IntelliGuide™ Grippers

Service Manual

Part Number 662842, Revision A

Brooks Automation

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

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

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

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

Technical Support

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

General Emails

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

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

Brooks Locations Worldwide:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

IntelliGuide Gripper Service Manual Revision History

Revision	ECO	Date	Action	Author
A	EC166341	August 15, 2025	Released manual at Rev. A to follow standard Brooks technical publication styles.	M. Ashenfelder

Table of Contents

1. Safety

Safety Setup

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

DANGER

Read the Safety Chapter

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

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

Explanation of Hazards and Alerts

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

Safety Text

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

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

- State how to avoid the hazard.

Safety Icons

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

Safety Icon Examples	
	Warning
	Two-Person Lift
	Electric Shock

Signal Words and Colors

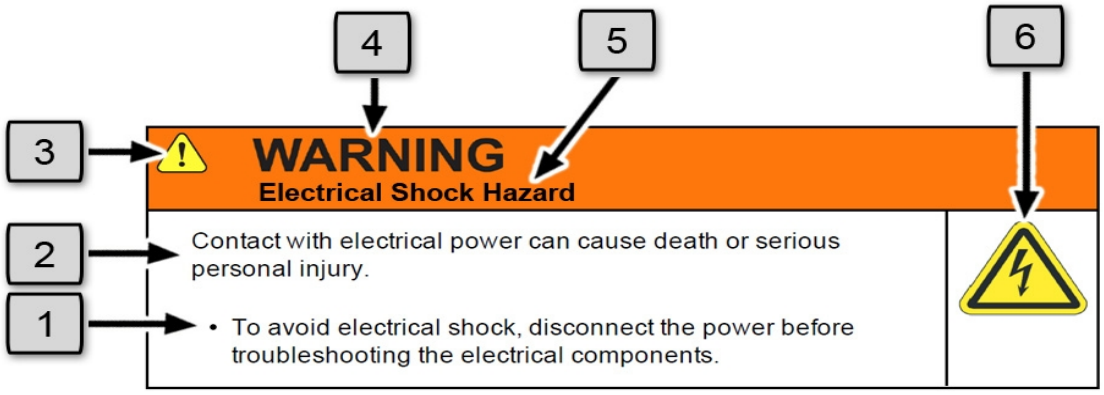
Signal words and colors inform of the level of hazard.

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

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

Alert Example

The following is an example of a Warning hazard alert.



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

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

General Safety Considerations

WARNING

Software

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

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

WARNING

Robot Mounting

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

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

WARNING

Do Not Use Unauthorized Parts

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

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

WARNING

Magnetic Field Hazard

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

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. IntelliGuide s23 and s60

IntelliGuide s23 Overview

The IntelliGuide s23 gripper contains a brushless servo motor with an incremental encoder. At power up, the encoder provides motor commutation information for a brief period and then switches the incremental encoder A, B, and Z signals onto the same set of wires. This allows the motor commutation to be initialized at start-up without any motion.

The motor has a twelve-tooth pinion gear cut directly on the motor shaft. This pinion drives a pair of opposing racks to open and close a set of finger mounts, which are attached to linear ball slides. Various fingers can be attached to the finger mounts.

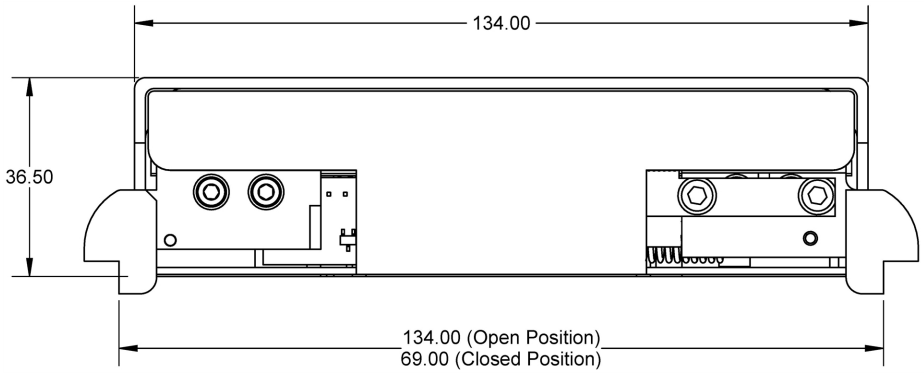
One finger mount is also attached to a spring return, which applies a continuous closing force to the finger mounts as they are coupled together by the pinion. If power is lost, the IntelliGuide gripper will close and maintain a closing force so that it does not drop parts.

The IntelliGuide s23 gripper has a maximum squeeze force of 23 N. It has a maximum stroke of 65 mm.

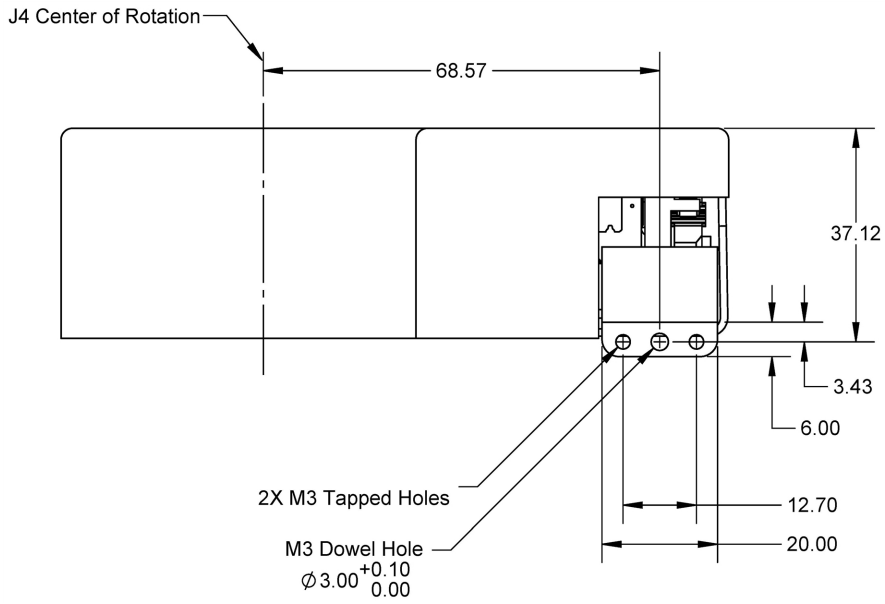
To avoid the IntelliGuide gripper slamming closed from the spring force when motor power is disabled, there is a 1000 ms delay after an E-stop or power disable command is sent before the motor power is cut off. During this period, the servo slowly closes the IntelliGuide gripper.

To support "free" mode, in which the fingers can be moved back and forth freely by hand, in the servo counterbalances the spring by applying an opposing force based on finger position.

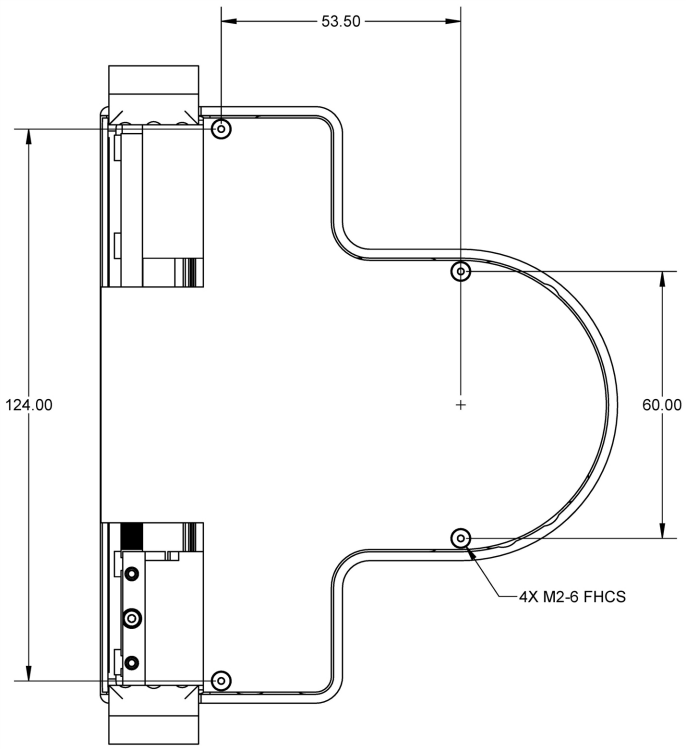
The IntelliGuide s23 and IntelliGuide s23D grippers use incremental encoders, and they must be homed after every power cycle.



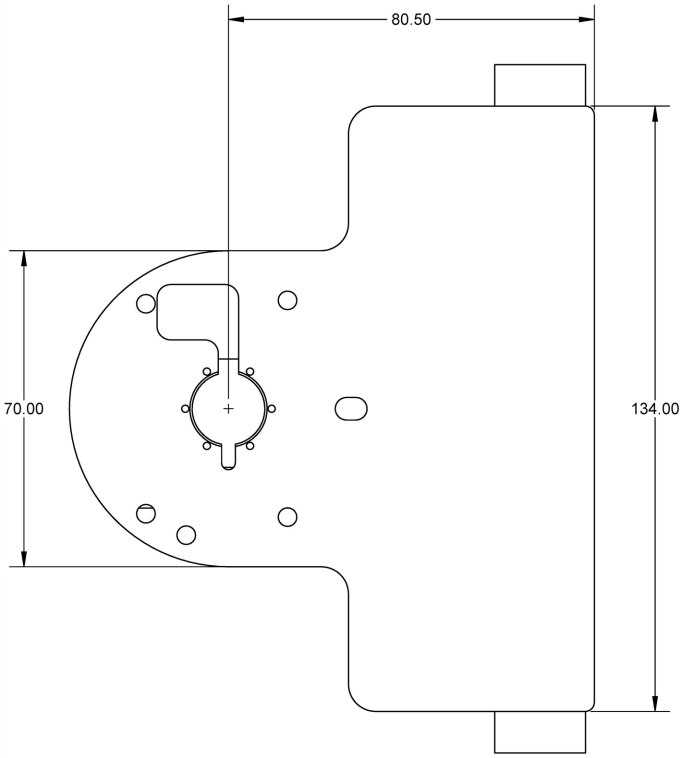
IntelliGuide s23, front view



IntelliGuide s23, side view



IntelliGuide s23, bottom view



IntelliGuide s23, top view

IntelliGuide s60 Overview

The IntelliGuide s60 gripper contains a brushless servo motor with an absolute encoder. At power up, the encoder provides motor commutation information for a brief period and then switches the absolute encoder signals onto the same set of wires. This allows the motor commutation to be initialized at start-up without any motion.

The motor has a tooth pinion gear cut directly on the motor shaft. This pinion drives a pair of opposing racks to open and close a set of finger mounts, which are attached to linear ball slides. Various fingers can be attached to the finger mounts.

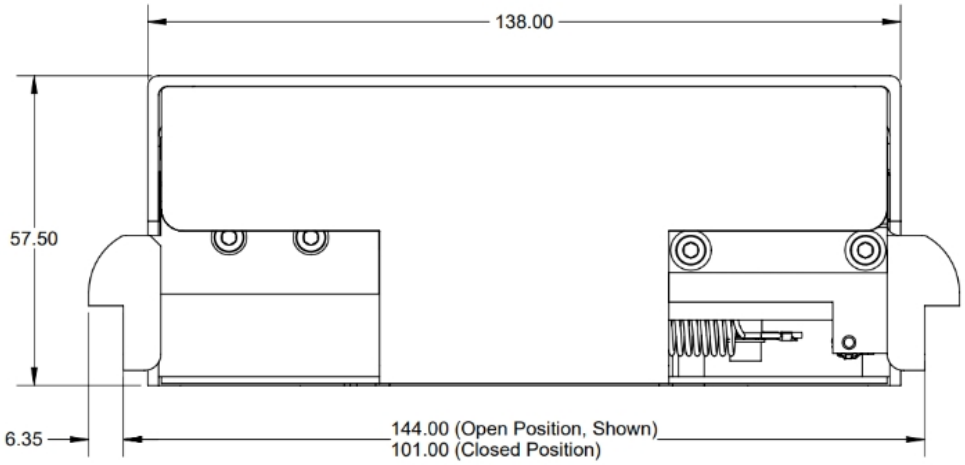
One finger mount is also attached to a spring return, which applies a continuous closing force to the finger mounts as they are coupled together by the pinion. If power is lost, the IntelliGuide gripper will close and maintain a closing force so that it does not drop parts.

The IntelliGuide s60 gripper has a maximum squeeze force of 60 N. It has a maximum stroke of 43 mm.

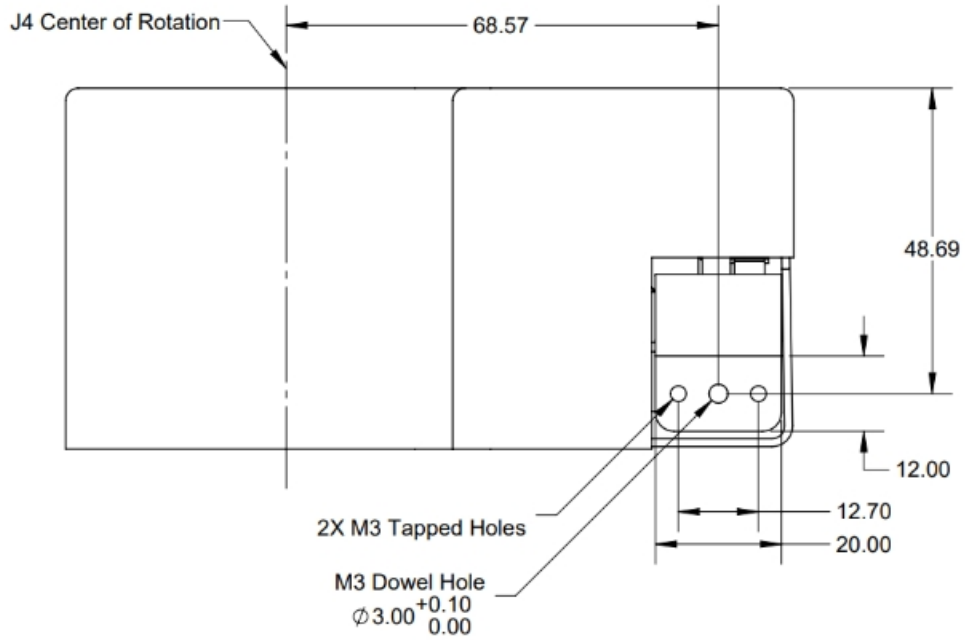
To avoid the IntelliGuide gripper slamming closed from the spring force when motor power is disabled, there is a 1000 ms delay after an E-stop or power disable command is sent before the motor power is cut off. During this period, the servo slowly closes the IntelliGuide gripper.

To support "free" mode, in which the fingers can be moved back and forth freely by hand, in the servo counterbalances the spring by applying an opposing force based on finger position.

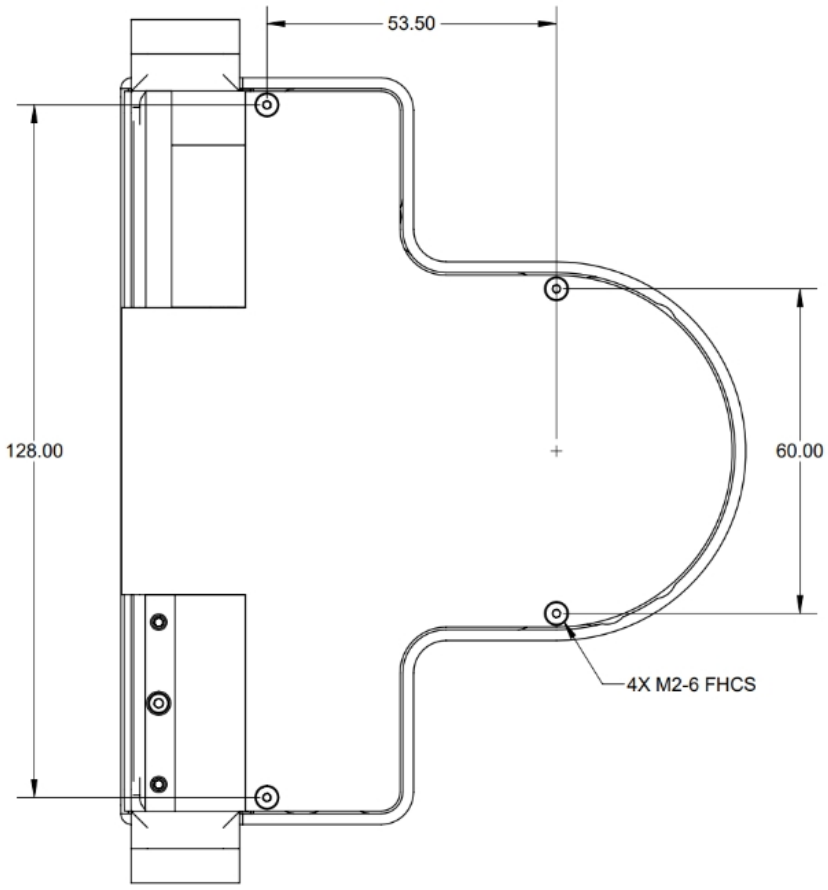
The IntelliGuide s60 gripper does not need to be homed after every power cycle.



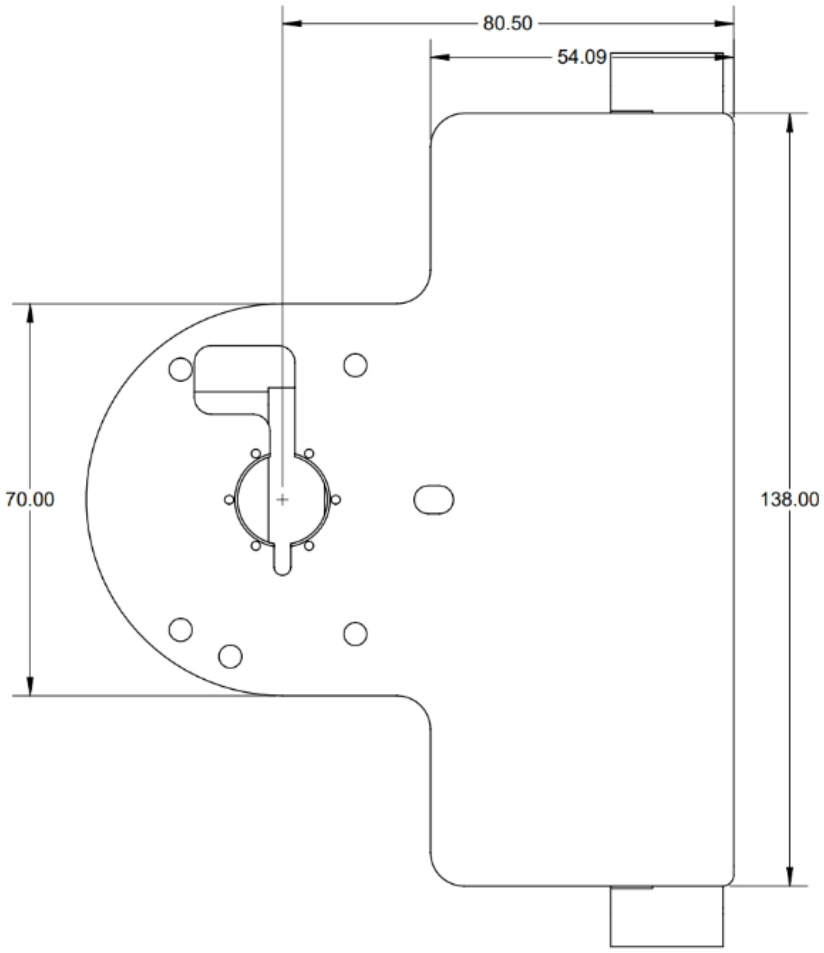
IntelliGuide s60, front view



IntelliGuide s60, side view



IntelliGuide s60, bottom view



IntelliGuide s60, top view

Replacing an IntelliGuide s23 or IntelliGuide s60 on a PreciseFlex Robot

Removing an IntelliGuide s23 or IntelliGuide s60 from a PreciseFlex Robot

NOTE: For IntelliGuide gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

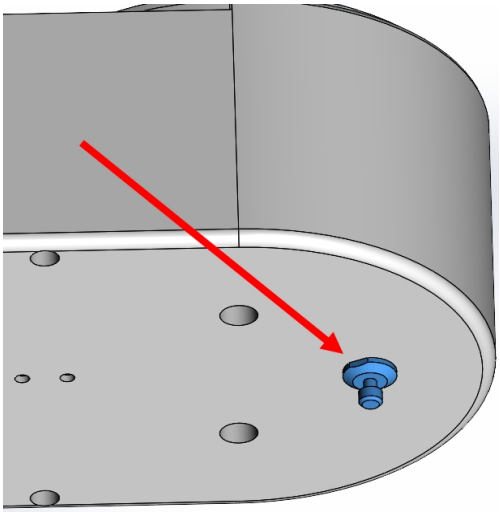
DANGER

Electrical Shock Hazard

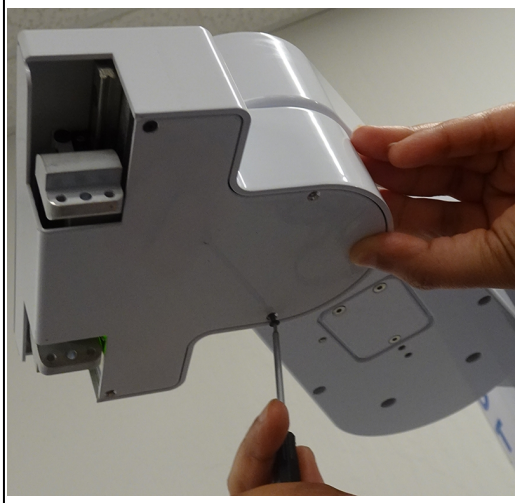
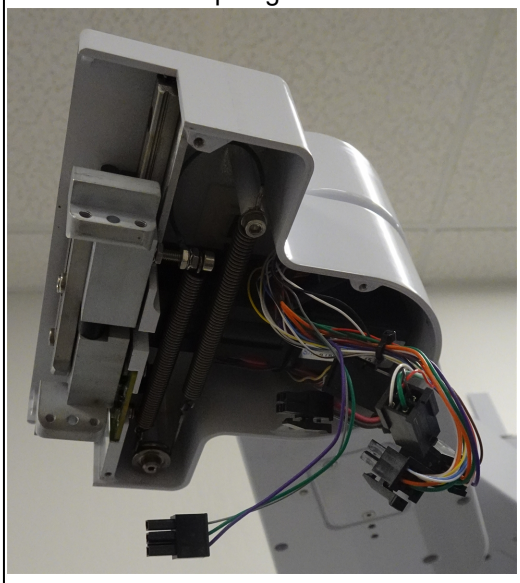
Contact with electrical power can cause serious personal injury or death.

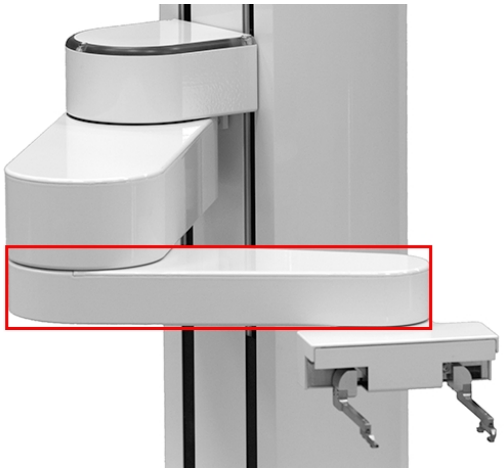
- Turn the robot power **off** when the robot covers are removed, and when working with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

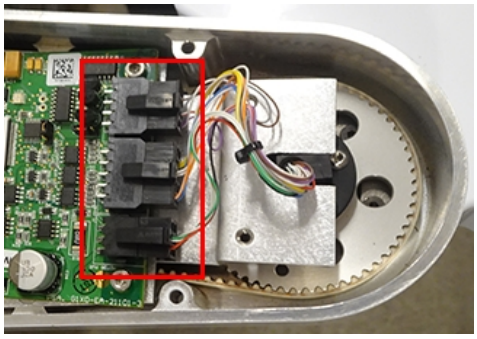
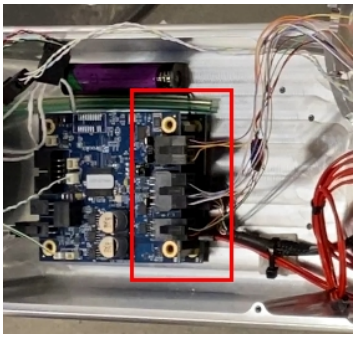
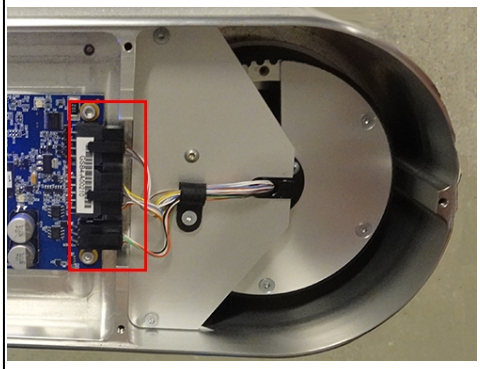
To raise and lower the robot arm, push and hold the brake button under the inner link while supporting the robot arm.

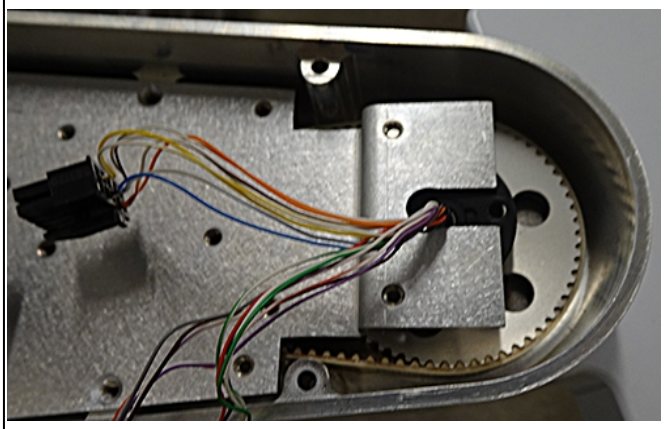
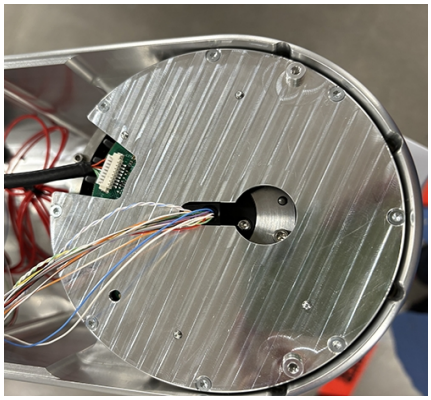
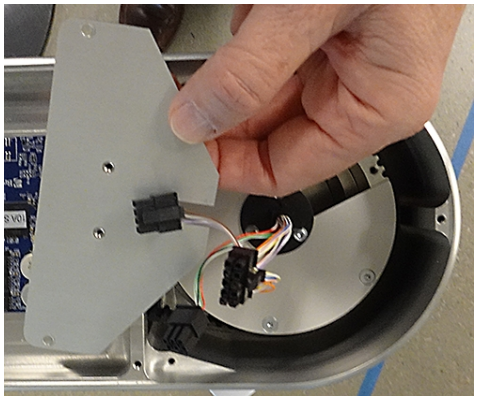


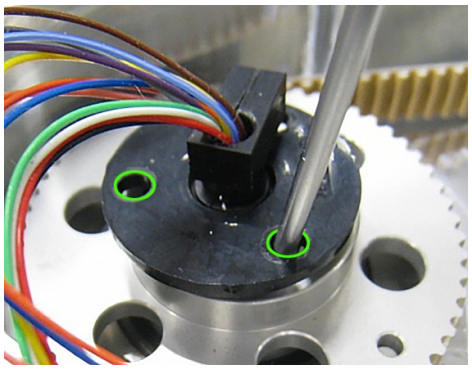
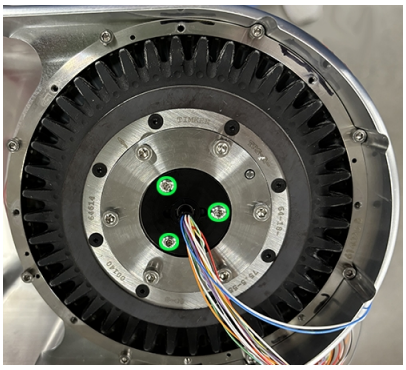
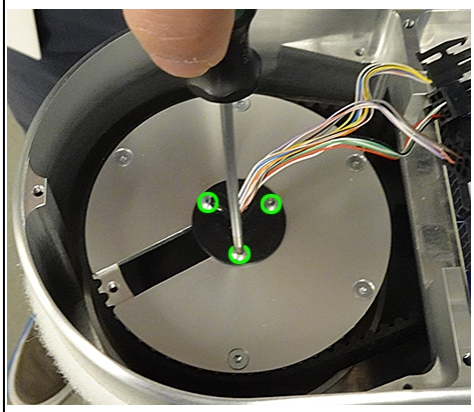
Perform the following procedure to remove an IntelliGuide s23 or s60 from a PreciseFlex robot.

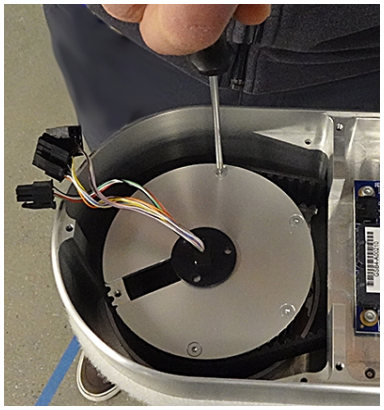
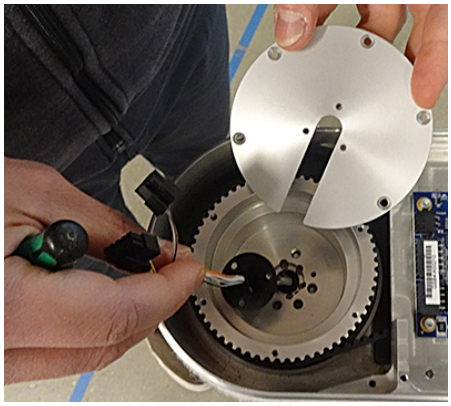
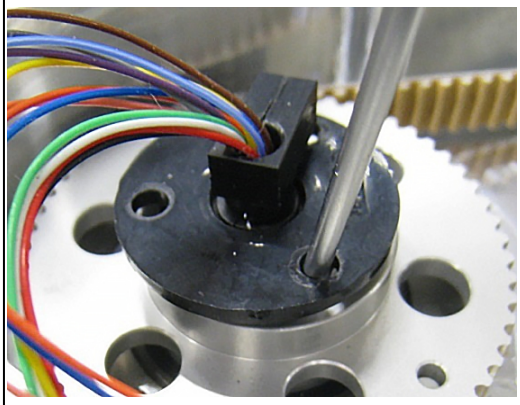
Step	Action
1.	*Prepare the Gripper for Removal* Raise the robot arm, using an M1.3 screwdriver, unscrew the 4X M2-5 screws, and remove the IntelliGuide gripper bottom.  **PreciseFlex 400 and 3400**
2.	Disconnect the slip ring harness wires from the IntelliGuide gripper wires.  **PreciseFlex 400 and 3400**

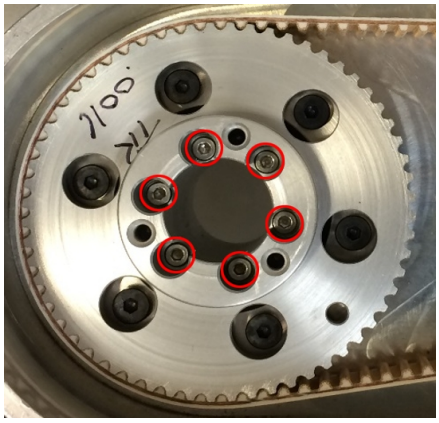
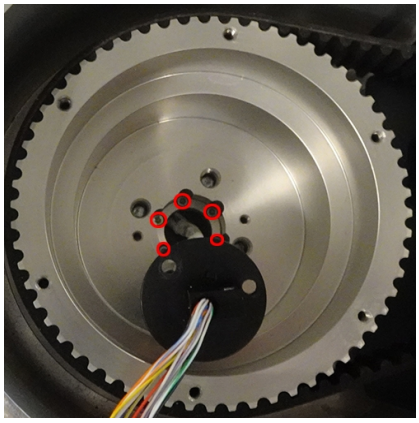
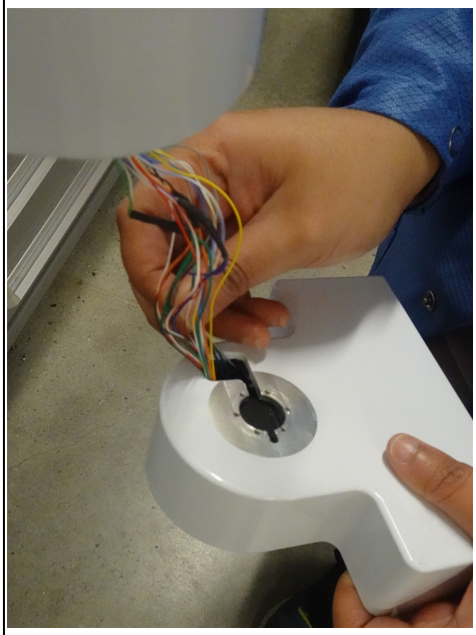
Step	Action
3.	*Remove the Outer Link Cover* Lower the robot arm. **PreciseFlex 400 and 3400:** For the outer link cover, using an M2.5 screwdriver, unscrew the 4X M3-30 SHCS screws and remove the cover.  **PreciseFlex 400 and 3400** **PreciseFlex c10 and PreciseFlex DD 4** : Using an M2.5 screwdriver, unscrew the 8X M3-6 screws from the blue covers, and remove the covers. Using an M2 screwdriver, unscrew the 6X M3-6 FHCS screws from the metal top cover, and remove the cover.  **PreciseFlex c10 and PreciseFlex DD 4**

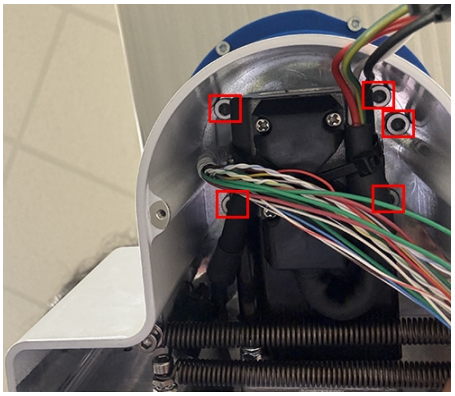
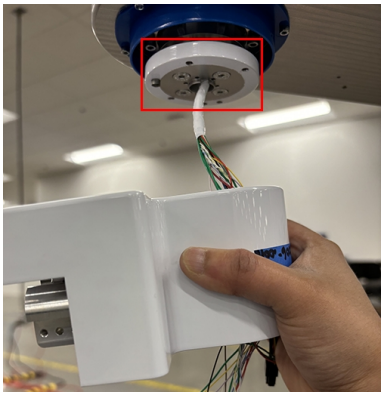
Step	Action
4.	*Disconnect the Slip Ring Harness from the GSB*  **PreciseFlex 400 and 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

Step	Action
5.	*Remove the Metal Slip Ring Cover* **PreciseFlex 400 and 3400**: Remove both the GSB and J4 interface board, and unscrew and remove the metal cover protecting the slip ring.  **PreciseFlex c10**: Unscrew and remove the slip ring metal cover.  **PreciseFlex DD 4**: Unscrew and remove the slip ring metal cover and clamp. 

Step	Action
6.	*Unscrew the Slip Ring* Using an M2 screwdriver, unscrew the 3X M3 slip ring screws (shown below in green).  **PreciseFlex 400 and 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

Step	Action
7.	**PreciseFlex DD 4:** Using an M2 screwdriver, unscrew the 5X M3 cover plate screws and remove the cover plate.  
8.	*Unscrew and Remove the Gripper* **PreciseFlex 400 and PreciseFlex 3400:** Rotate the loose slip ring to access the 6X M2-16 SHCS screws that hold the IntelliGuide gripper. 

Step	Action
9.	**PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4:** Using an M1.5 screwdriver, unscrew the 6X M2-16 SHCS screws and lock washers that hold the IntelliGuide gripper (shown below in red). Do not remove the screws. Leave them in place.  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex DD 4**
10.	**PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4:** Remove the IntelliGuide gripper. When the last screw is unfastened, use one hand to remove the IntelliGuide gripper from the robot flange and another hand to gently pull the slip-ring harness cables through the slot on the top surface of the IntelliGuide gripper.  **PreciseFlex 400 and PreciseFlex 3400**

Step	Action
11.	**PreciseFlex c10:** Lift the robot arm. Inside of the IntelliGuide gripper housing, using an M3 screwdriver, unscrew the 5x M4-10 screws and washers, and remove the IntelliGuide gripper. Use one hand to remove the IntelliGuide gripper from the robot flange and another hand to gently pull the slip-ring harness cables through the slot on the top surface of the IntelliGuide gripper. ***NOTE:*** *The white adaptor screws into the joint 4 flange, and the IntelliGuide gripper screws into the adaptor.*  

Installing a Slip Ring Harness and IntelliGuide s23 or IntelliGuide s60 on a PreciseFlex Robot

NOTE: For IntelliGuide gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

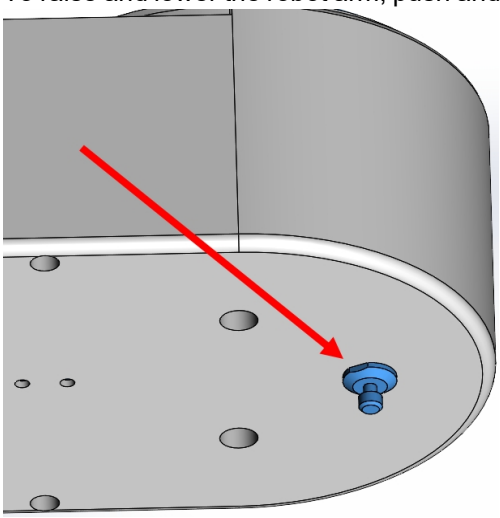
DANGER

Electrical Shock Hazard

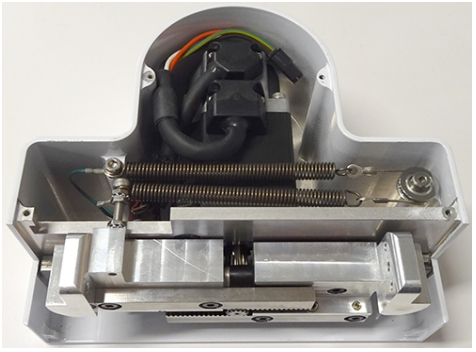
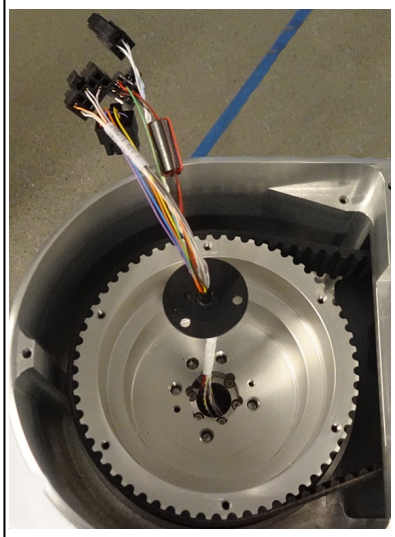
Contact with electrical power can cause death or serious personal injury.

