400 mm Z Axis 750 mm Z Axis 1160 mm Z Axis

PreciseFlex™ c5 Robot

User Manual

Part Number 660076, Revision A

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Revision History

Revision	ECO	Date	Action	Author
A	EC165294	July 1, 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.

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

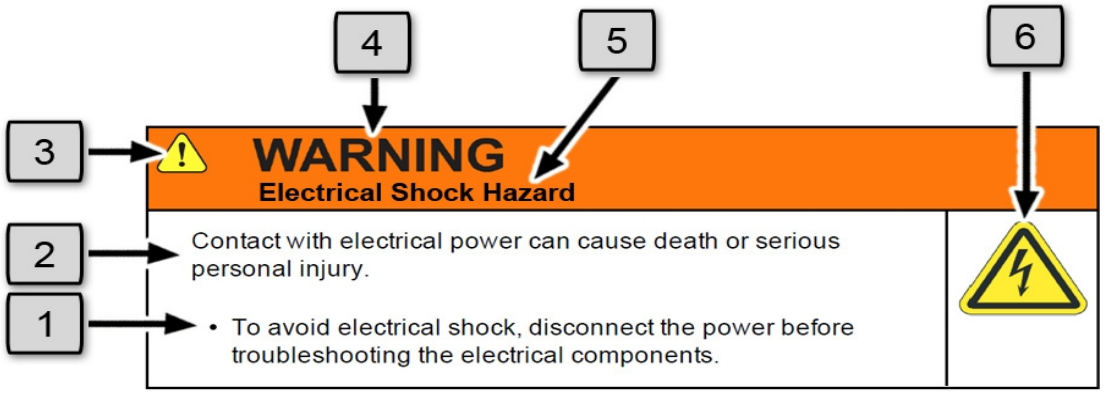
Signal Words and Colors

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

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, 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.

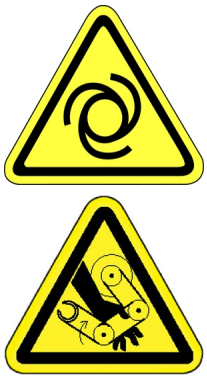
- Do not operate the product without the protective covers in place.

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.

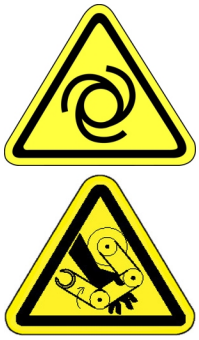
- Be aware of the potential movement area of the product whenever power is applied.
- Never place any part of your body between the robot arms and fixed surfaces.
- Do not operate the robot without the guards and protective covers in place and all safety interlocks enabled.

WARNING

Unplanned Robot Motion

Brooks motion software and motion processor are not safety certified to protect the user from unplanned or faulty automatic robot motion which may cause death or serious injury.

- Be aware that unplanned robot motion may occur.
- Know and stay out of the robot's range of motion.
- Place physical barriers to prohibit others from entering the working range of the robot.
- Follow safe practices for working with energized robots.
- Do not rely on the system software or processor technology to prevent unexpected robot motion



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

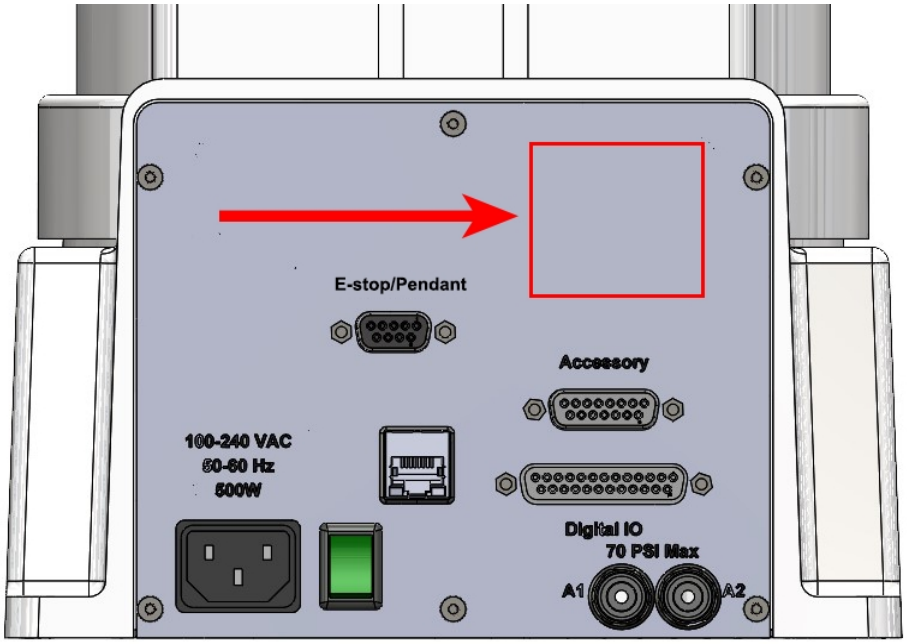
Brooks Automation complies with the EU Directive 2002/96/EU Waste Electrical and Electronic Equipment (WEEE).

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@brooksautomation.com.

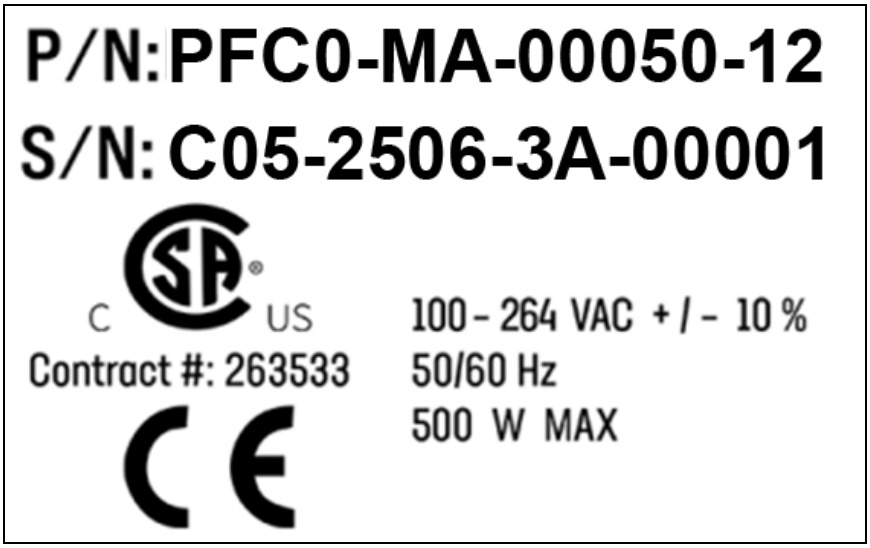
2. Overview

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.



Location of the product label on the facilities panel at the base of the robot



Part Number (P/N)

The first line of the sample part number label – Part Number (P/N) – describes these properties.

P/N: PFC0-MA-00050-12

Code	Description
PFC0	PreciseFlex c3, c5, c8A, or c10
MA	Machine assembly
00050	PreciseFlex c5
12	1160 mm Z stroke

The robot part number follows the digit scheme:

- AAAA (four digits)
- BB (two digits)
- CCCCC (four digits)
- DD (two digit)
- E (one digit)
- FF (two digits)

Refer to the table below.

AAAA	
CODE	**PRODUCT**

PFC0	C-Series
	BB
CODE	**TYPE**
MA	Machine Assembly
	CCCCC
CODE	**TYPE**
PFC0	00050 = PreciseFlex c5
	DD
NUMBER	**AXIS SIZE**
04	400 mm Z Stroke
07	750 mm Z Stroke
12	1160 mm Z Stroke

Serial Number (S/N)

The second line of the label is the Serial Number (S/N), which describes the following properties.

S/N: C05-2506-3A-00001

Code	Description
C05	PreciseFlex c5
25	Two-digit year code (2025)
06	Two-digit month code (June)
3A	Major and minor revision code
00001	Sequential production number

The robot serial number follows the scheme:

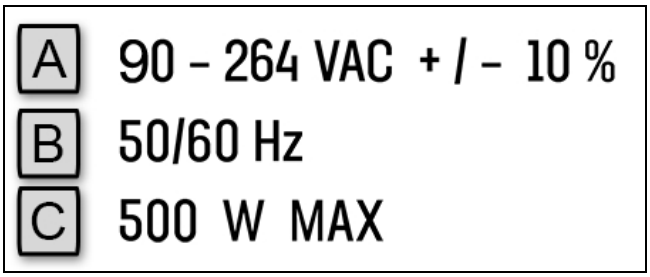
- AAA (four digits)
- BB (two digits)
- CC (two digits)
- E (one digit)

- F (one digit)
- GGGGG (five digits)

Refer to the table below to decode this scheme.

AAA	
CODE	**MODEL**
C05	C-Series
BB CC	
CODE	**MFG DATE CODE (START DATE)**
BB	Two-Digit Year Code
CC	Two-Digit Month Code
EF	
Code	**Rev Code**
E	Major Revision Code
F	Minor Revision Code
GGGGG	
G	Sequential Production Number

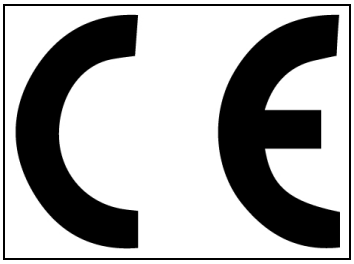
Robot Power Requirements



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

CE: Conformité Européenne (European Conformity)

The CE Marking affirms compliance with relevant EU legislation. See Standards Compliance and Agency Certifications for more information.



System Overview and Description

The PreciseFlex c5 robot is a 4-axis robot ideal for automating the handling of small parts and labware within the Medical Products, Semiconductor, Automotive, Laboratory Automation, and Electronics industries. It has a horizontal reach of 721 mm and a vertical (Z-axis) reach of 400, 750, or 1160 mm. The robot payload capacity is 5.0 kg. The robot includes an embedded controller, a 48 VDC motor power supply, and a 24 VDC logic power supply. Iit may include an optional electric gripper or solenoid valves to support pneumatic grippers.

The PreciseFlex c5 robot is quiet and smooth during operation, with excellent positioning repeatability. The horizontal axes (Joints 1, 3, and 4) are powered by direct drive motors with absolute encoders, while the Z-axis (Joint 2) is powered by a brushless DC motor with absolute encoder and belt drive.

The PreciseFlex c5 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, and Linear Rail options, which extend the robot reach by 1.0, 1.5, or 2.0 meters.

Based on the risk assessment and after evaluation of the application and payload, the robot speed should be configured and kept at safe levels. It is the integrator's and end user’s responsibilities to always perform a risk assessment of the final application.

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 with:
  - GP Flow, an intuitive no-code, point-and-click application builder
  - GPL, a powerful, full-featured object-oriented scripting language
- Ethernet-IP (PLC) mode, an Embedded Language mode

- PC Control mode, where the PC issues commands and requests status to/from the robot via the TSC API.

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 from Guidance Development Studio. During runtime, vision processes can be initiated from GP Flow, GPL, or TCS API.

Robot Release History

Beta release robots are designated by serial numbers C05-yymm-2A-zzzzz. They were released in 2024, and for customer feedback and evaluation.

