	Cycle robot power to reboot the controller.

Step	Action
5.	Follow the procedure for Loading a GPL Project.
6.	Place the reset jumper back to its original configuration/position after formatting the flash memory and uploading the correct PAC files. Otherwise, the factory default configuration files are uploaded every time the robot is turned off and on.

Updating Robot Configuration (PAC) Files

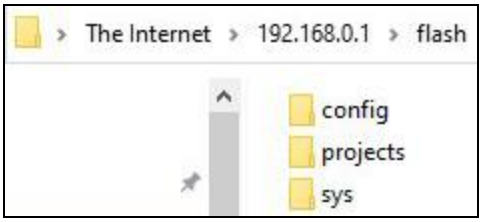
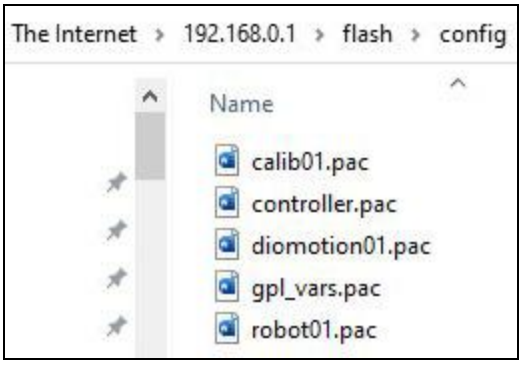
Perform the following procedure.

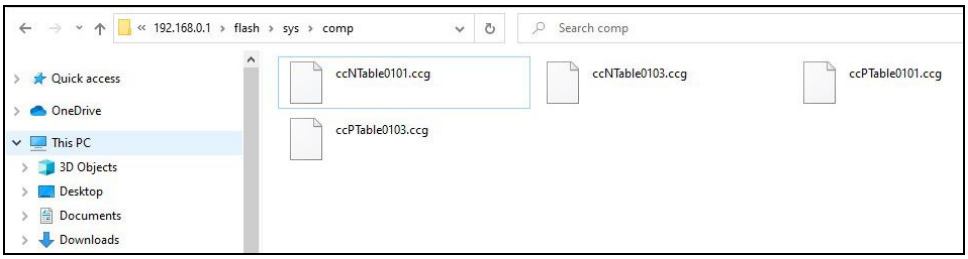
Step	Action
1.	In the browser interface, click **Admin > Utilities > System Utilities > Backup and Restore**. In the *Backup and Restore Control* window, click **Start File Manager** to open an FTP client. 
2.	In the FTP client, open the *config* folder. 

Step	Action
3.	Paste a backup copy of the PAC files into the **Config** folder. These files will all have a **.pac** extension. Wait at least 15 seconds after the copy is complete before turning off the controller. Reboot the robot after the new PAC files are installed for them to take effect. 

Loading a GPL Project

If CAL_PP or a different program needs to be loaded into the controller from an external computer, this may be done via FTP. Previous generations of GPL supported this process directly from the GPL Web Server, but Windows 10 and Edge no longer allow this. To load a project (program) or update PAC files, complete the following steps.

Step	Action
1.	Use the File Explorer to access the flash directly. For example, type **ftp://192.168.0.1/flash** in the File Explorer address line if the controller is set to the default address 192.168.0.1. Otherwise, use the controller IP address. This should bring up a window with the following files: 
2.	To load a GPL Project, such as CALPP, Open the **Projects** folder and paste the project folder into this area. There may be several other projects (programs) loaded into this folder, which is stored in flash ram in the controller. A project folder is a software folder than may have several files inside it. The entire folder must be loaded, not just the files inside.
3.	Once the appropriate project (for example CAL_PP) has been loaded into flash memory, it must then be loaded into dynamic memory in order to execute.
4.	To load or update PAC files, open the **Config** folder and paste a backup copy of the PAC files into the **Config** folder. These files will all have a **.pac** extension. Wait at least 15 seconds after the copy is complete before turning off the controller. Reboot the robot after the new PAC files are installed for them to take effect. 

Step	Action
5.	To update the DD motor cogging compensation tables, go back up to the top-level directory and open the FLASH file, then open the sys file, then open the comp file. Paste the new cogging compensation tables into the comp file, wait 15 seconds, and then reboot the controller. 