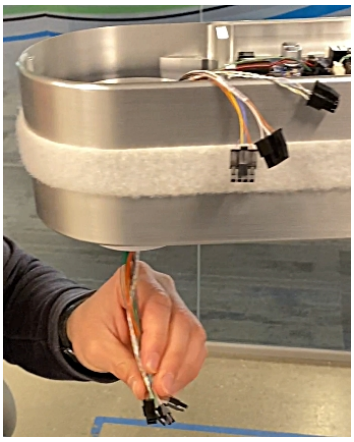
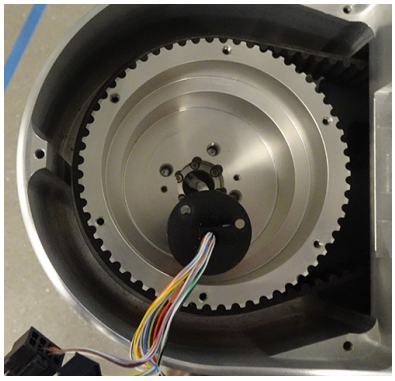
- Turn the robot power **off** when robot covers are removed, and you work with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

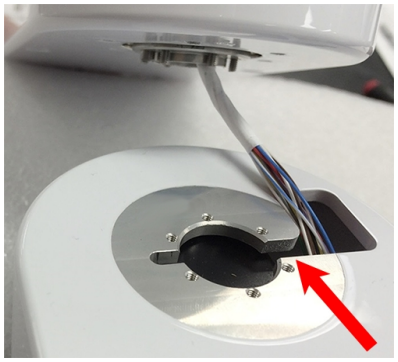
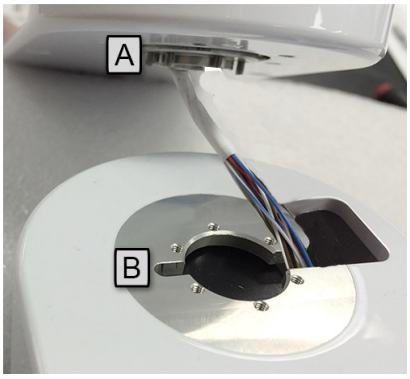
To raise and lower the robot arm, push and hold the brake button under the inner link.

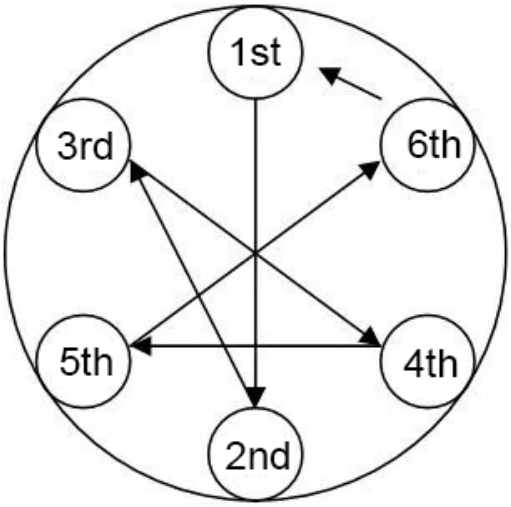
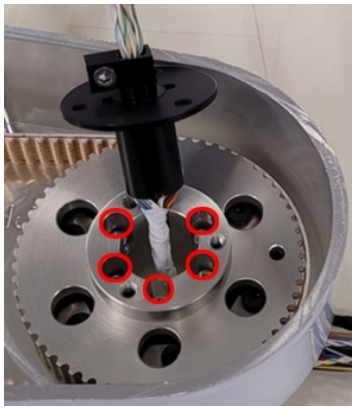
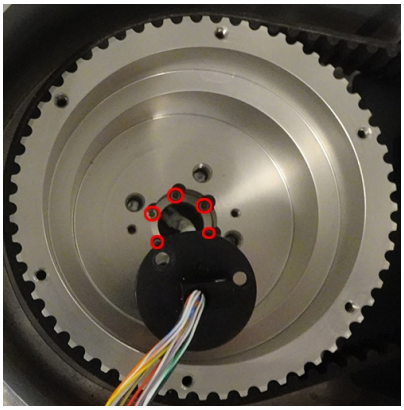


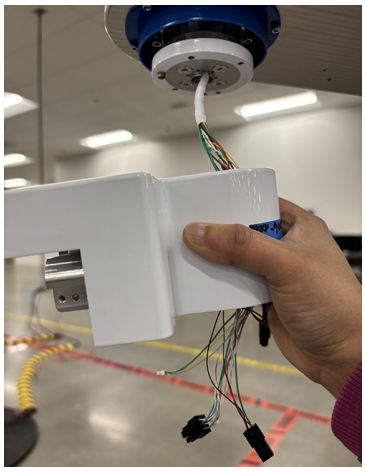
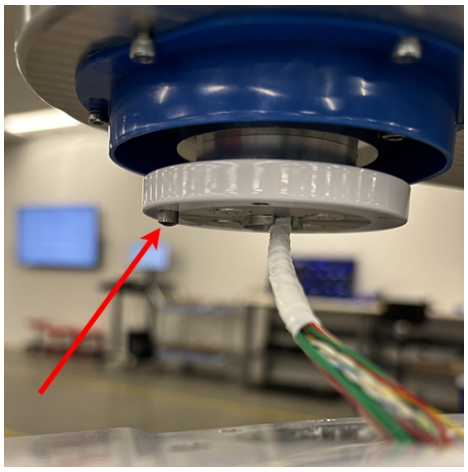
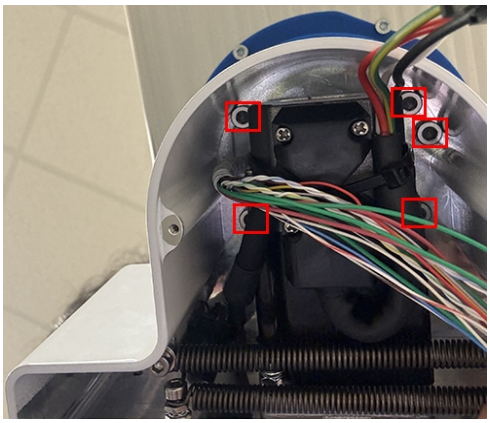
Step	Action
1.	*Remove the Gripper* Follow the instructions for Removing an IntelliGuide s23 or IntelliGuide s60 from a PreciseFlex Robot.

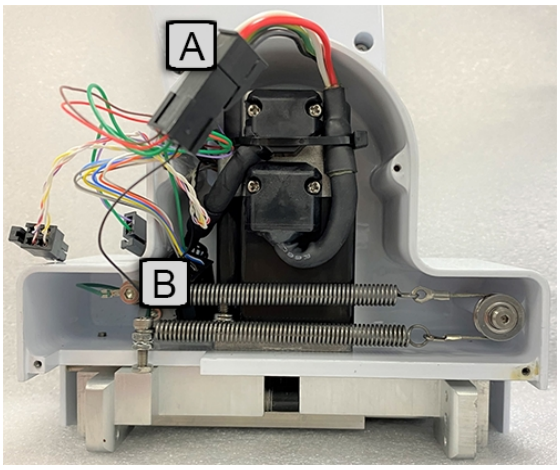
Step	Action
2.	*Prepare the New Gripper for Installation* Separate the new gripper top and bottom. ***NOTE:*** *Do not remove the tape from the wires. Loose wires may get tangled in the springs.*  **IntelliGuide s23**  **IntelliGuide s23**
3.	*Remove the Old Slip Ring Harness* Lower the robot arm and remove the slip ring harness. You may need to push one connector through the flange at a time.  **PreciseFlex DD 4**

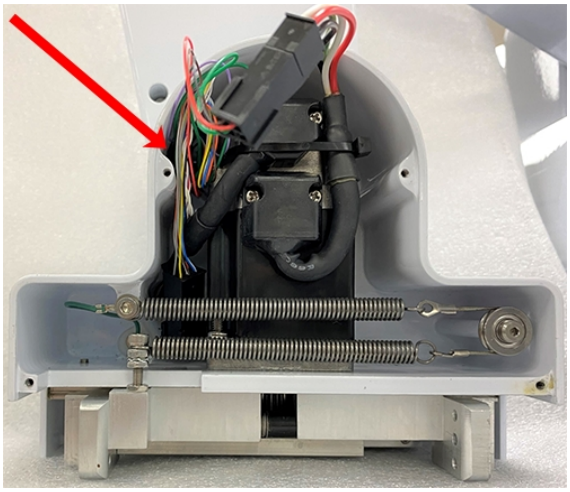
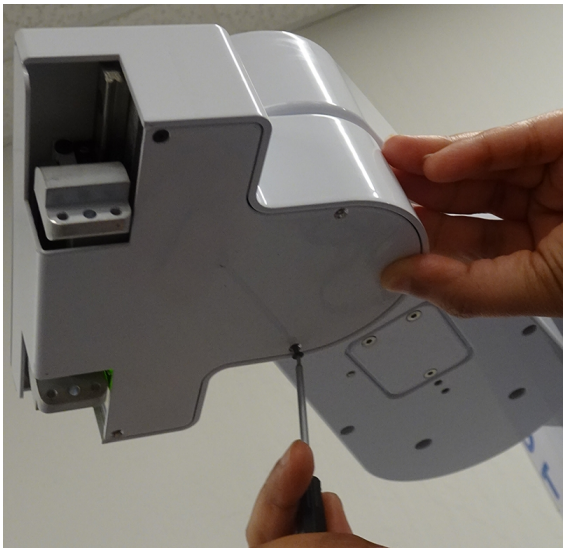
Step	Action
4.	*Insert the New Slip Harness* Insert the new slip-ring harness wires down through the joint 4 flange with the longer wires and slip ring end pointed downward.  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

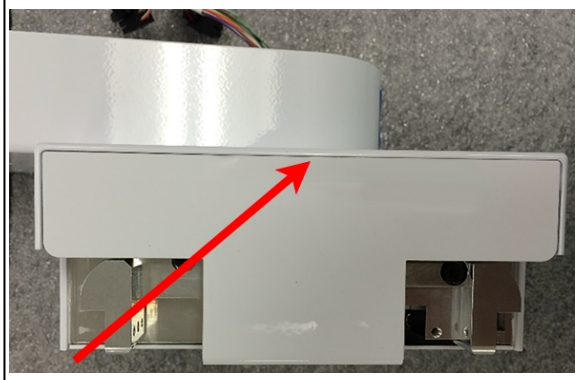
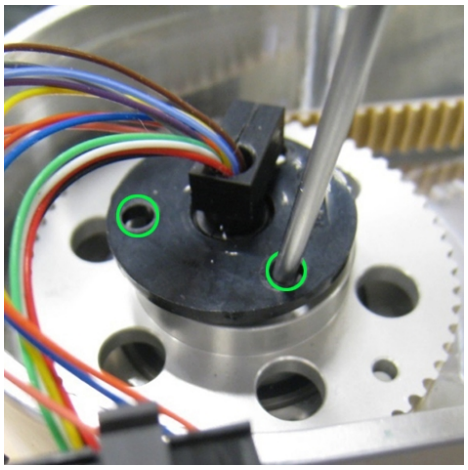
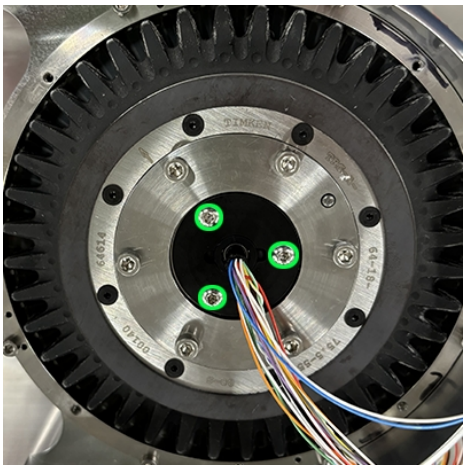
Step	Action
5.	*Attach the Gripper to the Robot* **PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4**: Insert the slip ring harness wires into the gripper slot. Hold the gripper firmly against the underside of joint 4, aligning the protruding guide pin on the underside of joint 4 (A) with the guide slot on the gripper (B).  **Gripper slot**  **Guide pin and guide slot**
6.	**PreciseFlex 400, 3400, and DD 4**: Lower the robot arm while holding the gripper firmly in place against the underside of joint 4.  **PreciseFlex DD 4**

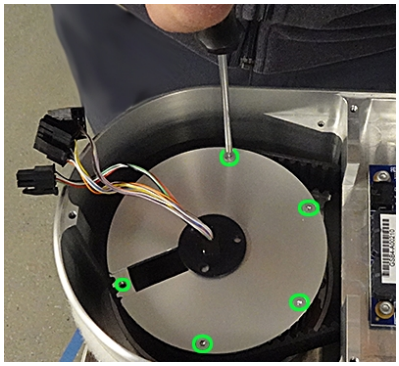
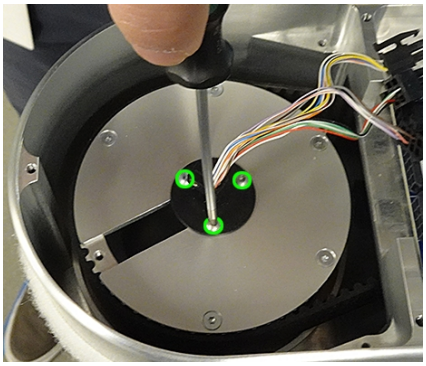
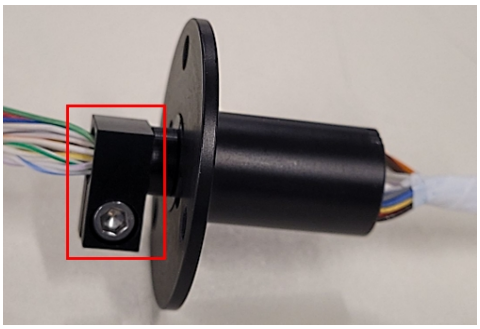
Step	Action
7.	Prepare to fasten the gripper. When fastening the gripper, screw the six screws in a little at a time in a star pattern.  **Screws in a star pattern**
8.	**PreciseFlex 400, 3400, and DD 4**: Using an M1.5 screwdriver, screw the 6X M2-16 SHCS mounting screws and lock washers (shown below in red) into the gripper. ***NOTE:*** *Support the gripper on the underside of joint 4 with your free hand to keep the gripper from falling.*  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex DD 4**

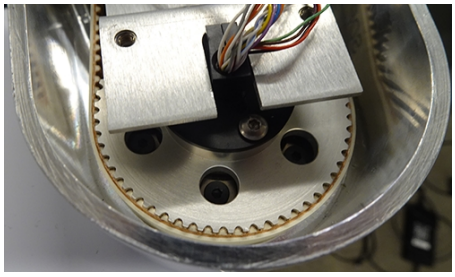
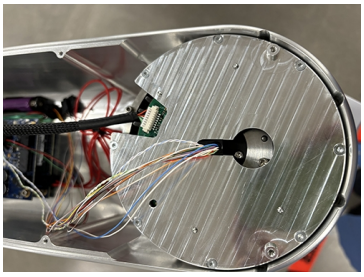
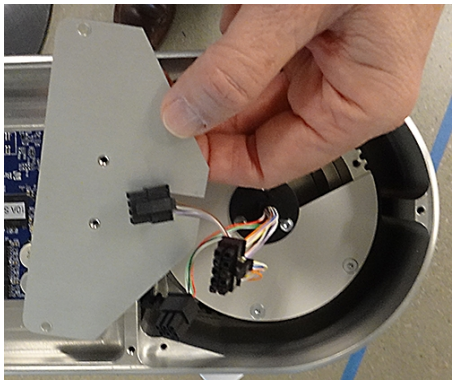
Step	Action
9.	**PreciseFlex c10**: Insert the slip-ring harness wires into the gripper top slot. Hold the gripper top firmly against the flange, aligning the protruding guide pin on the underside of the flange with the guide slot on the gripper.  **Wires in top slot**  **Guide pin**
10.	**PreciseFlex c10**: Hold the gripper firmly against the flange on the underside of joint 4. On in the inside of the gripper housing, using an M3 screwdriver, screw in the 5x M4-10 screws and washers. ***NOTE:*** *The white adaptor screws into the joint 4 flange. The gripper screws into the adaptor.*  **IntelliGuide s60**

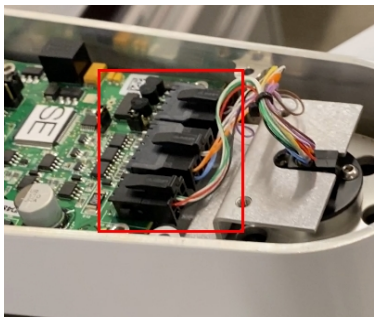
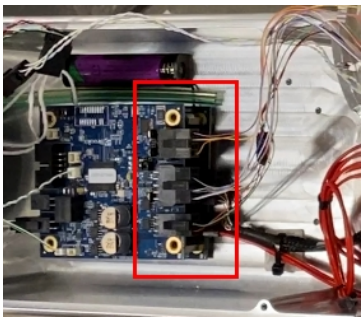
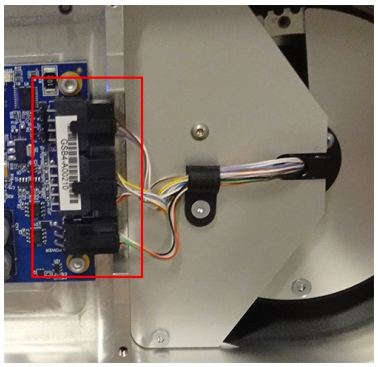
Step	Action
11.	*Connect the Slip Ring Harness Wires to the Gripper* ***NOTE:*** *For slip ring harness and IntelliGuide motor details, refer to the Appendices IntelliGuide s23, s23D, and v23 Motor, IntelliGuide s60 and v60 Motor, and Slip Rings.* Raise the robot arm and attach the connectors from the slip ring harness wires to the connectors in the gripper. The matching connectors should be easily recognizable. Connector **A** is a six-pin male connector for the motor power. Secure the motor cable to the motor body with a cable tie. Connector **B**, tucked behind the springs, is a four-pin male connector for the encoder.  **IntelliGuide s60** For the IntelliGuide s23, there is an additional three-pin plug that is connected to a sensor behind the spring assembly. There is an optional six-pin female connector for an accessory such as a bar code scanner or similar device.

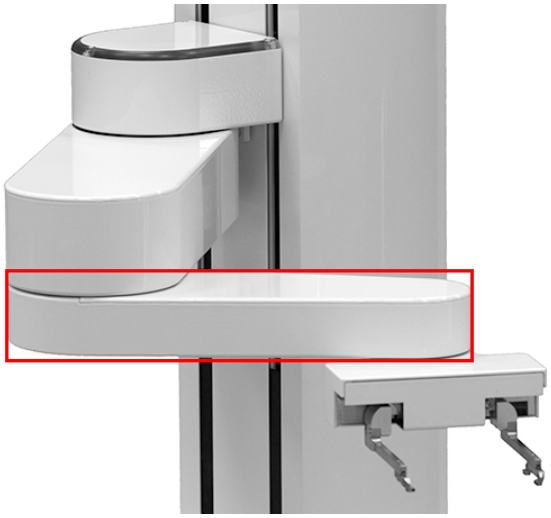
Step	Action
12.	Zip tie loose wires together to keep them away from the gripper springs. Fold and tuck the wires and unused connectors into the area shown below. Confirm that the wires cannot get pinched by the springs.  **IntelliGuide s60**
13.	*Attach the Gripper Bottom* Using an M1.3 screwdriver, screw the bottom to the gripper housing with 4x M2-5 screws. Do not over-torque the screws in this step; once the screw heads have made contact with the mating bore, stop fastening.  **PreciseFlex 400 and 3400**

Step	Action
14.	Confirm that there is no gap between the frame and the gripper cover. 
15.	*Screw in the Slip Ring* Lower the robot arm. Using an M2 screwdriver, screw the 3X M3 slip ring screws (shown below in green) into the slip ring.  **PreciseFlex 400 and 3400**  **PreciseFlex c10**

Step	Action
16.	**PreciseFlex DD 4** Slide the cover plate on under the slip ring. Using an M2 screwdriver, screw the 5X M3 screws into the cover plate, and screw the 3X M3 slip ring screws into the slip ring.  **Cover plate**  **Slip ring**
17.	Attach the slip ring clamp. Slide the loose wires through the clamp, and, using an M2 screwdriver, tighten the clamp with a 1X M2.5-5 SHCS.  **Slip ring and clamp**

Step	Action
18.	*Screw in the Slip Ring Cover*  **PreciseFlex 400 and 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

Step	Action
19.	*Connect the Slip Ring to the GSB* ***NOTE:*** For slip ring harness and GSB details, refer to the Appendices Slip Rings and Guidance Slave Boards (GSBs)  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

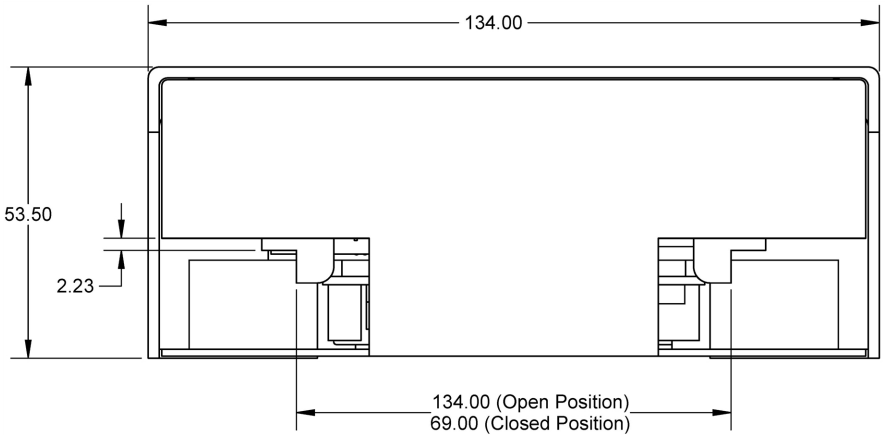
Step	Action
20.	*Put the Cover on the Outer Link* **PreciseFlex 400 and PreciseFlex 3400**: Put the cover onto the outer link, and, using an M2.5 screwdriver, screw in the 4X M3-30 SHCS.  **PreciseFlex c10 and PreciseFlex DD 4**: Put the outer link top cover on, then put the side covers back on. 
21.	*Recalibrate* See your robot user manual for recalibration instructions.

3. IntelliGuide s23D

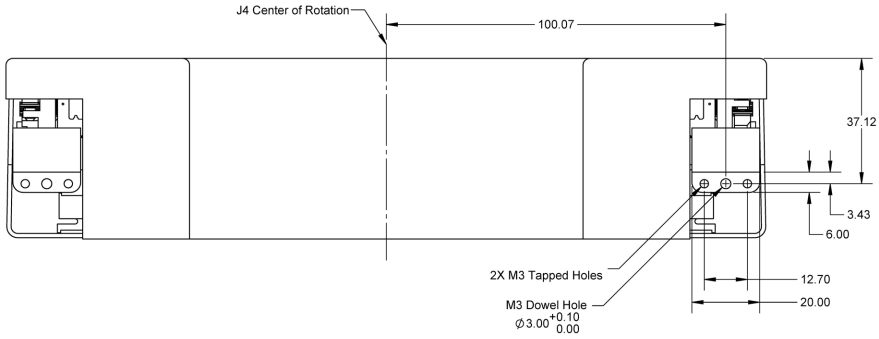
IntelliGuide s23D Overview

The IntelliGuide s23D functions as two IntelliGuide s23 grippers end-to-end in the same housing. It enables the robot to pick a plate while holding another plate, which creates higher throughput. Each side of the IntelliGuide s23D gripper is independently controlled.

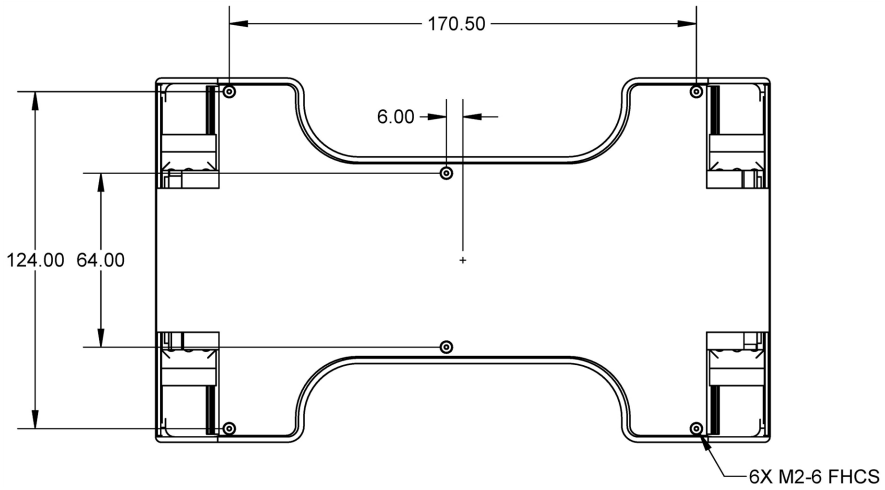
Due to spacing for the motor, the IntelliGuide s23D uses incremental encoders. It must be homed after every power cycle.



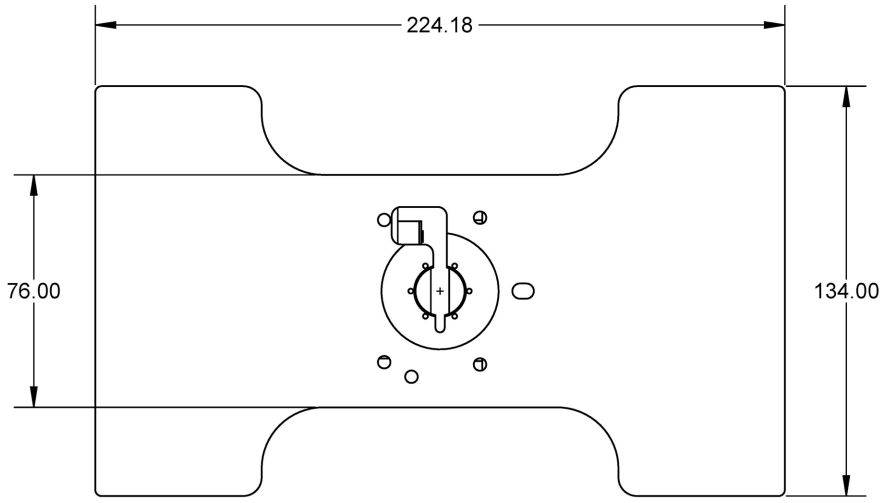
IntelliGuide s23D, front view



IntelliGuide s23D, side view



IntelliGuide s23D, top view



IntelliGuide s23D, bottom view

Replacing an IntelliGuide s23D on a PreciseFlex Robot

Removing an IntelliGuide s23D from a PreciseFlex 3400 Robot

NOTE: For IntelliGuide gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5

- M2
- M2.5
- M3
- M5
- M6

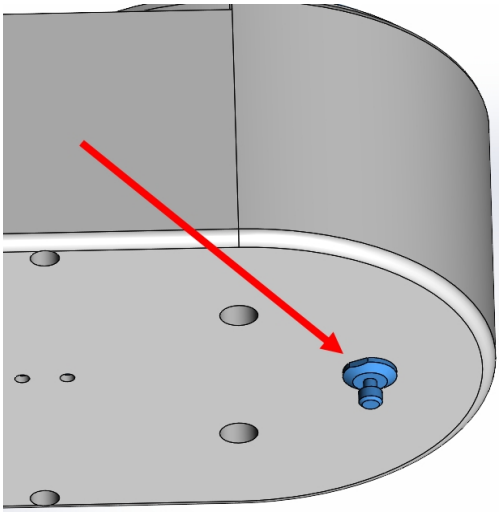
DANGER

Electrical Shock Hazard

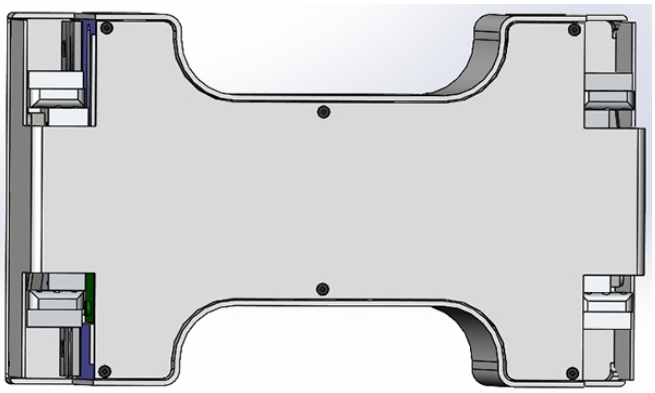
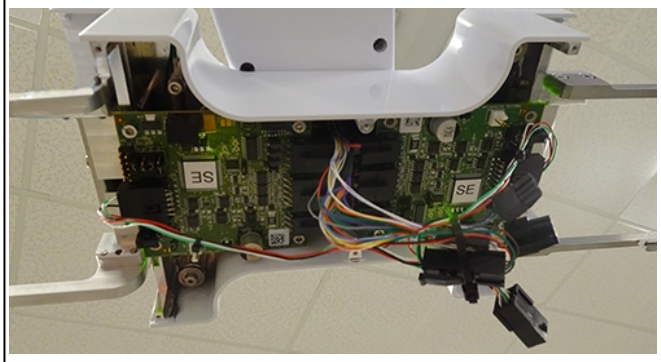
Contact with electrical power can cause serious personal injury or death.

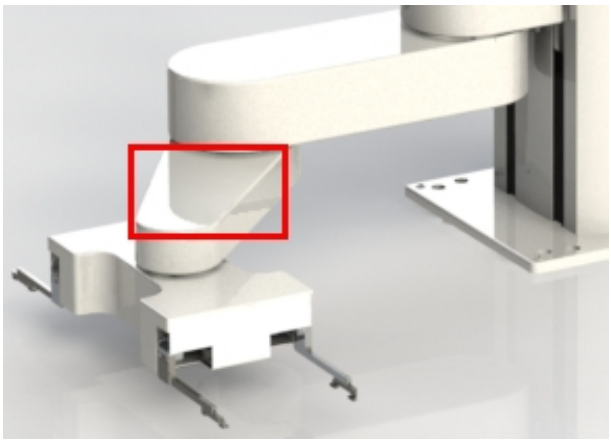
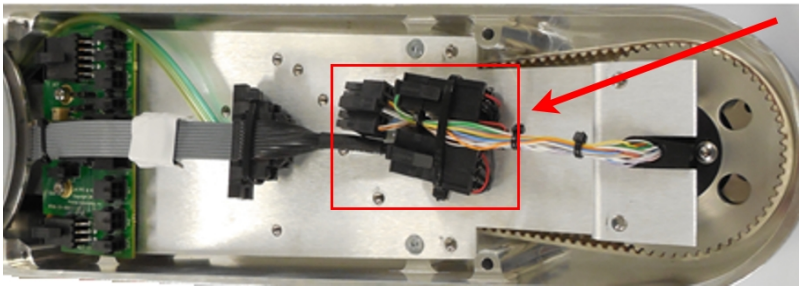
- Turn the robot power **off** when robot covers are removed, and when working with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

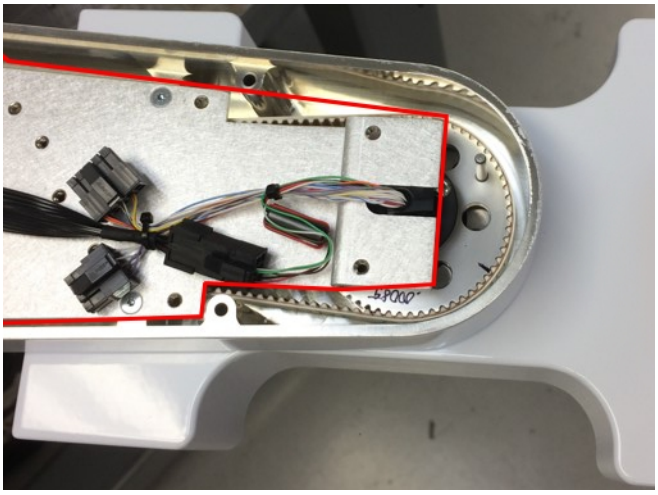
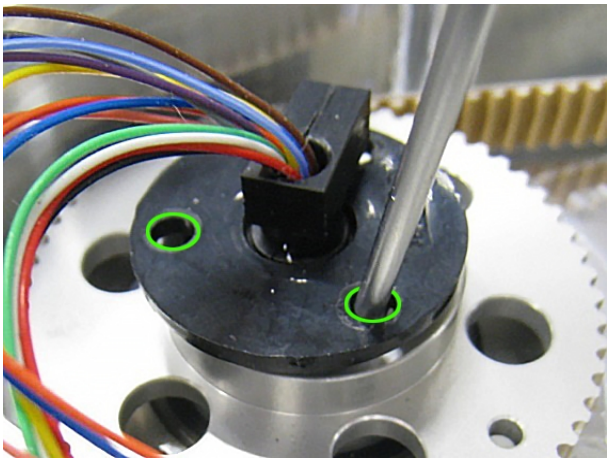
To raise and lower the robot arm, push and hold the brake button under the inner link while supporting the robot arm.

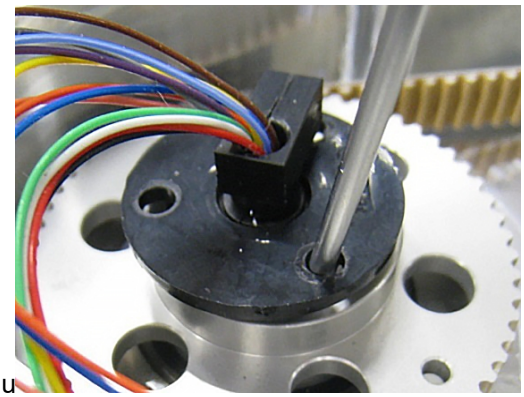
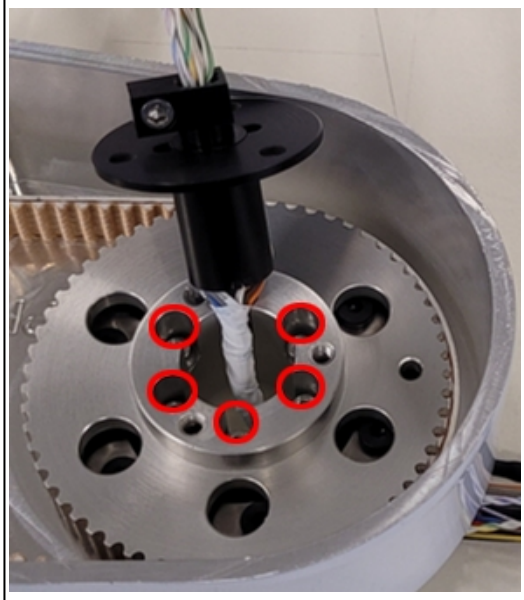


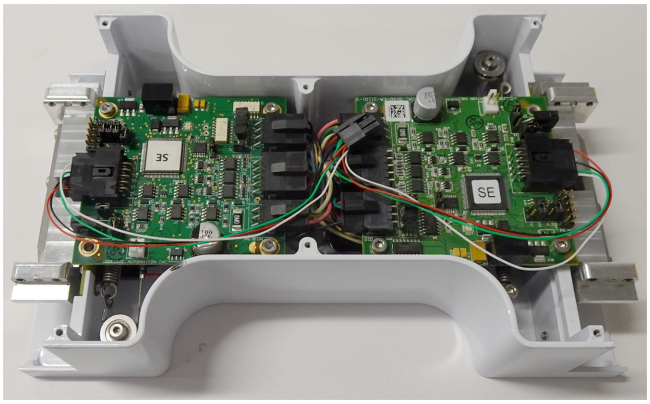
Perform the following procedure to remove an IntelliGuide s23D from a PreciseFlex 3400 robot

Step	Action
1.	*Prepare the Gripper for Removal* Raise the robot arm, using an M1.3 screwdriver, unscrew the 6X M2-5 screws from the IntelliGuide gripper bottom, and remove the IntelliGuide gripper bottom. 
2.	Disconnect the slip ring harness wires from the IntelliGuide gripper. 

Step	Action
3.	*Remove the Outer Link Cover* Lower the robot arm. Using an M2.5 screwdriver, unscrew the 4X M3-30 SHCS screws from the outer link cover, and remove the cover.  **Outer link cover on a PreciseFlex 3400**
4.	*Disconnect the Slip Ring Harness* Disconnect the slip ring harness from the extended cable harness.  **Outer link of PreciseFlex 3400, slip ring harness connector on extended cable harness**

Step	Action
5.	*Remove the Slip Ring Cover* Unscrew and remove the metal cover protecting the slip ring. 
6.	*Unscrew the Slip Ring* Using an M2 screwdriver, unscrew the three M3 slip ring screws (shown below in green). 

Step	Action
7.	*Unscrew and Remove the Gripper* Rotate the loose slip ring to access the 6X M2-16 SHCS screws that hold the IntelliGuide gripper. Using an M1.5 screwdriver, unscrew the 6X M2-16 SHCS screws.  u **Slip ring**  **Screws that hold the IntelliGuide gripper**

Step	Action
8.	Remove the IntelliGuide gripper. 