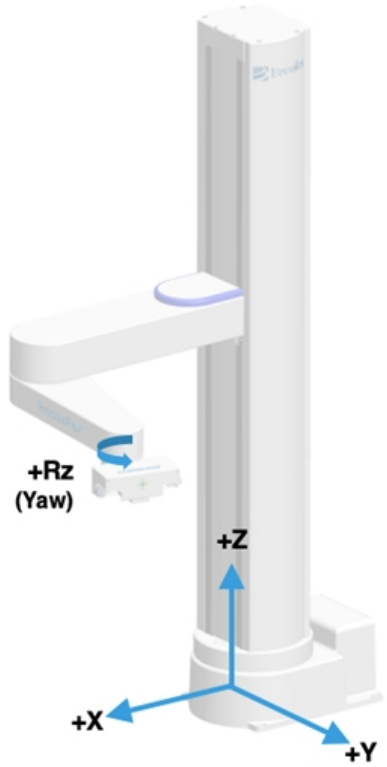
Production release robots are designated by Serial Numbers C05-yymm-3A-zzzzz. They will be released in the summer of 2025.

- yy = year
- mm = month
- # = robot major revision
- Y = robot minor revision
- zzzzz = unique number

Robot Coordinate Systems

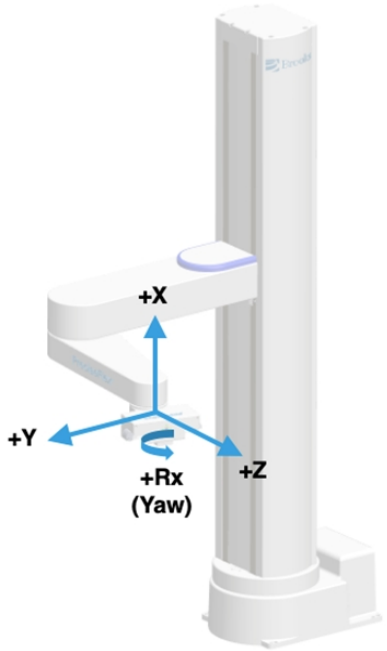
The robot operates using three coordinate systems: **World**, **Tool**, and **Joint**.

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



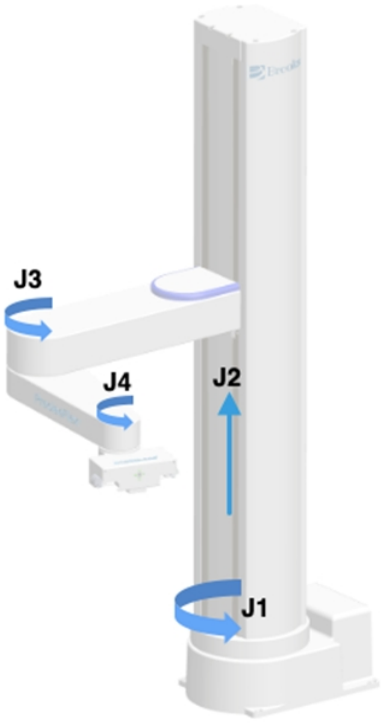
World coordinate system

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, Robot base	± 168 degrees
J2, Z-axis	400, 750, 1160 mm
J3, Elbow	10.5 to 349.5 degrees
J4, Wrist	±962

J1, Robot Base

The first axis (J1) rotates the robot column about the Z-axis. When the robot base is centered on its range of motion, the J1 axis is at its 0-degree joint angle. A positive change in the axis angle results in a positive rotation about the World Z-axis.

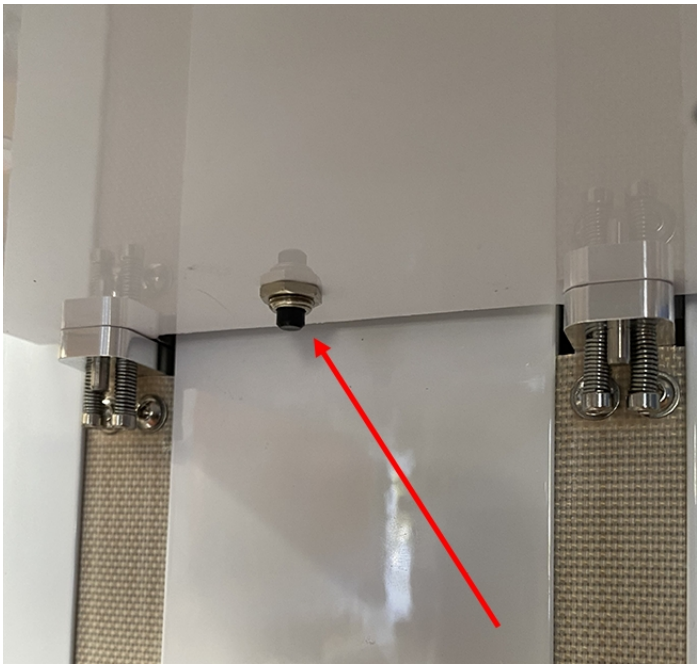
J2, Z-Axis

When the robot arm is at its lowest position, the Z-axis (J2) is at its 0 position in the Joint Coordinate system and in the World Coordinate system. As the robot arm moves upwards, both its joint position and the World Z Coordinate increase in value.

An LED light is mounted at the top of the inner link near the Z-axis column. It blinks once per second to indicate that the controller is operational and four times per second when power is being supplied to the motors. The RGB LED can be configured to use different colors to indicate modes of operation assigned by the end user.

Fail-Safe Brake

The Z-axis includes a fail-safe brake. This brake must be released to move the Z-axis up and down manually. There is a manual brake release button on the bottom of the inner link near the Z-axis.



Brake release button

Brake Release Switch

The PreciseFlex c5 robot is equipped with a brake release switch, located under the robot inner link. This switch is active when AC power is applied to the robot and the main power switch is ON. When a hard E-stop be triggered, the Z brake will engage, and motor power will be disconnected from all motors. As the J1, J3, and J4 axes on the PreciseFlex c5 do not have brakes, they may be freely pushed by the operator.

To release the Z brake, press the brake release button, while supporting the robot arm.

J3, Elbow

The J3 rotary axis (elbow) rotates the outer link around the J3 axis. 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-degree joint angle, however there is a hard stop at 10 degrees, so the link cannot reach the center position.

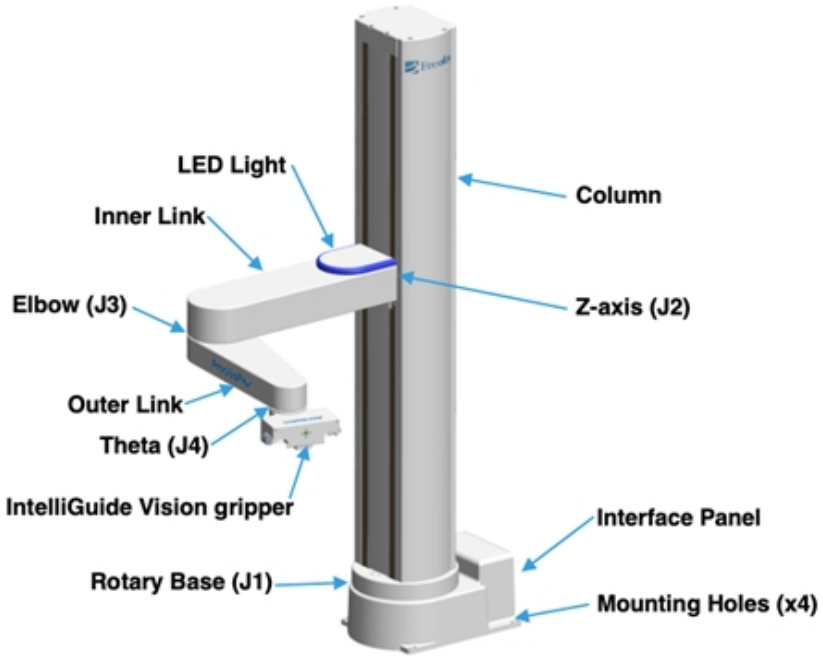
The outer link can rotate underneath the inner link, allowing the robot to change configuration from a "left hand" robot to a "right hand" robot without swinging the J3 axis (elbow) through the zero position. This allows the robot to work in compact workcells, and it minimizes the radius to the payload, therefore 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.

Pressing this button when 24 VDC power is on will release the Z-axis brake while the button is pressed. It is not necessary for the control system to be operating for the brake release to function. The only requirement is providing 24 VDC to the controller. Care should be taken to support the Z-axis when the brake release button is pushed, as the axis will fall due to gravity.

System Components



The PreciseFlex c5 has a maximum payload of 5 kg, without the gripper.

> ***NOTE:*** For optimal performance, the robot payload parameter should be set for the actual payload. Use GPL to set the Dynamic Feed Forward parameter 16071, or use the GPL “Robot.Payload” property. The payload can also be set using the browser interface (**Admin > Control Panels > Robot Payload**). This is important prior to entering Free Mode because a drastically incorrect payload can cause the Z-axis

gravity compensation to be incorrect and cause the Z-axis to start to move up or sag down until the velocity restrict safety limit cuts in to stop any excessive speed.

100% equals 5 kg for the gripper and payload mass. For lighter masses, this value should be reduced. Setting the payload correctly is important both for optimal dynamic performance of the robot and for proper gravity compensation, including “free” mode. For pick-and-place applications, the property `Robot.Payload` can be set by the application program to change the payload.

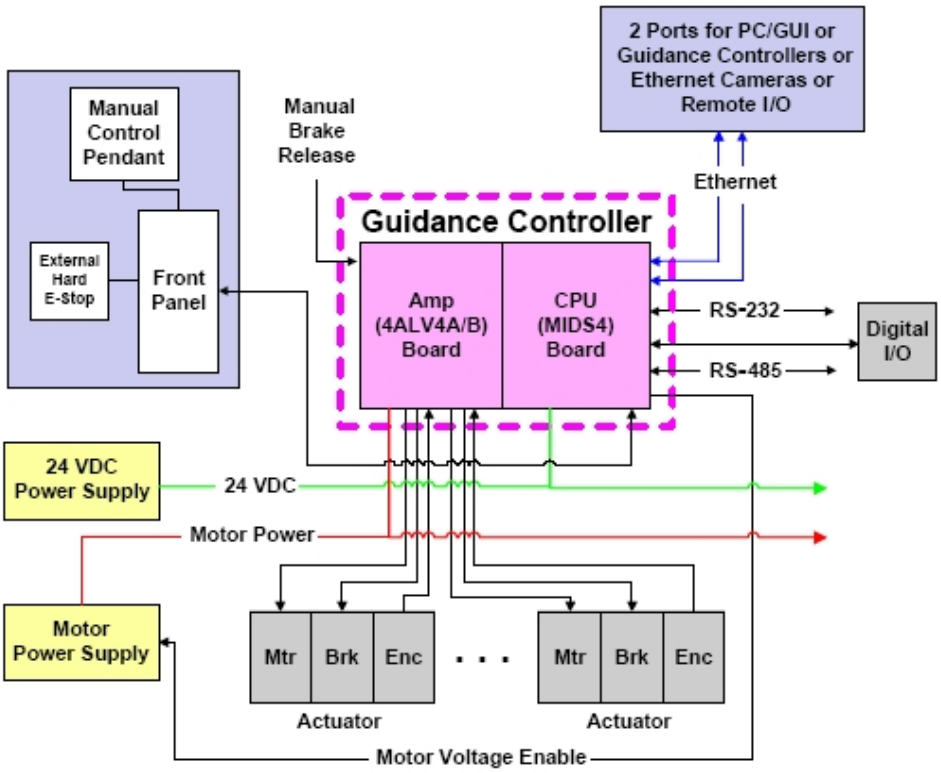
Also, it is important to set the correct tool X, Y, Z offset distance in mm in the first three values of parameter 16051, and tool Yaw, Pitch, and Roll in values 4-6 for the distance of the center of mass of the gripper and payload from the J4 axis of rotation.

