# PreciseFlex™ 400 Robot

## User Manual

**Robot Rev D**

**Manual Number 658057, Manual Revision A**

# Brooks Automation

Information provided within this document is subject to change without notice, and although believed to be accurate, Brooks Automation assumes no responsibility for any errors, omissions, or inaccuracies.

AcuLigner™, Advan Tag, AutoTeach™, ATR™, AXM™, BiSymmetrik™, CenterSmart™, Crate to Operate™, CrossingConnect™, DARTS™, Enerta™, e-RMA™, e-Spares™, e-Volution™, Falcon™, FIXLOAD™, FrogLeg™, GuardianPro™, Independent Twin Linear Exchange™, InCooler™, InLigner™, Isoport™, ITLX™, Jet™, Jet Engine™, LEAP™, LeapFrog™, LowProfile™, LPT™, M2 Nano™, Marathon 2, Marathon Express, PASIV™, Pathway™, PowerPak™, PowerTools™, PuroMaxx™, QuadraFly™, Radius™, Radient™, Radient Express™, Reliance™, Reliance ATR™, RetroEase™, SCARA™, SmartPM™, SMIF-INX™, SMIF-LPT™, SPOTLevel™, The New Pathway to Productivity™, Time Optimized Trajectory™, Time Optimal Trajectory™, Time Optimized Path™, TopCooler™, TopLigner™, VacuTran™, VersaPort™, WaferEngine™, LEAP™, Pathway™, GIO, GSB, Guidance 6600, Guidance 6430, Guidance 6420, Guidance 6410, Guidance 6000, Guidance 3400, Guidance 3300, Guidance 3200, Guidance 2600, Guidance 2400, Guidance 2300, Guidance 2200, Guidance 1400, Guidance 1300, Guidance 1200, Guidance 0200 Slave Amplifier, Guidance 0006, Guidance 0004, Guidance Controller, Guidance Development Environment, GDE, Guidance Development Suite, GDS, Guidance Dispense, Guidance Input and Output Module, Guidance Programming Language, GPL, Guidance Slave Board, Guidance System, Guidance System D4/D6, IntelliGuide, PreciseFlex™ 100, PreciseFlex™ 300, PreciseFlex™ 400, PreciseFlex™ 3400, PreciseFlex™ c3, PreciseFlex™ c5, PreciseFlex c8a™, PreciseFlex c10™, PreciseFlex™ 1300, PreciseFlex™ 1400, PreciseFlex™ DD4, PreciseFlex™ DD6, PreciseFlex™ DDR, PreciseFlex™ G5400, PreciseFlex™ G5600, PreciseFlex™ G6400, PreciseFlex™ G6410, PreciseFlex™ G6420, PreciseFlex™ G6430, PreciseFlex™ G6600, PreciseFlex™ GSB Slave Amp, PreciseFlex™ PFD0, PrecisePlace 100, PrecisePlace 0120, PrecisePlace 0130, PrecisePlace 0140, PrecisePlace 1300, PrecisePlace 1400, PrecisePlace 2300, PrecisePlace 2400, PrecisePower 300, PrecisePower 500, PrecisePower 1000, PrecisePower 2000, PreciseVision, IntelliGuide Vision, and RIO logos are trademarks of Brooks Automation.

Fusion®, Guardian®, MagnaTran®, Marathon®, Razor®, Spartan®, Vision®, Zaris®, and the Brooks and design logo are registered U.S. trademarks of Brooks Automation.

All other trademarks are properties of their respective owners.



This technology is subject to United States export Administration Regulations and authorized to the destination only; diversion contrary to U.S. law is prohibited.

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

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

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

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

## Technical Support

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

## General Emails

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

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

Brooks Locations Worldwide:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

# 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 |

# 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 |

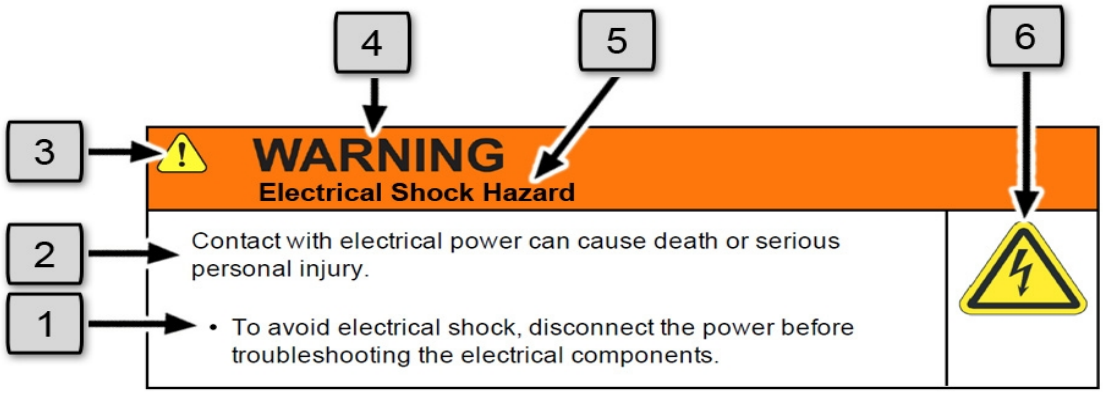
## Signal Words and Colors

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**.<br><br>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**.<br><br>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**.<br><br>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**.<br><br>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.

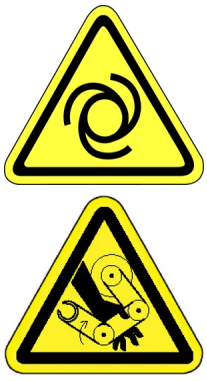
- Do not operate the product without the protective covers in place.

**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.

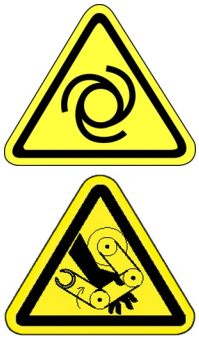
- Be aware of the potential movement area of the product whenever power is applied.
- Never place any part of your body between the robot arms and fixed surfaces.
- Do not operate the robot without the guards and protective covers in place and all safety interlocks enabled.

**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 the cost of disposal. For further information and assistance in disposal, email Brooks Automation Technical Support at support_preciseflex@brooksautomation.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-wwww-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-wwww-xy-zzzzz. After that, there were two other significant releases.

Rev B, designated by serial numbers F0B-wwww-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.

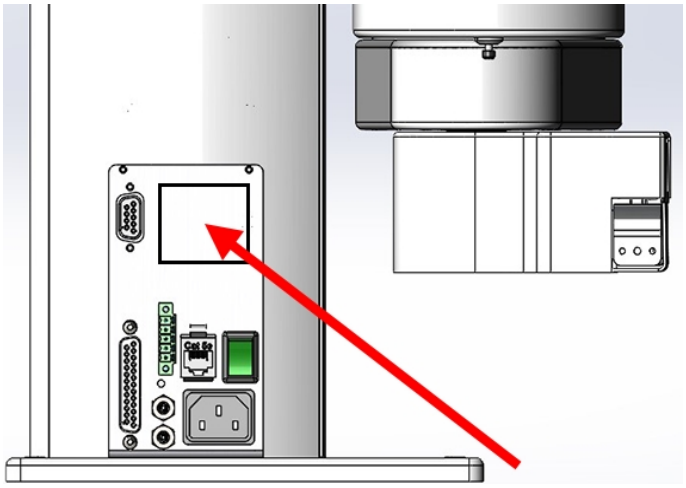
Rev C, designated by serial numbers F0C-wwww-xy-zzzzz, was released in the fall of 2016:

- 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.

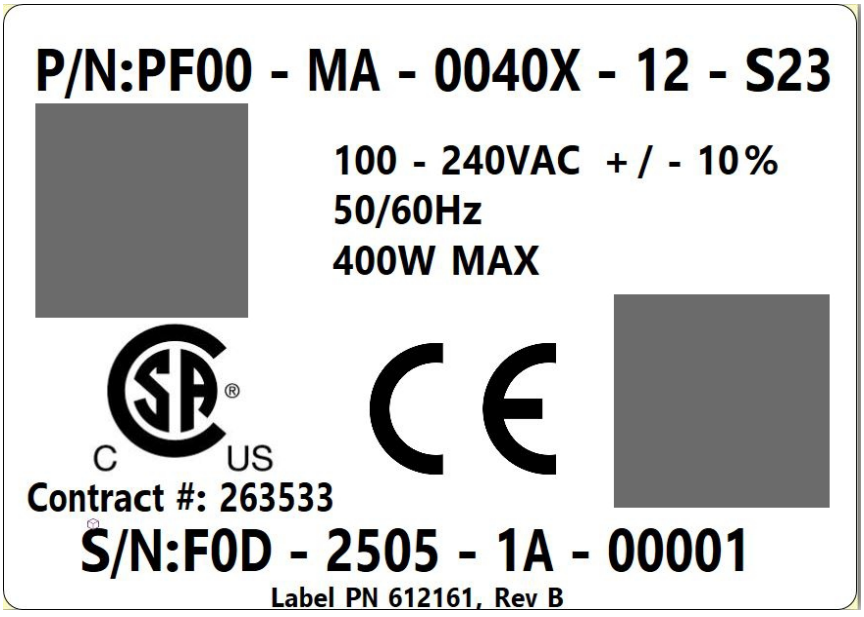
Revision C was discontinued in June 2025 when Revision D was introduced.

# 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-CCCCD-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 | 23 Newton IntelliGuide servo gripper |
| v23 | 23 Newton IntelliGuide vision gripper |


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.