Installing a Slip Ring and IntelliGuide s23D on a PreciseFlex 3400 Robot

NOTE: For IntelliGuide gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

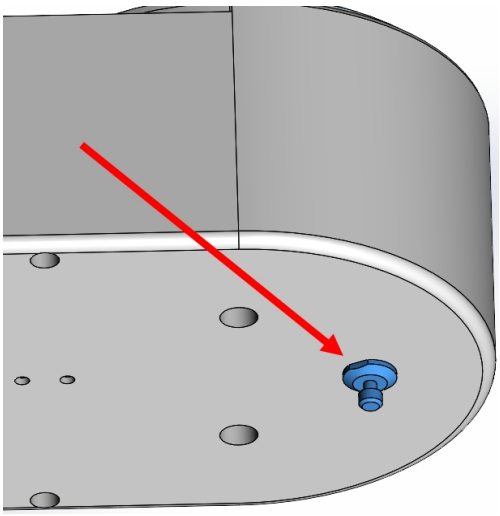
DANGER

Electrical Shock Hazard

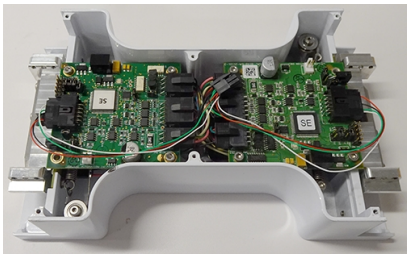
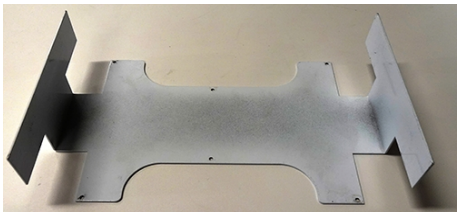
Contact with electrical power can cause serious personal injury or death.

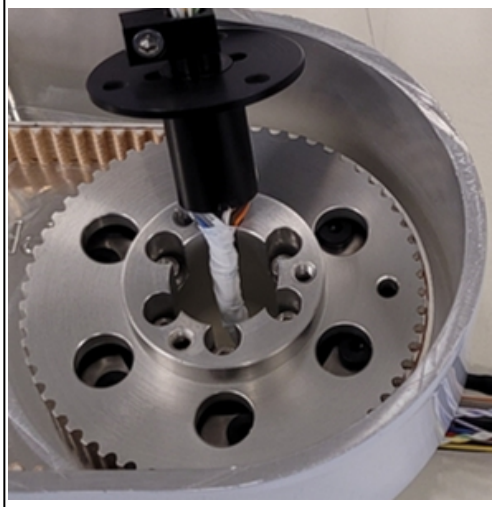
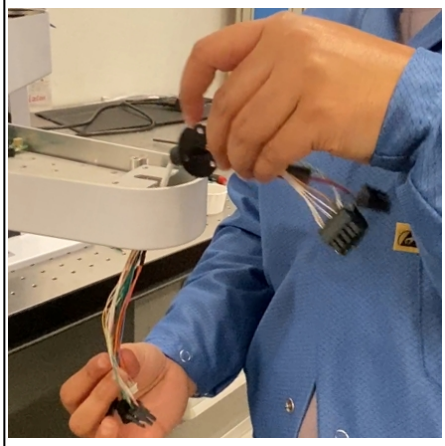
- Turn the robot power **off** when robot covers are removed, and when working with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

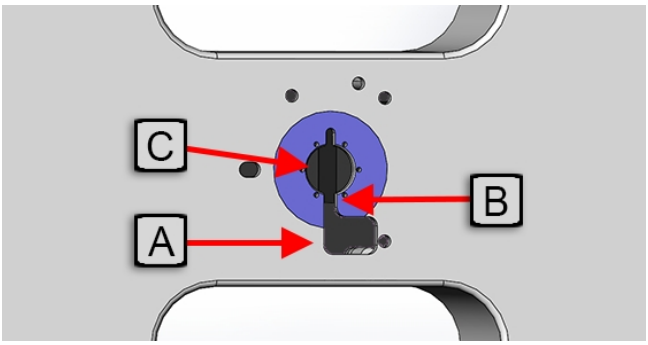
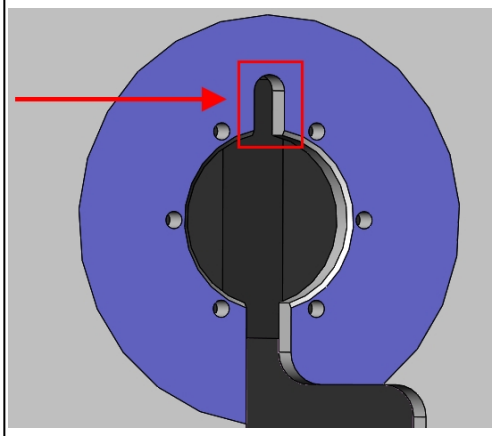
To raise and lower the robot arm, push and hold the brake button under the inner link.

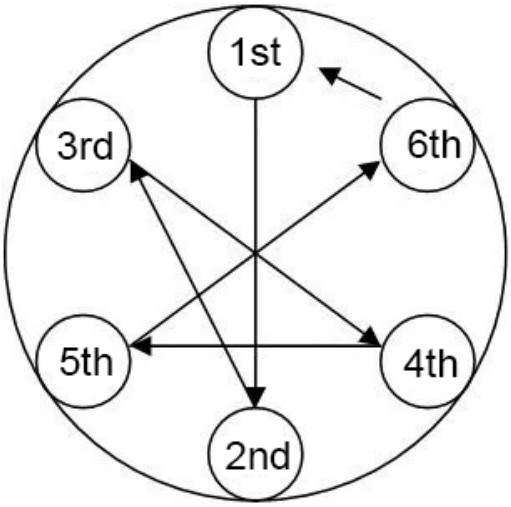
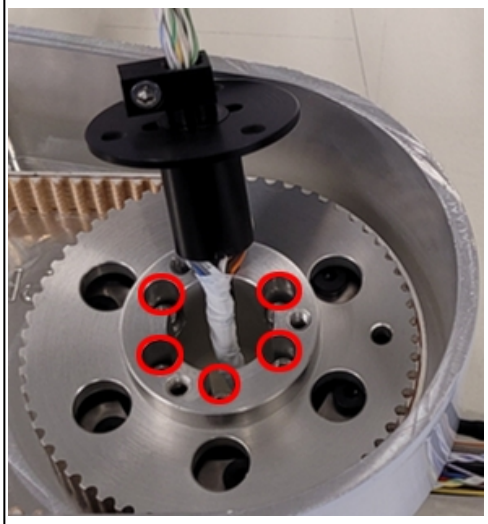


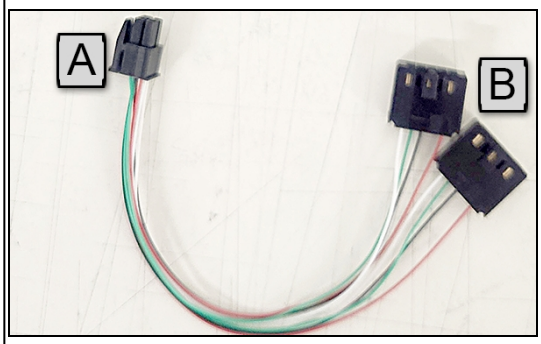
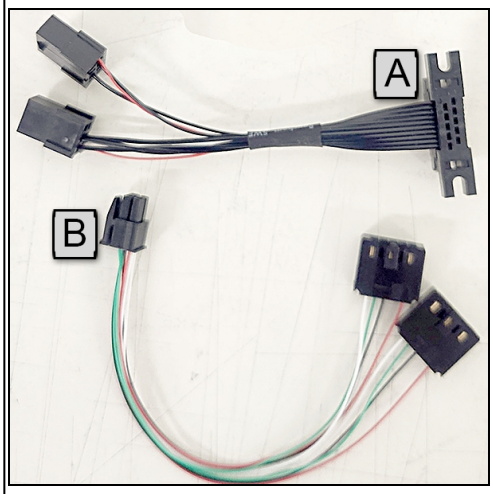
Perform the this procedure to install a slip ring and IntelliGuide s23D on a PreciseFlex 3400 robot.

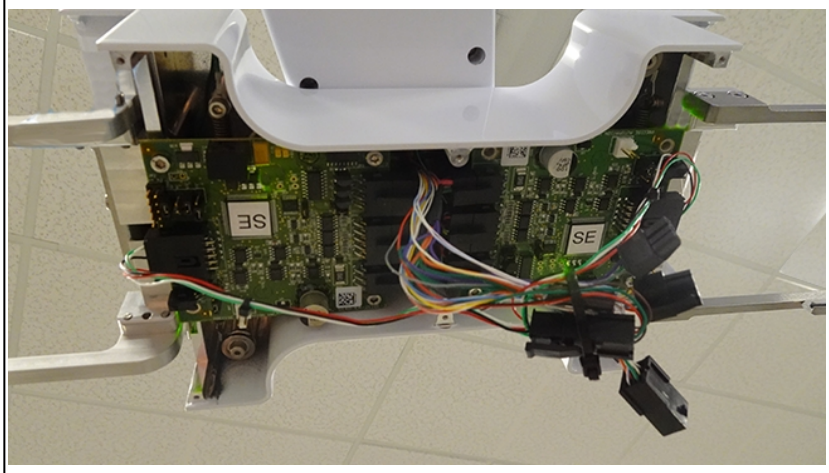
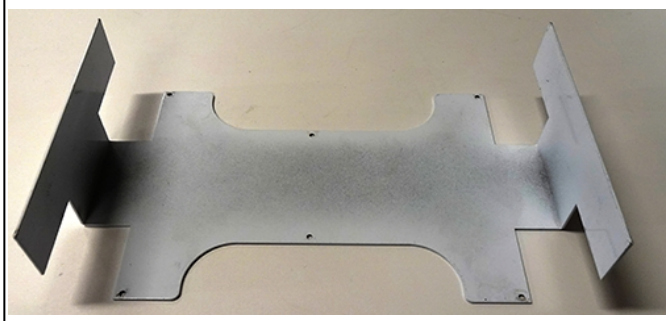
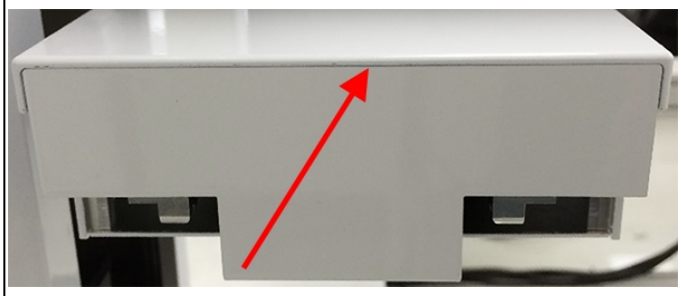
Step	Action
1.	*Remove the Gripper* Follow the instructions for Removing an IntelliGuide s23D from a PreciseFlex 3400 Robot.
2.	*Prepare the New Gripper for Installation* Separate the new IntelliGuide gripper top and bottom. The IntelliGuide s23D top will contain two GSBs into which the slip ring wires will get connected. ***NOTE:*** *Do not remove tape from wires. Loose wires may get tangled in the IntelliGuide gripper springs.*  **IntelliGuide s23D Top**  **IntelliGuide s23D Bottom**

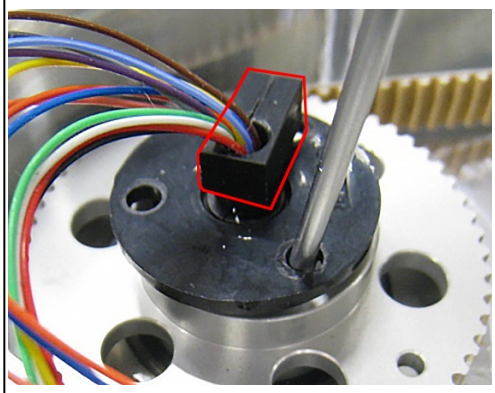
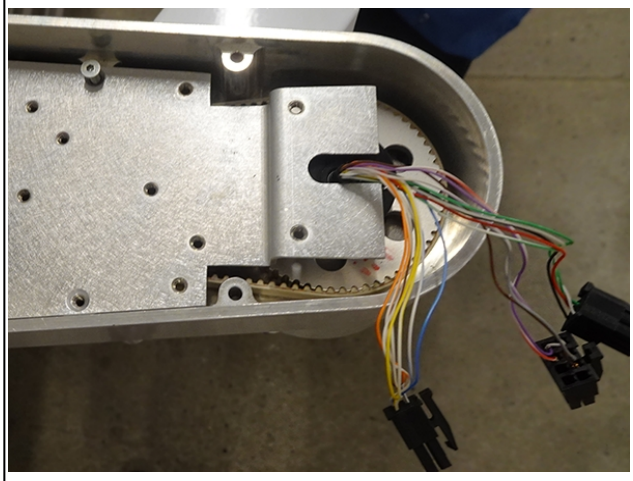
Step	Action
3.	*Remove the Old Slip Ring* Lower the robot arm and remove the slip ring. 
4.	*Insert the New Slip Ring* Insert the new slip ring wires down through the joint 4 hole with the longer wires and slip ring end pointed downward. Zip tie the loose wires together above and below the slip ring to keep them from getting caught in moving mechanical parts.  **Slip ring in a PreciseFlex 3400**

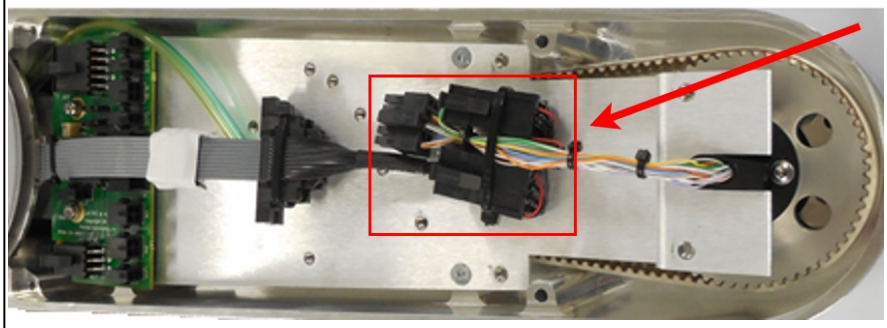
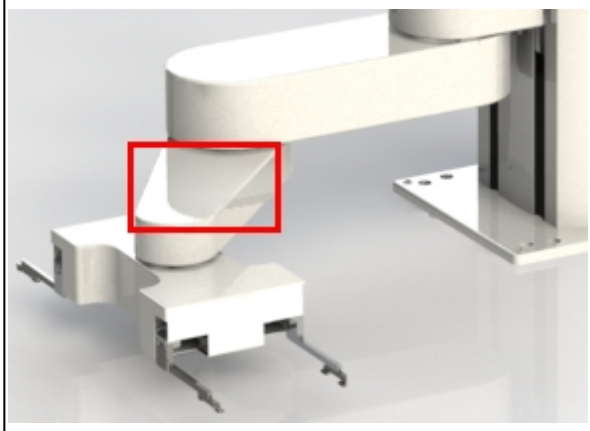
Step	Action
5.	*Attach the Gripper to the Robot* Raise the robot arm. Insert the slip ring wires into the large slot (A) and slide the wires through the narrow slot (B) to the IntelliGuide gripper top hole (C). 
6.	Hold the IntelliGuide gripper firmly against the underside of joint 4 and align the protruding **guide pin** on the underside of joint 4 with the **guide slot** on the IntelliGuide gripper.  **Guide pin**  **Guide slot**

Step	Action
7.	Prepare to screw in the IntelliGuide gripper. When screwing it in, keep the IntelliGuide gripper weight even by screwing the six screws in a little at a time in a star pattern.  **Star pattern for screws**
8.	Lower the robot arm while firmly holding the IntelliGuide gripper in place. Using an M1.5 screwdriver, screw in the 6X M2-16 SHCS screws and 6X M2 lock washers that hold the IntelliGuide gripper (shown below in red). 

Step	Action
9.	*Connect the Slip Ring Wires to the Gripper* Raise the robot arm. The s23D slip ring wire connectors (A) split the wires and their signals into two identical sets (B) that connect to the two GSBs in the s23D. (See the next steps.) 
10.	Connect the slip ring six-pin power plug (A) and four-pin encoder plug (B) to their slip ring splitters. ***NOTE:*** *For details, refer to Slip Rings in the Appendix.* 

Step	Action
11.	Connect the splitters' two six-pin power plugs and two four-pin encoder plugs to their matching connectors on the GSBs. 
12.	*Attach the Gripper Bottom* Using an M1.3 screwdriver, screw the IntelliGuide gripper bottom to the IntelliGuide gripper with 6x M2-5 screws. 
13.	Confirm that there is no gap between the cover and the frame. 

Step	Action
14.	*Screw in the Slip Ring* Lower the robot arm. Put the slip ring clamp (shown below in red) on by sliding the wires through the clamp to the center hole. Using an M2 screwdriver, tighten the clamp with a 1X M2.5-5 SHCS. 
15.	*Screw in the Slip Ring Cover* Screw in the metal protective slip ring cover. 

Step	Action
16.	*Connect the Slip Ring Harness* Connect the slip ring harness to the extended cable harness. 
17.	*Put the Cover on the Outer Link* Using an M2.5 screwdriver, screw the 4X M3-30 SHCS screws into the outer link cover.  **PreciseFlex 3400 outer link**
18.	*Recalibrate* See your robot user manual for recalibration instructions.

4. IntelliGuide v23 and v60

IntelliGuide Vision Gripper Overview

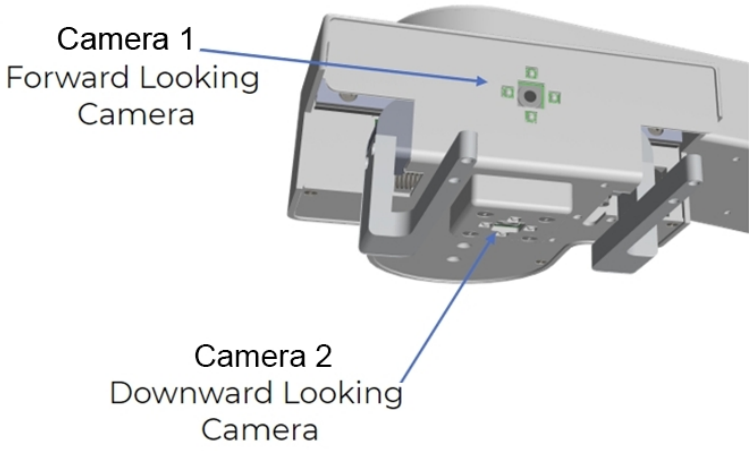
IntelliGuide vision grippers have an integrated vision system with two 5 MP cameras (forward- and downward-facing), manually adjusted lenses, onboard processor, and PWM-controlled lighting. It is connected to the robot controller via Ethernet and is configured using Guidance Development Studio (GDS).

IntelliGuide vision grippers are calibrated and installed on PreciseFlex robots from the factory with a working distance of 150 mm. For more information on adjusting the lens focus or recalibrating the gripper, refer to the Appendices titled Adjusting the Focus of IntelliGuide v23 and v60 Grippers and Performing Calibration of IntelliGuide v23 and IntelliGuide v60 Grippers.

Key Features:

- 1D/2D barcode reading for traceability
- AutoTeach for hands-off position teaching
- Object location and identification
- Classification for presence/ absence tasks
- Onboard image processing

For more information on configuration and using the above key features, refer to the *IntelliGuide Gripper Users Manual*. For more information on the available vision tools, refer to the *IntelliGuide Vision Toolkit Users Manual*.



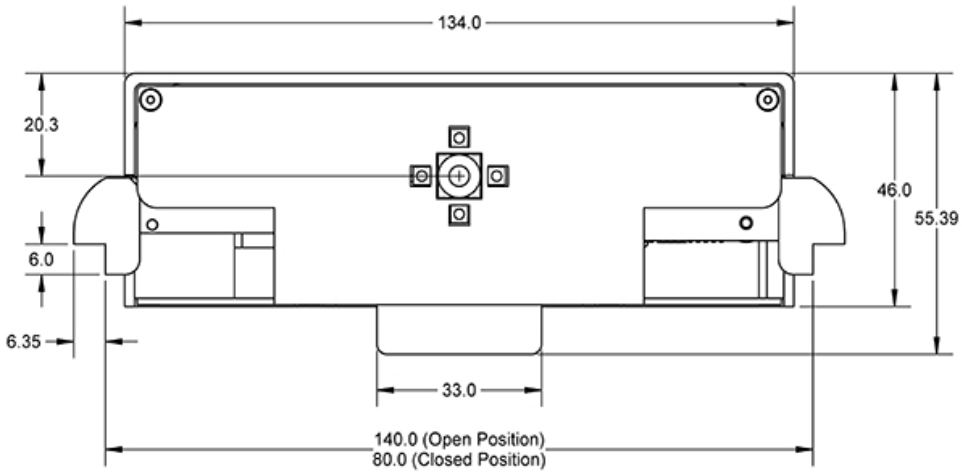
IntelliGuide v23

The IntelliGuide v23 gripper has similar specifications as the IntelliGuide s23 gripper, in addition to two 5 MP cameras and an onboard processor. The IntelliGuide v23 is also capable of handling SBS micro plates in both portrait and landscape orientations.

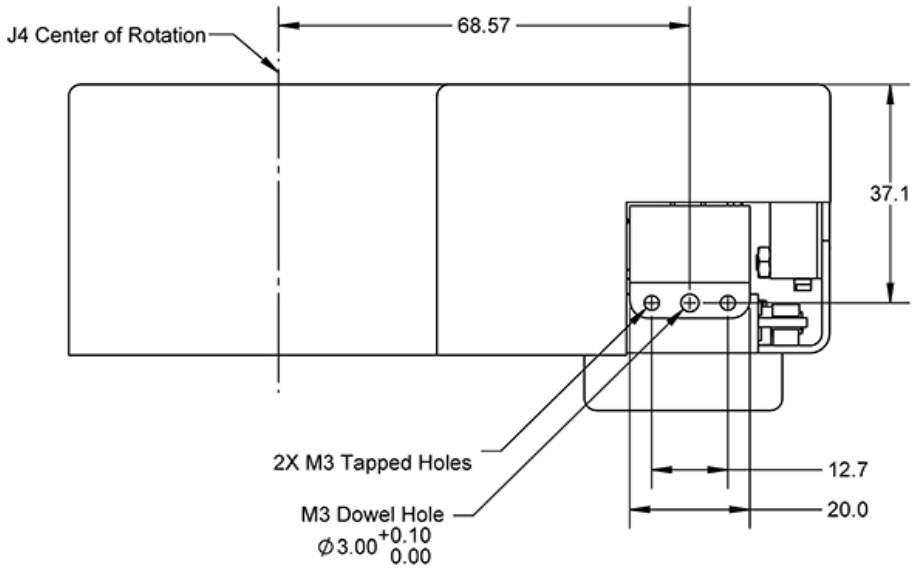
The IntelliGuide v23 features include:

- 23 N gripping force
- 60 mm stroke
- 1 kg payload (may be limited by robot payload)

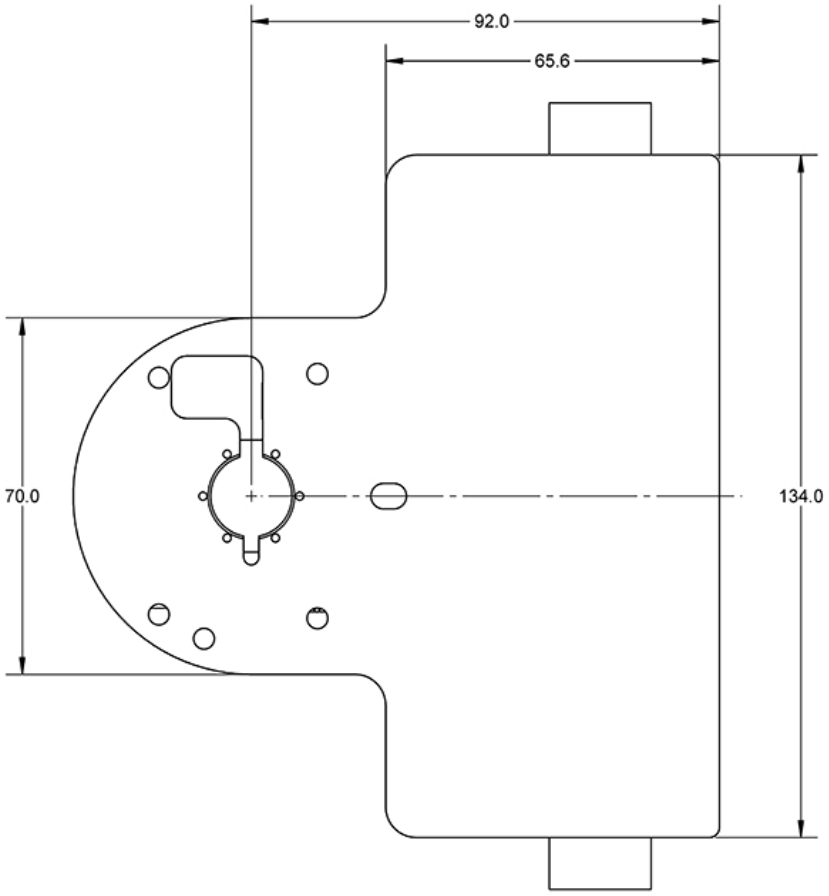
NOTE: All dimensions are in millimeters.



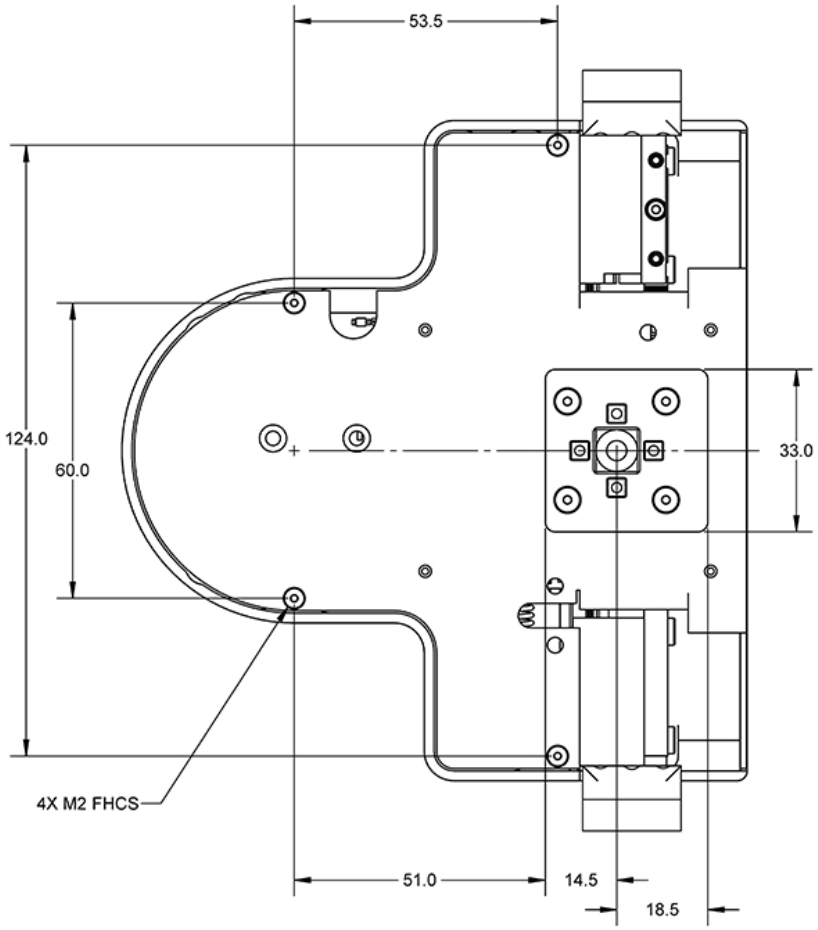
IntelliGuide v23, front view



IntelliGuide v23, side view



IntelliGuide v23, top view



IntelliGuide v23, bottom view

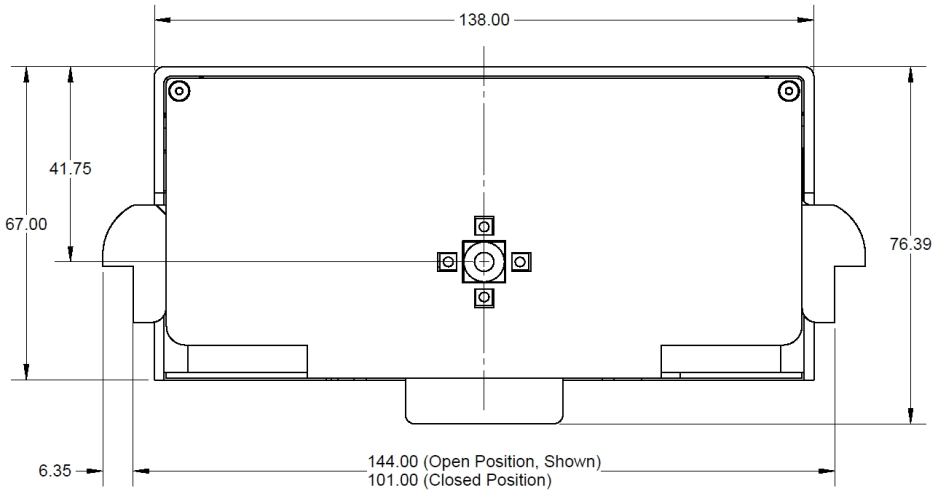
IntelliGuide v60

The IntelliGuide v60 gripper has similar specifications as the IntelliGuide s60 gripper in addition to two 5 MP cameras and an onboard processor.

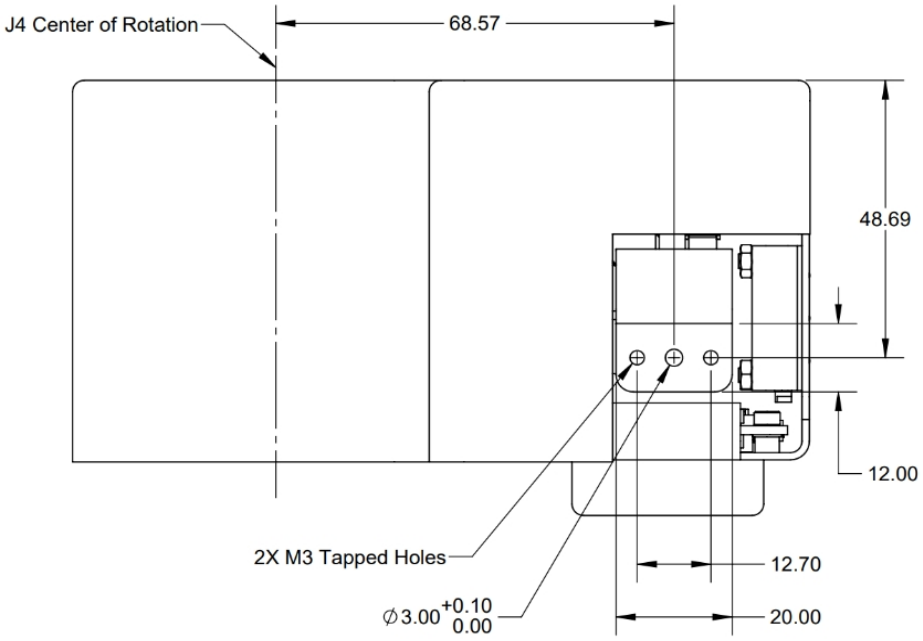
The IntelliGuide v60 features include:

- 60 N gripping force
- 43 mm stroke
- 3 kg payload (when using friction-fit gripping)

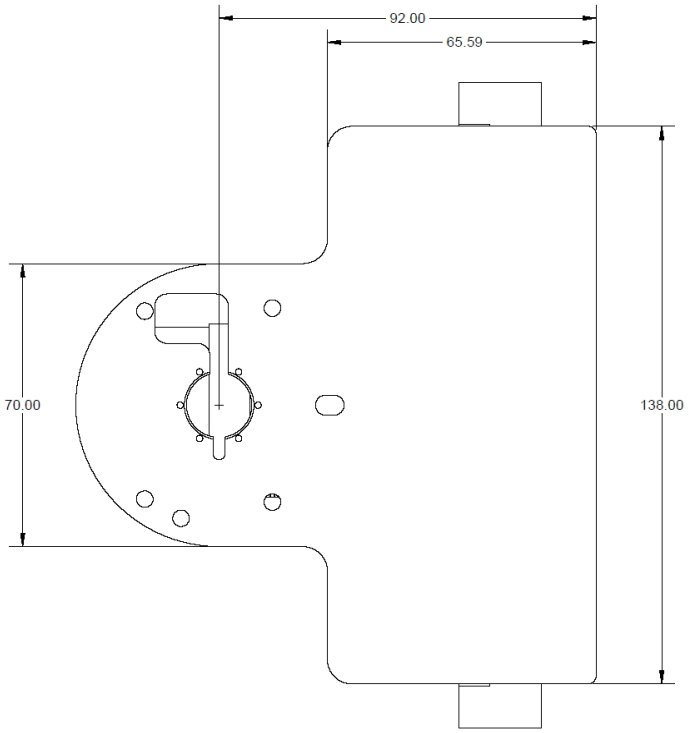
NOTE: All dimensions are in millimeters.



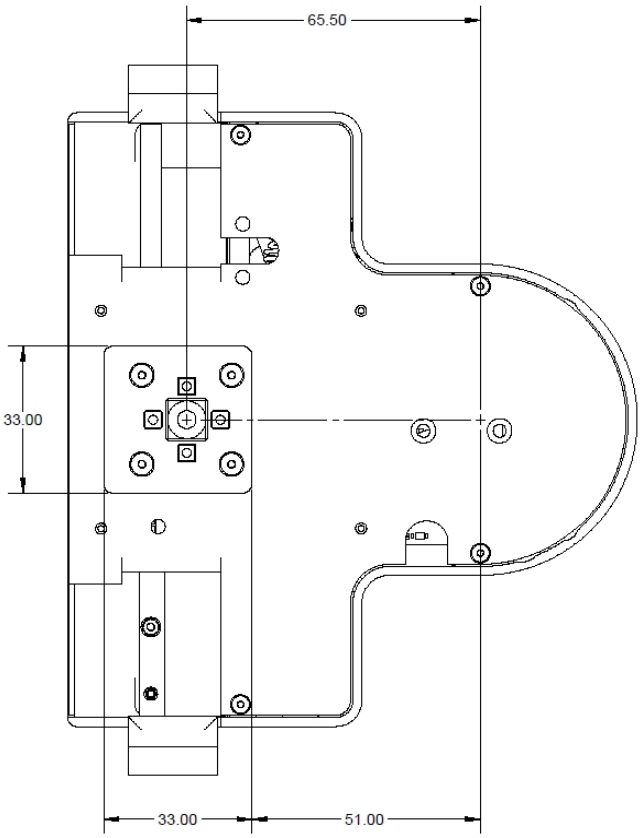
IntelliGuide v60, front view



IntelliGuide v60, side view



IntelliGuide v60, top view



IntelliGuide v60, top view

Replacing an IntelliGuide v23 or IntelliGuide v60 on a PreciseFlex Robot

Removing an IntelliGuide v23 or IntelliGuide v60 from a PreciseFlex Robot

NOTE: For IntelliGuide gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

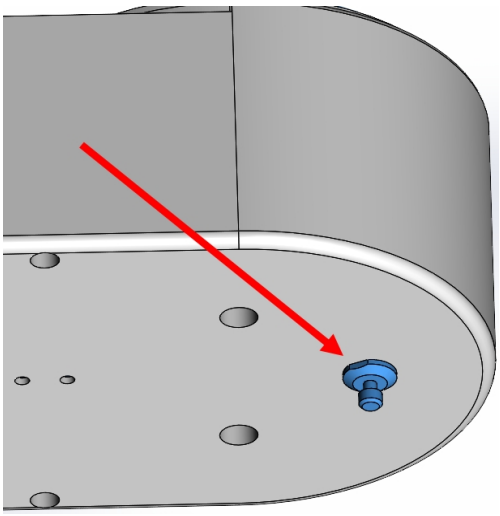
DANGER

Electrical Shock Hazard

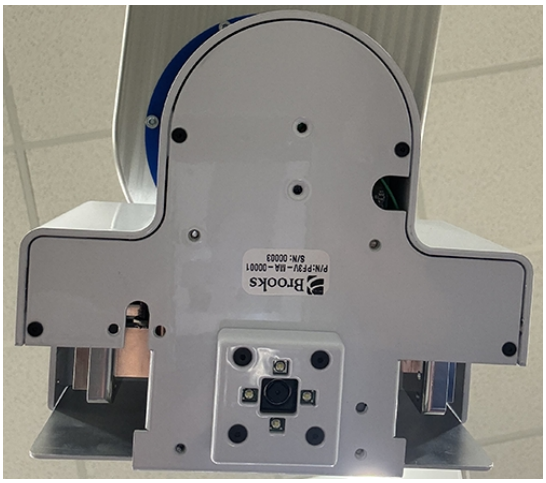
Contact with electrical power can cause serious personal injury or death.

