



PreciseFlex™ 400 Robot

User Manual

Robot Rev D

Manual Number 658057, Manual Revision B



Brooks Automation

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Revision History

This user manual applies only to Rev D of the PreciseFlex 400 robot. The user manual for Rev C of the PreciseFlex 400 robot is covered in the *PreciseFlex 400 User Manual* located online at <https://www.brooks.com/support/brooks-preciseflex-support/robots/>.

Revision	ECO	Date	Action	Author
A	EC164813	July 27, 2025	New Release for PreciseFlex 400 Rev D	M. Ashenfelder
B	EC175348	July 24, 2026	Updated the user manual to include the following: • Removed Unplanned Movement Warning • Added section on RS-485 Network Termination with Linear Rails • Added an updated General Specifications List • Added an updated Spare Parts section	S. McLellan

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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 <i>Safety</i> 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.	

Authorized Personnel Only

This product is intended for use by trained and experienced personnel. Operators must comply with applicable organizational operating procedures, industry standards, and all local, regional, national, and international laws and regulations.

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

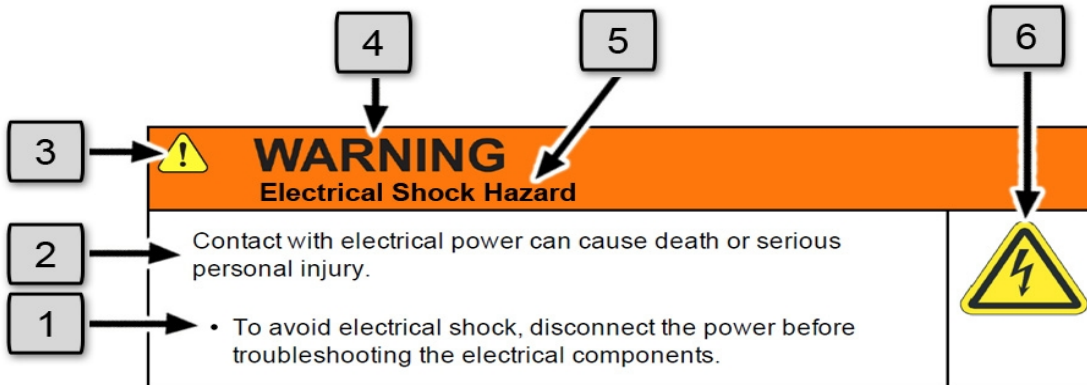
Signal Words and Colors

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

General Safety Considerations

 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, severe injury, or death. • 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.	

Mechanical Hazards

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

 WARNING Automatic Movement	
Whenever power is applied to the product, there is the potential for automatic or unplanned movement of the product or its components, which could result in personal injury. - Follow safe practices for working with energized products per the facility requirements. - Do not rely on the system software or process technology to prevent unexpected product motion. - Do not operate the product without its protective covers in place. - While the collaborative robotics system is designed to be safe around personnel, gravity and other factors may present hazards and should be considered.	 

 CAUTION Vibration Hazard	
As with any servo-based device, the robot can enter a vibratory state resulting in mechanical and audible hazards. Vibration indicates a serious problem. Immediately remove power. • Before energizing, ensure the robot is bolted to a rigid metal chamber or stand.	

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

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

 WARNING Entrapment	
Entrapment by this product can cause death or serious injury. To avoid entrapment by this product, follow these steps: • Assess the product and identify any components that may cause entrapment. • Ensure safety personnel is observing any procedure that may create an entrapment hazard. • Beware of any moving parts.	 

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

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 cost for disposal. For further information and assistance in disposal, email Brooks Automation Technical Support at support@preciseflex@brooks.com.

2. Overview

This user manual applies to the PreciseFlex 400 Rev D robot. Earlier robot models are covered in separate user manuals. Refer to the earlier PreciseFlex 400 User Manuals online at <https://www.brooks.com/support/brooks-preciseflex-support/robots/> for details.

Robot Release History

The PreciseFlex 400 robot Rev D, designated by serial numbers F0D-`www-xy-zzzzz`, was released in the summer of 2025. It consists of a new controller processor with 3X faster processor speed and 8X more memory than the previous robot (Rev C). The Rev D release also added digital I/O signals (8 inputs and 8 outputs) to the base of the robot, whereas they were optional on previous releases. Rev D also supports GPL 5.XX.

The PreciseFlex 400 was initially released in 2011, designated by SN F0X-`www-xy-zzzzz`. After that, there were two other significant releases.

Rev B, designated by serial numbers F0B-`www-xy-zzzzz`, was released in 2014. It improved the high-speed, continuous duty performance of the robot. The main changes in Rev B were:

- a wider timing belt in J2 (12 mm replaced 9 mm)
- changing to all steel drive pulleys from aluminum to improve the bond strength of the drive pulleys to the motor shaft
- changing the slip ring in the wrist for improved reliability.

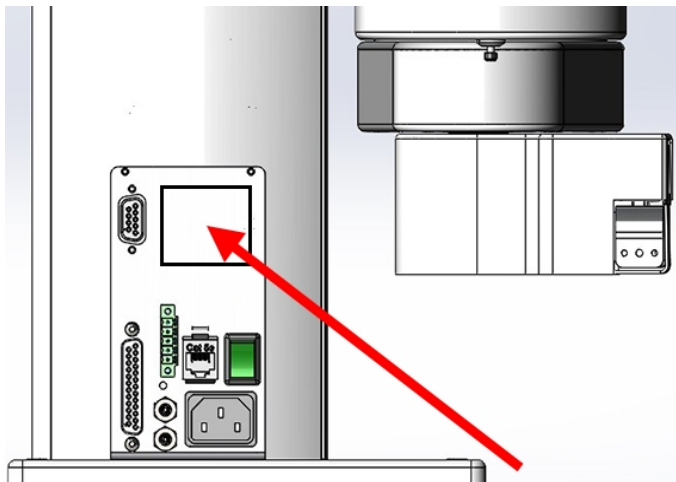
Rev C, designated by serial numbers F0C-www-xy-zzzzz, was released in the fall of 2016:

- It improved the resistance of the robot to high-speed crashes by adding clamp rings and beveled retaining rings to the J2, J3, and J4 bearings, so that these bearings cannot come loose in a high-speed crash.
- It improved support for pneumatic grippers and control of solenoid valves in the outer link.
- Some longer life cam followers for the J2 timing belt were installed.
- A longer life Ethernet cable was installed that should last for the life of the robot running continuous duty for at least 3 years.

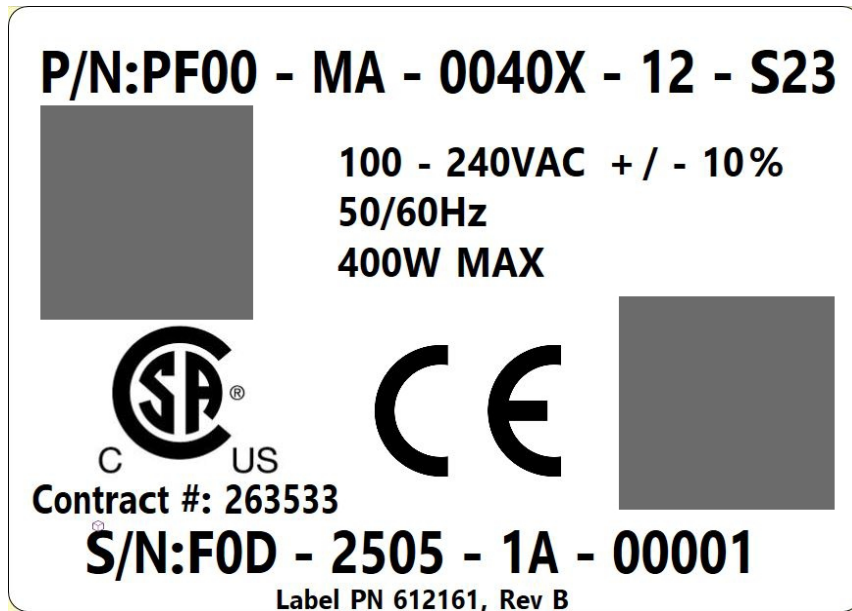
Revision C was discontinued in June 2025 when Revision D was introduced.

Explanation of the Product Label

The product label is on the robot interface panel at the base of the robot. Use the following sections to decode the part number and serial numbers.



Product label at the base of the robot



Sample robot product label

Example Sections from the Product Label

Product Number

P/N: PF00 - MA - 0040X - 12 - S23

In the example above, the first line of the label -- Product Number (P/N) -- describes:

- PF00 = PreciseFlex 400
- MA = machine assembly
- 0040 = PreciseFlex 400
- X = Extended reach
- 12 = 1160 mm Z stroke
- S23 = IntelliGuide s23 servo gripper

The robot part number follows the scheme: **AAAA-BB-CCCD-EFF**. Refer to the table below to decode this scheme.

[***the first four digits]

AAAA [1st set of four digits]	
CODE	PRODUCT
PF00	PreciseFlex 400
PF0X	Linear Rail
BB [1st set of two digits]	
CODE	TYPE
MA	Machine Assembly, an assembly of individual components
CCCC [2nd set of four digits]	
CODE	TYPE
0040	PreciseFlex 400 or 3400
D [1st single digit]	
CODE	ARM LENGTH
0 / S	Standard
X / L	Extended / Long
E or EE	
NUMBER	AXIS SIZE
4	400 mm Z Stroke
7	750 mm Z Stroke
12	1160 mm Z Stroke
10	1.0 m linear rail
15	1.5 m linear rail
20	2.0 m linear rail
GGGG (Optional)	
[empty]	ISO flange
s23	IntelliGuide s23 servo gripper
v23	IntelliGuide v23 vision gripper

S/N:F0D - 2505 - 1A - 00001

In the example above, the second line of the label -- Serial Number (S/N) -- describes:

- F0D = PreciseFlex 400, Revision D
- 25 = Two-Digit Year Code
- 05 = Two-Digit Month Code
- 1A = Revision
- 00001 = Robot Unit Build Number

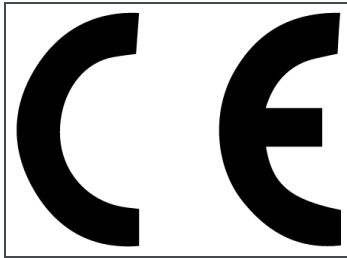
Refer to the Serial Number (SN) table below for detailed information about the Serial Number naming scheme.

The robot serial number follows the scheme: **AAA**-**BBCC**-**EF**-**GGGG**. Refer to the table below to decode this scheme.

AAA [1st three digits]	
CODE	MODEL
F0C/F0X	PreciseFlex 400
F0D	PreciseFlex 400, Revision D
FXB	Linear Rail
BBCC	
CODE	MFG DATE CODE (START DATE)
BB	Two-Digit Year Code
CC	Two-Digit Month Code
EF	
Code	Revision Code
E	Major Rev Code
F	Minor Rev Code Valid for Rev Code 9J and up
GGGGG	
G	Sequential Production Number

Contract #: 263533

Brooks Automation's contract ID within the CSA group



The [CE Marking](#) affirms compliance with relevant EU legislation. See [Standards Compliance and Agency Certifications](#) for more information.

A	100 – 240 VAC + / – 10 %
B	50/60 Hz
C	400 W MAX

Robot Power Requirements

Letter	Description
A	Robot power voltage requirements.
B	Robot power frequency requirements
C	Robot power maximum draw

Standards Compliance and Agency Certifications

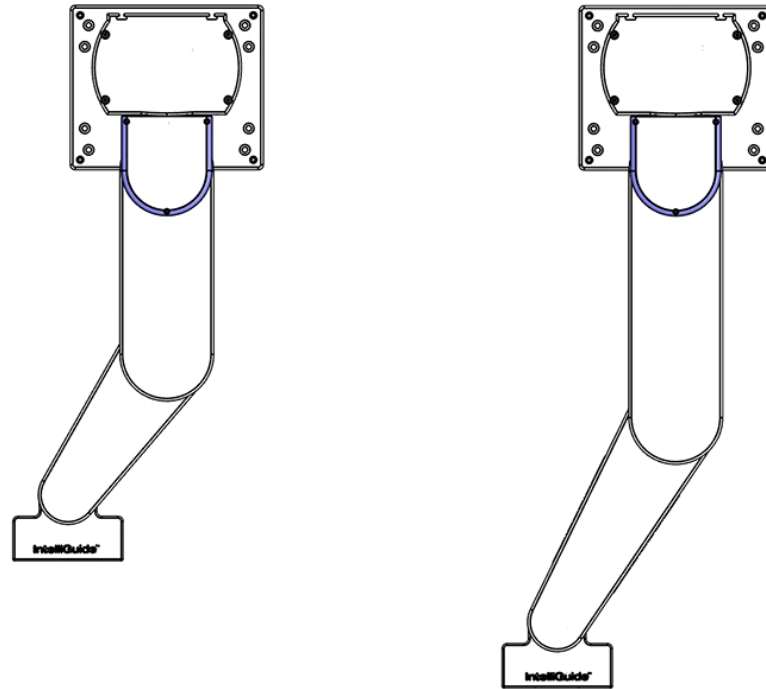
PreciseFlex robots are designed to be integrated into larger systems and are classified as components rather than standalone machines. PreciseFlex 400 (rev D) robots comply with the following applicable requirements:

- CAN/CSA C22.2 NO. 61010-1-12 +AMD1+(Third Edition)(R2022)
- ANSI/UL 61010-1 3rd Edition (2012), AMD1:2018
- CSA C22.2 No. 61010-2-081:19
- UL 61010-2-081, 3rd Edition (2019)
- EN 61326-1:2013 and EN IEC 61326-1:2021

System Description and Overview

The PreciseFlex 400 robot is ideal for automating applications in the Life Sciences, Medical Products, Semiconductor, and Electronics industries.