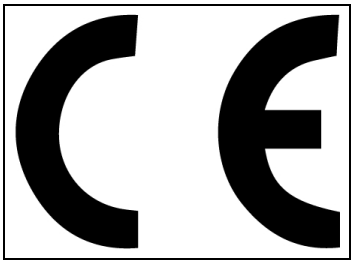
The robot serial number follows the scheme: AAA - BBCC - EF-GGGG. Refer to the table below to decode this scheme.

| AAA [1st three digits] | |
|---|---|
| **CODE** | **MODEL** |
| F0C/F0X | PreciseFlex 400 |
| F0D | PreciseFlex 400, Revision D |

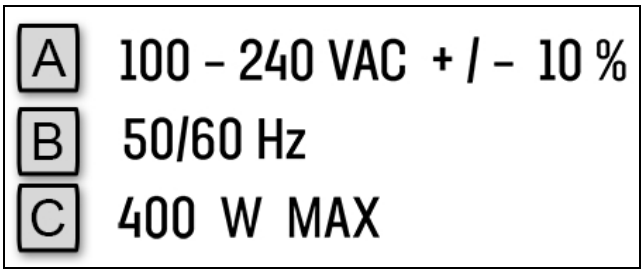
| | |
|---|---|
| FXB | Linear Rail |
| **BBCC** | |
| **CODE** | **MFG DATE CODE (START DATE)** |
| BB | Two-Digit Year Code |
| CC | Two-Digit Month Code |
| **EF** | |
| **Code** | **Revision Code** |
| E | Major Rev Code |
| F | Minor Rev Code<br>Valid for Rev Code 9J and up |
| **GGGGG** | |
| G | 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.




**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

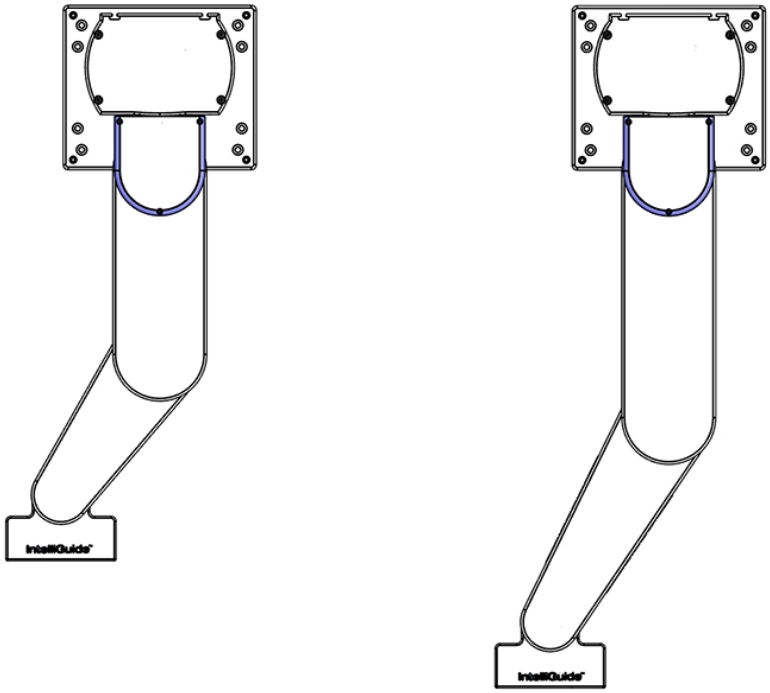
PreciseFlex robots are designed to be integrated into larger systems and are classified as components rather than standalone machines. PreciseFlex 400 (rev D) robots comply with the following applicable requirements:

- 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.

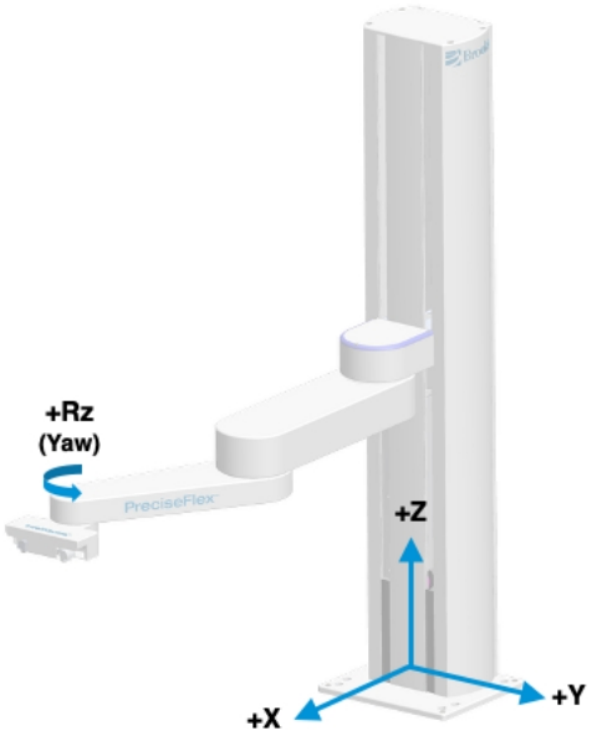
In all modes of operation, the controller includes a browser-based operator interface. This interface is used for configuring the system, starting and stopping execution, and monitoring its operation. The interface can be accessed locally using a browser or remotely via the Internet. This remote interface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

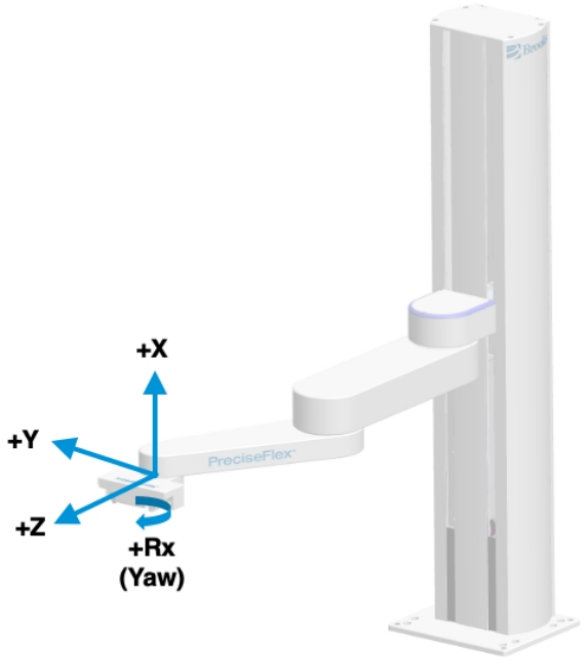
The robot operates using three coordinate systems: **World**, **Tool**, and **Joint**.

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



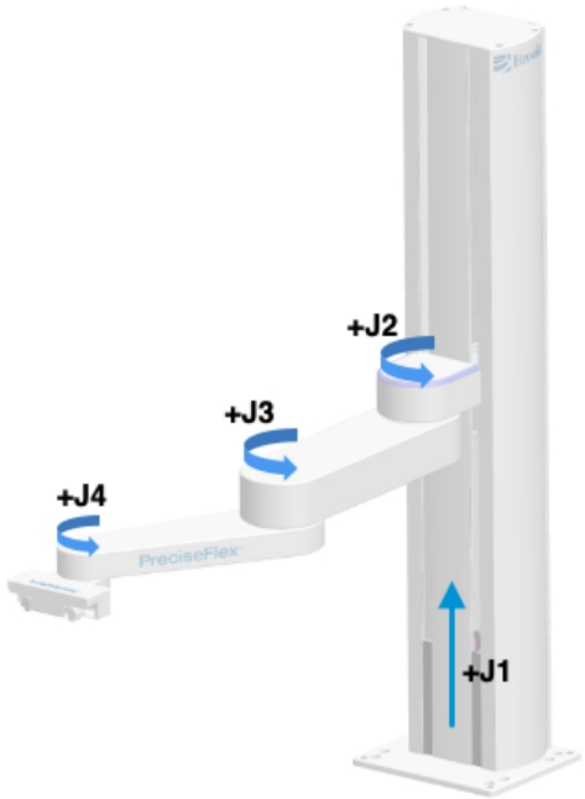

**World coordinate system**

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 | ±93° |
| J3, elbow | 12° to 348° |
| J4, wrist | ±960° |

## 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

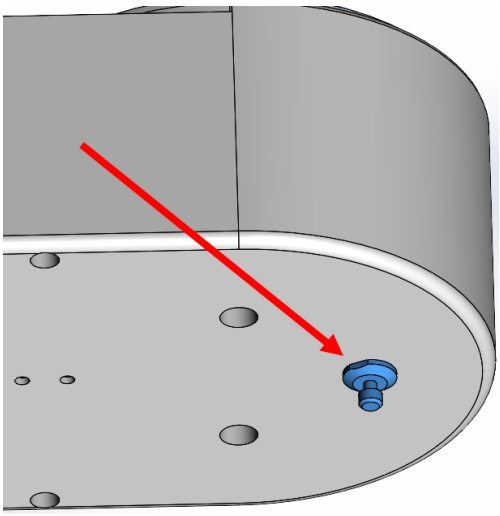
The second axis (J2) rotates the robot inner link. When the inner link is centered on its range of motion, the J2 axis is straight out and positioned at 0° joint angle. A positive change in the axis angle results in a positive rotation about the World Z-axis.