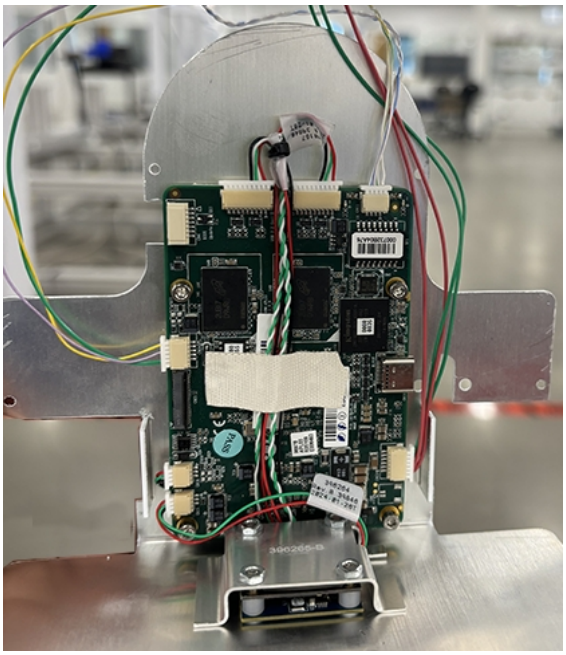
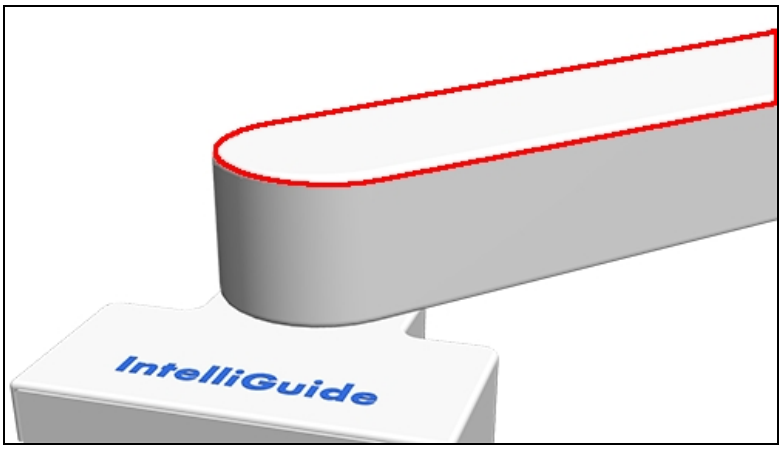
- Turn the robot power **off** when the robot covers are removed, and when working with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

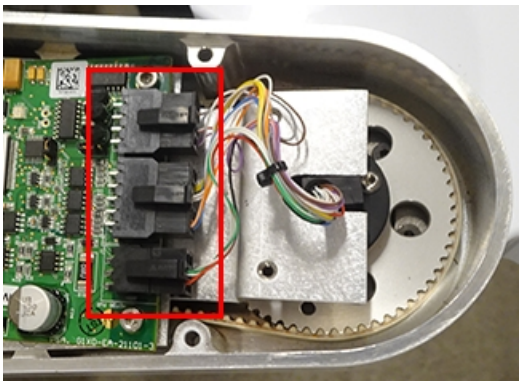
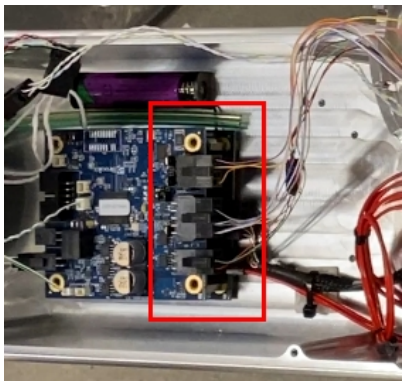
To raise and lower the robot arm, push and hold the brake button under the inner link.

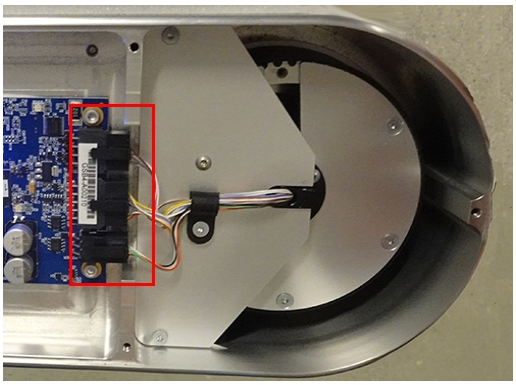
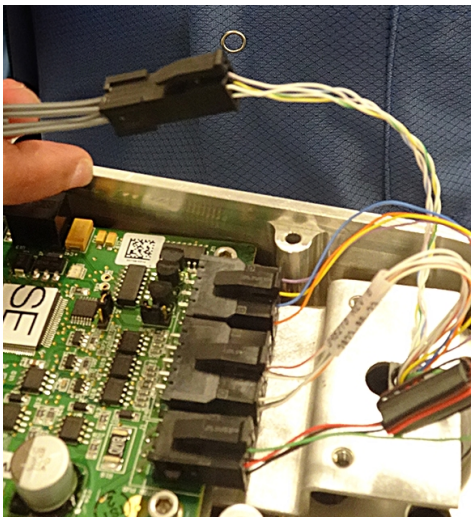


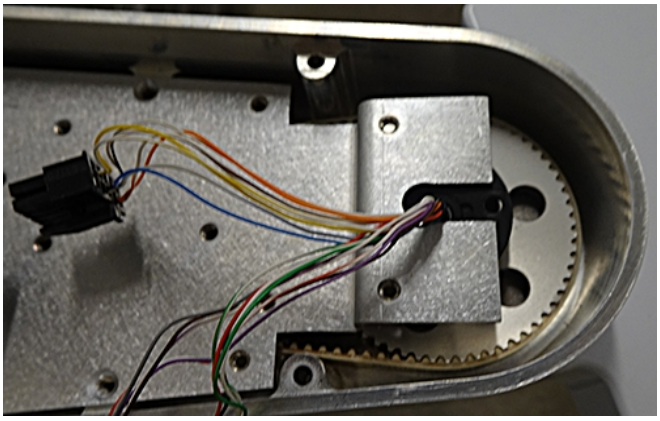
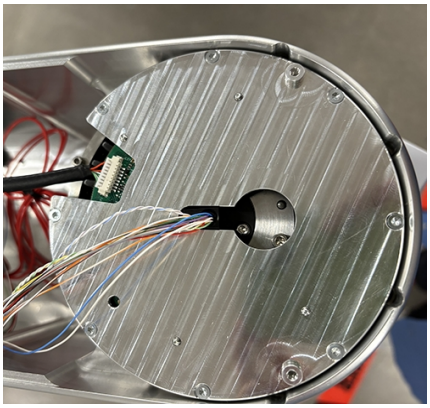
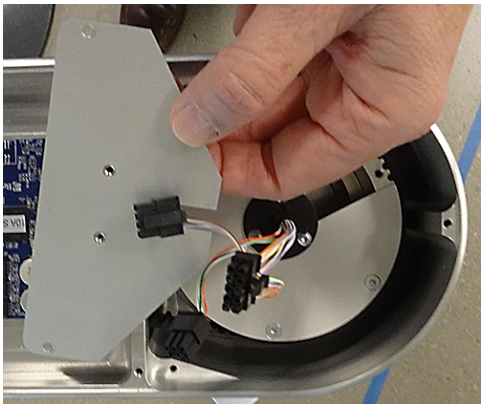
Perform the following procedure to remove an IntelliGuide v23 or v60 from a PreciseFlex robot.

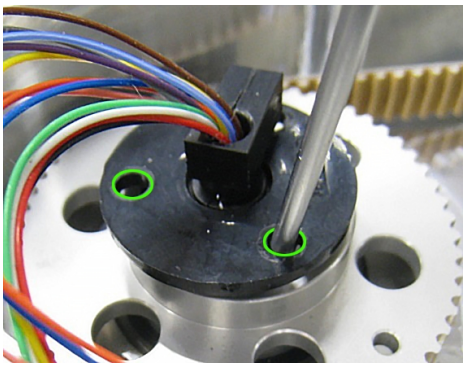
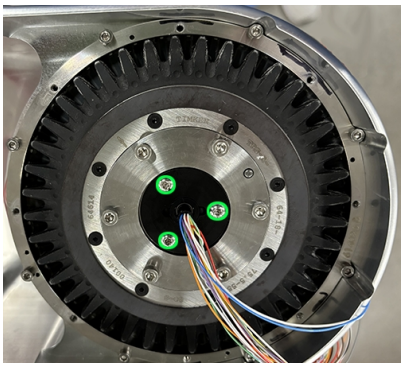
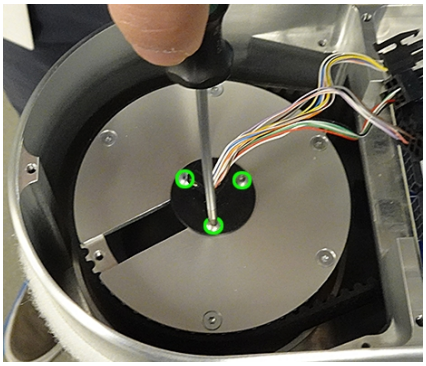
Step	Action
1.	*Prepare the Gripper for Removal* Raise the robot arm. Using an M1.3 screwdriver, unscrew the 4x M2-5 screws from the IntelliGuide vision gripper bottom, and remove the bottom.  **IntelliGuide v23 bottom, exterior**

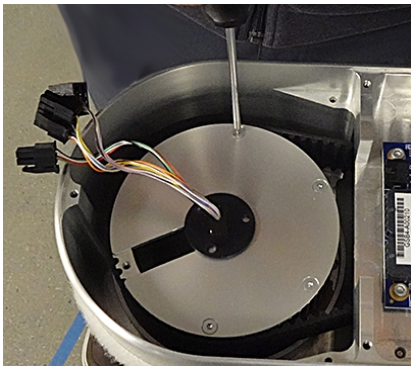
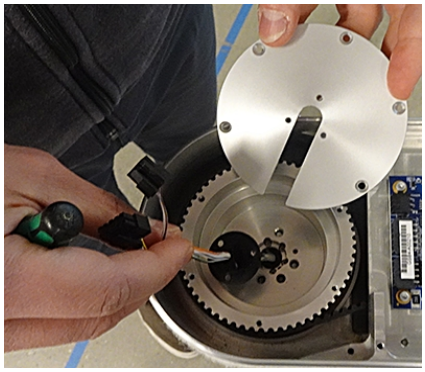
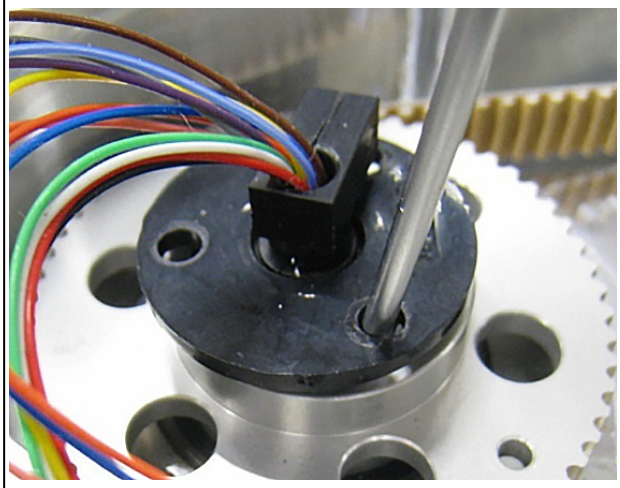
Step	Action
2.	Disconnect the slip ring wires from the IntelliGuide vision processor and from the IntelliGuide gripper motor.  **IntelliGuide v23 bottom, interior**
3.	*Remove the Outer Link Cover* **PreciseFlex 400 or PreciseFlex 3400**: Using an M2.5 screwdriver, unscrew the 4X M3-30 SHCS screws from the outer link cover, and remove the cover.  **PreciseFlex 400 and 3400**

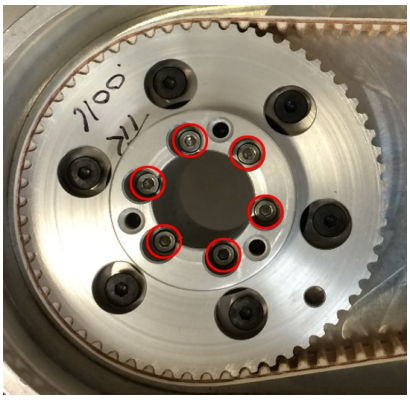
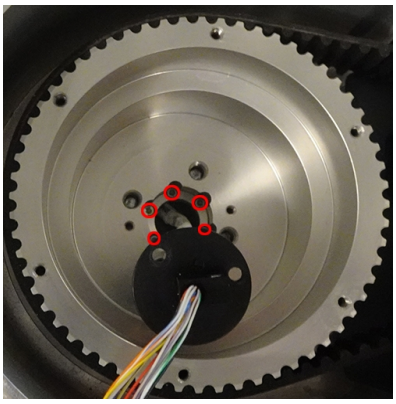
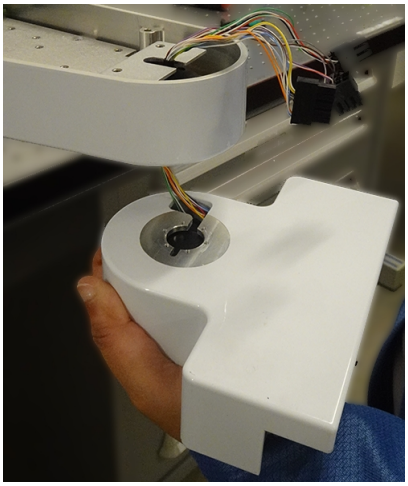
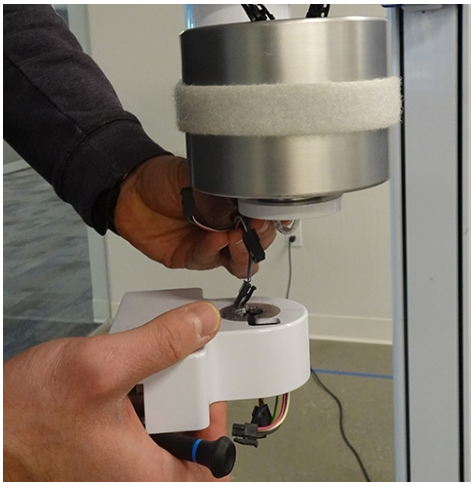
Step	Action
4.	**PreciseFlex c10 and PreciseFlex DD 4**: Using an M2.5 screwdriver, unscrew the 8X M3-6 screws from the blue covers, and remove the covers. Using an M2 screwdriver, unscrew the 6X M3-6 FHCS screws from the metal top cover, and remove the cover.  **PreciseFlex DD 4 and PreciseFlex c10**
5.	*Disconnect the Slip Ring from the GSB*  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10**

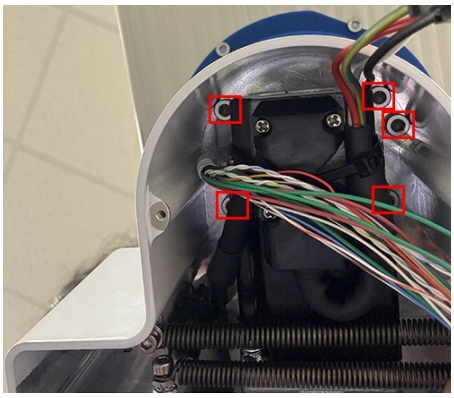
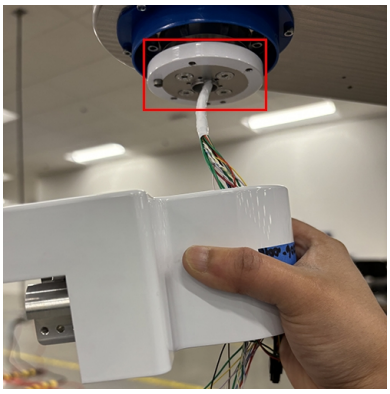
Step	Action
6.	 **PreciseFlex DD 4**
7.	Disconnect the slip ring from the internal Ethernet cable.  **PreciseFlex 400, Ethernet connector**

Step	Action
8.	*Remove the Slip Ring Cover* **PreciseFlex 400 and PreciseFlex 3400**: Disconnect and remove the GSB and unscrew and remove the metal cover. 
9.	**PreciseFlex c10**: Unscrew and remove the slip ring metal cover.  **PreciseFlex DD 4**: Unscrew and remove the slip ring metal cover and wire clamp. 

Step	Action
10.	*Unscrew the Slip Ring* Using an M2 screwdriver, unscrew the 3x M3 screws holding the slip ring (shown in green)  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**

Step	Action
11.	**PreciseFlex DD 4**: Using an M2 screwdriver, unscrew the 5X M3 cover plate screws and remove the cover plate.  
12.	*Unscrew and Remove the Gripper* Lower the robot arm. **PreciseFlex 400 and PreciseFlex 3400**: Rotate the loose slip ring to access and, using an M1.5 screwdriver, unscrew the 6X M2-16 SHCS screws – shown in the next step – that hold the IntelliGuide gripper. 

Step	Action
13.	**PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4:** Using an M1.5 screwdriver, unscrew the 6X M2-16 SHCS screws that hold the IntelliGuide gripper (shown below in red). Do not remove the screws. Leave them in place. ***NOTE:*** *Support the unscrewed IntelliGuide gripper top with your free hand.*  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex DD 4**
14.	**PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4**: Remove the IntelliGuide vision gripper.  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex DD 4**

Step	Action
15.	**PreciseFlex c10**: Lift the robot arm. In the inside of the IntelliGuide gripper, using an M3 screwdriver, unscrew the 5x M4-10 screws and remove the IntelliGuide gripper. ***NOTE:*** *The IntelliGuide gripper is screwed into the white adaptor, which is screwed into the joint 4 flange.*  

Installing a Slip Ring Harness and IntelliGuide v23 or IntelliGuide v60 on a PreciseFlex Robot

NOTE: For IntelliGuide Vision Gripper support, email support_preciseflex@brooksautomation.com.

Required Tools

- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

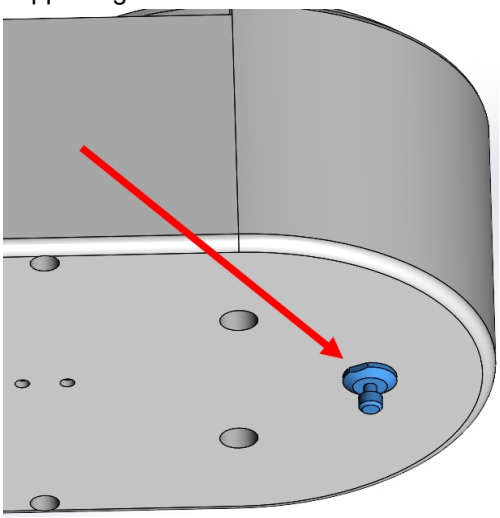
DANGER

Electrical Shock Hazard

Contact with electrical power can cause serious personal injury or death.

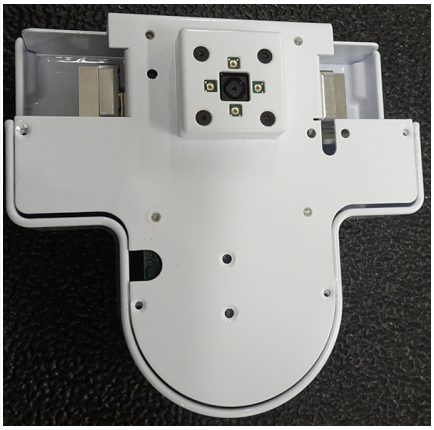
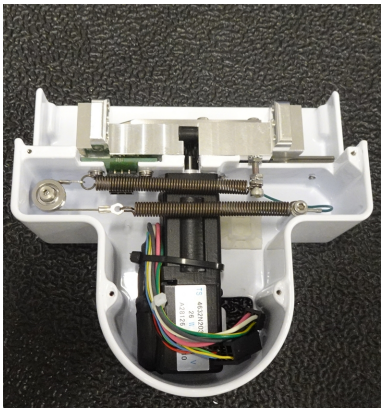
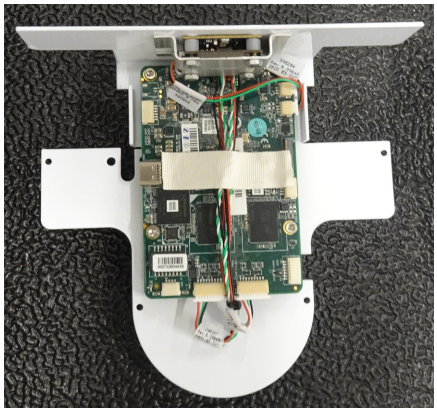
- Turn the robot power **off** when the robot covers are removed, and when working with the exposed wires and circuit boards.
- Turn the robot power **on** to raise and lower the robot arm.

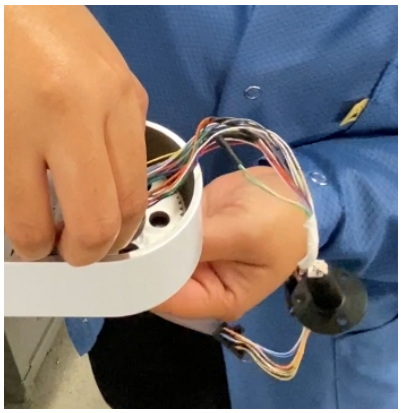
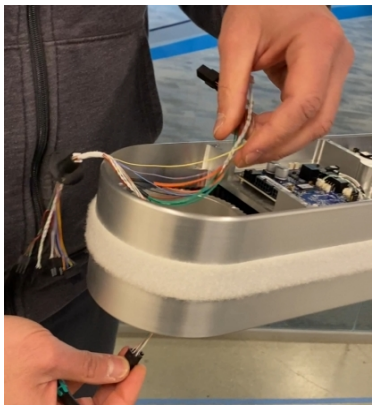
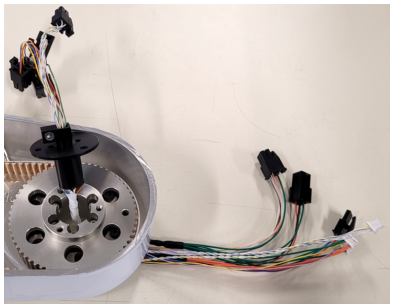
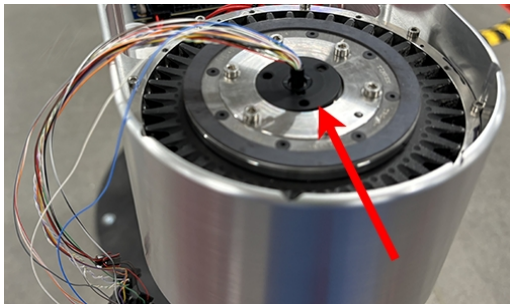
To raise and lower the robot arm, push and hold the brake button under the inner link while supporting the robot arm.

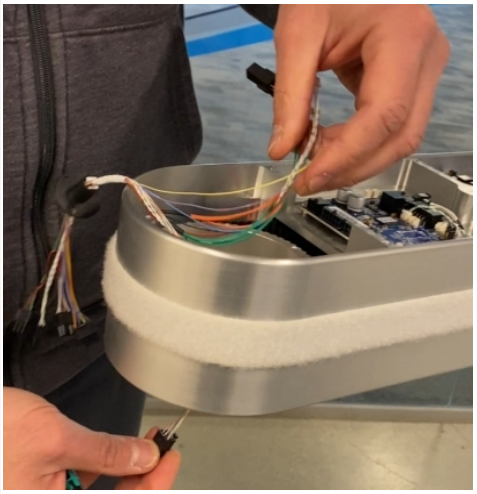
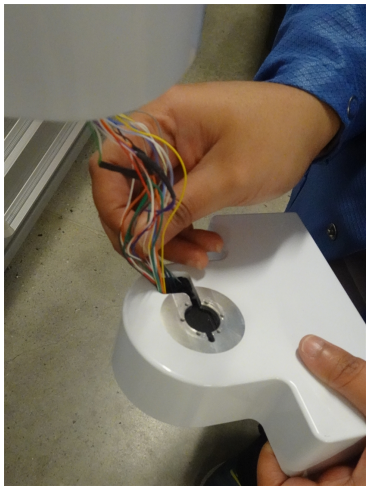
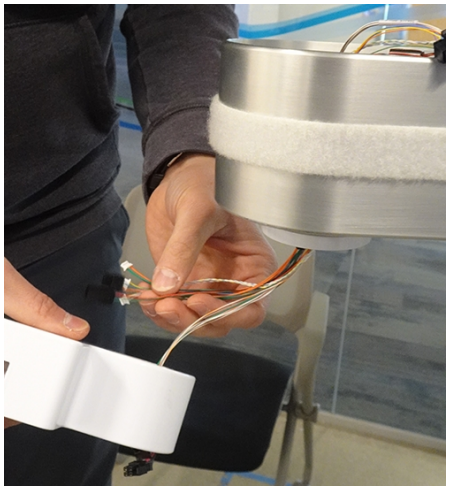


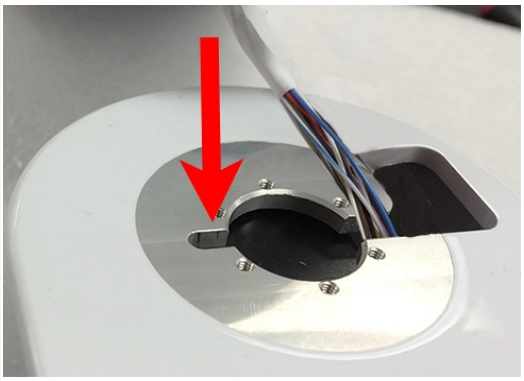
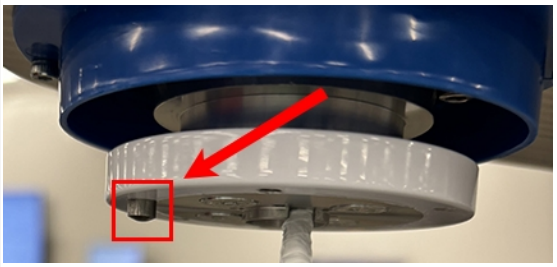
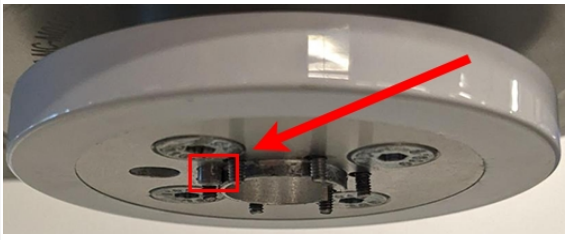
Perform the following procedure to install a slip ring and an IntelliGuide v23 or v60 on a PreciseFlex Robot.

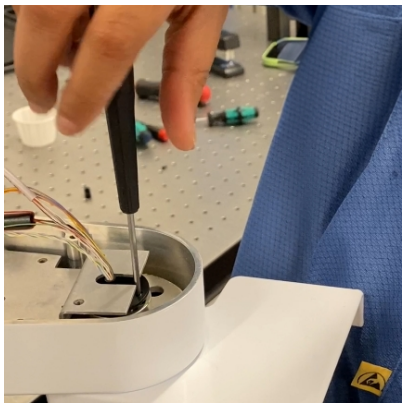
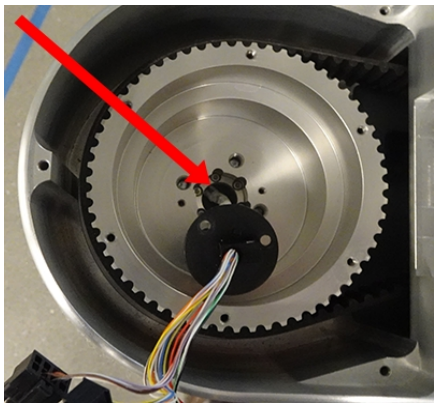
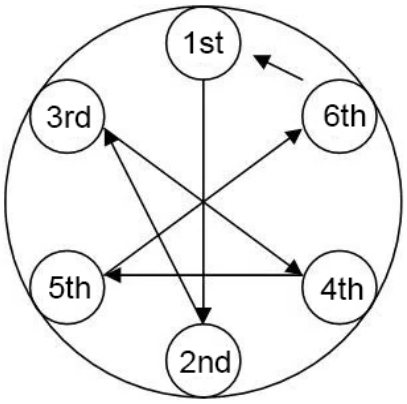
Step	Action
1.	*Remove the Gripper* Follow the instructions for Removing an IntelliGuide v23 or IntelliGuide v60 from a PreciseFlex Robot.

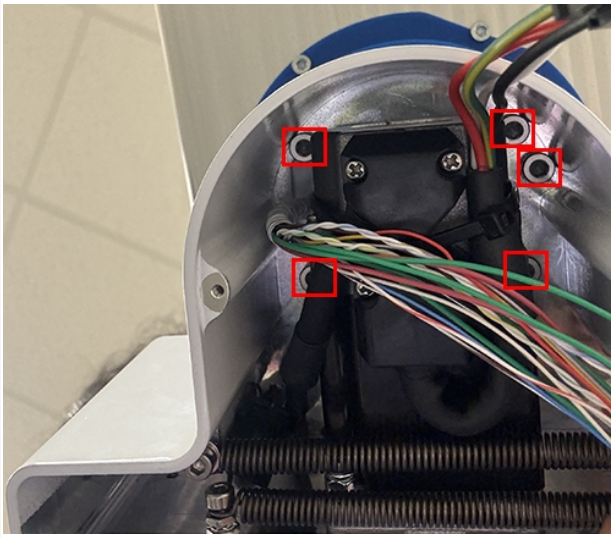
Step	Action
2.	*Prepare the New IntelliGuide v23 or v60 for Installation* Using an M1.3 screwdriver, unscrew the 4x M2-5 screws from the IntelliGuide Vision Gripper's bottom plate.  **IntelliGuide v23**
3.	Separate the vision gripper top and bottom halves. ***NOTE:*** *Do not remove the tape from the wires. Loose wires may get tangled in the gripper springs.*  **IntelliGuide v23, top**  **IntelliGuide v23, bottom**

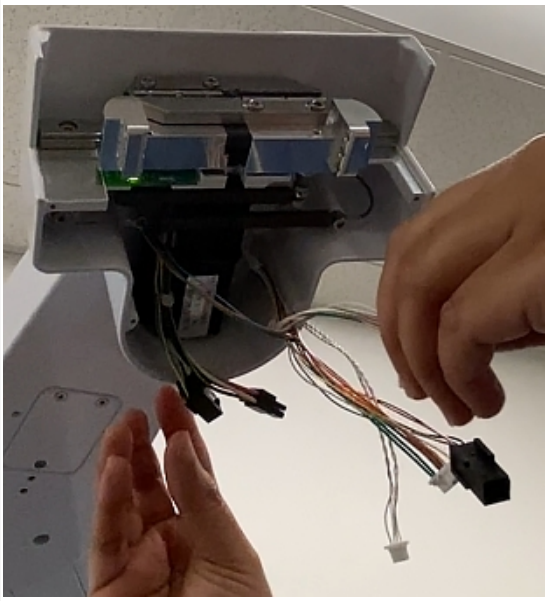
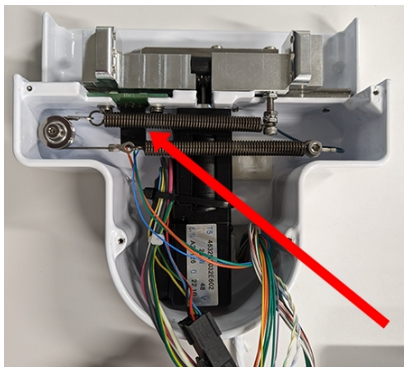
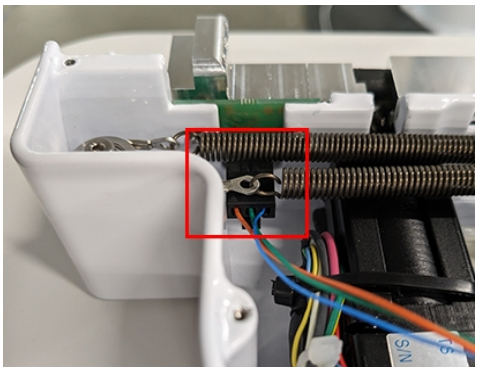
Step	Action
4.	*Remove the Old Slip Ring* Lower the robot arm and pull out the old slip ring.  **PreciseFlex 400 and 3400**  **PreciseFlex DD 4**
5.	*Insert the New Slip Ring* Insert the new slip ring wires -- the end with the white connectors -- down through the Joint 4 hole. Zip tie the loose wires together above and below the black plastic slip ring to keep wires from getting caught in moving mechanical parts. ***NOTE:*** *IntelliGuide vision gripper slip rings have three white connectors; regular slip rings do not. Also, the IntelliGuide vision gripper slip ring for the v60 has* ***two*** *black connectors at the end, and the IntelliGuide vision gripper slip ring for the v23 has* ***three*** *black connectors.*  **PreciseFlex 400 and 3400**  **PreciseFlex c10**

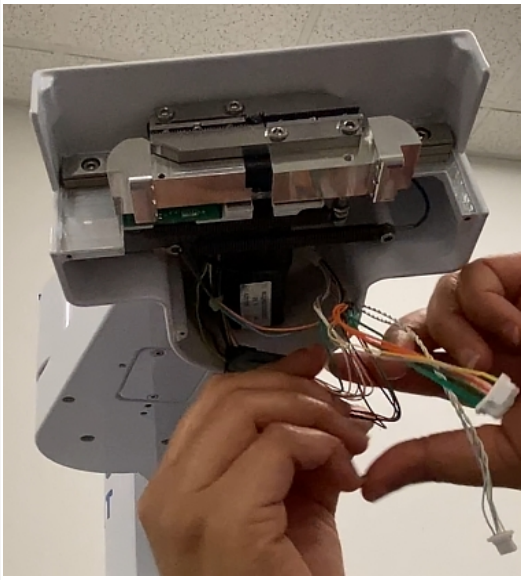
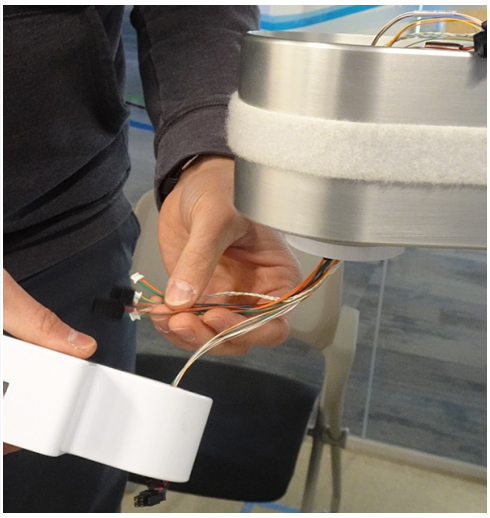
Step	Action
	 **PreciseFlex DD 4**
6.	*Attach the Vision Gripper to the Robot* Insert the slip ring wires into the gripper slot.  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10 and PreciseFlex DD 4**

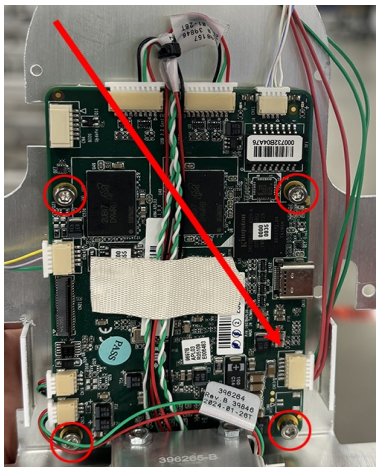
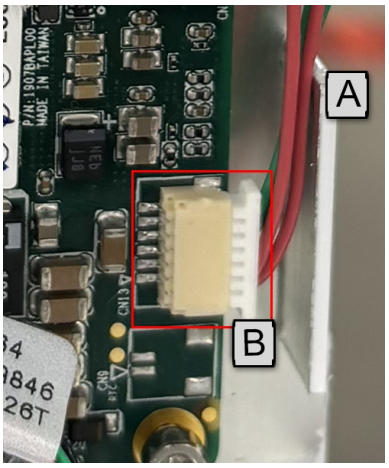
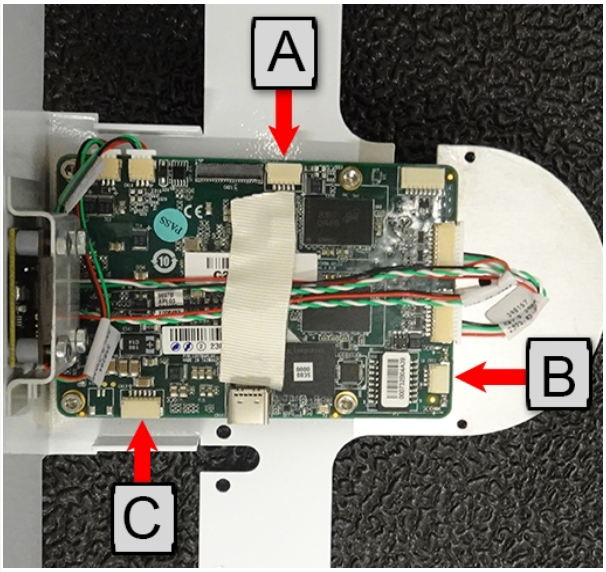
Step	Action
7.	Lift the IntelliGuide vision gripper up to the bottom of joint 4 and align the protruding guide pin on the underside of joint 4 (see the next step) with the guide-pin slot on the gripper top.  **IntelliGuide v23, guide-pin slot**
8.	Slide the guide pin on the underside of joint 4 into the guide pin slot on the IntelliGuide vision gripper and press the IntelliGuide vision gripper firmly against joint 4.  **Guide pin, PreciseFlex 400 and PreciseFlex 3400**  **Guide pin, PreciseFlex c10**  **Guide pin, PreciseFlex DD 4**

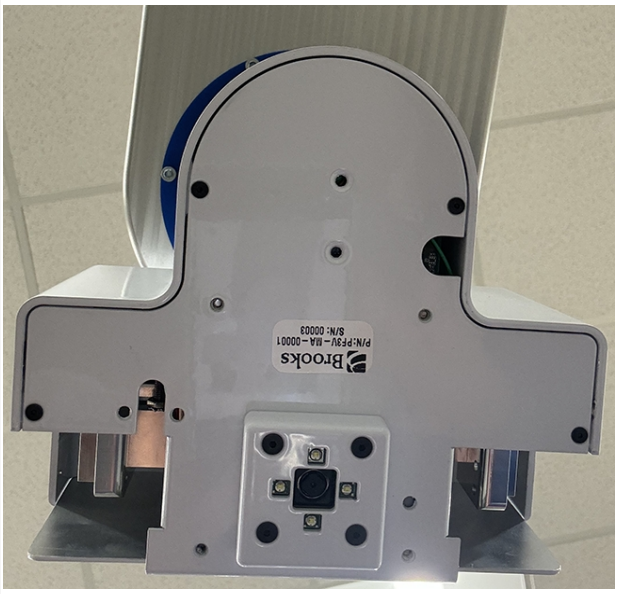
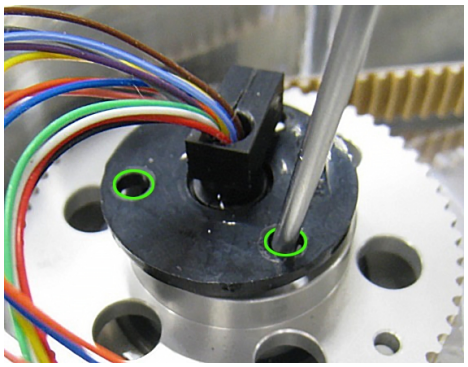
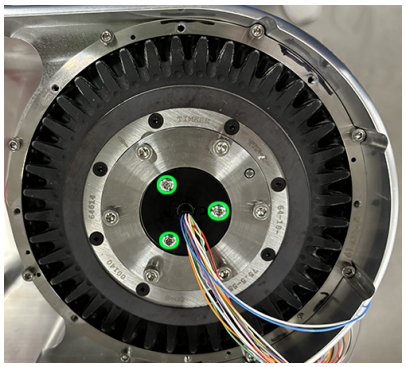
Step	Action
9.	Lower the robot arm. **PreciseFlex 400, PreciseFlex 3400, and PreciseFlex DD 4**: Continue holding the gripper against the underside of joint 4. Using an M1.5 screwdriver, screw the 6X M2-16 SHCS screws into the gripper. Keep the weight evenly distributed as you hold the gripper by screwing in the six screws a little turn at a time in the star pattern shown below: 1st screw, 2nd screw, 3rd screw, etc.  **PreciseFlex 400 or PreciseFlex 3400**  **PreciseFlex DD 4**  **"Star Pattern" for Screws**