Robot Mounting Orientation

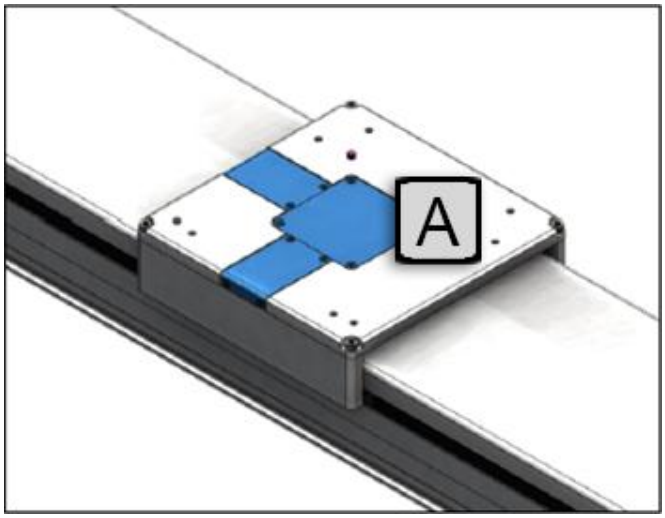
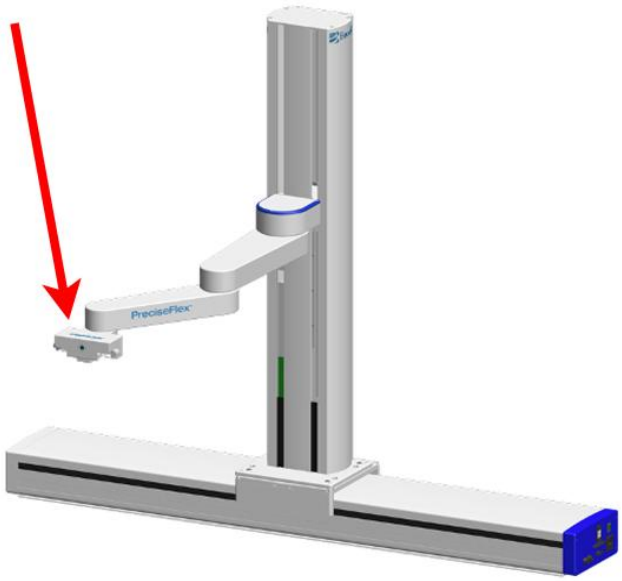
Correct robot mounting orientation is critical for ensuring accurate motion and reachability along the linear rail. Improper orientation, such as mounting the robot 180° reversed or misconfiguring its rotation, can lead to:

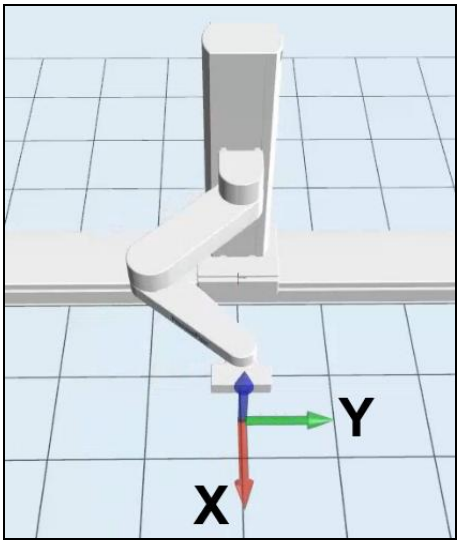
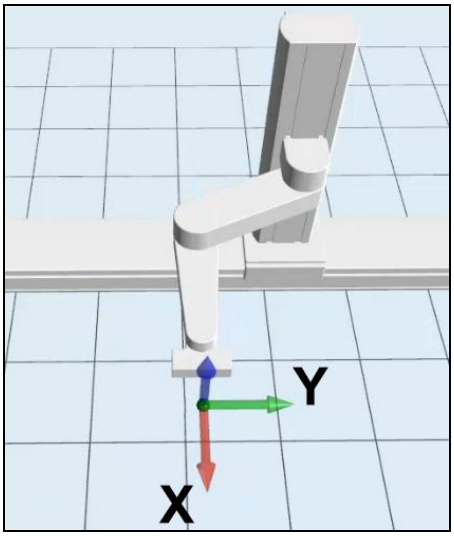
- Inaccurate coordinate reporting
- Limited reachability (for example., “dead zones” on one side of the rail)
- Collisions or unreachable positions
- Confusion during calibration and programming

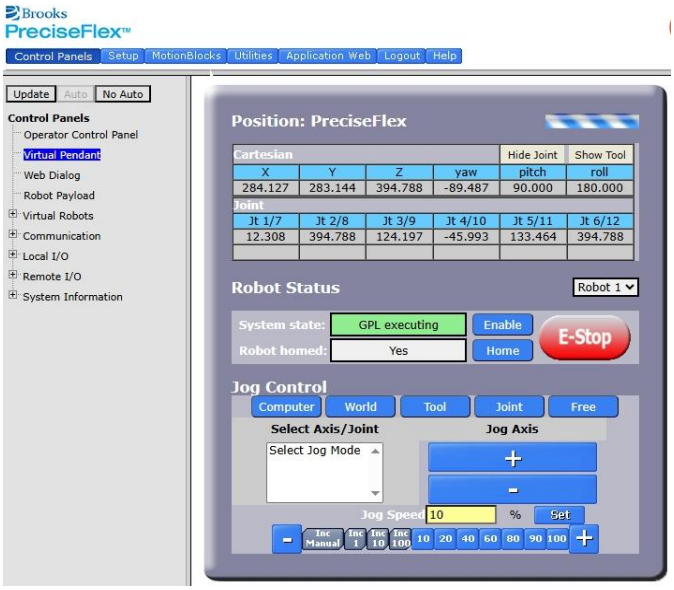
This verification procedure helps ensure the robot is mounted and configured correctly before operation. For the procedure, hold the gripper in place and move the carriage. If X and Y values change significantly, the robot is misconfigured. This simple manual test can save hours of troubleshooting and remounting. Always perform it before finalizing your setup.