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

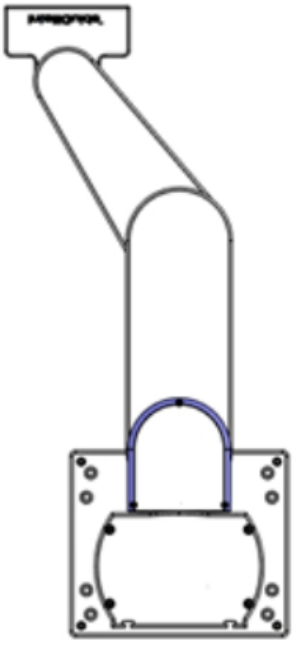
To move the robot arm up and down manually, the fail-safe brake must be pressed. The brake release button is located on the bottom of the inner link under joint 2. This switch is active when AC power is applied to the robot, and the main power switch is **on**.

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.

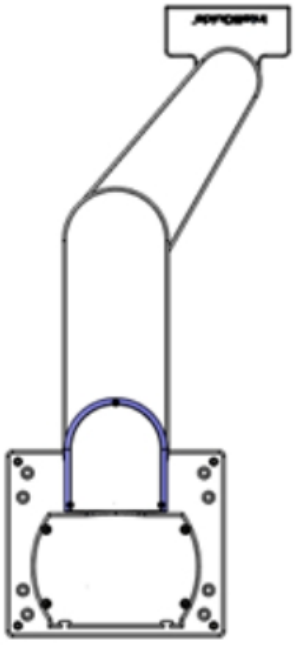


## J3, Elbow

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.



**Left hand robot**



**Right hand robot**

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.

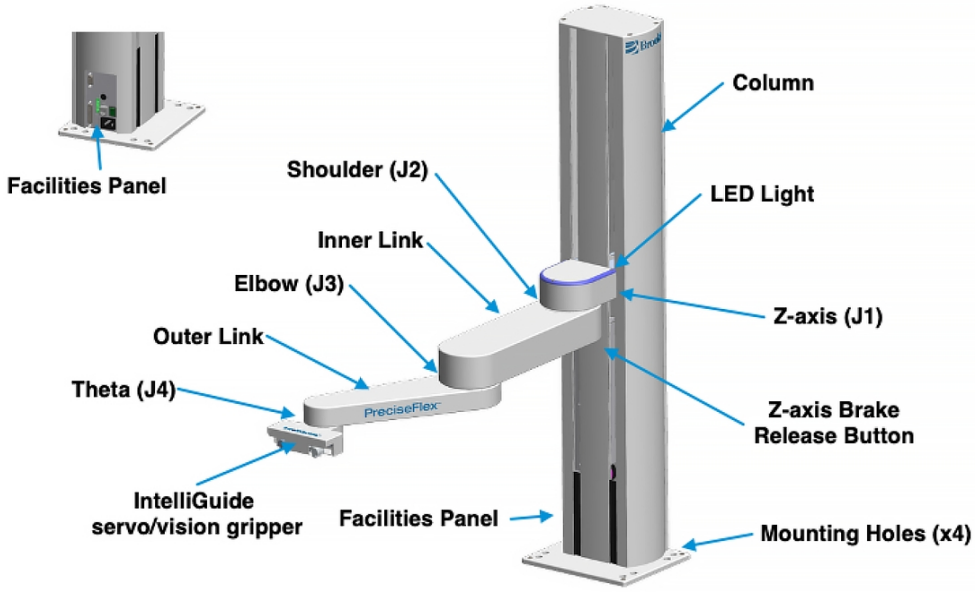
### J4, Wrist

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**

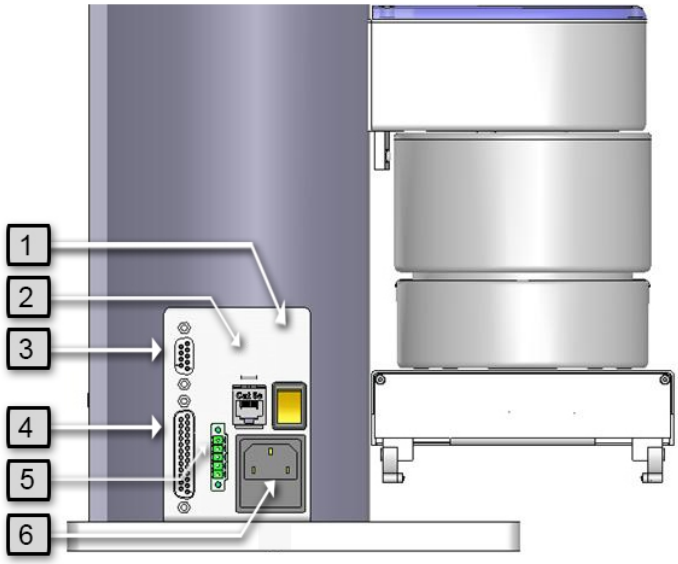
**High Voltage**

| | |
|---|---|
| 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 |

| Annotation | Name | Description |
|---|---|---|
| 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.

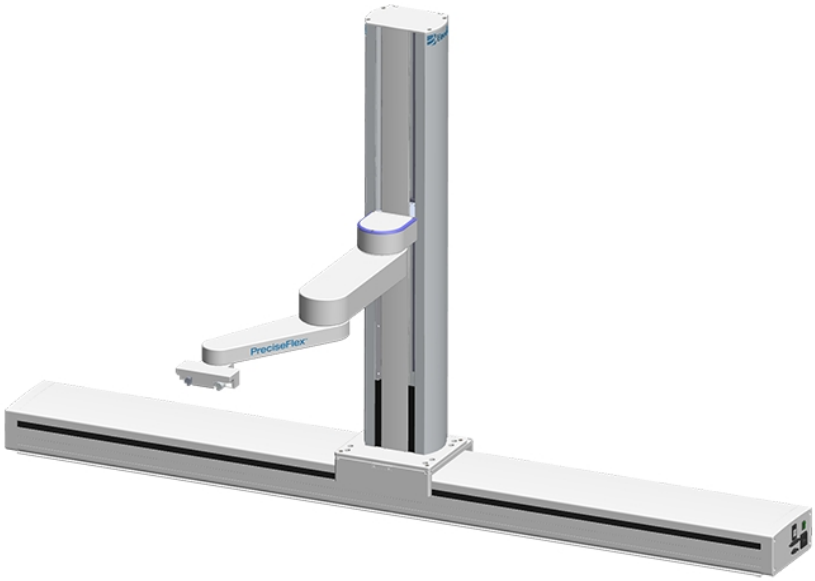

**IntelliGuide v23 (shown with gripper fingers)**

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.

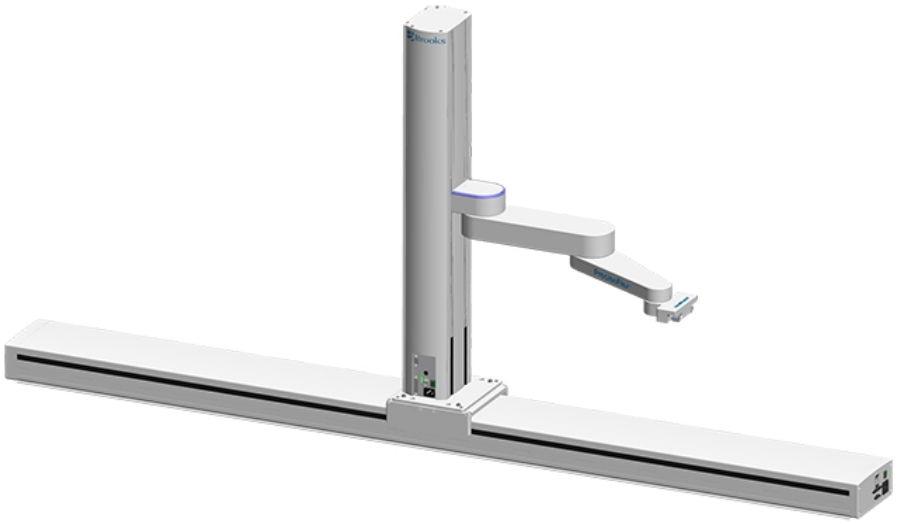
## Linear Rail

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

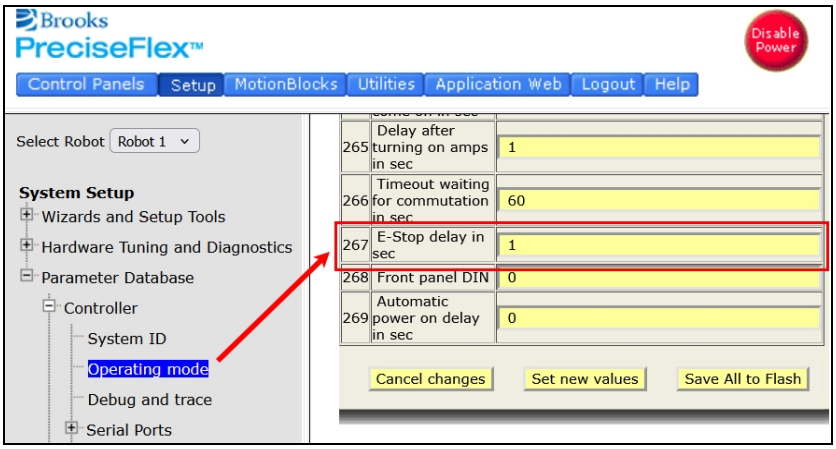
manually re-enabled before program execution and robot motions are resumed. This function is also like a rapid deceleration feature except that a rapid deceleration only affects a single robot, and no program error is generated.

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.