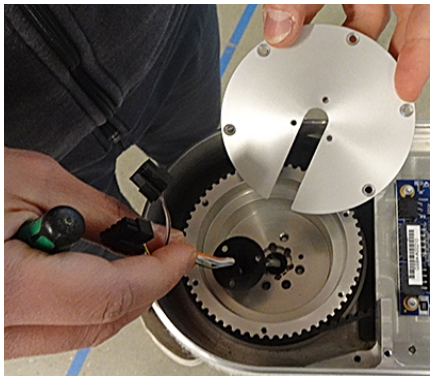
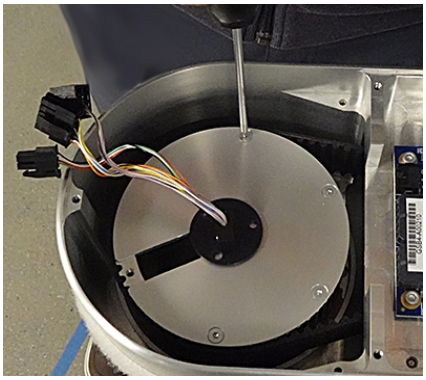
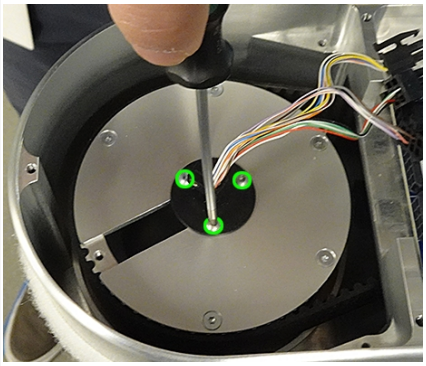
Step	Action
10.	**PreciseFlex c10**: Hold the IntelliGuide vision gripper in place against the underside of joint 4.  **PreciseFlex c10**
11.	**PreciseFlex c10**: Raise the robot arm, and screw the five screws through the IntelliGuide vision gripper and into joint 4.  **PreciseFlex c10**

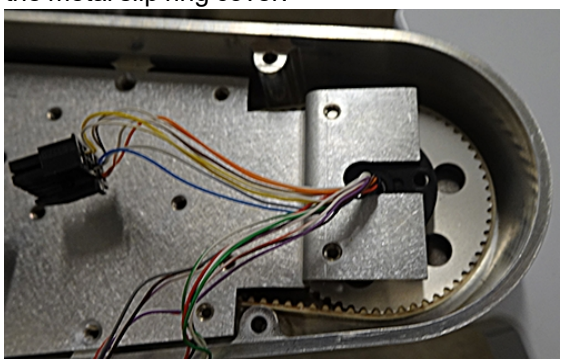
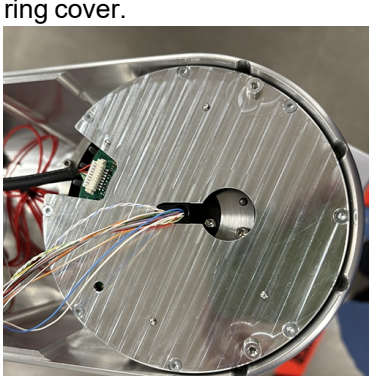
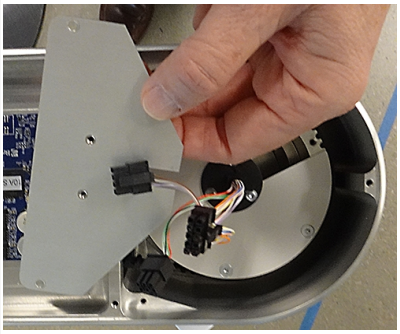
Step	Action
12.	*Connect the slip ring wires to the IntelliGuide vision gripper* ***NOTE:*** *For slip ring harness, Guidance Slave Board (GSB), and IntelliGuide s60 and v60 Motor details, refer to the Appendices Slip Rings, Guidance Slave Boards (GSBs), and IntelliGuide s60 and v60 Motor.*
13.	**PreciseFlex c10, PreciseFlex DD 4, PreciseFlex 400, and PreciseFlex 3400**: Attach the wires from the slip ring to the vision gripper. Each connector is unique and should be easy to identify and attach.  **PreciseFlex 400**
14.	Plug the 3-pin connector into the travel sensor behind the spring.  **IntelliGuide v23, top**  **IntelliGuide v23, top**

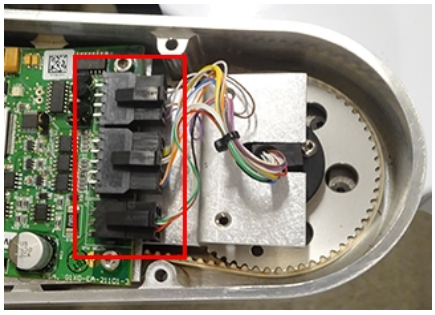
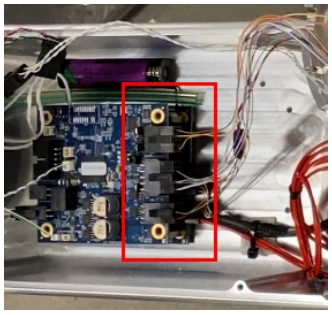
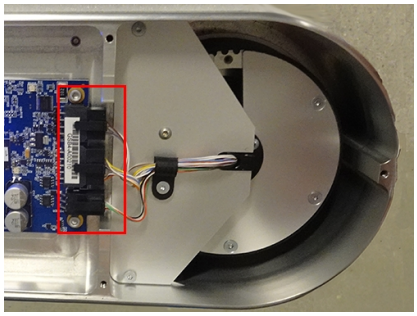
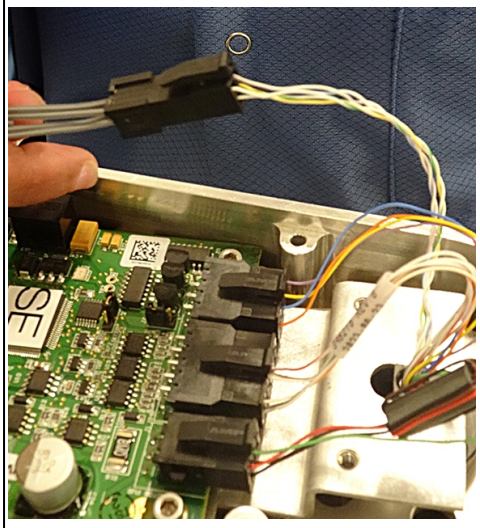
Step	Action
15.	Bundle the loose slip ring wires together and wrap a zip tie around them to keep the wires away from the IntelliGuide vision gripper springs.  **PreciseFlex 400 and IntelliGuide v23 top**
16.	*Attach the IntelliGuide vision gripper bottom.* Each connector is unique and should be easy to identify and attach. The number of pins in the connector ends will match their corresponding connectors .  **IntelliGuide v23 and PreciseFlex DD 4**

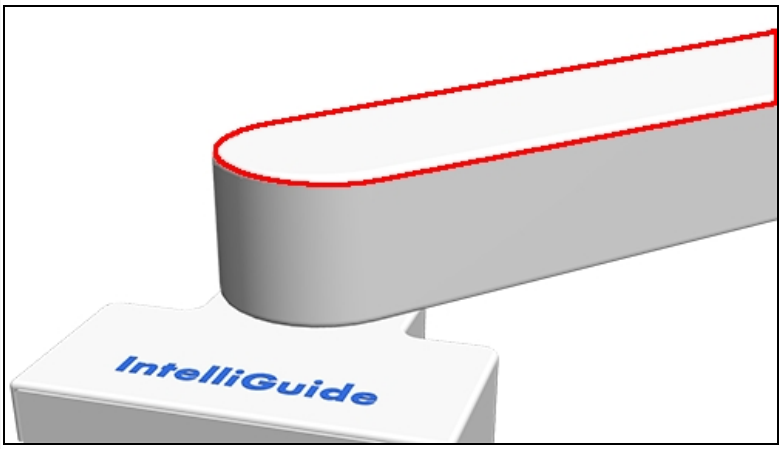
Step	Action
17.	Loosen the four screws that hold the circuit board (below left with red circles), and locate the six-pin 24 V power connector (below, left, indicated by the arrow). Lift the circuit board to get clearance above the flange (A, below right), and connect to the six-pin 24 V connector (B). For details, refer to the Appendix titled "System Schematics and Pinouts," the section IntelliGuide Vision Processor Pinout.  
18.	Plug the white slip ring connectors into the bottom of the IntelliGuide vision gripper at points A, B, and C. After connecting the wires, tighten the screws on the circuit board.  **IntelliGuide v23**

Step	Action
19.	Attach the IntelliGuide vision gripper bottom to the IntelliGuide vision gripper top and, using an M1.3 screwdriver, screw it in with the 4x M2-5 screws.  **IntelliGuide v23**
20.	*Screw in the slip ring* Lower the robot arm. Using an M2 screwdriver, screw in the 3X M3 screws holding the slip ring top (shown in green).  **PreciseFlex 400 and PreciseFlex 3400**  **PreciseFlex c10**

Step	Action
21.	**PreciseFlex DD 4**: Using an M2 screwdriver, screw the cover plate back in with the 5X M3 cover plate screws.  
22.	**PreciseFlex DD 4**: Using an M2 screwdriver, screw in the 3X M3 screws holding the slip ring top (shown in green).  **PreciseFlex DD 4**

Step	Action
23.	*Screw in the Slip Ring Cover* **PreciseFlex 400 and PreciseFlex 3400**: Attach the metal slip ring cover.  **PreciseFlex c10**: Screw in the slip ring cover.  **PreciseFlex DD 4**: Screw in the slip ring cover and clamp. 

Step	Action
24.	*Connect the slip ring to the GSB.*  **PreciseFlex 400 and 3400**  **PreciseFlex c10**  **PreciseFlex DD 4**
25.	Connect the IntelliGuide vision gripper Ethernet ribbon cable to the remaining connector.  **PreciseFlex 400, Ethernet connector**

Step	Action
26.	*Put the Cover on the Outer Link* **PreciseFlex 400 and PreciseFlex 3400**: Using an M2.5 screwdriver, screw the 4X M3-30 SHCS screws into the outer link cover. 
27.	**PreciseFlex DD 4 and PreciseFlex c10**: Put the metal cover on the outer link using an M2 screwdriver to screw the 8X M3-6 FHCS screws into the cover. Put the blue plastic covers on using an M2.5 screwdriver to screw the 6X M3-6 mm screws into the covers.  **PreciseFlex DD 4 and PreciseFlex c10**

Step	Action
28.	*Recalibrate* Calibrate the robot and IntelliGuide vision gripper. • For instructions on calibrating the robot, refer to your robot user manual. • For instructions on calibrating the IntelliGuide vision gripper, refer to the Appendix titled Performing Calibration of IntelliGuide v23 and IntelliGuide v60 Grippers.

Retrofitting a PreciseFlex 400 or PreciseFlex 3400 for an IntelliGuide Vision Gripper

For PreciseFlex 400 robots of serial number F0C-xxxx-9L-xxxxx or earlier and PreciseFlex 3400 robots of serial number F3C-xxxx-9K-xxxxx or earlier, an Ethernet cable must be internally installed in the robot to provide communication between the IntelliGuide vision gripper and the robot controller.

This procedure should only be followed by personnel who have attended training by Brooks, as it involves partial disassembly and reassembly of the robot with a particular installation of the internal cable harness.

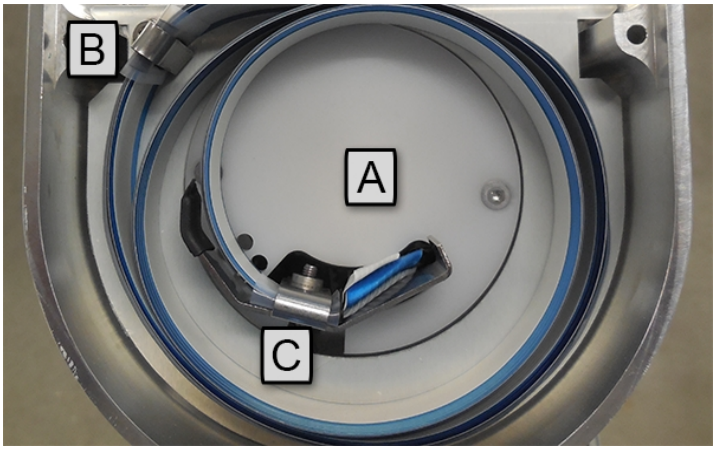
NOTE: Errors in this process can lead to pinched cables which may result in unresponsive IntelliGuide Vision grippers.

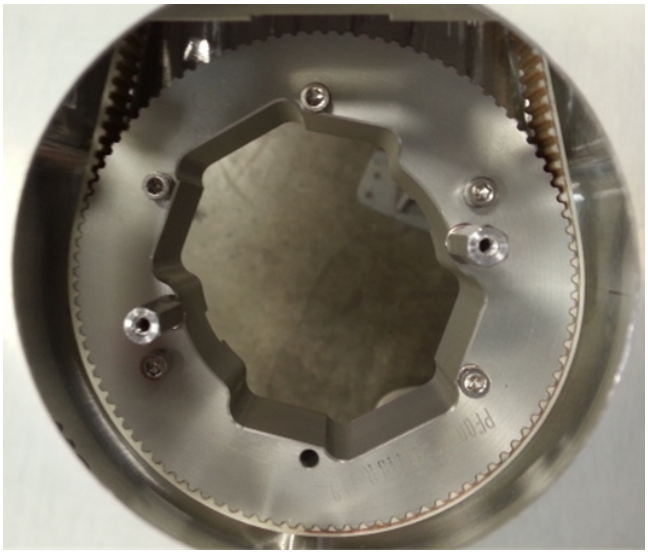
Required Tools

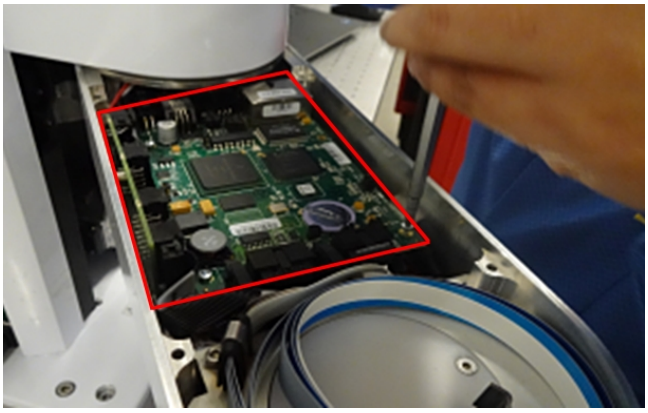
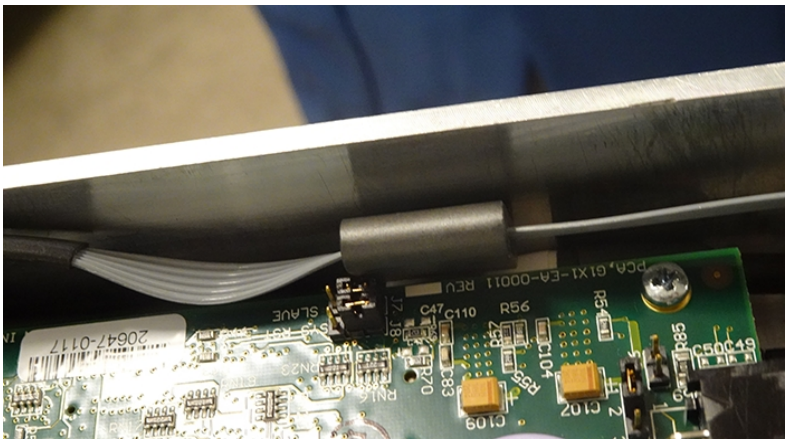
- Hex screwdrivers
  - M1.3
  - M1.5
  - M2
  - M2.5
  - M3
  - M5
  - M6

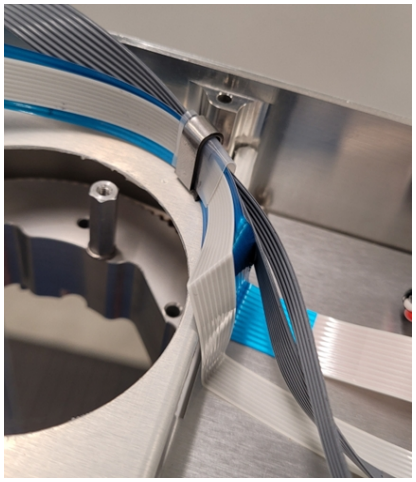
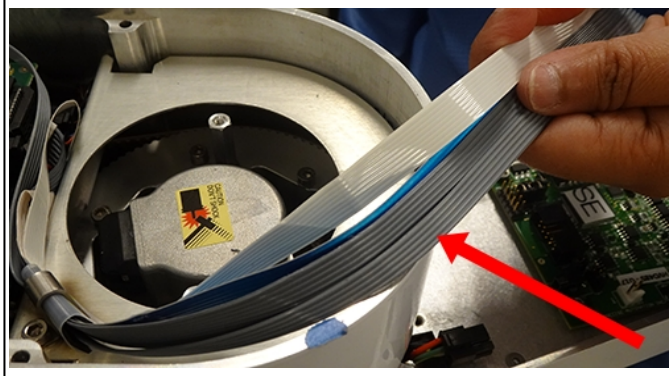
Required Kits (See IntelliGuide Product Numbers in the Appendices for part numbers)

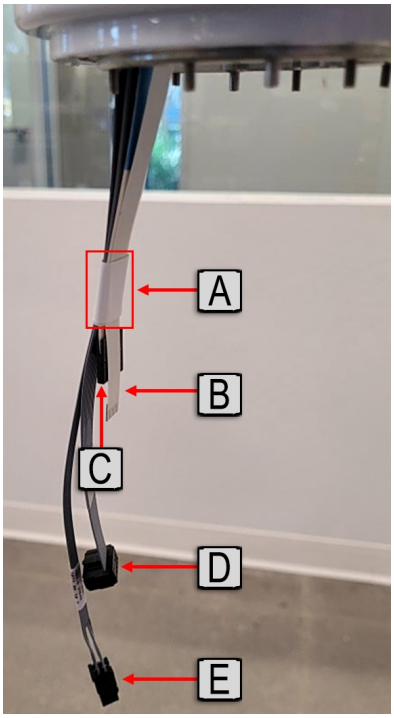
- IntelliGuide v23: IntelliGuide v23 Retrofit Kit for PreciseFlex 400/ 3400
- IntelliGuide v60: IntelliGuide v60 Retrofit Kit for PreciseFlex 3400

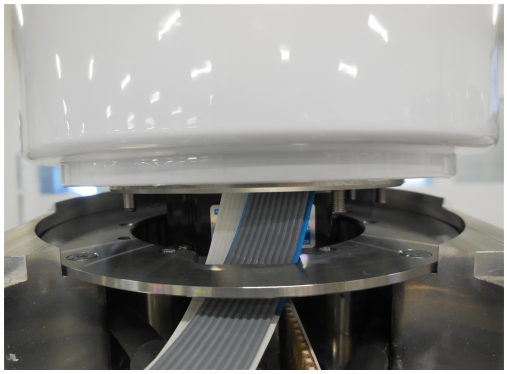
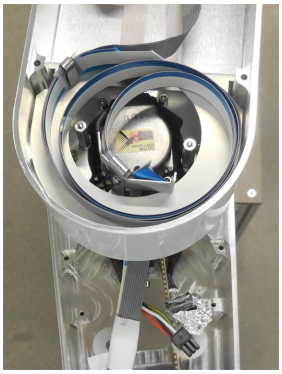
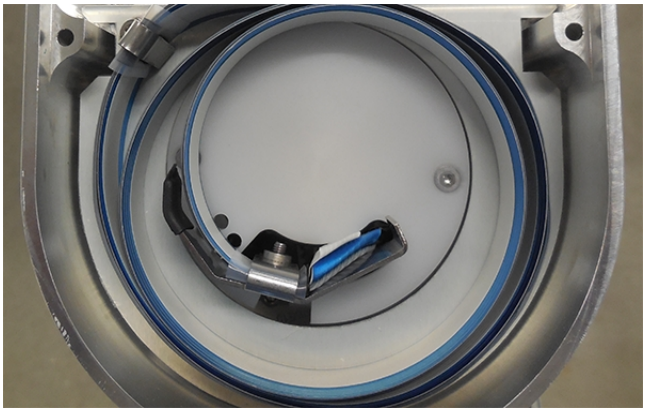
Step	Action
1.	### *Remove the Gripper* Follow the instructions for Removing an IntelliGuide s23 or IntelliGuide s60 from a PreciseFlex Robot.
2.	### *Remove the Outer Link* • Remove the J4 elbow motor cover (A) by using an M2.5 screwdriver to unscrew the 2X M3-10 mm FHCS. • Remove the clamps (B) by using an M2.5 screwdriver to unscrew the 1X M3-10 mm SHCS. • Remove clamp (C) by using an M2.5 screwdriver to unscrew the M3-35 mm SHCS. Keep the cable harness contained inside of the clamp (C). 

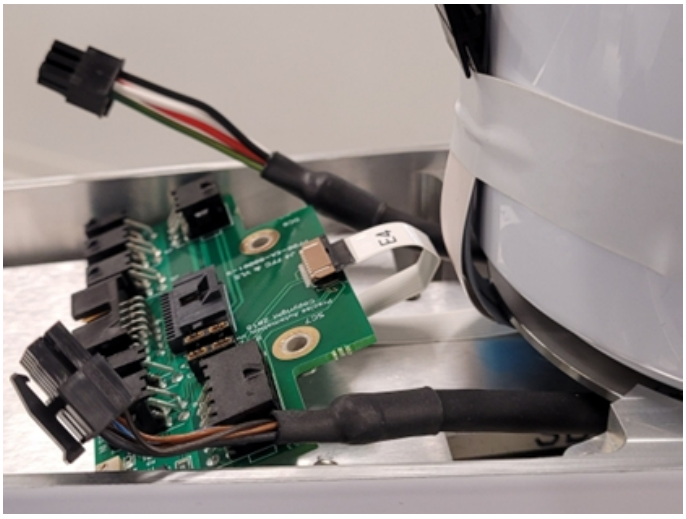
Step	Action
3.	Disassemble the outer link from the inner link using an M2.5 screwdriver to unscrew the 5X M3-35 mm SHCS holding the two links together. Lower the outer link slowly while carefully removing the flat cables from the outer link. Leave all screws in place except for the screw fasting the clamp. 
4.	***Install the Ethernet Cable*** Locate the Ethernet switch on the robot controller. Bend the new Ethernet cable 180° back on itself at the plug, and insert it into the switch. 

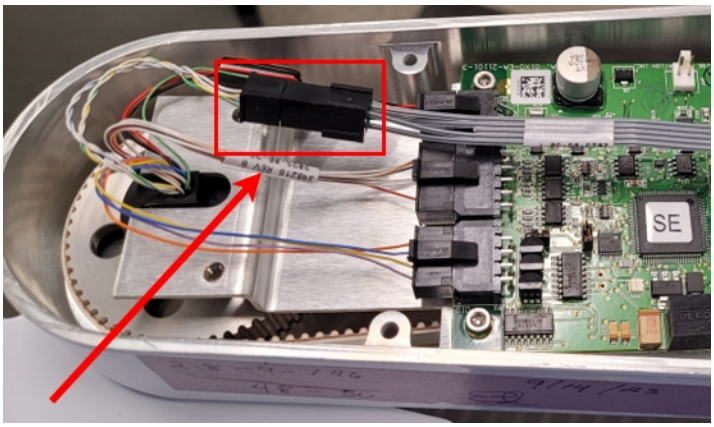
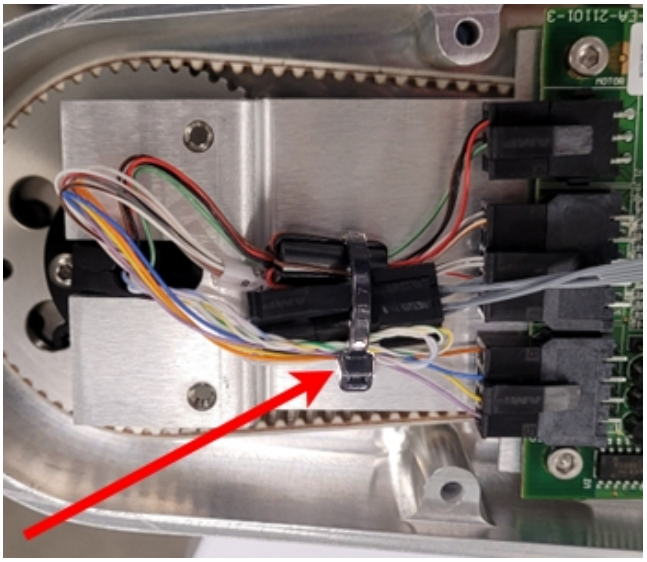
Step	Action
5.	If space near the Ethernet switch is tight, it may be necessary to loosen the controller board and lift the end to create space to plug in the Ethernet cable. Use an M2 screwdriver to remove the 4X M3-5 mm BHCS. 
6.	Run the new Ethernet cable between the controller board and the inner link wall. 

Step	Action
7.	Wrap the Ethernet cable around the outside of the existing cable harness. Place all cables inside the first small clamp. Lightly fasten the clamp in place.  
8.	Ensure the Ethernet cable is wrapped around the outside of the cable harness. 
9.	Bend the Ethernet cable to match the 90° bend in the other ribbon cables. Use an M2.5 screwdriver to remove the M3-5 mm BHCS. Insert the new Ethernet cable into the clamp with the rest of the cable harness, and refasten the clamp together with the screw.  

Step	Action
10.	Rewind the cable harness counterclockwise twice and pass them down through the inner link output pulley. Put the clamp back on the pulley and the M3-35 mm screw through its mating hole. If needed, lift the sheet metal cover to insert the screw. 
11.	As shown in the graphic below, wrap tape around the hanging cables (A). Viewing from the right side, the order of cables is: (B) E4 , (C) M4 , (D) RS-485 , (E) Ethernet. 

Step	Action
12.	### *Install the Outer Link* Thread the cables between the motor and mounting plate of the outer link. Align the dowel pins of the inner link pulley to the dowel hole and slot on the outer link mounting plate. Using an M2.5 screwdriver, tighten 5 of the M3-35 SHCS, but leave the clamp screw loose for now.  
13.	Install the cable cover removed from step 2. Align the clamp with the cable cover and fasten the clamp via the last screw. 
14.	### *Prepare the New IntelliGuide v23 or IntelliGuide v60 for Installation* Follow the instructions for Installing a Slip Ring Harness and IntelliGuide v23 or IntelliGuide v60 on a PreciseFlex Robot up to the section titled *Connect the Slip Ring to the GSB*, then return here, and complete the steps below.

Step	Action
15.	Insert the E4 cable into the J4 interface board, and close the connector tab. Gently pull on the cable to ensure the cable is seated properly. Fold the cable, and tuck the fold under the board. 
16.	Plug the motor power and motor encoder cable into their connectors. Push both cables against the link inner wall. Plug the M4 cable into its connector, and fasten the J4 interface board to the sheet metal cover. 

Step	Action
17.	Connect the new Ethernet cable to the 4-pin connector on the slip ring. 
18.	Bind the wires and Ethernet cable connector with a cable tie. 

Step	Action
19.	Configure the GSB3 jumpers. Position: • J3 jumper on pins 1 and 2 • J4 jumper on pins 2 and 3 • J6 jumper ON • J7 jumper on pins 2 and 3 • J8, J9, and J10 jumpers ON • J11 jumper OFF. For more information on the jumpers and their functions, refer to the *GSB User Manual*. 
20.	Install the inner link and outer link covers on your PreciseFlex 400 or 3400 robot.
21.	*Recalibrate* Calibrate the robot and IntelliGuide vision gripper. • For instructions on calibrating the robot, refer to your robot user manual. • For instructions on calibrating the IntelliGuide vision gripper, refer to the Appendix titled Performing Calibration of IntelliGuide v23 and IntelliGuide v60 Grippers.

5. General Service Procedures

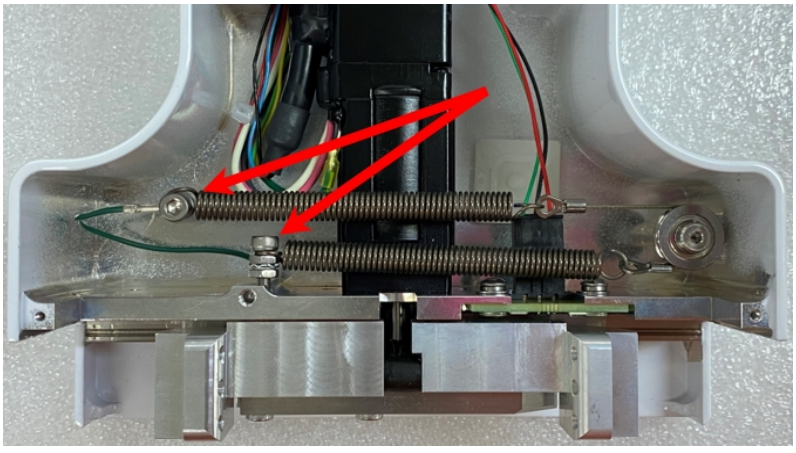
Adjusting the Rack and Pinion Backlash

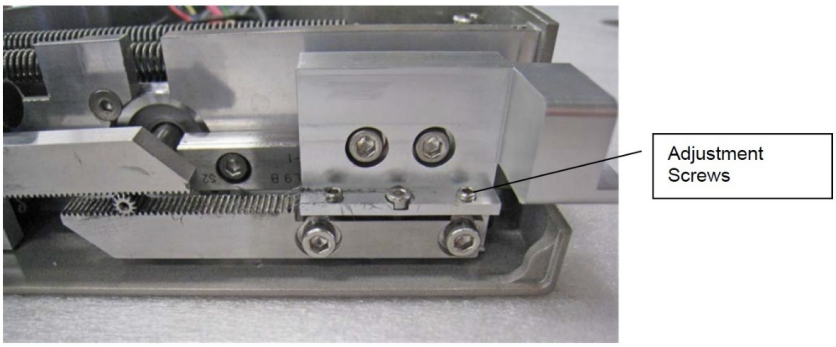
Tools Required

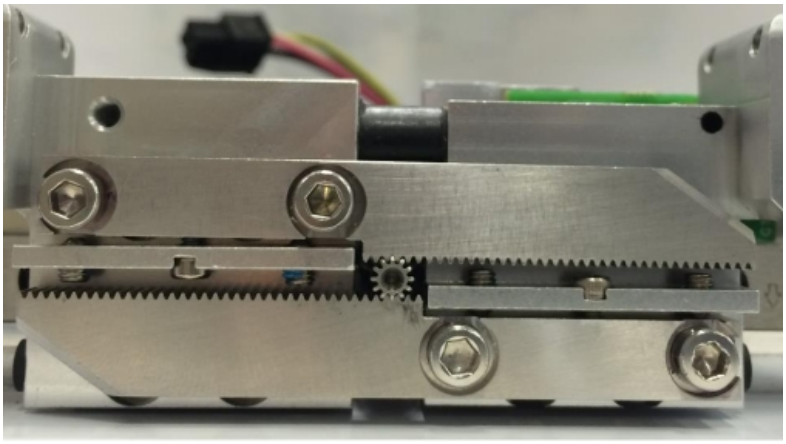
- 1.3 mm hex L wrench
- 1.5 mm hex L wrench

Spare Parts Required: none

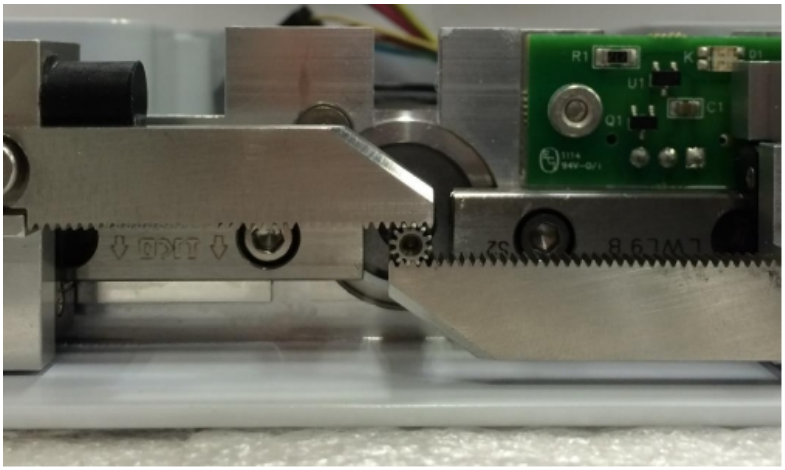
To adjust the gripper backlash, perform the following procedure:

Step	Action
1.	Raise the robot arm. Using an M1.3 screwdriver, unscrew the 4x M2-5 screws from the IntelliGuide vision gripper bottom, and remove the bottom. ***NOTE:*** *The IntelliGuide s23, v23, s60, and v60 have 4 screws. The IntelliGuide s23D has 6 screws.*
2.	Disconnect one end of the spring to remove tension.  **Spring ends. s23D shown.**

Step	Action
3.	Move the racks back and forth to determine which rack has backlash and where it is located on the rack.
4.	Loosen the 2X M3-8 mm SHCS that clamp the rack to the finger mount.
5.	Adjust the M2 SHCS and M3 set screws to adjust the rack backlash or center the racks as needed if a crash has caused the racks to skip teeth or come loose. 
6.	Remove the 2X M3-8 mm SHCS, apply Loctite 243 screwlock, and reinstall and tighten.



Gripper racks centered in fully closed position



Gripper racks centered in fully open position

Replacing the Spring Assembly

Tools Required

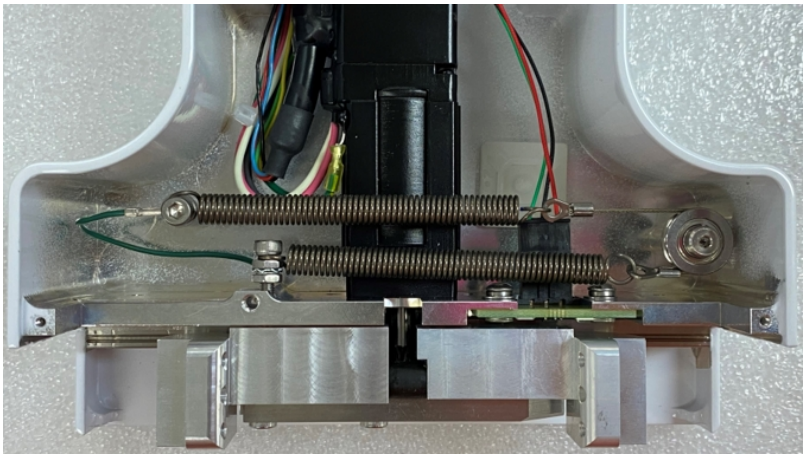
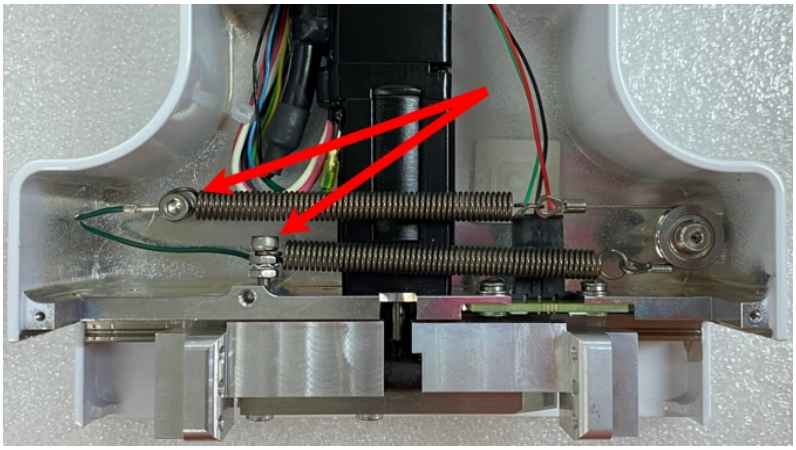
- 1.3 mm hex driver
- 2.5 mm hex driver
- 7 mm open end wrench
- Loctite 222

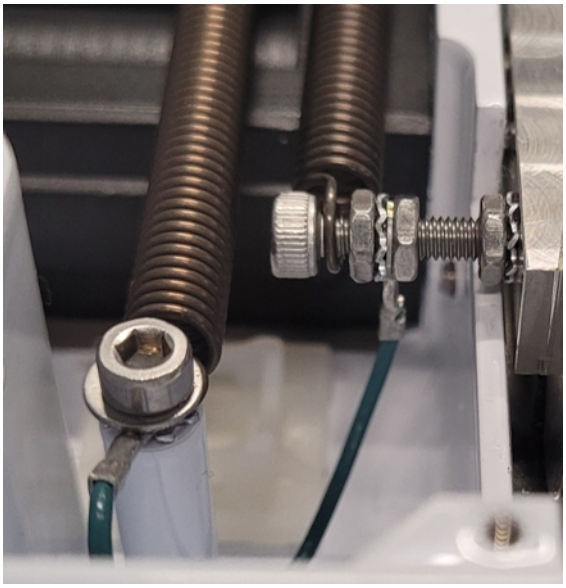
Spare Parts Required

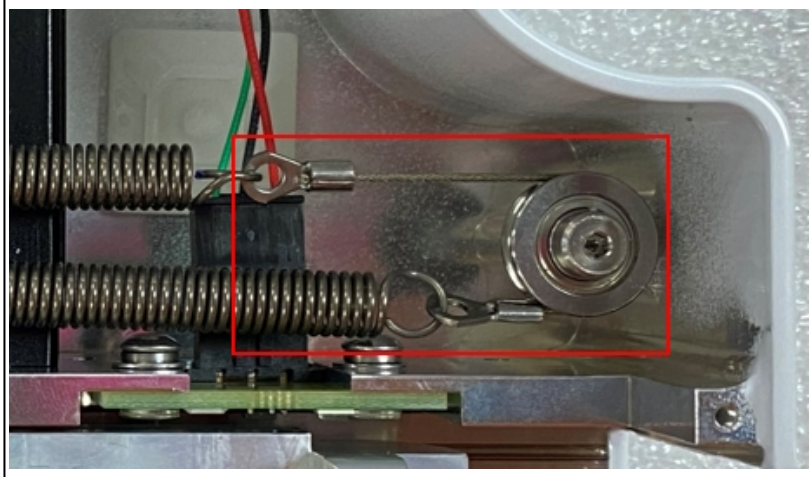
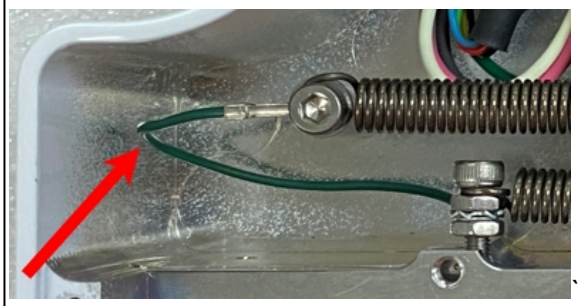
- Spring or Cable Assembly. Refer to the IntelliGuide Gripper Spare Parts List in the appendices.