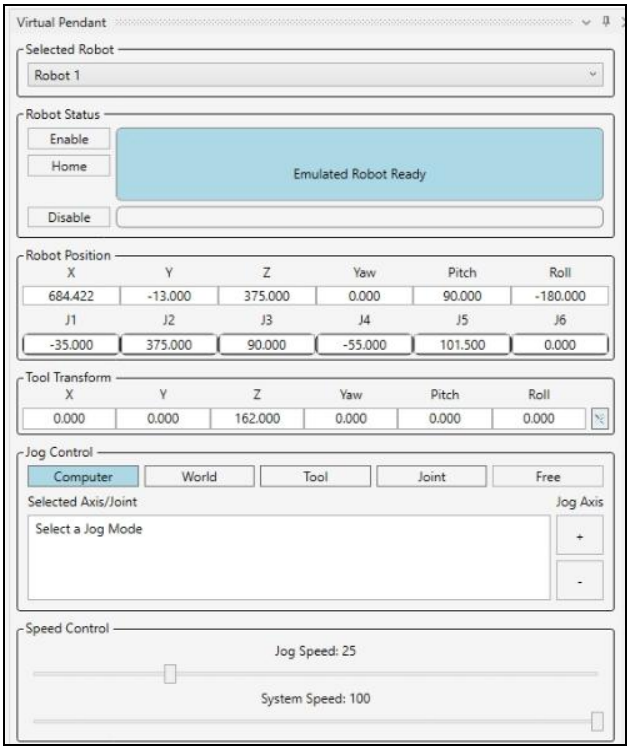
The power can be off for this procedure.

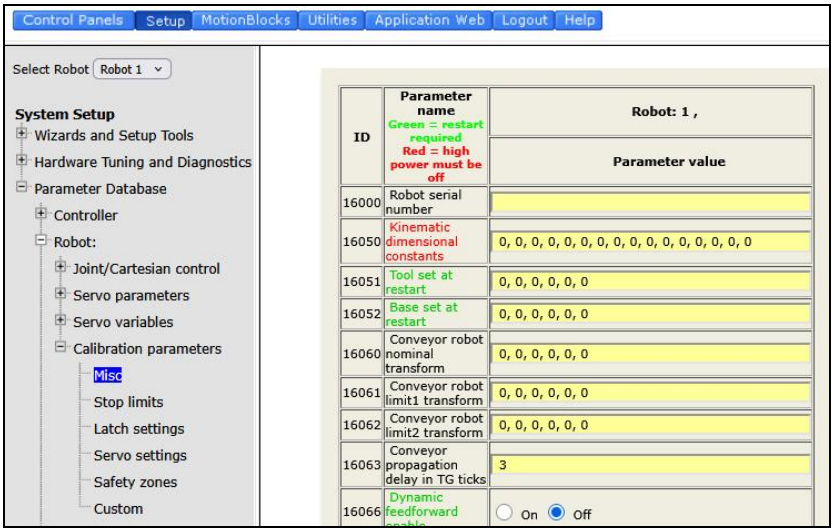
Step	Action
	Initial Setup

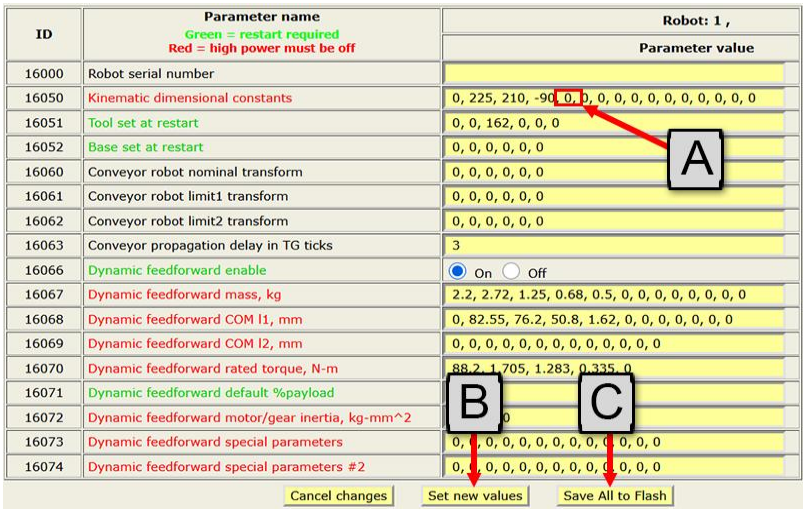
Step	Action
1.	Make sure the robot is securely mounted to the carriage (A). 
2.	Make sure the gripper is accessible and safe to hold manually. 
Hold the Gripper	

Step	Action
3.	With one hand, hold the gripper still. Maintain the gripper and the X axis position in a fixed point in space. Do not allow the gripper to move 
Slide the Carriage	
4.	With your other hand, slide the carriage along the linear rail (Y axis). Move it a significant distance (for example, 300 mm) to observe coordinate changes. 

Step	Action
5.	Monitor the robot's X and Y positions via the browser interface's Virtual Pendant.  **Browser Virtual Pendant**

Step	Action
6.	Or monitor positions in the GDS Virtual Pendant. .  **GDS Virtual Pendant**
7.	**If the robot is correctly configured**, only the rail should show significant motion. **If the robot is misconfigured**, you will see large changes (e.g., 300 mm) in X or Y values. This indicates the robot is facing the wrong direction or has incorrect rotation settings.
Verify the Software Configuration	
8.	Verify that the software matches the physical orientation of the robot. ***NOTE:*** *A common mistake is to enter +90° instead of -90° in the robot's orientation settings.*
9.	Verify that J6 increased as the rail carriage is moved to the right, and decreases as it moves to the left. If J6 did not increase, the rail was calibrated at the wrong end

Step	Action
10.	Verify that the Cartesian X and Y positions remain constant within about 10 mm. • If both the X and Y change is larger than 10 mm, then the robot rotation is off by +/- 90° • If only one of the two axes change by more than 10 mm, then the robot orientation is off by 180° • If neither X nor Y change more than 10 mm, then the robot is configured correctly
To Update the Robot Orientation	
11.	In the browser interface, select **Admin > Setup > System Setup > Parameter Database > Robot > Calibration Parameters > Misc**. 