It is a 4-axis robot with a standard horizontal reach or an extended horizontal reach. Additionally, it is available with a vertical reach of 400, 750, or 1160 mm. The robot is designed for tabletop mounting and can carry a payload of up to 500 grams with an IntelliGuide servo gripper.



Top view of PreciseFlex 400 standard reach (left) and extended reach (right)

The robot has an embedded controller in the base and a 48 VDC motor power supply, along with a 24 VDC logic power supply located inside the Z-column.

PreciseFlex 400 robots are quiet, with smooth operation, very reliable, and have excellent positioning repeatability. The robot axes are powered by brushless DC motors with absolute encoders.

The robot has several communications and hardware interfaces. These include digital Input and output lines, an Ethernet interface, an RS-232 serial interface, and an RS-485 serial interface.

In addition, the robot can be purchased with several optional peripherals. These include:

- IntelliGuide servo and vision grippers, which are installed from the factory
- Linear rail options, which extend the robot's horizontal reach by 1.0, 1.5, or 2.0 meters.

The robot can be programmed by means of a PC connected through Ethernet in one of the following modes:

- Embedded Language mode, where the robot is programmed from the Guidance Development Studio (GDS) with:
 - GP Flow, an intuitive no-code, point-and-click application builder
 - GPL, a powerful, full-featured object-oriented scripting language
- PC Control mode, where the PC issues commands and requests status to/from the robot via the TSC API.
- Ethernet-IP (PLC) mode, an Embedded Language mode

When programmed in Embedded Language or Ethernet-IP mode, the PC can be removed after programming is completed and the controller will operate standalone. The PC is required for operation in the PC Control mode. Also, a PLC is required for operation in Ethernet-IP mode.

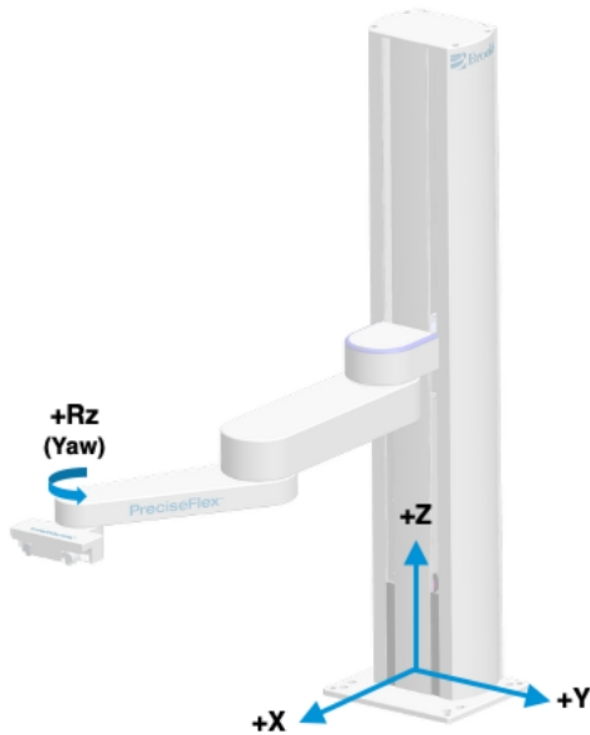
In all modes of operation, the controller includes a browser-based operator interface. This interface is used for configuring the system, starting and stopping execution, and monitoring its operation. The interface can be accessed locally using a browser or remotely via the Internet. This remote interface is of great benefit in system maintenance and debugging.

When IntelliGuide Vision is used, there is an embedded iPC in the gripper that processes vision instructions. IntelliGuide Vision can be configured in Guidance Development Studio. During runtime, vision processes can be initiated from GP Flow, GPL, or TCS API.

Robot Coordinate Systems

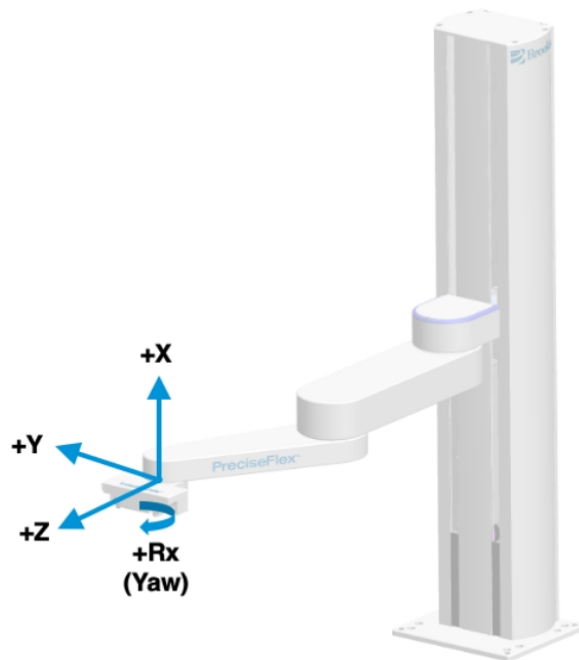
The robot operates using three coordinate systems: **World**, **Tool**, and **Joint**.

The **World** coordinate system serves as the foundational reference for all other coordinates.



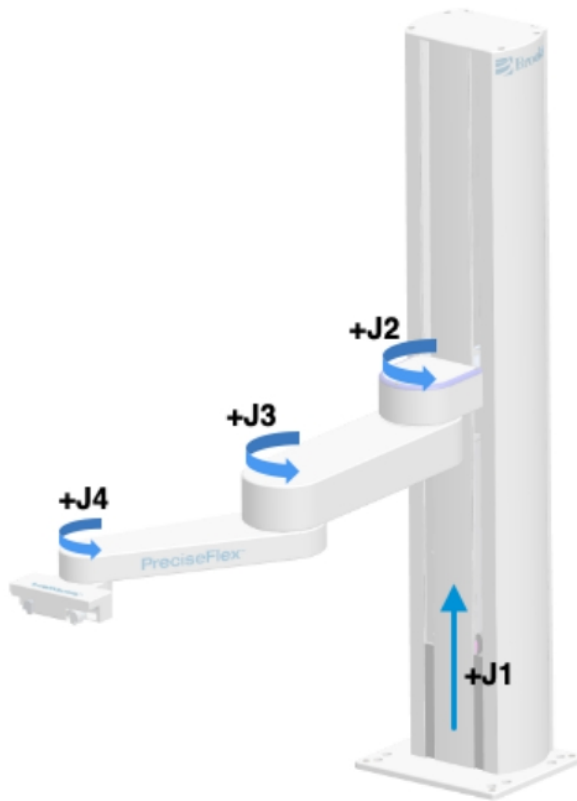
World coordinate system

The **Tool** coordinate system is derived from the World coordinate system and represents the position and orientation of the robot's tool center point.



Tool coordinate system

The **Joint** coordinate system refers to how individual robot joints, or axes, move. While in Joint mode, only one joint will move at a time.



Joint coordinate system

Axis	Travel
J1, Z-axis	400, 750, 1160 mm
J2, shoulder	$\pm 93^\circ$
J3, elbow	12° to 348°
J4, wrist	$\pm 960^\circ$

J1, Z-Axis

The first axis (J1) moves the robot arm up and down along the vertical column, the Z-axis. When the inner link is closest to the bottom, the Z-axis is at its 0 position in the Joint coordinate system and Z=30 mm in the World coordinate system. As the robot arm moves upwards, both its Joint position and the World Z coordinate increase in value.

J2, Shoulder

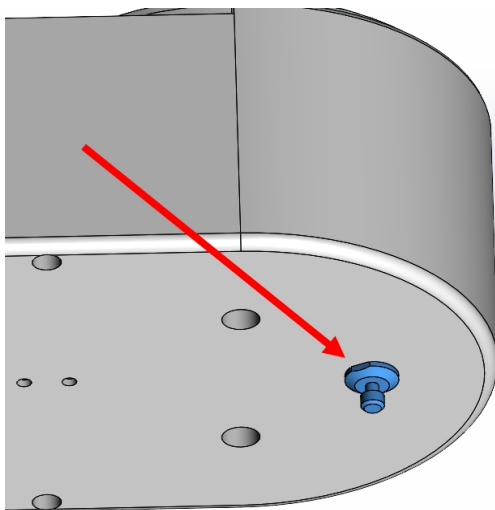
The second axis (J2) rotates the robot inner link. When the inner link is centered on its range of motion, the J2 axis is straight out and positioned at 0° joint angle. A positive change in the axis angle results in a positive rotation about the World Z-axis.

A light bar is mounted at the top of the shoulder cover and blinks at a rate of once per second to indicate that the controller is operational and at a rate of four times per second when power is being supplied to the motors.

Fail-Safe Brake

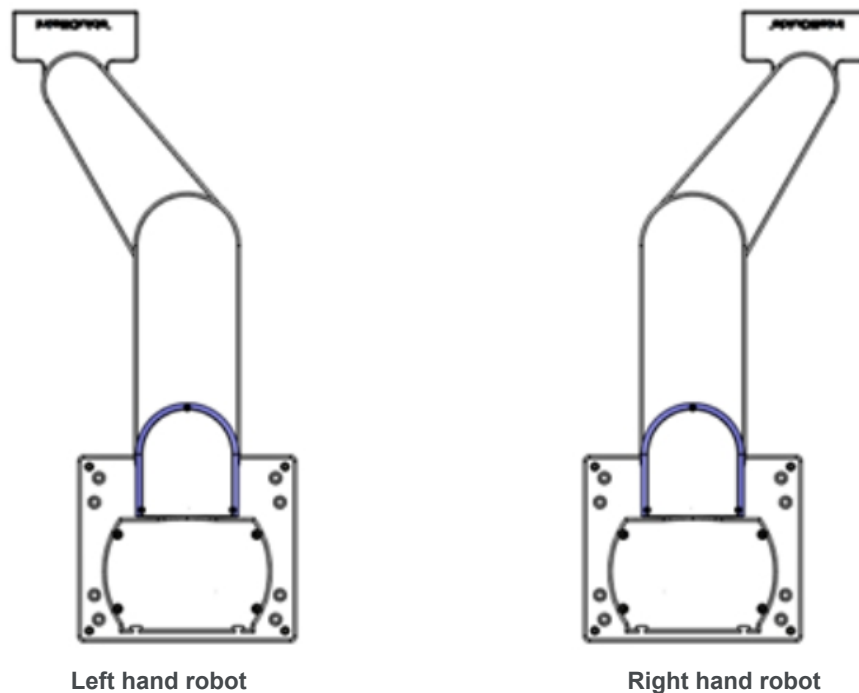
To move the robot arm up and down manually, the fail-safe brake must be pressed. The brake release button is located on the bottom of the inner link under joint 2. This switch is active when AC power is applied to the robot, and the main power switch is **on**.

To release the brake, press and hold the brake release button while supporting the robot arm. Care should be taken to support the Z-axis when the brake release button is pushed; the axis will fall due to gravity.



J3, Elbow

The third axis (J3) rotates the outer link. A positive change in the axis angle results in a positive rotation around the J3 axis. When the link is centered, it is at its 0° joint angle. However, there is a hard stop at 10°, so the J3 cannot reach the center position. The outer link rotates underneath the inner link allowing the robot to change configuration from a "left hand" robot to a "right hand" robot without extending the outer link and passing through the zero position.



This allows the robot to work in compact workcells, and it minimizes the radius to the robot and its payload, therefore reducing the kinetic energy of the payload when moving across a workcell. This helps minimize potential collision forces.

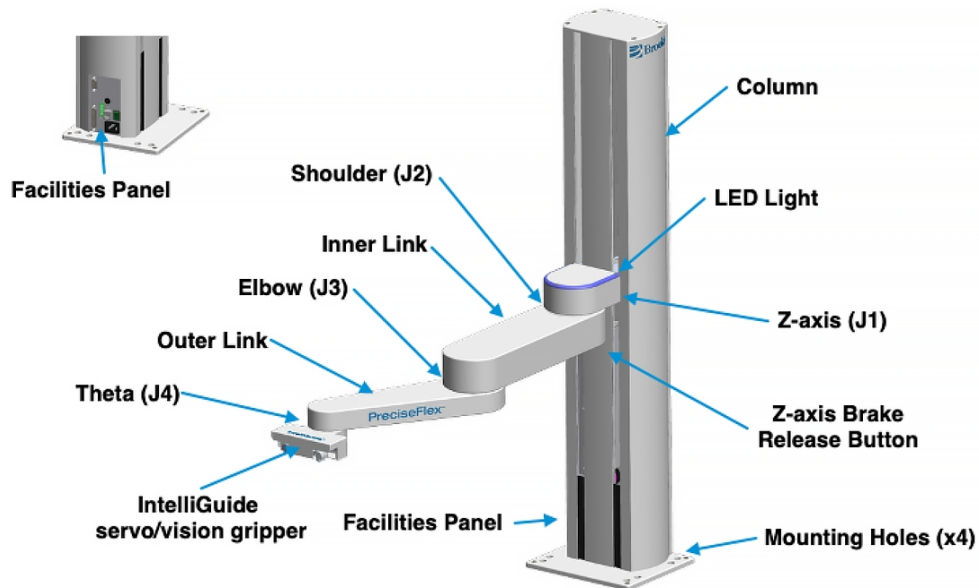
J4, Wrist

The J4 axis is at the end of the outer link. A positive change in the J4 axis angle results in a rotation about a wrist axis parallel to the world Z axis.

