PrecisePlace 100 Robot

Hardware Introduction and Reference Manual

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Warning Labels

The following warning and caution labels are utilized throughout this manual to convey critical information required for the safe and proper operation of the hardware and software. It is extremely important that all such labels are carefully read and complied with in full to prevent personal injury and damage to the equipment.

There are four levels of special alert notation used in this manual. In descending order of importance, they are:

DANGER: This indicates an imminently hazardous situation, which, if not avoided, could result in death or serious injury.

WARNING: This indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or major damage to the equipment.

CAUTION: This indicates a situation, which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation

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Introduction to the Hardware

System Overview

System Description

The PrecisePlace 100 Robot is a collaborative four-axis robot which includes an embedded Guidance 1400A four-axis motion controller, one or more single axis controllers, a 48VDC motor power supply, and a 24VDC logic power supply located inside the X axis of the robot. In addition, it may optionally include an electric gripper and electric gripper controller.

The robot is available in two basic configurations; an XZ configuration, and an XYZ configuration. A theta rotation and electric gripper are available for both of these basic configurations. The Z axis of this robot is available with a standard travel of 229 mm for the XZ configuration and 260mm for the XYZ configuration. The robot is designed as tabletop unit and can carry a payload of up to 2kg in the gripper. These robots are low cost, extremely quiet and smooth, very reliable, and have excellent positioning repeatability. To achieve these results, the axes are powered by brushless DC motors with absolute encoders. With these characteristics, these robots are ideal for automating applications in the Life Sciences, Medical Products, Semiconductor, and Electronics industries.

A number of communications and hardware interfaces are provided with the basic robot. These include an RS-232 serial interface, an RS485 serial interface, an Ethernet interface, and a number of digital input and output lines. In addition, the robot can be purchased with several types of optional Precise peripherals. These include digital cameras, remote I/O, and a hardware manual control pendant.

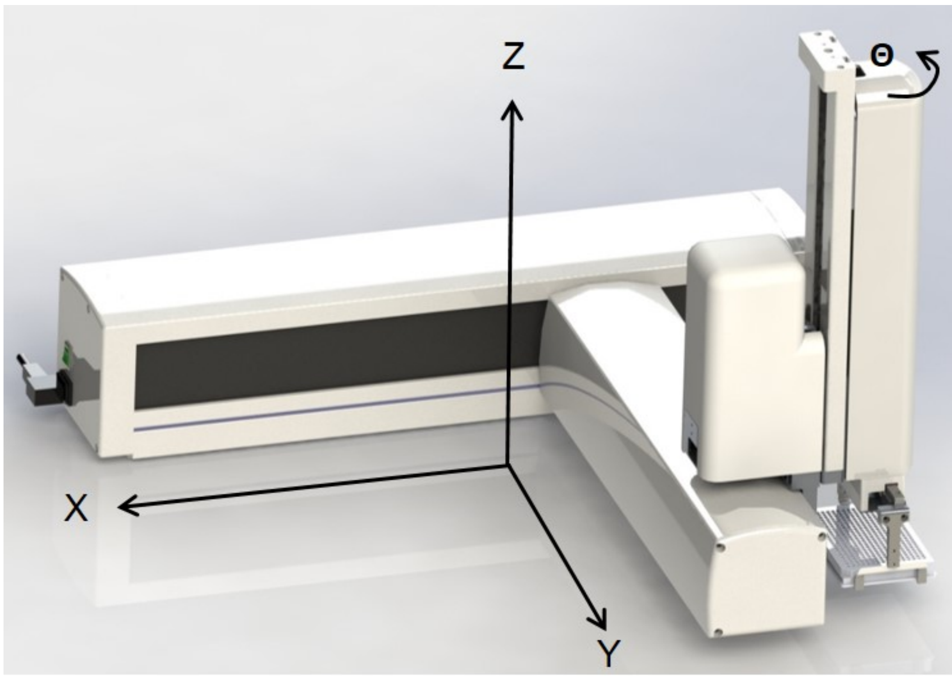
The controller is programmed by means of a PC connected through Ethernet. There are four programming modes: a Digital IO mode (MotionBlocks), a Graphical Programming mode (Guidance Motion), an Embedded Language mode (GPL), and a PC Control mode (TCP Command Server). When programmed in the MotionBlocks, Guidance Motion, or GPL mode, the PC can be removed after programming is completed and the controller will operate standalone. The PC is required for operation in the TCP Command Server mode.

In all modes of operation, the controller includes a web-based operator interface. This interface is used for configuring the system, starting and stopping execution, and monitoring its operation. The web interface can be accessed locally using a browser or remotely via the Internet. This remote interface is of great benefit in system maintenance and debugging. It is also possible to use a wireless tablet or computer to access the web browser, if the controller is connected to a wireless router.

The optional machine vision system, “PreciseVision”, can execute in a PC connected through Ethernet or in an embedded PC inside the robot. PreciseVision requires cameras connected via Ethernet or USB, allowing any processor on the network to obtain and process information from any camera on the network, and provide the results to any networked motion controller.

System Diagram and Coordinate Systems

The PrecisePlace 100 robot is available in several configurations, including XZ, XZTheta, XZTheta+Gripper, and XY, XYZ, XYZTheta, and XYZTheta+Gripper. The orientation and origin of its World Cartesian coordinate system are shown in the diagram below.



Axis	Description of Motion
X	Varies with model
Y	0 or 350mm
Z	229mm XZ, or 260mm XYZ
Theta	+/- 270 degrees
Gripper	76 to 136mm

The first axis of the robot is the X-axis. When the carriage is closest to the right end, the X-axis is at its 0 position in the Joint Coordinate system and in the World Coordinate system. As the robot arm moves to the left, both its joint position and the World X Coordinate increase in value.

The X Extrusion also contains the 24VDC and 48VDC power supplies and the controller, as well as a connector panel in the end cap. When the gripper is installed, the gripper controller is located on the Z extrusion.

The second axis of the robot is the Y axis. When the carriage is closest to the X-axis, the Y-axis is at its 0 position in both the Joint Coordinate system and in the World Coordinate system.

The third axis of the robot is the Z axis. Note for the Z axis, the positive direction is upwards in the World Coordinate system and downwards in the Joint Coordinate system.

The fourth axis is the theta axis and rotates the gripper about the World Z-axis. A positive change in the axis angle results in a positive rotation about the World Z-axis following the right-hand rule.

The robot may include an optional electric gripper, along with a gripper controller. It is also possible to order the robot with a pneumatic gripper, in which case the outer link will house a solenoid to control air to the pneumatic gripper. A light bar is mounted at the top of the theta cover and blinks at a rate of once per second to indicate that the controller is operational and at a rate of 4 times a second when power is being supplied to the motors.

The Z-axis includes a fail-safe brake. This brake must be released to move the Z-axis up and down manually. There is a manual brake release button at the back of the Z-axis drive cover. Depressing this button when 24VDC power is on will release the Z-axis brake while the button is depressed. It is not necessary for the control system to be operating for the brake release to function; the only requirement is providing 24VDC to the controller. Care should be taken to support the Z-axis when the brake release button is pushed, as the axis will fall due to gravity.

System Components

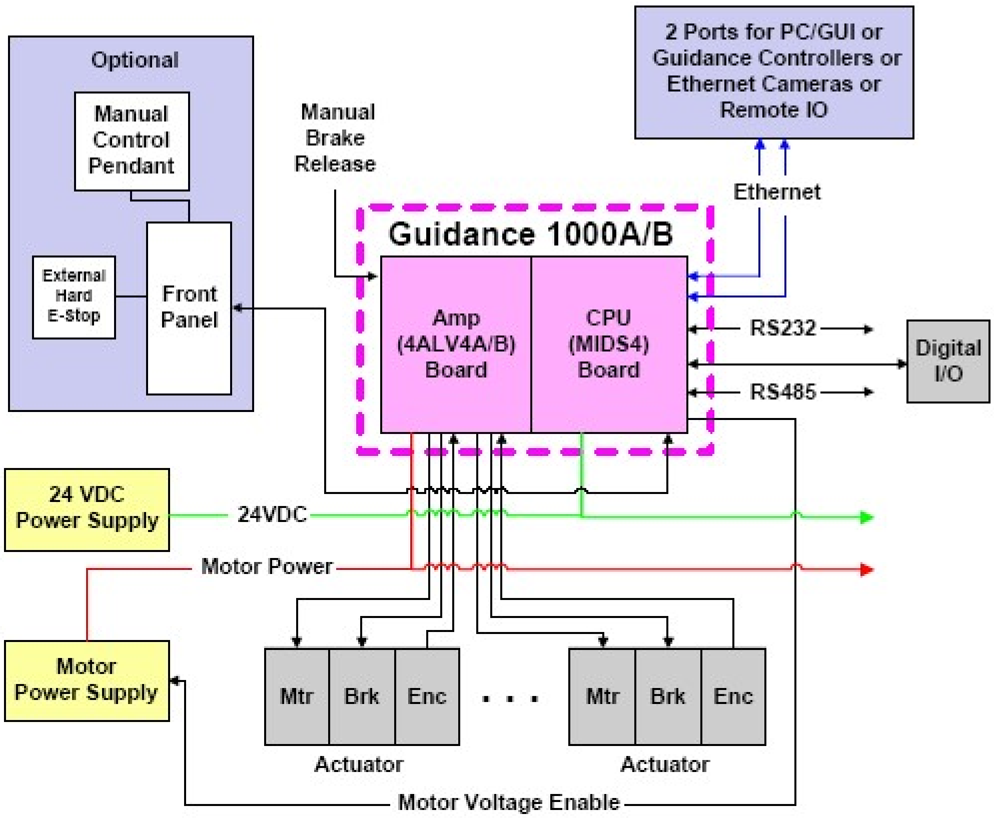
PrecisePlace 100 Robot

Optional Gripper

The robot may be ordered with a servo Gripper. It may also be ordered without a gripper.

Guidance 1400A Controller

The Guidance 1400A Controller is a four-axis general purpose motion controller that contains four motor drives and four encoder inputs. It must be attached to a heat sink. The heat sink is provided by sheet metal in the X extrusion. The controller includes local digital IO. It also supports RS232 and RS 485 serial communication and an optional Precise Remote IO module. It contains two Ethernet ports. The controller and power supplies are shown in the system diagram below.



For detailed information on the controller including interfacing information, please see the *"Guidance 1000A/B Controllers Manual* P/N: G1X0-DI-A0010*"*.

Low Voltage Power Supplies

The PrecisePlace 100 Robot has an integrated 125-watt, 24VDC Power Supply that accepts a range of AC input from 90V to 264V and an integrated 365W, 48VDC Power Supply for the motors.

DANGER: In addition to exposed high voltage pins and components, **the heat sinks on the Power Supplies are not grounded and expose high voltage levels.** AC power to the robot must be disconnected prior to accessing these units.

Energy Dump Circuit

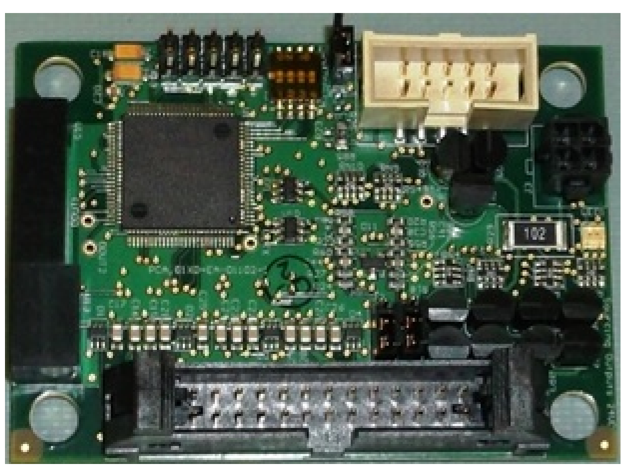
The 48 VDC supply has a regulated output and an overvoltage protection circuit that is triggered if the voltage reaches 60 volts. Rapid deceleration of the robot motors can generate a Back EMF voltage that can pump up the motor voltage bus. In order to avoid bus pump up, an Energy Dump Circuit is connected to the 48 VDC bus, and a regeneration resistor is connected to the controller to dissipate this energy when necessary.

Remote Front Panel, E-Stop Box and Manual Control Pendant

For users that wish to have a hardware E-Stop button, Precise offers an E-Stop Box or a portable Hardware Manual Control Pendant that includes an E-Stop button. The E-Stop box can be plugged into the 9 pin D-sub connector in the connector panel in the base of the robot. The E-Stop box completes a circuit from Pin 6 (24VDC) to Pin 7 (E-Stop) in this connector. If this circuit is not completed it is not possible to enable motor power to the robot. If no E-Stop box or Manual Control Pendant is connected, a jumper must be connected between these two pins to enable robot motor power. The Manual Control Pendants can be plugged directly into the 9 pin Dsub connector mounted on the robot's Facilities Panel in the base of the robot. The E-Stop connections are also present on the 9 pin Dsub connector and each of these units provides the hardware signals to permit power to be enabled and disabled.

Optional RS485 IO Module (GIO)

For users who wish to have IO available at the base of the robot, an optional IO module may be added. This module provides 12 digital inputs and 8 digital outputs in a 25 pin Dsub connector at the robot rear panel and is connected via RS485 to the robot controller.



Optional Digital IO Module (GIO)

Remote IO Module (Ethernet Version)

For applications that require a large number of Inputs and Outputs, a Precise Remote IO (RIO) module may be purchased. The RIO interfaces to any PreciseFlex robot and its embedded Guidance Controller via 10/100 Mb Ethernet and requires 24 VDC power. Up to 4 RIO's can be connected to a controller.

The basic RIO includes: 32 isolated digital input signals, 32 isolated digital output signals and one RS-232 serial line. An enhanced version of the RIO adds 4 analog input signals, a second RS-232 port and one RS-422/485 serial port.

The Enhanced RIO module is pictured below.:

WARNING: The RIO contains unshielded 24 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

Machine Vision Software and Cameras

The Guidance 1400 Series controllers support the PreciseVision machine vision system. This is a vision software package than can run in a PC.

Cameras must be connected via Ethernet or USB. Vendors such as DALSA already offer a variety of Ethernet machine vision cameras. In addition, other vendors offer USB cameras that are supported in PreciseVision.

Precise offers an Arm-Mounted Camera Option for certain robots. Contact Precise for details.

Machine Safety

Safety and Agency Certifications

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

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

We recommend that you read EN ISO 10218-2011-1 and -2, Manipulating Industrial Robots – Safety, which contains guidelines for robot system installation, safeguarding, maintenance, testing, startup, and operator training. We also recommend that you read the International Standard IEC 204 or the European Standard EN 60204, Safety of Machinery – Electrical Equipment of Machines.

Standards Compliance and Agency Certifications

The PreciseFlex robots are intended for use with other equipment and are considered a subassembly rather than a complete piece of equipment on their own. They meet the requirements of these standards:

ENISO 10218-1-2011-1 Robots for Industrial Environments, Safety Requirements
EN 610204-1 **S**afety of Machinery, Electrical Equipment of Machines
EN 61000-6-2 EMC Directive (Immunity)
EN 61000-6-4 EMC Directive (Emissions)
CSA/UL
CE

To maintain compliance with the above standards the controller must be installed and used in accordance with the regulations of the standards, and in accordance with the instructions in this user's guide.

Moving Machine Safety

The PreciseFlex robots can operate in Manual Control Mode, in which an operator directly controls the motion of the robot, or Computer Control Mode in which the robot operation is automatic. Manual Control Mode is often used to teach locations in the robot workspace. The robot's speed is limited in Manual Control Mode to a maximum of 250mm per second for safety. While the PrecisePlace 100 is a light-duty robot that can only apply approximately 120 Newtons of force (or less in collaborative mode), it is very important for operators to keep their hands, arms and especially their head out of the robot's operating volume, when the robot is running under computer control. It is important that operators wear safety glasses when inside the robot's operating volume.

In Computer Mode the robot can move quickly. The PP100 has been designed to be "hand-safe" even in computer mode, and in some cases a risk assessment of the application may indicate that it can be used without operator safety screens. However safety glasses should be worn at all times when an operator is within the robots working volume. Please refer to the EN ISO 10218-2011-1 and -2, for Industrial Robots for information on recommended safe operating practices and enclosure design for robots of various sizes and payloads.

Voltage and Power Considerations

The Guidance 1400A controller requires two DC power supplies, a 24 VDC power supply for the processor and user IO, and a separate 48VDC motor power supply.

> **DANGER:** The Guidance 1400, the 48 VDC and the 24 VDC power supplies are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. These products are intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.

The PrecisePlace 100 power supplies have a dual input range of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz. Inrush current can be as high as 100 Amps at 240 VAC for short periods of time. The power supplies are protected against voltage surge to 2000 volts. Transient over voltage (< 50 µs) may not exceed 2000 V phase to ground, as per EN61800-31996. The power supplies are protected against over current and over voltage conditions.

The robot consumes less than 200 Watts during normal operation.

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

Mechanical and Software Limit Stops

The X-axis, Y-axis, Z-axis, Theta rotation, and Gripper have hard limit stops at the end of travel which are factory installed. The soft-limit stops must be set within the range of these hard stops. Since the robot has absolute encoders with battery backup on all axes except the gripper, even if the robot is turned off, the encoders keep track of joint position. If any axis is pushed outside of the soft limit stops, the robot will not allow the axis to run under computer control until the axis is moved back inside the software limit stop either under manual control or by hand. The joint position can be viewed either on the optional Manual Control Pendant, or in the Virtual Manual Control Pendant in the Web Based Operator Interface. (See Guidance Controller Setup and Operation Quick Start Guide)

Stopping Time and Distance

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

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

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

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

A Hard E-Stop is generated by one of several hardware E-Stop inputs and causes motor power to be disabled. However, there is a parameter that determines a delay between the time the Hard E-Stop signal is asserted and the time the motor power supply relay is opened. This delay is nominally set at 0.5 seconds. It may be adjusted by an operator with administrator privileges. On the web-based operator interface menu, go to Setup/Parameter Database/Controller/Operating Mode/ and set parameter 267 to the desired delay. If this delay is set to 0, the high-power relay will be disabled within 1ms.

For the PrecisePlace 100 robot, the X-axis, Y-axis, and Theta rotation axes do not have mechanical brakes. Therefore, leaving the motor power enabled for 0.5 sec allows the servos to decelerate the robot. The servos will typically decelerate the robot at 1.0G, or 10,000mm/sec^2. If the robot is moving at a speed of 500mm/sec, the distance traveled will be 12.5mm to reach a full stop, and the time will be 0.050sec. If the robot is moving at its maximum speed of 1500mm/sec, the time to stop will be about 150ms and the distance about 110mm.

Releasing a Trapped Operator: Brake Release Switch

Should a hard E-Stop be triggered, the Z brake will engage, and motor power will be disconnected from all motors. As the J1, J2, and J4 axes have no brakes, they may be freely pushed by the operator. To release the Z brake, the operator may press the brake release switch, at the rear of the Z axis motor cover, as long as 24VDC is present. It is not necessary for motor power to be on for the brake release to work.

Brake Release Switch

Installation Information

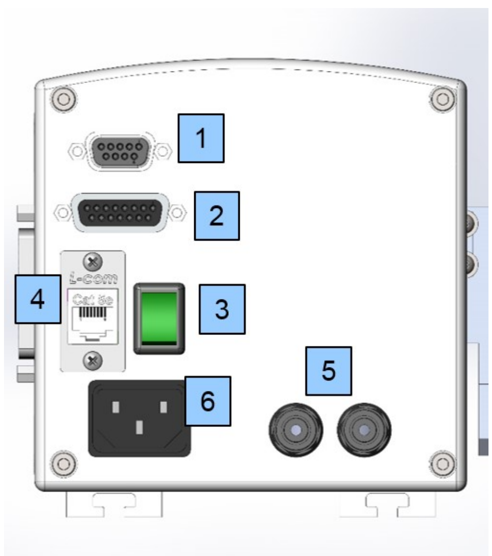
Environmental Specifications

The PreciseFlex robots must be installed in a clean, non-condensing environment. Light fluid splashing around the base of the robot is acceptable, but this robot is not intended for use in a washdown or spray environment. Please see the Environmental Specifications in Appendix B for specific environmental limits.