Step	Action
12.	• (A) Set the 5th value of parameter 16050 to the chosen orientation (0 or -90). • (B) Click "Set new values" • (C) Click "Save all to flash" 
13.	• Wait for the "Writing to Flash" banner to disappear • Wait an additional 10 seconds for all controller write operations to complete • Power cycle the robot. The linear rail configuration changes should take effect.
Verification	
14.	Verify J6 increases as the rail carriage is moved to the right and decreases as it moves to the left. If not the rail was calibrated at the wrong end.
15.	Verify the Cartesian X and Y position remains constant within about 10 mm • If X and Y changes are larger than 10 mm, then the robot rotation is off by +/- 90° • If only one of the two axes change by more than 10 mm, then the robot orientation is off by 180° • If neither X nor Y change more than 10 mm the robot is configured correctly.

Cogging Compensation Files

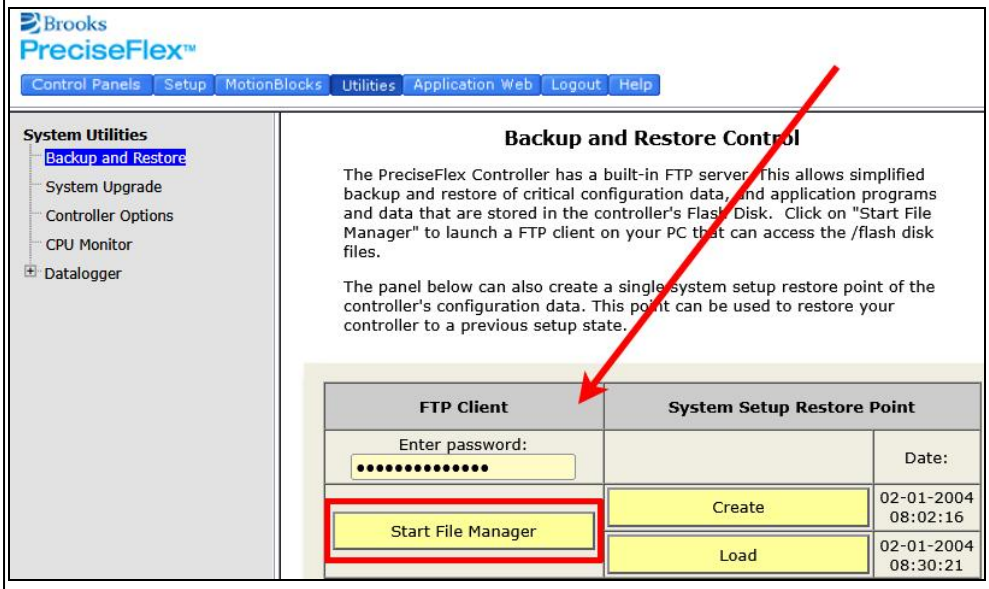
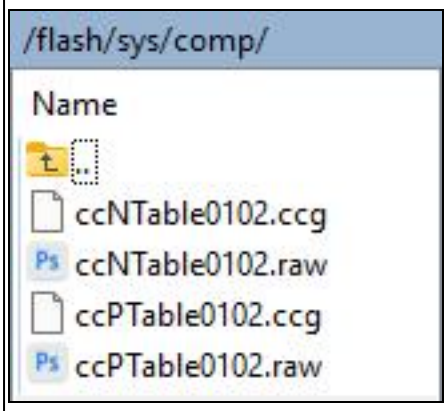
Cogging is a motor behavior caused by magnetic-phase locking in direct drive motors, which are used in c10, c3, c5, and c8A robots.

> ***NOTE:*** For the procedure below, confirm that the robot is a c-series model using direct drive motors.

Unlike belt-driven systems, direct drive motors require precise compensation to avoid jerky movements. **Cogging compensation** ensures smooth joint motion by mapping and adjusting for magnetic field strong points.

> ***NOTE:*** If you are generating new compensation folders, the robot will perform a full range of motion sweep. Configure the robot in the workcell to allow full motion sweep during operation of this test.

Step	Action
1.	Get a copy of the cogging compensation folder by means of one of these three methods: • Use your backup copy of the cogging compensation files • Request a backup copy of the cogging compensation files from Brooks at support_preciseflex@brooksautomation.com • Generate a new folder of cogging compensation files by running the Cogging Compensation GPL Program or Guidance Configuration Utility (GCU). Refer to the *GDS User Manual* or the robot user manual.
2.	Open the folder, select the files, and copy them.

Step	Action
3.	Go to **Admin > Utilities > System Utilities > Backup and Restore** , and, in the *FTP Client* window, click on **Start File Manager**. 
4.	Go to the *flash/sys/comp* window, and paste in the cogging compensation files. 
5.	Wait 15 seconds and reboot.