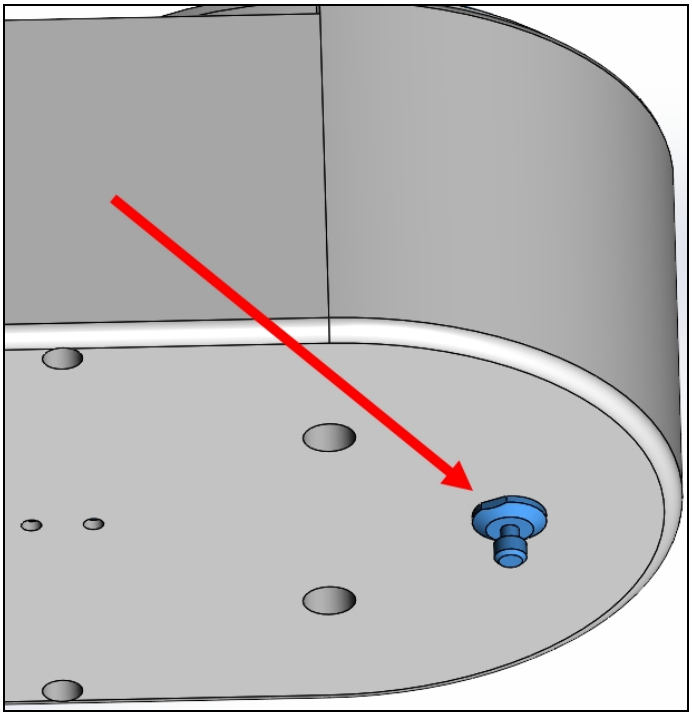

**PreciseFlex 400 controller browser interface**

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/sec$^2$. 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.

1. Unpack the PreciseFlex robot.
2. Mount the robot.
3. Add or remove a gripper (optional). See the *IntelliGuide Gripper User Manual*.
4. Connect the power.
5. 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.

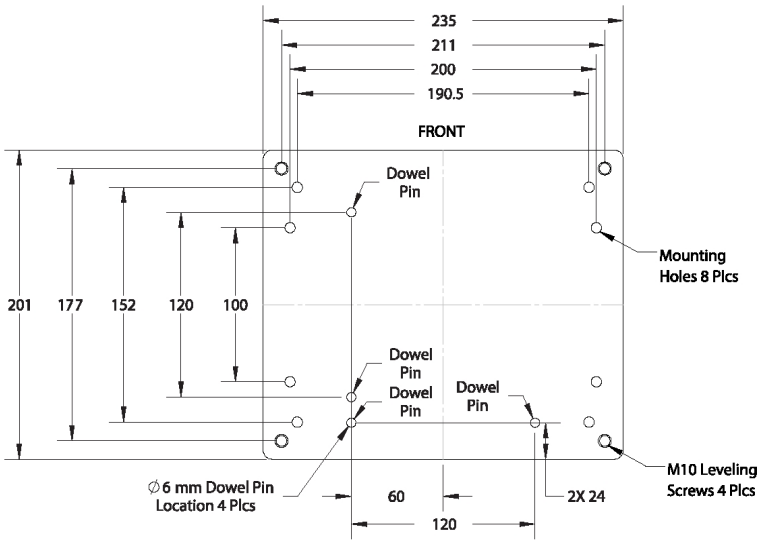
The robots weigh 25 kg or more, so two persons should move the robot to the installation location.

**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.

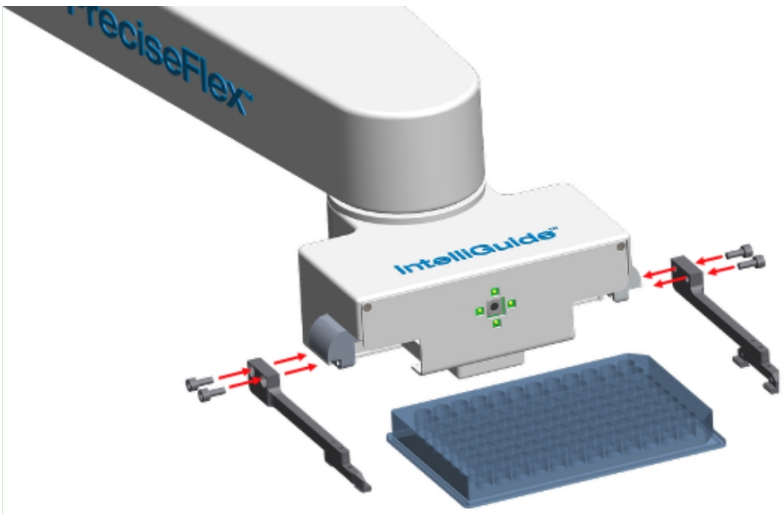
| Step | Action |
|---|---|
| 1. | Prepare the secure robot mounting surface.<br>  <br> |
| 2. | Loosen the latches on all four sides of the crate, and remove the top.<br>  <br> |

| Step | Action |
|---|---|
| 3. | 1. Have two or more people lift the robot out of the crate.<br>2. Take off the plastic wrapping.<br>3. Leave the Velcro strap restraining the arm attached, and carry the robot to where it will be mounted.<br>  |

| 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.<br><br>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.<br><br>  |
| **5.** | Plug in the:<br>• power cable<br>• E-stop button/switch<br>• 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.

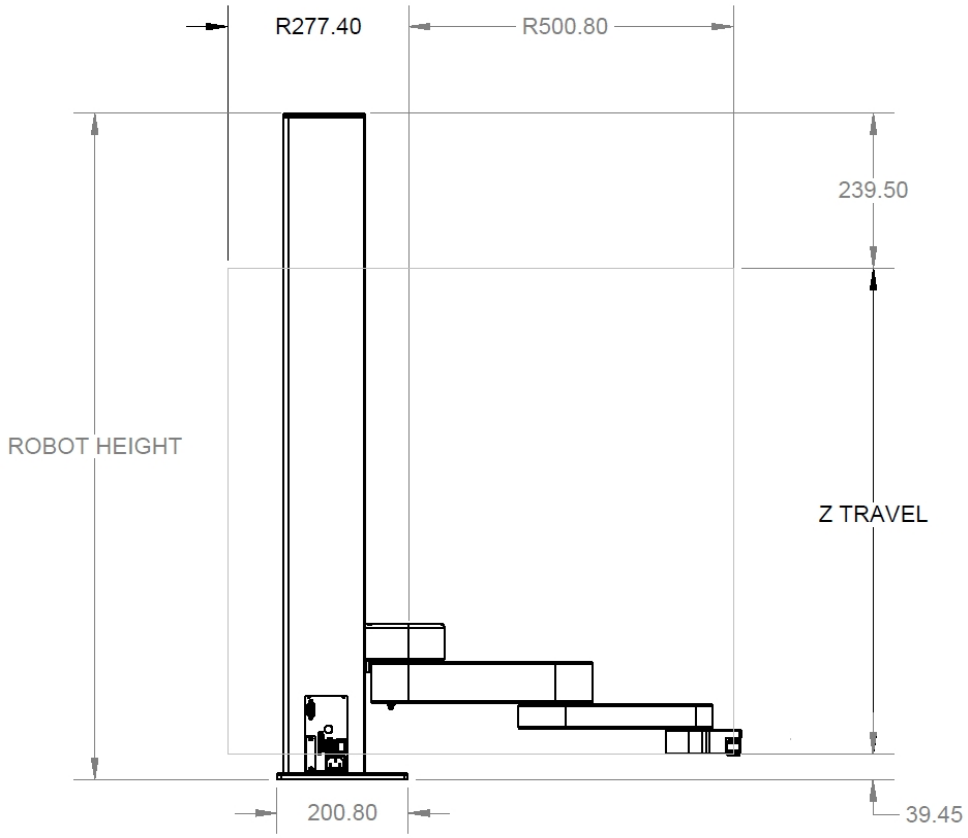



See the *IntelliGuide Gripper User Manual* for more details.

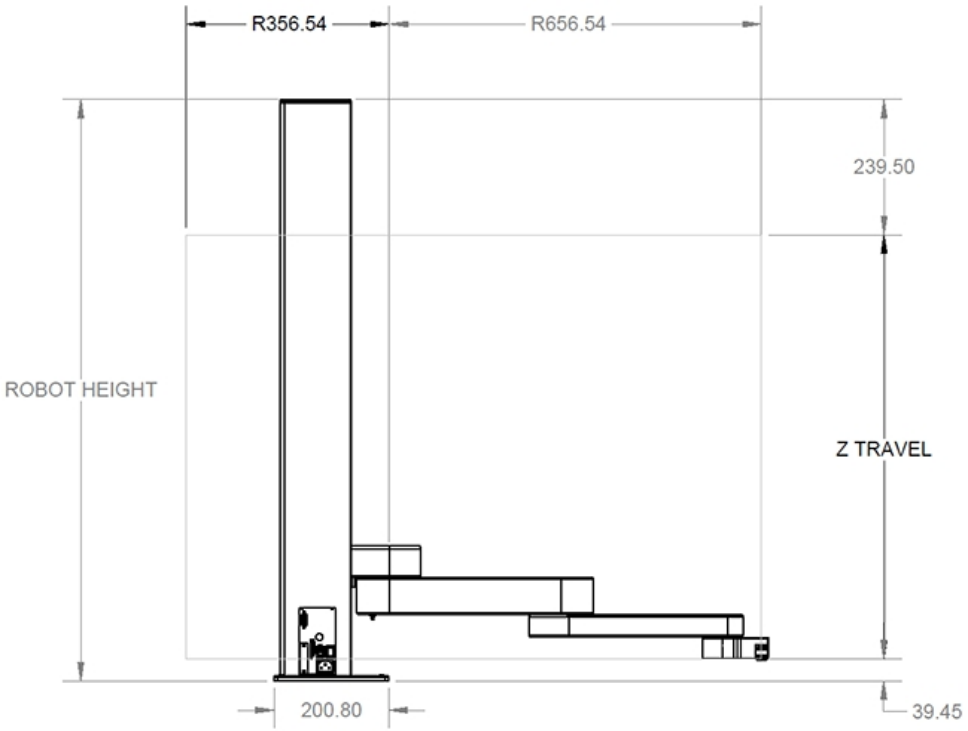
## Robot Dimensions

All dimensions below are in millimeters.