Facilities Connections

The Facilities Panel on the left end cap includes:

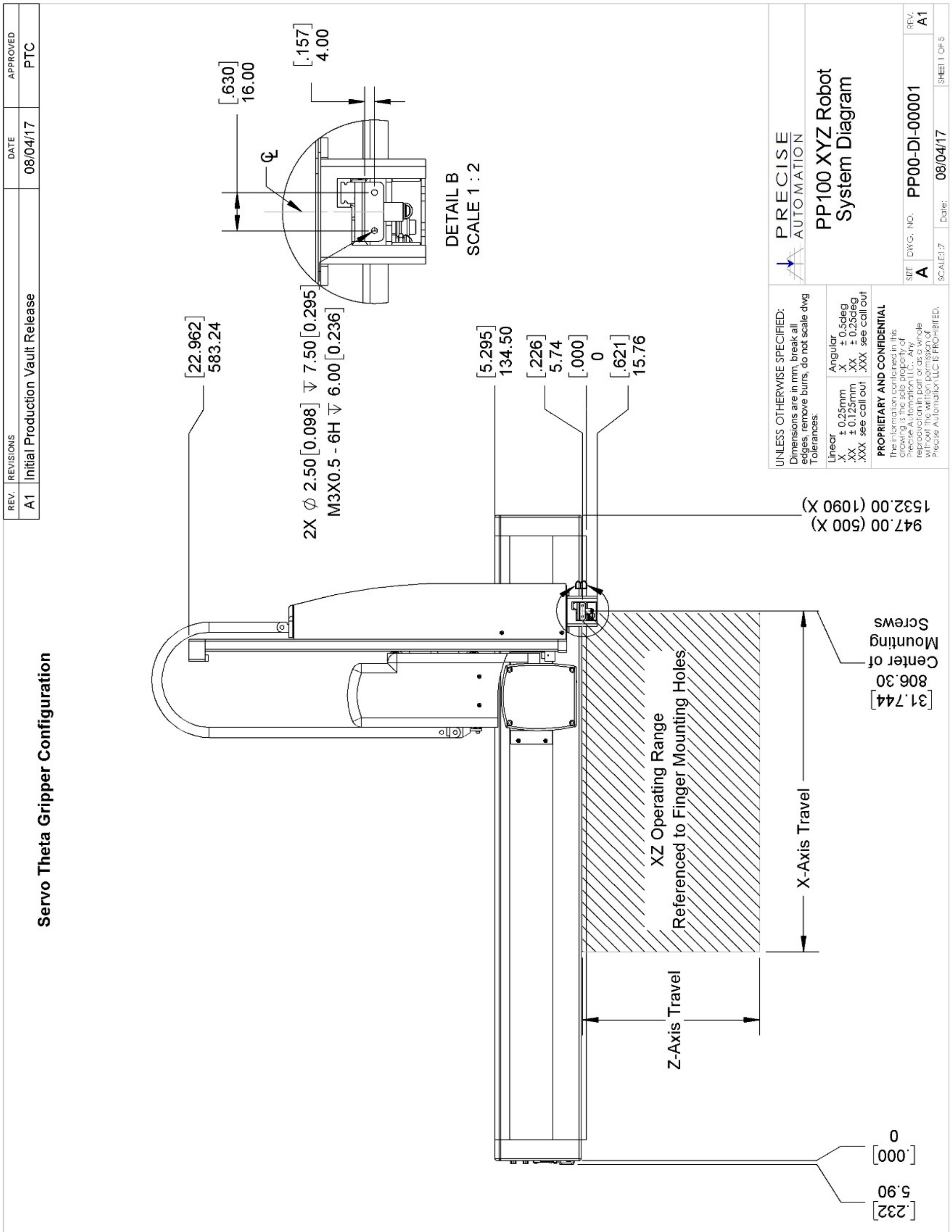
- System AC input power receptacle
- Lighted AC on/off power switch
- Connectors for controller input and output signals



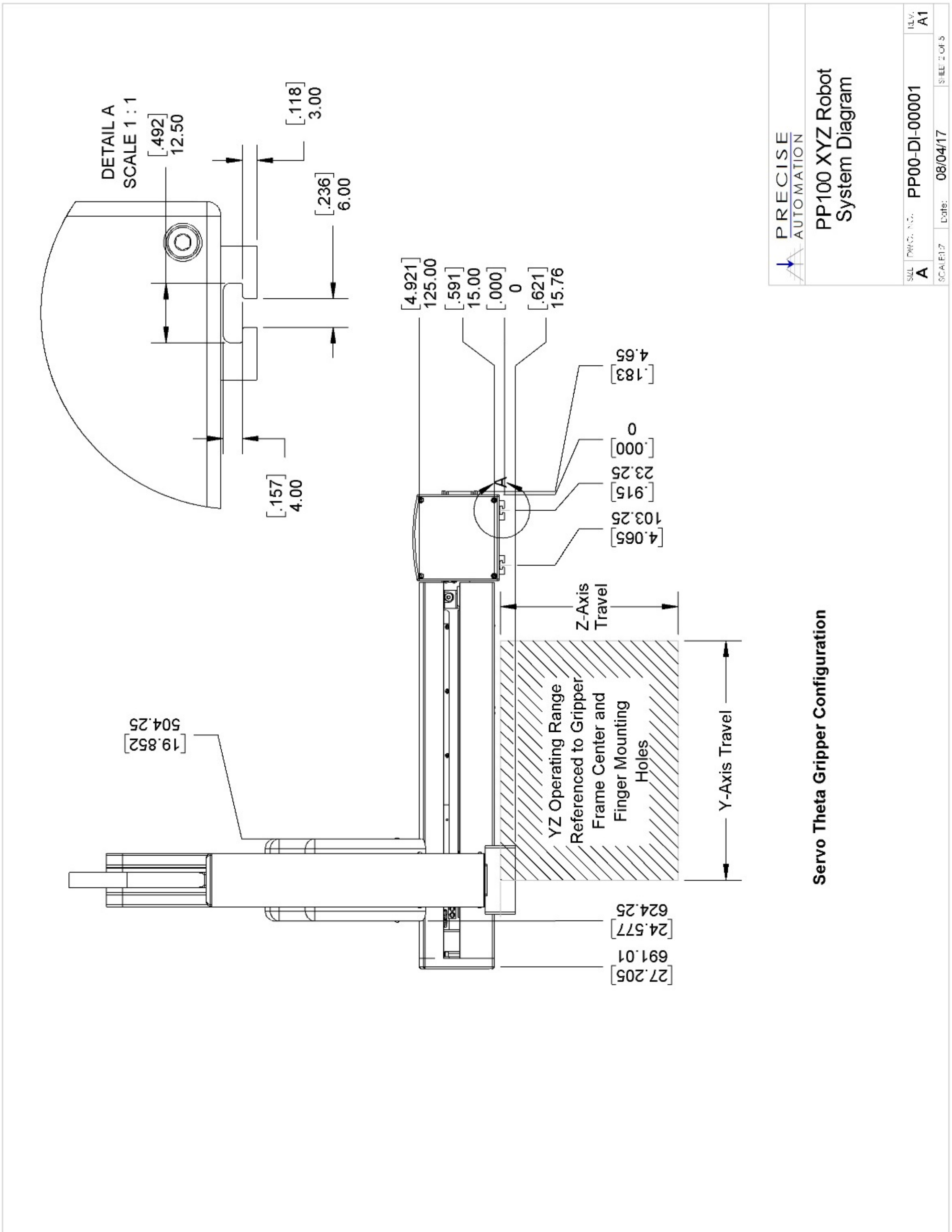
Item	Name	Description
1	9 Pin Dsub	Pendant and EStop
2	15 Pin Dsub	Digital IO
3	Switch	Power On with Light
4	RJ45	Ethernet Connector
5	Air	.125in air hose in
6	Power	Power Input with Filter

Specifications and System Dimensions

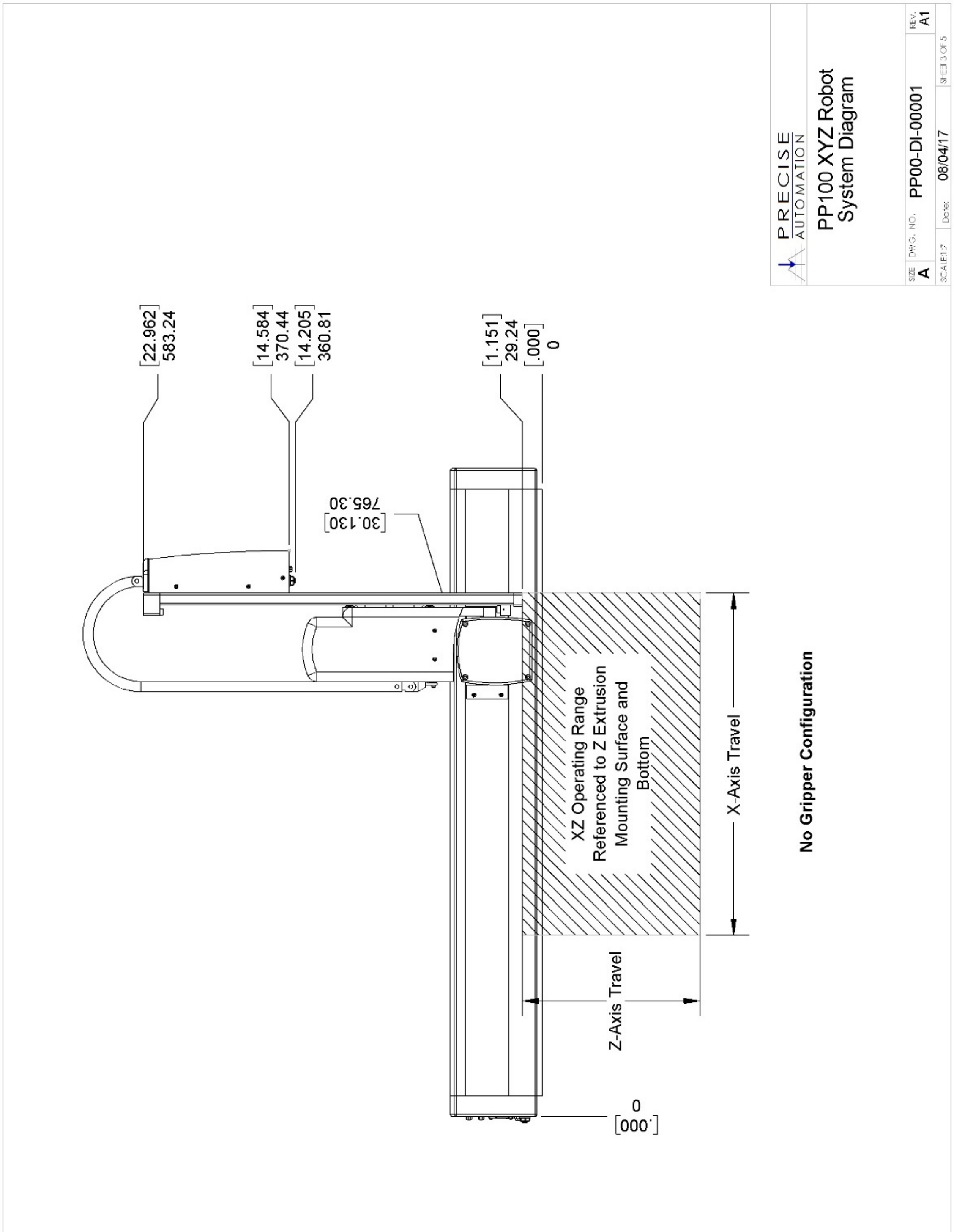
General Specifications	Range & Features
Range of Motion & Resolution	
X Axis	500 mm standard, 1090 mm option available in XYZ version 685 mm standard, 1270 mm option available in XZ version
Y Axis	350 mm standard
Z Axis	260 mm standard in XYZ version 229 mm standard in XZ version
Theta Axis	+/- 270 degrees
G ripper	An optional integrated servo gripper is available. The servo gripper has 60 mm of travel and can be outfitted with user developed fingers for holding a variety of different size parts. Software can control squeeze force (between approximately 0 -23 N for close force, 0 -10 N for open force) and open/close speed. Safety features include: protection against dropping parts when robot is powered down or e -stop pressed (gripper provides 7 -10 N of c lose force when motor power is off)
Repeatability	+/- 100 µm overall in X, Y and Z directions at 18 -22 degrees C
Performance and Payload	
Maximum Acceleration	1 .0 G with 500 gm payload
Maximum Speed	1 ,500 mm /sec in X/Y
Maximum Payload	2 kg with gripper option. 3 kg with XZ or XYZ configuration without Theta and gripper
Motors	Brushless DC servo motors with absolute encoders on X, Y , Z and Theta axes, no motion during homing.
TUV Certified Collaborative Forces	Precise collaborative robots have been measured by TUV and certified to exert forces that fall within the force guidelines for collaborative robots as defined by the recent ISO/TS 15066 Standard on Collaborative Robots. Even maximum speed collisions in free space are well under the ISO force limits for operator safety. However, in order to use a robot in an application without safety shields, the application as a whole (including end effectors, operation methods, objects being handled and obstacles in the workcell) must be evaluated for safety. For more information on the evaluation of applications and workcells without safety shields, please contact Precise Automation.
Interfaces	
General Communications	RS -232 C interface, 10 /100 M bps Ethernet port, E -stop input, all available on X axis end cap
Digital I/O Channels	Four optically isolated inputs and four optically isolated outputs available on X-axis endcap. Option available for an additional 12 optically isolated digital inputs and 8 optically isolated digital outputs on X - axis back cover. Additional remote I/O available via Precise RIO modules or 3rd party MOD BUS/TCP devices
Operator Interface	Web based operator interface supports local or remote control via browser connected to embedded web server
Programming Interface	Three methods available: Guidance Motion (simple G UI for non-programmers using teach and repeat methods), embedded Guidance Programming Language (standalone, modeled after Visual Basic.Net), PC control using open source TCP/IP Com m and Server operated via Ethernet connection (TCP).
Required Power	Input range: 90 to 264 V AC, s ingle phase, 50 -60 Hz, 365 watts maximum
Weight	20 kg for 635 mm travel version, 32 kg for 1270 mm travel version