To replace the spring or cable, perform the following procedure:

Step	Action
1.	Remove the IntelliGuide gripper. For an example of how to remove a gripper, refer to Removing an IntelliGuide s23 or IntelliGuide s60 from a PreciseFlex Robot.

Step	Action
2.	Remove the bottom of the gripper. The example below shows the gripper springs in an s23D. The spring cable assembly will be the same – and attach the same – for all IntelliGuide grippers. 
3.	Remove the 2X M3 screws and their washers. 

Step	Action
4.	Remove the spring cable assembly. 
5.	Attach the green ground wire. Attach the ends of the new spring cable assembly. Screw in the M3 screws. 

Step	Action
6.	Wrap the spring cable around the pulley. 
7.	Bend the green ground wire into the gripper case so it doesn't get caught in the mechanisms. 
8.	Re-attach the gripper bottom.

Appendices

Appendix A: Product Specifications

IntelliGuide v23 and v60 Specifications

Robot Compatibility	
IntelliGuide v23, s23	PreciseFlex 400*, PreciseFlex 3400*, PreciseFlex c10
IntelliGuide v60, s60, s23D	PreciseFlex 3400*, PreciseFlex c10
*Also compatible with these robots on Collaborative Linear Rail	

Specifications	
Cameras	Forward Looking and Downward Looking
Resolution	5 MP, H:2592, V:1944
Pixel Size	H:1.4 µ, V: 1.4 µ
Lens	• 6 mm • Manual adjustment requires camera recalibration
Working Distance	150 mm (as configured from the factory)
Focal Length	2.8 mm
FOV (H):	72°
Lighting	PWM Controlled LED lighting (White)
Precision, Typical from Static Position at Working Distance	±0 18 mm in X/Y/Z, ±0.19° in Rotation (results can vary with application)

Specifications	
Barcode Formats 1D	• Code39 (standard and extended) • Code128 (standard and short) • Code25 (ITF) • Codebar (Codabar) • EAN_8 • EAN_13 • UPC_E • UPC_A • Code 39 Checksum • Code 39 Start/Stop • Code 25 Checksum • Code 93
Barcode Formats 2D	• PDF_417 (standard and Micro) • DATA_MATRIX • DATABAR • PATCH_CODES • Aztec QR Code
IntelliGuide v23, s23, s23D	23 Newtons of gripping force with a 60 mm stroke • 1.0 kg payload (when friction is the only gripping force) robot payload capacity must also be considered • Picks SBS plates in portrait and landscape orientation
IntelliGuide v60, s60	• 60 Newtons of gripping force with a 33 mm stroke • 3.0 kg Payload (when friction is the only gripping force) Robot payload capacity must also be considered
Options	
• ArUco labels for quick start • IntelliGuide calibration target • SBS Plate fingers (for IntelliGuide v23)	
Software	
• Programming via Guidance Development Studio (GDS) • Compatible with Guidance Programming Language (GPL) • Compatible with TCS API	

Appendix B: IntelliGuide Gripper Spare Parts List

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

Description	Part Number
Grippers and Fingers	
IntelliGuide s23 gripper	PF00-MA-00059-1
IntelliGuide s23D gripper	PF00-MA-00094
SBS Plate Fingers, IntelliGuide s23 Gripper (buy two sets for IntelliGuide s23D)	PF0S-MA-00010
IntelliGuide v23 gripper	397209
SBS Plate Fingers, IntelliGuide v23 Gripper	397673
IntelliGuide s60 gripper	PF00-MA-00093
IntelliGuide v60 gripper	601388
Retrofit Kits, with an Ethernet Cable	
IntelliGuide v23, Retrofit Kit for PreciseFlex 400/3400	PF0V-MA-00001-2
IntelliGuide v60, Retrofit Kit for PreciseFlex 3400	PF3V-MA-00001-2
Upgrade Kits, without an Ethernet Cable	
IntelliGuide v23 Upgrade Kit for PreciseFlex 400/3400	PF0V-MA-00001-1
IntelliGuide v23 Upgrade Kit for PreciseFlex c10	PF0V-MA-C1001-1
IntelliGuide v60 Upgrade Kit for PreciseFlex 3400	PF3V-MA-00001-1
IntelliGuide v60 Upgrade Kit for PreciseFlex c10	PF3V-MA-C1001-1
ArUco Markers and Calibration Targets	
Kit, ArUco labels, SBS plates	620515-1
Kit, ArUco labels, small	620522-1
Kit, ArUco labels, medium	620528-1
Kit, ArUco labels, large	620529-1
Teach Plate, with ArUco markers	620521-1
IntelliGuide calibration target, 8.5 x 11	620530-1
IntelliGuide calibration target, 11 x 17, small	620531-1
IntelliGuide calibration target, 11 x 17, large	620532-1
General	
Century gripper springs	SPC-65409
Cable for gripper springs	PF00-MC-M0140
Lens focus tool, Largan, for vision gripper	639148

PreciseFlex 400 Robots

Model	Description	Part Number Vision	Part Number Servo
IntelliGuide v23/s23 Gripper	Slip ring harness	398215	397515
	Gripper assembly	397209	PF00-MA-00059-1
	Gripper cover	610398	PF00-MC-M0148-1
	GSB3 board	G1X0-EA-T1101-4	G1X0-EA-T1101-4
	GSB4 board	389629-0005	389629-0005

PreciseFlex 3400 Robots

Model	Description	Part Number Vision	Part Number Servo
IntelliGuide v23/s23 Gripper	Slip ring harness	398215	397515
	Gripper assembly	397209	PF00-MA-00059-1
	Gripper cover	610398	PF00-MC-M0148-1
	GSB3 board	G1X0-EA-T1101-4	G1X0-EA-T1101-4
	GSB4 board	389629-0005	389629-0005
IntelliGuide s23D Gripper	Slip ring harness	N/A	397515 + PF00-MA-00095
	Gripper assembly		PF00-MA-00094
	Gripper cover		PF00-MC-M0282-1
	GSB3 board (Primary)		G1X0-EA-T1101-4
	GSB3 board (Secondary)		G1X0-EA-T1101-4

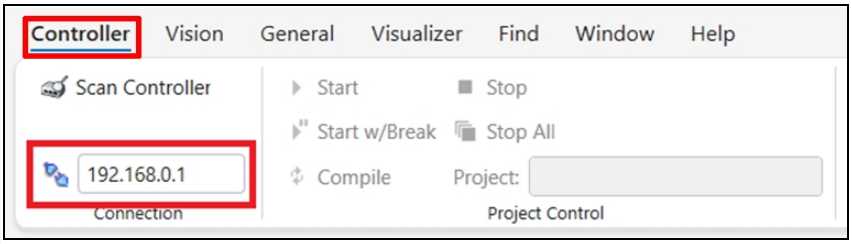
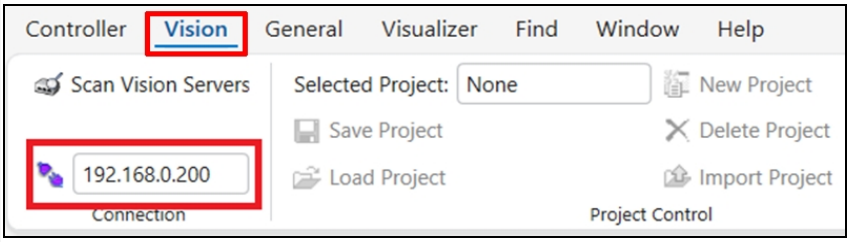
Model	Description	Part Number Vision	Part Number Servo
IntelliGuide v60/s60 Gripper	Slip ring harness	600186	PF04-MA-00030-E2
	Gripper assembly	601388	PF00-MA-00093
	Gripper cover	610810	PF00-MC-M0289-1
	GSB3 board	G1X0-EA-T1101-4D	G1X0-EA-T1101-4D
	GSB4 board	389629-0005	389629-0005

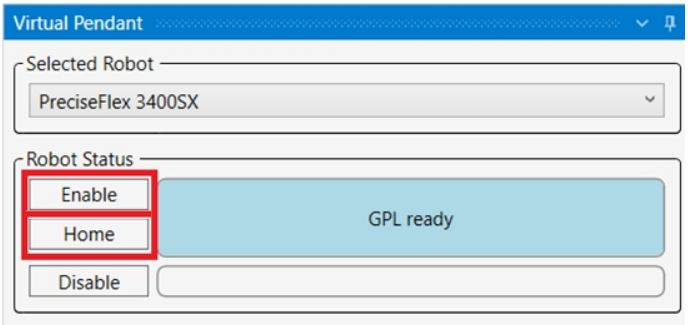
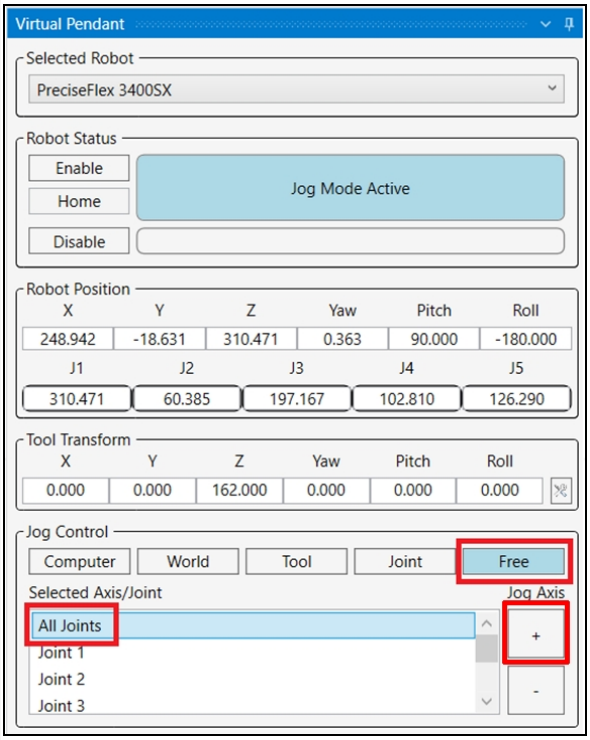
PreciseFlex c10 Robots

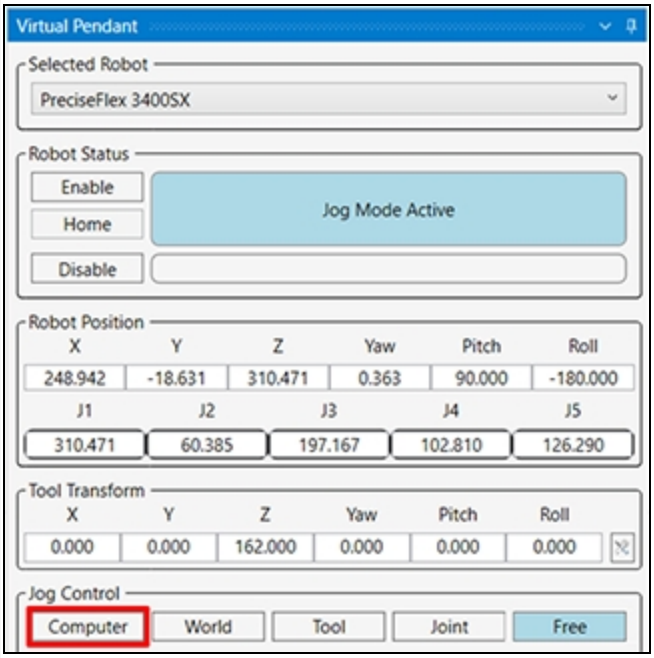
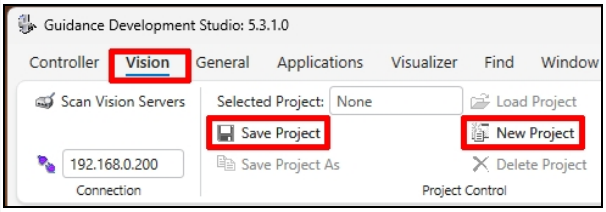
Model	Description	Part Number Vision	Part Number Servo
IntelliGuide v23/s23 Gripper	Slip ring harness	627468	627487
	Gripper assembly	397209	PF00-MA-00059-1
	Cover assembly	610398	PF00-MC-M0148-1
	GSB4 board	389629-0005	389629-0005
IntelliGuide v60/s60 Gripper	Slip ring harness	627235	627540
	Gripper assembly	601388	PF00-MA-00093
	Gripper cover	610810	PF00-MC-M0289-1
	GSB4 board	389629-0005	389629-0005

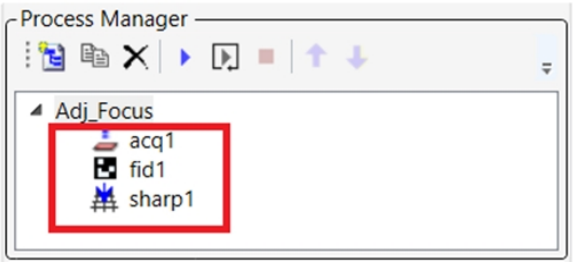
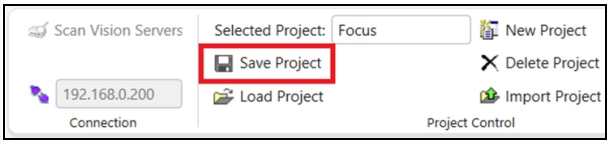
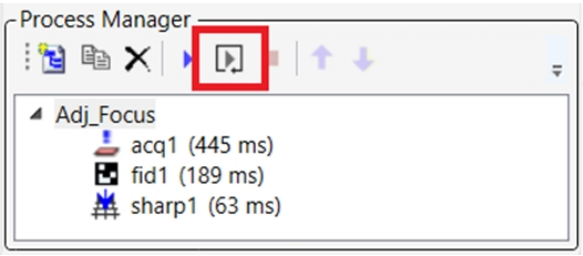
Appendix C: Adjusting the Focus of IntelliGuide v23 and v60 Grippers

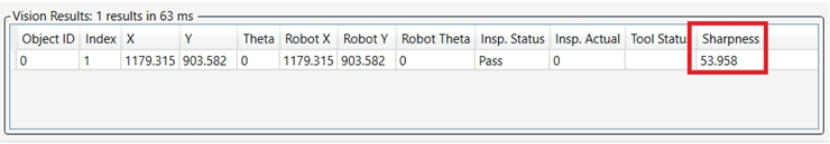
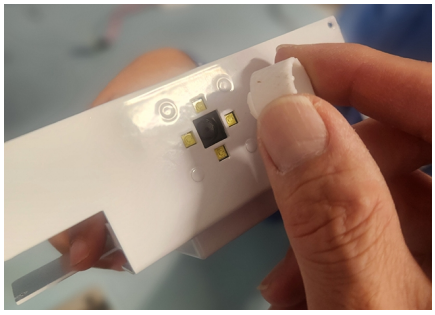
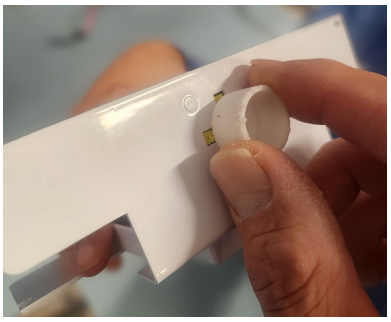
Included with the IntelliGuide Calibration Target options for the IntelliGuide v23 and v60 grippers is a lens focus tool. This tool should be used to adjust the focus of the IntelliGuide v23 and v60 cameras when the default 150 mm is not sufficient for an application. This might be due to the length of custom fingers or due to work cell requirements. To adjust the focus of either lens, follow the steps below.

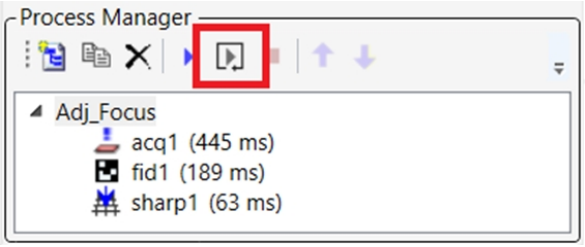
Step	Action
1.	Turn on power to the PreciseFlex robot and open Guidance Development Studio.
2.	• Click on the **Controller** tab. • Click on the **Connect** icon ( ) to connect to the robot controller. 
3.	• Click on the **Vision** tab. • Click on the **Connect** icon ( ) to connect to the vision controller. 

Step	Action
4.	Using the Virtual Pendant, click the **Enable** button and wait for 2-3 seconds until you hear a click from the internal power supply, then click the **Home** button. ***NOTE:*** *For the IntelliGuide v23 gripper, there will be motion of the fingers during the homing process.* 
5.	Click the **Free** button to place the robot into free mode, and click **All Joints** and the plus-sign (**+**) button. 

Step	Action
6.	If you know the desired working distance for your application, use your hands to move the IntelliGuide gripper, and position one of the cameras at the desired working distance away from an ArUco marker kit or IntelliGuide calibration target. A ruler or measuring tape can be used. Click the **Computer** button on the Virtual Pendant to disable *Free* mode. 
7.	• Click on the **Vision** tab. • Click the **New Project** button and name the project. • Click the **Save Project** button. 

Step	Action
8.	Click the **New Process** button. 
9.	Create a new *Acquisiton* tool, *Fiducial Locator* tool, and *Sharpness Detector* tool, and add them to the newly created vision process. The *Acquisition* tool should come first in the process, followed by the *Fiducial Locator* tool and the *Sharpness Detector* tool. 
10.	Use the *Tool Properties* window to adjust the properties of the newly created tools. The properties for the *Acquisition* and *Fiducial Locator* tools will vary depending on the lighting conditions and ArUco markers used.
11.	Click the **Save Project** button under the **Vision** tab. 
12.	In the *Vision Projects* window, click the **Auto execute** button to continuously run the newly created vision process. 

Step	Action
13.	Monitor the *Sharpness* result returned from the vision process in the *Vision Results* window. The minimum and maximum values aren't normalized and will be different for various focus distances and lighting conditions. 
14.	Get the focus adjustment tool.  **Focus adjustment tool**
15.	Find the max value by inserting the focus tool's four teeth into the slots around the camera's lens and slowly rotating in any direction, giving the system time to acquire and display images.  
16.	Once the max value is found, stop adjusting the lens and remove the focus tool.

Step	Action
17.	In the *Vision Projects* window, click the **Auto execute** button again to stop the continuous acquisition of images. The camera's focus has now been adjusted. Repeat for the other camera if necessary. 

Appendix D: Performing Calibration of IntelliGuide v23 and IntelliGuide v60 Grippers

NOTE: IntelliGuide Vision grippers are installed and calibrated from the factory with a working distance of 150 mm.

Calibration involves using the IntelliGuide Vision gripper to take multiple images of the IntelliGuide calibration target and creating a calibration model. The calibration model is stored in the *flash* folder on the robot's controller and is used by various tools and algorithms such as the *object finder* tool and the `StereoLocator` class. These tools use the model to locate 2D objects in the robot's work cell and to AutoTeach locations, pallets, or frames.

There is a unique calibration model for each camera on an IntelliGuide Vision gripper. Recalibrating a camera should take place when the IntelliGuide gripper is replaced, its cover has been removed and refastened, or when performance improvements are available via software updates.

Calibration takes roughly 30 minutes to complete for each camera.

Requirements

- A PreciseFlex robot, calibrated and homed
- An IntelliGuide Calibration Target
- An installed IntelliGuide Vision gripper with a properly adjusted lens focus
- The robot mounted on a rigid surface where no other devices or machinery can cause vibration that can be transferred to the arm or the calibration board
- An installed copy of Guidance Development Studio (GDS), available on https://www.brooks.com/support/brooks-preciseflex-support/software-updates/.

NOTE: Brooks recommends that the light source is consistent and the vision process is tested before starting the calibration.

CAUTION

Robot Movement

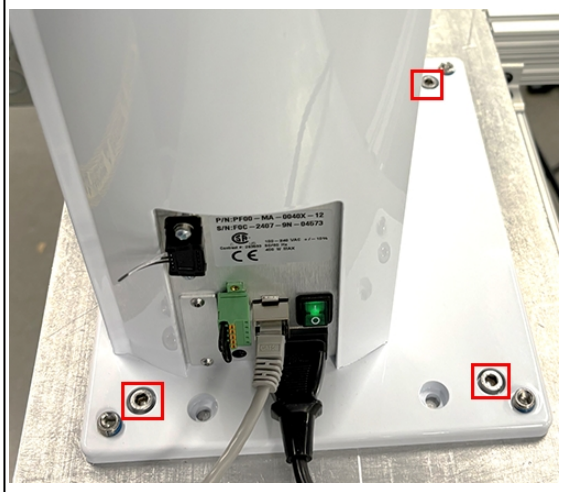
During the stereoscopic camera calibration, the robot will automatically move to locations. Position the robot properly before starting the process, and ensure nothing is obstructing the robot's motion during the calibration process.

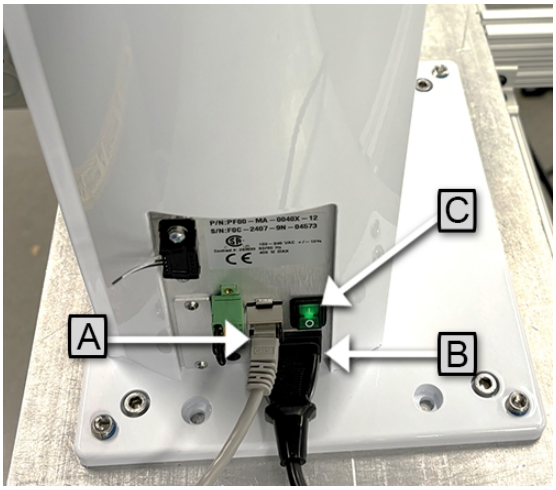
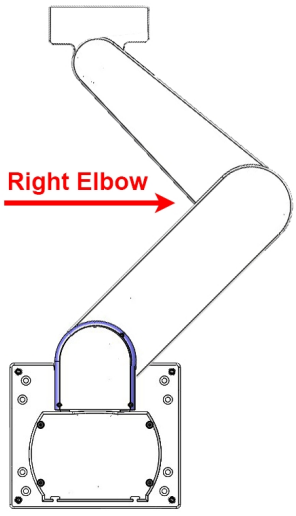
Before starting the calibration procedure, make sure the robot and vision system are accessible, and a connection to the IntelliGuide Vision gripper can be established in GDS.

For GDS versions 5.2 and earlier, you must create or use an existing vision project that include at least one vision process with an *Acquisition* tool and *Fiducial Locator* tool configured for the camera being calibrated. For GDS versions 5.3 and later, the calibration wizard can create the vision project, if needed.

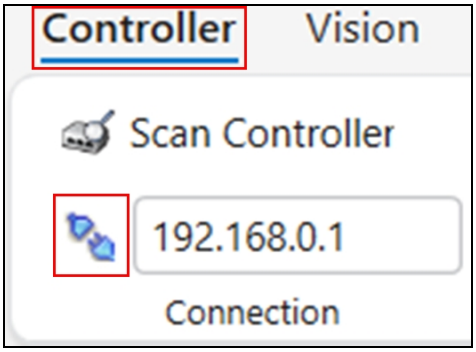
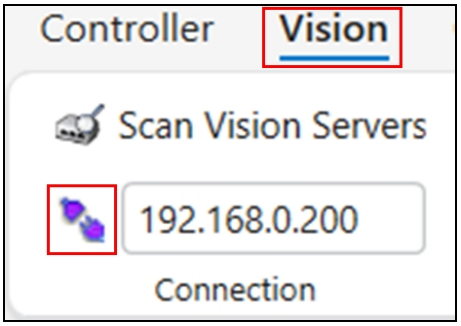
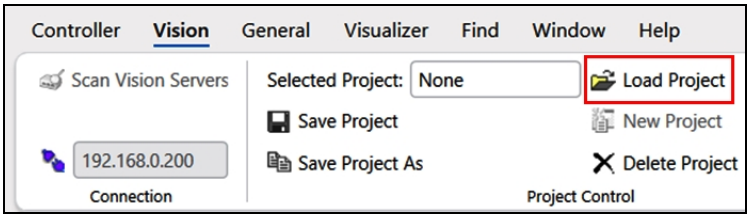
For tips on creating and testing vision processes, refer to the *IntelliGuide Vision Toolkit User Manual*.

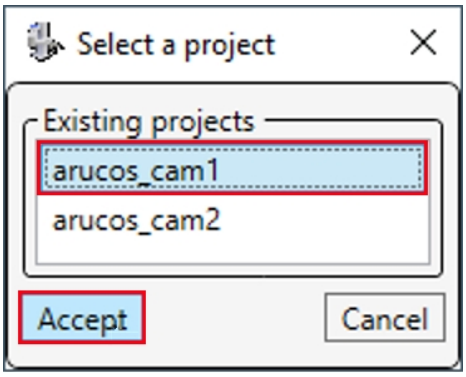
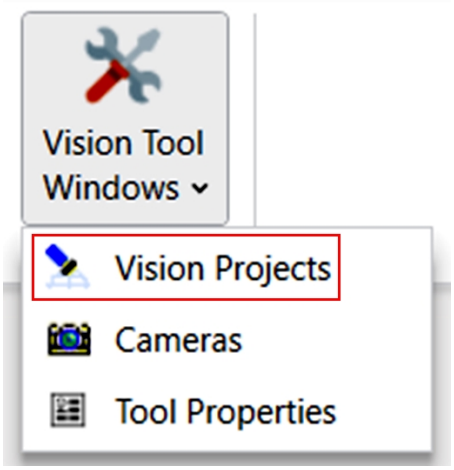
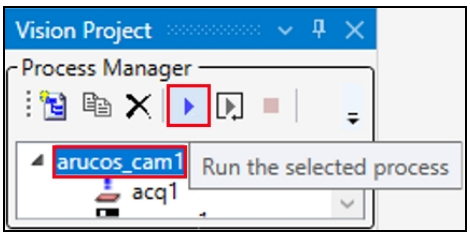
Preparing the Robot

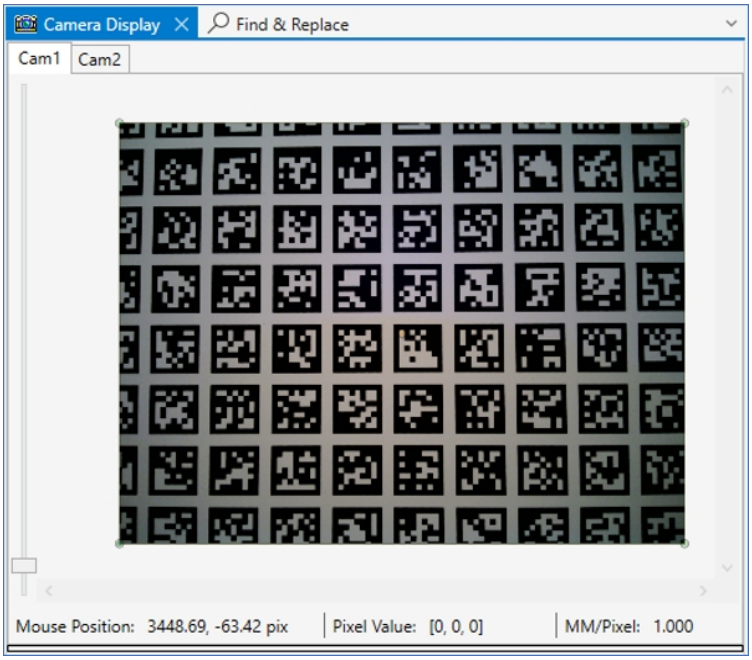
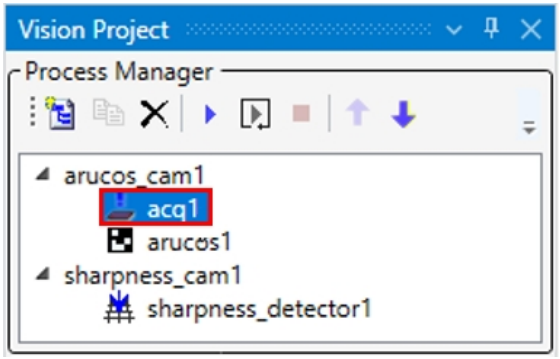
Step	Action
1.	Ensure that the robot is fastened to a solid surface on all four sides with M6-16 socket head cap screws. In the image below, three of the four screws are highlighted. 

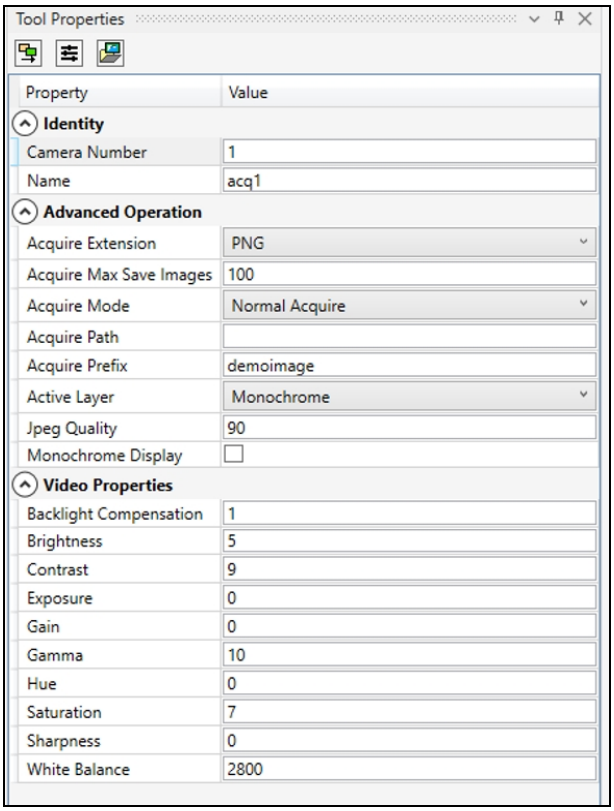
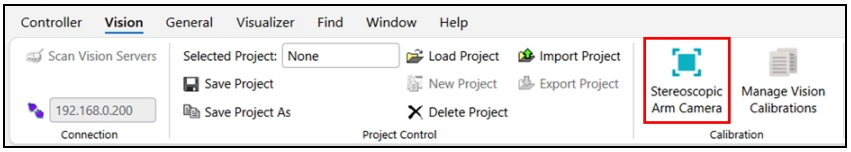
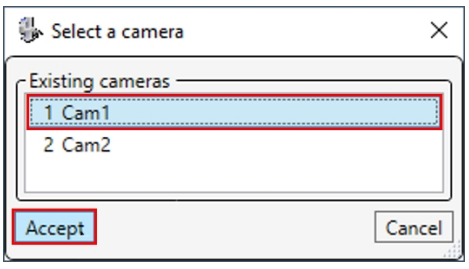
Step	Action
2.	Power up the robot and connect the Ethernet cable so the browser interface on the PC can control the robot. On the facilities panel: • Connect the Ethernet cable from the robot to the PC (A) • Plug in the robot's AC power cord (B) • Turn on the robot's power (C). 
3.	Bend the robot’s arm into a *righty* configuration, as if the robot arm were your right arm and the elbow is bent at the right side. 

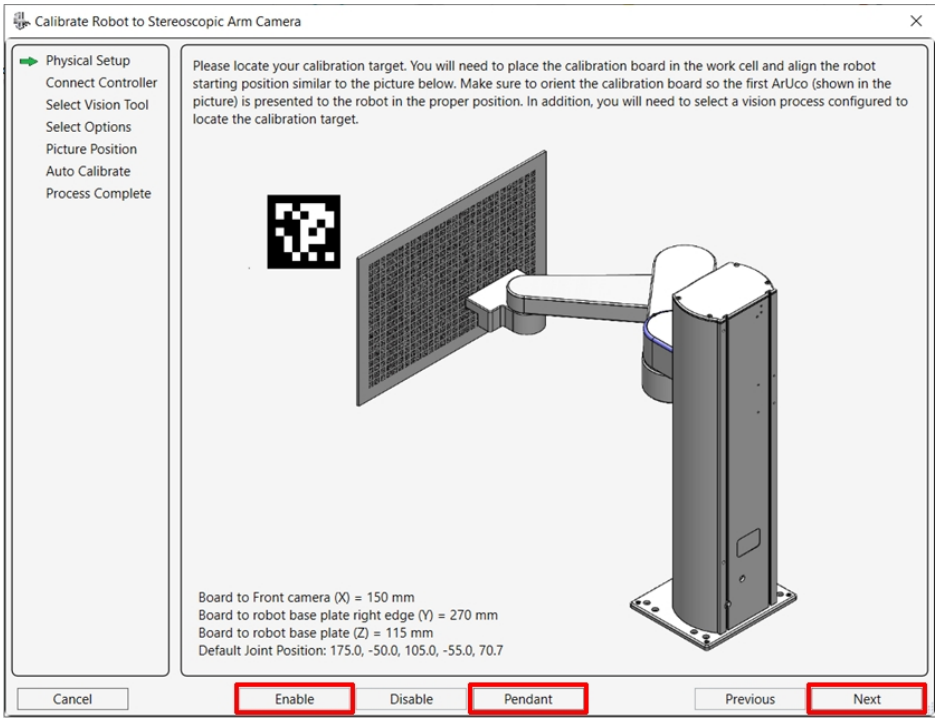
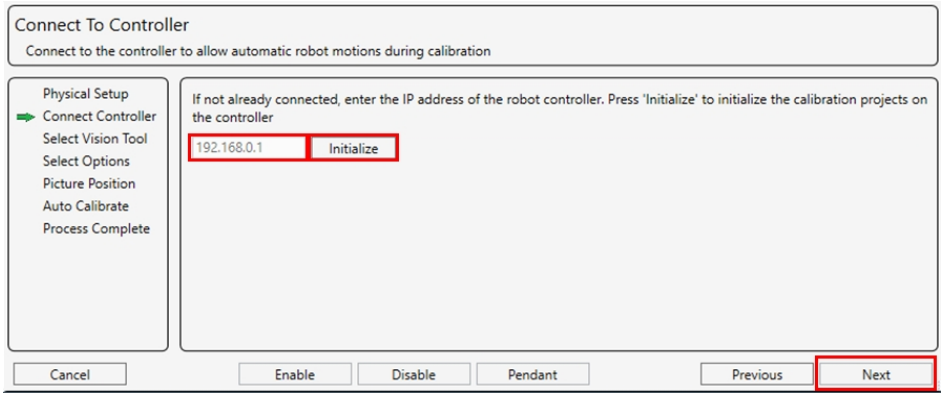
Calibrating the Front-facing Camera

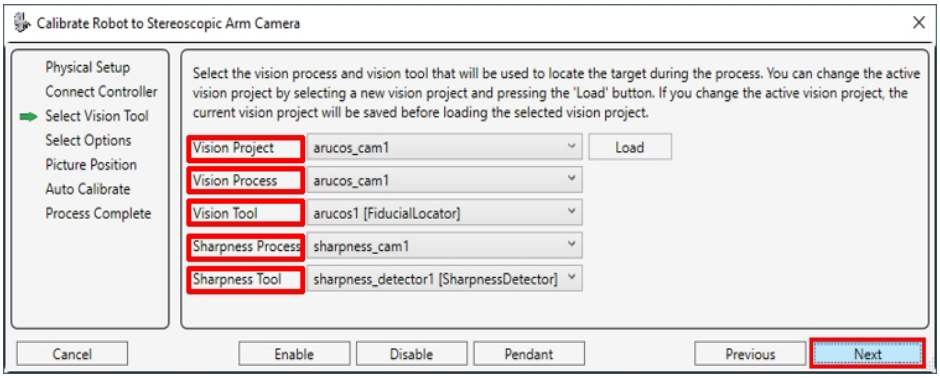
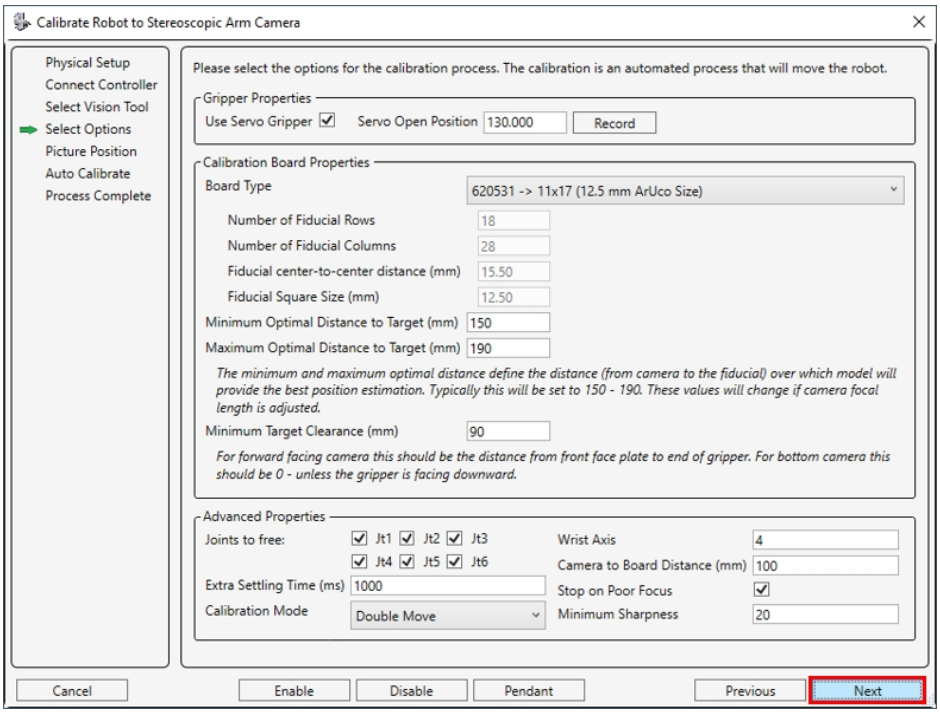
Step	Action
1.	• In GDS, click on the **Controller** tab. • Click the blue **Connection** button. 
2.	• Click on the **Vision** tab. • Click the purple **Connection** button. 
3.	Under the **Vision** tab, click on **Load Project**. 