System Components

The PreciseFlex 400 Robot

The PreciseFlex 400 is a 4-axis robot that may include an IntelliGuide servo or vision gripper. The illustration below shows the major components of the robot.



The Robot Controller

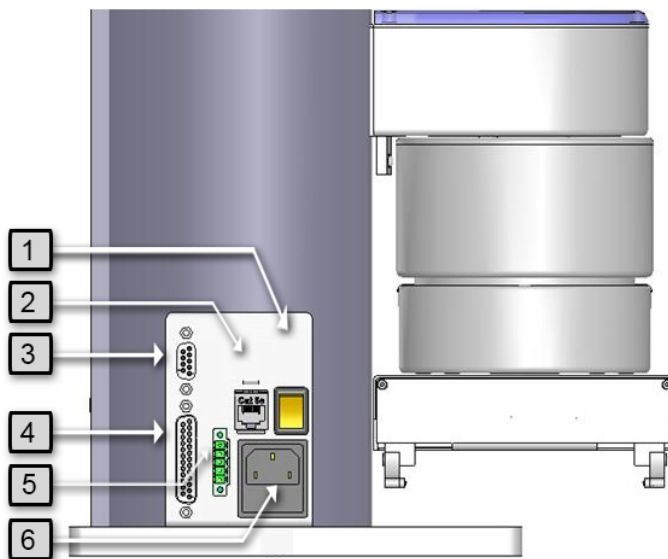
The robot controller is mounted in the robot inner link, and the power supplies are mounted in the robot Z column. Unless otherwise stated, robot interface signals and connections are accessible from the facilities panel.

 DANGER High Voltage	
In the event it is necessary to access the robot controller, before removing the covers or servicing the robot disconnect the AC power to prevent exposure to high voltage levels.	

Facilities Connections

The Facilities Panel at the base of the robot includes:

- System AC input power receptacle
- Lighted AC on/off power switch
- Connectors for external E-stop, Ethernet, RS-232 and digital input and output signals.



Facilities Panel

Annotation	Name	Description
1	Power switch	Lighted power switch
2	Ethernet connector	For Ethernet to computer cable
3	External E-stop 1, serial interface	9 pin D-sub connector for E-stop. This connector supports an E-stop box or a manual control pendant, which uses RS-232.
4	Digital I/O	25 pin D-sub connector for digital I/O signals, 8 inputs, 8 outputs
5	External E-stop 2	External E-stop for cell interlock signals
6	Power entry module	For IEC plug. Contains dual fuse drawer.

E-Stop Box and Manual Control Pendant

An external E-stop Box and portable manual control pendant, which includes an E-stop button, are available as accessories to the PreciseFlex 400 robot. The E-stop box can be plugged into the green Phoenix connector in the facilities panel at the base of the robot. The manual control pendant can be plugged directly into the 9-pin D-sub connector mounted on the robot's facilities panel in the base of the robot.

If no E-stop box or manual control pendant is connected, a jumper must be connected between these two pins to enable robot motor power. See ["External Emergency Stop \(E-stop\)"](#).

For those applications where an operator must be inside the working volume of the robot while teaching, a second teach pendant with a 3-position run hold switch is available. The E-stop connections are also present on the 9-pin D-sub connector and each of these units provides the hardware signals to permit power to be enabled and disabled.

**E-stop box****Manual control pendant**

IntelliGuide Servo Grippers

The PreciseFlex 400 robot may be ordered with the IntelliGuide s23 servo gripper. This gripper has a stroke of 60 mm and gripping force of 23 N. The gripper is ideal for labware or small parts handling. When used for handling microtiter plates, the gripper can pick the plate in portrait or landscape mode.

**IntelliGuide s23 (shown with gripper fingers)**

When ordered with the robot, the gripper is installed at the factory. See the *IntelliGuide Gripper User Manual* for more details.

IntelliGuide Vision Grippers

The PreciseFlex 400 robot may also be ordered with the IntelliGuide v23 vision gripper. This gripper has similar specifications to the IntelliGuide s23 gripper, in addition to two 5 MP cameras and an embedded PC.



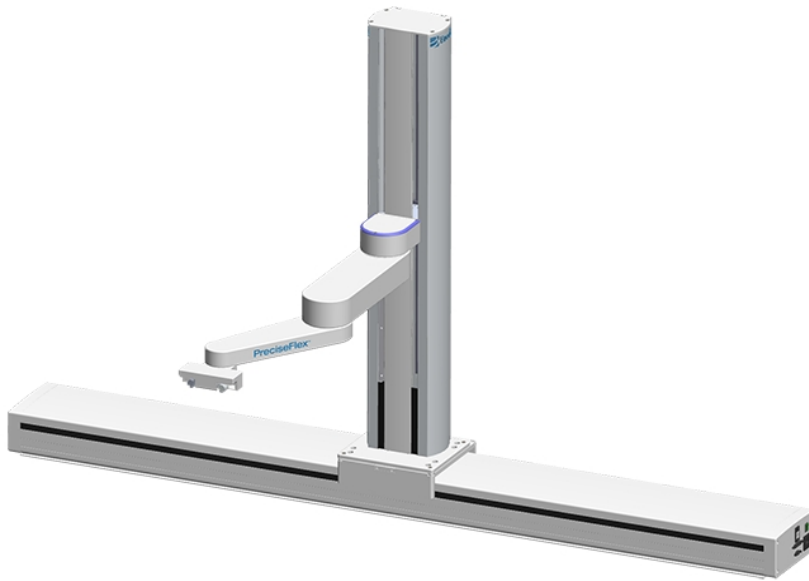
IntelliGuide v23 (shown with gripper fingers)

When ordered with the robot, the gripper is installed – and the cameras are calibrated – at the factory. See the *IntelliGuide Gripper User Manual* for more details.

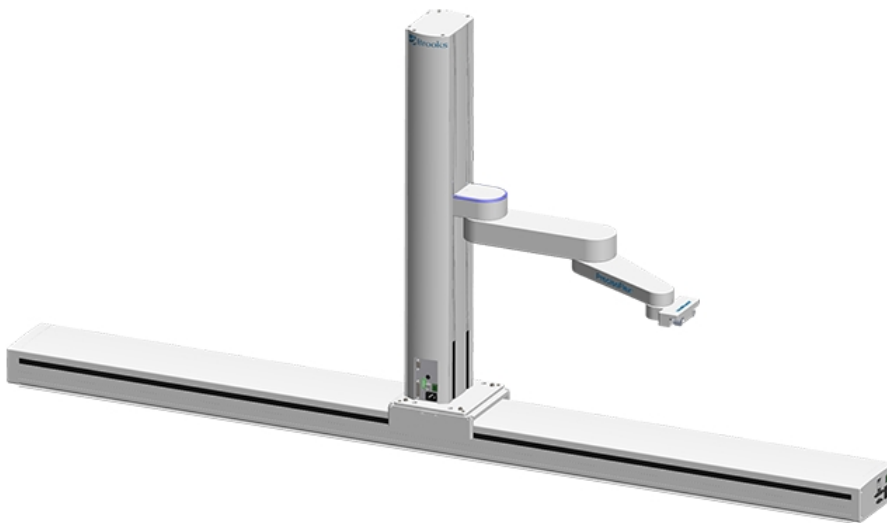
Linear Rail

The PreciseFlex 400 robot may be attached to an optional linear rail, which extends the robot travel horizontally by 1000 mm, 1500 mm, or 2000 mm distances. The linear rail overall length is approximately 380 mm longer than the travel distance.

All cables and controls are contained inside the linear rail. The linear rail must be used in conjunction with a PreciseFlex robot and cannot operate as a standalone rail.



PreciseFlex 400 Robot on a linear rail (shown in the default mounting configuration with optional IntelliGuide servo gripper)



PreciseFlex 400 Robot on a linear rail (shown in the 90° mounting configuration with optional IntelliGuide servo gripper)

See the *PreciseFlex Linear Rail User Manual* for more information.

NOTE: Linear rails for the PreciseFlex 400 robots are different from linear rails for the new c-series model robots. Linear rails for the PreciseFlex 400 robots have white end caps, while linear rails for the PreciseFlex c3 and c5 robots have a blue end cap on the facilities end of the rail. Do not connect PreciseFlex 400 robots to c-series rails or connect PreciseFlex c3/c5 robots to legacy linear rails.

Machine Safety

PreciseFlex robots are computer-controlled mechanisms that are capable of moving at high speeds and exerting considerable force. Like all robot and motion systems, and most industrial equipment, they must be treated with respect by the user and the operator.

This manual should be read by all personnel who operate or maintain PreciseFlex systems or who work within or near the work cell.

Moving Machine Safety

PreciseFlex robots can operate in manual-control mode, in which an operator directly controls the motion of the robot, or computer-control mode in which the robot operation is automatic. Manual control mode is often used to teach locations in the robot workspace. The robot's speed is limited in manual control mode to a maximum of 250 mm per second for safety.

While the PreciseFlex 400 is a light-duty robot that can only apply approximately 20-60 Newtons of force in manual mode, operators must keep their hands, arms, and especially their head out of the robot's operating volume. It is important that operators wear safety glasses when inside the robot's operating volume.

In computer mode, the robot can move quickly. The PreciseFlex 400 has been designed to be "hand-safe" even in computer mode, and in some cases a risk assessment of the application may indicate that it can be used without operator safety screens. However, safety glasses should be worn at all times when an operator is within the robot's working volume.

Voltage and Power Considerations

The PreciseFlex 400 robot has an input voltage range of 100 to 240 VAC, +/- 10%, 50/60 Hz.

The embedded robot controller has two DC power supplies, a 24 VDC power supply for the processor and user I/O and a separate 48 VDC motor power supply.

Mechanical and Software Limit Stops

The Z column, shoulder, and elbow have hard limit stops at the end of travel which are factory installed. The soft-limit stops must be set inside the range of these hard stops.

The wrist axis has a slip ring when the IntelliGuide gripper is installed, allowing continuous rotation. However, soft-limit stops constrain rotation to plus or minus 970 degrees.

The robot has absolute encoders with battery backup. When robot power is turned off, the encoders keep track of joint positions. If the wrist axis is rotated manually beyond the 970-degree software limit stops, it will be necessary to manually rotate it back to within the allowed software limits before the robot will run.

The joint position can be viewed either on the optional manual control pendant or in the virtual manual control pendant in the browser-based operator interface. See the *Guidance Controller User Manual*.

Stopping Time and Distance

The robot control system responds to two types of E-stops.

Soft E-Stop

A "Soft E-stop" initiates a rapid deceleration of all robots currently in motion and generates an error condition for all GPL programs that are attached to a robot. This property can be used to quickly halt all robot motions in a controlled fashion when an error is detected. A soft E-stop is typically generated by an application program under conditions determined by the programmer.

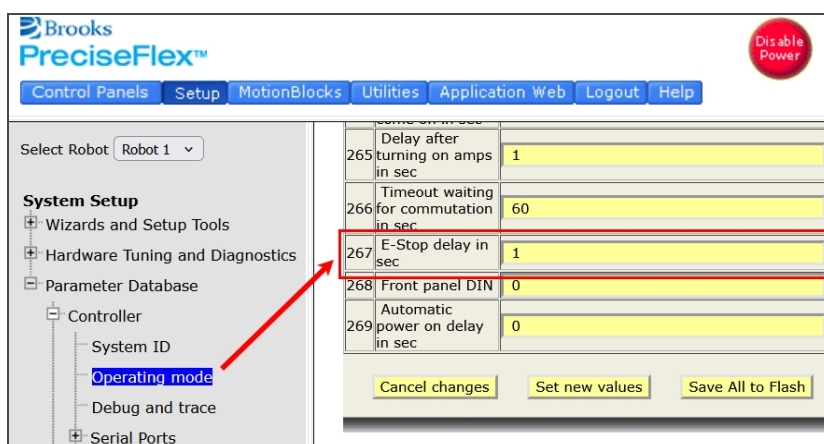
This function is like a "Hard E-stop" except that soft E-stop leaves high power enabled to the amplifiers and is therefore used for less severe error conditions. Leaving power enabled is beneficial in that it prevents the robot axes from sagging and does not require high power to be manually re-enabled before program execution and robot motions are resumed. This function is also like a rapid deceleration feature except that a rapid deceleration only affects a single robot, and no program error is generated.

If set, the `SoftE-Stop` property is automatically cleared by the system if high power is disabled and re-enabled.

Hard E-Stop

A hard E-stop is generated by one of several hardware E-stop inputs and causes motor power to be disabled. However, there is a parameter that determines a delay between the time the hard E-stop signal is asserted and the time the motor power supply relay is opened. This delay is nominally set at 0.5 seconds. It may be adjusted by an operator with administrator privileges.

On the browser-based interface, go to **Admin > Setup > Parameter Database > Controller > Operating Mode** and set parameter 267 to the desired delay. If this delay is set to 0, the high-power relay will be disabled within 1 ms.