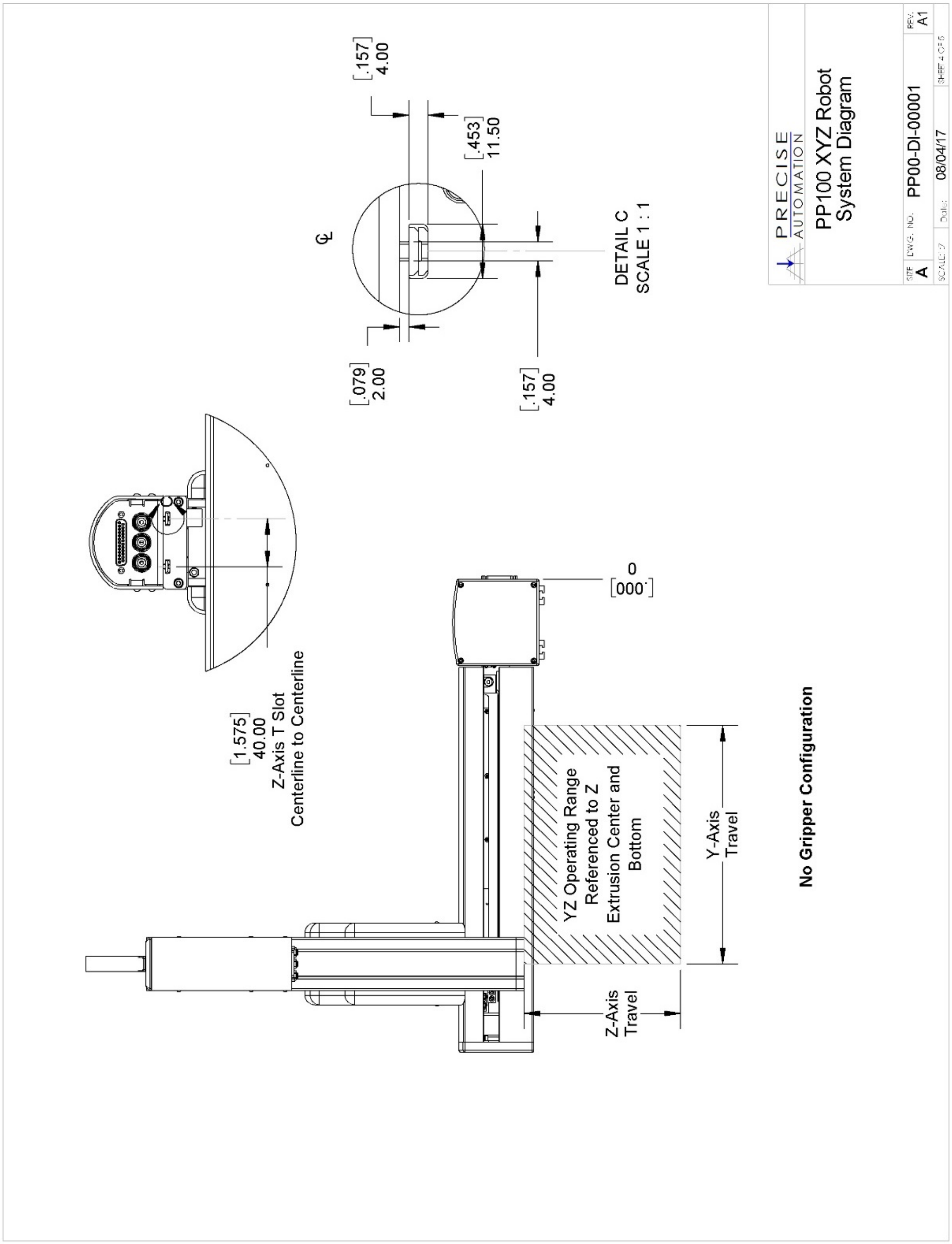
XYZ Robot with Gripper, Front View



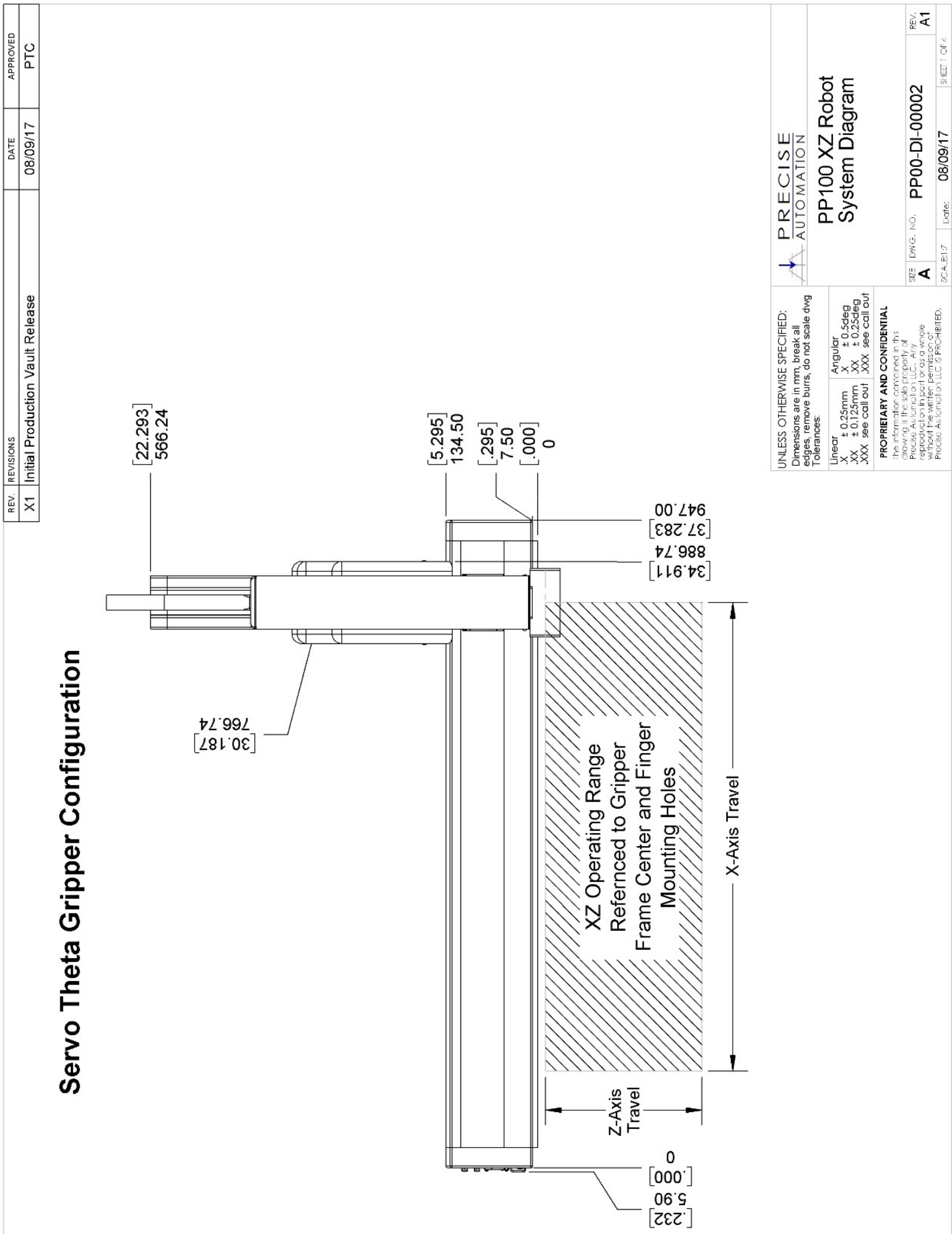
XYZ Robot with Gripper, Side View



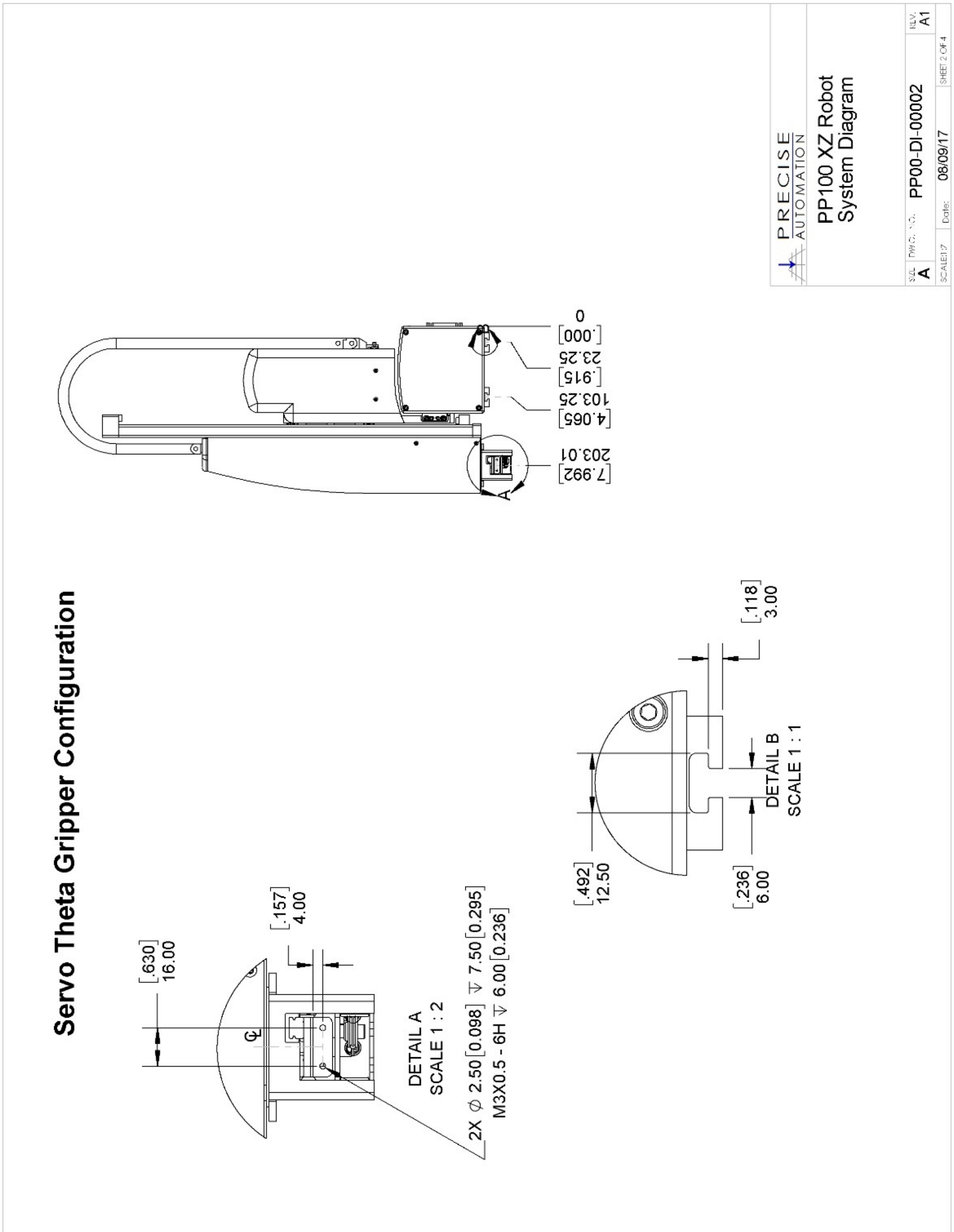
XYZ Robot without Gripper, Front View



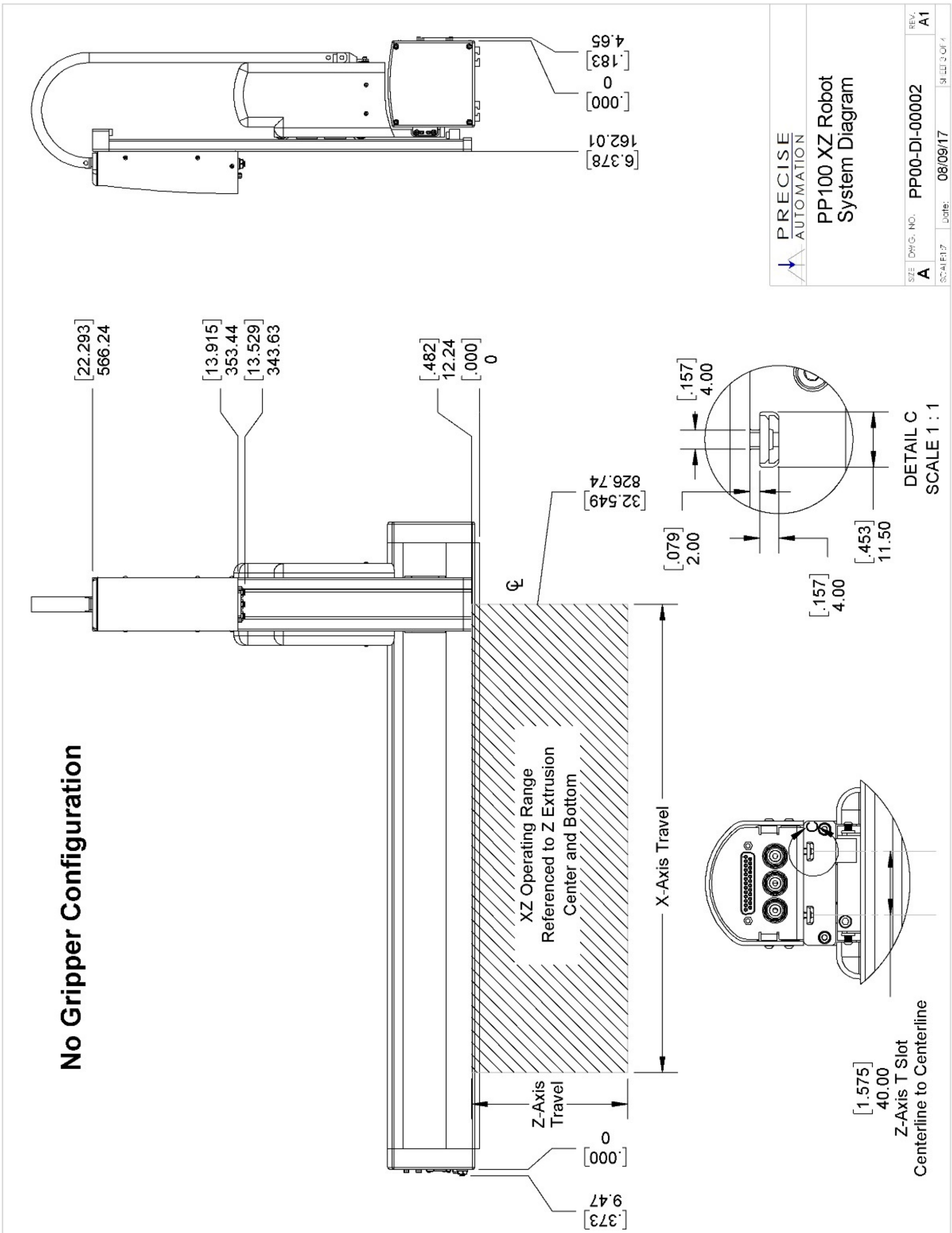
XYZ Robot without Gripper, Side View



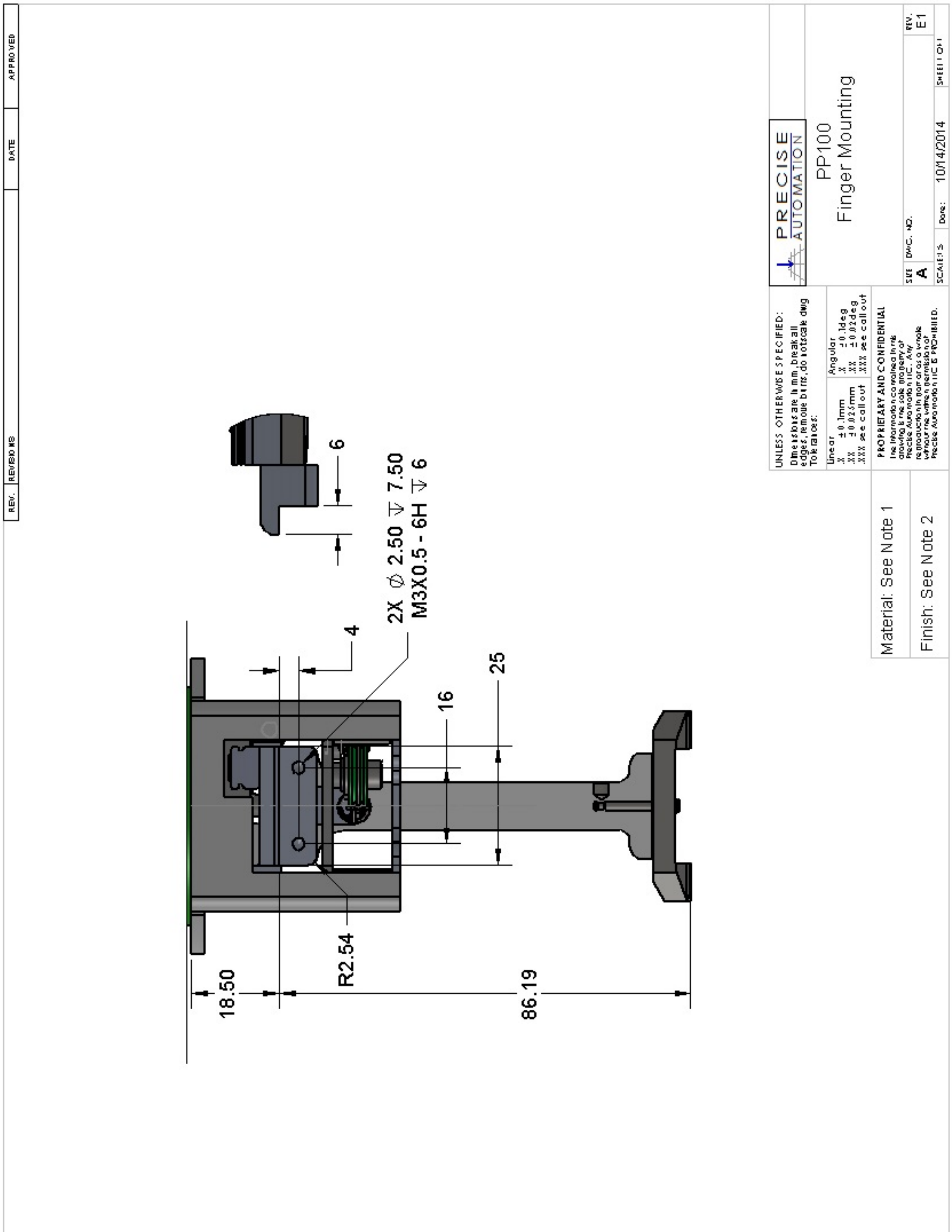
XZ Robot with Gripper Front View



XZ Robot with Gripper, Side View



XZ Robot without Gripper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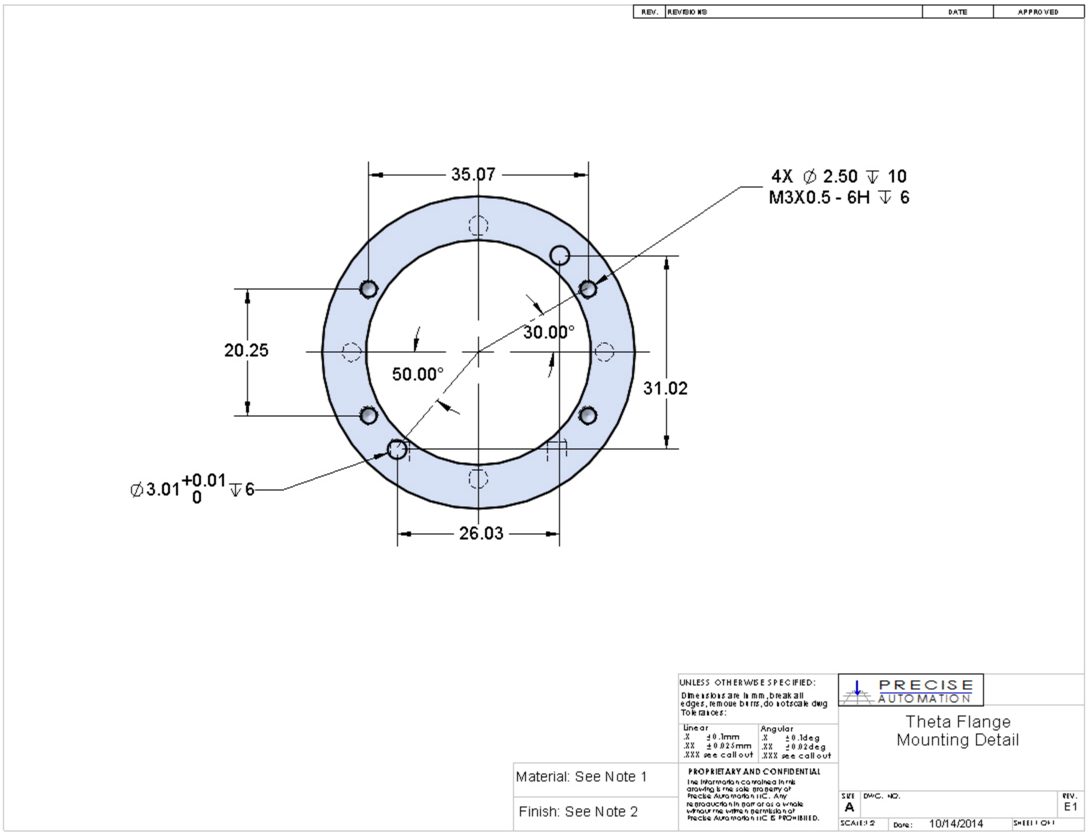
PP100 Finger Mounting



Mounting Instructions

PrecisePlace robots must be attached to a rigid surface that can withstand lateral forces of 200 Newtons without moving or vibrating. The robot X-axis has T-Slots to accommodate M4 Economy T-Nuts for mounting screws located as shown above. M4 Economy T-Nuts, PN NDM04022 are available from Buckeye Fasteners.

Tool Mounting – PrecisePlace 100

The PrecisePlace 100 is typically supplied with an electric gripper. In some cases, a pneumatic gripper or vacuum gripper may be supplied by Precise or by the end user. However, the standard robot does not include pneumatic lines, so if pneumatic tooling is needed, the robot must be ordered with pneumatic lines installed. There are fittings for two pneumatic lines in the end cap. If a Theta-axis is ordered, a pneumatic or vacuum gripper can be attached to the Theta flange. See drawing above.

To facilitate electrical interfacing to user tooling, digital I/O signals are available in the outer link. For robots with an electric gripper, the electric gripper controller in the outer link has two extra inputs and two extra outputs available for users. However, it should be noted that all the wires in the 10-conductor ribbon cable for the electric gripper are consumed by the electric gripper, so any additional IO wiring will have to be routed outside the robot wrist. For robots without the electric gripper, the robot can be ordered with the "GIO" option installed on the Z axis. This option provides 12 5-24V inputs and 8 24V, 100ma outputs, and can be used for air solenoids and other functions.

For robots where support for a pneumatic gripper or pneumatic tooling has been ordered, 2 1/8in OD air hoses are routed from the connector plate in the base through the robot and out to the Z extrusion. These air hoses can be connected to a solenoid(s) mounted on the Z extrusion for tooling control.

Accessing the Robot Controller

Although most of the controller interface signals are exposed on the Facilities Panel at the base, there are times when it may be necessary to access either the robot's controller or its power supplies. To access the robot controller, the cover on the rear of the X-axis must be removed by removing the M3 flat head screws that attach the rear cover to the X-axis.

Please see the *Guidance 1000A/B Controller, Hardware Introduction and Reference Manual* for detailed information on hardware configuration and interfacing the controller using the various input and output ports such as those for digital I/O. Also, please refer to the *Guidance System Setup and Operation Quick Start Guide* for information on configuring the PC and instructions on operating the robot. Both of these manuals are available in PDF format and are also contained in the *Precise Documentation Library*.

Power Requirements

The PreciseFlex robots contain auto-ranging power supplies that operate between 90 to 132 and 180 to 264 VAC, 50 or 60Hz. The robots are equipped with an IEC electrical socket that accepts country specific electrical cords. Power requirements vary with the robot duty cycle, but do not exceed 200 watts RMS.

Emergency Stop

It is necessary to wire an Emergency Stop Button to the controller. This button may be wired in series with other emergency stop contacts. The E-stop signals are available in the Manual Control Pendant 9-pin DSub connector that is mounted on the left end cap of the X-axis. Please see the Hardware Reference section of this manual for detailed information on the E-Stop signals.

Hardware Reference

System Schematics

System Diagram and Power Supplies

The robot has a 24VDC and 48VDC power supply located in the X-axis. The robot controller and electric gripper are powered by the 24VDC supply. The 4 main robot motors are powered by the 48VDC supply. The 48VDC supply is protected against over voltage bus pump up by an energy dump function, which connects a 25 Watt dump resistor across the 48VDC supply output when the voltage reaches 56 volts, and disconnects the dump resistor when the voltage drops to 52 volts. This protects the power supply during high speed motor deceleration when the motor generates Back EMF voltage that adds to the power supply voltage.

DC power is routed from the power supplies to the controller via an electrical harness.

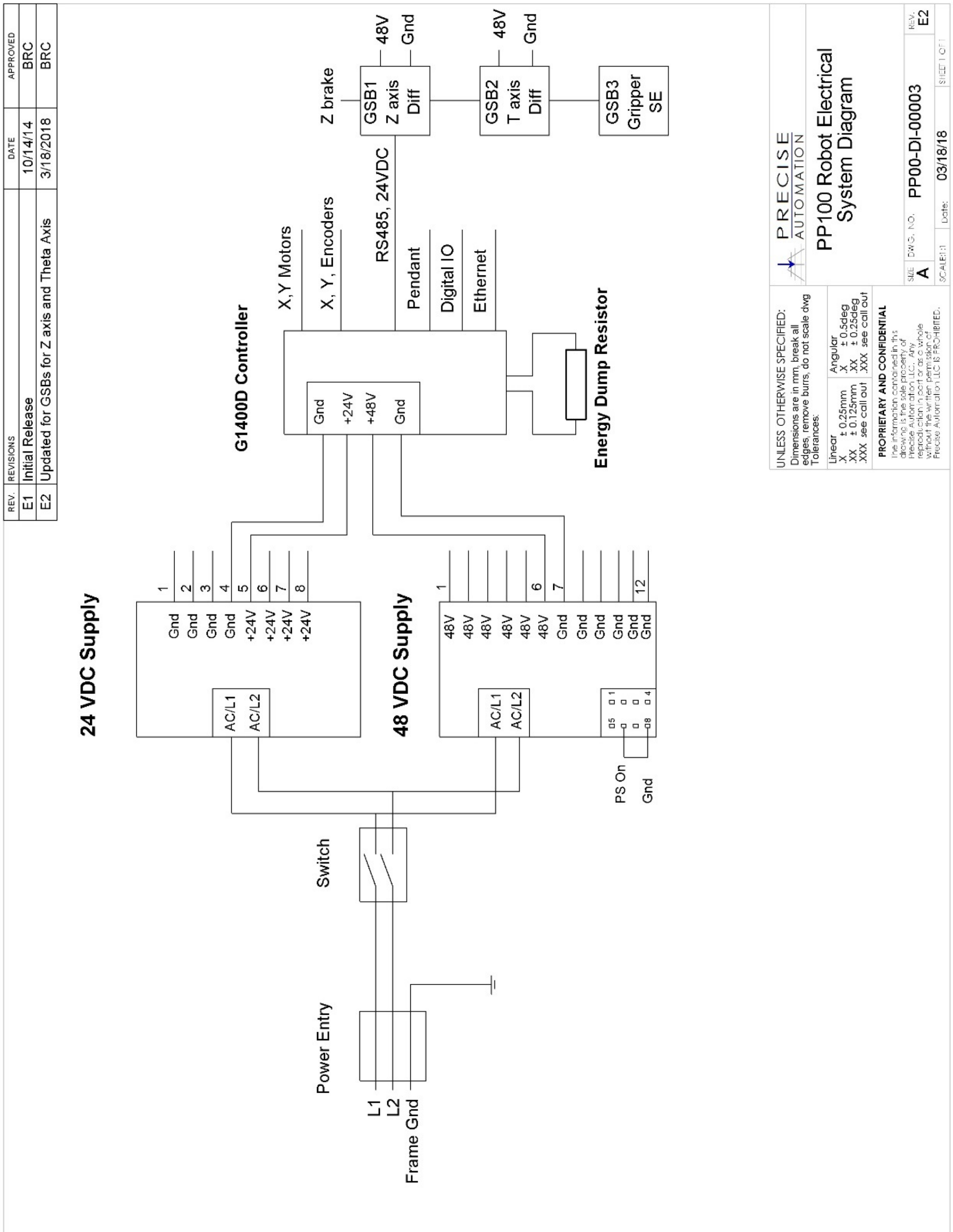
Four digital input and four digital output signals along with 24VDC and Ground from the main robot controller are connected to a 15 pin Dsub connector on the connector end cap.

The ESTOP circuit is also connected from the controller to the 9 pin Dsub connector on the end cap. The ESTOP pins on this connector must have either a jumper or ESTOP switch installed that completes the ESTOP circuit or motor power cannot be enabled.

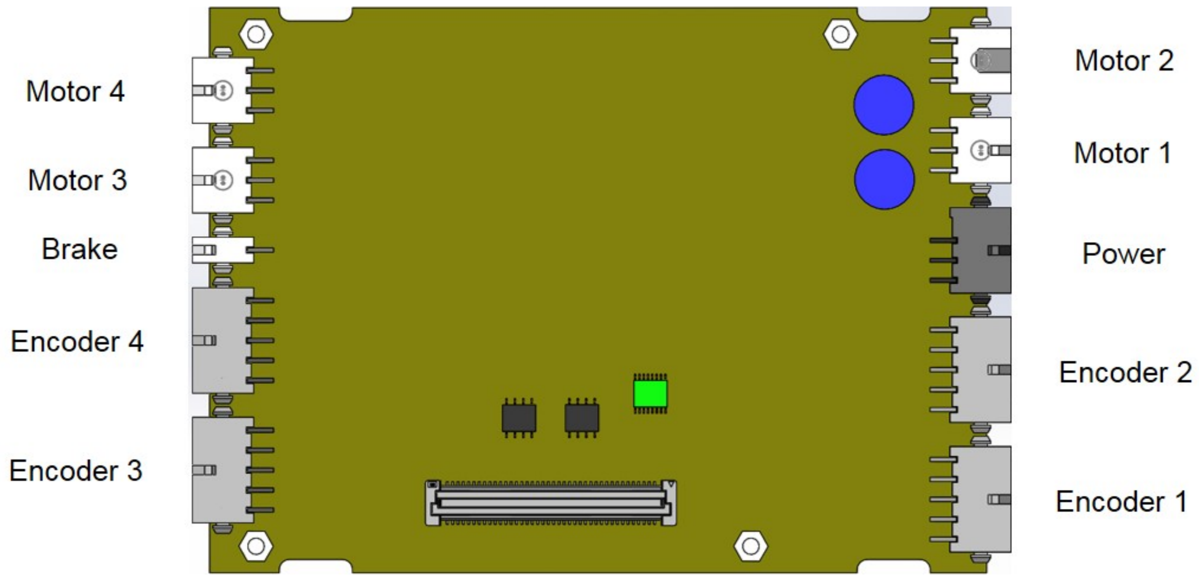
The gripper controller (GSB) is connected to the main controller through an RS485 cable that is routed through the robot. The RS485 cable also supplies 24VDC power for the gripper controller. The gripper motor has a single ended incremental encoder and therefore the gripper controller is configured for a single ended encoder and the GSB board has an “SE” label on it to indicate single ended.

The X motor and Y motor, if installed, plug into the G1400D controller in the back of the X extrusion. The Z motor and Theta motor signals are also connected to slave controllers (GSB) located on the Z axis. However, the Z motor and Theta motors have absolute differential encoders and therefore the GSBs for both these motors have “Diff” label to indicate the controller is configured for a differential encoder. The “SE” and “Diff” GSBs ARE NOT Interchangeable.

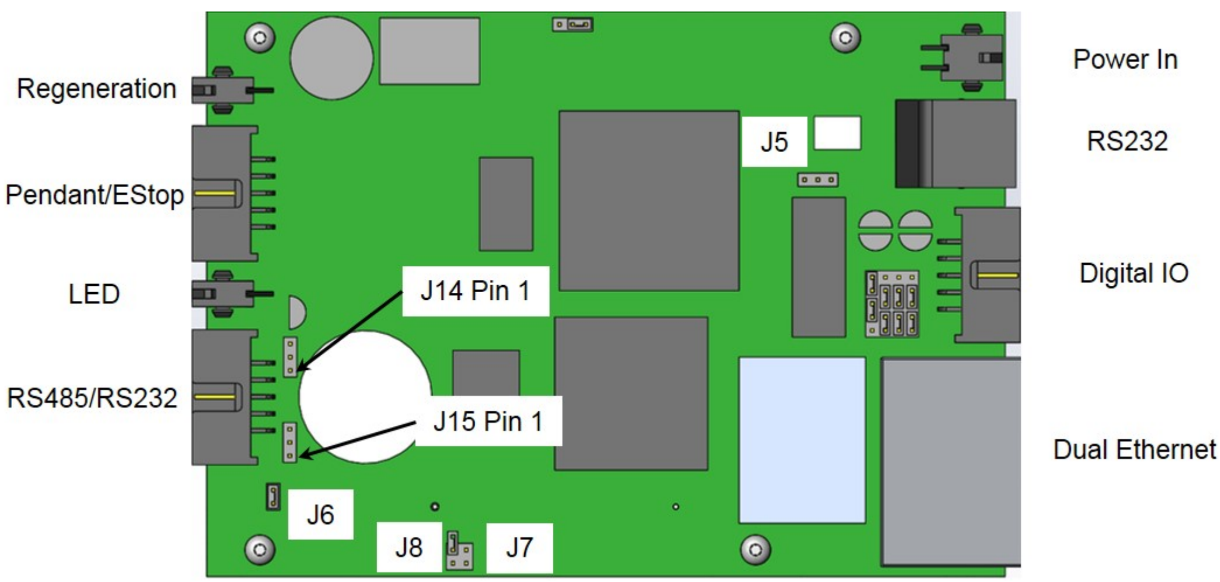
The cable from the brake release button at the rear of the Z motor housing plugs into the GSB controller located near the Z motor. This button provides a ground return from the Z axis brake to ground bypassing the transistor that performs this function under computer power so that the brake can be released manually without motor power being enabled.