Appendices

Appendix A: PreciseFlex Linear Rail Specifications

Range of Motion	1000 mm, 1500 mm, 2000 mm
Repeatability	+/- .050 mm for linear rail
Speed	Up to 750 mm/sec
Weight	30 kg for 1000 mm linear rail option, 60 kg for 2000 mm linear rail option
General Communications	RS-232 channel, 100 Mb Ethernet
Software	Programming via Guidance Development Studio (GDS) Compatible with Guidance Programming Language (GPL) Compatible with TCP Command Server (TCS API)
Power	100 to 240 VAC, ± 10%, 50/60 Hz., 200 watts typical 400 watts maximum

Appendix B: PreciseFlex Linear Rail Part Numbers

Product	Part Number
Legacy Linear Rails for PreciseFlex 400 and 3400 Robots	
PreciseFlex Linear Rail, 1.0 m PreciseFlex 400/3400	PF0X-MA-00000-10
PreciseFlex Linear Rail, 1.5 m PreciseFlex 400/3400	PF0X-MA-00000-15
PreciseFlex Linear Rail, 2.0 m PreciseFlex 400/3400	PF0X-MA-00000-20
c-Series Rails for PreciseFlex c3/c3X Robots	
PreciseFlex Linear Rail, 1.0 m, PreciseFlex c3	PF0X-MA-C3000-10
PreciseFlex Linear Rail, 1.5 m, PreciseFlex c3	PF0X-MA-C3000-15
PreciseFlex Linear Rail, 2.0 m, PreciseFlex c3	PF0X-MA-C3000-20
c-Series Rails for PreciseFlex c3/c3X Robots	
PreciseFlex Linear Rail, 1.0 m, PreciseFlex c5	PF0X-MA-C5000-10
PreciseFlex Linear Rail, 1.5 m, PreciseFlex c5	PF0X-MA-C5000-15
PreciseFlex Linear Rail, 2.0 m, PreciseFlex c5	PF0X-MA-C5000-20

Appendix C: PreciseFlex Linear Rail Spare Parts List

NOTE: For help replacing spare parts, email support_preciseflex@brooksautomation.com

Description	Part Number
25-pin connector GIO digital I/O board with pigtails	PF04-MA-00015-E2
E-stop loopback jumper plug	PP0H-MA-00019
G1100T secondary controller for legacy linear rails ("GSB3-DIFF") for 60 N servo gripper - PCA, single axis servo board W/LM5951 - Differential	G1X0-EA-T1101-4D
Secondary controller for c-series rails - GSB4X	389629-0005
Linear rail timing belt - GT2, 5 MMP, 488 G, 2440 MMPL - 1353 mm length for 1 m, 1853 mm length for 1.5 m, 2348 mm length for 2.0 m	PF0X-MC-X0003 • PF0X-MC-X0003-1 for 1 m • PF0X-MC-X0003-2 for 1.5 m • PF0X-MC-X0003-3 for 2 m
AC Power Cable	PF04-MA-00014-07 • 391524-0001 for 1 m • 391524-0002 for 1.5 m • 391524-0003 for 2 m
Pendant ribbon cable	PF04-MA-00014-01 • 392689-0001 for 1 m • 392689-0002 for 1.5 m • 392689-0003 for 2 m
Tape seal • PTFE glass black fabric 18 mm X 36 yards X .014" • 2575 mm length for 1 m • 3575 mm length for 1.5 m • 4575 mm length for 2.0 m	PP20-MC-X0019
Tape seal roller (Rev B) (set of 2)	PF0X-MA-0003B
Harness, battery, linear rail	PF04-MA-00043
Base plate, wide cutout, linear rail, PF400	PF0X-MC-M0044
Base plate, linear rail, PreciseFlex c5	643288

Appendix D: Preventative Maintenance

The following preventative maintenance procedures should be performed every one to two years. A one-year schedule is recommended for systems that continuously move 24 hours per day, 7 days a week, at moderate to high speeds. For systems with low-duty cycles and low to moderate speeds, these procedures should be performed at least once every two years.

Check List	Procedure If a Problem is Detected
Check all belt tensions	Re-tension if necessary
Check air harness tubing in elbow, if present, and theta axis for any wear	Replace if necessary
Replace the timing belt in optional linear axis	Typically every 6,000 hours of continuous operation
Check linear rail in “free mode” for high bearing friction and any sticking.	If a bearing is getting stiff, return to factory for bearing replacement.
Check second-stage (long) Z belt for any squeaking	If noisy, add thick grease to front and rear edge of belt if necessary. (Shell 222 XP or similar). The Z timing belt can get stiffer over time (2-3 years) and occasionally start squeaking against the pulley flanges.
Check if the front cover is rattling	If so, check .125 inch ID by .062 inch thick O rings on dowel pins in base plate under front cover for any deterioration and replace if necessary.
Replace slip ring	Replace the slip ring every third inspection test.

Linear Rail Project Maintenance Schedule

Rev A: Serial numbers FXX-…

Component	Expected Life	Action
Rev A		
Timing belt	60,000 hours/duty cycle*	Replace component
E-chain harnessing	2-4 years - 20,000 hours	Replace all cables
Tape seals (PreciseFlex c5 only)	2-4 years	Replace component

* If a machine part is supposed to last 6,000 hours when it is in use all the time, but it is only in use 10% of the time, then it will actually last much longer—about 60,000 hours—because it's not being used as much.

Appendix E: Tensioning the Belt

In some cases, it may be desirable to confirm the belt tension of one of the axes in the robot. This is not normally required because the robot is been designed with spring tensioners that only require loosening and then re-tightening some clamping screws to reset the belt tensions.

However, in the case of the long Z column belts, it is possible that after several years of operation, the belt may stretch enough that the tension spring pre-load screw may need to be adjusted. If it appears a belt tension is not being adjusted properly by the pre-load spring, the tension can be checked with a Gates Sonic Tension Meter.