For example, for a horizontal tool, if the center of a 2 kg mass is 150 mm from the center of rotation of axis 4 (the wrist), this parameter should be set to 0, 0,150, 0, 0, 0 for the Dynamic Feed Forward calculations to compute the correct feed forward motor torques and achieve optimal performance. For a vertical gripper with the same offset, this parameter should be 0, 0, 150, 0, 90, 0. The tool offset length must also be set in the Dynamic Feed Forward parameter 16068 value 6. The tool mass in kg must be set in parameter 16067 value 6 in order for the Dynamic Feed Forward to work properly.

NOTE: When setting the payload and gripper payload offset parameters in the database, these values must be entered and saved to flash, and the controller must be re-booted for them to take effect. See the software documentation about Parameters 16051, 16071, 16067, 16068, and the `Robot.Tool` and `Robot.Payload` properties for more a more detailed explanation.

The Robot Controller

The robot's controller is embedded into the robot base and the power supplies are embedded into the robot Z column. The controller and power supplies are shown in the system diagram below.



While most controller interface signals are exposed on the Facilities Panel at the robot base, there are times when it may be necessary to access either the robot's controller or its power supplies.

To access the robot controller, remove the cover on the inner link by removing (4) M3 X 20 SHCS from the bottom of the inner link.

See the *Guidance Controller* user manual for detailed information about hardware configuration and interfacing the controller using the various input and output ports such as those for digital I/O. Also, refer to the *Guidance Controller Quick Start Guide* for information on configuring the PC and instructions on operating the robot. Both manuals are available in PDF format and are also contained in the *PreciseFlex Library* on https://www.brooks.com/support/brooks-preciseflex-support/preciseflex-library/.

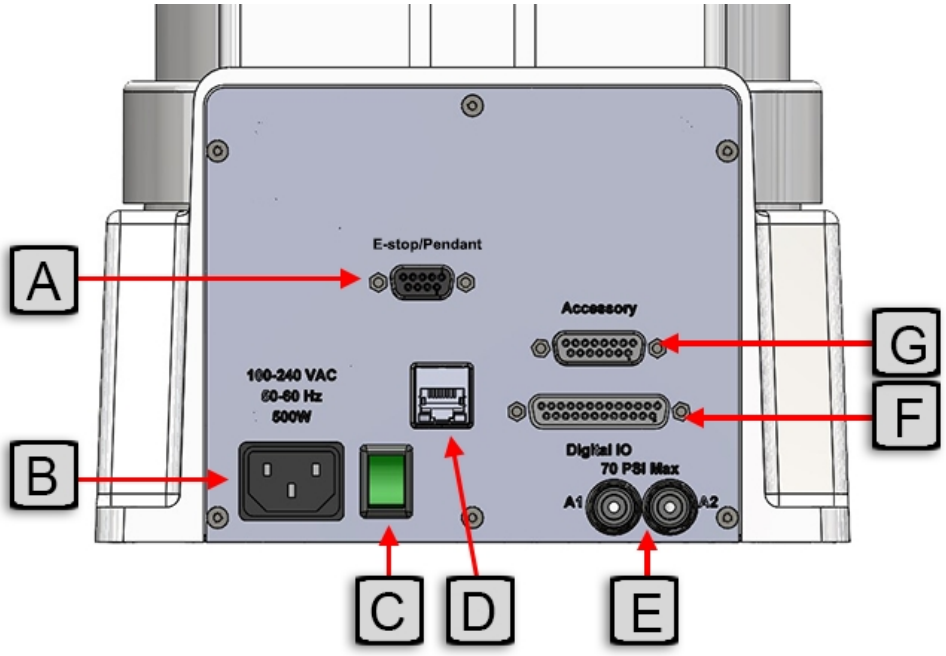
DANGER

High Voltage

To prevent exposure to high voltage levels, disconnect AC power before removing covers or servicing the robot.	

Facilities Panel

The Facilities Panel is located at the base of the robot.



Facilities Panel key

Annotation	Name	Description
A	E-stop/Pendant	9 Pin D-sub connector for external E-stop, RS-232 serial port.
B	Power Entry Module	For IEC plug. Contains dual fuse drawer. - 100-250 VAC - 50-60 Hz - 500 W
C	Power Switch	Lighted power switch
D	Ethernet Connector	For Ethernet-to-computer cable
E	Pneumatic Ports	A1 and A2 ports for attaching air lines for optional pneumatic gripper.
F	Digital I/O	25 pin D-sub connector for connecting external devices to the 12 Digital Inputs and 8 Digital Outputs.
G	Accessory	15 pin D-sub connector for optional accessories, including RS-232 and RS-485 communication.

If the pneumatic gripper option is ordered, two air lines are routed through the interior of the robot. These air lines are available in two fittings on the facilities panel. The other end of these lines exits at the outer link. When using these lines, provide clean, dry external air.

CAUTION **High Pressure Air**	
The maximum air pressure that can be conveyed by the air lines through the robot is 75 PSI. Applying a pressure exceeding this level may disconnect interior connections or damage fittings or hoses. If higher pressure is required, use an external air line.	

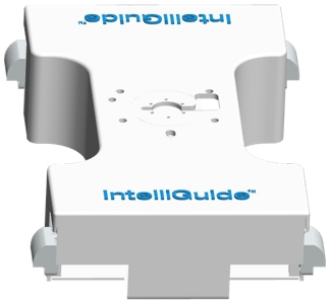
IntelliGuide Servo Grippers

The PreciseFlex c5 robot may be ordered with one of three optional IntelliGuide servo grippers.

- The IntelliGuide s23 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.
- The IntelliGuide s60 gripper has a stroke of 40 mm and gripping force of 60 N. The gripper is ideal for labware or small parts handling.
- The IntelliGuide s23D gripper has two independently actuated grippers with a stroke of 60 mm and gripping force of 23 N. With the dual configuration, the s23D gripper can increase throughput by carrying a plate (or other part) while removing another plate from an instrument or device.

IntelliGuide s23 (shown with gripper fingers)

IntelliGuide s60



IntelliGuide s23D

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 c5 robot may also be ordered with one of two optional IntelliGuide vision grippers. IntelliGuide vision grippers enable advanced functions like Auto-Teach, Clear-Check, and Barcode reading.

- The IntelliGuide v23 gripper has similar specifications as the IntelliGuide s23 gripper, in addition to two 5 MP cameras and an embedded PC.
- The IntelliGuide v60 gripper has similar specifications as the IntelliGuide s60 gripper, in addition to two 5 MP cameras and an embedded PC.

IntelliGuide v23
(shown with gripper fingers)

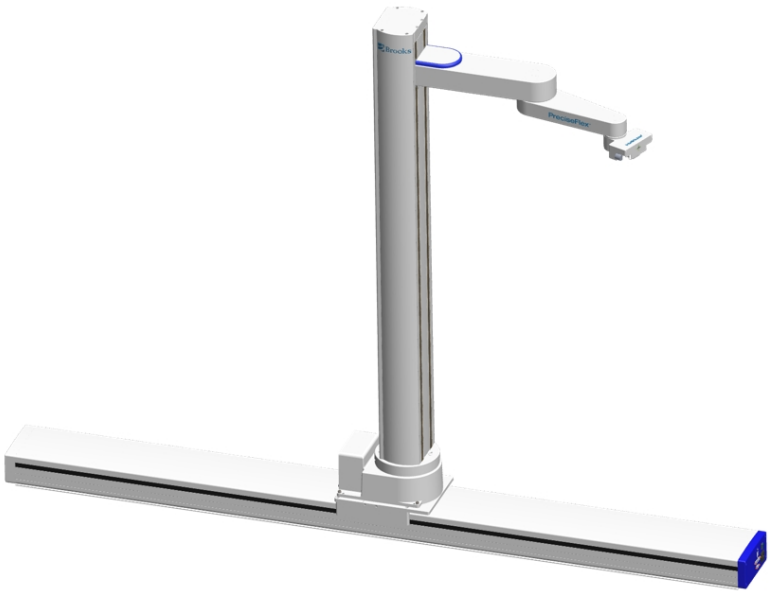
IntelliGuide v60

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 c5 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. The linear rail must be used in conjunction with a PreciseFlex robot and cannot operate as a standalone rail.



PreciseFlex c5 on Linear Rail (shown with optional IntelliGuide Vision Gripper)

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

> ***NOTE:*** Linear Rails for the PreciseFlex c5 Robot are different from linear rails used on earlier model robots: PreciseFlex 400 and PreciseFlex 3400. The blue end cap indicates the linear rail is compatible with c-series robots (PreciseFlex c5 and PreciseFlex c3).

Machine Safety

All robots and motion systems must be treated with respect by the user and the operator.

The PreciseFlex c5 robot is intended for use with other equipment and is considered a sub-assembly rather than a complete system. As of the publication date of this manual, the PreciseFlex c5 robot meets the requirements as stated below:

Standards Compliance and Agency Certifications

Standard	Description	Notes/Status
CAN/CSAC22.2 NO. 61010-1-12 +AMD1+(Third Edition) (R2022)	Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements	Complete

Standard	Description	Notes/Status
ANSI/UL 61010-1 3rd Edition (2012), AMD1:2018	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use- Part 1: General Requirements	Complete
CSAC22.2 No. 61010-2-081:19	Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-081: Particular Requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes - Third Edition	Complete
UL 61010-2-081, 3rd Edition (2019)	UL Standard for Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 2-081: Particular Requirements for Automatic and Semi-Automatic Laboratory Equipment for Analysis and Other Purposes - Third Edition	Complete
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	Complete
EN IEC 61326-1:2021	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	Complete
UL 1740	Standard for Robots and Robotic Equipment - Fourth Edition	Testing complete. Pending final report.
ISO 10218-1 2nd Edition, Dated July 1, 2011	Robots and robotic devices — Safety requirements for industrial robots —Part 1: Robots	Pending informative report.
IEC 60204-1, Edition 6.1	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	Pending informative report.

The robot must be installed and used in accordance with the above requirements and in accordance with the instructions in this user's guide. Additionally, it is the system integrator and end user responsibility to perform a task-based risk assessment per ISO-12100:2012, *Safety of machinery - General principles for design - Risk assessment and risk reduction*.

Voltage and Power Considerations

The PreciseFlex c5 robot has an input voltage range of 100 to 240 VAC, +/- 10%, 50/60 Hz. The robot contains two DC power supplies, a 24 VDC power supply for the processor and user I/O and a 48 VDC motor power supply.

DANGER **Electrical Shock**	
To prevent exposure to high voltage levels, disconnect AC power before removing covers or servicing the robot.	

The PreciseFlex c5 robot consumes less than 500 Watts during normal operation. The peak power under maximum load and acceleration can reach 500 W for a few seconds, but typical RMS power for most applications is less than 200 W RMS. With the motor power turned off, the controller consumes about 20 Watts. With the motor power on and the Z brake released, the robot consumes about 80 Watts. The robot running at 60% speed consumes about 150 Watts. These numbers may be useful when mounting this robot on mobile platforms.

The PreciseFlex controller can monitor motor power through its datalogging function. Intermittent power dropouts can be detected by setting a trigger in the data logger which can record and time-stamp power fluctuations.

Mechanical and Software Limit Stops

Joints 1, 2, and 3 have hard-limit stops at the end of travel that are factory installed. The soft-limit stops must be set within the range of these hard stops.

The wrist axis, J4, in the PreciseFlex c5 has a slip ring when the IntelliGuide gripper is installed, allowing +/- 298 degrees rotation. Since the robot has absolute encoders with battery backup, even if the robot is turned off, the encoders keep track of joint position. The joint position can be viewed either on the optional Manual Control Pendant or in the Virtual Manual Control Pendant in Guidance Development Studio (GDS). See Chapter 4, "Operation," of the *Guidance Controller Setup and Operation, Quick Start Guide* on https://www.brooks.com/support/brooks-preciseflex-support/motion-control/ for more information.