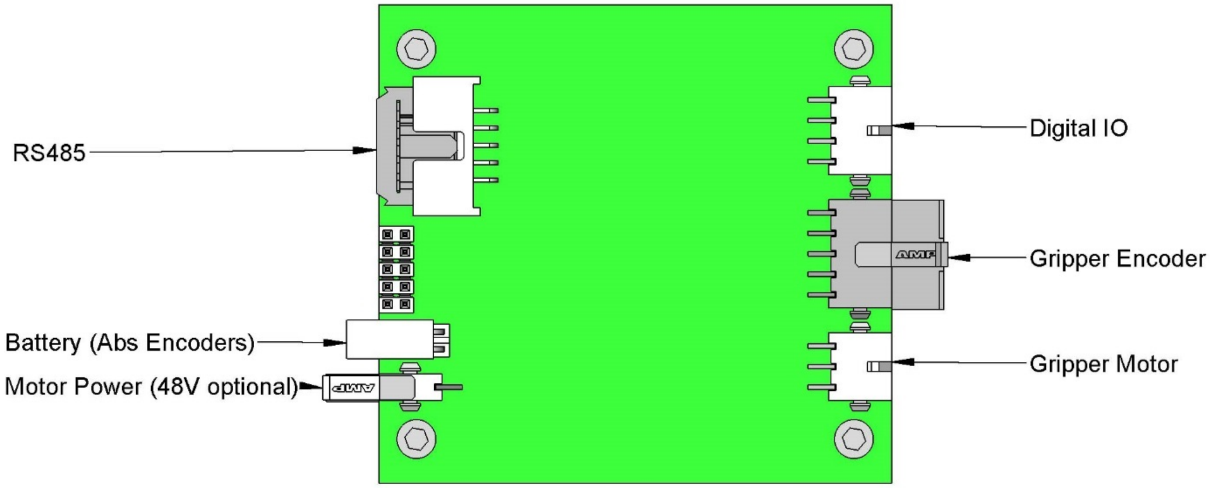
PP100 System Diagram



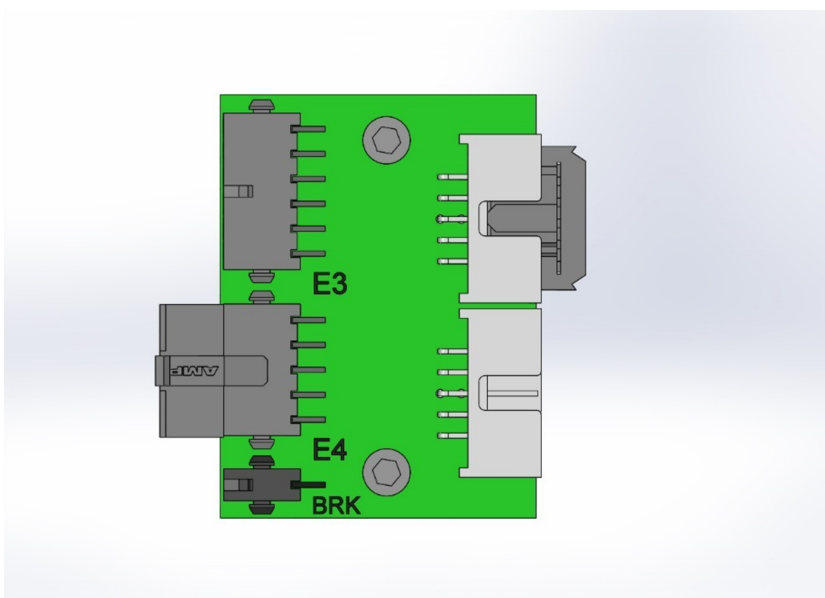
Controller Power Amplifier Connectors



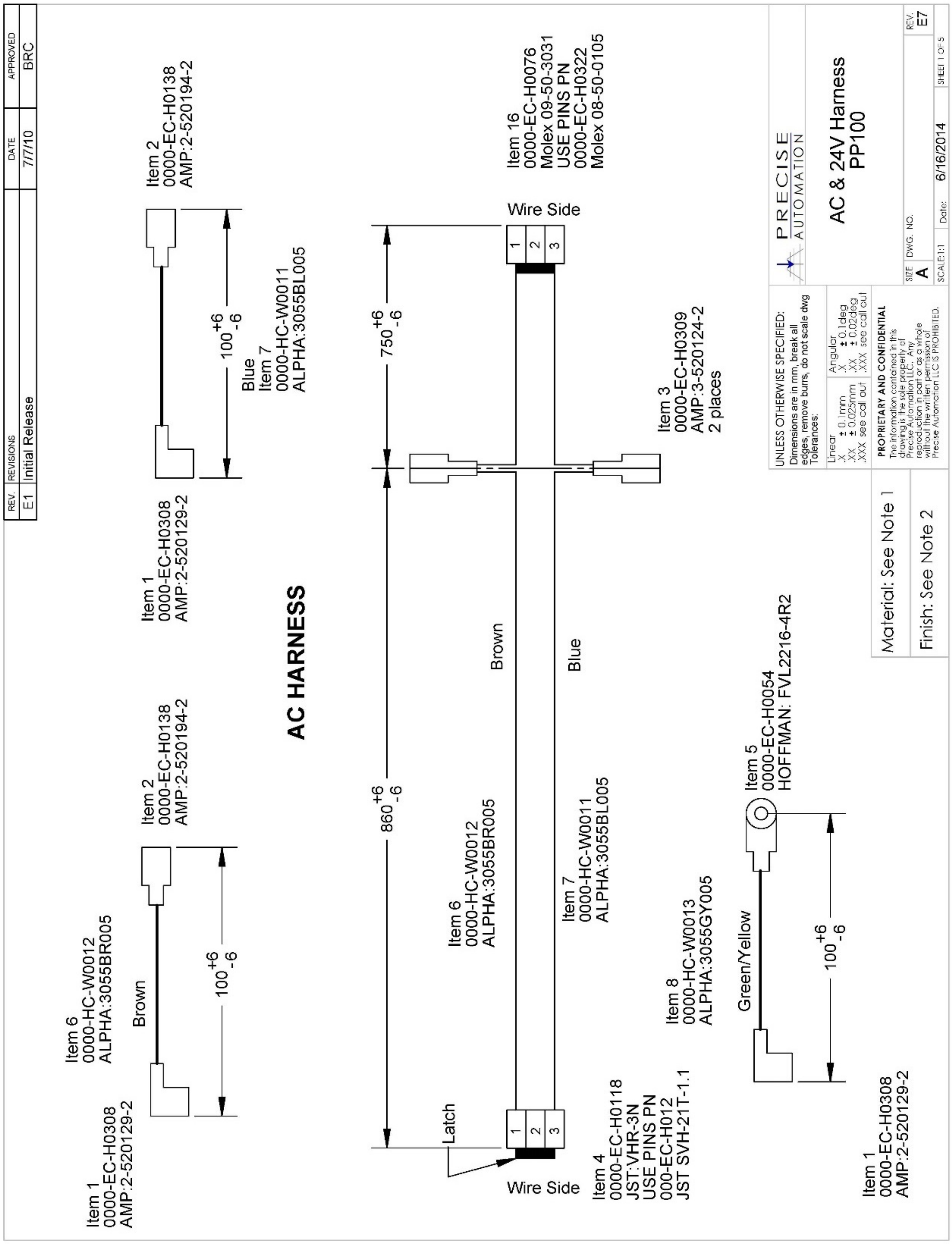
Control Board Connectors



GSB Controller Connectors



Encoder Patch Board (Discontinued when GSBs Added for Z and T axes)



REV.
REVISIONS
DATE
APPROVED
E1
Initial Release
7/7/10
BRC
AC HARNESS
Item 1
0000-EC-H0308
AMP:2-520129-2
Item 6
0000-HC-W0012
ALPHA:3055BR005
Brown
100 +6 -6
Item 2
0000-EC-H0138
AMP:2-520194-2
Blue
Item 7
0000-HC-W0011
ALPHA:3055BL005
860 +6 -6
750 +6 -6
Latch
Wire Side
Item 4
0000-EC-H0118
JST:VHR-3N
USE PINS PN
000-EC-H012
JST SVH-21T-1.1
Item 3
0000-EC-H0309
AMP:3-520124-2
2 places
Item 16
0000-EC-H0076
Molex 09-50-3031
USE PINS PN
0000-EC-H0322
Molex 08-50-0105
Item 8
0000-HC-W0013
ALPHA:3055GY005
Green/Yellow
Item 5
0000-EC-H0054
HOFFMAN: FVL2216-4R2
1
2
3
Material: See Note 1
Finish: See Note 2
UNLESS OTHERWISE SPECIFIED:
Dimensions are in mm, break all edges, remove burrs, do not scale dwg
Tolerances:
Linear
.X ± 0.1mm
.XX ± 0.025mm
.XXX see call out
Angular
.X ± 0.1deg
.XX ± 0.02deg
.XXX see call out
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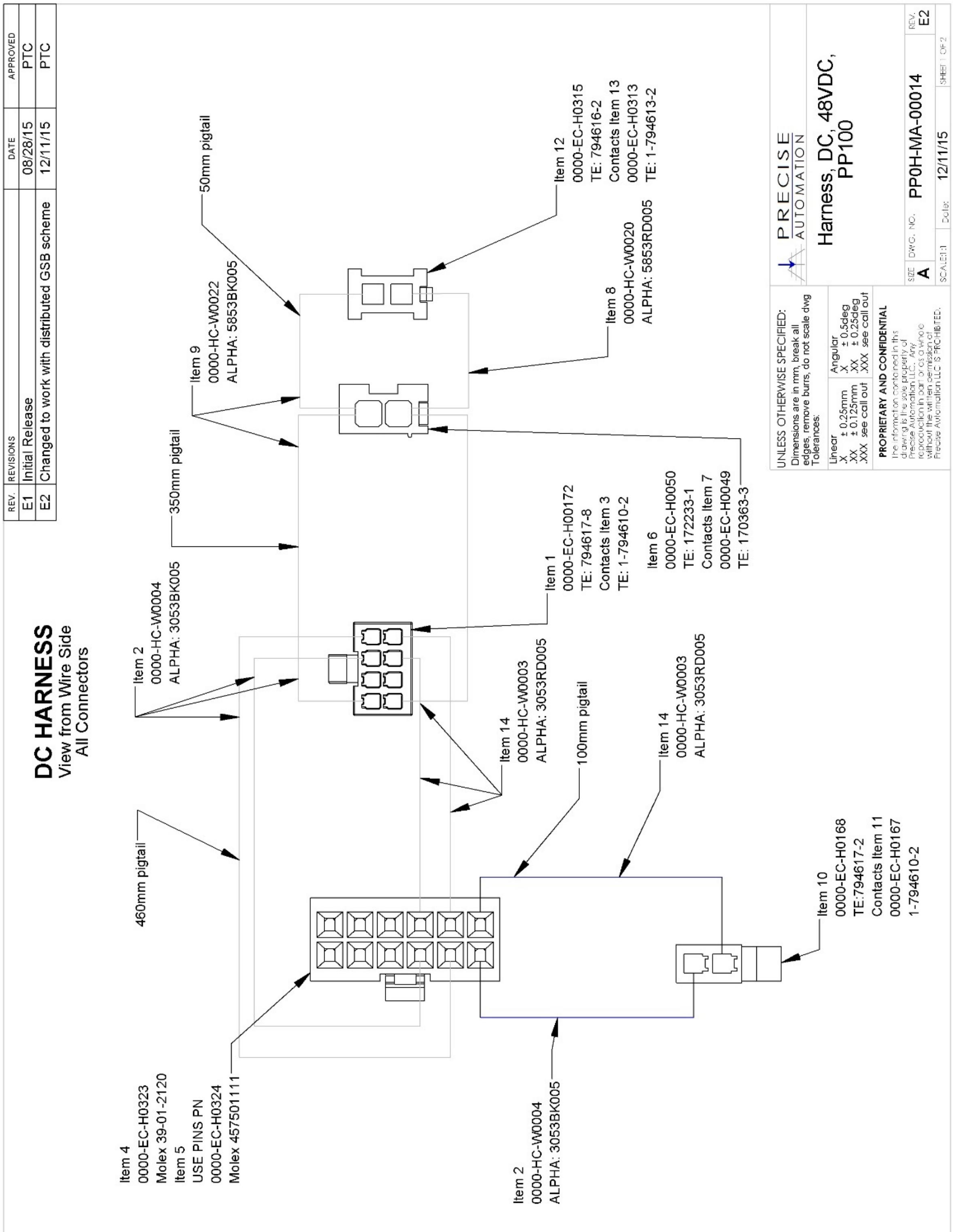
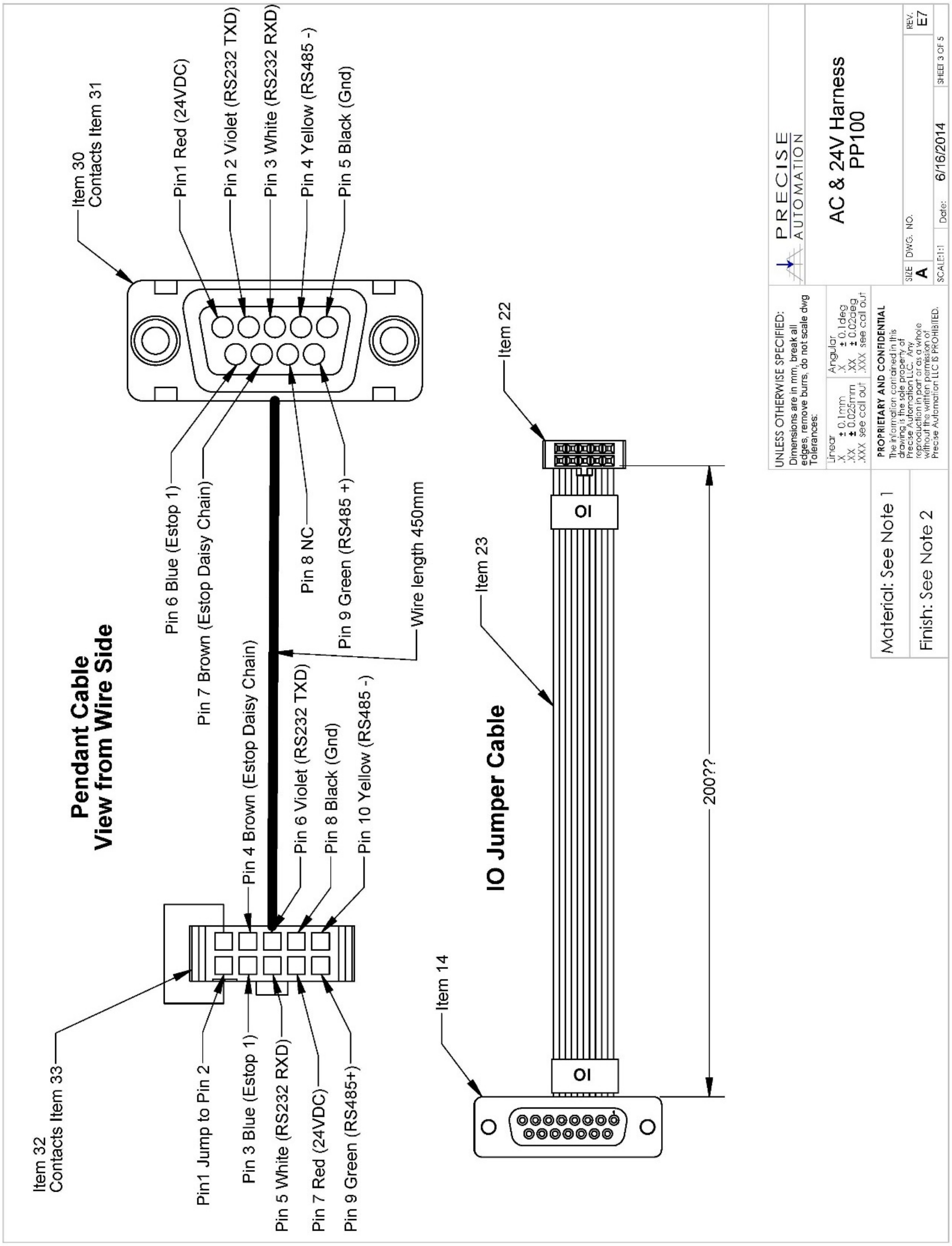
PRECISE
AUTOMATION
AC & 24V Harness
PP100
SIZE
A
DWG. NO.
REV.
E7
SCALE:1:1
Date:
6/16/2014
SHEET 1 OF 5


REV. | REVISIONS | DATE | APPROVED
E1 | Initial Release | 08/28/15 | PTC
E2 | Changed to work with distributed GSB scheme | 12/11/15 | PTC
DC HARNESS
View from Wire Side
All Connectors
460mm pigtail
Item 2
0000-HC-W0004
ALPHA: 3053BK005
350mm pigtail
Item 9
0000-HC-W0022
ALPHA: 5853BK005
50mm pigtail
Item 12
0000-EC-H0315
TE: 794616-2
Contacts Item 13
0000-EC-H0313
TE: 1-794613-2
Item 8
0000-HC-W0020
ALPHA: 5853RD005
Item 1
0000-EC-H00172
TE: 794617-8
Contacts Item 3
TE: 1-794610-2
Item 6
0000-EC-H0050
TE: 172233-1
Contacts Item 7
0000-EC-H0049
TE: 170363-3
Item 14
0000-HC-W0003
ALPHA: 3053RD005
100mm pigtail
Item 14
0000-HC-W0003
ALPHA: 3053RD005
Item 4
0000-EC-H0323
Molex 39-01-2120
Item 5
USE PINS PN
0000-EC-H0324
Molex 457501111
Item 2
0000-HC-W0004
ALPHA: 3053BK005
Item 10
0000-EC-H0168
TE:794617-2
Contacts Item 11
0000-EC-H0167
1-794610-2
UNLESS OTHERWISE SPECIFIED:
Dimensions are in mm, break all edges, remove burrs, do not scale dwg
Tolerances:
Linear
.X ± 0.25mm
.XX ± 0.125mm
.XXX see call out
Angular
.X ± 0.5deg
.XX ± 0.25deg
.XXX see call out
PROPRIETARY AND CONFIDENTIAL
PRECISE AUTOMATION
Harness, DC, 48VDC, PP100
SIZE A
DWG. NO. PP0H-MA-00014
REV. E2
SCALE 1:1
Date: 12/11/15
SHEET 1 OF 2


Pendant Cable
View from Wire Side
Item 30
Contacts Item 31
Pin1 Red (24VDC)
Pin 2 Violet (RS232 TXD)
Pin 3 White (RS232 RXD)
Pin 4 Yellow (RS485 -)
Pin 5 Black (Gnd)
Pin 6 Blue (Estop 1)
Pin 7 Brown (Estop Daisy Chain)
Pin 8 NC
Pin 9 Green (RS485 +)
Wire length 450mm
Item 32
Contacts Item 33
Pin1 Jump to Pin 2
Pin 3 Blue (Estop 1)
Pin 5 White (RS232 RXD)
Pin 7 Red (24VDC)
Pin 9 Green (RS485+)
Pin 4 Brown (Estop Daisy Chain)
Pin 6 Violet (RS232 TXD)
Pin 8 Black (Gnd)
Pin 10 Yellow (RS485 -)
IO Jumper Cable
Item 14
Item 22
Item 23
IO
IO
200??
UNLESS OTHERWISE SPECIFIED:
Dimensions are in mm, break all edges, remove burrs, do not scale dwg
Tolerances:
Linear
.X ± 0.1mm
.XX ± 0.025mm
.XXX see call out
Angular
.X ± 0.1deg
.XX ± 0.02deg
.XXX see call out
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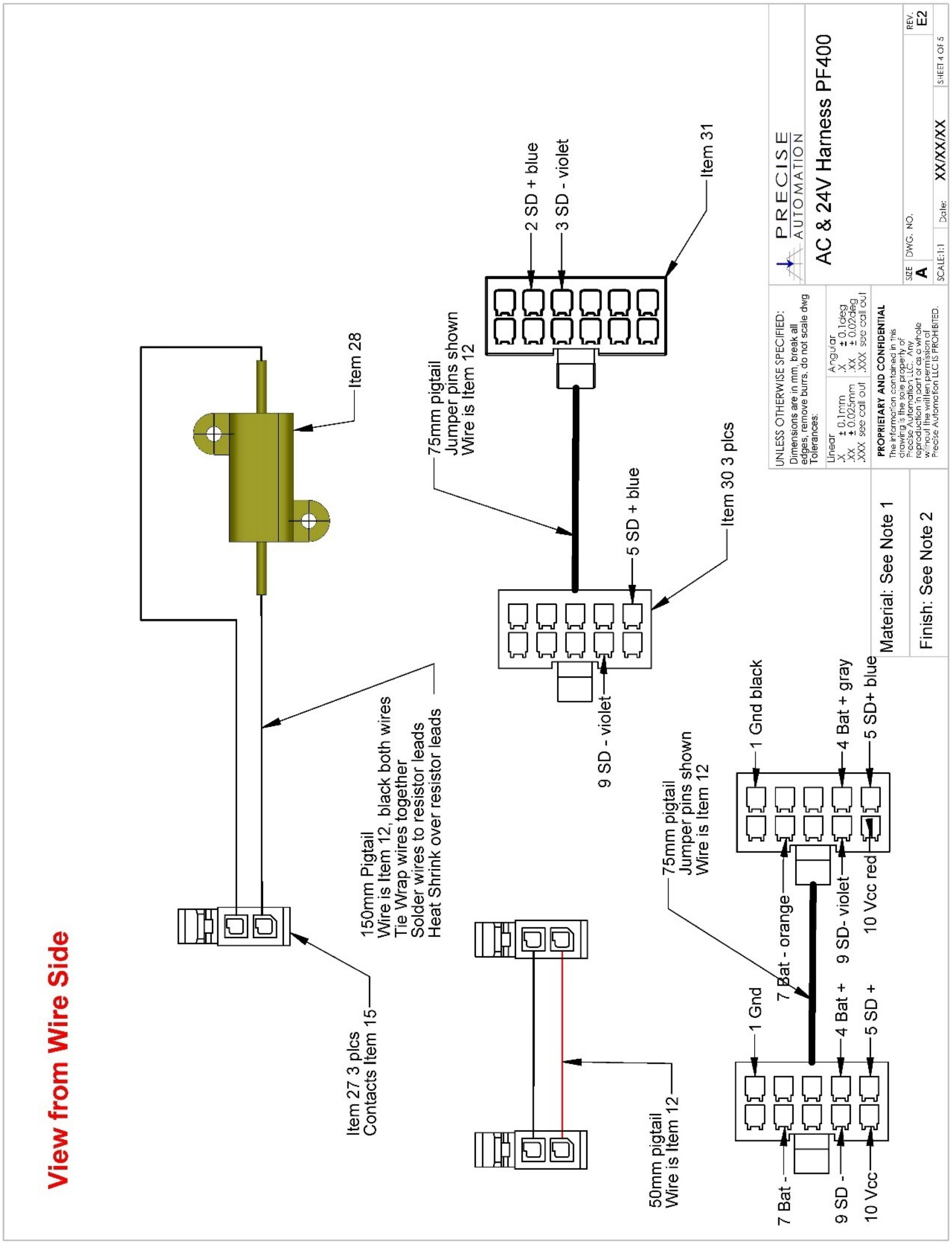
Material: See Note 1
Finish: See Note 2
PRECISE
AUTOMATION
AC & 24V Harness
PP100
SIZE
A
DWG. NO.
REV.
E7
SCALE:1:1
Date: 6/16/2014
SHEET 3 OF 5



View from Wire Side
Item 27 3 plcs
Contacts Item 15
150mm Pigtail
Wire is Item 12, black both wires
Tie Wrap wires together
Solder wires to resistor leads
Heat Shrink over resistor leads
Item 28
75mm pigtail
Jumper pins shown
Wire is Item 12
2 SD + blue
3 SD - violet
Item 31
5 SD + blue
Item 30 3 plcs
9 SD - violet
50mm pigtail
Wire is Item 12
75mm pigtail
Jumper pins shown
Wire is Item 12
7 Bat -
9 SD -
10 Vcc
1 Gnd
4 Bat +
5 SD +
7 Bat - orange
9 SD- violet
10 Vcc red
1 Gnd black
4 Bat + gray
5 SD+ blue
Material: See Note 1
Finish: See Note 2
UNLESS OTHERWISE SPECIFIED:
Dimensions are in mm, break all edges, remove burrs, do not scale dwg
Tolerances:
Linear .X ± 0.1mm .XX ± 0.025mm .XXX see call out
Angular .X ± 0.1deg .XX ± 0.02deg .XXX see call out
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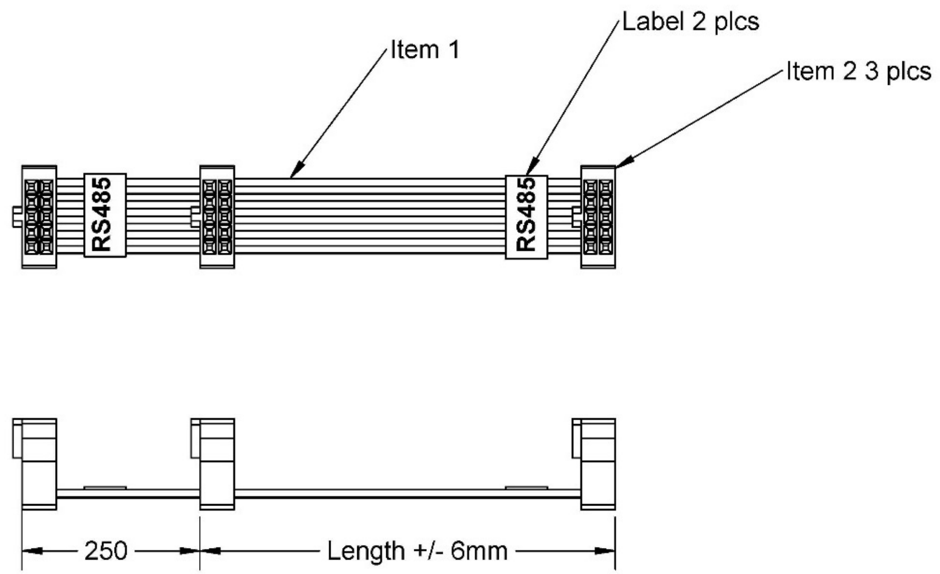
PRECISE AUTOMATION
AC & 24V Harness PF400
SIZE A
DWG. NO.
REV. E2
SCALE:1:1
Date: XX/XX/XX
SHEET 4 OF 5