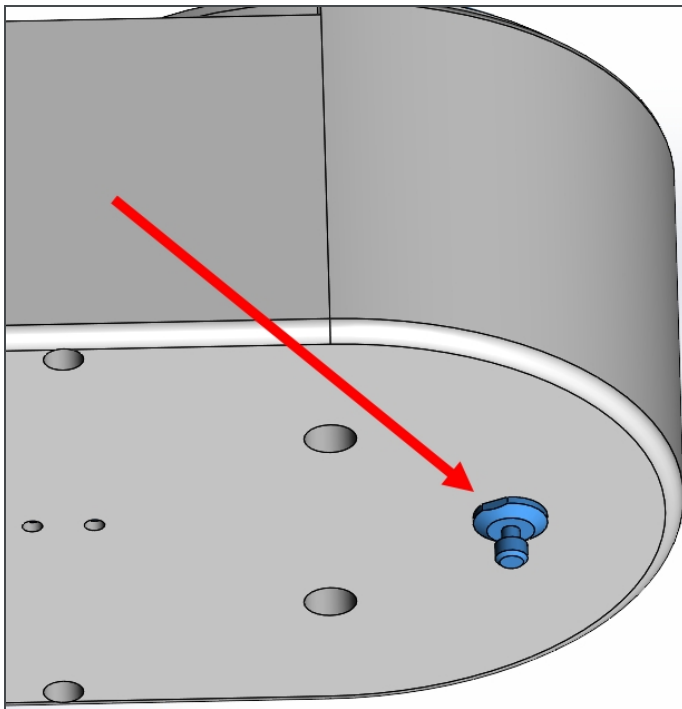
PreciseFlex 400 controller browser interface

For the PreciseFlex 400 robot, the shoulder, elbow, and wrist axes do not have mechanical brakes. Therefore, leaving the motor power enabled for 0.5 sec allows the servos to decelerate the robot. The servos will typically decelerate the robot at 0.12 G, or 1250 mm/sec². If the robot is moving at a speed of 500 mm/sec, the distance traveled will be 100 mm to reach a full stop, and the time will be 0.4 sec.

Releasing a Trapped Operator: Brake Release Switch

If a hard E-stop is triggered, the Z brake will engage, and motor power will be disconnected from all motors. As the J2, J3, and J4 axes have no brakes, they may be freely pushed by the operator.

To release the Z brake, press the brake release switch under the inner link, as long as 24 VDC is present. It is not necessary for motor power to be on for the brake release to work.



Z-axis brake release switch

Safety Zones

Safety zones on PreciseFlex robots stop robot motion and disable motor power if the tool center point (TCP) enters or leaves a designated area. When triggered, these zones cause a sudden deceleration, which depends on the setting in "RapidDecel deceleration in %" (Parameter Database ID 2101) and the robot's speed.

Safety zones are not intended to stop the robot during normal operation conditions and will not control the robot's TCP speed.

For configuration details, search for "Safety Zones" in the Online Help section of the Brooks Automation website at <https://www2.brooksautomation.com/>.

3. Installation

Setup and Operation

Follow these steps to set up the PreciseFlex 400 robot for operation.

- a. Unpack the PreciseFlex robot.
- b. Mount the robot.
- c. Add or remove a gripper (optional). See the *IntelliGuide Gripper User Manual*.
- d. Connect the power.
- e. Connect the PreciseFlex robot to a PC or tablet, and open the browser-based interface.

Unpacking and Mounting the Robot

PreciseFlex robots are shipped in wooden crates with international ratings and foam inserts to protect the robots. Additionally, there is an accessory box in the box which contains:

- Power cables for North America, UK, and Europe
- One Ethernet cable
- Four M6 socket head cap screw (SHCS) mounting screws and four nylon washers
- One M6 calibration pin.

The robots weigh 25 kg or more, so two persons should move the robot to the installation location.

CAUTION

Heavy Lift Hazard

Failure to take 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 move the robot.

Step	Action
1.	Prepare the secure robot mounting surface.
2.	Loosen the latches on all four sides of the crate, and remove the top.

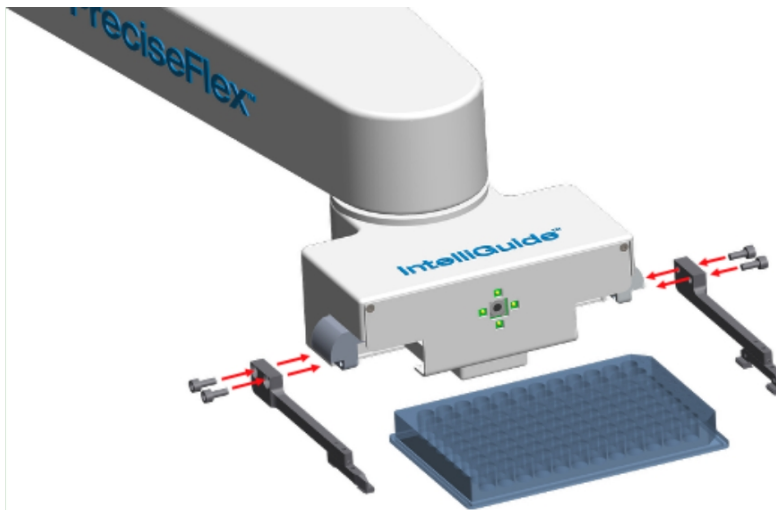
Step	Action
3.	a. Have two or more people lift the robot out of the crate. b. Take off the plastic wrapping. c. Leave the Velcro strap restraining the arm attached, and carry the robot to where it will be mounted.
4.	Set the robot on the mounting surface and secure it with the four M6 screws and Nylon washers. Keep the robot supported until it is secured to the mounting surface. There are four M8 leveling set screws on the robot base that can be used to level the robot on the mounting surface as necessary.



Step	Action
5.	Plug in the: • power cable • E-stop button/switch • Ethernet cable
6.	Remove the Velcro strap restraining the arm.

IntelliGuide Gripper and Finger Mounting

When ordered with the robot, the IntelliGuide servo or vision gripper is installed at the factory. The gripper supports custom gripper fingers, which can vary with the application. The image below shows how gripper fingers are attached to the IntelliGuide Vision gripper with (qty 4) 2.5 mm socket head screws.

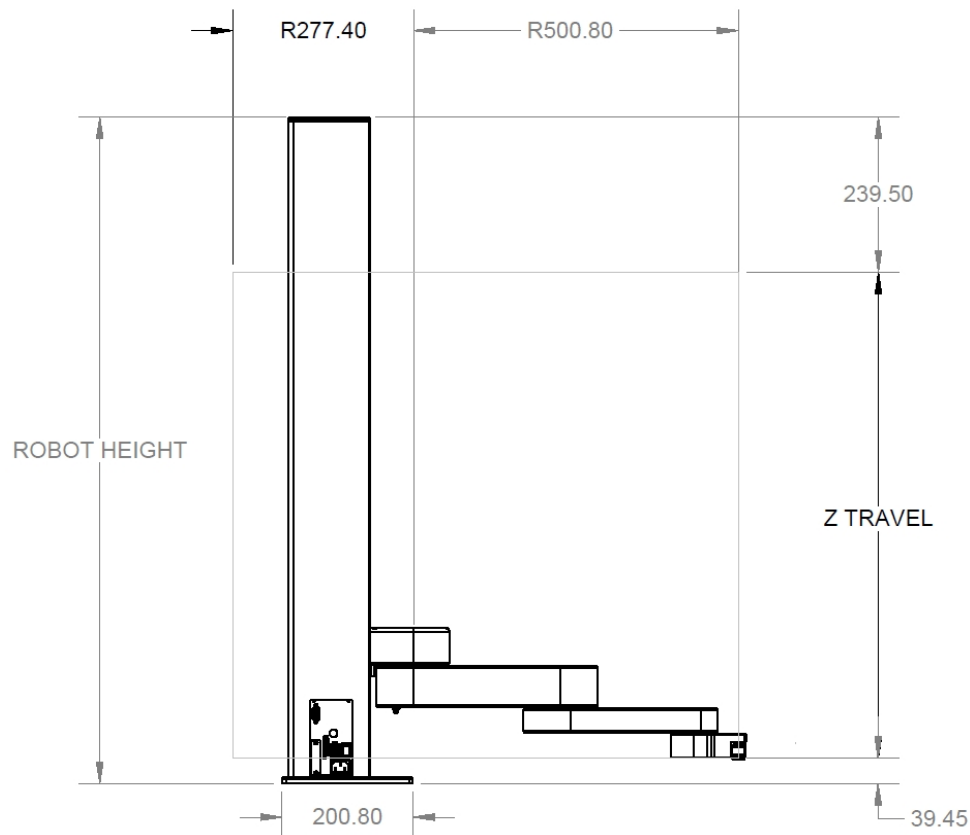


See the *IntelliGuide Gripper User Manual* for more details.

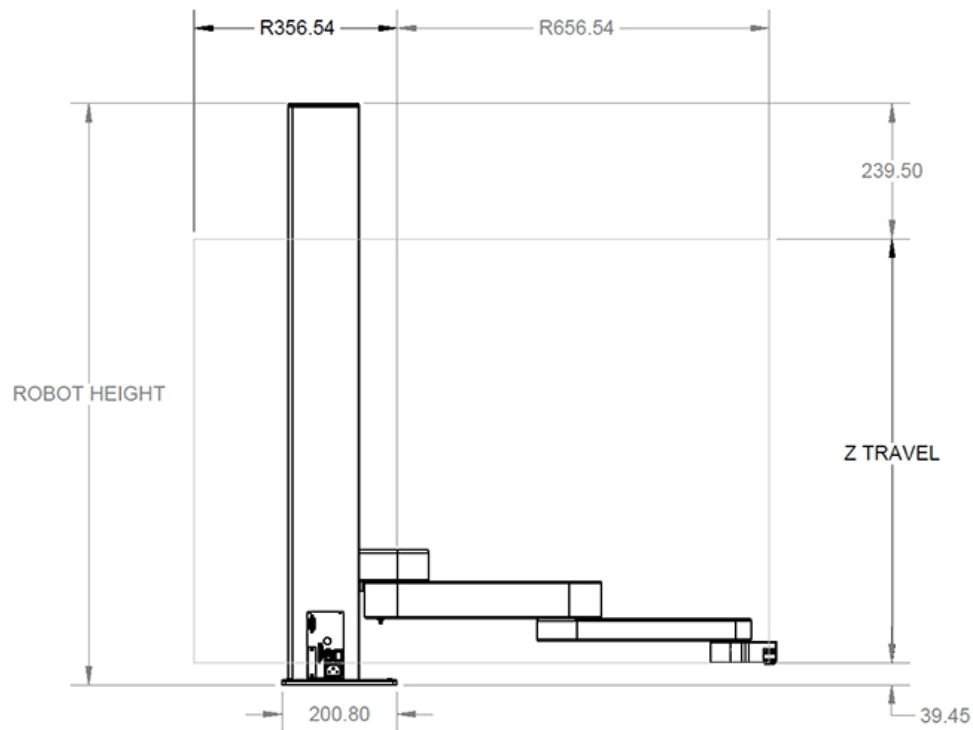
Robot Dimensions

All dimensions below are in millimeters.

Z Travel	Robot Height
400 mm	679 mm
750 mm	1029 mm
1160 mm	1439 mm



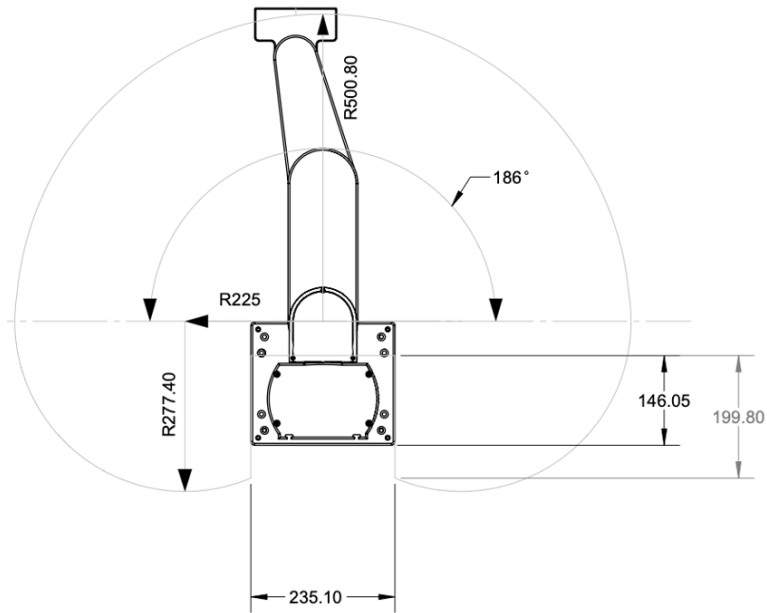
PreciseFlex 400 standard reach, side view



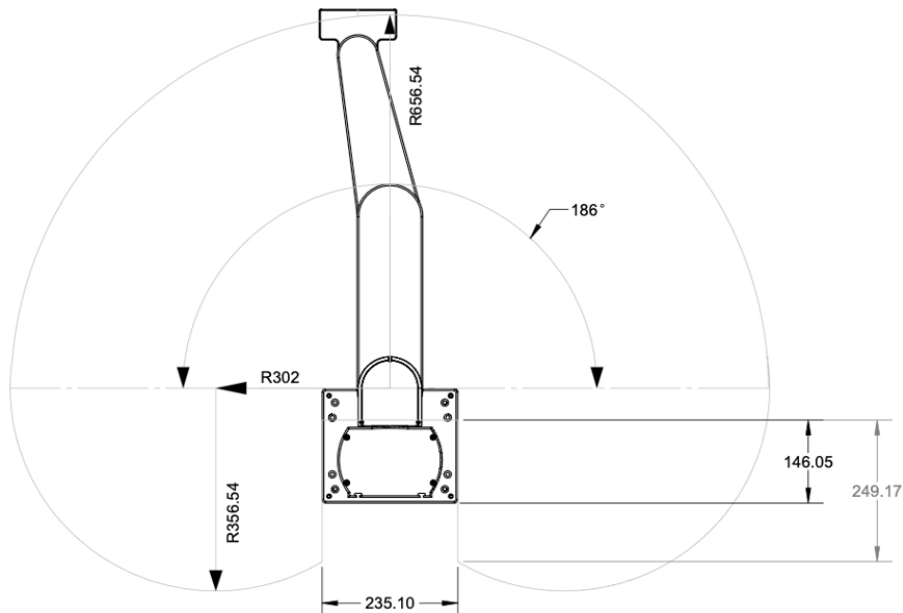
PreciseFlex 400 extended reach, side view

Work Envelope

All dimensions are in millimeters.