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 robot joints 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.

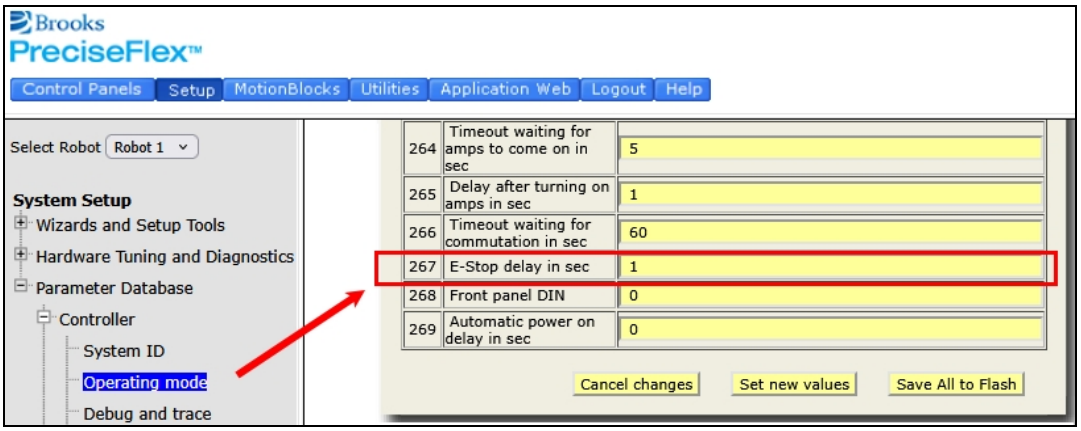
This function is similar to a hard E-stop except that soft E-stop leaves high power enabled to the amplifiers and is therefore used for less severe error conditions. Leaving power enabled is beneficial in that it prevents the robot axes from sagging and does not require high power to be manually re-enabled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

If set, the `SoftEStop` property is automatically cleared by the system if High Power is disabled and re-enabled.

Hard E-stop

A hard E-stop is generated when an external E-stop circuit is opened and causes motor power to be disabled. 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. The default delay is set to 1.0 seconds. It can be adjusted by an operator with administrator privileges.

On the browser operator interface menu, 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 motor power will be disabled within 1 ms.



For the PreciseFlex c5 robot, joint 1 (base), joint 2 (elbow), and J4 (theta) do not have mechanical brakes. Leaving the motor power enabled for 1.0 sec allows the servos to decelerate the robot. The servos are set to decelerate the robot at 0.015 G or 1500 degrees/sec2. If the robot is moving at a joint speed of 100 degrees/sec, the distance traveled will be about 30° to reach a full stop, and the time will be 0.66 sec. These settings provide a smooth deceleration and stop with full payload. If a

faster deceleration is desired, email support_preciseflex@brooksautomation.com for directions to increase the deceleration setting for E-stop.

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 c5 robot for operation.

1. Unpack the PreciseFlex robot. (See Unpacking and Mounting the Robot)
2. Add or remove a gripper (optional). (See IntelliGuide Gripper and Finger Mounting .)
3. Connect the power.
4. Connect the PreciseFlex robot to a PC or tablet, open the browser interface, and run the robot. (See Operation.)

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.

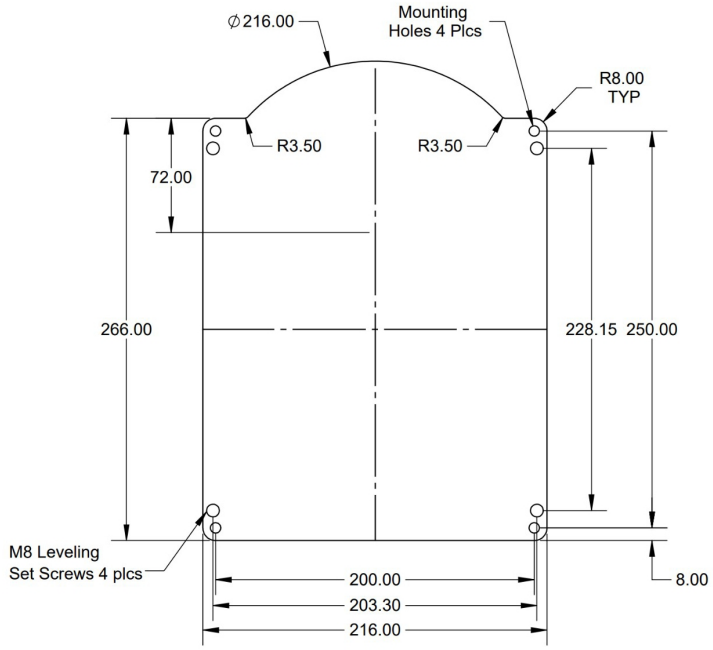
The robots weigh 25 kg or more, so two persons should move the robot to the installation location.

CAUTION

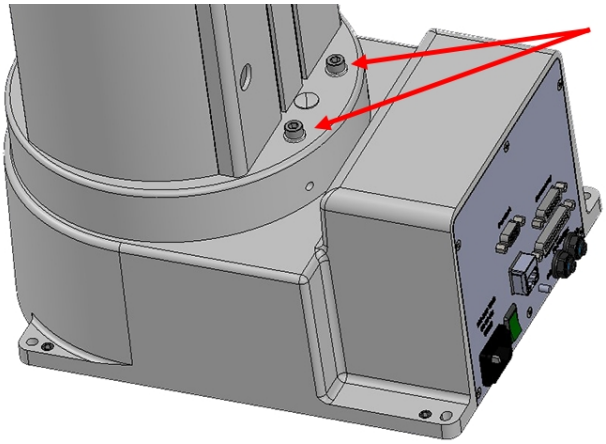
Heavy Lift Hazard

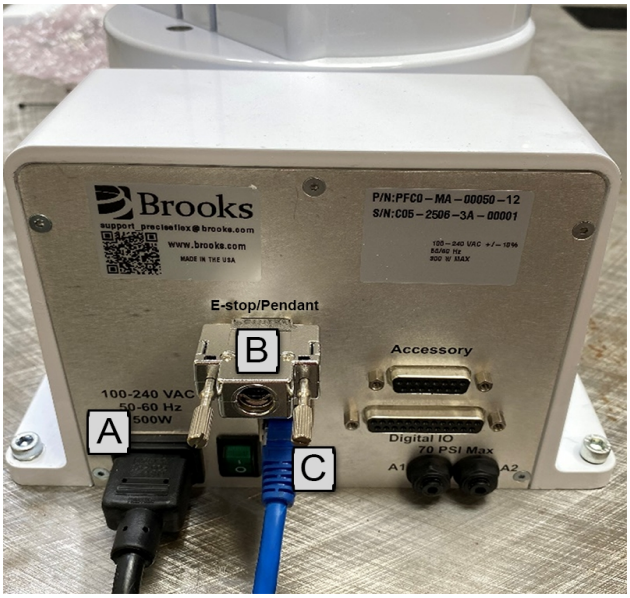
Failure to take proper precautions before moving the robot could result in back injury and muscle strain.

- 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.	Unlatch the crate latches on all four sides of the crate, and remove the crate top. 

Step	Action
3.	Using two people or more, lift the robot out of the crate, remove the plastic wrapping, and carry the robot to the installation location. 

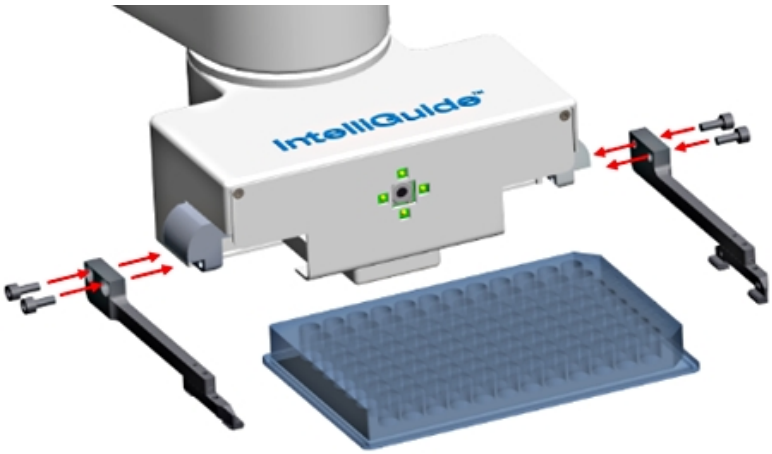
Step	Action
4.	Set the robot on the mounting surface and secure it with the four M6 screws and Nylon washers. Keep the robot supported until it is secured to the mounting surface. There are four M8 leveling set screws on the robot base that can be used to level the robot on the mounting surface as necessary. 
5.	After the robot is securely mounted, remove the two anti-rotation M6-45 SHCS and two M6 Nylon washers. Retain these screws in case the robot is shipped to a different location in the future. ***NOTE:*** *Remove the screws before operating the robot. Always install the screws before lifting and moving the robot* 

Step	Action
6.	Plug in the: • Power cable (A) • E-stop button/switch (B) • Ethernet cable (C) 
7.	Remove the Velcro strap that restrains 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.

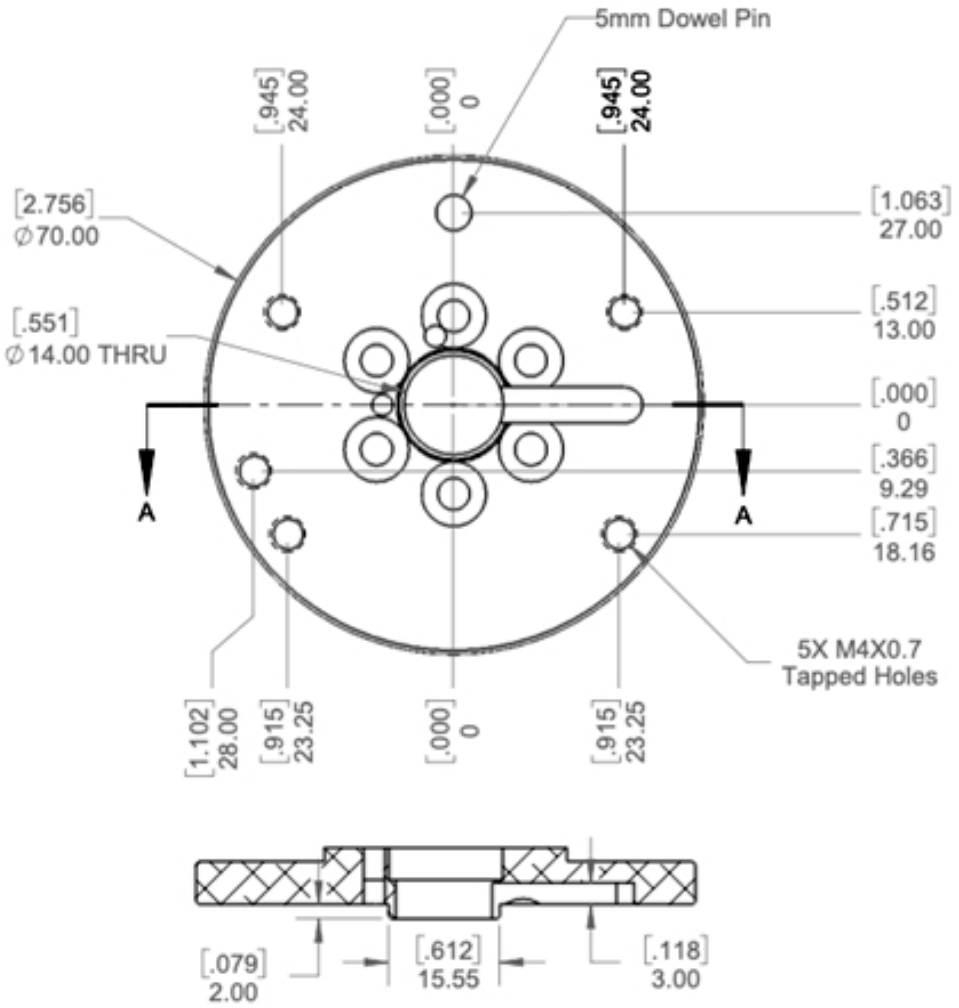


Gripper Adapter Flange for End-of-Arm Tooling

The Gripper Adapter is used to attach grippers to the PreciseFlex x5 robot. Grippers are attached with 4 M4 screws and oriented with an M5 dowel pin.