REV.	REVISIONS	DATE	APPROVED
E1	Initial Release	1/4/2011	BRC

RS485 Cable



X Travel	Y Travel	Z Travel	Length
635mm	0	228mm	1900mm
635mm	0	553mm	
635mm	300mm	228mm	
1270mm	0	533mm	
1270mm	0	228mm	2535mm
1270mm	300mm	228mm	

Material: See Note 1

Finish: See Note 2

UNLESS OTHERWISE SPECIFIED:
Dimensions are in mm, break all edges, remove burrs, do not scale dwg
Tolerances:

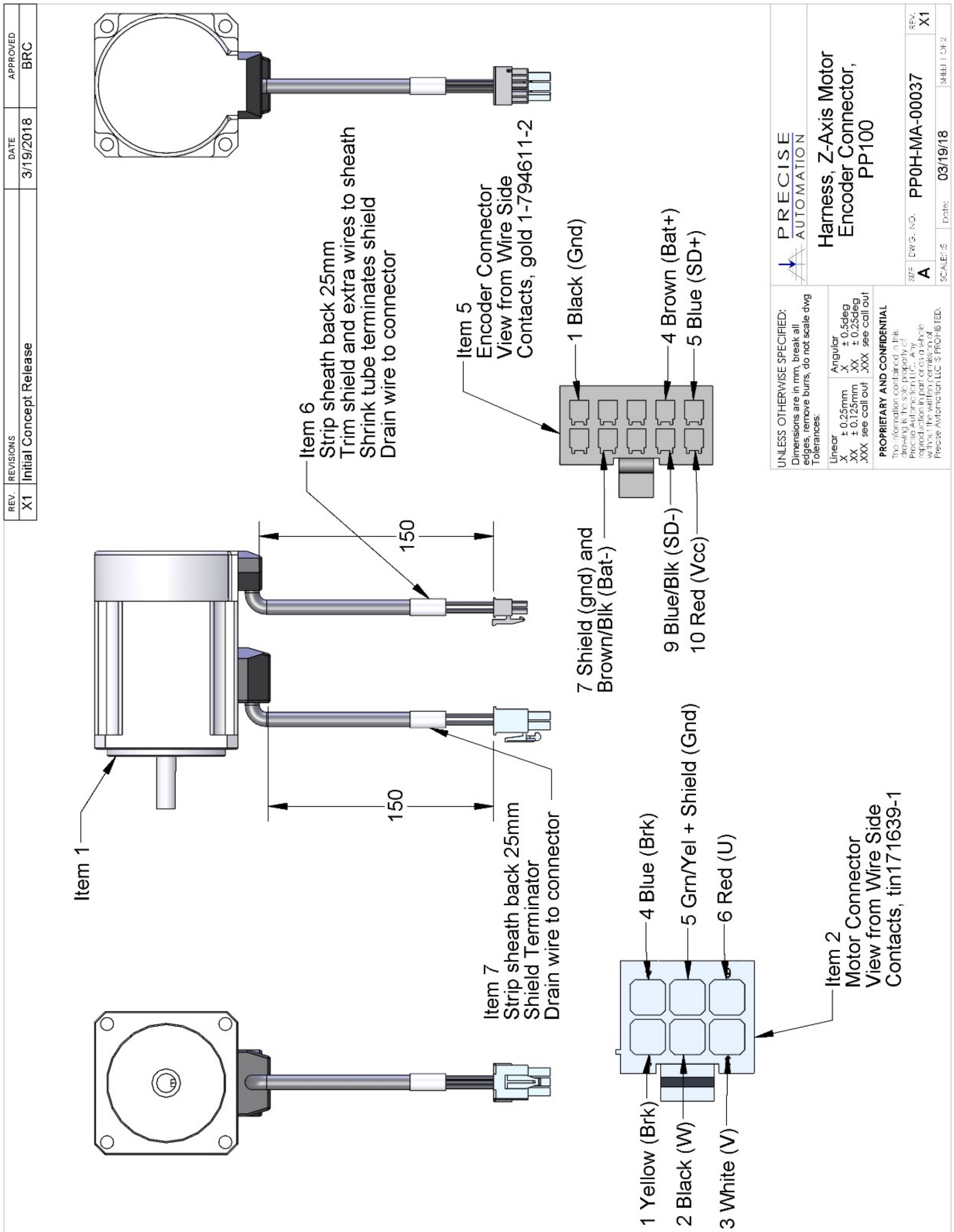
Linear		Angular	
.X	± 0.1mm	.X	± 0.1deg
.XX	± 0.025mm	.XX	± 0.02deg
.XXX	see call out	.XXX	see call out

PRECISE AUTOMATION

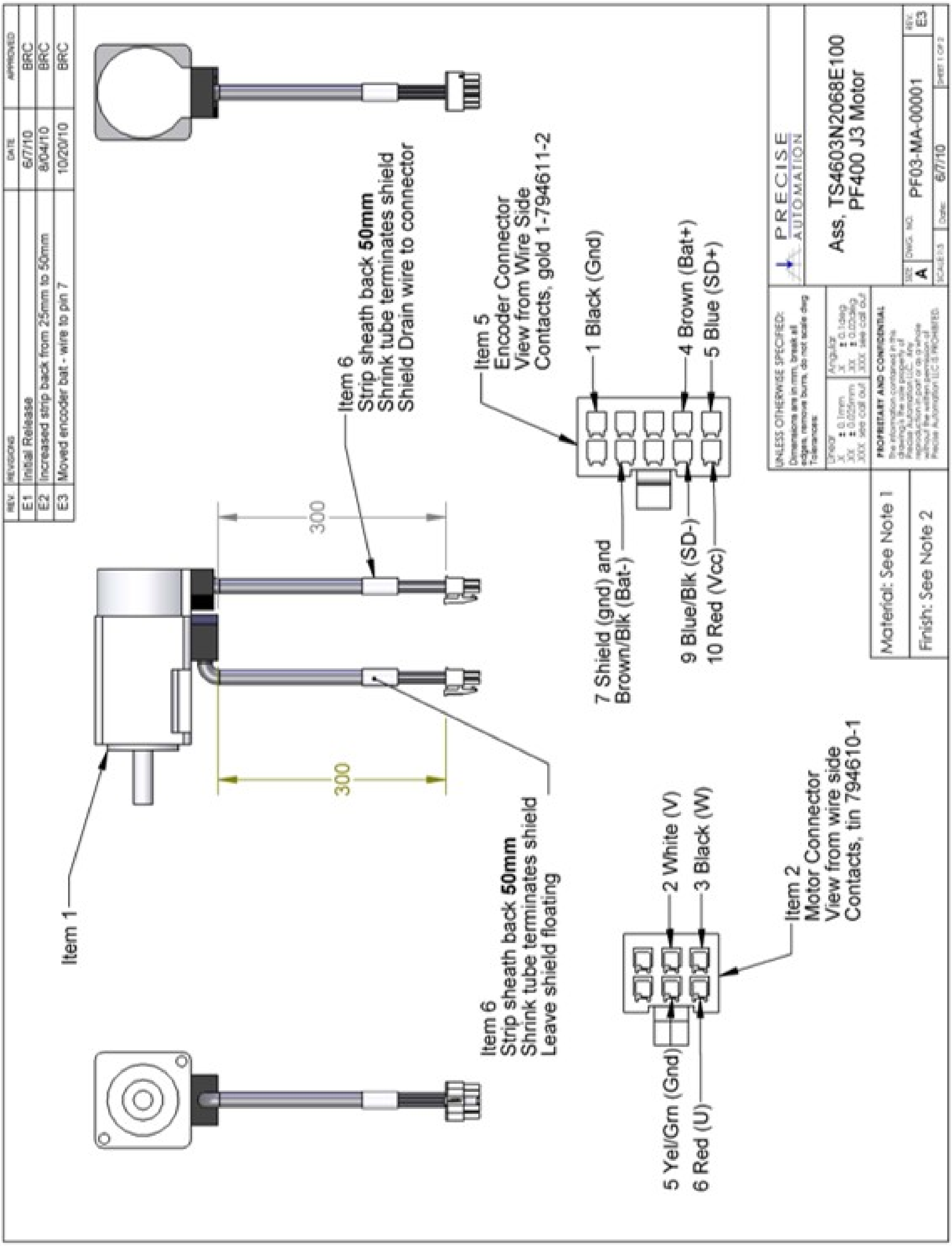
PP100
Robot Cables

SIZE A | DWG. NO. PF0H-MA-000XX | REV. E1

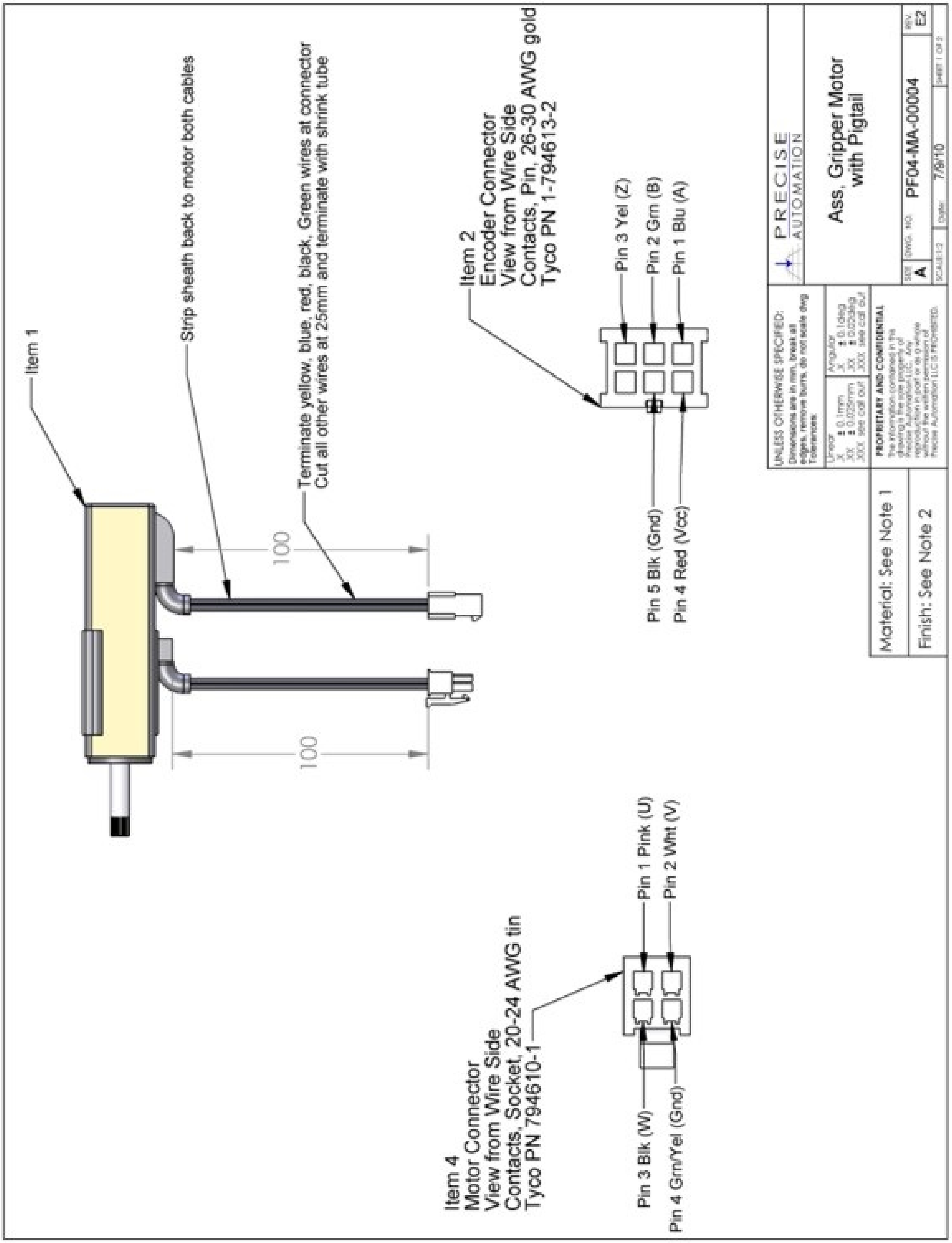
SCALE:1:1 | Date: 7/29/2014 | SHEET 1 OF 7



Z Motor Assembly



X, Y, Theta Motor Assembly



Gripper Motor Assembly

Robot Inputs and Outputs

Robot Interfaces

Each of these interfaces is described in detail in the following sections. In addition, the robot's controller, which is mounted in the X-axis of the robot, may contain additional interfaces (e.g. inputs or outputs). Please refer to the *Guidance 1000A/B Controllers, Hardware Introduction and Reference Manual* for additional information.

DANGER: The Guidance 1400A controller, and the 24 VDC and 48 VDC power supplies are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. . **The main AC power should always be disconnected before the Facilities Panel is removed.**

If the pneumatic gripper option is ordered one air line is routed through the interior of the robot. At the connector end cap, this air line is presented in a fitting mounted to the connector end cap. The other end of this line exits at the Z Extrusion. When using this line, clean, dry external air should be provided.

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

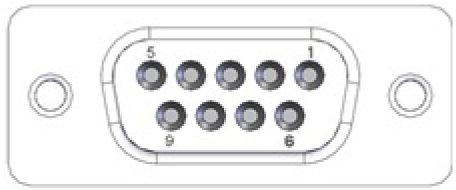
MCP / E-Stop Interface

The MCP interface includes the signals necessary to connect a Manual Control Pendant, an E-Stop circuit, or an external RS485 Remote IO Module. These signals are provided in a DB9 female connector mounted on the X-axis end cap.

In order for the robot to allow motor power to be enabled the E-Stop circuit must connect 24 VDC to E-Stop1 in this connector. If no E-Stop box or circuit is connected, then the circuit must be completed with jumper plugs. (The robot is shipped with a Dsub jumper plug that satisfies this requirement.)

If a Manual Control Pendant is not connected to the secondary RS-232 port provided in this connector, this serial interface can be accessed via a GPL procedure as device "/dev/com2" for general communications purposes. Please note that unlike the primary serial interface, THIS SECONDARY SERIAL INTERFACE DOES NOT SUPPORT FLOW CONTROL.

The RS485 port is used internally to communicate with the gripper controller and is also be used for the Remote IO option. As such it has a dedicated protocol and is not available for general use



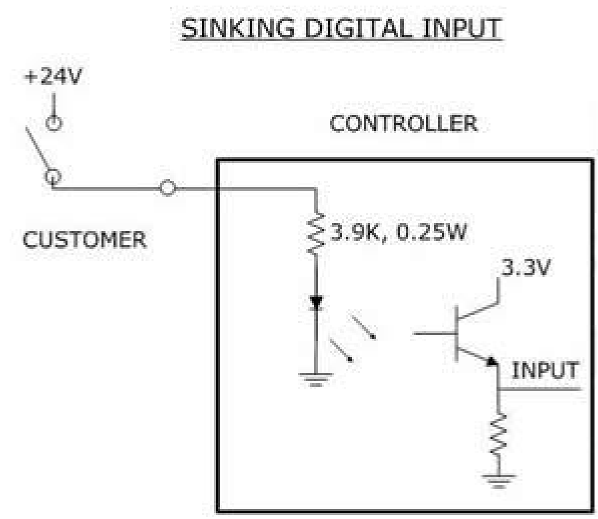
Pin	Description
1	24VDC
2	RS232 TXD
3	RS232 RXD
4	RS485-
5	Gnd
6	E-Stop1
7	E-Stop Daisy Chain
8	48VDC
9	RS485+
Interface Panel Connector Part No	DB9 Female Connector AMP 5747150-7
User Plug Part No	DB9 Male Plug Amp 1658655-1 (crimp) Pins 22-26AWG 745254-6

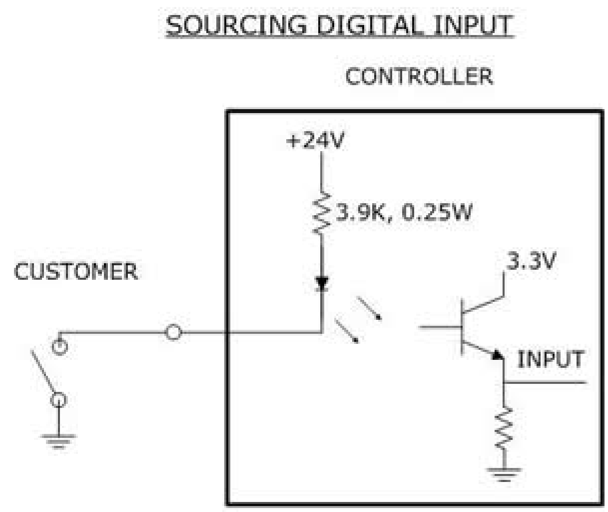
Digital Input / Output Signals

Digital Input Signals

The standard PrecisePlace 100 robot provides 4 general purpose optically isolated digital input and output signals at the X-axis end cap (in addition to those signals that are available at the Gripper Control Board).

The input signals can be configured as "sinking" or "sourcing". If an input signal is configured as "sinking", the external equipment must pull its input high to 5VDC to 24VDC to indicate a logical high value or must allow it to float to no voltage for a logical low. These 4 inputs are configured at the factory as “sinking”.



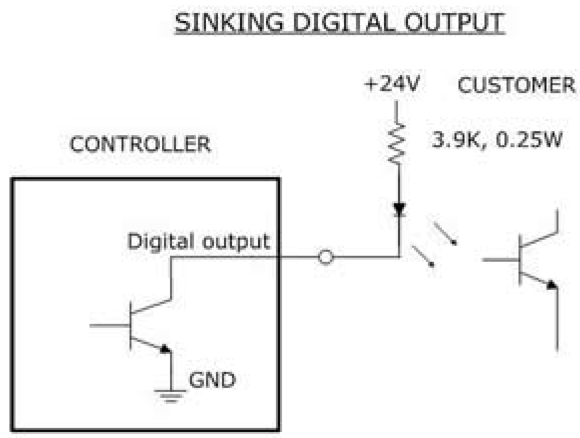


By setting Jumpers on the CPU (MIDS4) board, the four output signals can be individually configured as "sinking" or "sourcing" and the four digital inputs can be configured as a group to all operate as either sinking or sourcing. For more information on configuring the jumpers, please see the *Guidance 1000A/B Controllers, Hardware Introduction and Reference Manual.*

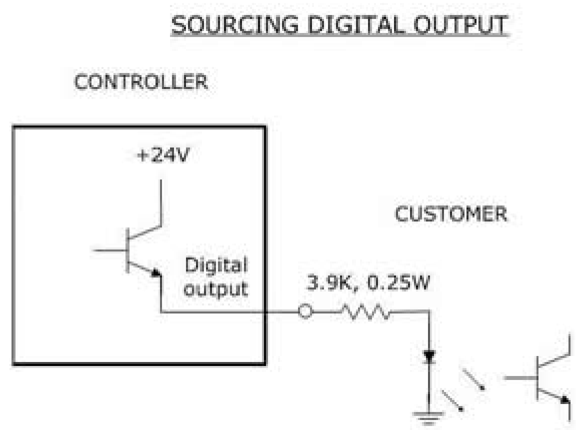
Digital Output Signals

The PreciseFlex robot provides 4 general-purpose optically isolated digital output signals at the G1400A controller.

These output signals can be configured as "sinking" or "sourcing". ***As shipped from the factory, output signals 1-3 are configured as "sourcing"***, i.e. these outputs provide 24VDC when turned on. ***Output 4 is configured as "sinking"***, i.e. the external equipment must provide a <u>5VDC to 24VDC pull up</u> voltage on an output pin and the controller pulls this pin to ground when the signal is asserted as true.

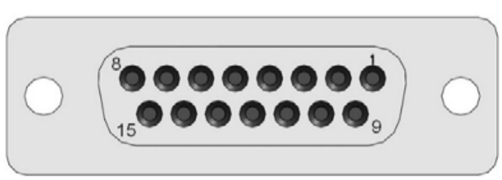


Alternately, the output signals can be configured as "sourcing", i.e. the external equipment must pull down an output pin to ground and the controller pulls this pin to 24VDC when the signal is asserted as true.



Outputs can be individually configured as sinking or sourcing signals. For more information on configuring the jumpers, please see the *Guidance Controller, Hardware Introduction and Reference Manual.*

The pin out for the 15 Pin Dsub Digital Input and Output Connector and the corresponding GPL signal numbers are described in the following table.



Pin	GPL Signal Number	Description
1	13	Digital Output 1
2	15	Digital Output 3

3		GND
4	10001	Digital Input 1
5	10003	Digital Input 3
9	14	Digital Output 2
10	16	Digital Output 4
11		24 VDC
12	10002	Digital Input 2
13	10004	Digital Input 4
User Plug Part No		TE 1-747946-5 15 pin plug with backshell or DB9 Male Plug Amp TE 1658657-1 (crimp) Pins 22-26AWG TE 745254-6

Gripper Controller Digital Inputs and Outputs

If the robot is equipped with an electric gripper, the gripper controller includes 3 sinking digital inputs and 3 sourcing digital outputs. One digital input and one digital output are dedicated for a lighted teach button on some electric grippers. The other two inputs and outputs are available in the outer link for application use.

Pin	GPL Signal Number	Description
1	200013	Digital Output 1/LED driver
2	200014	Digital Output 2
3	200015	Digital Output 3
4		24 VDC output
5		GND
6	210001	Digital Input 1
7	210002	Digital Input 2
8	210003	Digital Input 3
User Plug Part No		Amp 794617-8, crimp contacts 1-794611-2

RS485 Remote IO Module (GIO)

Customers who need additional digital IO may order the RS485 Remote IO Module. This module installs in the X-axis of the robot and provides 12 Digital Inputs and 8 Digital Outputs in a 25 pin Dsub connector.

The RS485 Remote IO Module (GIO) provides 12 general-purpose optically isolated digital input signals and 8 general-purpose optically isolated digital output signals. Two inputs, 11 and 12, can be optionally configured as analog inputs by means of jumpers J1 and J2. Connecting J1 to pins 1 and 2 (default) configures these inputs as digital and connecting pins 2 and 3 configures them as analog. These input and output signals are intended for interfacing to tooling and sensors or for general application needs. This board is connected to the controller by an RS485 serial line that allows the controller to scan the GIO I/O with a nominal period of 4 milliseconds.

The DIO signals are accessible via the DB25 female connector that is mounted on the facilities panel when this option is ordered. The DIO signals addresses are determined by a base address set by a DIP switch on the DIO board. For the PF400 robot without the linear axis option the DIO option is located at the robot connector panel and for both this location and also for the location at the end of the optional linear axis, all the address jumpers will NOT be installed, which sets the address of this module to “8”. This address avoids conflicts with other RS485 network controllers for the gripper and optional linear axis. See “Installing the optional G IO Board” under Service Procedures for details on installing this module.