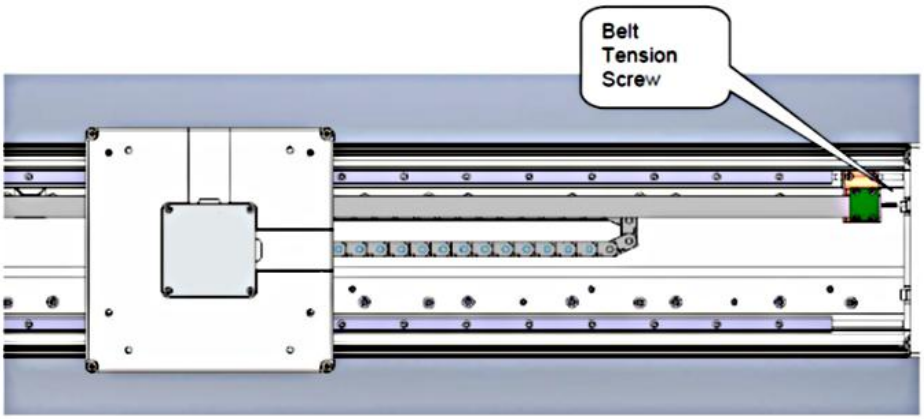
DANGER
Electrical Shock

Disconnect AC power before tensioning the timing belts. Removing the front cover enables access to the AC power terminals.

Required Tools

- Gates Sonic Belt Tension Meter, Model 507C, 508C, or 550C
- 3.0 mm hex driver or hex L wrench

Tensioning the Linear Rail Belt

Step	Action
1.	Slide the carriage to one end of travel, and remove the two top M4 X 30 SHCS from each end cap to remove the linear rail top cover.
2.	It may also be necessary to loosen the connector end cap by loosening the screws attaching the connector end cap to the Linear Rail Extrusion so that the cover can be lifted up and removed.
3.	Slide the carriage so that there is a 500 mm span of the belt between the belt tension clamp block and the idler roller on the carriage.
4.	Loosen the two clamping screws on the belt tension clamp block slightly.
5.	Using the Tension Meter, turn the Belt Tension Screw to adjust the belt tension to the values below in the Belt Tension Table. 

Step	Action
6.	Turn on the meter's power.
7.	Click the **Mass** button and enter the belt mass from the table below.
8.	Click the **Width** button and enter the belt width from the table below.
9.	Click the **Span** button and enter the belt free span from the table below.
10.	Click **Select** to record the data.
11.	Click **Measure** to take a tension reading.
12.	Place the microphone near the belt, typically within 3 mm or so. Gently pluck the belt so it vibrates. The tension meter will calculate the belt tension from the acoustic vibrations and display the tension in Newtons.
13.	Compare the tension to the Belt Tension Table below.
14.	Adjust the belt tension preload screws if necessary.
15.	Tighten the clamping screws.
16.	Move the carriage back and forth the full length of travel and check the belt tension again.
17.	Replace the cover.

Belt Tension Table

Belt	Mass (g/m)	Width (mm)	Span (mm)	Tension Min N	Tension Max N	Frequency Min Hz	Frequency Max Hz
Linear rail	4.1	20	500	135	160	41	44

Appendix F: Replacing the Controller

Tools Required

- 2.5 mm hex driver or hex L wrench
- 2.0 mm hex driver

Spare Parts Required

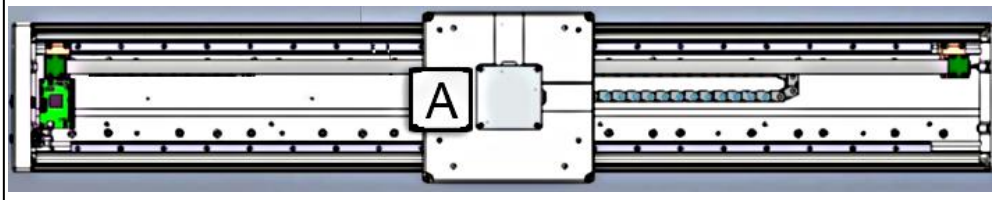
- G1100T secondary controller for legacy rails (“GSB3-DIFF”) or secondary controller for c-series rails. See the PreciseFlex Linear Rail Spare Parts List.

NOTE: Note this part has differential encoder inputs and is NOT the same part as the GSB3-SE for the gripper, which has single-ended encoder inputs.