Step	Action
4.	Select **arucos_cam1** and click **Accept**. 
5.	• On the top-level menu bar, select **Vision** and then **Vision Tool Windows**. • **Select Vision Projects** to display the *Vision Projects* window. 
6.	The *Vision Project* window will display. • In the *Vision Project* > *Process Manager* window, select **arucos_cam1**. • In the *Process Manager* toolbar, click **Run the selected process**. 

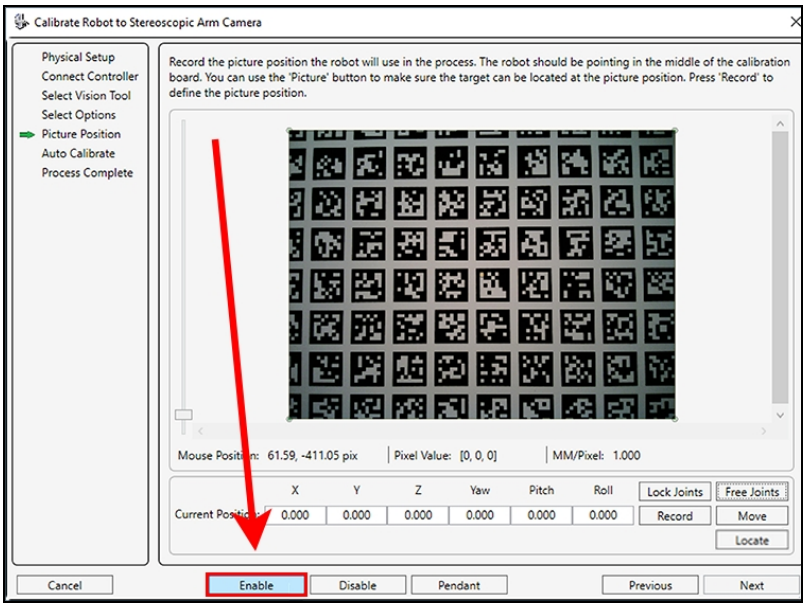
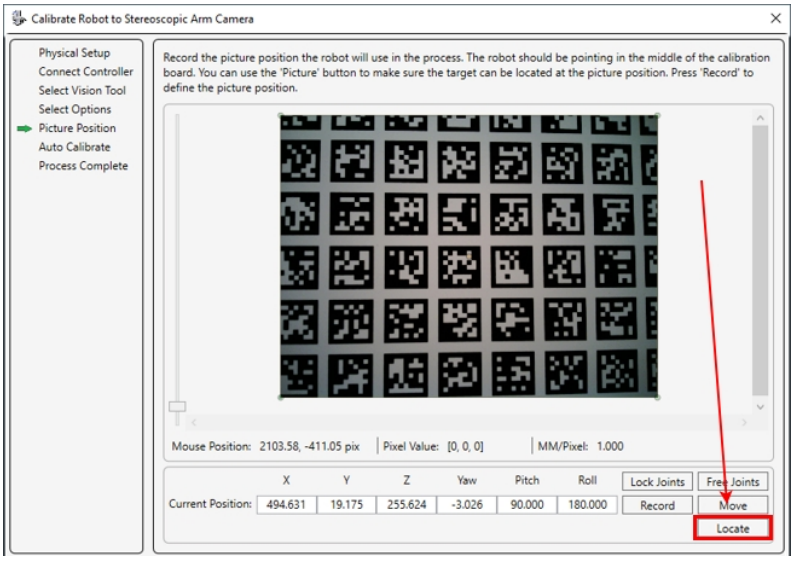
Step	Action
7.	The front calibration target should display in the *Camera Display* window. 
8.	In the *Vision Project* > *Process Manager* window, double-click on **acq1** to open the *Tool Properties* window. 

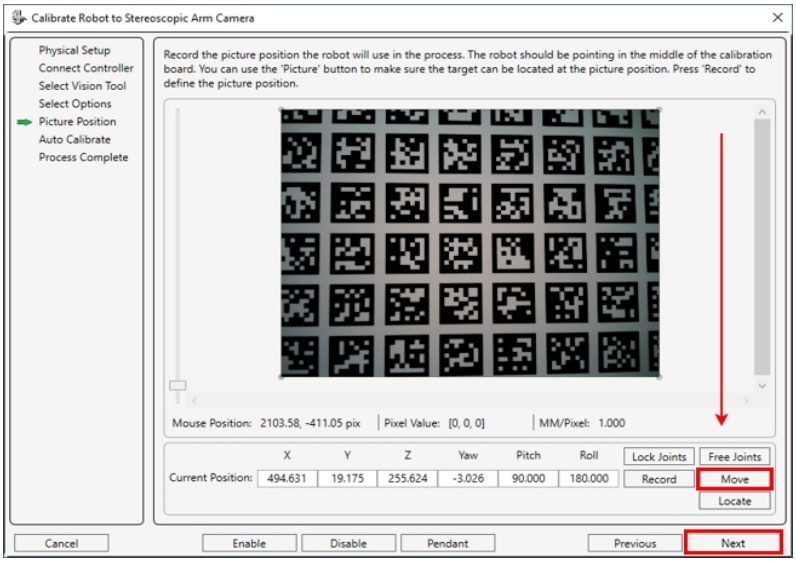
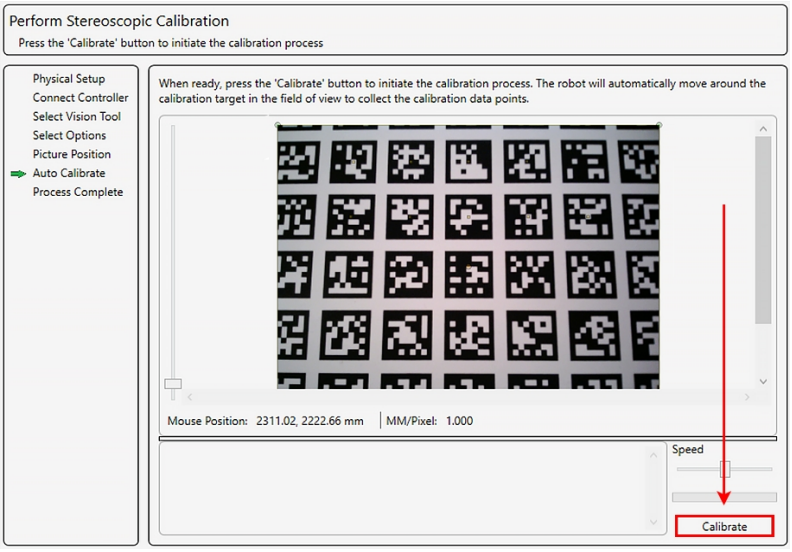
Step	Action
9.	The *Acquisition* tool Video Properties below are shown as an example and are dependent on lighting conditions in the work cell around the robot. 
10.	Under the **Vision** tab, select **Stereoscopic Arm Camera**. 
11.	Select **Cam1**, and click **Accept**. 

Step	Action
12.	The *Physical Setup* step of the calibration wizard will show an image of the physical setup for the robot. At the bottom left of the window, approximate distances are provided to set up the calibration target relative to the robot. • Click the **Enable** button and wait for ~3 seconds. • Click the **Pendant** button to place the robot into Free mode. • Move the joints to the values shown, then click **Next**. 
13.	For the *Connect Controller* step, enter the IP address of the robot controller and click **Initialize**. This will load the required system files into the controller's memory. Then click **Next**. 

Step	Action
14.	For the *Select Vision Tool* step, open the drop-down menus, and select **Vision Project**, **Vision Process**, **Vision Tool**, **Sharpness Process**, and **Sharpness Tool** as shown below. Then click on **Next**. 
15.	For the *Select Options* step, configure all required options for performing the vision calibration. ***NOTE:*** *This is a critical step. Be careful to configure the parameters properly according to the details listed in the next step.* Enter the data listed in the next step. 

Step	Action
16.	***NOTE:*** *See the previous step.* In the *Select Options* step, enter these details: *Gripper Properties* • **Use Servo Gripper** = Check • **Servo Open Position** =130.000 *Calibration Board Properties* • **Board Type**. This will be the part number of the IntelliGuide Calibration Target that was purchased. In this example, part number 620531 is used. • **Number of Fiducial Rows**, **Number of Fiducial Columns**, **Fiducial center-to-center distance**, and **Fiducial Square Size** will be auto-populated based on the **Board Type** selection. • **Minimum Optimal Distance to Target** = 150 mm. This value will depend on the adjusted focus distance. For instance if the camera's lens was focused to a working distance of 200 mm, set this value to 200 mm. • **Maximum Optimal Distance to Target** = 190. Set this value at least a value of 40 greater than the Maximumm Optimal Distance to Target. • **Minimum Target Clearance (mm)** = 90. This value should reflect the length of the IntelliGuide gripper fingers when measured from the face of the camera being calibrated. • **Advanced Properties**. Check all **Joints to free** boxes. Some steps in the wizard require you to free the joints and move the robot manually. You have the option to specify which joint should be put in Free mode. By default, all joints are selected. *Advanced Properties* • Check all **Joints to free** boxes. Some steps in the wizard require you to free the joints and move the robot manually. You have the option to specify which joint should be put in free mode. By default, all joints are selected. • **Wrist Axis** = 4 • **Camera to Board Distance (mm)** = 100 mm • **Extra Settling Time (ms)** = 1000 ms. The time that the robot will wait to completely settle as it captures data during the calibration procedure. • **Stop on Poor Focus** = Check • **Calibration Mode** = Double Move • **Minimum Sharpness** = 20 When finished, click **Next**.

Step	Action
17.	For the *Picture Position*, click the **Enable** button to enable power to the robot. 
18.	Click the **Locate** button. This will acquire an image with the camera. 

Step	Action
19.	Click **Move** to position the robot in the recorded picture location, then click **Next**. 
20.	In the *Auto Calibrate* step, click **Calibrate** in the lower right corner. ***NOTE:*** *During stereoscopic camera calibration, the robot will automatically move to locations close to the four corners of the calibration target. Do not obstruct robot motion or move the calibration target.* 

Step	Action
21.	During calibration, the robot will automatically move around the calibration target for data collection. The speed of the motion during the calibration routine can be adjusted by moving the **Speed** slider. By default, the speed is set to 50%. 
22.	Once the calibration starts, the gripper moves to the top left corner and measures the image sharpness between distances 130 – 230 mm.
23.	The calibration process will take approximately 30 minutes. It will indicate it is completed in the *Output* window.

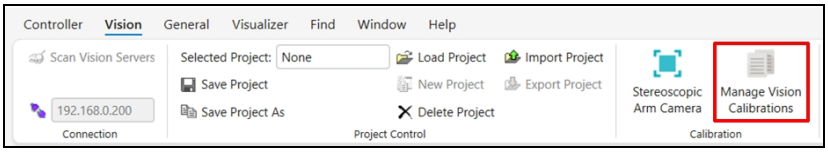
Calibrating the Downward-Facing Camera

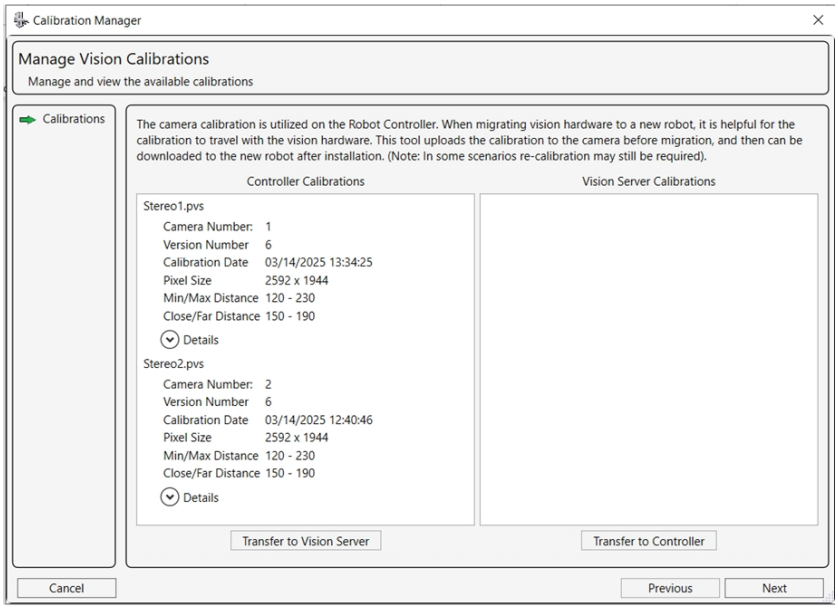
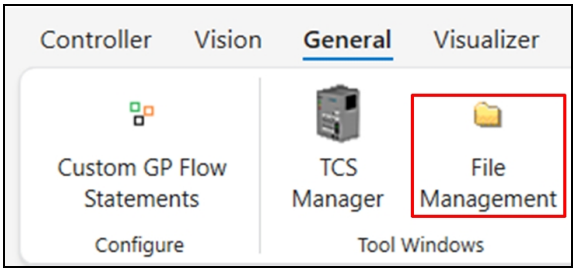
Follow the *Calibrating the Forward-Facing Camera* instructions, but:

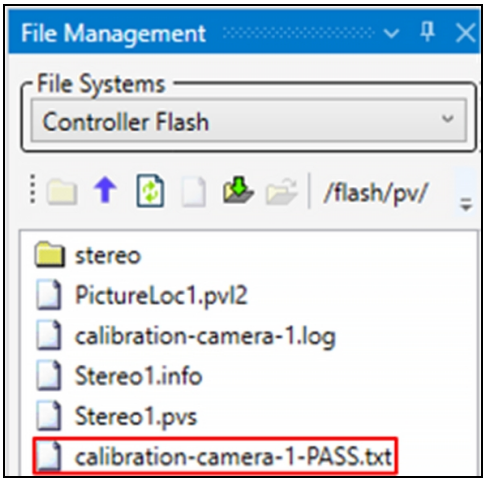
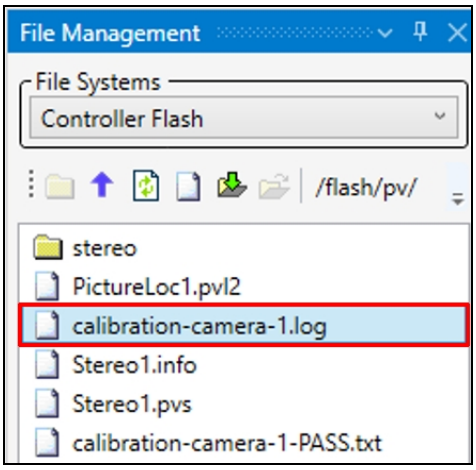
- Select the **arucos_cam_2** vision project (from step 2).
- Select **Cam2** from the *Stereoscopic Arm Camera* wizard (from step 10).
- Set up the calibration target according to the *Physical Setup* (from step 11).

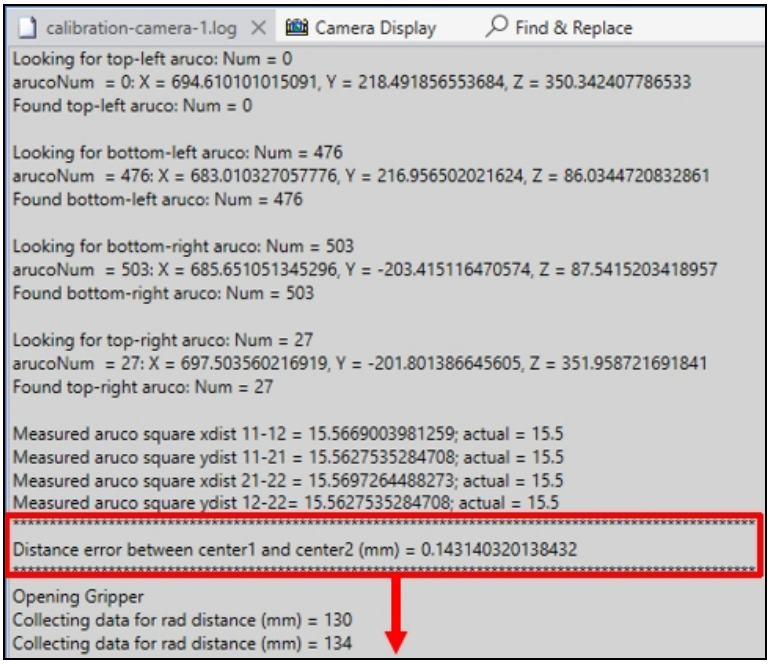
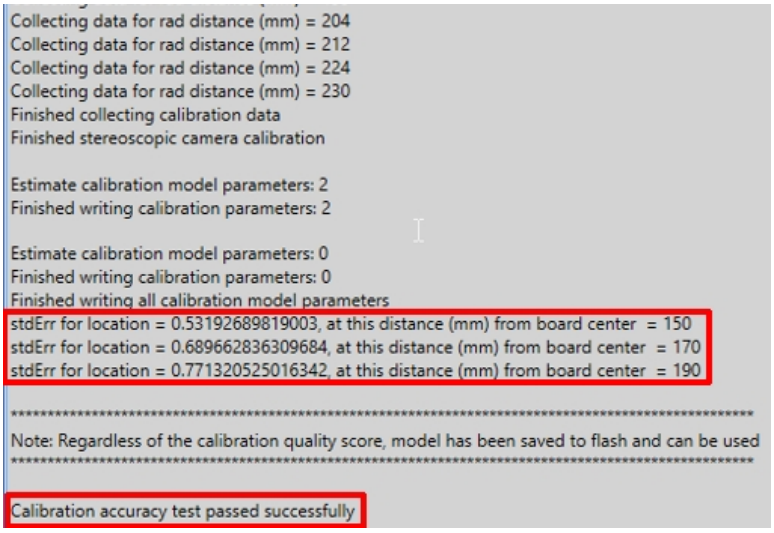
Checking for Calibration Errors

Follow this procedure to determine if the stereoscopic calibration generated any error messages

Step	Action
1.	Navigate to the **Vision** tab and click **Manage Vision Calibrations**. 

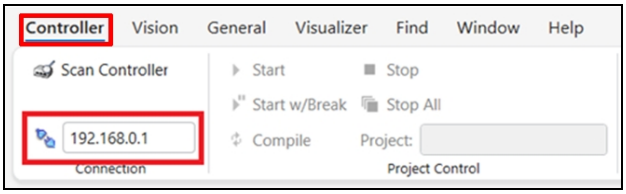
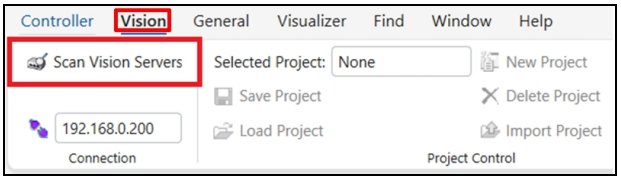
Step	Action
2.	Completed calibrations will be listed under *Controller Calibrations*. 
3.	Under the **General** tab of the main menu, click **File Management**. 

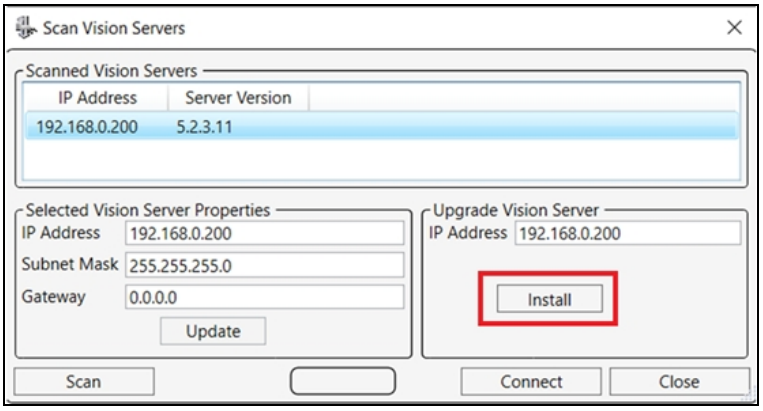
Step	Action
4.	Navigate to *Controller Flash* > *flash* > *pv* and look for the "calibration-camera-1-PASS.txt" file. If the file is not there, it means the calibration is still in progress. When the calibration is completed, the "calibration-camera-1-PASS.tx" file will be in the *pv* folder. 
5.	When the calibration is complete, double-click the "calibration-camera-1.log" to see calibration errors, if there are any. 

Step	Action
6.	On the Output window, the distance error between center 1 and center 2 is displayed. In the example below, it is 0.143. Always ensure the distance error is less than 1.5 mm. If it is above 1.5 mm, re-perform the calibration.  calibration-camera-1.log × Camera Display Find & Replace Looking for top-left aruco: Num = 0 arucoNum = 0: X = 694.610101015091, Y = 218.491856553684, Z = 350.342407786533 Found top-left aruco: Num = 0 Looking for bottom-left aruco: Num = 476 arucoNum = 476: X = 683.010327057776, Y = 216.956502021624, Z = 86.0344720832861 Found bottom-left aruco: Num = 476 Looking for bottom-right aruco: Num = 503 arucoNum = 503: X = 685.651051345296, Y = -203.415116470574, Z = 87.5415203418957 Found bottom-right aruco: Num = 503 Looking for top-right aruco: Num = 27 arucoNum = 27: X = 697.503560216919, Y = -201.801386645605, Z = 351.958721691841 Found top-right aruco: Num = 27 Measured aruco square xdist 11-12 = 15.5669003981259; actual = 15.5 Measured aruco square ydist 11-21 = 15.5627535284708; actual = 15.5 Measured aruco square xdist 21-22 = 15.5697264488273; actual = 15.5 Measured aruco square ydist 12-22= 15.5627535284708; actual = 15.5 Distance error between center1 and center2 (mm) = 0.143140320138432 Opening Gripper Collecting data for rad distance (mm) = 130 Collecting data for rad distance (mm) = 134 If you adjusted the `Minimum or Maximum Optimal Distance To Target` values, they will be reflected here instead.
7.	Ensure the test errors at distance 150, 170, and 190 are less than 1.5 mm.  Collecting data for rad distance (mm) = 204 Collecting data for rad distance (mm) = 212 Collecting data for rad distance (mm) = 224 Collecting data for rad distance (mm) = 230 Finished collecting calibration data Finished stereoscopic camera calibration Estimate calibration model parameters: 2 Finished writing calibration parameters: 2 Estimate calibration model parameters: 0 Finished writing calibration parameters: 0 Finished writing all calibration model parameters stdErr for location = 0.53192689819003, at this distance (mm) from board center = 150 stdErr for location = 0.689662836309684, at this distance (mm) from board center = 170 stdErr for location = 0.771320525016342, at this distance (mm) from board center = 190 Note: Regardless of the calibration quality score, model has been saved to flash and can be used Calibration accuracy test passed successfully

Appendix E: Performing a Software Update on IntelliGuide v23 and v60 Grippers

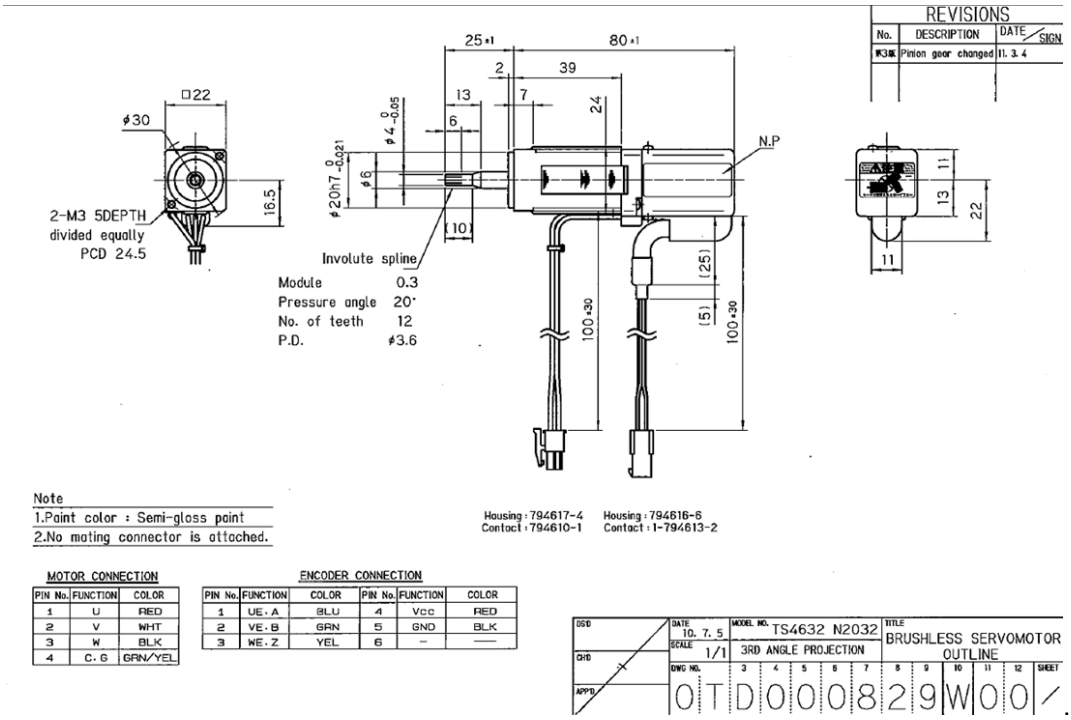
To update IntelliGuide Vision Gripper software, follow this procedure.

Step	Action
1.	Download the latest version of the IntelliGuide Vision Service from the *Software Updates* section on the Brooks website. from the Brooks website athttps://www.brooks.com/support/brooks-preciseflex-support/software-updates/.
2.	The downloaded file will be zipped. Unzip the file to an appropriate location on the host machine. 
3.	Open the Guidance Development Studio (GDS), and click on the **Controller** tab. Click the blue **Connection** button to connect to the PreciseFlex robot. 
4.	Click on the **Vision** tab, and click on the **Scan Vision Servers** button. 

Step	Action
5.	Select the connected IntelliGuide Vision gripper. Click the **Install** button and navigate to the unzipped file from step 2 above. Double-click on that file to begin the update process. 
6.	The update is complete once the progress bar stops flashing green. It may take up to 1 minute.
7.	Restart GDS. Check the bottom panel to make sure that the “Remote Vision Engine Version” is updated and correct after connecting to the IntelliGuide Vision gripper.

Appendix F: System Schematics and Pinouts

IntelliGuide s23, s23D, and v23 Motor



IntelliGuide s23/s23D/v23 Motor Connector Pin Assignments

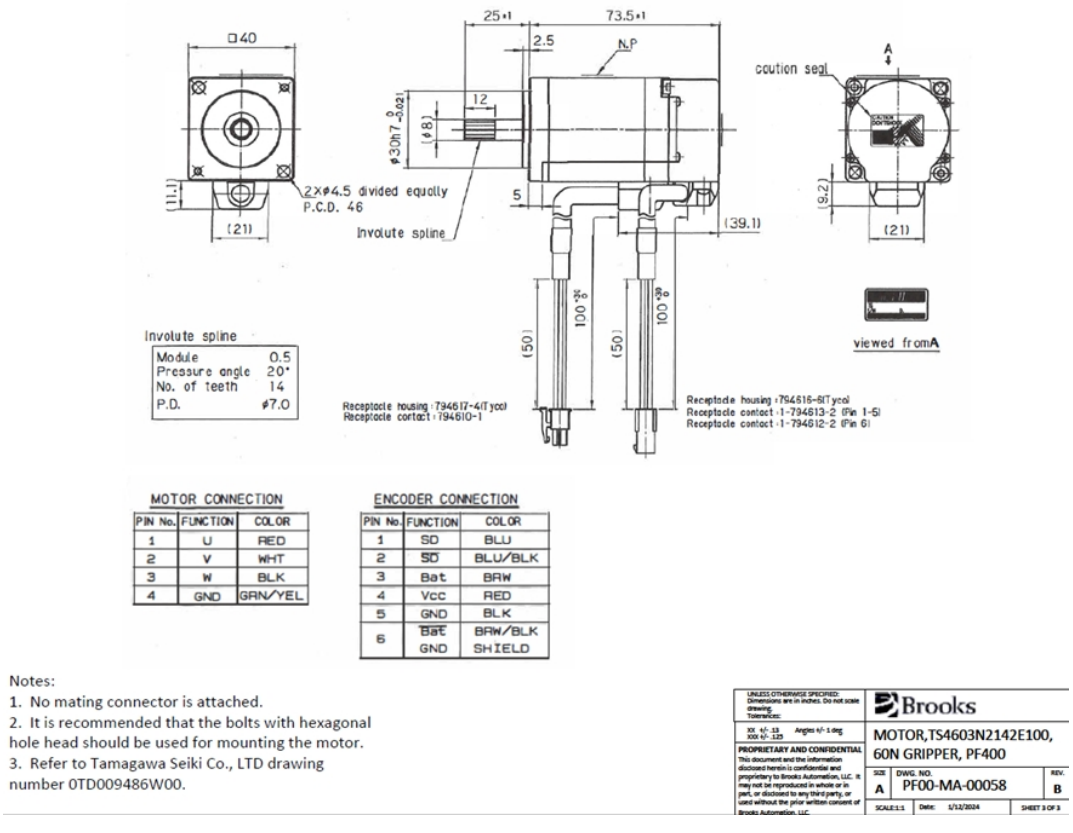
Pin	Description
1	U
2	V
3	W
4	Chassis Ground
Contact Part No	TE Mate-N-Lock 794610-1 (crimp)
Plug Part No	TE Micro Mate-N-Lock 794617-4

IntelliGuide s23/s23D/v23 Encoder Connector Pin Assignments

Pin	Description
1	A

Pin	Description
2	B
3	Z
4	Vcc
5	GND
6	-
Contact Part No	TE Mate-N-Lock 1-794613-2 (crimp)
Plug Part No	TE Micro Mate-N-Lock 794616-6

IntelliGuide s60 and v60 Motor



MOTOR CONNECTION

PIN No.	FUNCTION	COLOR
1	U	RED
2	V	WHT
3	W	BLK
4	GND	GRN/YEL

ENCODER CONNECTION

PIN No.	FUNCTION	COLOR
1	SD	BLU
2	$\overline{SD}$	BLU/BLK
3	Bat	BRW
4	Vcc	RED
5	GND	BLK
6	$\overline{Bat}$ GND	BRW/BLK SHIELD

Notes:
1. No mating connector is attached.
2. It is recommended that the bolts with hexagonal hole head should be used for mounting the motor.
3. Refer to Tamagawa Seiki Co., LTD drawing number 0TD009486W00.

UNLESS OTHERWISE SPECIFIED: Dimensions are in inches. Do not scale drawing. Tolerances: XX ±/- .13, XXX ±/- .125, Angles +/- 1 deg
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Brooks

MOTOR,TS4603N2142E100, 60N GRIPPER, PF400

SIZE A | DWG. NO. PF00-MA-00058 | REV. B
SCALE:1:1 | Date: 1/12/2024 | SHEET 3 OF 3

IntelliGuide s60/ v60 Motor Connector Pin Assignments

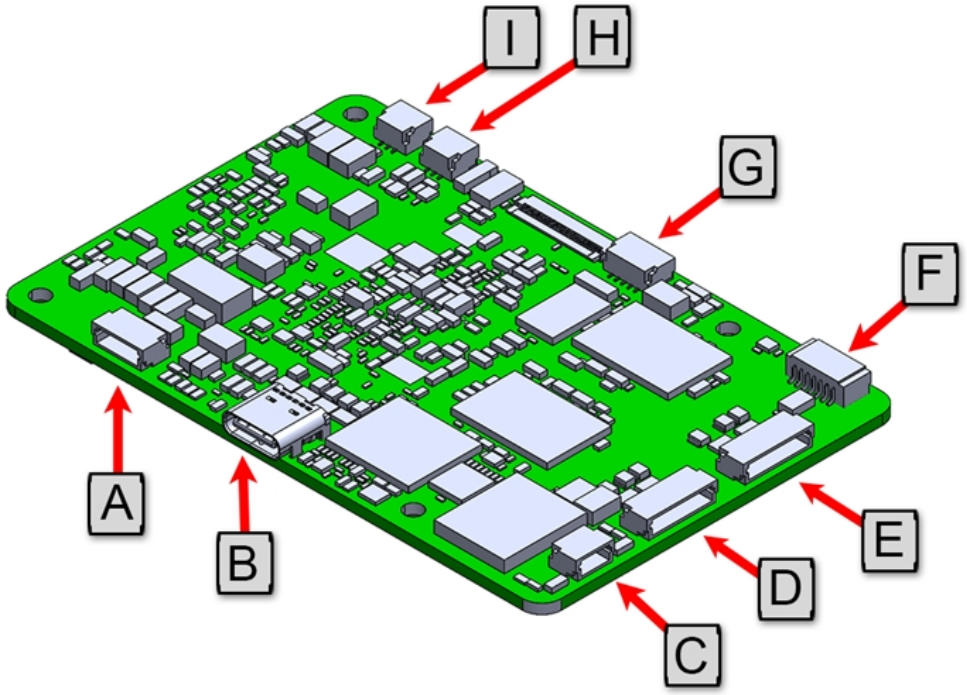
Pin	Description
1	U
2	V

Pin	Description
3	W
4	Chassis Ground
Contact Part No	TE Mate-N-Lock 794610-1 (crimp)
Plug Part No	TE micro Mate-N-Lock 794617-4

IntelliGuide s60/ v60 Encoder Connector Pin Assignments

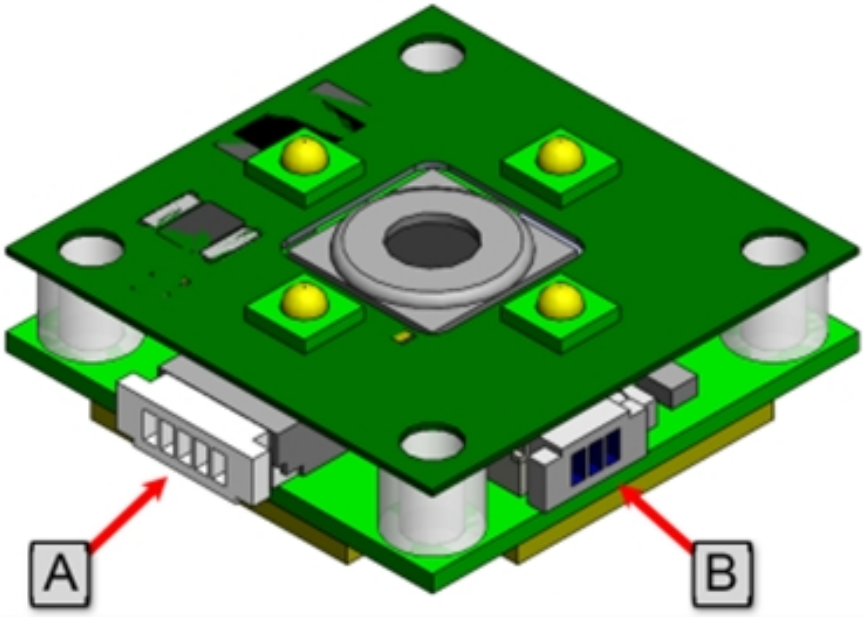
Pin	Description
1	SD
2	SD-
3	Bat
4	Vcc
5	GND
6	Bat-, GND
Contact Part No	TE Mate-N-Lock 1-794613-2 (crimp, pins 1-5), 1-794612-2 (crimp, pin 6)
Plug Part No	TE micro Mate-N-Lock 794616-6

IntelliGuide Vision Processor Pinout



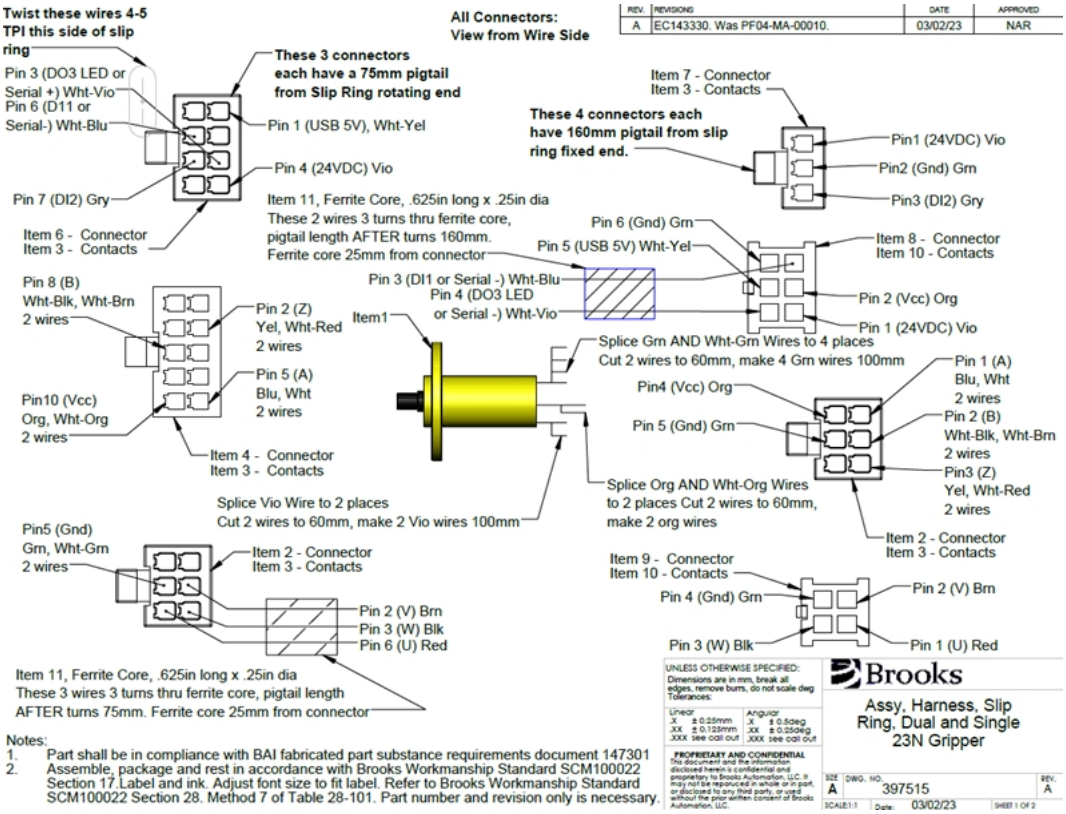
Connector	Description
A	24 VDC power input
B	USB-C header. Unused
C	Ethernet
D	USB. Used For front-facing camera communication
E	USB. Used For bottom-facing camera communication
F	Unused
G	Digital Outputs
H	PWM. Used for bottom-facing LED
I	PWM. Used for front-facing LED