PreciseFlex 400 standard reach



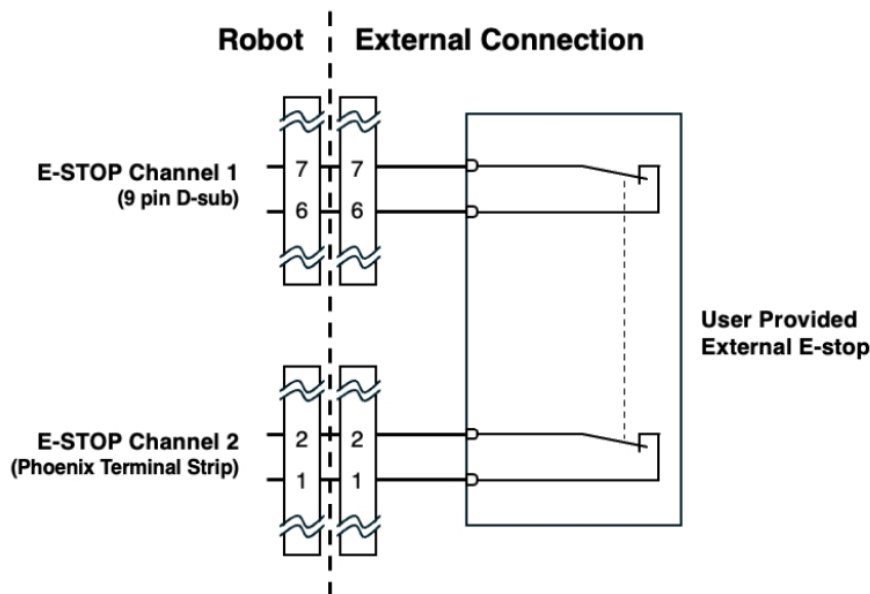
PreciseFlex 400 extended reach

External Emergency Stop (E-stop)

The PreciseFlex 400 robot has a two E-stop channels accessible at the robot facilities panel. One E-stop (channel 2) is connected to the 5-pin Phoenix terminal strip, and the other (channel 1) is connected to the 9-pin D-sub connector. Both E-stop circuits must be closed for robot power to be enabled. If either channel is open the robot will stop, and robot power is disabled.

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

- A user-provided external E-stop connected to the Phoenix terminal strip and/or 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 complete a circuit from Pin 7 (E-stop 1) to Pin 6 (FE Out 1) of the 9-pin D-sub connector, and from Pin 21 (E-stop 2) to Pin 1 (FE Out2) of the Phoenix terminal. If this circuit is not completed, it is not possible to enable motor power to the robot. The FE Out signals allow each E-stop circuit to be toggled during the startup sequence to make sure both circuits are working.

If no E-stop box or manual control pendant is connected to the 9-pin D-sub connector, a jumper must be connected between pins 6 and 7 to enable robot motor power. Likewise, if no external E-stop is connected to the Phoenix terminal, a jumper must be connected between pins 1 and 2. For those applications where an operator must be inside the working volume of the robot while teaching, a second teach pendant with a 3-position run hold switch is available. The manual control pendant can be plugged directly into the nine-pin D-sub connector.

The robot is shipped with a jumper plug in the nine-pin D-sub connector and a jumper on the Phoenix terminal that satisfy these requirements. If a remote signal (for example from a PLC) is used to trigger E-stop, it should be wired to a relay that closes the E-stop circuits.

5-Pin Phoenix terminal pinouts and descriptions

Pin	Description
1	E-stop channel 2 In
2	E-stop channel 2 out
3	Ground
4	No connection
5	24 VDC

Ethernet Interface

PreciseFlex robots include an Ethernet switch with two 10/100 Mbit Ethernet ports. This enables the robot to be interfaced with external Ethernet devices. The Ethernet switch automatically detects the sense of each connection, so either straight-through or cross-over cables can be used to connect the controller to other Ethernet devices.

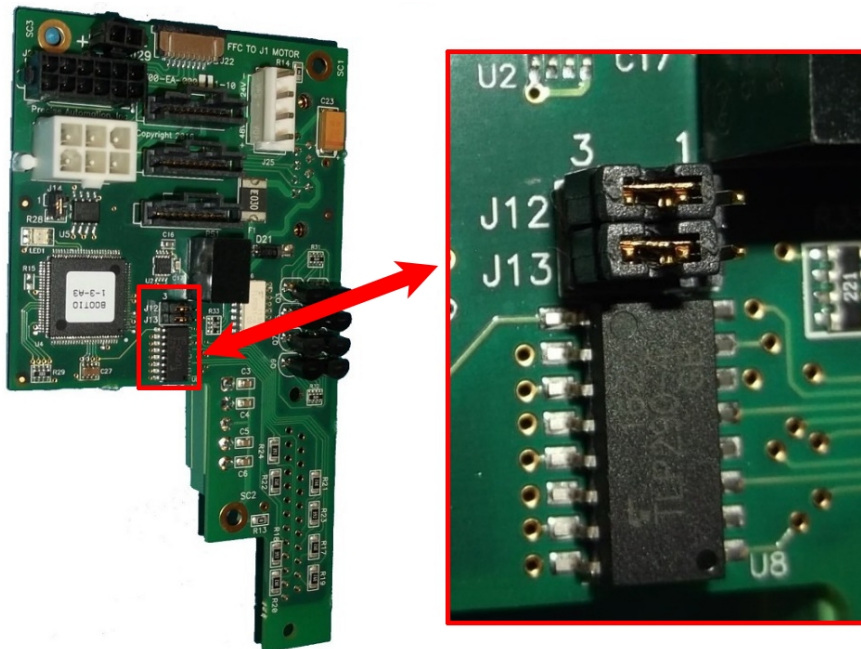
One Ethernet port is available via an external RJ45 connector at the robot base. This port is typically used to interface the robot to a PC. The second Ethernet port is available inside the inner link of the robot and can be used to connect items that are mounted on the robot. A PC connected to the Ethernet plug on the robot base can communicate with the robot's controller as well as the device connected to the other Ethernet port.

Digital Input and Output Signals

Digital Input and Output Signals at the Robot Base

There are eight general-purpose, optically isolated digital input signals.

The **inputs** are configured as *sinking* from the factory and can be changed to *sourcing* in blocks of four by changing jumpers on the SFT board in the base of the robot. Move J12 and J13 jumpers to connect pins 1 and 2, instead of pins 2 and 3.



Jumper locations on the SFT board

There are eight optically isolated digital **output** signals (100 mA each) available at the robot base on the 25 pin D-sub connector. The outputs are configured as *sourcing* from the factory and cannot be changed.

Digital Input Sinking and Sourcing

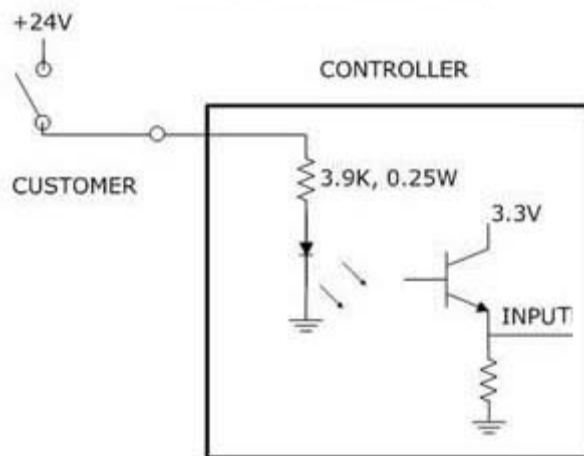
For Sinking Input (NPN Logic), the input device connects the robot controller input terminal to ground (0V). The robot controller input terminal is internally connected to positive voltage.

When the input device is activated, it “sinks” current from the input. This configuration is common in Asia and with NPN sensors.

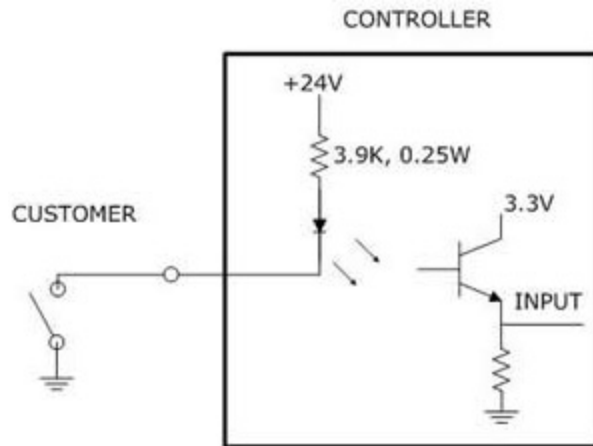
The direction of current flow defines the type:

- *Sourcing inputs* receive current
- *Sinking inputs* provide a path to ground.

For Sourcing Input (PNP Logic), the input device (e.g., sensor or switch) provides positive voltage to the robot controller input terminal. The robot controller input terminal is internally connected to ground (0V). When the input device is activated, it “sources” current into the input. This configuration is common in Europe and with PNP sensors.



Sinking digital input

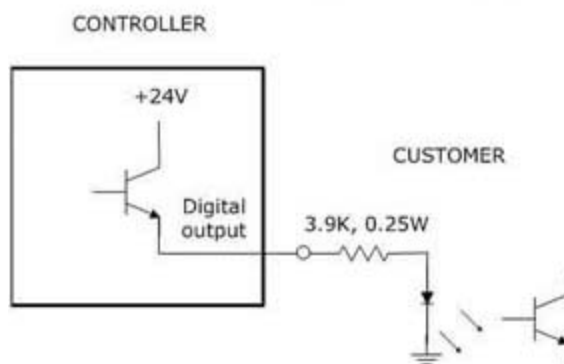


Sourcing digital input

Digital Output Sourcing

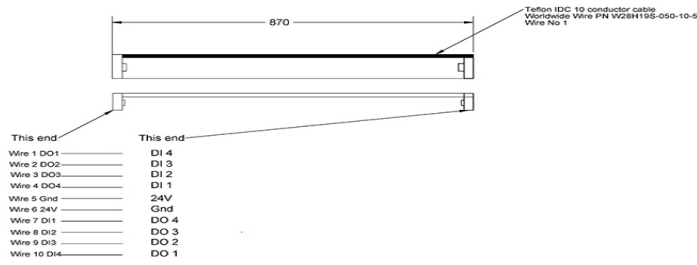
For Sourcing Output (PNP Logic), the robot controller output terminal provides positive voltage to the load. The load is connected between the output terminal and ground (0V). When the output is ON, current flows from the robot controller to the load. This configuration is suitable for loads that expect a positive voltage.

- *Sourcing outputs* supply current to the load
- *Sinking outputs* provide a path for current to return to ground.



Sourcing digital output

The pinout for the PreciseFlex 400 digital input and output connector and the corresponding GPL signal numbers are described in the following table.



DB25 female connector

25-Pin D-sub connector for I/O signals

Pin	GPL Signal Number	Description
1		Ground
2	10001	Digital Input 1
3	10003	Digital Input 3
4	10005	Digital Input 5
5	10007	Digital Input 7
6		Not used
7		Not used
8		24 VDC
9	13	Digital Output 1
10	15	Digital Output 3
11	17	Digital Output 5
12	19	Digital Output 7
13		24 VDC
14		Ground
15	10002	Digital Input 2
16	10004	Digital Input 4
17	10006	Digital Input 6
18	10008	Digital Input 8
19		Not used
20		Not used
21		24 VDC
22	14	Digital Output 2
23	16	Digital Output 4
24	18	Digital Output 6
25	20	Digital Output 8
User Plug Part No		Amp 1658657-1, (crimp) Pins 22-26AWG 745254-6

RS-232 Serial Interface in the Robot Inner Link

The PreciseFlex robot includes a standard RS-232 serial line equipped with hardware or software flow control. However, this port is only available from the inner link of the robot and is not brought out to any outside connector on this robot. This port can be used to communicate to the system serial console or can be connected to external equipment for general communication purposes or to bar code readers. When used for general communications, this port is referenced as device `"/dev/com1"` within the Guidance Programming Language (GPL).

The connector for this interface is a standard RJ11 serial interface connector that has pin assignments compatible with standard PC "com" ports. For this robot, it is only used for debugging and special service procedures.