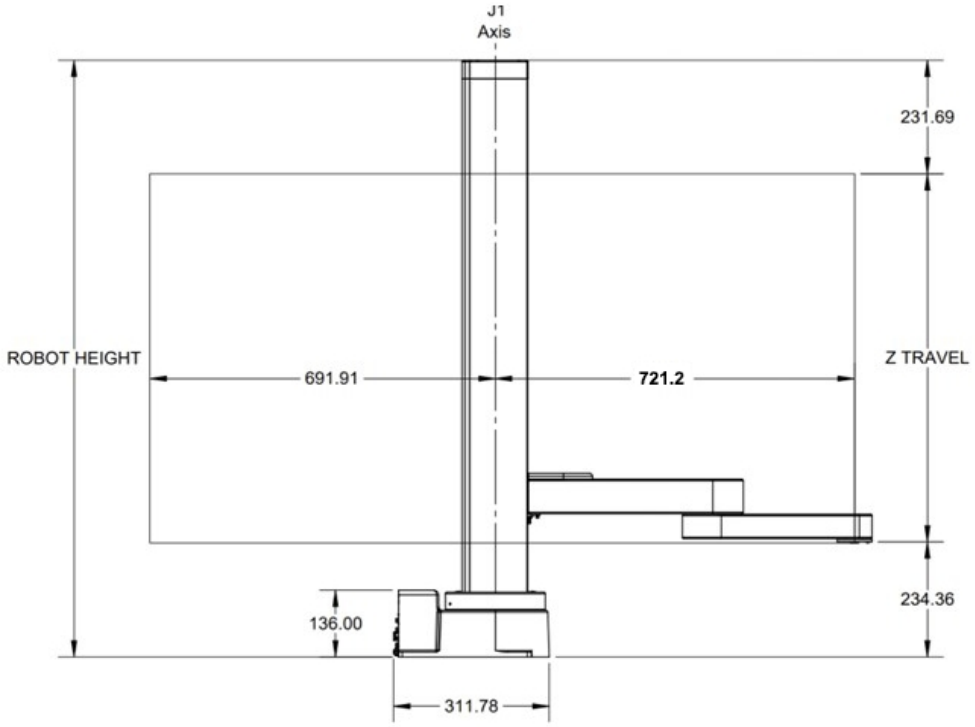
NOTE: This adaptor is not an ISO standard flange.

Dimensions in the graphic below are in mm and inches (inches are displayed in square brackets [ ]). Note the 5 mm dowel pin pressed into the flange



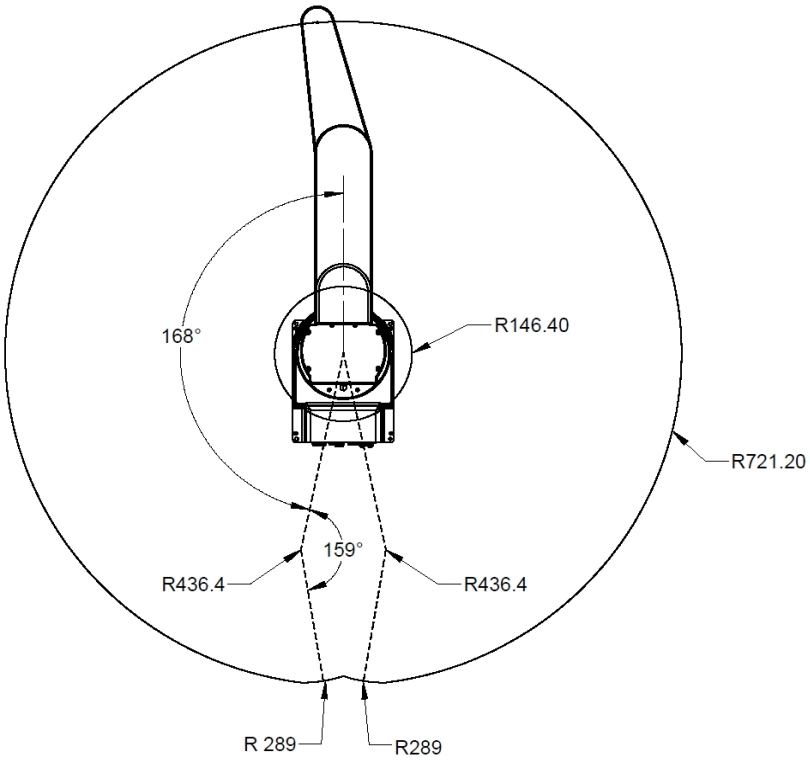
PreciseFlex c5, gripper adapter flange

PreciseFlex c5 Robot Dimensions and Work Envelope

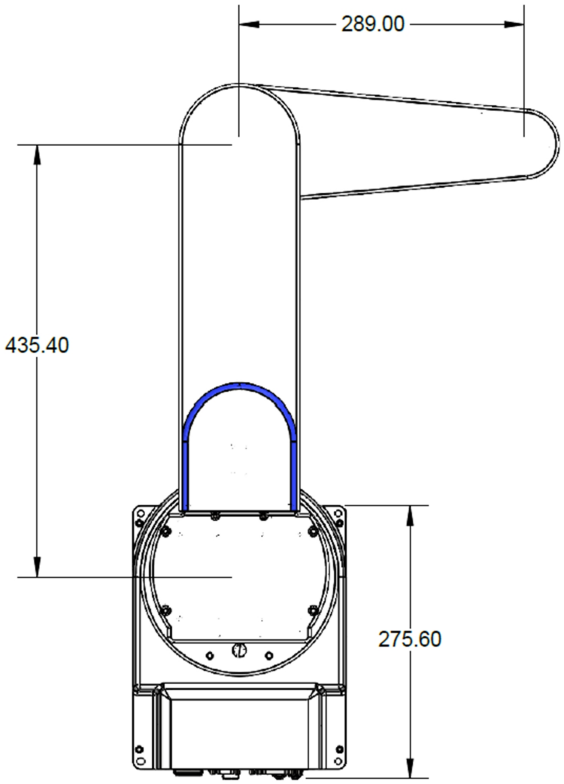


Work envelope, side view

Z Travel	Robot Height
400 mm	866.05 mm
750 mm	1216.05 mm
1160 mm	1626.05 mm



Work envelope, top view



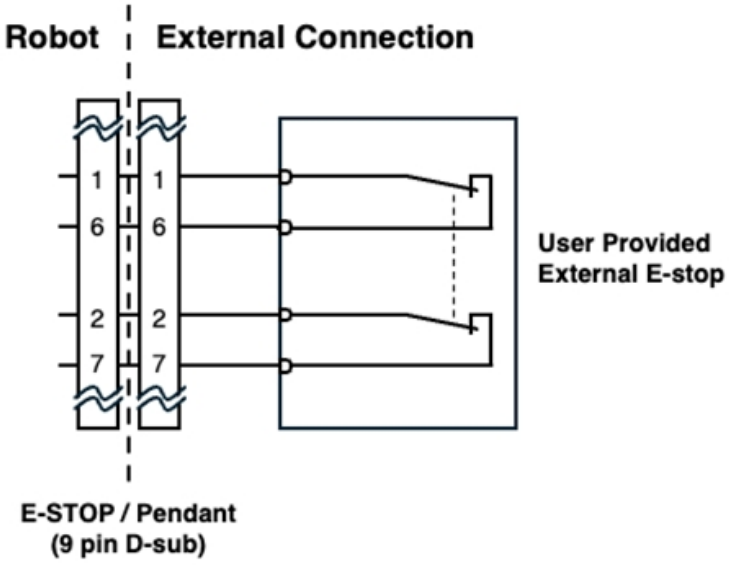
Arm length, top view

External Emergency Stop (E-stop)

The PreciseFlex c5 robot has a dual-channel E-stop input on the 9-pin D-sub connector. This facilitates a normally closed (NO) external E-stop connection, when open, stops the robot and disables robot power.

An external E-stop can be connected in 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 must complete a circuit from Pin 1 (E-stop 1) to Pin 6 (FE Out 1) and from Pin 2 (E-stop 2) to Pin 7 (FE Out2) in this connector . 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 CAT3 startup sequence to make sure both circuits are working.

If no E-stop box or Manual Control Pendant is connected, jumpers must be connected between these four pins to enable robot motor power. 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 mounted on the robot's Facilities Panel in the base of the robot.

The robot is shipped with a jumper plug in the nine-pin D-sub connector 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.

This button may be wired in series with other emergency stop contacts. The E-stop signals are available in the 9 pin D-sub E-stop connector and the manual control pendant 9-pin D-sub connector mounted on the Facilities Panel.

Pinouts and Descriptions

Pin	Description
1	E-stop_L1
2	E-stop_L2
3	RS-232 RXD (Com 2)
4	24 VDC
5	NC
6	FORCE E-stop_L1 (toggles E-stop low at start up, then high)
7	FORCE E-stop_L2 (toggles E-stop low at start up, then high)
8	RS-232 (Com2)
9	Ground
Interface panel connector part no	DB9 Female Connector AMP 5747150-7
User plug part no	DB9 Male Plug Amp 1658655-1 (crimp) Pins 22-26AWG 745254-6

Digital Input and Output Signals

Digital Input and Output Signals at the Robot Base

There are twelve general-purpose, optically isolated digital input signals and eight digital output signals available at the robot base on the 25 pin D-sub connector.

The **inputs** are configured as sinking from the factory and can be changed in blocks of four by means of software configuration. Set Data ID 531 "DIN sink mode 1-4, 5-8, 9-12" to configure source vs. sink for digital input groups. 0 means sourcing, 1 means sinking.

The **outputs** are configured as sinking from the factory and can be changed individually by means of software configuration. Set Data ID 530 "DOUT sink mode 1, 2, 3, 4, 5, 6, 7, 8" to configure source vs. sink for digital outputs. 0 means sourcing, 1 means sinking.