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



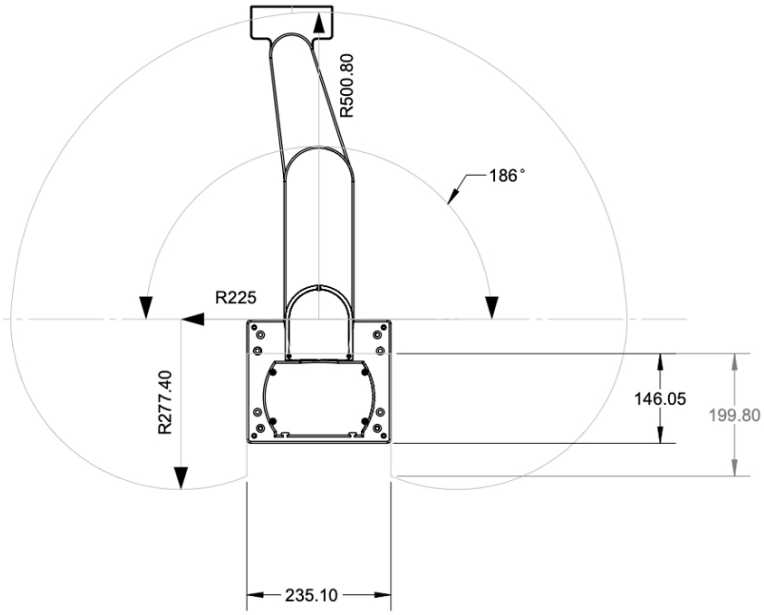

**PreciseFlex 400 standard reach, side view**



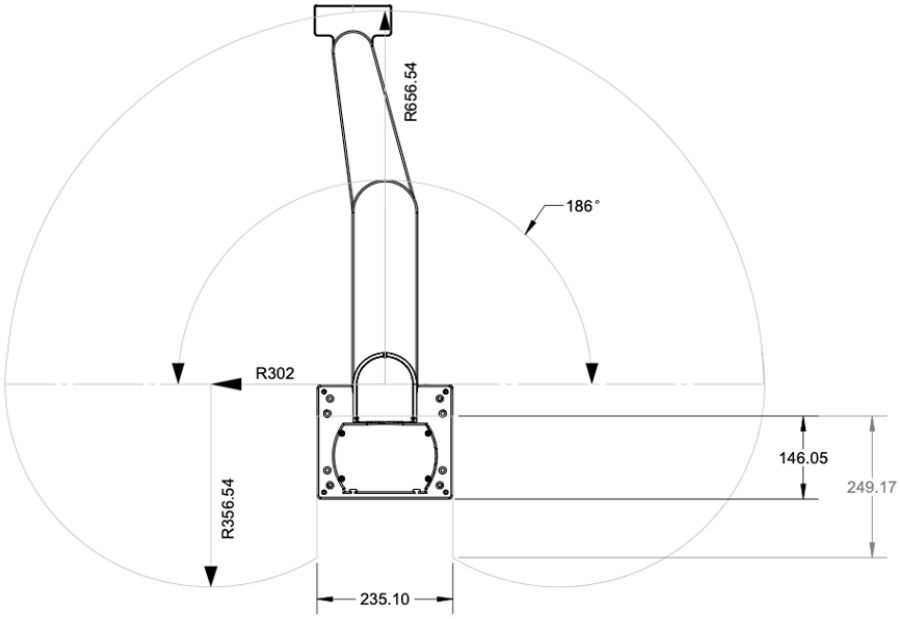

**PreciseFlex 400 extended reach, side view**

# Work Envelope

All dimensions are in millimeters.




**PreciseFlex 400 standard reach**



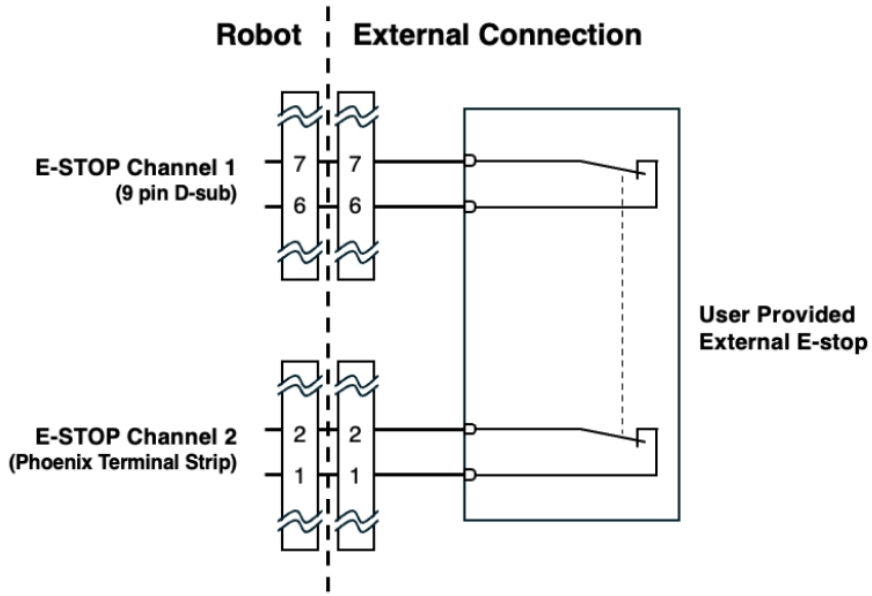

**PreciseFlex 400 extended reach**

# 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.

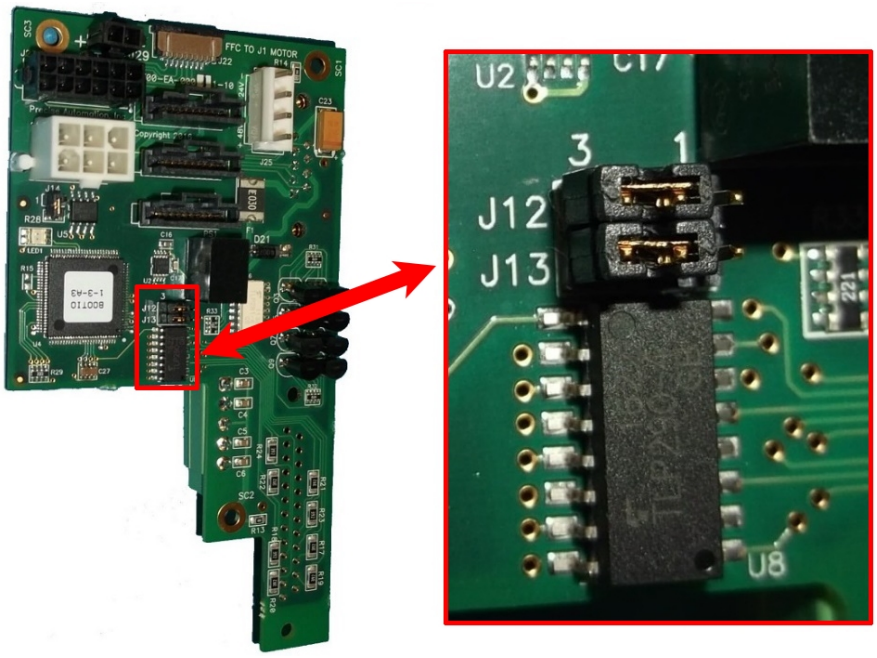
One Ethernet port is available via an external RJ45 connector at the robot base. This port is typically used to interface the robot to a PC. The second Ethernet port is available inside the inner link of the robot and can be used to connect items that are mounted on the robot. A PC connected to the Ethernet 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.

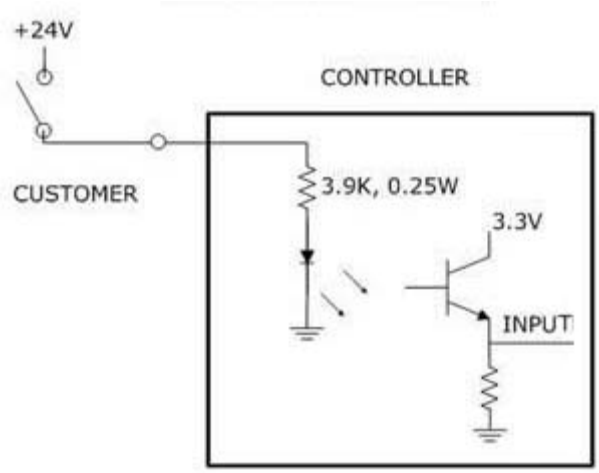
## Digital Input Sinking and Sourcing

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.