AC Power Input

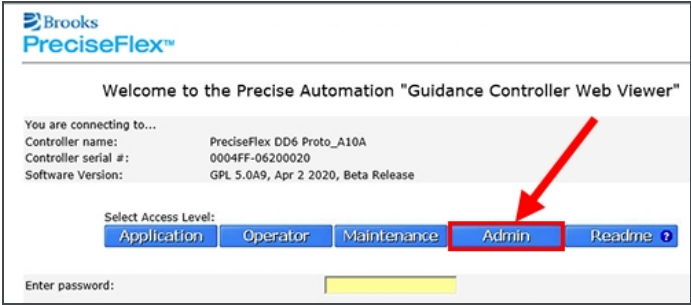
The PreciseFlex 400 robot accepts a range of AC input from single-phase 100 V to 264 V.

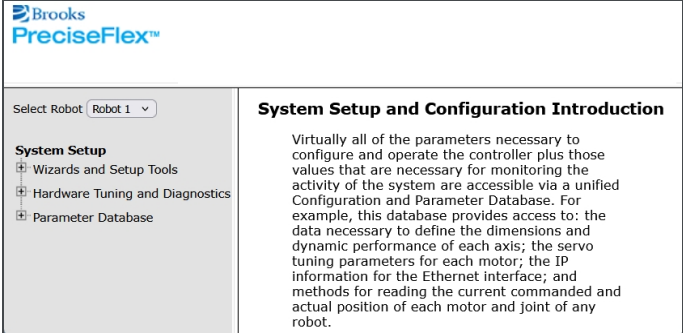
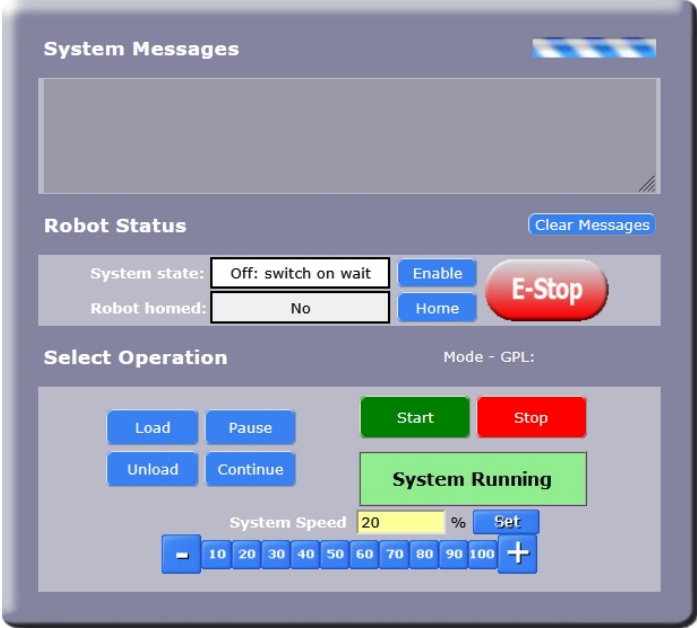
 DANGER High Voltage	
Disconnect AC power before removing covers or servicing the robot to prevent exposure to high voltage levels,	

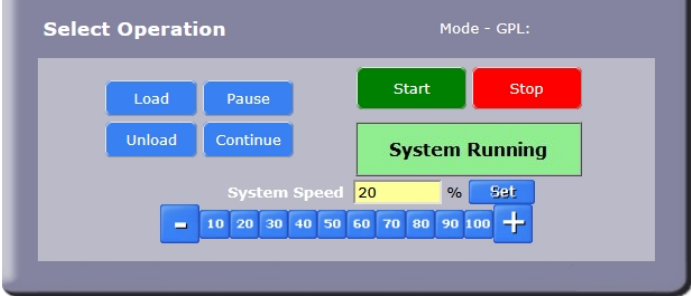
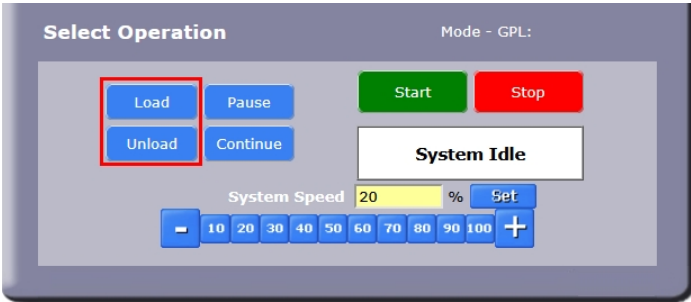
4. Operation

Browser Interface

To run the robot, update software in the controller, and more, access the browser interface embedded in the controller. Follow this procedure:

Step	Action
1.	Open a browser on a device connected to the robot via Ethernet. You must know the IP address of the robot controller. The IP address 192.168.0.1 is the factory default. Configure the PC LAN interface address (for example, 192.168.0.100 with subnet mask 255.255.255.0). The interface will display. Click Admin. You can use also GDS or other software to discover a robot's unknown IP address. NOTE: Enter a password if a company has protected access to the browser interface. 

Step	Action
2.	After clicking Admin, the <i>System Setup</i> window will display. 
3.	Click the Control Panels button in the top bar. In the left navigation column, click Operator Control Panel to display the <i>Operator Control Panel</i>. 

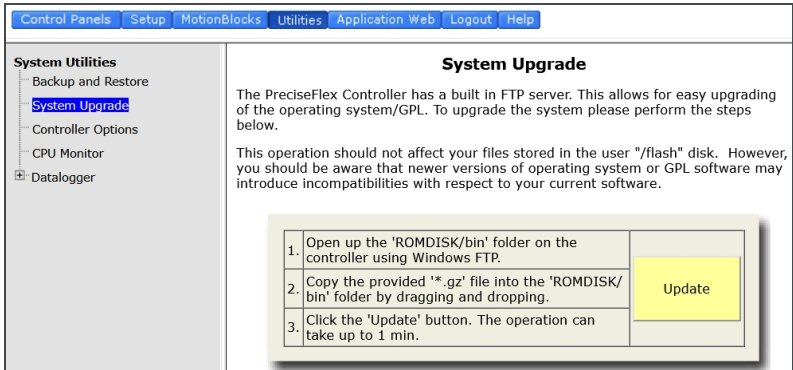
Step	Action
4.	If an application is running, <i>System Running</i> will display in green. To run diagnostics, click Stop. 
5.	At the top right of the screen, click Disable Power to ensure the motor power is off. 
6.	To load a new project (for example CAL_PP), click Unload and then Load before loading the new project into RAM. 
7.	Click Start to start the program.

Loading a GPL Project

Use GDS to load a GPL project. Refer to the *GDS User Manual* on <https://www.brooks.com/support/brooks-preciseflex-support/guidance-development-studio-gds/>.

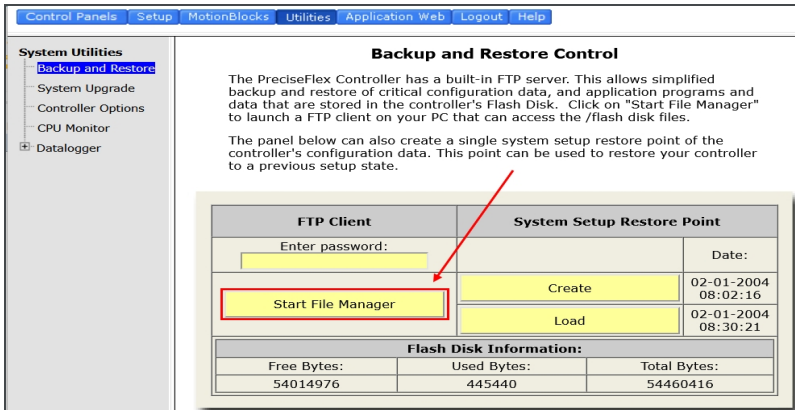
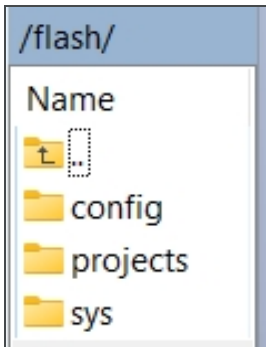
Updating Firmware and Operating System

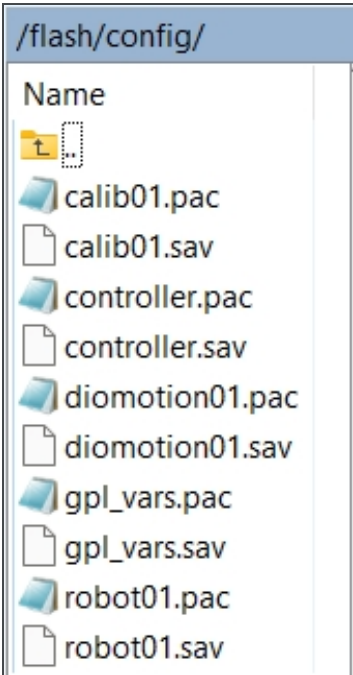
GPL (the system software and firmware are now a single file in GPL 5.0 and later) may be upgraded in the field. To update GPL (system software and firmware), complete the following steps:

Step	Action
1.	Get the appropriate upgrade software from Brook in the form of a .gz file. Email support@preciseflex.com .
2.	Use the Windows File Explorer to access the ROMDISK GPL storage area directly. Type ftp://192.168.0.1/ROMDISK/bin in the File Explorer address line. 
3.	Paste the new GPL system file into this folder.
4.	a. In the Browser Interface, click Admin > Utilities > System Utilities > System Upgrade. b. Click Update and follow the instructions. 

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 <i>Backup and Restore Control</i> window, click Start File Manager to open an FTP client.  The screenshot shows the 'Backup and Restore Control' window. The sidebar on the left has 'System Utilities' expanded, with 'Backup and Restore' selected. The main content area has a title 'Backup and Restore Control' and two paragraphs of text. Below the text are two main sections: 'FTP Client' and 'System Setup Restore Point'. The 'FTP Client' section has an 'Enter password:' field and a 'Start File Manager' button, which is highlighted with a red box. The 'System Setup Restore Point' section has 'Create' and 'Load' buttons and a 'Date' column. Below these is a 'Flash Disk Information' table. <table><tr><th colspan="3">Flash Disk Information:</th></tr><tr><td>Free Bytes:</td><td>Used Bytes:</td><td>Total Bytes:</td></tr><tr><td>54014976</td><td>445440</td><td>54460416</td></tr></table>	Flash Disk Information:			Free Bytes:	Used Bytes:	Total Bytes:	54014976	445440	54460416
Flash Disk Information:										
Free Bytes:	Used Bytes:	Total Bytes:								
54014976	445440	54460416								
2.	In the FTP client, open the <i>config</i> folder.  The screenshot shows the FTP client interface. The address bar displays '/flash/'. Below it, a directory listing shows three folders: 'config', 'projects', and 'sys'. The 'config' folder is highlighted.									

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. 

TCS API

The TCS (TCP Command Server) API is a method of controlling PreciseFlex robots from a PC. The TCS API is open source and can be used to send discrete commands to the robot and request status. With TCS API is used the PC issuing commands must be connected to the robot during runtime.

Linear Rail Configuration

To configure the PreciseFlex 400 robot to be used with the optional linear rail, Guidance Programming Language (GPL) O.S. version must be 3.2.H4 or later, and the PAC files must be changed to support the robot with Linear Rail. If a robot is installed on, or removed from, a linear

rail, new PAC files must be obtained from Brooks (email support_preciseflex@brooks.com) and installed in the robot controller, and the robot must be re-calibrated using CALPP_Rev21 or later.

See the *Linear Rail User Manual* for details on configuring the PAC files.

RS-485 Network Termination with Linear Rails

The PreciseFlex 400 robot uses an internal RS-485 network to communicate between the main robot controller (located in the base) and the GSB servo boards. To maintain signal integrity and improve noise immunity, termination resistors are installed at the ends of the RS-485 network. This termination is enabled by a jumper installed on J6 of the main robot controller.

When the PreciseFlex 400D robot is installed on a linear rail, the RS-485 network is extended to the GSB inside the linear rail. It is then necessary to remove the J6 jumper, which deactivates the termination resistors on the main controller. C-series linear rails are preconfigured with the necessary termination resistors in place.

To remove the J6 jumper on the PreciseFlex 400D robot, follow the procedure below.

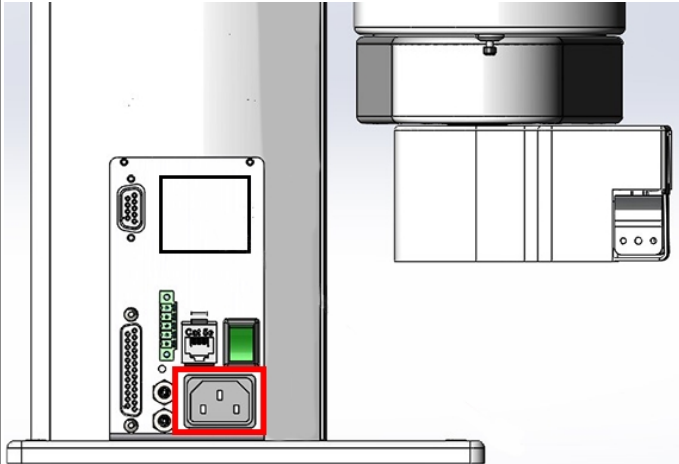
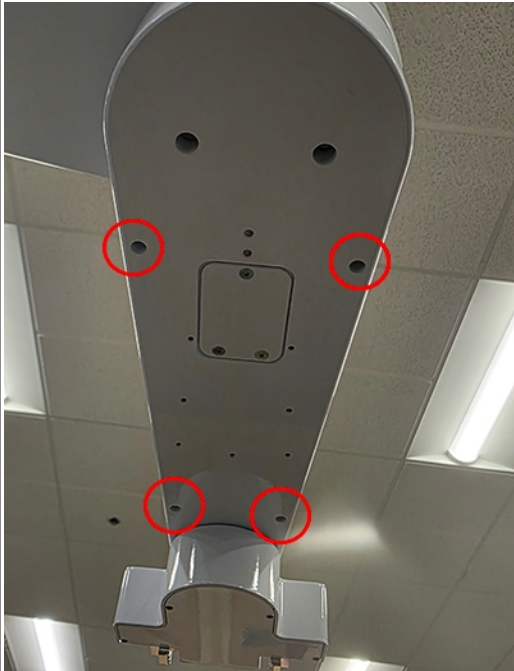
 DANGER Electrical Shock	
Turn off the AC power before replacing the robot controller.	