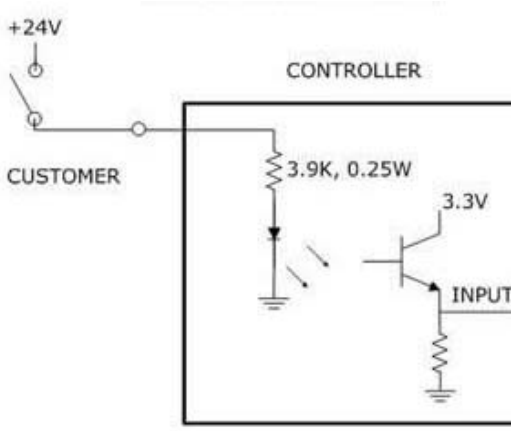
Digital Input Sourcing Versus Sinking

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

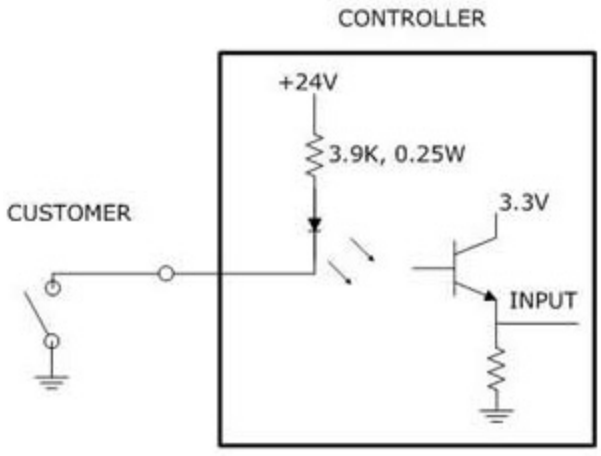
ground (0V). When the input device is activated, it “sources” current into the input. This configuration is common in Europe and with PNP sensors.

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.



Sinking digital input



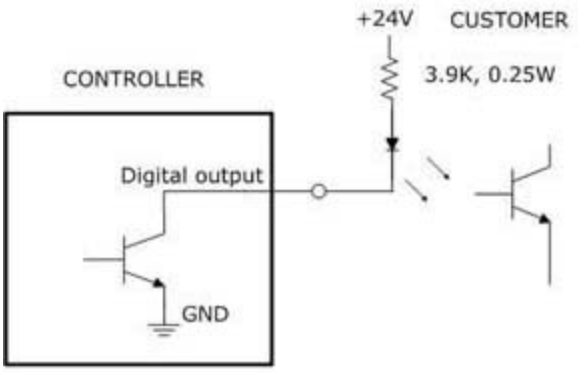
Sourcing digital input

Digital Output Sourcing Versus Sinking

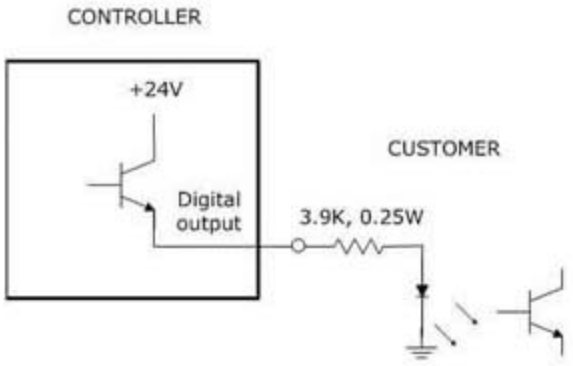
For Sourcing Output (PNP Logic), the robot controller output terminal provides positive voltage to the load. The load is connected between the output terminal and ground (0V). When the output is ON, current flows from the robot controller to the load. This configuration is suitable for loads that expect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

For Sinking Output (NPN Logic), the robot controller output terminal connects the load to ground (0V). The load is connected between positive voltage and the output terminal. When the output is ON, current flows from the load into the robot controller. This configuration is suitable for loads that expect a grounded return path.

Sourcing outputs supply current to the load; sinking outputs provide a path for current to return to ground.

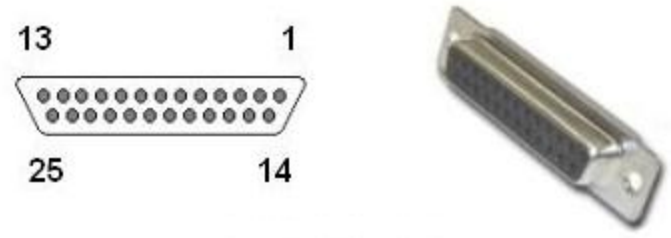


Sinking digital output



Sourcing digital output

The pinout for the PreciseFlex c5 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 IO 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	10009	Digital Input 9
7	10011	Digital Input 11
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	10010	Digital Input 10
20	10012	Digital Input 12
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

Digital Input and Output Signals at the Robot Outer Link

When no IntelliGuide gripper is installed on the robot, there are 3 digital input and 3 digital output signals available at the outer link in the GSB4. These I/O signals are optically isolated.

The digital input signals are configured as "sinking." That is, the external equipment must provide a 5 VDC to 24 VDC voltage to indicate a logical high value or must allow it to float to no voltage for a logical low. For convenience, the 8-pin connector supplies 24 VDC. These inputs are compatible with "sourcing" (PNP) sensors.

The digital output signals are configured as "sourcing." That is, the external equipment must pull-down an output pin to ground, and the GSB pulls this pin to 24 VDC when the signal is asserted as true. Each output signal can supply a maximum of 100 mA. For convenience, a ground pin is supplied in the 8-pin connector. These outputs are compatible with "sinking" (NPN) devices.

If a gripper is installed, a GSB4 is added to the system, and the available I/Os related to this GSB are described above. GSB4 will still have listed the above number of I/Os.

If an IntelliGuide s23, s60, or s23D gripper is installed, users have access to one digital input and one digital output at the gripper GSB.

If an IntelliGuide v23 or v60 gripper is installed, there are **no** digital input or output signals available at the gripper GSB.

See the *GSB* user manual on https://www.brooks.com/support/brooks-preciseflex-support/motion-control/ for details.

Accessory Connector

The accessory D-sub connector provides access to the RS-232 serial port, external encoder, and OSSD signals.

Fifteen-Pin D-Sub Signals

Pin	Description
1	24 VDC
2	48 VDC
3	Ground
4	RS-232 TXD (Com1)
5	OSSD1 (Output Signal Switching Device for Safety Devices)
6	RS-485+
7	A+ (Belt)
8	B+ (Belt)
9	48-VDC
10	Ground
11	RS-232 RXD (Com1)
12	OSSD2 (Output Signal Switching Device for Safety Devices)
13	RS-485
14	A- (Belt)

Pin	Description
15	B- (Belt)
Interface Panel Connector Part No	DB15 Female Connector AMP 5747299-7
User Plug Part No	DB15 Male Plug Amp 1658656-1 (crimp) Pins 22-26AWG 745254-6

RS-232 Serial Interface

The PreciseFlex c5 robot includes a standard RS-232 serial line equipped with hardware or software flow control.

RS-232 Serial Interface at the Base of the Robot

This port is available on the 15-pin D-sub connector on the connector panel in the base of the robot as COM1. This port can be used to communicate to the system serial console or can be connected to external equipment for general communication purposes. Equipped with hardware or software flow control, this port is referenced as device "/dev/com1" within the Guidance Programming Language (GPL).

RS-232 Serial Interface at the Robot Outer Link

The PreciseFlex robot includes a standard RS-232 serial port. This serial port is accessed from the GSB4 board mounted inside the robot outer link. This serial port can be used to communicate to the system serial console or can be connected to external devices such as a barcode reader or other device for general communication purposes.

To connect to the serial port, see the *GSB* user manual on https://www.brooks.com/support/brooks-preciseflex-support/motion-control/ for more details.

When used for general communications, this port is referenced as device "/dev/com1" within the Guidance Programming Language (GPL).

Ethernet Interface

The PreciseFlex c5 robot includes an Ethernet switch that implements two 10/100 Mb Ethernet ports. This capability was designed to permit the controller to be interfaced to multiple Ethernet devices such as other PreciseFlex controllers or robots and remote I/O units. 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 any other Ethernet device.

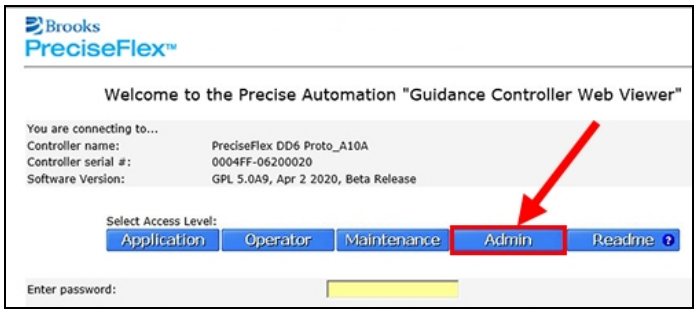
Due to limited space on the Facilities Panel, only one of the two Ethernet ports is available via an external RJ-45 connector. This external Ethernet port is typically used to interface the robot to a PC. In this case, a PC that is connected to the Ethernet plug on the Facilities Panel can communicate with the robot's controller.

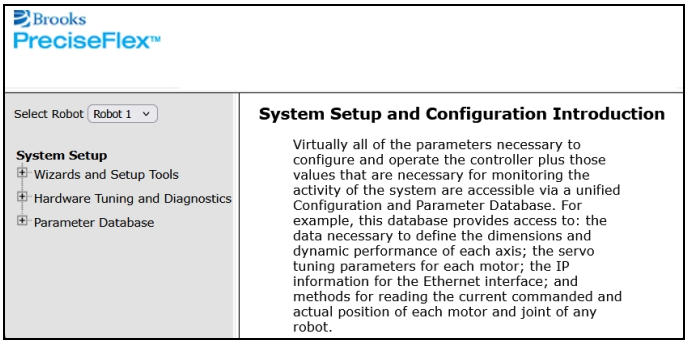
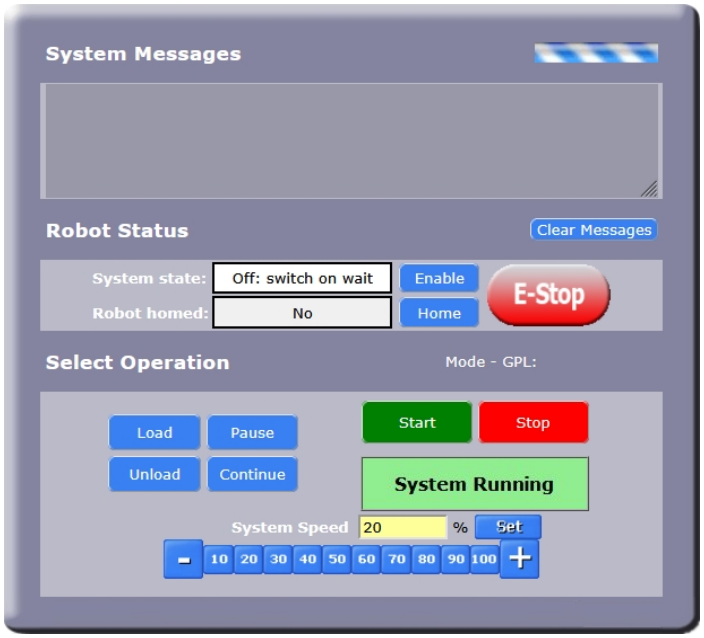
See the *Guidance Controller Setup and Operation Quick Start Guide* on https://www.brooks.com/support/brooks-preciseflex-support/motion-control/ for instructions on setting the IP address for the controller.