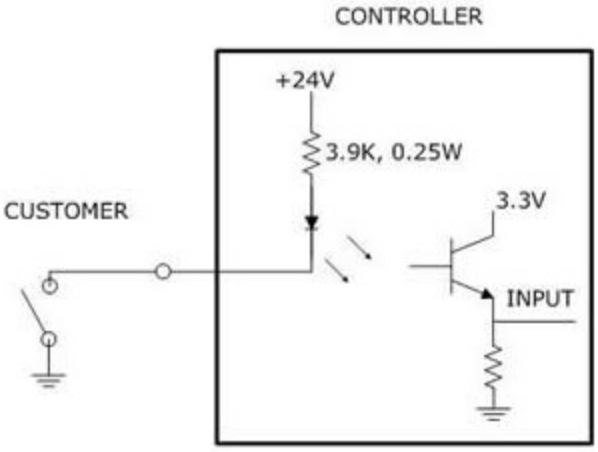
The direction of current flow defines the type:

- *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**

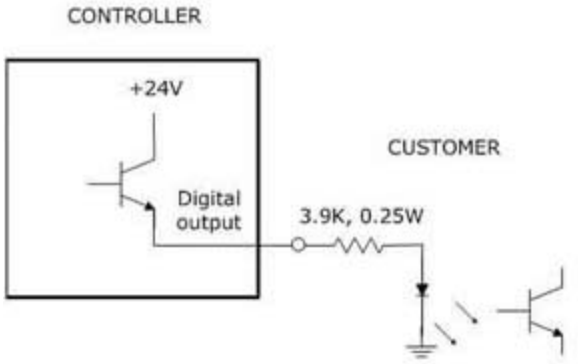



**Sourcing digital input**

## Digital Output Sourcing

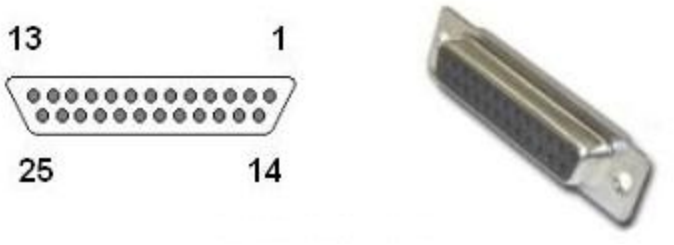
For Sourcing Output (PNP Logic), the robot controller output terminal provides positive voltage to the load. The load is connected between the output terminal and ground (0V). When the output is ON, current flows from the robot controller to the load. This configuration is suitable for loads that expect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

| Pin | GPL Signal Number | Description |
|---|---|---|
| 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**

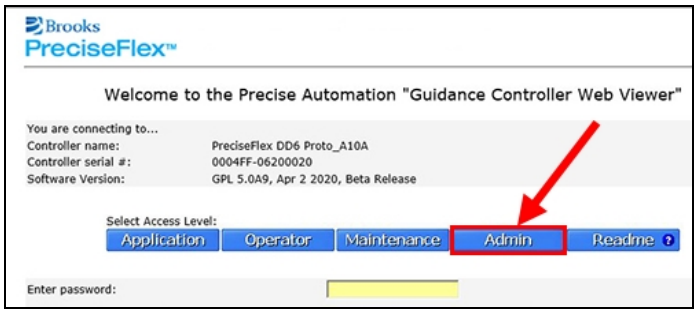
**High Voltage**

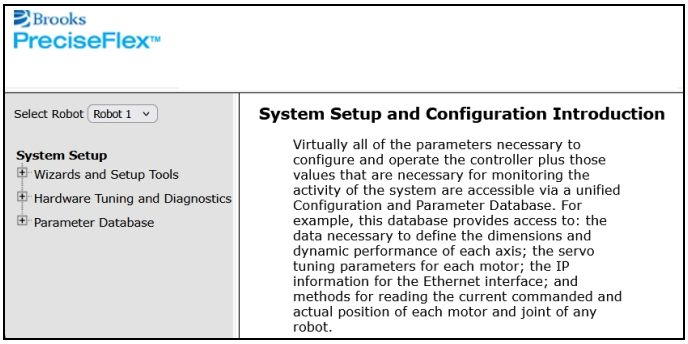
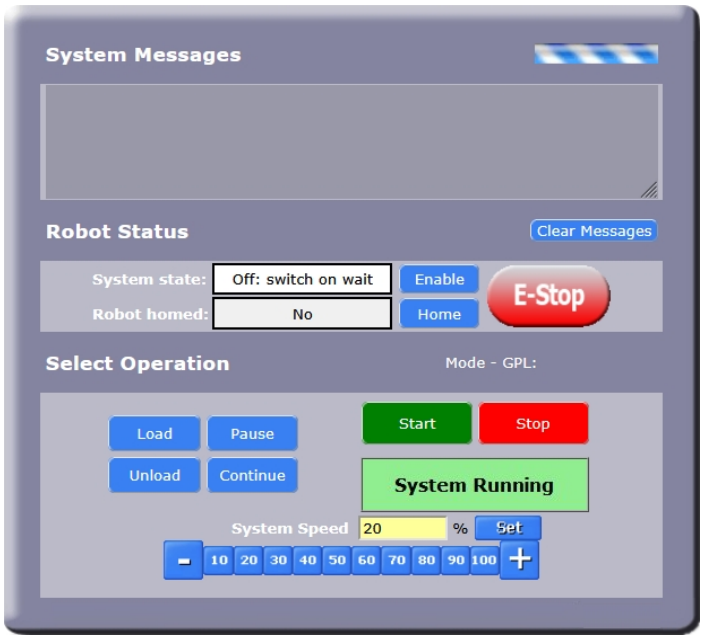
Disconnect AC power before removing covers or servicing the robot to prevent exposure to high voltage levels,

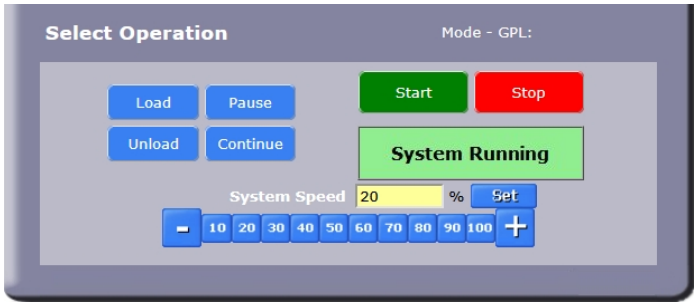
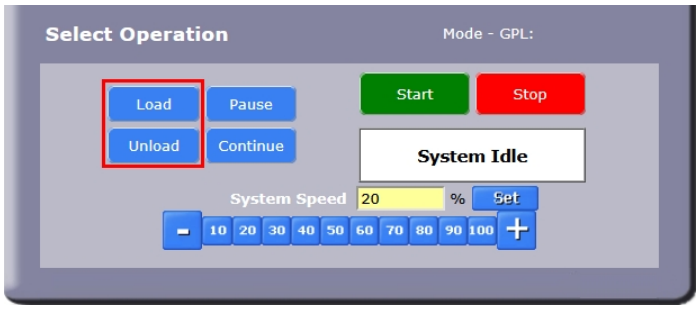
# 4. Operation

## 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**.<br><br>You can use also GDS or other software to discover a robot's unknown IP address.<br><br>***NOTE:*** *Enter a password if a company has protected access to the browser interface.*<br>  |

| Step | Action |
|---|---|
| 2. | After clicking **Admin**, the *System Setup* window will display.<br>  |
| 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*.<br>  |

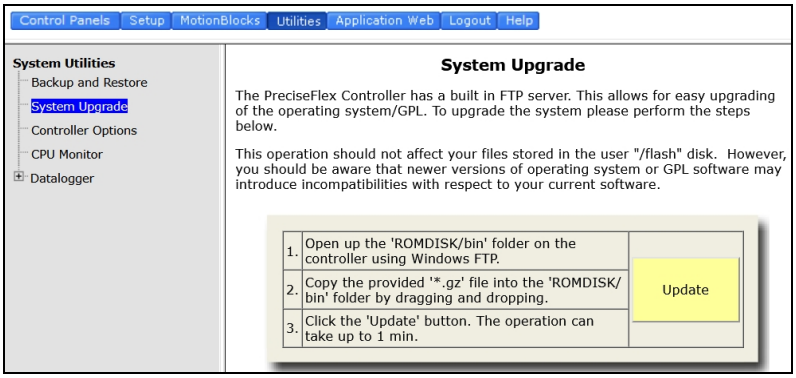
| Step | Action |
|---|---|
| 4. | If an application is running, *System Running* will display in green.To run diagnostics, click **Stop**.<br>  |
| 5. | At the top right of the screen, click **Disable Power** to ensure the motor power is off.<br>  |
| 6. | To load a new project (for example CAL_PP),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

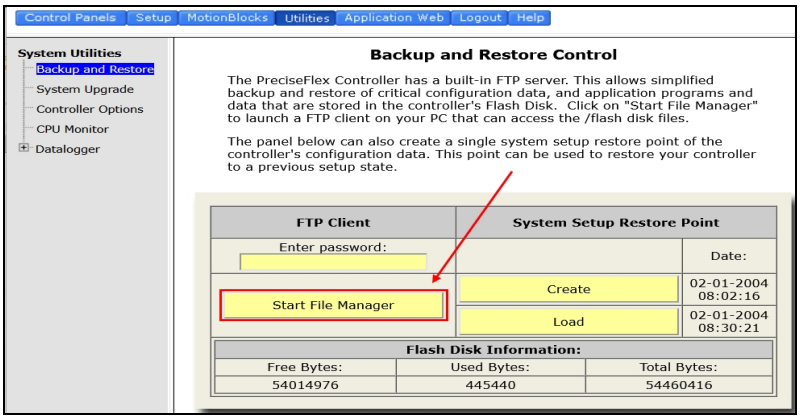
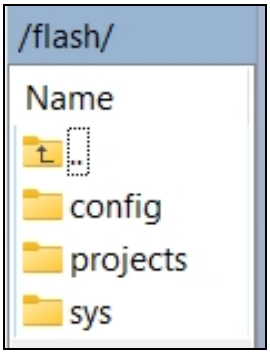
# Updating Firmware and Operating System