Tools Required

- 2 mm hex driver or hex L wrench
- Needle nose pliers

Spare Parts Required

- None

Step	Action
1.	Turn off the robot power and remove the AC power cord. 
2.	To access the inner link, remove the (4) M3 × 20 mm SHCS and lock washers from the bottom of the link. Once the fasteners have been removed, lift off the top cover. 

Step	Action
3.	Move the J6 jumper over one position so that the termination resistors are not connected. By moving the jumper over one position, the jumper is still available if the robot is later removed from the linear rail. 
4.	Return the link cover to its original position and ensure it is secure. NOTE: Do not over-tighten the inner or outer link cover screws. Excessive torque can pull the press-fit PEM nuts out of the sheet metal, potentially requiring cover replacement.

Appendices

Appendix A: Product Specifications

General Specification	Range
PERFORMANCE	
Payload	0.5 kg with IntelliGuide s23 or v23 gripper 1.0 kg without IntelliGuide s23 or v23 gripper
Max speed at TCP	Horizontal: 500 mm/sec Vertical: 500 mm/sec
Max Joint Speed	J1 - 500 mm/sec J2 – 360°/sec J3 - 720°/sec J1 - 500 mm/sec
Max Acceleration	2500 mm/sec ²
Repeatability	±0.090 mm
RANGE OF MOTION	
Joint 1 (Z-axis)	400, 750, 1160 mm
Joint 2 (Base)	±93°
Joint 3 (Elbow)	12° to 348°
Joint 4	±960° with IntelliGuide s23 or v23 gripper
Horizontal Reach (from center of Joint 2 to gripper finger mount)	500.8 mm, standard reach 656.54 mm, extended reach
COMMUNICATIONS	

General Specification	Range
General	100 Mb Ethernet, TCP/IP EtherNet/IP ModbusTCP, RS232 at base and end of arm
Operator Interface	Browser-based operator interface
Digital I/O	8 inputs at 24 VDC 8 outputs at 24 VDC (100 mA)
FACILITIES	
Power	100 to 240 VAC, auto selecting 50-60 Hz 100-175 watts typical operation
Pneumatics	None
External E-stop	Dual channel
Controller Type	Embedded into robot base
Weight	- Standard Reach 400 mm Z-axis: 20 kg 750 mm Z-axis: 25 kg 1160 mm Z-axis: 30 kg - Standard Reach/Extended Reach 400 mm Z-axis: 25 kg 750 mm Z-axis: 30 kg 1160 mm Z-axis: 35 kg
Noise Level	<40db LAF50
SOFTWARE	
Programming	- TCS API for controlling robot from workflow, scheduling software - GPL (Guidance Programming Language): full-featured object-oriented programming language - GP Flow for no-code, point-and-click application builder - Programming via Guidance Development Studio (GDS)
Enhanced Functions	Hand guiding (standard) Horizontal compensation (X/Y compliance) Z-height detection
PERIPHERALS AND ACCESSORIES	
General	IntelliGuide s23 servo gripper Gripper fingers for SBS-format microplates
Vision	IntelliGuide v23 gripper
Linear Rail	Horizontal travel 1.0, 1.5, and 2.0 meters Speed up to 750 mm/sec Repeatability: ±0.05 mm

General Specification	Range
ENVIRONMENTAL SPECIFICATIONS	
Indoor use only	Yes
Ambient temperature	0°C to 40°C (indoor use only)
Storage and shipment temperature	-25 °C to +55 °C
Relative Humidity	10 - 75%, non-condensing, non-corrosive
Altitude	Up to 3000 m
Voltage	100-240 VAC +/- 10%, 50/60 Hz
Mains cord rating, min	18 AWG, 3 conductor, 5 amps min
Pollution Degree	2
Approved cleaning agents	IPA, 70% Ethanol/30% water, H ₂ O ₂ vapor up to 1000 ppm
IP rating	11
IK impact rating	IK08: 5 joule

Appendix B: Spare Parts List

Refer to the spare parts list in the *PreciseFlex 400 Robot Rev D Service Manual* for detailed information.

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

Appendix C: Preventative Maintenance

For support with preventative maintenance, addressing error codes, or service related issues contact support_preciseflex@brooks.com.

The following preventative maintenance procedures should be performed at an interval of one to two years. For robots operating continuously 24 hours per day, 7 days a week at moderate to high speeds, a one-year interval is recommended. For robots with low duty cycles and low to moderate speeds, these procedures should be performed at least once every two years.

Preventative Maintenance, Checklist, and Procedures

Check List	Procedure If Problem 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 timing belt in optional linear axis	Typically, every 6,000 hours of continuous operation
Check all joints in "free mode" for low bearing friction and any sticking.	If a bearing gets stiff, return it to the factory for bearing replacement.
Check second stage (long) Z belt for any squeaking	If noisy, add thick grease to the front and rear edge of the belt if necessary. (Shell 222 XP or similar). Z timing belt can get stiffer over time (2-3 years) and occasionally start squeaking against pulley flanges.
Check if front cover is rattling	If so, check .125 in ID by .062 in thick O rings on dowel pins in base plate under front cover for any deterioration and replace if necessary.

Check List	Procedure If Problem Detected
Check Cam Followers on J2 timing belt for grease leaking or discoloration.	Replace if necessary. Note that units have a 12 mm wide timing and the Cam Followers are different. See the "Spare Parts List" .
Replace slip ring	Replace the slip ring every third inspection test.

Preventative Maintenance Schedule

Component	Expected Life	Action
Slip ring	3-5 years	Replace component
J2 timing belt	5 years	Replace component

Appendix D: Calibrating the Robot: Setting the Encoder Zero Positions

Cal_PP is a service program that must be run to set the zero positions of the absolute encoders on each motor. The zero positions must be re-established if any of the motors are replaced, their cables disconnected for a long duration, or the encoder backup battery has been disconnected.

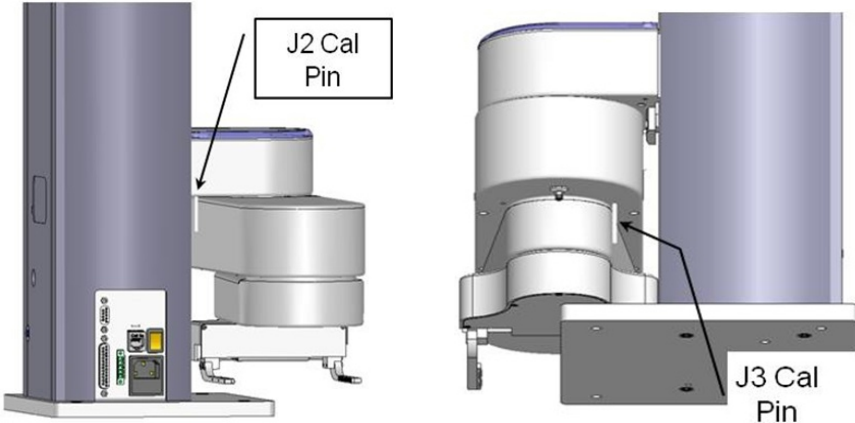
Cal_PP is supplied on the *Guidance Controller System Software CD*. To run Cal_PP, the controller must be configured to run GPL programs and Cal_PP must be loaded into the controller's memory (See ["Preventative Maintenance"](#)).

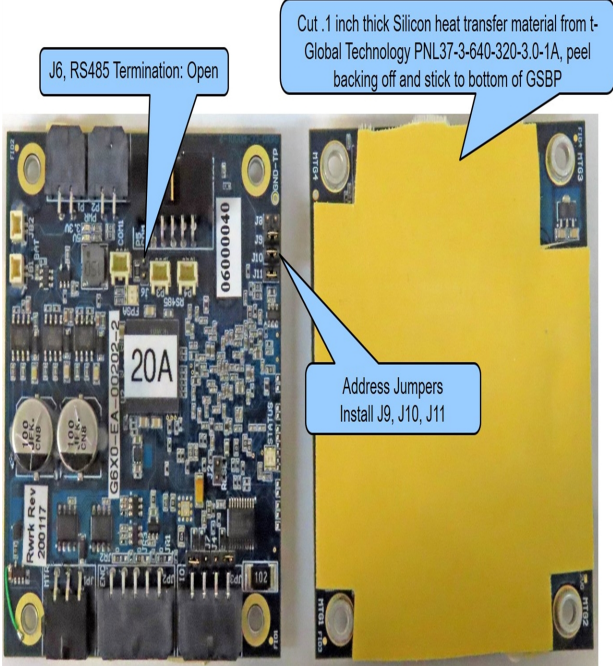
Tools Required:

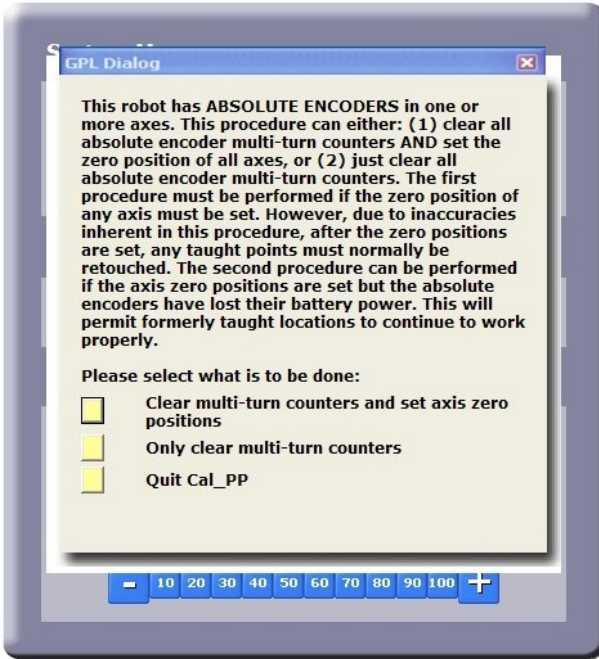
- 2.5 mm and 3.0 mm hex drivers or hex L wrenches
- Set of (3) Calibration Dowel Pins, located in plastic bag inside the hollow slot in the front cover

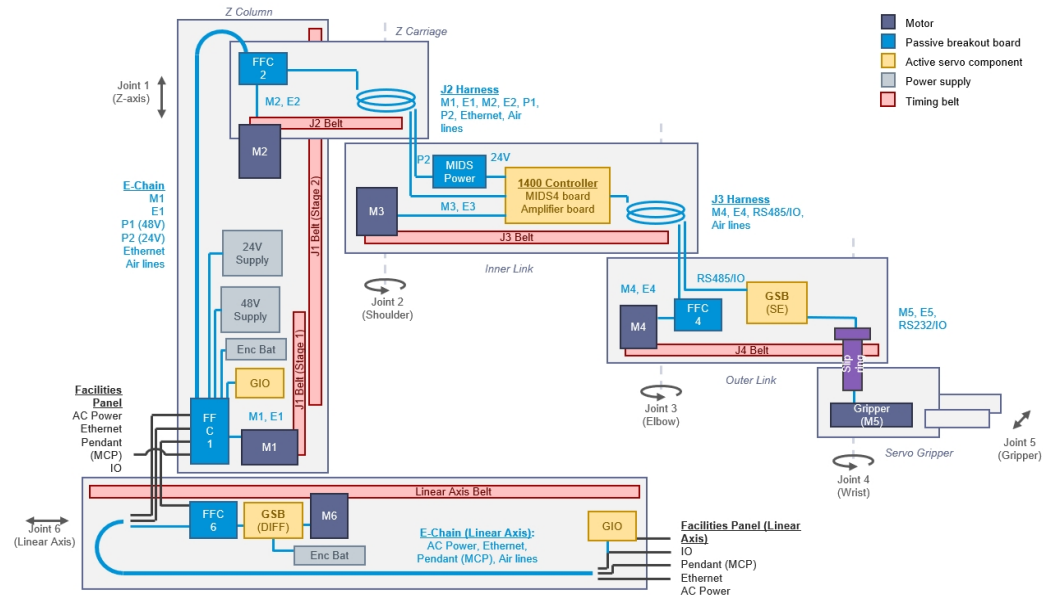
The following procedure describes the steps for defining the zero positions of the PF400 robot axes using Cal_PP.