The software addresses will then be as follows.

Pin	GPL Signal Number	Description
1		Gnd
2	810001	Digital Input 1
3	810003	Digital Input 3
4	810005	Digital Input 5
5	810007	Digital Input 7
6	810009	Digital Input 9
7	810011	Digital Input 11
8		24VDC
9	800013	Digital Output 1
10	800015	Digital Output 3
11	800017	Digital Output 5
12	800019	Digital Output 7
13		24VDC
14		Gnd
15	810002	Digital Input 2
16	810004	Digital Input 4
17	810006	Digital Input 6
18	810008	Digital Input 8
19	810010	Digital Input 10
20	810012	Digital Input 12
21		24VDC
22	800014	Digital Output 2
23	800016	Digital Output 4

24	800018	Digital Output 6
25	800020	Digital Output 8
Interface Panel Connector Part No		DB25 Female Connector
User Plug Part No		DB25 Male Plug

Ethernet Interface

PreciseFlex robots include an Ethernet switch that implements two 10/100 Mbit Ethernet ports. This capability was designed to permit the controller to be interfaced to multiple Ethernet devices such as other Precise controllers or robots, remote I/O units and Ethernet cameras. The Ethernet switch automatically detects the sense of each connection, so either straight-thru or cross-over cables can be used to connect the controller to any other Ethernet device.

Due to limited space on the Facilities Panel, only one of the two Ethernet ports is available via an external RJ45 connector. This external Ethernet port is typically used to interface the robot to a PC. The second Ethernet port is only available inside the X-axis of the robot. In some cases, it may be used to connect an Ethernet camera that is mounted on the robot or a vision processing unit mounted inside the X-axis.

In this case, a PC that is connected to the Ethernet plug on the Facilities Panel can communicate with the robot's controller as well as receive images from an arm-mounted camera. If a camera is mounted in the workcell, an external Ethernet switch must be added to connect these cameras and the robot to a PC.

See the *Setup and Operation Quick Start Guide* for instructions on setting the IP address for the controller.

RS-232 Serial Interface

The PreciseFlex robot includes a standard RS-232 serial line equipped with hardware or software flow control. However, this port is only available on the G1400A controller in the X-axis of the robot and is not brought out to any outside connector on this robot. If needed, a DB9 connector can be added by the user to the rear sheet metal panel of the X-axis and a RJ-11 to DB9 pigtail can be added to access this port. This port can be used to communicate to the system serial console or can be connected to external equipment for general communication purposes. When used for general communications, this port is referenced as device "/dev/com1" within the Guidance Programming Language (GPL).

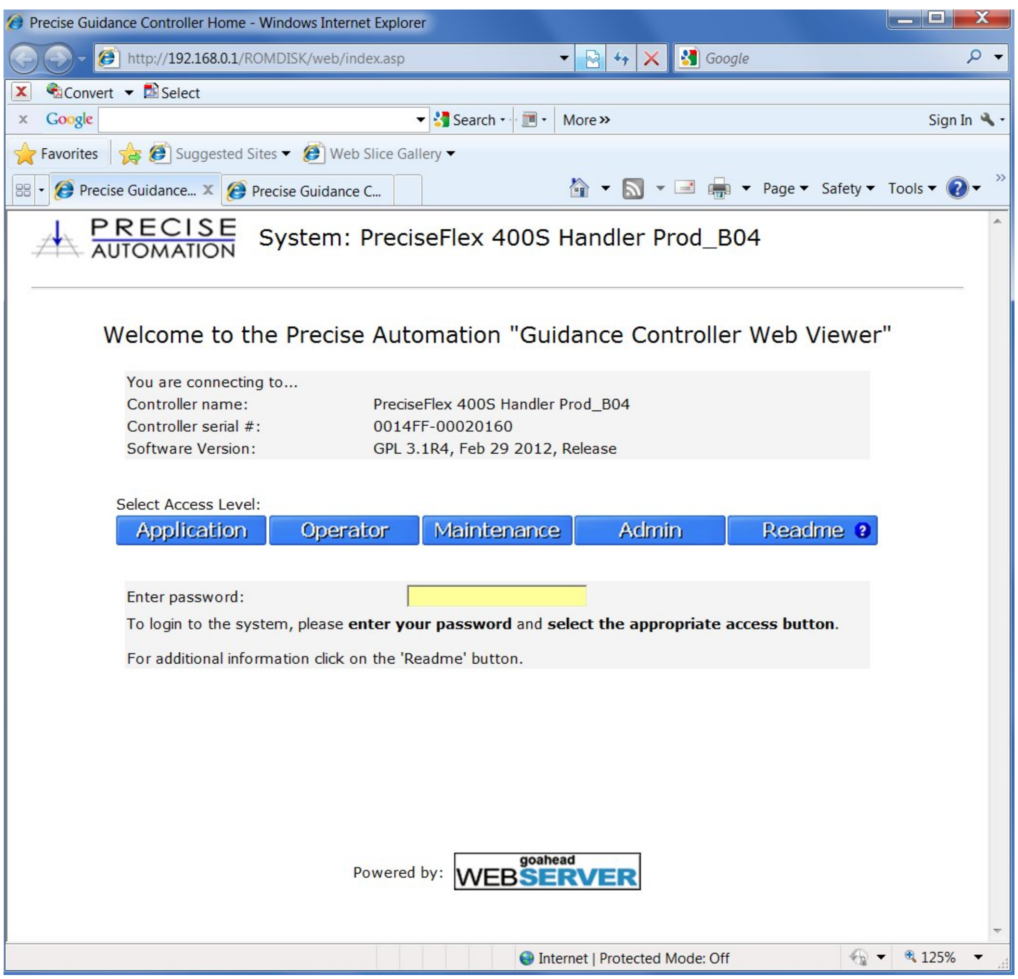
The connector for this interface is a standard RJ11 serial interface connector that has pin assignments compatible with standard PC "com" ports. For this robot it is only used for debugging and special service procedures.

Software Reference

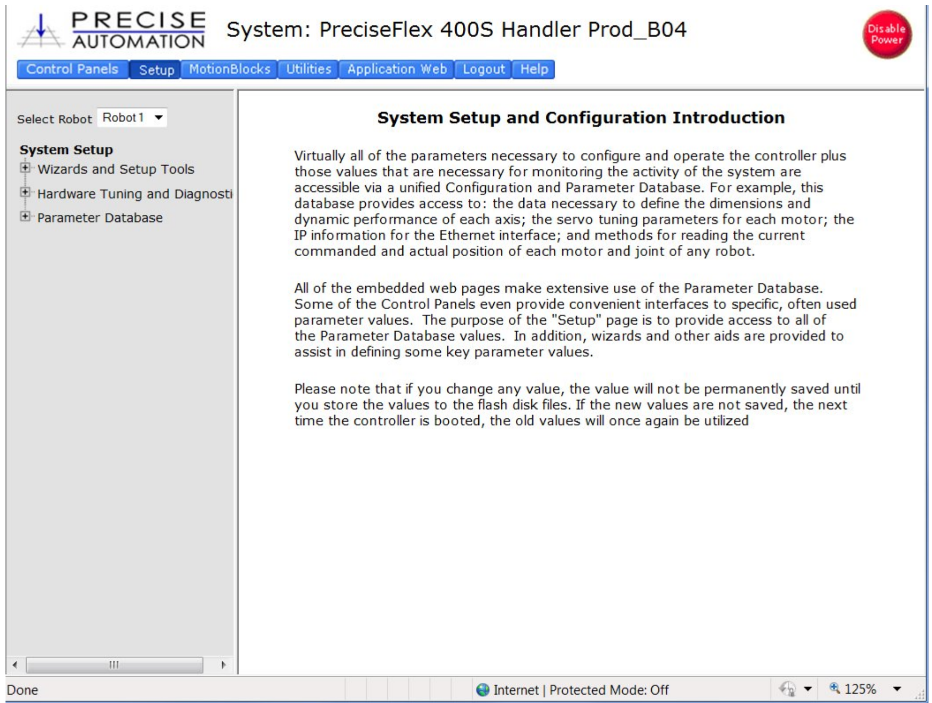
Accessing the Web Server

Many OEM customers run the PF400 using a PC to provide an application-specific operator interface. In order to update software in the controller, and view certain error messages, it is necessary to access the Web Server Interface embedded in the controller.

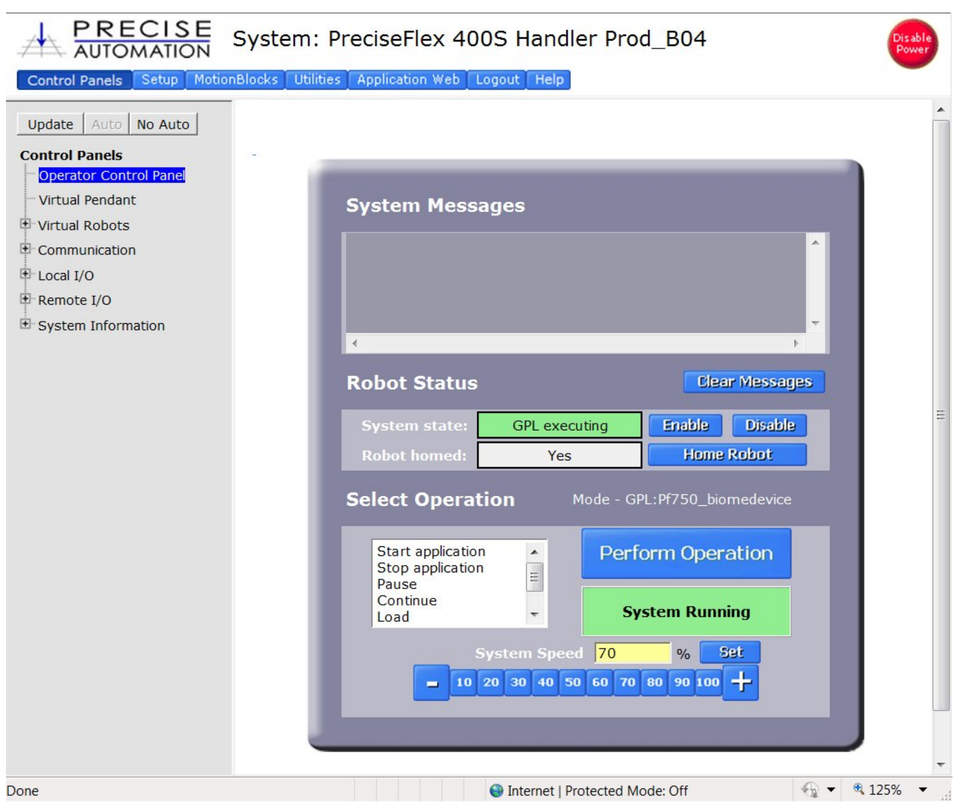
The Web Server Interface may be addressed by opening a browser (such as Internet Explorer) in a PC that is connected to the robot via Ethernet. You must know the IP address of the robot controller. Two common IP addresses are 192.168.0.1 and 192.168.0.10. The PC LAN interface address must be configured correctly (for example 192.168.0.100, with subnet mask 255.255.255.0). The Web Server Interface will come up with the window below.



It may be necessary to enter a password if your company has protected access to the Web Interface. Once the password has been entered, click on “Admin” to access all the features to perform system upgrades. The window below will open up.



Click on “Control Panels”, then “Operator Control Panel”. The window below will appear.



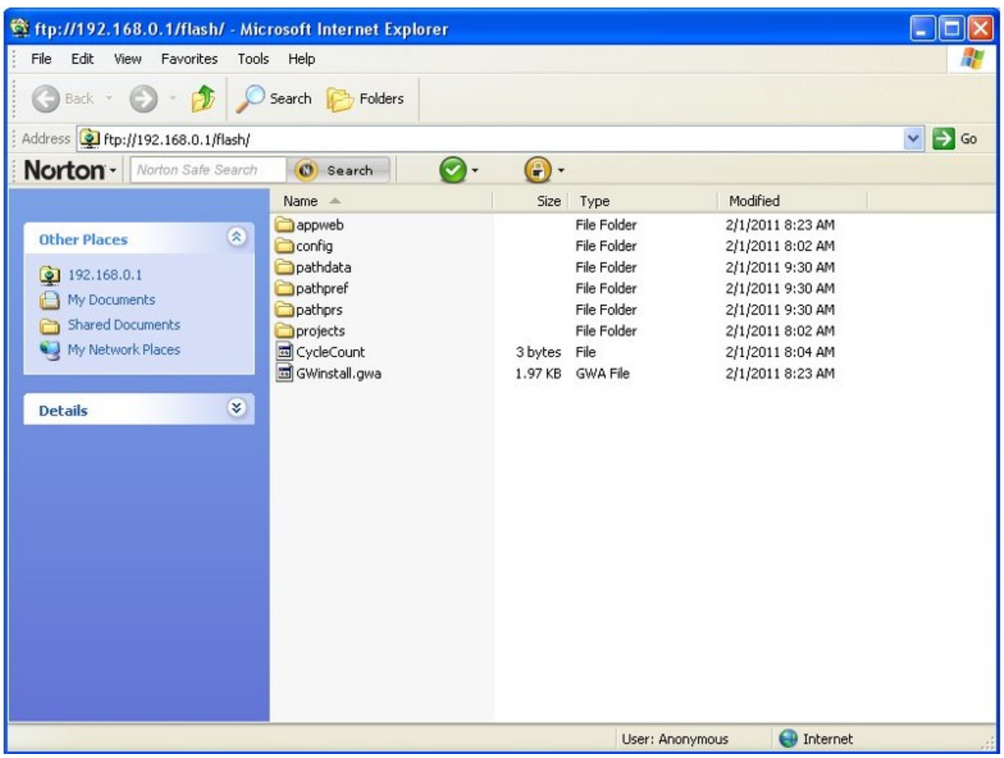
If an application is running, the “System Running” panel will display in green. In order to run diagnostics, you must stop the application from running. Click “Stop Application” and then “Perform Operation”. This will stop the application from running. You should click the “Disable Power” button to be sure motor power is off. If you need to load a new project (for example CAL_PP) you will need to click on “Unload” and then “Perform Operation” before you can load the new project into RAM.

You may now perform the procedures below.

Loading a Project (Program) or Updating PAC Files

If CAL_PP or a different program needs to be loaded into the controller from an external computer, this may be done using the Web Interface.

1. In the Web Based Operator Interface, select “Utilities/Backup and Restore
2. Click on Start File Manager. It may be necessary to hold down the Control Key to allow the pop-up. An ftp directory pop-up will come up. In the “Page” menu in Windows Internet Explorer select “Open ftp site in Windows Explorer”. Another window will open showing several folders, including “Config” and “Projects”.



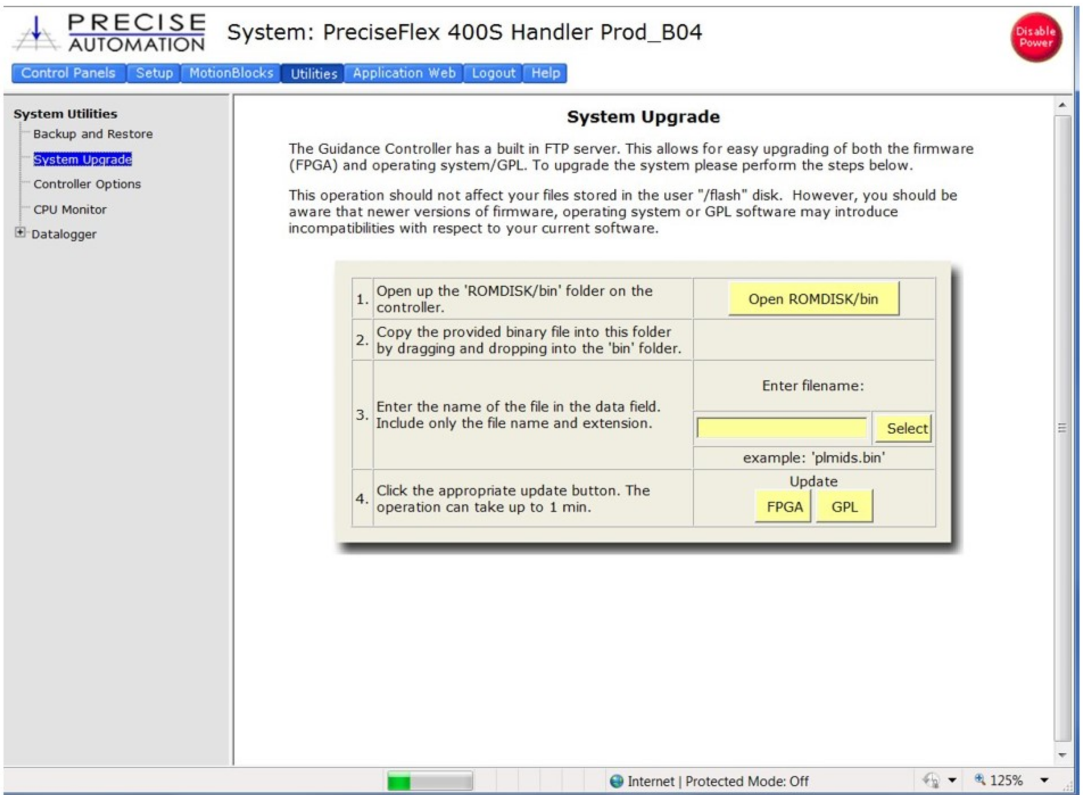
3. To load a Project, Open the “Projects” folder and paste the Project folder into this area. There may be several other projects (programs) loaded into this folder, which is stored in flash ram in the controller. A project folder is a software folder than may have several files inside it. You must load the entire folder, not just the files inside.
4. To load or update PAC files, open the “Config” folder and paste a backup copy of the PAC files into the “Config” folder. These files will all have a **.pac** extension. The robot must be re-booted after new PAC files are installed for them to take effect.

5. Once the appropriate project (for example CAL_PP) has been loaded into flash memory, it must then be loaded into dynamic memory in order to execute. See the section below on "Calibrating the Robot" for an example on how to load and execute the CAL_PP program.

Updating GPL (System Software) or FPGA (Firmware)

Both GPL (the system software) and the FPGA firmware may be upgraded in the field. To perform an upgrade:

1. Obtain the appropriate upgrade software from Precise, in the form of a .bin file.
2. In the Operator Interface, go to the Utilities/System Upgrade menu.



3. Click on Open ROMDISK/bin. This will open an FTP window. You will need to select "page" in Internet Explorer and scroll to the bottom of the page menu and click "Open site in Windows Explorer". This will open a second ftp window in Windows. Paste the appropriate GPL or FPGA .bin file in this window.
4. Under item 3 in the System Upgrade menu, click on the Select button. A pick list will open up. Highlight the upgrade code in this pick list and click on the Select button again. The name of the file will appear in the filename field.
5. Then in step 4 in the menu click on either FPGA or GPL to upgrade the appropriate file. The banner in the Upgrade menu will start flashing for about 10 seconds while the flash RAM is being written with the new file. Wait about 10 additional seconds after this banner stops flashing, then reboot the robot, and the new code will be installed.

Recovering from Corrupted PAC Files

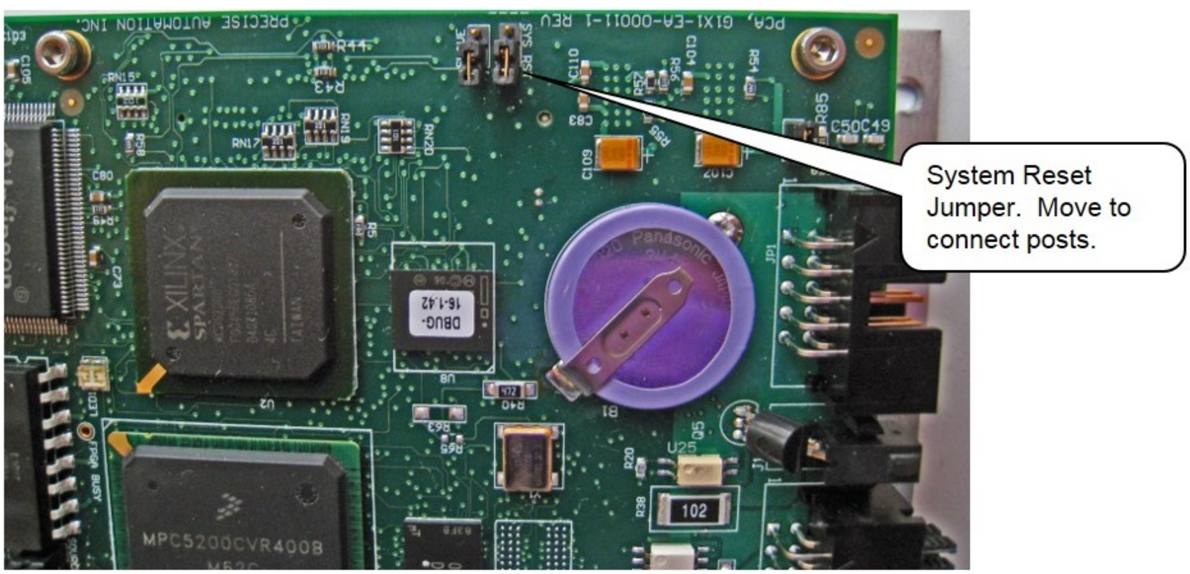
PAC files are configuration files that determine the configuration of the robot for the software, including the robot factory calibration data. These files are stored in Flash RAM. Flash RAM is also used to store robot programs. The Flash RAM requires some time for a complete write cycle. During the write cycle, the console will display a flashing warning not to turn off robot power. If robot power is turned off during the Flash RAM write cycle, the Flash data may be lost or corrupted. If this happens, it is necessary to reload both the robot PAC files and any user programs that were stored in Flash RAM. This problem should typically not be encountered by a user unless the user is changing configuration files in the robot.

Precise maintains a record of PAC files shipped with each robot Serial Number. If the PAC files have been corrupted, it is possible to get a backup copy from Precise. The backup copy will contain the factory configuration and calibration data, but will not contain any changes, including any new calibration data, made after the robot has left the factory.

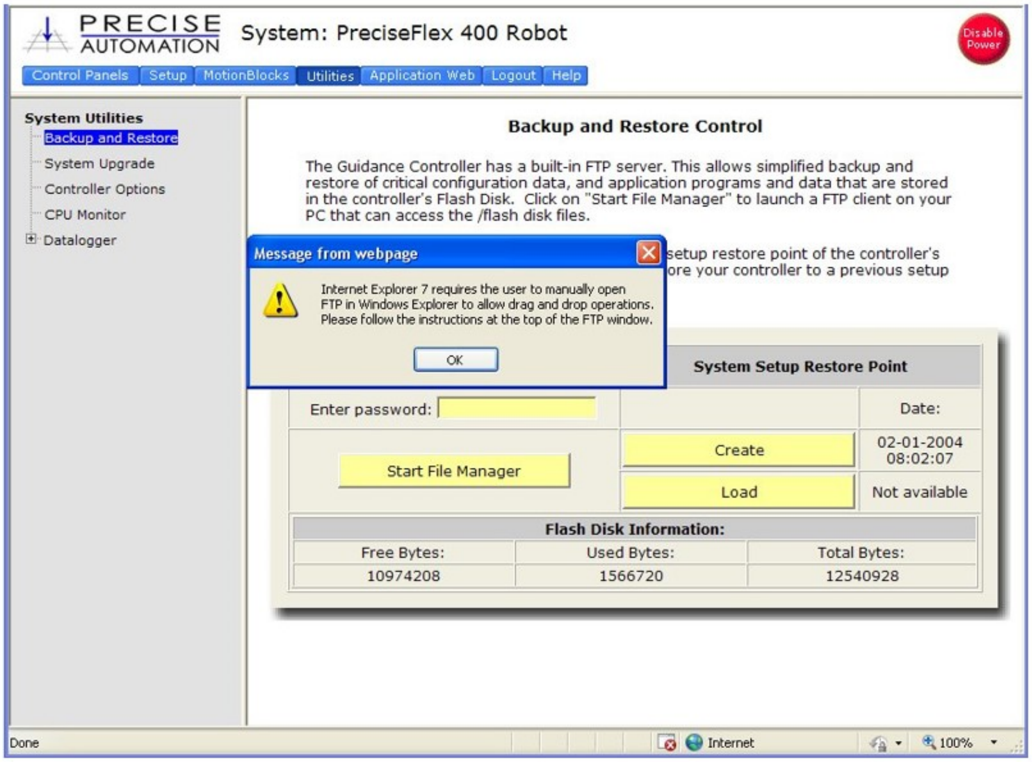
In order to allow the controller to recover from corrupted PAC files, a set of recovery boot up PAC files is loaded in the system area of the Flash.