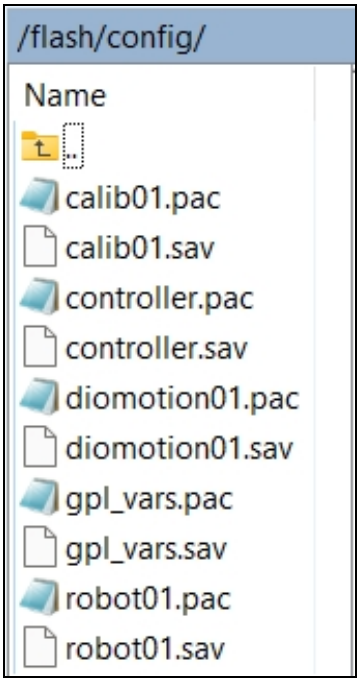
GPL (the system software and firmware are now a single file in GPL 5.0 and later) may be upgraded in the field. To update GPL (system software and firmware), complete the following steps:

| Step | Action |
|---|---|
| **1.** | Get the appropriate upgrade software from Brook in the form of a .gz file. Email support_preciseflex@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.<br>  |
| **3.** | Paste the new GPL system file into this folder. |
| **4.** | 1. In the Browser Interface, click **Admin > Utilities > System Utilities > System Upgrade**.<br>2. Click **Update** and follow the instructions.<br>  |

# 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.<br>  |
| 2. | In the FTP client, open the *config* folder.<br>  |

| 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.<br>  |

# 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@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: Product Specifications

## General Specifications

| General Specification | Range |
|---|---|
| **PERFORMANCE** | |
| Payload | • 0.5 kg with s23 or v23 gripper<br>• 1.0 kg without IntelliGuide gripper |
| Max speed at TCP | • Horizontal: 500 mm/sec<br>• Vertical: 500 mm/sec |
| Max Acceleration | 2500 mm/sec2 |
| Max Joint Speed | • J1 - 500 mm/sec<br>• J2 – 360°/sec<br>• J3 - 720°/sec<br>• J4 - 720°/sec |
| Repeatability | ±0.090 mm |
| **RANGE OF MOTION** | |
| Joint 1 (Z-axis) | 400, 750, 1160 mm |
| Joint 2 | ±93° |
| Joint 3 | 12° to 348° |
| Joint 4 | ±960° with IntelliGuide gripper |
| Horizontal Reach (from center of Joint 2 to gripper finger mount) | • 500.8 mm, standard reach<br>• 656.54 mm, extended reach |
| **COMMUNICATIONS** | |
| General | • 100 Mb Ethernet, TCP/IP<br>• EtherNet/IP |
| Operator Interface | Browser-based operator interface |
| Digital I/O | • 8 inputs at 24 VDC<br>• 8 outputs at 24 VDC (100 mA) |

| General Specification | Range |
|---|---|
| **FACILITIES** | |
| Power | • 100 to 240 VAC, auto selecting<br>• 50-60 Hz 100-175 watts typical operation |
| Controller Mounting | Embedded into robot base |
| External E-stop | Dual channel |
| Weight | • Standard Reach<br>◦ 400 mm Z-axis: 20 kg<br>◦ 750 mm Z-axis: 25 kg<br>◦ 1160 mm Z-axis: 30 kg<br>• Standard Reach/Extended Reach<br>◦ 400 mm Z-axis: 25 kg<br>◦ 750 mm Z-axis: 30 kg<br>◦ 1160 mm Z-axis: 35 kg |
| **SOFTWARE** | |
| Programming | • TCS API for controlling robot from workflow, scheduling software<br>• GPL (Guidance Programming Language): full-featured object-oriented programming language<br>• GP Flow for no-code, point-and-click application builder<br>• Programming via Guidance Development Studio (GDS) |
| Enhanced Functions | • Hand guiding (standard)<br>• Horizontal compensation (X/Y compliance)<br>• Z-height detection |
| **PERIPHERALS AND ACCESSORIES** | |
| General | • IntelliGuide s23 servo gripper<br>• Gripper fingers for SBS plates, tubes, vials |
| Linear Rail | • Horizontal travel 1.0, 1.5, and 2.0 meters<br>• Speed up to 750 mm/sec<br>• Repeatability: ±0.05 mm |
| Vision | IntelliGuide v23 gripper |

## Environmental Specifications

***NOTE:*** Our PreciseFlex robots are powered by 24 VDC and 48 VDC low-voltage DC power supplies with built-in overcurrent protection. For this reason, the PreciseFlex robots do not have an SCCR.

The PreciseFlex Robots must be installed in a clean, non-condensing environment with the following specifications:

| General Specification | Range and 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, non-corrosive |
| Altitude | Up to 3000 m |
| Voltage | 100-240 VAC +/- 10%, 50/60 Hz |
| Main cord rating, min | 18 AWG, 3 conductor, 5 Amps min |
| Pollution Degree | 2 |
| Approved Cleaning Agents | IPA, 70% Ethanol/30% water, H2O2 Vapor up to 1000 ppm |
| IP rating | 11 |
| IK impact rating | IK08: 5 Joule |

# Appendix B: PreciseFlex 400 Spare Parts List

***NOTE:*** Email support_preciseflex@brooksautomation.com for help replacing spare parts.

The part number format is:

- F0v-wwww-xy-zzzzz
- v - Major version - "D" for revision D robots
- wwww - Ship date,yymm. So, 2509 means September 2025
- x is the controller rev
- y is the robot rev
- zzzzz - is a unique robot number.

| Description | Part Number |
|---|---|
| Absolute Encoder Battery Assembly | PF0H-MA-00057 |
| J1 Motor Assembly | PF00-MA-00028 |
| J1 Stage 1 Belt | PF00-MC-X0021 |
| J1 Stage 2 Belt 400 mm | PF00-MC-X0022 |
| J1 Stage 2 Belt 750 mm | PF00-MC-X0023 |
| J3 Motor Assembly | PF00-MA-00030 |
| J3 Belt - Standard Reach | PF00-MC-X0035 |
| J3 Belt - Extended Reach | PF00-MC-X0066 |
| J4 30 W Motor Assembly | PF00-MA-00031 |
| J4 Belt for Standard Reach | PF00-MC-X0004 |
| J4 Belt for extended reach | PF00-MC-X0065 |
| PreciseFlex 400 s23 servo gripper with spring, without fingers | PF00-MA-00059-1 |
| PreciseFlex 400 s23 servo gripper with brake, without fingers | PF00-MA-00115 |
| Finger claw assembly - s23 servo gripper fingers | PF0S-MA-00010 |
| Controller | G5X0-EA-B5400 |
| GSB3-SE/DIFF – for gripper or rail - configurable | 389629-0005 |
| 24 VDC power supply | PS10-EP-24150 |
| 48 VDC power supply | 605889 |
| Slip Ring Harness Assembly, s23 brake gripper | PF04-MA-00002-E8 |
| Slip Ring Harness Assembly, s23 spring gripper | 397515 |
| Harness, FFC, J4 Motor | PF0H-MA-00002-02 |
| Harness, FFC, J4 Encoder | PF0H-MA-00020-2 |
| Harness, Gripper Controller | PF0H-MA-00014 |
| J1 Motor Interface PCA | 602414-0011 |
| J2 Motor Interface PCA | 602414-0021 |

| Description | Part Number |
|---|---|
| J3/MIDS Motor Interface PCA | 602414-0031 |
| J4 Motor Interface PCA | 602414-0041 |

# Appendix C: Preventative Maintenance

For support with preventative maintenance, addressing error codes, or service related issues contact support_preciseflex@brooksautomation.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 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 PreciseFlex 400 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 |
| Ethernet cable | 2-4 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).

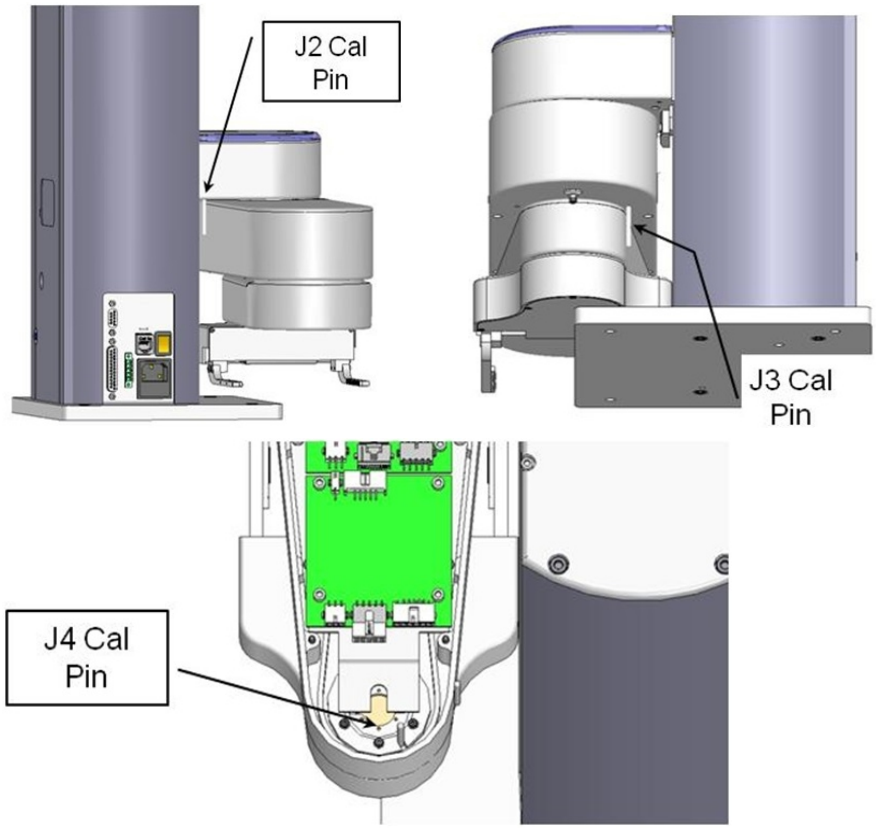
**Tools Required**:

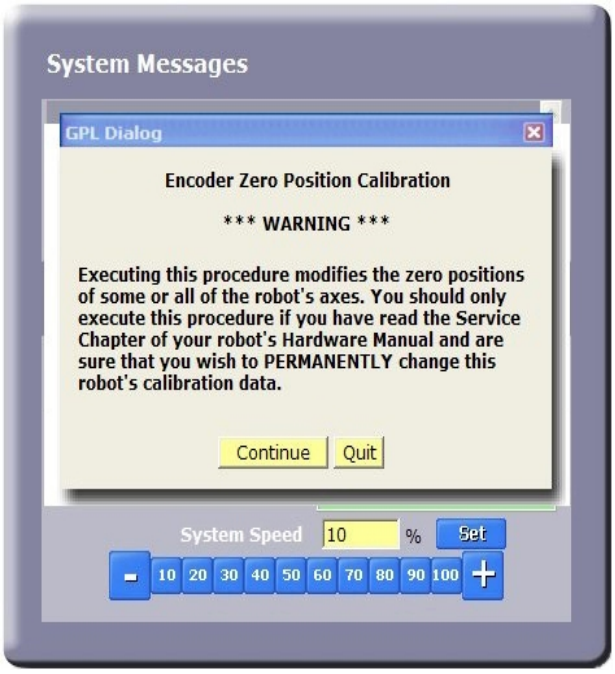
- 2.5 mm and 3.0 mm hex drivers or hex L wrenches
- Set of (3) Calibration Dowel Pins, located in plastic bag inside the hollow slot in the front cover

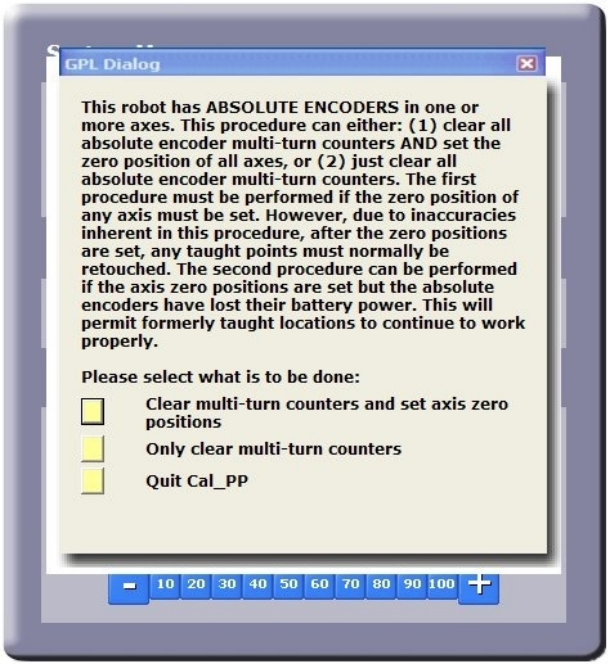
The following procedure describes the steps for defining the zero positions of the PF400 robot axes using Cal_PP.

| 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.<br><br>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. |

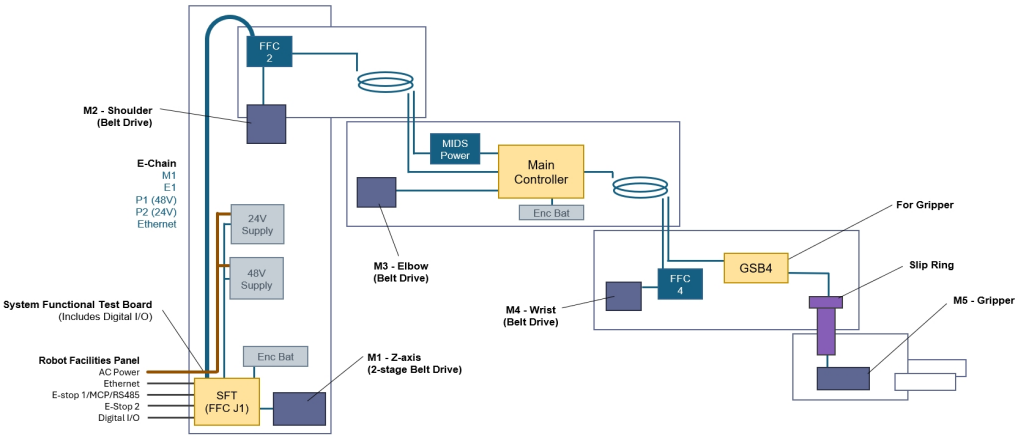
| Step | Action |
|---|---|
| **5.** | In the window, click **CALPP_RevXX** and click **Select**. To execute the Project, select **Start application** and click **Perform Operation**.<br><br>If CALPP is not loaded in the robot, first Load Cal_PP into the controller's memory from a PC. Refer to the *GDS User Manual* 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.<br><br>***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.<br>  |
| **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. |

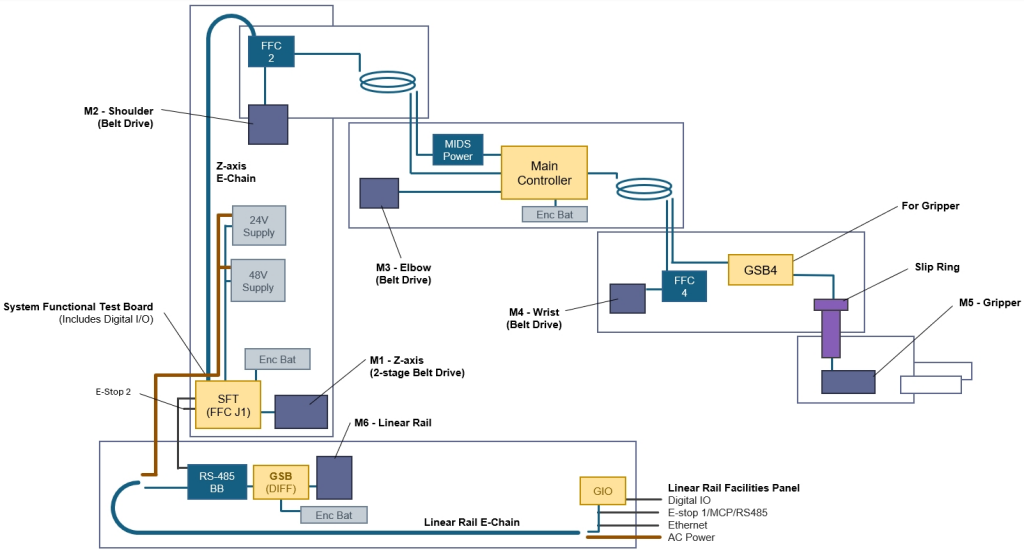
| Step | Action |
|---|---|
| 13. | With the CALPP application loaded, select **Start Application** and then click **Perform Operation**. The application should start and prompt the user to confirm the correct robot position for calibration.<br>  |

| Step | Action |
|---|---|
| **14.** | The CALPP application takes about 1 minute to run.<br>  |
| **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. |

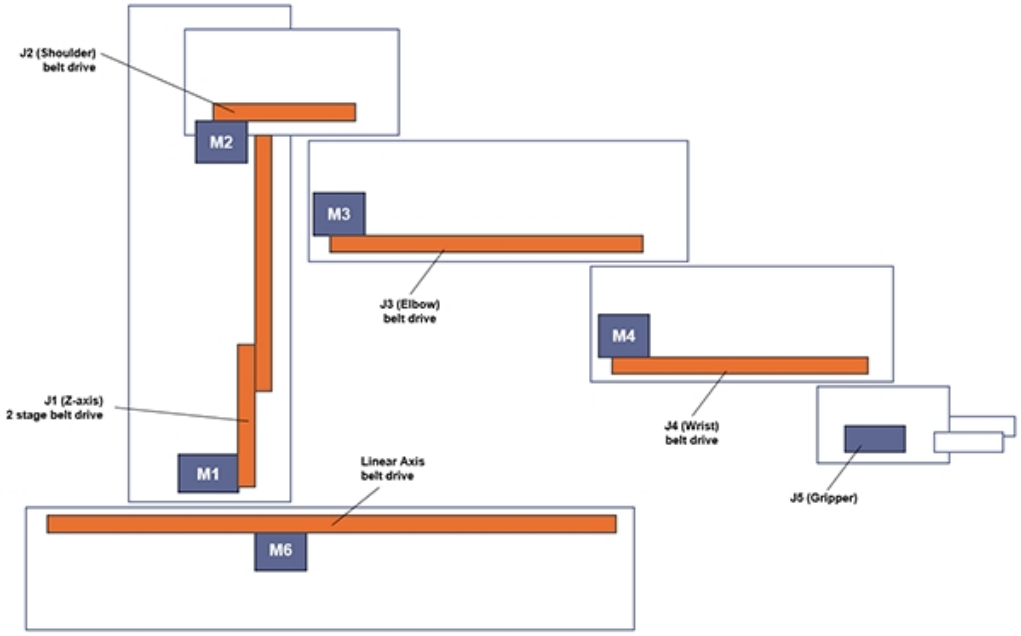
# Appendix E: Robot Anatomy




**PreciseFlex 400 - Block Diagram**




**PreciseFlex 400 - Block Diagram (with Linear Rail)**




**PreciseFlex 400 - Motor Drive**