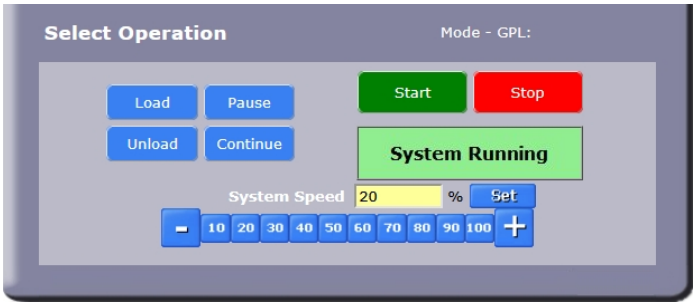
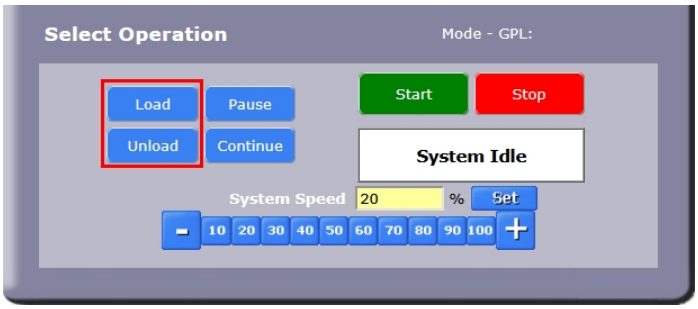
4. Operation

Browser Interface

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

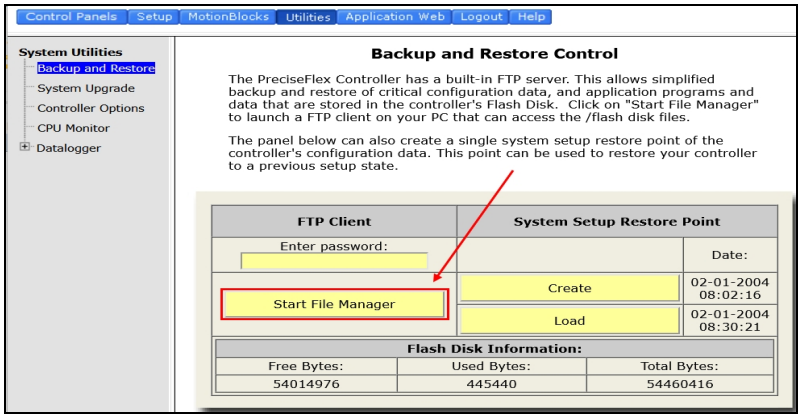
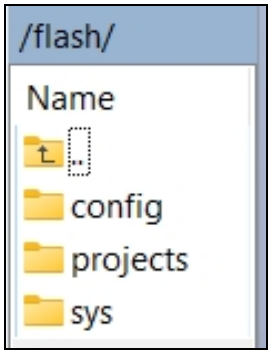
Step	Action
1.	Open a browser in a device connected to the robot via Ethernet. You must know the IP address of the robot controller. Two common IP addresses are 192.168.0.1 and 192.168.0.10. Configure the PC LAN interface address (for example 192.168.0.100, with subnet mask 255.255.255.0). The interface will display. Click **Admin** . ***NOTE:*** *Enter a password if a company has protected access to the browser interface.* 

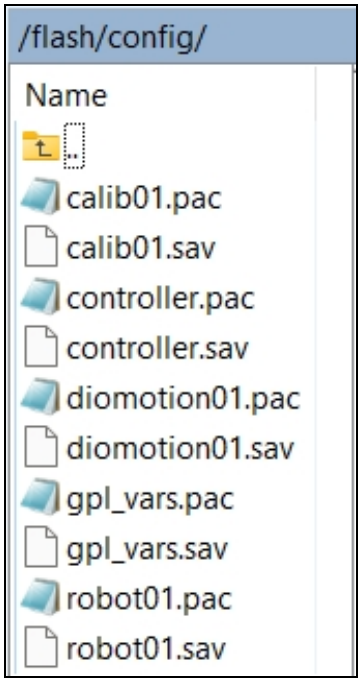
Step	Action
2.	After clicking, **Admin**, the *System Setup* window will display. 
3.	Click the **Control Panels button** in the top bar. In the left navigation column, click **Operator Control Panel** to display the *Operator Control Panel*. 

Step	Action
4.	If an application is running, *System Running* will display in green. In order 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. 

Updating Robot Configuration (PAC) Files

Perform the following procedure.

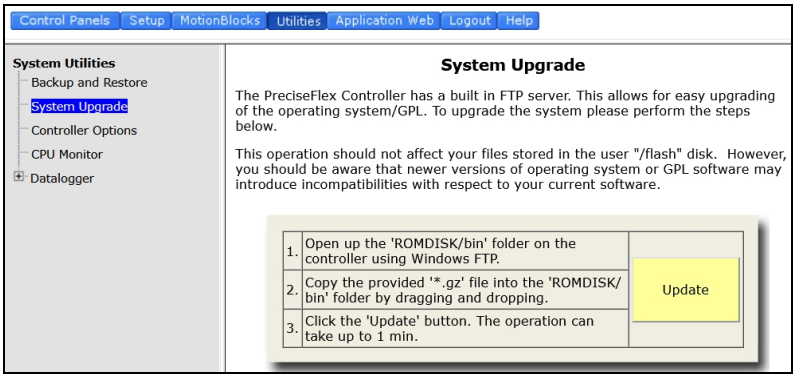
Step	Action
1.	In the browser interface, click **Admin > Utilities > System Utilities > Backup and Restore**. In the *Backup and Restore Control* window, click **Start File Manager** to open an FTP client. 
2.	In the FTP client, open the *config* folder. 

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. 

Updating Updating Firmware and Operating System

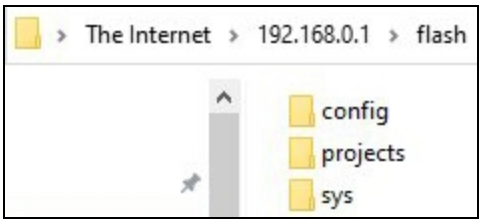
GPL (the system software and firmware are now a single file in GPL 5.0 and later) may be upgraded in the field. To update GPL (system software and firmware), complete the following steps:

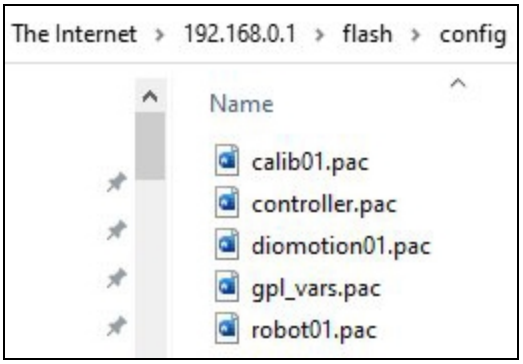
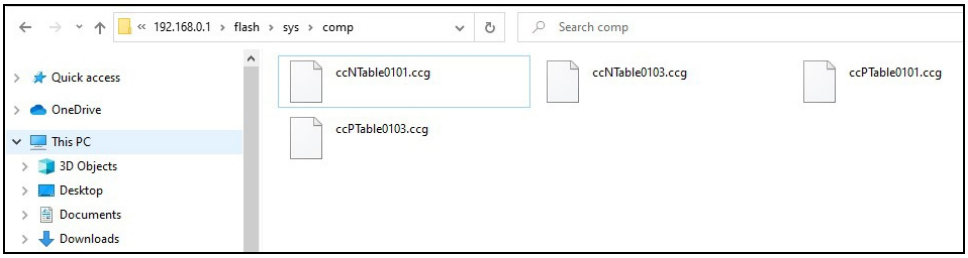
Step	Action
1.	Get the appropriate upgrade software from Brook in the form of a .gz file. Email support_preciseflex@brooksautomation.com.
2.	Use the Windows File Explorer to access the ROMDISK GPL storage area directly. Type **ftp://192.168.0.1/ROMDISK/bin** in the File Explorer address line. 

Step	Action
3.	Paste the new GPL system file into this folder.
4.	1. In the Browser Interface, click **Admin > Utilities > System Utilities > System Upgrade**. 2. Click **Update** and follow the instructions. 

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: 

Step	Action
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. 
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. 

TCS API

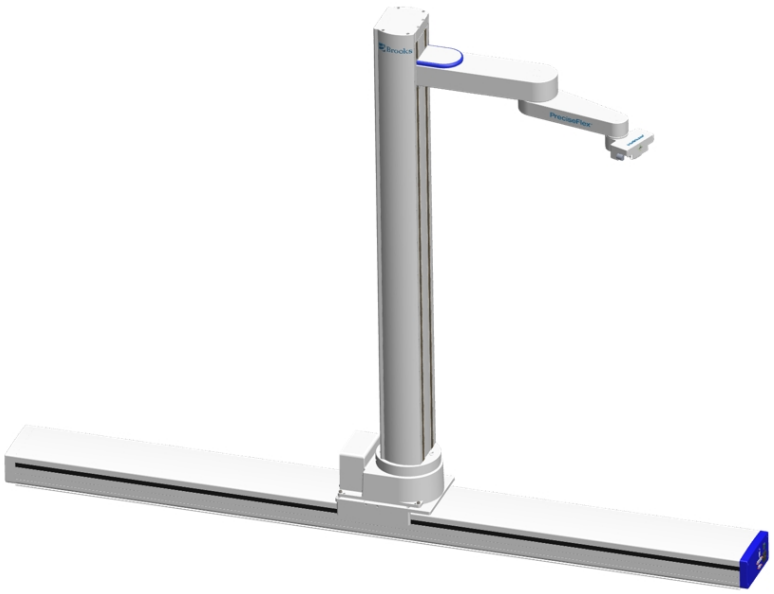
The TCS (TCP Command Server) API is a method of controlling PreciseFlex robots from a PC. The TCS API is open source and can be used to send discrete commands to the robot and request

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 c5 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@brooksautomation.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.



Appendices

Appendix A: Specifications

PreciseFlex c5 Robot, General Specifications

General Specification	Range
PERFORMANCE	
Payload (without gripper)	Max: 5.0 kg Rated: 3.0 kg
Max Speed at TCP	Horizontal: 1500 mm/sec Vertical: 600 mm/sec
Typical Speed at TCP	Horizontal: 750 - 1000 mm/sec
Max Joint Speed	J1 - 200°/sec J2 - 600 mm/sec J3 - 360°/sec J4 - 360°/sec
Max Acceleration	1500 mm/sec^2
Repeatability	± 0.050 mm at tool flange center
RANGE OF MOTION	
Joint 1 (base)	± 168°
Joint 2 (Z-axis)	400, 750, 1160 mm
Joint 3 (Elbow)	+10.5° to +349.5°
Joint 4	±962°
Horizontal Reach	719 mm to Tool Center Point (TCP) IntelliGuide grippers add 68.7 mm
COMMUNICATIONS	
General	100 Mb Ethernet, TCP/IP EtherNet/IP Modbus/TCP RS-232 at end-of-arm
Operator Interface	Browser-based operator interface
Digital I/O	12 inputs at 24 V 8 outputs (100 mA) at 24 V Remote I/O available
FACILITIES	

General Specification	Range
Power	100-264 VAC, auto selecting, 50-60 Hz 100-175 watts typical operation DC power option available
Pneumatics	Two 3.2 mm OD (1.7 mm ID) airlines provided for end-of-arm-tooling. 4.9 bar max (71 PSI)
E-stop	Dual channel
Controller Type	Embedded into robot base
Weight – w/o Gripper (does not include packaging)	400 mm Z-axis: 28.8 kg 750 mm Z-axis: 34.5 kg 1160 mm Z-axis: 41.9 kg
Noise Level	< 50 dB(A)
SOFTWARE	
Programming	• *GP Flow* for no-code, point-and-click application builder • *TCS API* for controlling robot from work flow, scheduling software • *GPL (Guidance Programming Language)*: full-featured object-oriented programming language. • Programming via *Guidance Development Studio (GDS)*
Enhanced Functions	Hand-guided teaching
PERIPHERALS AND ACCESSORIES	
General	IntelliGuide s23 gripper IntelliGuide s60 gripper IntelliGuide s23D gripper (Dual) Remote I/O (RIO)
Vision	IntelliGuide v23 Vision IntelliGuide v60 Vision
Linear Rail	1.0, 1.5, and 2.0 meters travel (optional)

Environmental Specifications

The PreciseFlex c5 robot must be installed in a non-condensing environment with the specifications from the table below. Tape seals for the vertical column are included and provide some protection for environments where fluid or particles may splash against the robot. For applications where the connector panel in the base may be exposed to conductive particles or fluid, it is recommended a panel cover splash hood be added to protect the connectors.