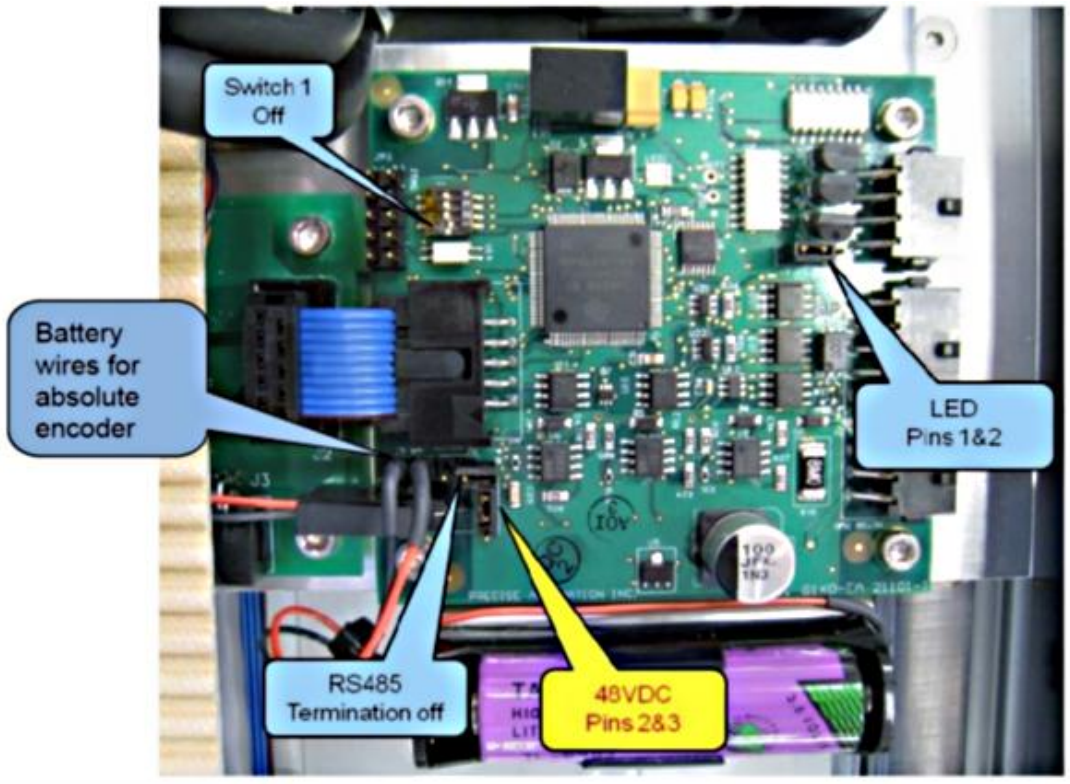
DANGER
Electrical Shock

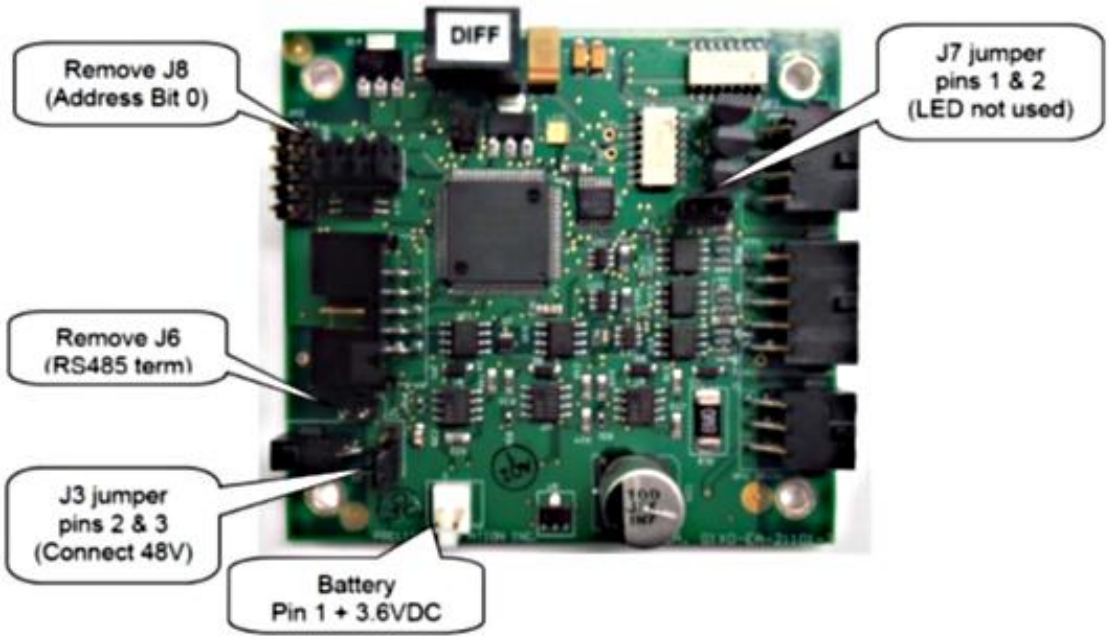
Disconnect the AC power before replacing the controller. Removing the front cover allows access to the AC power terminals.

To use the Tension Meter, perform the following procedure.

Step	Action
1.	Remove the PreciseFlex linear rail cover by sliding the carriage to one end of travel and removing the 4 M4 X 30 SHCS from the end caps retaining the cover. It may also be necessary to loosen the connector end cap by loosening the bottom two screws attaching the connector end cap to the linear rail extrusion so the cover can be lifted up and removed.
2.	Remove the cable covers on the robot mount plate.
3.	Remove the robot mount plate (A). 

Step	Action
4.	Replace the PreciseFlex linear rail controller board. Be sure all jumpers are set as shown below and the battery wires are re-connected as shown. It will be necessary to recalibrate the robot if this board is replaced and the absolute encoder battery wires are disconnected.





Appendix G: Installing the Optional GIO Board (Legacy Linear Rails Only)

For legacy linear rails, Brooks sells a digital I/O board that provides 12 inputs and 8 outputs as an option. This board may be installed in the PreciseFlex linear rail extrusion. The board is provided with a 150 mm pigtail harness to a 25-pin D-sub connector. The board is attached with 4 M3 X 10 SHCS, and the 25-pin D-sub is attached with standard D-sub 4-40 mounting standoffs. It is typically installed at the factory, but it can be installed in the field for robots that have the appropriate mounting holes.

Tools Required

- 3 mm hex driver or hex L wrench
- 2.5 mm hex driver
- M5 socket driver
- M5 open-end wrench

Spare Parts Required

- GIO digital I/O Board; see the PreciseFlex Linear Rail Spare Parts List.