To configure the controller to boot up in recovery mode the user must:

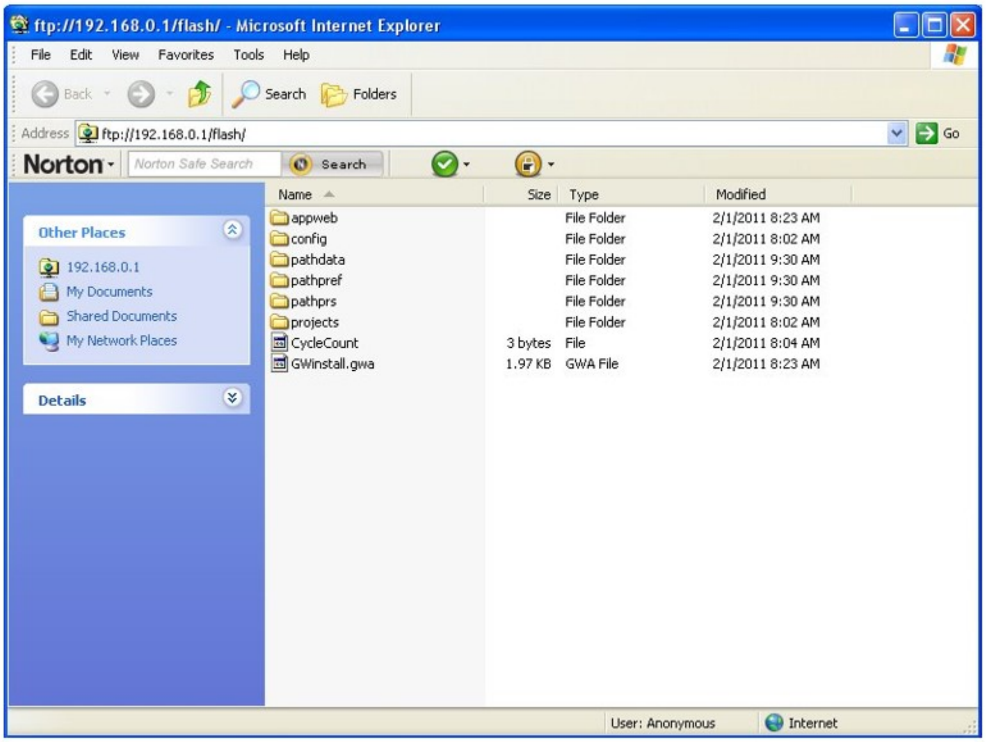
1. Obtain a set of backup PAC Files from Precise or local backup.
2. Disconnect power from the robot and remove the X-axis Cover of the robot.
3. Move Jumper J8 (see figure below) so that it connects the two jumper posts. This will cause the factory default configuration files to be loaded at controller boot up.



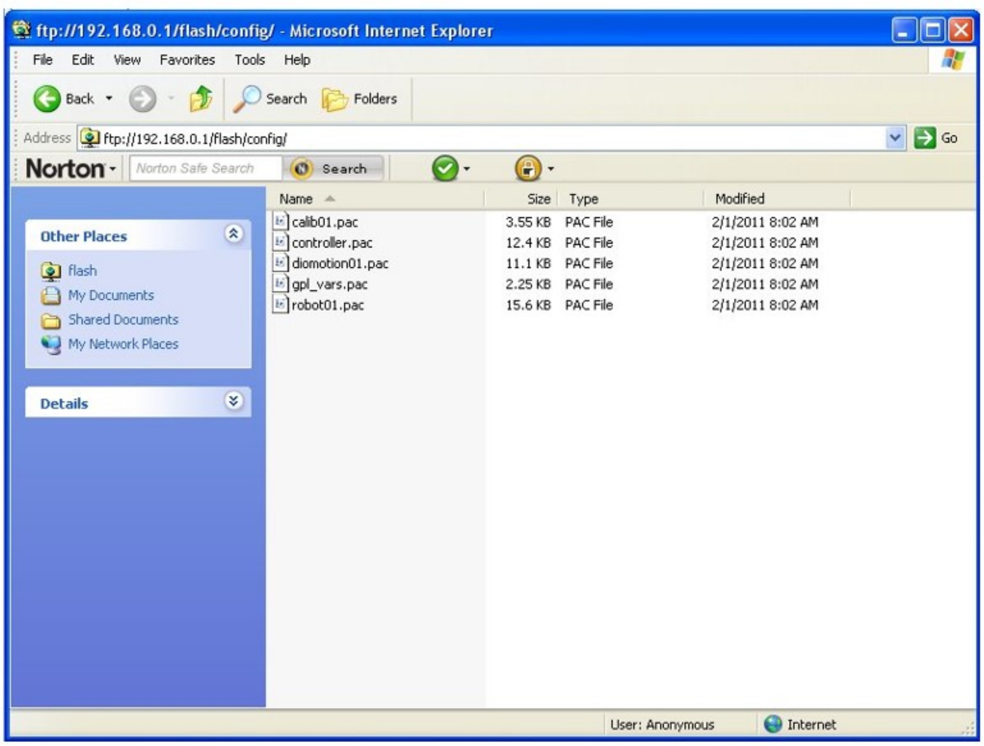
4. Cycle robot power to reboot the controller.
5. In the Web Based Operator Interface, select “Utilities/Backup and Restore



6. Click on Start File Manager. It may be necessary to hold down the Control Key to allow the pop-up. An ftp directory pop-up will come up. In the “Page” menu in Windows Internet Explorer select “Open ftp site in Windows Explorer”. Another window will open showing several folders, including “Config” and “Projects”.



7. Open the “Config” folder and paste the backup copy of the PAC files into this folder.



8. Wait until the console prompt stops flashing, about 10-15 seconds.
9. Turn off robot power.

10. Restore Jumper J8 to its previous position.
11. Reboot the robot. The PAC files should be restored and the robot should run.
12. If the robot has ever been recalibrated since the backup PAC files were created, it will be necessary to recalibrate the robot, as the calibration files will be out of date.
13. Replace the X axis Rear Cover.

Controller Software Extensions

This section discusses extensions to the standard Guidance Controller software that are specific to the PrecisePlace 100 Robot. Precise offers a Command Server software package that allows a PC to send high level commands to the PP100 robot. This package is available upon request.

Controlling the Precise Servo Gripper

Overview

The Precise Servo Gripper with spring return contains a brushless servo motor with an incremental encoder with both counting and motor phase tracks. 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 startup without any motion.

The motor has a 12-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. So, if power is lost the gripper will close and maintain a closing force so that it does not drop parts.

In order to avoid the gripper slamming closed from the spring force when motor power is disabled, there is a 500ms delay after an EStop or power disable command is sent before the motor power is cut off. During this period, the servo slowly closes the gripper.

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

Software Revision

The Spring Gripper functionality is fully supported by GPL version 3.1.P11 or later and PAC files PrecisePlace130S 140901 or later.

Controlling the Gripper

Precise has created a GPL software routine that controls the spring gripper. This routine includes features for controlling the gripper squeeze force and detecting if a plate is present during a grip. Precise makes this routine available to customers upon request. This routine is also available in the Precise Command Server Software for the PF400 and PP100.

Gripper Squeeze (Simple Method)

The spring applies a closing force of approximately 7 Newtons at a finger opening of 103mm, which is halfway between a portrait titer plate grip at 83mm and a landscape titer plate grip at 123mm. The force is closer to 6N in portrait mode and 8N in landscape mode and 9-10N at the full open homing position. These closing forces appear adequate to prevent dropping titer plates weighing up to 200gms and are selected to allow enough motor torque to overcome the spring and still provide reasonable opening force for inside grips.

The motor can apply about 18N of force at its rated current of 1.26A. When closing the fingers, the motor adds its force to the spring force, so a maximum closing force of about 24-26N is possible, depending on portrait or landscape gripping. When opening, the motor must oppose the spring force, so a maximum opening force of about 8- 12N is possible, depending on the opening of the fingers.

The motor squeeze force can be limited by modifying the rated current of the motor. This can be done by writing into the 5th field in Parameter Data Base # 10611. The motor current can be set once and saved into flash or modified dynamically by a GPL program using the Controller.PDbNum instruction.

The formula for determining the approximate gripper squeeze is 7N +(Rated Current/1.26Amps) X18N for squeeze and (Rated Current/1.26Amps) X18N –9N for gripper opening force.

Note that in order to home the gripper must open all the way its maximum hard stop. The spring force at this point is about 10N. So the motor current should not be set below about 12N/18NX1.26A or 0.8A for the simple method of controlling gripper squeeze, giving a range of about 18N minimum to 24N maximum squeeze.

Gripper Squeeze (Asymmetric Method)

There may be cases where 18N of squeeze is too much. In this case there is a more sophisticated method to control squeeze.

There are two parameters in the database, 10351 and 10352 that can be used to limit the torque from the PID loop in the positive and negative directions. These parameters were developed to limit the downwards force of a robot running with dynamic feedforward, where the dynamic feedforward compensates for the gravity torque of the robot. The feedforward torque is NOT limited by these parameters, only the PID torque. So for a perfectly balanced robot, setting these parameters to a low value for a gravity loaded axis limits the maximum force the axis can apply from any position error. So if the axis crashes into a hard stop, the downwards or upwards force can be limited to a small value.

These same parameters can be used to limit the gripper squeeze in an asymmetric manner. Parameter 10352 can be set to a negative value of torque counts (tcnts) to limit the torque from the PID loop in the controller in the negative direction only. Parameter 10351 can similarly be set to limit tcnts from the PID loop in the positive direction. Since the spring compensation in the gripper is treated as a feedforward torque, these parameters do not affect the spring compensation torque.

For this case it is more exact to know the exact number of tcnts to oppose the spring at various openings. For the portrait mode opening of 83mm it takes 1600 tcnts to oppose the spring. For the landscape mode opening of 123mm it takes 2200 tcnts to oppose the spring.

If the rated torque of the motor has been set to its maximum value of 1.26A, the formula for setting parameter 10352 is (Spring force at position) +((-<Contents of 10352>-<tcnts to oppose spring force>)/4378) X18N, where 4378 is the number of tcnts corresponding to 1.26A or the rated torque of the motor. For example, for portrait mode the spring force is about 6N, and if the contents of 10352 are -

3200, this value will be 6N + (3200-1600)/4378) X18N or about 12.5N. If the value of 10352 is -1600, the squeeze will be 6N which is the spring force only.

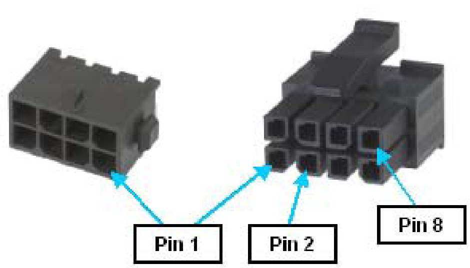
In a similar manner parameter 10351 can be used to limit the gripper opening force. In this case the value for the opening force is ((<Contents of 10351>-<tcnts to oppose spring force>)/4378)X18N – (Spring force at position). For example, in landscape mode the spring force is about 8N, and if the contents of 10351 are 5200, this value will be (5200-2200)/4378X18N -8N or 4.3N. Note that 5200 is about as low a value as you would want to use in landscape mode for parameter 10351, to ensure there is enough force to oppose the spring and open the gripper all the way to the homing position. For many cases, 10351 can be left at its default value of 0, in which case it is disabled.

Grip Test and Squeeze Check

It may be desirable to check if a plate is gripped by checking the gripping torque value. The output torque to the motor is available in Parameter 12304, value 5 in the parameter data base. For a non-spring gripper, this value varies between 0 and 4378 tcnts for a maximum gripper force of 18N. For a spring gripper, per above, for a portrait grip, the spring adds about 1600 tcnts to the squeeze and for a landscape grip, it adds about 2200 torque counts to the squeeze. Since this value is taken into account by the spring compensation and is offset from the torque commanded to the motor in Parameter 12304, when checking Parameter 12304 to determine squeeze the spring compensation must be subtracted from the torque value in Parameter 12304. For example, if the gripper is at the portrait position and not holding a plate, it must servo against the spring. In this case the value in Parameter 12304 will be about 1600 tcnts. To determine the effective squeeze torque, subtract 1600 tcnts from this value, which results in zero tcnts of squeeze force. If the value in 12304 is -2700, then the gripper motor is squeezing with -2700 tcnts, and the spring is adding -1600 tcnts, and the effective squeeze is -4300 tcnts, or about 18N. The exact spring compensation value is stored in field 5 of Parameter 12331. For the best accuracy in determining effective squeeze force at any gripper opening, subtract this value from the value in 12304.

Servo Gripper Controller Digital Inputs and Outputs

The Servo Gripper Controller PCA (GSB) adds 3 general optically isolated digital outputs and 3 general optically isolated digital inputs to the standard digital I/O found on the Guidance Controller. Like the other general inputs and outputs, they can be utilized as remote DIO by the master Guidance Controller for general workcell interfacing; driving an LED, encoder latching inputs for conveyor tracking or camera synchronization; inputs to the GSB servo for homing or limit stops; etc. These signals are presented in an 8-pin AMP 3-794618-8 that mates with an AMP 794617-8 plug. This type of connector permits these signals to be easily interfaced to other devices.



Unlike the controller's standard digital I/O that are directly accessed on demand, these I/O are scanned by the controller. The scanning period is nominally 4 milliseconds, so your application must be able to handle a delay of up to 4 milliseconds for signal changes to propagate through the system.

For the PP100, Output 3 of the servo gripper controller is connected to the blue status LED, and so is not available for general IO.

The GSB I/O signals are shown in the table below:

Pin	GPL Signal Number	Description
1	200013	Digital Output 1
2	200014	Digital Output 2
3	200015	Digital Output 3 (LED on Theta Cover)
4		24 VDC output
5		GND
6	210001	Digital Input 1
7	210002	Digital Input 2
8	210003	Digital Input 3

Optional Pneumatic or Vacuum Gripper

It is possible to order an optional pneumatic or vacuum gripper. In these cases, the GSB board provides two outputs and 3 inputs that can be used to control solenoids and sense end of travel. As a special option the GSB board can be replaced by a GIO optional IO board with 12 inputs and 8 outputs, described earlier. Signals from the GIO board can then be used to control gripper solenoids and IO. In this case the blue status light LED is wired back to the GSB board that drives the Z axis.

Control of Status Lamp on Theta Cover

Users normally do not need to modify the setting of the status lamp (Digital Output 200015) since the standard robot software typically manages this signal. However, if desired this signal can be manually altered under program control via the GPL SIGNAL.DIO instruction. This is controlled by DOUT signal 200015. If direct control of this signal is desired, DataID 235 should be set to 0 and signal number 200015 should be controlled by program control.

Service Procedures

Recommended Tools

The following tools are recommended for these service procedures:

1. Gates Sonic Belt Tension Meter, Model 507C for checking timing belt tension.
2. A set of metric “stubby” hex L-keys, for example McMaster Carr PN 6112A21 with 1.5, 2.0, 2.5, 3.0, 4, 5, and 6mm L Keys.
3. A set of metric hex drivers including 1.27, 1.5, 2.0, 2.5 and 3.0mm driver, for example McMaster Carr PN 52975A21.
4. A pair of tweezers or needle nose pliers.
5. A pair of side angle cutters.
6. Small flat bladed screw driver, with 1.5mm wide blade typical
7. M5 socket driver or M5 open end wrench or pliers

Trouble Shooting

Precise robots and controllers have an extensive list of error messages. Please refer to the HTML document *Precise_Documentation_Library.chm* to search for a specific error message and cause. Listed below are a few errors that may be generated by hardware failures.

Symptom	Recommended Action
System error message generated	
“ESTOP not Enabled”	Check 9 pin Dsub for Estop jumper.
“Encoder Battery Low”	Replace absolute encoder battery in X-axis of robot
“Encoder Battery Down”	If encoder cable has been disconnected, recalibrate robot. If battery voltage has dropped below 2.5V replace encoder battery and recalibrate robot.
“Encoder Operation Error”	Joint rotated too quickly with power off. See Procedure below.
“Encoder Data, Accel/decel Limit Error”	Encoder cable may be damaged and encoder is getting intermittent communication, causing apparent jumps in position. Check encoder connectors. Replace cable. Replace motor.
“Encoder Communication Error”	Check encoder connectors on flat ribbon cable. Replace encoder cable or motor/encoder.
"Encoder quadrature error"	Replace slip ring. Replace motor/encoder (only Gripper motor).
"Missing zero index"	See "Encoder quadrature error"
“Motor duty cycle exceeded”	Reduce speed or acceleration of robot. Check for instability.
“Amplifier under voltage”	Motor power supply has reached current limit and shutdown. Slow down robot. Check Energy Dump PCA. Replace 48V supply.
“Amplifier Fault”	Check harness and motor for shorts.
“Amplifier Over Voltage”	Check that energy dump resistor is connected.
“Soft Envelope Error”	Make sure robot not pressing against surface. If this occurs on

	the gripper repeatedly, replace slip ring.
"Hard Envelope Error"	Typically means robot has crashed into something.
Pneumatic Gripper Sensor not working	Check continuity of cable through wrist. Check green lights on sensor to see if sensor is triggering.
"Time Out Nulling Error"	Check that joint is free to move with brake off. Check that joint is not vibrating or unstable. If unstable check belt tension. If Gripper, replace slip ring after checking that brake releases.
"Joint Out of Range"	The joint actual or commanded position may be beyond the software limit stop. Move joint back into range while monitoring virtual pendant or check program for commanded position.
"PAC Files Corrupted"	See recovering from corrupted PAC Files
Physical or audible problem	
Brown streaks on linear bearing	Clean with alcohol and add grease to bearing blocks. This should not be required sooner than 20,000 hours of run time. Grease is Alvania Grease EP2 from Shell.
Mechanical noise from any joint	Check joint bearings for failure. Re-tension belt.
Loud buzzing or vibration from any joint	Re-tension timing belts.

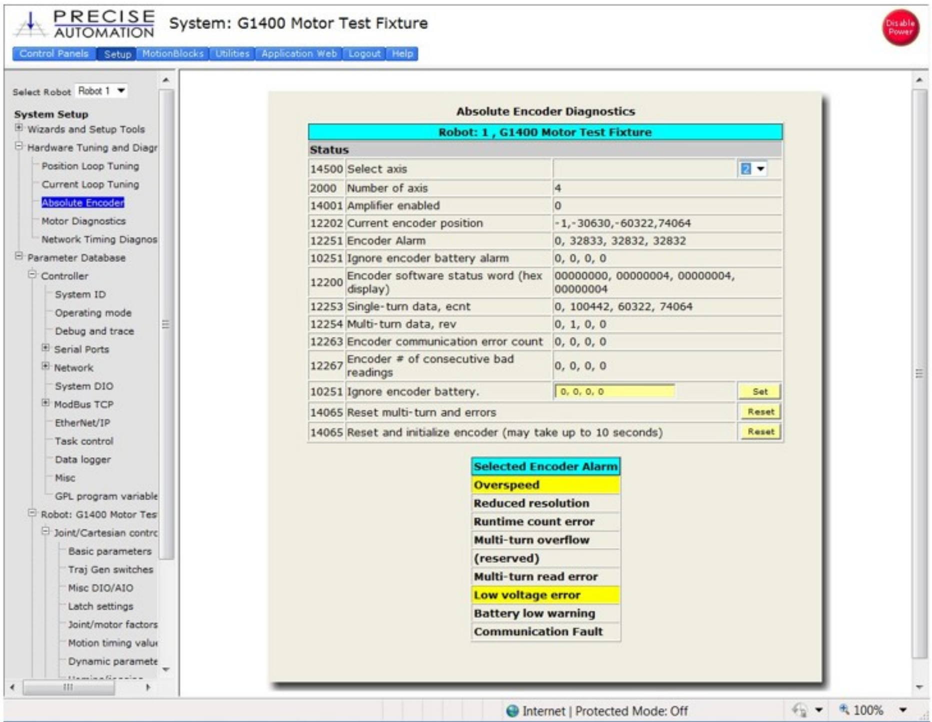
Encoder Operation Error

The PP100 robot is equipped with absolute encoders that keep track of the robot position even when AC power to the robot is disconnected. There is a battery in the base of the robot that provides standby power to the encoders. In standby mode, there is a limit on how quickly the motor can turn and still have the standby counter operate properly. The limits are 6,000 rpm and 4000 rad/s^2. Even at 100% speeds the robot joints normally do not move faster than about 2,000 rpm and 1300 rad/s^2. However, if the robot is shocked during shipping, it is possible the standby operation acceleration error limit may be exceeded. This can generate an encoder operation error that will prevent the robot from homing after power up.

This error will be displayed in the Operator Window of the Web Interface as "Encoder Operation Error" Robot 1: <axis number>.

Assuming the robot has not been damaged by the shipping process, this error can be reset by the following procedure:

1. Access the Web Operator Interface to the robot with either "Maintenance" or "Administrator" privileges.
2. In the "Setup" menu, select "Hardware Tuning and Diagnostics", then select "Absolute Encoder". You should see a screen similar to that shown below.



3. In the pull-down menu at the top right of the screen, select the robot axis that was associated with the error and check to see if the Overspeed panel is yellow. This indicates an overspeed error during encoder standby mode due to shock or vibration. This error can be reset by selecting the reset button next to “Reset and initialize encoder”. This button resets error flags but does not reset the encoder counters. The robot can then be homed normally.
4. For cases where the encoder operation error was triggered by shipping vibration, IN MOST CASES the encoder will not have lost any position data. However, after homing the robot it is a good idea to move the robot to the calibration position (using the calibration pins where required desired-see Calibrating the Robot), or another known position, and check the joint angles in the Virtual Pendant in the Web Operator Interface. The joint angles in the Calibration Position are:

    X Axis at hard stop opposite connector panel: -2mm
    Z Axis at upper hard stop: -2mm
    Y axis at hard stop near X axis: -2mm
    Theta axis when rotated to negative hard stop and reversed to calibration pin: -270 degrees for the XY
    Gripper closed with power off after calibration: 72mm

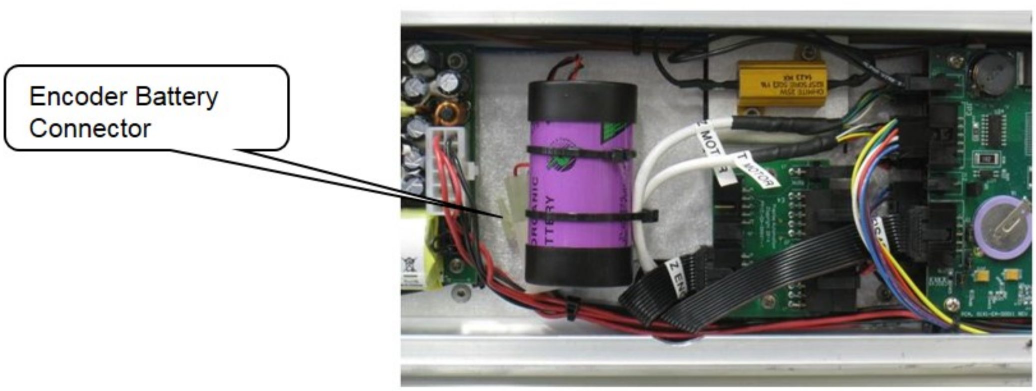
If the robot joints after this procedure followed by homing are different from the above, then the robot needs to be re-calibrated. See procedure below.