Image Sensor and LED Board Pinout

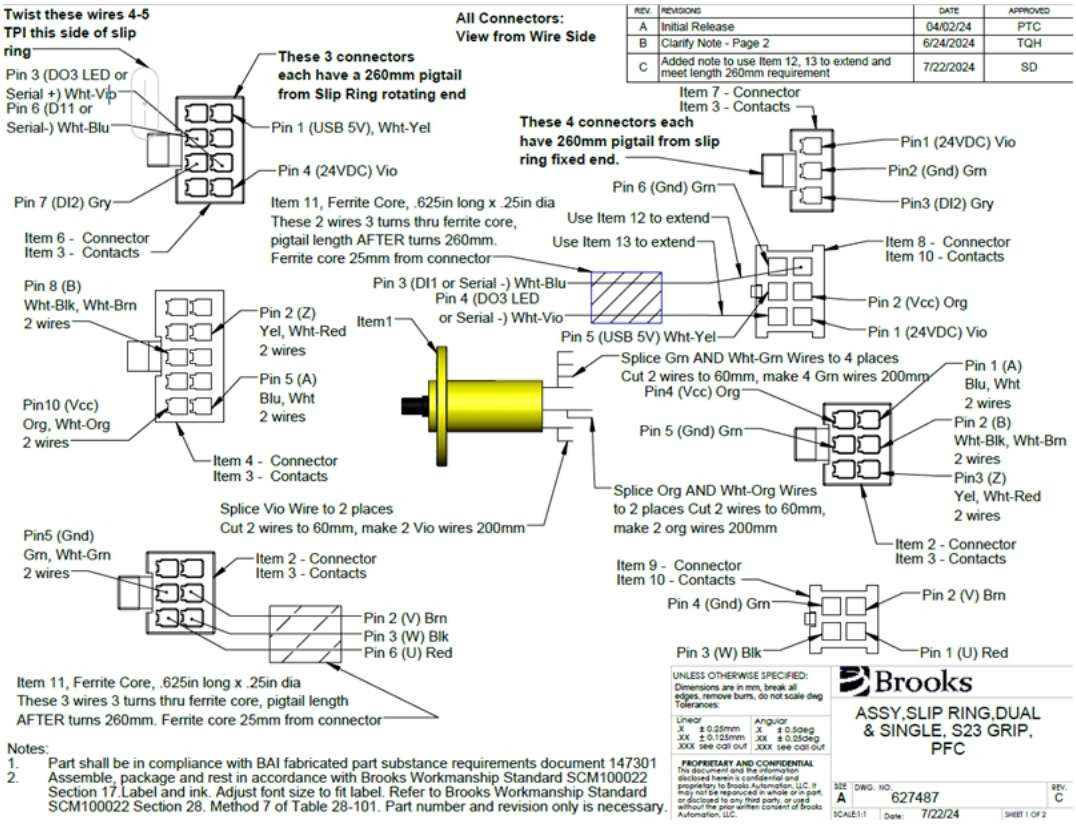


Connector	Description
A	USB. Used for camera communication.
B	PWM. Used for LED

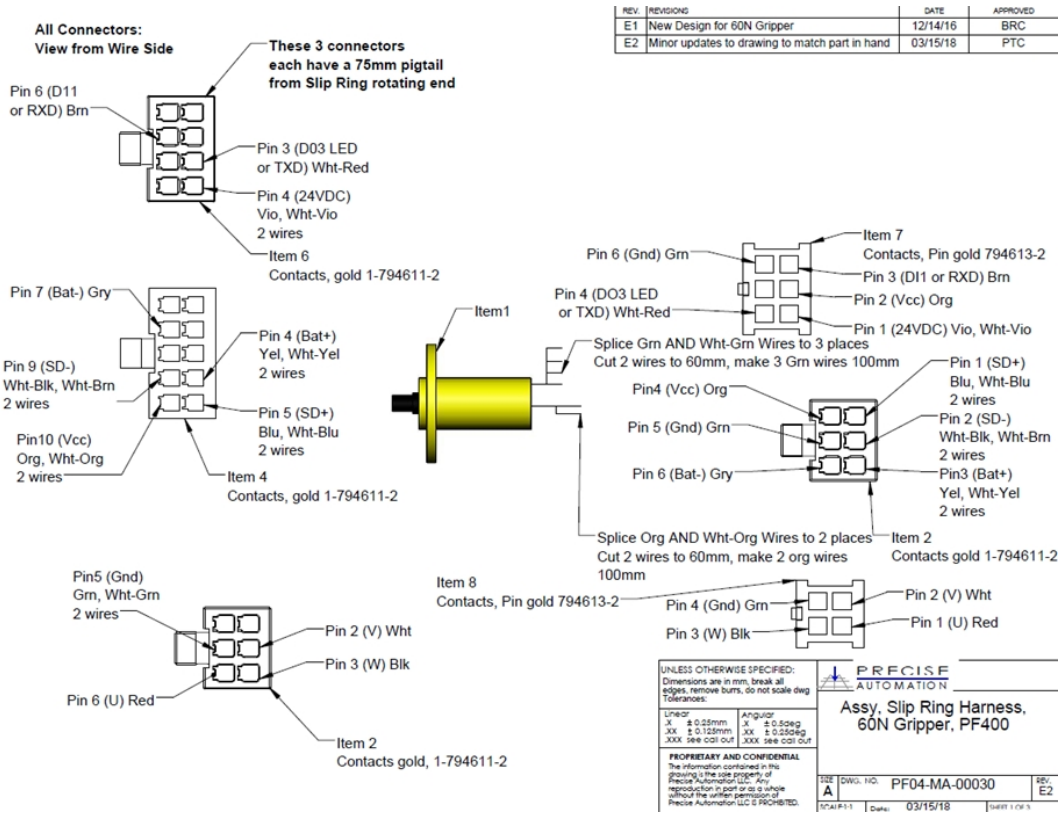
Appendix G: Slip Rings



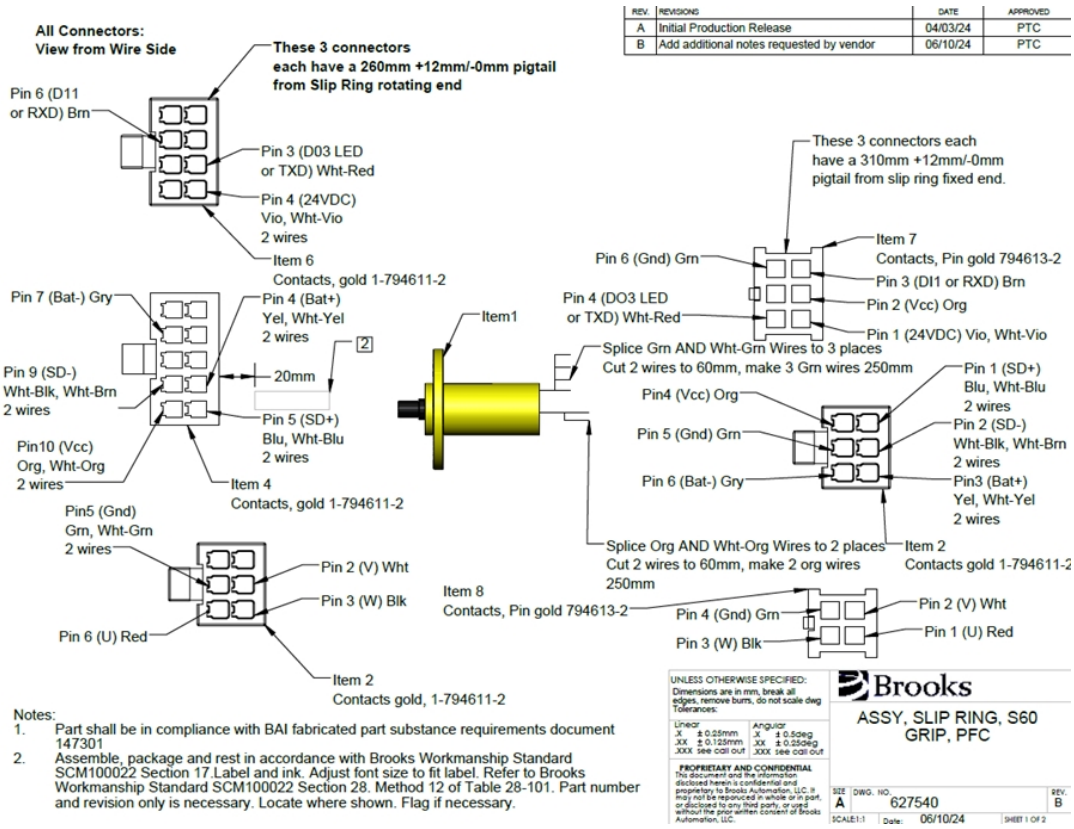
Slip ring harness for IntelliGuide s23 and s23D, PreciseFlex 400 and 3400



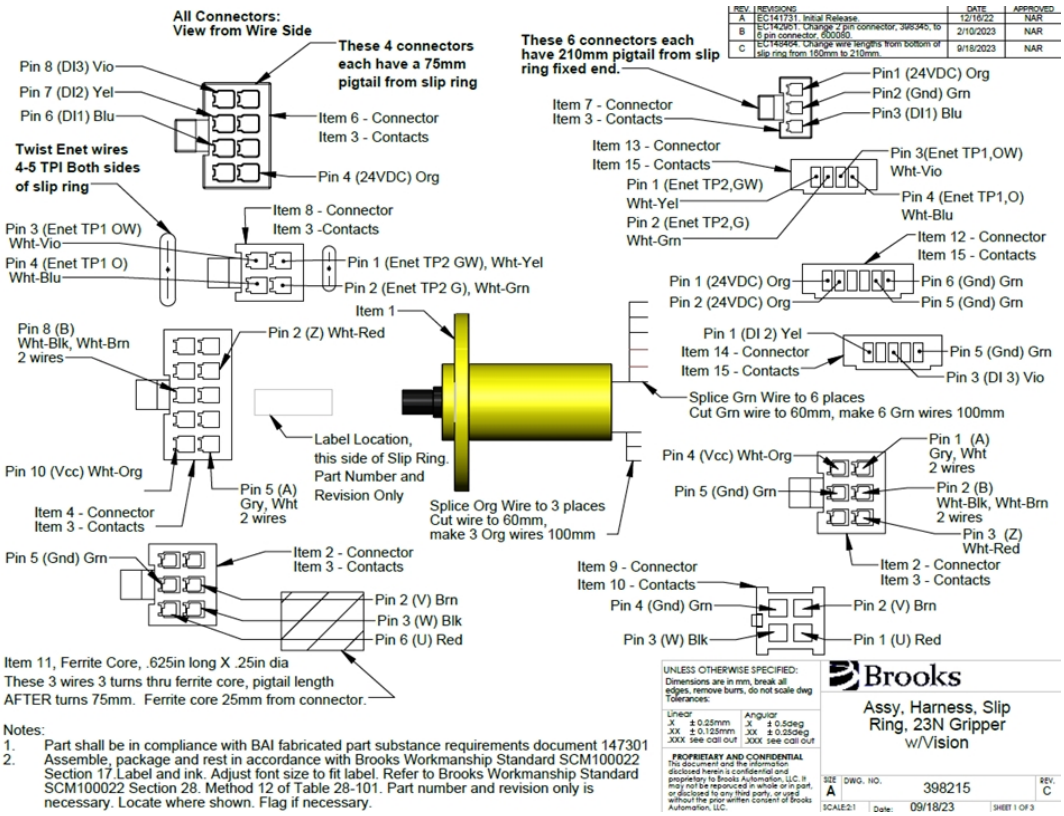
Slip ring harness for IntelliGuide s23 & s23D, PreciseFlex c10



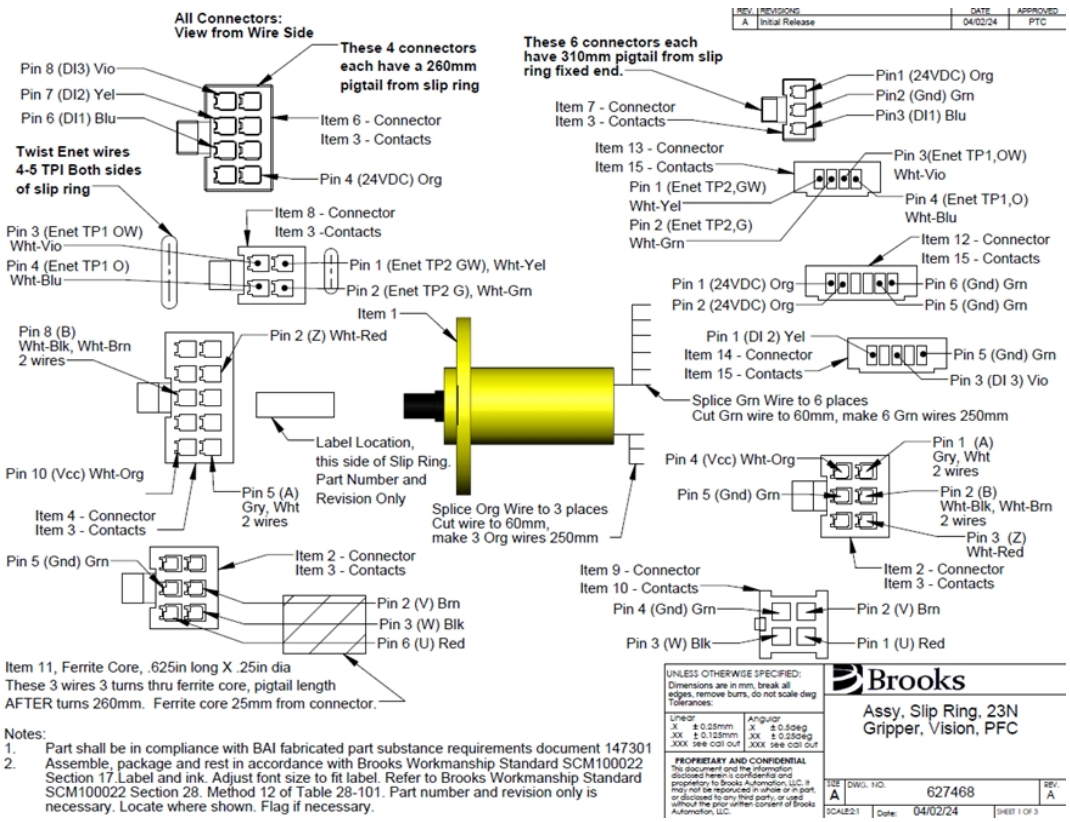
Slip ring harness for IntelliGuide s60, PreciseFlex 3400



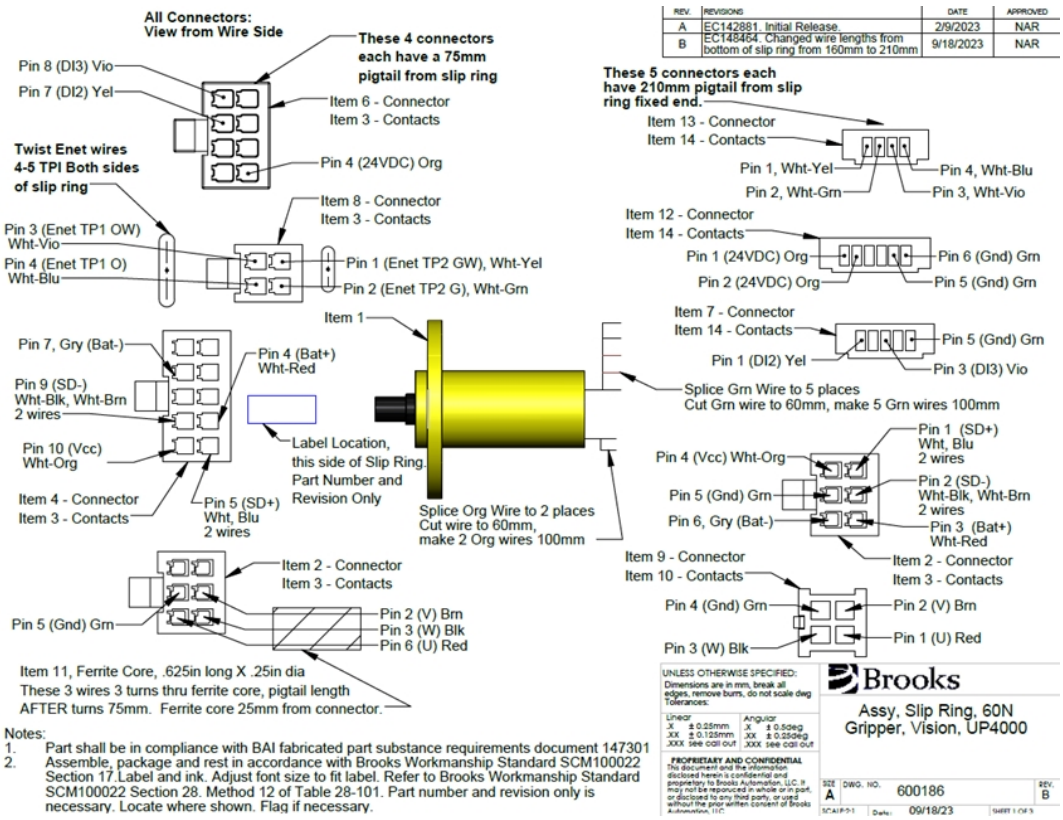
Slip ring harness for IntelliGuide s60, PreciseFlex c10



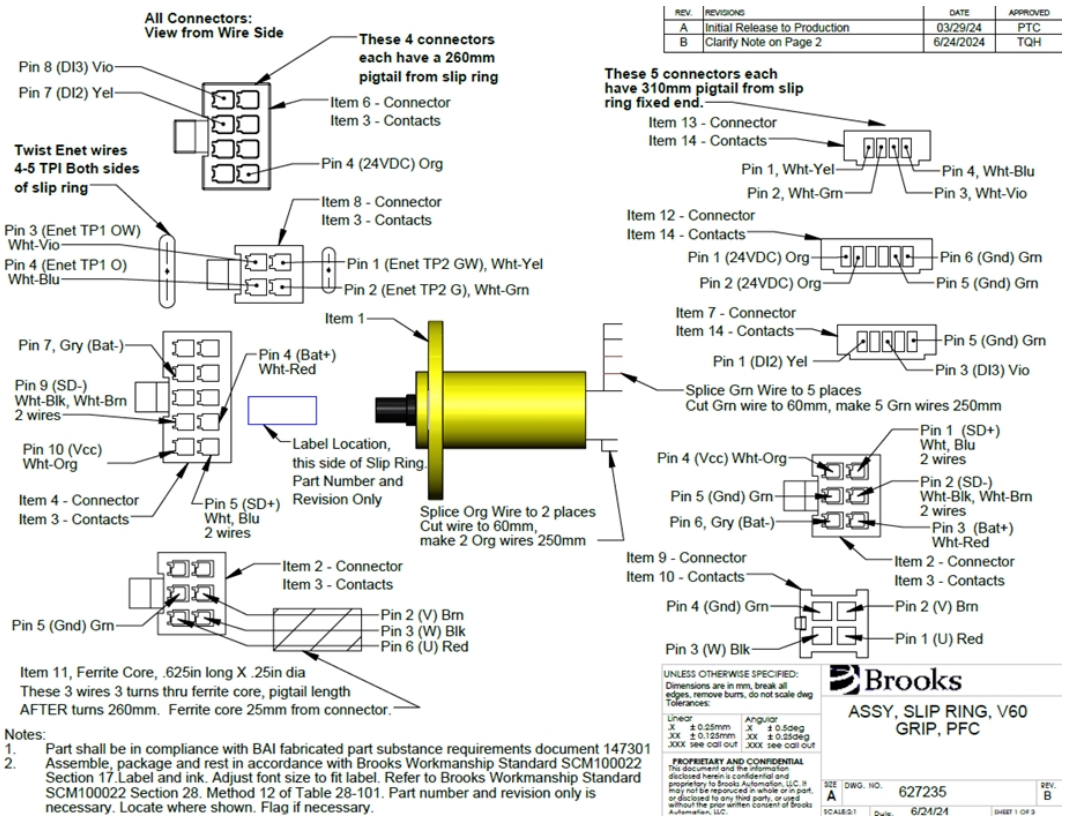
Slip ring harness for IntelliGuide v23, PreciseFlex 400 and 3400



Slip ring harness for IntelliGuide v23, PreciseFlex c10



Slip ring harness for IntelliGuide v60, PreciseFlex 3400



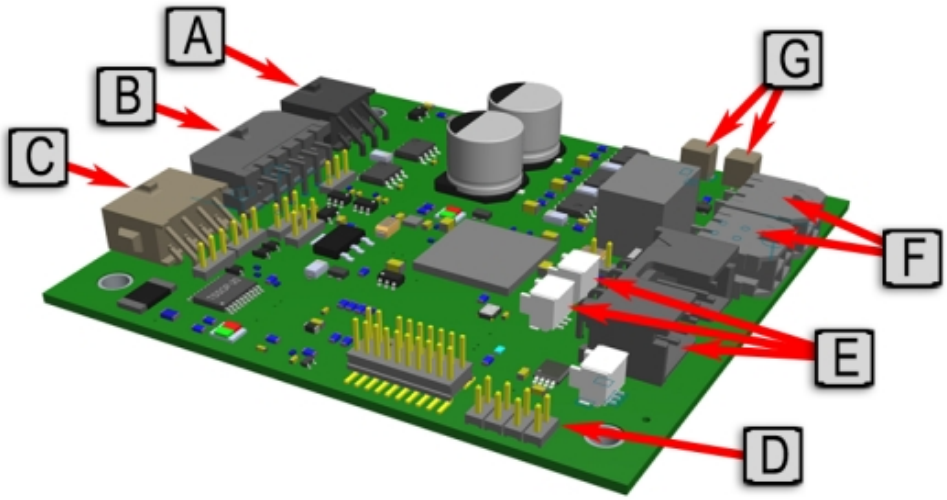
Slip ring harness for IntelliGuide v60, PreciseFlex c10

Appendix H: Guidance Slave Boards (GSBs)

GSB4

The GSB4 is included with all PreciseFlex C-series robots as well as revision D PreciseFlex 400s and 3400s. Refer to the PreciseFlex 400 and 3400 User Manuals to find the revision of your robot.

GSB4 Connectors



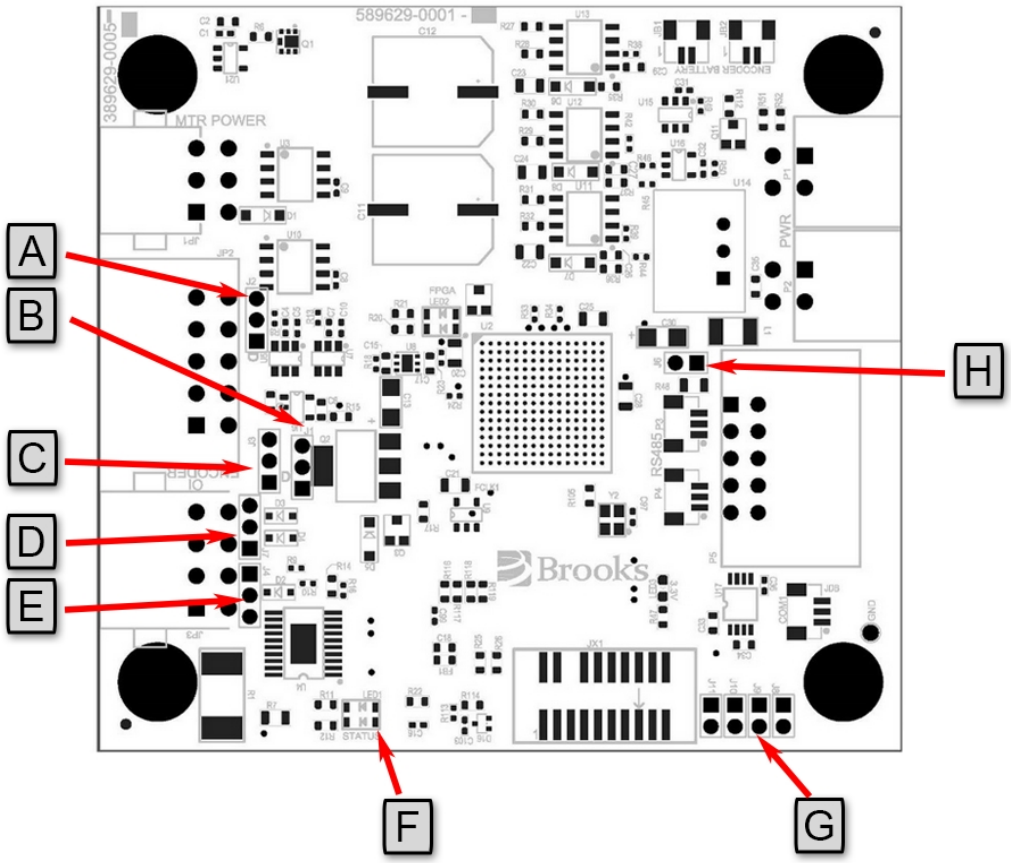
GSB4 Connector Assignments

Connector	Description
A	Motor power
B	Encoder
C	Digital input/output
D	Unit/compatibility jumpers
E	RS-485
F	Logic 24 VDC and motor power
G	Encoder battery

GSB 4 Jumpers

The GSB has several hardware jumpers that determine the configuration of various hardware functions. Depending upon the type of jumper, there may be two or three jumper posts. Posts are tied (shorted) together using black jumper plugs. The three wide jumpers for configuring the motor drive voltage are shown below.

The location of each key jumper set is illustrated below and identified by stenciled labels on the GSB board's surface.



Letter	Description
A	J2-Channel A DIFF/SE
B	J1 Channel Z DIFF/SE
C	J3 Channel B DIFF/SE
D	J7 DOUT3 to TXD
E	J4 DIN1 to RXD

Letter	Description
F	Status LED
G	J8-J11 Unit #/Compatibility Jumpers
H	J6 RS-485 Termination

The table below describes each of the sets of jumpers and how the pins must be shorted ("jumpered") in order to set a specific configuration. When a direction (e.g. left verses right) is described, it is with respect to the GSB board oriented as shown above.

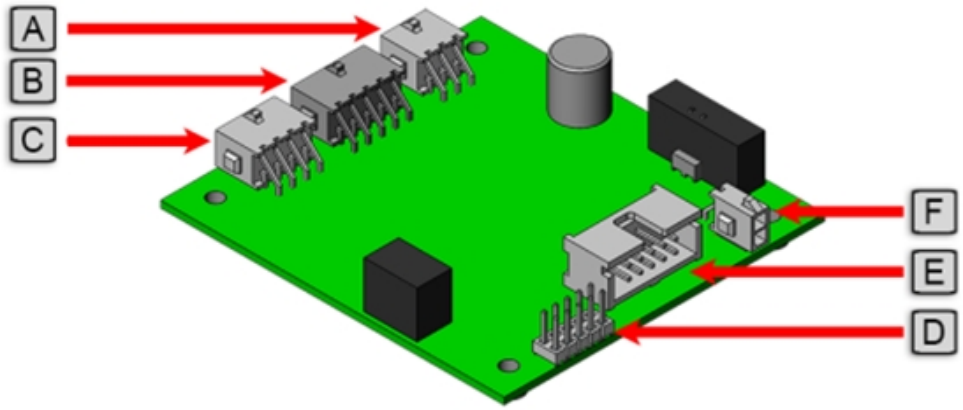
Jumpers	Description	Setting
J8/J9/J10/J11 Unit Number / Compatibility	The right-most jumper in this group (J11) determines if a GSB4 board operates compatibly with a GSB2 and can execute properly with the same set of controller configuration PAC Files. If this jumper is not installed in a GSB4, the GSB4 operates in compatibility mode. When a new robot is being configured for the first time, native (non-compatibility) mode should generally be selected since this makes use of all the features of the GSB4. The setting of the compatibility mode jumper is especially important when an incremental quadrature encoder is utilized. As shipped from the factory, this jumper is installed.	Remove right-most jumper (J11) in GSB4 to execute compatibly with GSB2. Install for native mode.
	In the low-level RS-485 communication protocol, the Unit Number (J8/J9/J10) determines which GSB is the originator or recipient of each message, not the position of the GSB board in the RS-485 daisy chain. See Unit Number /Compatibility Jumpers for a description of these jumpers. The left most jumper is J8. As shipped from the factory, all three (3) of these jumpers are installed and the board is set to unit #1.	Install or remove left 3 jumpers to define GSB Unit Number.

Jumpers	Description	Setting
J7 DOUT3 to TXD	This jumper is provided to support the future capability of the PreciseFlex 400 robot. It determines whether pin 3 of the GSB Digital Input and Output Signal connector conveys the 3rd local digital output signal DOUT3 (standard configuration) or whether this pin is connected to the TXD pin of the RS-485 connector. ***NOTE:*** *In the standard configuration, DOUT3 has a 1k resistor in series with its output. This limits the current and voltage that can be output by this signal and was designed to permit a LED to be directly driven by DOUT3. As shipped from the factory, this jumper selects DOUT3 to output.*	Always jumper J7-2 to J7-3 (left most pins) to enable DOUT3 Jumper J7-1 to J7-2 (right most pins) to connect the DOUT3 pin to the TXD pin
J6 RS-485 Bus Termination	This jumper controls if RS-485 Bus Termination is enabled on this board. For reliable communications, if a GSB is at the end of a RS-485 daisy chain, this jumper must be installed to terminate the communication line. If a GSB is in the middle of a RS-485 daisy chain, this jumper must be uninstalled to disable the termination. As shipped from the factory, this jumper is installed and the GSB should be installed at the end of the RS-485 daisy chain.	Install jumper J6 to terminate the RS-485 communication lines.
J4 DIN1 to RXD	This jumper is provided to support a future capability of the PreciseFlex 400 robot. It determines whether pin 6 of the GSB Digital Input and Output Signal connector in connected to the first local digital input signal DIN1 (standard configuration) or whether this pin is connected to the RXD pin of the RS-485 connector. ***NOTE:*** *As shipped from the factory, this jumper selects DIN1 input.*	Always jumper J4-2 to J4-3 (top most pins) to enable DIN1 Jumper J4-1 to J4-2 (bottom pins) to connect the DIN1 pin to the RXD pin
Status LED	This is a green and red LED that blinks to indicate the operational status of the controller.	

GSB3

The GSB3 is included with revision C and B PreciseFlex 400s and 3400s. Refer to the PreciseFlex 400 and 3400 User Manuals to find the revision of your robot

GSB3 Connectors



GSB3 Connector Assignments

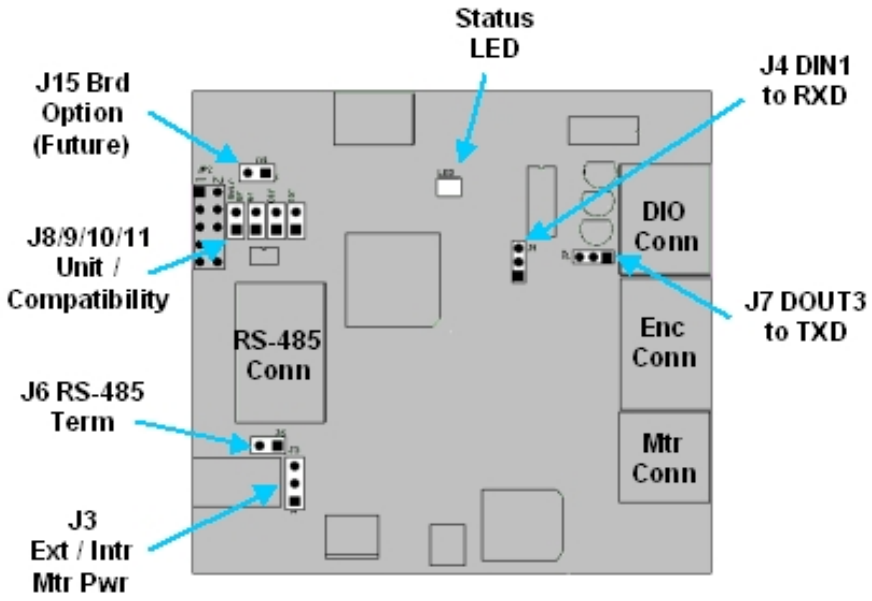
Connector	Description
A	Motor power
B	Encoder
C	Digital input/output
D	Unit/compatibility jumpers
E	RS-485 and 24 VDC logic
F	48 VDC motor power

GSB3 Jumpers

The GSB has a number of hardware jumpers that determine the configuration of various hardware functions. Depending upon the type of jumper, there may be two or three jumper posts. Posts are tied (shorted) together using black jumper plugs. The three wide jumper for configuring the motor drive voltage is shown below.

Three-wide jumper for configuring the motor drive voltage

The locations of each of the key sets of jumpers are illustrated below and are identified by stenciled labels on the surface of the GSB board.



Key sets of jumpers

The table below describes each of the sets of jumpers and how the pins must be shorted ("jumpered") in order to set a specific configuration. When a direction (e.g. left verses right) is described, it is with respect to the GSB board oriented as shown.

Jumper Instructions

Jumpers	Description	Setting
J15 Brd Option (Future)	This jumper is currently unused but will be used in the future to indicate the presence of a hardware/software option. As shipped from the factory, this jumper is not installed.	Always removed.

Jumpers	Description	Setting
J8/J9/J10/J11 Unit Number / Compatibility	The right-most jumper in this group (J11) determines if a GSB3 board operates compatibly with a GSB2 and can execute properly with the same set of controller configuration (*.PAC) files. If this jumper is not installed in a GSB3, the GSB3 operates in compatibility mode. When a new robot is being configured for the first time, native (non-compatibility) mode should generally be selected since this makes use of all of the features of the GSB3. The setting of the compatibility mode jumper is especially important when an incremental quadrature encoder is utilized. As shipped from the factory, this jumper is installed.	Remove right-most jumper (J11) in GSB3 to execute compatibly with GSB2. Install for native mode.
	In the low-level RS-485 communication protocol, the Unit Number (J8/J9/J10) determines which GSB is the originator or recipient of each message, not the position of the GSB board in the RS-485 daisy chain. The left most jumper is J8. As shipped from the factory, all three (3) of these jumpers are installed and the board is set to unit #1.	Install or remove left 3 jumpers to define GSB Unit Number.
J7 DOUT3 to TXD	This jumper is provided to support a future capability of the PreciseFlex 400 robot. It determines whether pin 3 of the GSB Digital Input and Output Signal connector conveys the 3rd local digital output signal DOUT3 (standard configuration) or whether this pin is connected to the TXD pin of the RS-485 connector. ***NOTE:*** *In the standard configuration, DOUT3 has a 1 k resistor in series with its output. This limits the current and voltage that can be output by this signal and was designed to permit a LED to be directly driven by DOUT3. As shipped from the factory, this jumper selects DOUT3 to output.*	Always jumper J7-2 to J7-3 (left most pins) to enable DOUT3 Jumper J7-1 to J7-2 (right most pins) to connect the DOUT3 pin to the TXD pin
J6 RS-485 Bus Termination	This jumper controls if RS-485 Bus Termination is enabled on this board. For reliable communications, if a GSB is at the end of a RS-485 daisy chain, this jumper must be installed to terminate the communication line. If a GSB is in the middle of a RS-485 daisy chain, this jumper must be uninstalled to disable the termination. As shipped from the factory, this jumper is installed and the GSB should be installed at the end of the RS-485 daisy chain.	Install jumper J6 to terminate the RS-485 communication lines.

Jumpers	Description	Setting
J4 DIN1 to RXD	This jumper is provided to support a future capability of the PreciseFlex 400 robot. It determines whether pin 6 of the GSB Digital Input and Output Signal connector in connected to the first local digital input signal DIN1 (standard configuration) or whether this pin is connected to the RXD pin of the RS-485 connector. ***NOTE:*** *As shipped from the factory, this jumper selects DIN1 input.*	Always jumper J4-2 to J4-3 (top most pins) to enable DIN1 Jumper J4-1 to J4-2 (bottom pins) to connect the DIN1 pin to the RXD pin
J3 Ext / Intr Mtr Pwr	This jumper controls whether the power to drive the motor comes from the External Motor Power Input Connector or whether power is derived from the internal 24 VDC logic power that is provided by the RS-485 Signal / 24 VDC Power Connector. Most systems require that an external power source be provided, which permits higher powered motors to be driven and voltages up to 48 VDC. However, for systems that utilize a low power motor, it may be acceptable to siphon some of the 24 VDC that normally powers the logic of the GSB board. This eliminates the need to provide a separate power supply and power cable. As shipped from the factory, this jumper is set to select external motor power.	For external motor power (standard), jumper J3-2 to J3-3 (top most posts) For nternal power, jumper J3-1 to J3-2 (lower most posts)
Status LED	This is a green and red LED that blinks to indicate the operational status of the controller.	

Unit Number/Compatibility Jumpers

In the low-level RS-485 communications, the "unit number" determines which GSB is the originator or recipient of each message, not the position of the GSB board in the RS-485 daisy chain. This unit number is configurable using a group of three jumper posts on the top of the GSB board. The unit numbers can be arbitrarily assigned and do not have to be sequential, but they do have to be unique within a controller system.

The unit number also determines a keyword ("GSB_<unit_number>") that is specified to configure a GSB board as a node in a controller's Servo Network.

> ***NOTE:*** At the software application level, the network node number and not the GSB board unit number determines how the GSB's motor and encoder are addressed.

In addition, this block of jumper posts include a pair of posts (J11) that determine if the GSB operates in "native" mode (jumper installed) or "compatibility" mode (jumper removed). If a GSB3 is replaced with GSB4, the J11 jumper on GSB4 should be the same as J11 on GSB3. If a GSB2 is replaced with GSB4 (a rare case), the J11 jumper must be removed on GSB4. Also, it is required to update GPL to 4.2k1.

For more information on node numbers and configuring the controller, refer to the Hardware and Software Configuration section.

In the table below, the interpretation of the Unit Number Jumpers (J8, J9, J10) is provided. As shipped from the factory, all of the jumpers are installed, which indicates GSB unit #1.

> ***NOTE:*** The Unit Number Jumpers for the GSB are J8/J9/J10 whereas the GIO board utilizes J7/J8/J9.

J8	J9	J10	GSB Unit	GSB Keyword
In	In	In	1	GSB_1
Out	In	In	2	GSB_2
In	Out	In	3	GSB_3
Out	Out	In	4	GSB_4
In	In	Out	5	GSB_5
Out	In	Out	6	GSB_6
In	Out	Out	7	GSB_7
Out	Out	Out	8	GSB_8

Appendix I: Torque Values for Screws

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

Torque Values in Newton-Meters

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