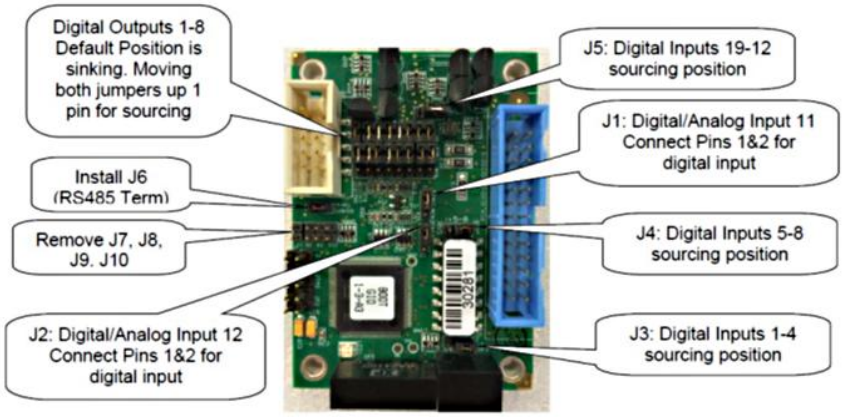
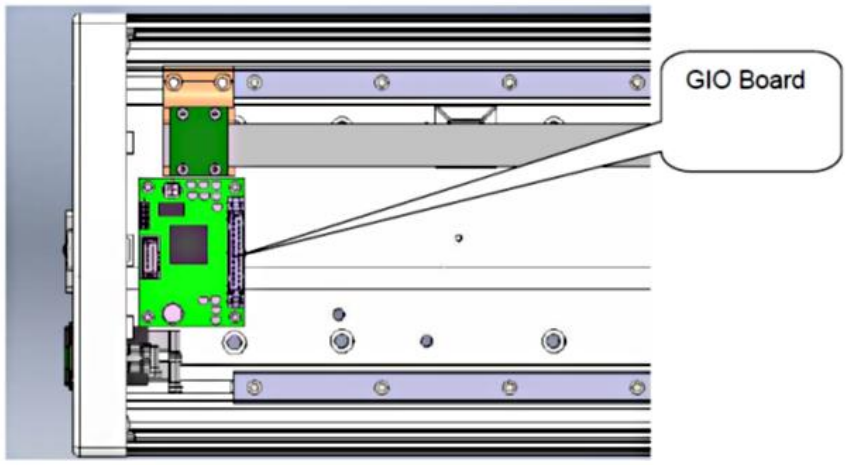
DANGER

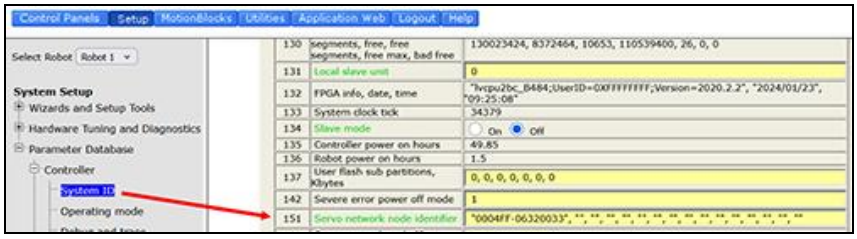
Electrical Shock

Disconnect the AC power before replacing the controller. Removing the front cover allows access to the AC power terminals.

To install the GIO Board in a robot with a PreciseFlex linear rail, perform the following procedure.

Step	Action
1.	Slide the carriage of the PreciseFlex linear rail to one end of travel.
2.	Remove the top cover from the PreciseFlex linear rail by removing 4 M4 X 30 SHCS from the end caps. It may be necessary to loosen the two bottom screws on the connector end cap to provide clearance to remove the cover.

Step	Action
3.	Remove all four address jumpers on the GIO board J7-J10 
4.	Install the GIO board in the PreciseFlex linear rail using 4 M3 X 10 SHCS and lockwashers. 
5.	Remove the termination resistor from the 10-pin connector plug attached by 4 wires to the 9-pin D-sub pendant connector and plug the 10-pin connector into the GIO board.
6.	Install the GIO output pigtail by plugging the 26-pin connector to the GIO board and attaching the 25-pin D-sub connector to the end cap with the 4-40 standoffs provided.
7.	Make an accordion fold with the extra ribbon cable, and tie-wrap to hold the fold down over the GIO board.
8.	Replace the covers.

Step	Action
9.	In the operator browser interface, set value 8 in Data ID 151 to “GIO_8” so this ID reads “<Controller Serial No>”, “GSB_1”, “”, “”, “”, ”“”, “”,GIO_8.” This parameter may be found in **Admin > Setup > Parameter Database > Controller > System ID**. 
10.	GIO signals may then be checked under **Admin > Control Panels > Remote I/O > Servo Node 8**.

Appendix H: Torque Values for Screws

Use these torque values for all screws and fasteners unless otherwise stated.

Torque Values in Newton-Meters

	Zinc	SS	Zinc	SS	Zinc	SS
Screw Size M	SHCS	SHCS	BHCS	BHCS	FHCS	FHCS
1.6	0.18	0.15	0.00	0.00	0.00	0.00
2	0.37	0.31	0.00	0.00	0.00	0.00
2.5	0.77	0.64	0.00	0.00	0.00	0.00
3	1.34	1.12	0.56	0.51	0.83	0.75
4	3.16	2.63	1.31	1.17	1.53	1.38
5	6.48	5.40	2.66	2.39	3.11	2.79
6	10.96	9.14	4.50	4.05	5.40	4.86