Step	Action
1.	If the Calibration Pins have not already been removed from the robot, it may be necessary to remove the top cover of the robot by removing the (4) M5 Low Head screws with a 3.0 mm hex driver and then removing the front cover to access the bag with the Calibration Pins which are inside the front cover extrusion at the bottom.
2.	Enable power to the robot's controller, but do not turn on power to the motors. (This procedure should be executed with the motor power off. The robot does not move).
3.	The CALPP program is typically installed at the factory and should be loaded into flash memory. Using the operator control panel, first unload any currently loaded programs. Select the UnLoad item in the left scrolling window and click Perform Operation . This ensures that no GPL project is currently selected for execution.
4.	Select the Load item and click Perform Operation . This displays a pop-up list of Projects that are in the flash disk and available for execution.
5.	In the window, click CALPP_RevXX and click Select . To execute the Project, select Start application and click Perform Operation . If CALPP is not loaded in the robot, first Load Cal_PP into the controller's memory from a PC. Refer to the <i>GDS User Manual</i> on https://www.brooks.com/support/brooks-preciseflex-support/guidance-development-studio-gds/ .
6.	Take off the top cover of the outer link by removing the (4) M3 X 20 SHCS that are located in counter bores under the outer link. NOTE: If the optional Linear Axis is installed, move the Linear Axis carriage to the hard stop near the connector end cap. For the Linear Axis calibration, be sure to use CALPP Revision 21 or later.
7.	Ensure that the Z-axis is resting on the lower hard stop by releasing the Z-axis brake by pushing on the brake release button under the shoulder while supporting the robot arm, and lowering the robot arm gently until it rests on the lower hard stop.
8.	Insert an M3 X 30 mm Calibration Dowel Pin into the J4 (wrist) pulley with the gripper positioned under the outer link and rotate the gripper back and forth until the pin drops into a slot in the outer link, locating the gripper under the center of the outer link.
9.	Insert a tapered 0.5 in Calibration Dowel Pin into the hole in the bottom of the shoulder. Rotate the inner link counter-clockwise until it rests against this pin as shown in Step 10.

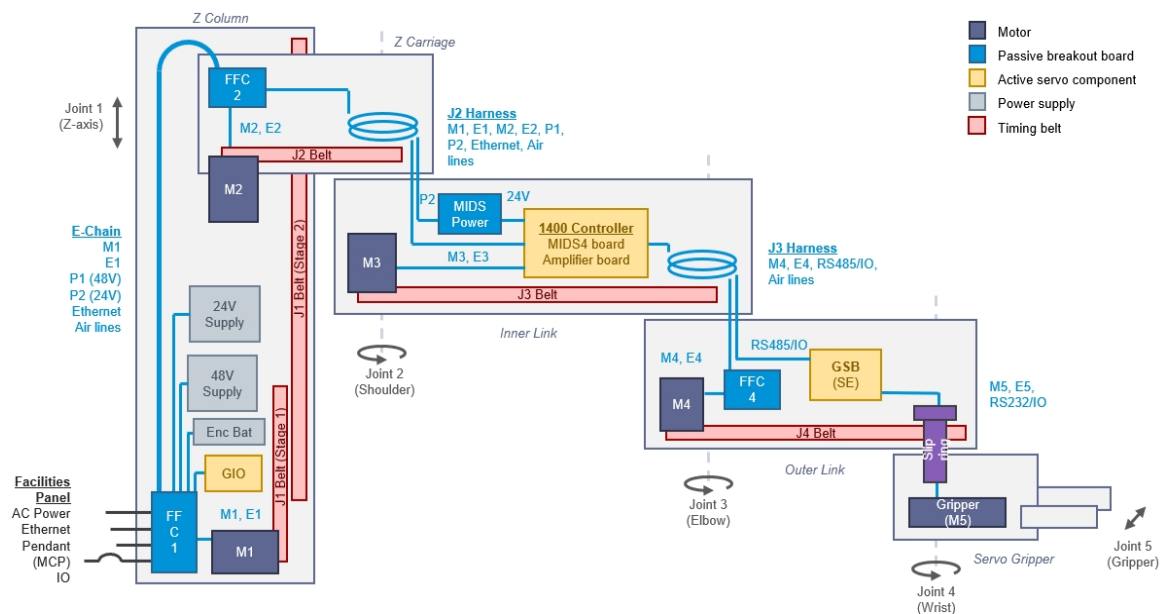
Step	Action
10.	Insert a tapered 0.5 in Calibration Dowel Pin into the hole on the inner link.  FTP directory /flash/ at 192.168.0.1 To view this FTP site in File Explorer: press Alt, click View, and then click Open FTP Site in File Explorer. <u>Up to higher level directory</u> <pre> 01/01/1970 12:00AM Directory . 04/13/2020 02:41PM Directory .. 01/27/2020 05:19PM Directory config 04/03/2020 03:35PM Directory projects 04/03/2020 03:34PM Directory sys </pre>
11.	Rotate the outer link clockwise until it rests against the dowel pin.
12.	If the robot is installed on a linear rail, push the rail carriage all the way to the hard stop at the linear rail connector end cap.

Step	Action
13.	With the CALPP application loaded, select Start Application and then click Perform Operation. The application should start and prompt the user to confirm the correct robot position for calibration.  J6, RS485 Termination: Open Cut .1 inch thick Silicon heat transfer material from t-Global Technology PNL37-3-640-320-3.0-1A, peel backing off and stick to bottom of GSBP Address Jumpers Install J9, J10, J11

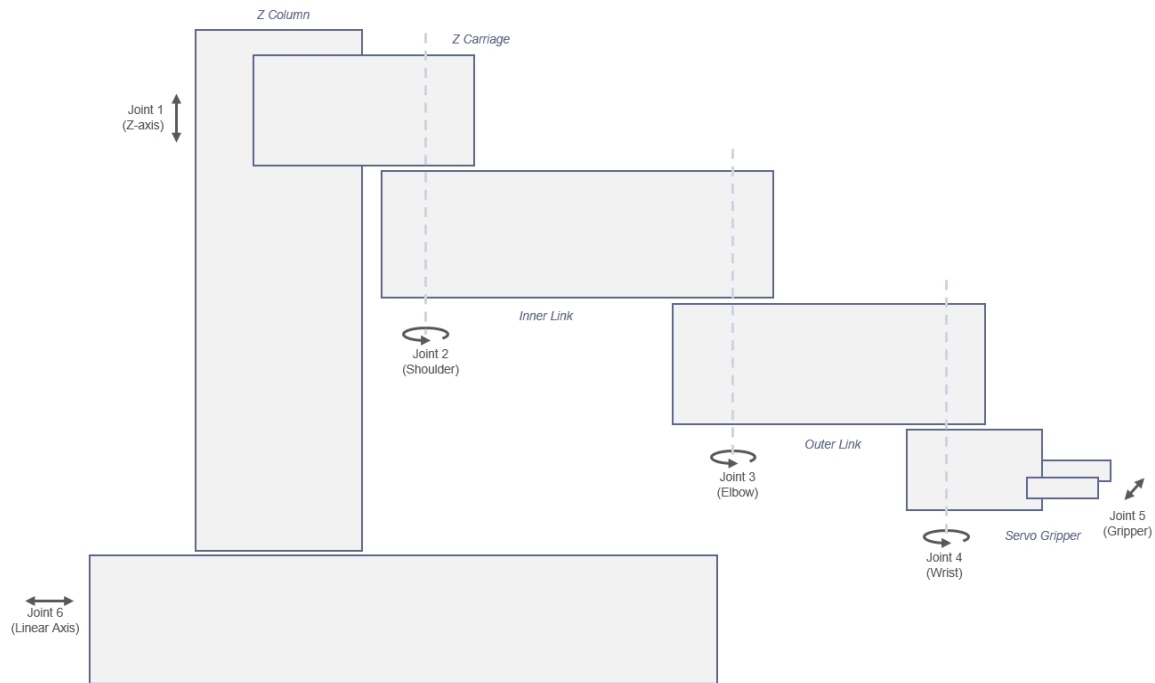
Step	Action
14.	The CALPP application takes about 1 minute to run. 
15.	After calibration is complete, use the brake release button and move the Z-axis up from the hard stop. Failing to do this will produce an error as the robot is outside of the soft stop limits.
16.	Ensure that the pins are removed.
17.	Re-install the front cover on the Z-Axis if it was removed, and re-install the outer link cover with the 4X M3-20 SHCS and Lock Washers.
18.	Enable power and home the robot. Calibration does not take effect until the robot is homed.



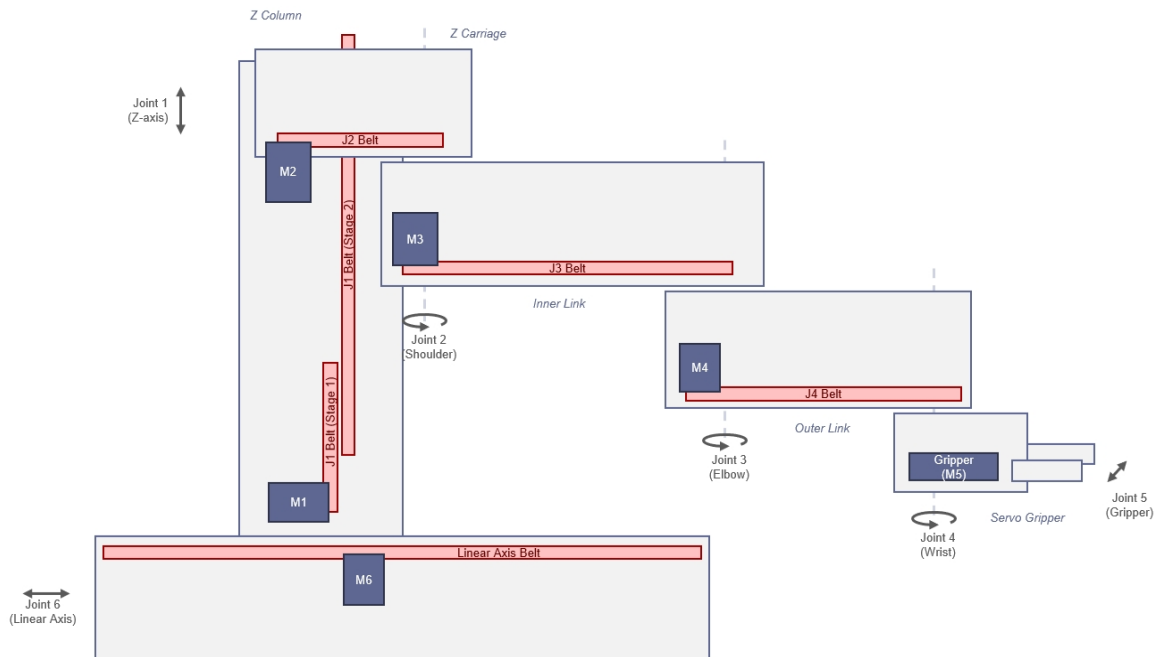
Four Axes - with Rail



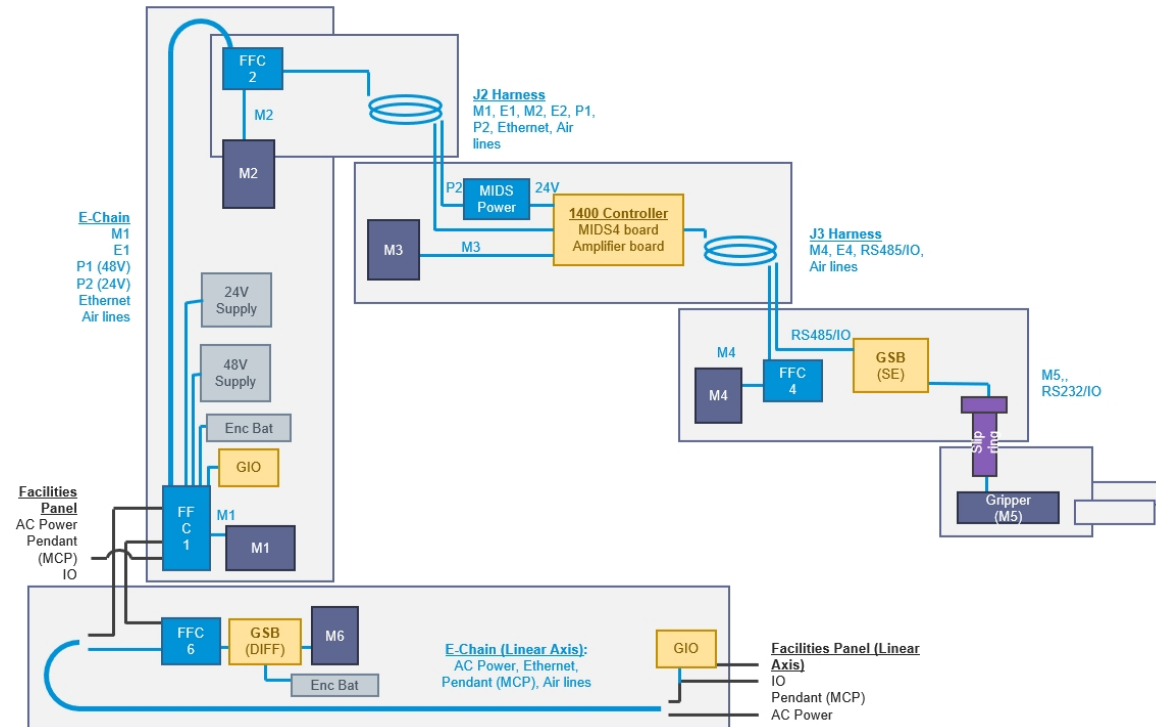
Four Axes - No Rail



Four Axes – Joints



Four Axes – Belt Drives



Four Axes – Power