With tape seals and a connector hood the robot is rated at IP52. Without these features the robot is rated at IP11. This robot is not intended for use in a washdown or heavy spray environment.

General Specification	Range & Features
Indoor use only	
Ambient temperature	0º C to 40º C
Storage and shipment temperature	-25º C to +55º C
Humidity range	10 to 75%, non-condensing
Altitude	Up to 3000 m
Voltage	100-240 VAC ± 10%, 50/60 Hz
Mains cord rating, min	16 AWG, 3 conductor, 10 Amps min
Pollution degree	2
Approved cleaning agents	IPA, 70% Ethanol/30% water, H_2O_2 Vapor up to 1000 ppm
IP rating with tape seal option	52
IP rating without tape seal option	11
IK impact rating	IK08: 5 Joule

Appendix B: Spare Parts List

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

Description	Part Number
Absolute encoder battery, 3.6 V lithium battery	G1S0-EC-X0007
Belt, Z, 400 mm	PF00-MC-X0023-7
Belt, Z, 750 mm	PF00-MC-X0023-8
Belt, Z, 1160 mm	PF00-MC-X0023-9
Cable, brake release 1600 mm extension, PFD0	389630-0001
Cable, DC Interconnect, PFD0	622725
Cable, J5 to J6, PFD0	622724
Cable, J3 Clockspring, PFD0	622726
Cable, signal and DC power, base, PFD0	621475
Controller, DD robot, PreciseFlex D0X3 W/RMII	890242-0001
Energy dump resistor, PFD0	389641
GSB4X 28.57 A	589629-0001
GSB4 10 A	389629-0005
J1 Timken encoder, 8-pin PFD0X	621306
J3 Timken encoder, 8-pin PFD0X , 150 mm	621306-0001
Power supply, 24 VDC 150 W	PS10-EP-24150
Power supply, 48 VDC, 500 W, 56 V minimum OVP	605889
Slip ring harness, IntelliGuide s23 and s23D	397515
Slip ring harness, IntelliGuide s23 and s23D	627487
Slip ring harness for IntelliGuide s60 gripper	627540
Slip ring harness for IntelliGuide s60 gripper, MOOG 18 wire	PF04-MA-00030-E2
Slip ring harness for IntelliGuide v23 gripper	627468
Slip ring harness for IntelliGuide v60 gripper	627235
Solenoid valve for PreciseFlex 400 pneumatic gripper	PF05-MC-X0001
Tape, 400 mm travel	629984-0001
Tape, 750 mm travel	629984-0002
Tape, 1160 mm travel	629984-0003
Z-Axis Motor	628854

Appendix C: Preventive Maintenance

Every one to two years, the following preventive maintenance procedures should be performed. For robots that are continuously moving 24 hours per day, 7 days a week at moderate to high speeds, a one-year schedule is recommended. For robots with low duty cycles and low to moderate speeds, these procedures should be performed at least once every two years.

Refer to the *PreciseFlex c5 Robot Service Manual* for detailed procedures.

	Procedure If Problem Detected
Check Z-axis belt tension.	Re-tension if necessary.
Check air harness tubing in elbow if present, and theta axis for any wear.	Replace if necessary.
Check Z-axis belt for squeaking.	If noisy, add thick grease to front and rear edge of 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.
Replace slip ring in PreciseFlex c5 if present.	For robot IntelliGuide Grippers, replace the slip ring every third inspection test or 20,000 hours of operation.

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.

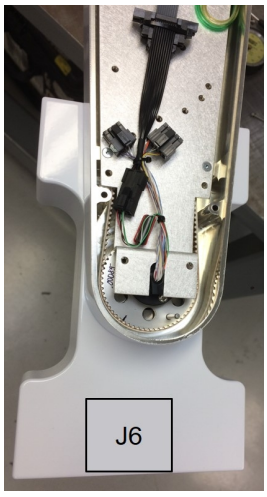
Cal_PP is supplied on the *Guidance Controller System Software CD*. To run Cal_PP, the controller must be configured to run GPL programs and Cal_PP must be loaded into the controller's memory (See Preventive Maintenance).

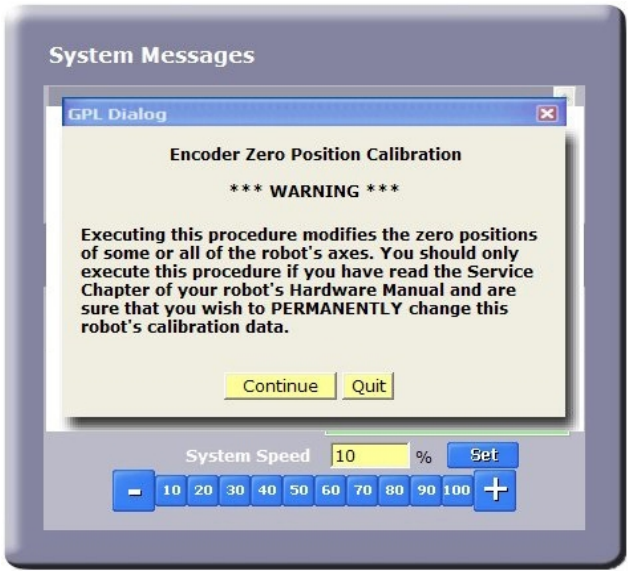
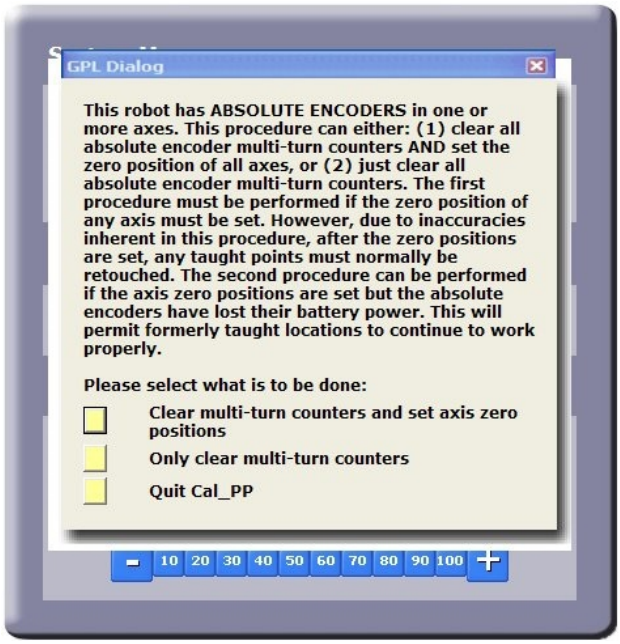
Tools Required:

- 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.

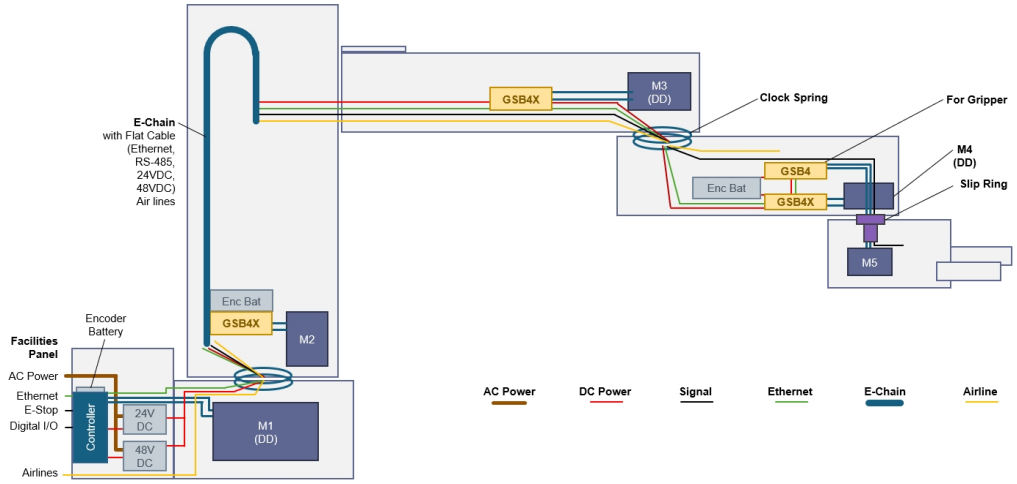
Step	Action
1.	Enable power to the robot's controller, but do not turn on power to the motors. (This procedure should be executed with the motor power off. The robot does not move).
2.	The CALPP program is typically installed at the factory and should be loaded into flash memory. Using the browser-based Operator Control Panel (see Browser Interface), 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.
3.	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.
4.	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, using the Operator Control Panel. See Loading a GPL Project.

Step	Action
5.	Manually move the robot into the configuration shown in Step 10. The top cover of the outer link will need to be removed 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.*
6.	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.
7.	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.
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.
10.	Insert an tapered 0.5 in Calibration Dowel Pin into the hole on inner link as shown below. Rotate outer link clockwise until it rests against the dowel pin. 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.
11.	For the Dual Gripper, J6 will be in the outwards orientation in the CALPP position. 

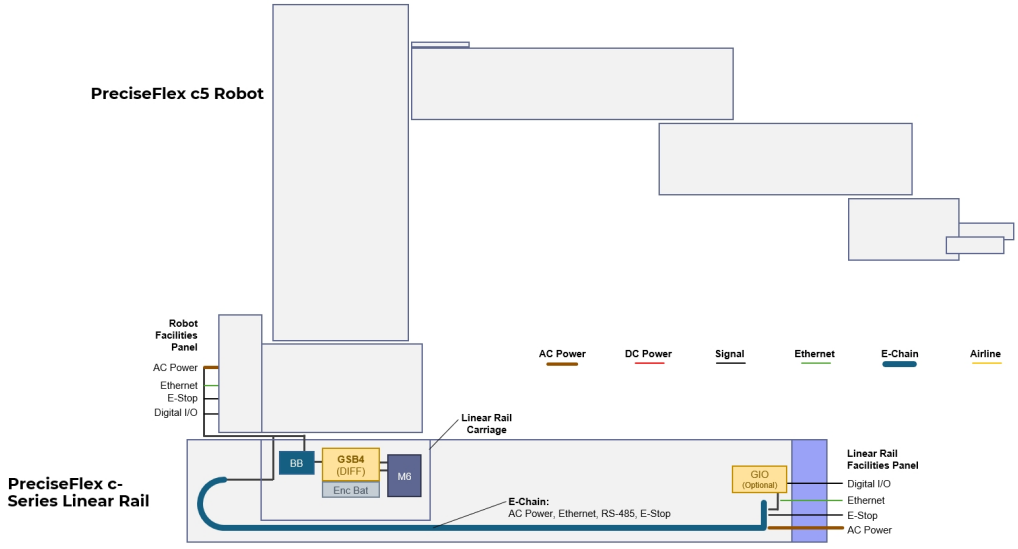
Step	Action
12.	With the CALPP application loaded, select **Start Application** and then click **Perform Operation**. The application should start and prompt the user to confirm the correct robot position for calibration. 
13.	The CALPP application takes about 1 minute to run. 
14.	After calibration 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.

Step	Action
15.	Ensure that the pins are removed.
16.	Enable power and home the robot. Calibration does not take effect until the robot is homed.

Appendix J: PreciseFlex c5 Robot Anatomy



PreciseFlex c5 Robot Anatomy



Linear Rail Anatomy