Replacing the Encoder Battery

DANGER: Before replacing the encoder battery, the AC power should be disconnected. Removing the rear cover allows access to the AC power terminals.

The Encoder Battery is designed to last for several years with robot power turned off. With robot power turned on, there is no drain on the battery. The battery voltage is monitored by the system. The nominal battery voltage is 3.6 volts. If the battery voltage drops to 3.2 volts an error message “Encoder Battery Low” is generated. At this level the absolute encoder backup function will still work, however the Battery should be replaced. If the voltage drops to 2.75 volts, an error message “Absolute Encoder Down” is generated. At this point, the absolute encoder backup function will not work.

Note that if any motor/encoder is disconnected from the encoder battery by disconnecting the encoder cable, the “Encoder Battery Low” or Encoder Battery Down” message will be generated. However in this case the encoder battery does not need to be replaced. It is only necessary to re-calibrate the robot, see below.



Tools Required:

1. 3.0mm hex driver or hex L wrench

Parts Required:

1. New Encoder Battery PN PF00-EA-00002
2. 2 8 in long by .093 wide tie wraps

To replace the Encoder Battery the user must:

1. Turn off power to the robot and remove the AC power plug.
2. Remove the Rear Cover of the X axis.
3. The Encoder Battery is located in the middle of the electronics in the X axis. The Encoder Battery has a connector which plugs into a connector in the controller harness. Unplug the old battery and replace with a new battery. It may be necessary to recalibrate the robot after the battery has been replaced. The encoders have standby capacitors that allow the old battery to be

disconnected for a few minutes while a new battery is installed, without losing calibration, but these capacitors age over time and may not hold their charge very long.
4. Attach the new Encoder Battery to the hold down with one tie wrap and replace the second tie wrap securing the motor cables to the encoder battery.
5. Replace the Rear Cover.

If the error message “Encoder Battery Down” was generated, the robot must be re-calibrated after this procedure.

Calibrating the Robot: Setting the Encoder Zero Positions

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

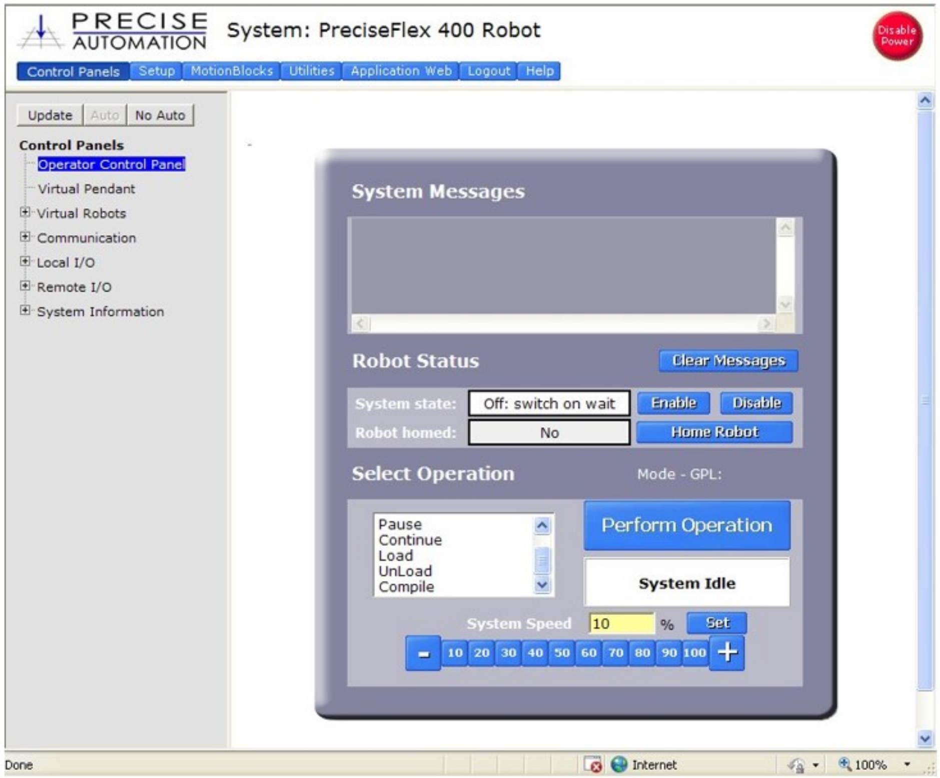
Cal_PP is supplied on the *Guidance Controller System Software CD*. To run Cal_PP, the controller must be configured to run GPL programs and Cal_PP must be loaded into the controller's memory (See Appendix D).

Tools Required:

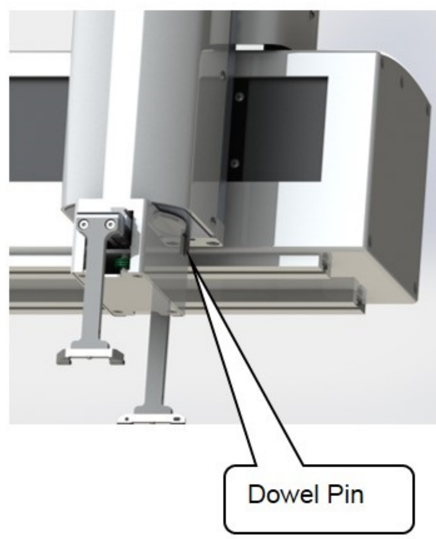
1. 2.5mm and 3.0mm hex drivers or hex L wrenches
2. Set of 1 Calibration Dowel Pin**,** located in a plastic bag inside the Z motor cover under the Z motor pulley.

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

1. Enable power to the robot’s controller, but do not turn on power to the motors.. (This procedure should be executed with motor power off. The robot does not move.)
2. The CALPP program is typically installed at the factory and should be loaded into flash memory. Using the Web based Operator Control Panel first unload any currently loaded programs. Select the “Unload" item in the left scrolling window and press the "Perform Operation" button. This ensures that no GPL project is currently selected for execution. Select the "Load" item and press the "Perform Operation" button. This displays a popup list of Projects that are in the flash disk and available for execution. In the popup display, click on CALPP_RevXX and press "Select". When you are ready to execute the Project, select "Start application" and press the "Perform Operation" button. If CALPP is not loaded in the robot, first Load Cal_PP into the controller’s memory from a PC, using the web Operator Control Panel, as described above in the Software Reference Section.



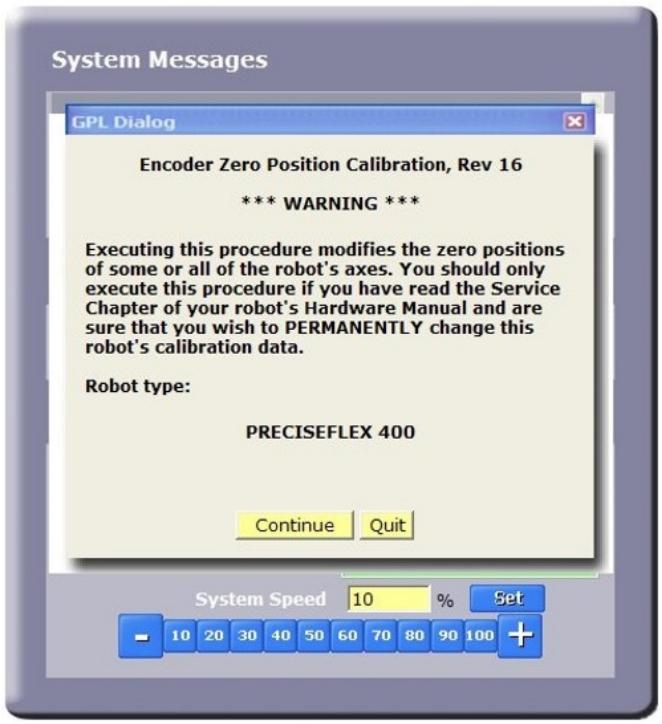
3. Manually move the robot into the configuration shown below. (XZTheta robot shown)

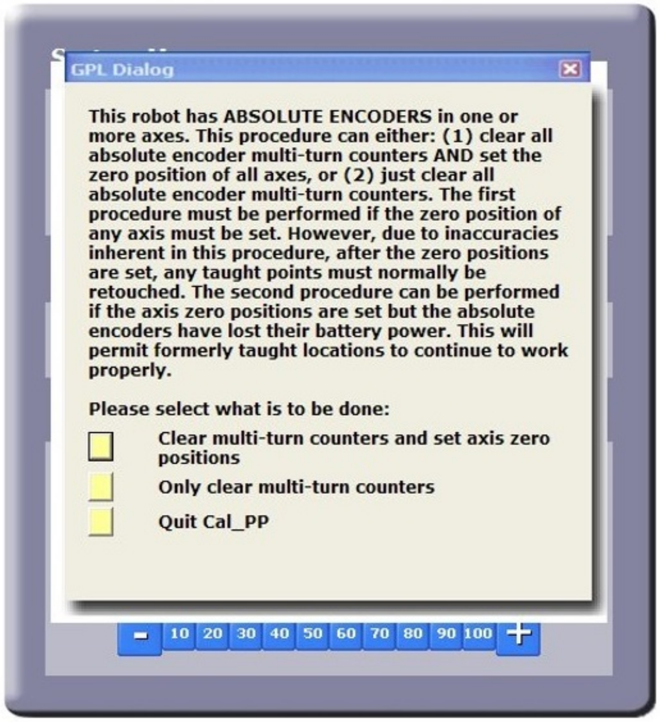


4. Ensure X-axis is against the hard stop opposite the connector end cap.

5. If a Y axis is present, ensure the Y axis is pressed against the stop nearest the X axis.
6. Ensure the Z axis is at the hard stop at the top of the range of travel by releasing the Z axis brake by pushing on the brake release button at the back of the Z axis cover while supporting the robot arm with your hand, and raising the robot arm gently until it rests against the upper hard stop.
7. Remove the 3mm tapered calibration pin from the plastic bag under the Z axis cover, under the Z axis motor.
8. Rotate the Theta axis all the way to the negative hard stop (counter clockwise looking down at Theta), then rotate it back about 20 degrees and insert the tapered dowel pin in the 3mm hole in the bottom of the Theta axis, then rotate the Theta axis back in the negative direction until the gripper housing presses against the dowel pin. If the axis springs away from the pin due to the wire harness clock spring wind up, use masking tape to hold the gripper housing against the pin.
9. With the CALPP application loaded, select "Start Application", then press "Perform Operation"

    a. Application should start and prompt user to confirm correct robot position for calibration





b. The CALPP application takes about 1 minute to run.

10. After calibration is complete, use the brake release button and move the Z-axis up from the hard stop. Failing to do this will produce an error as the robot is outside of the soft stop limits.
11. **Make sure the pin is removed.**
12. **Enable power and home the robot. Calibration does not take effect until the robot is homed.**

Replacing Belts and Motors

The timing belts and motors are designed to last the life of the robot. It is not expected that they will need to be replaced in the field. In most cases, if a belt or a motor needs to be replaced, the robot should be returned to the factory. While there are procedures at the end of this manual for replacing belts and motors, only experienced service technicians should attempt these procedures.

General Belt Tensioning

The PrecisePlace 100 has been designed to make belt tensioning very simple. See Appendix E for belt tension specifications.

Tensioning the X Axis Belt

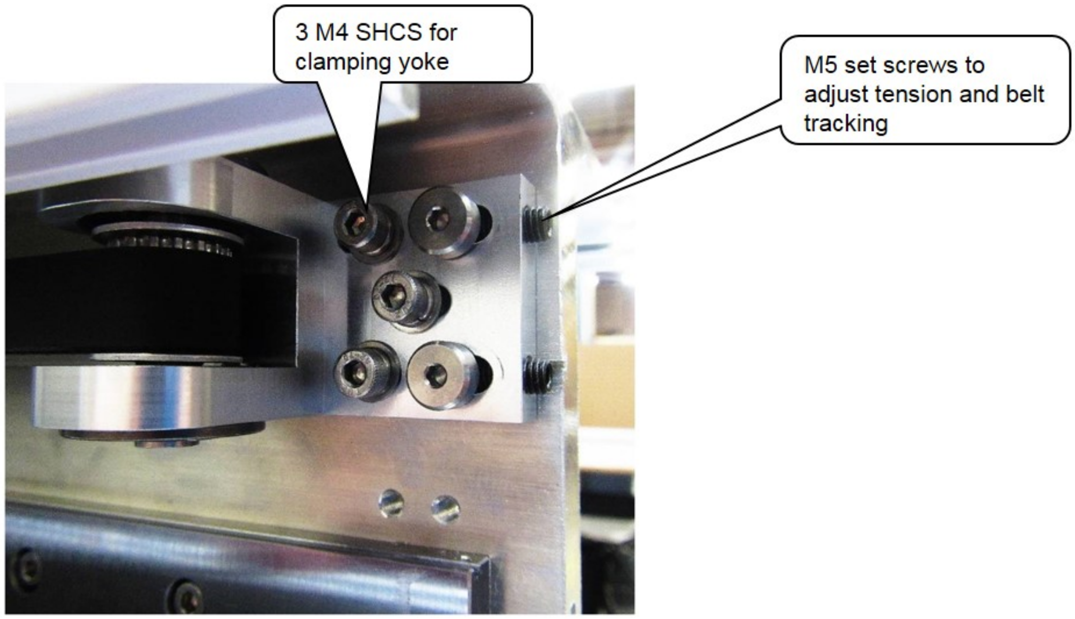
DANGER: Before tensioning the timing belts or replacing any motors, the AC power should be disconnected. Removing the front cover allows access to the AC power terminals.

Tools Required:

1. 2.0mm hex driver or hex L wrench
2. 3.0mm hex driver or hex L wrench

To adjust tension in the X Axis Belt the user must:

1. Turn off robot power and remove the AC power cord.
2. Loosen the tape seal of the robot by removing the 4 M3 socket head screws that attach the tape seal brackets to the vertical Z riser plate. Once the screws are removed pull the tape seal ends and the tape seal out of the X axis extrusion grooves so that the X carriage can slide back and forth without dragging the tape seals.
3. Remove the right end cap by removing 1 M3 X 10 FHCS from the rear cover and 4 M4 by 35 SHCS from the end cap.
4. Loosen the 3 M4 screws that clamp the right end pulley yoke to the X extrusion.
5. Move the X carriage to a position so that there is 500mm from the carriage to the right end pulley yoke where the belt is tangent to the yoke, to set the belt span to 500mm.
6. Measure the belt tension with the Gates belt tension meter using the settings in Appendix E. Measure the belt tension by holding the microphone close to the belt in the middle of the 500mm span and gently plucking the belt.
7. Adjust the belt tension by turning the belt tensioning set screws in the pulley yoke.
8. Run the X carriage back and forth a few times to check the belt tracking. Adjust the set screws if necessary to make the sure the yoke is parallel to the X axis and the belt is tracking in the pulley and not pressing against the pulley flange.
9. Tighten the M4 screws to lock down the yoke and replace the end cap and tape seals.



Replacing the X Axis Motor Assembly

> **DANGER:** Before replacing the X axis Motor, the AC power should be removed.

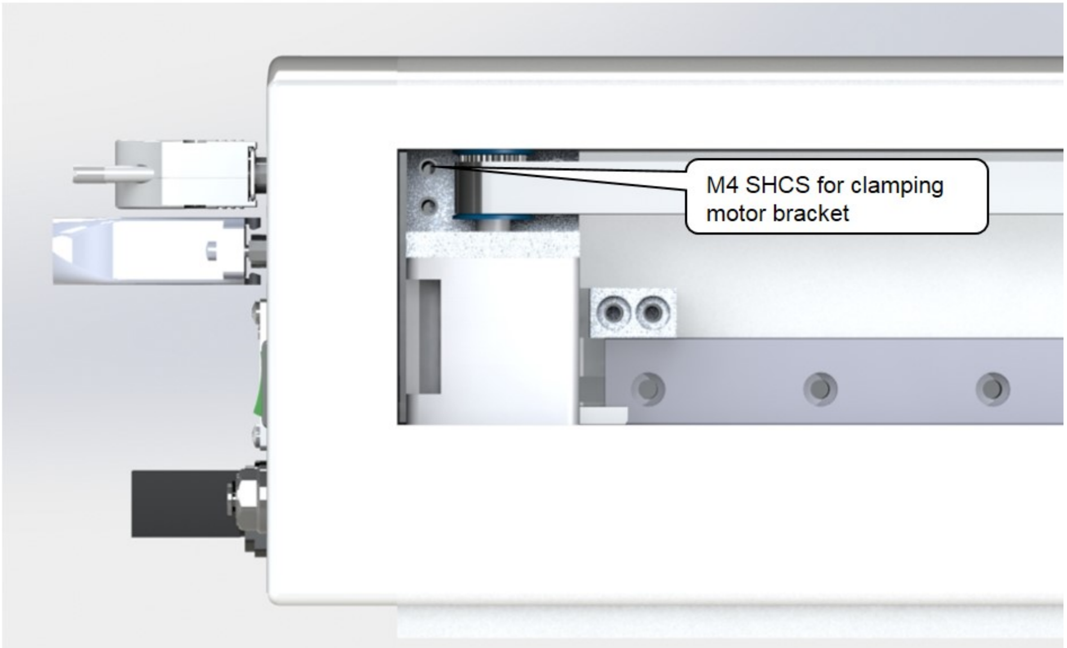
Tools Required:

1. 3.0mm hex driver or hex L wrench
2. 2.0 mm hex driver or hex L wrench
3. Loctite 243

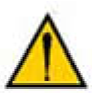
To replace the X axis motor, the user must:

1. Remove the rear cover from the X axis.
2. Unplug the X axis motor and encoder connectors from the controller. (Refer to the “Replacing the Power Supplies or Controller” section for detail on these connectors.)
3. Remove both tape seal brackets from the X carriage.
4. Remove the right end cap by removing 4 M4 X 35 SHCS and 1 M3 /x 10 FHCS from rear panel.
5. Loosen the 3 M4 SHCS clamping the tension yoke to release the belt tension and back out the M5 set screws that tension the belt.
6. Remove the left end cap by removing 4 M4 X 35 SHCS.
7. Remove the X axis motor and motor bracket by removing 4 M4 X 12 SHCS.
8. Remove the X axis motor assembly from the motor bracket by removing 2 M4 X 10 SHCS.
9. Install the new motor and re-assemble components using Loctite 243 to attach the motor to the motor bracket and the motor bracket to the X extrusion. Plug the motor into the controller.
10. Re-tension the X axis belt per instructions above.

11. Recalibrate the robot.



Replacing the X Axis Timing Belt



DANGER: Before replacing the X axis Timing Belt, the AC power should be removed.

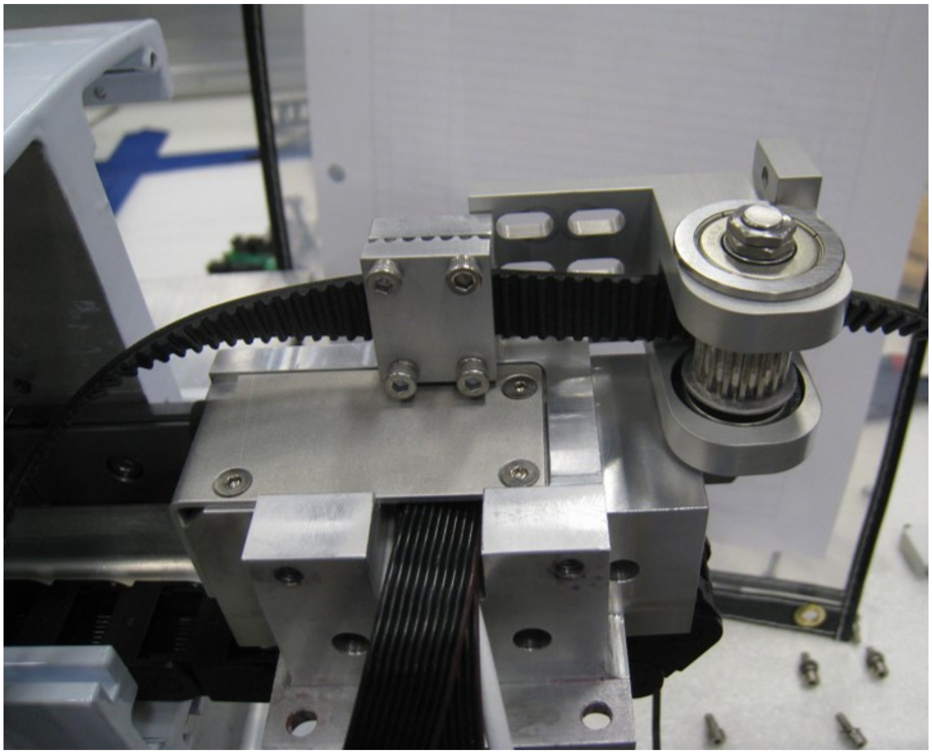
Tools Required:

1. 3.0mm hex driver or hex L wrench
2. 2.0 mm hex driver or hex L wrench
3. Loctite 243

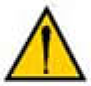
To replace the X-axis timing belt, the user must:

1. It is not necessary to remove the Z axis for this procedure. The Z axis has been removed in the picture below for clarity.
2. Remove the rear cover from the X-axis.
3. Remove both tape seal brackets from the X carriage.
4. Remove the Tension Screw from the right end cap and remove the right end cap by removing 4 M4 X 35 SHCS.
5. Remove the 4 M4 X 16 SHCS clamping the tension yoke to release the belt tension and free the yoke.
6. Remove the stop block by removing 2 M4 X 20 SHCS.
7. Unplug the robot cables going from the Echain through the hole in the X extrusion to the robot controller.

8. Cut the tie wraps holding the harness to the Echain end bracket.
9. Remove the two M3 X 6 FHCS attaching the Echain end bracket to the X extrusion.
10. Loosen all the M4 SHCS screws attaching the linear rail about 2 turns.
11. Slide the linear rail about 150 mm out the right end of the X extrusion. It is a good idea to put a tie wrap through the last M4 clamping hole in the linear rail so the carriage cannot slide off the rail, which can cause the bearing block balls to fall out of the bearing block.
12. Unhook the X belt from the X motor pulley and slide the X carriage out past the end of the X extrusion on the linear rail. Be careful not to slide it off the rail, per above. It is now possible to access the X axis belt clamp.
13. Remove the 4 M3 X 12 SHCS and lock washers retain the belt clamp.
14. Thread the new belt through the tension yoke and pulley and clamp with the belt clamp. Make sure the belt is centered under the belt clamp.
15. Re-assemble the robot. When re-attaching the Echain bracket to the X extrusion, first install the M3 X 6 FHCS to attach the Echain bracket. Then pull the cables in the Echain tight, mark the cables with a pen at the bracket, then push the cables 5mm back into the Echain so that the cables are floating in the Echain and not stretched tight. Secure the harness with two tie wraps around the Echain bracket fingers.



Replacing the Y Axis Motor or Belt Assembly



DANGER: Before replacing the Y axis Motor or Belt Assembly, the AC power should be removed.

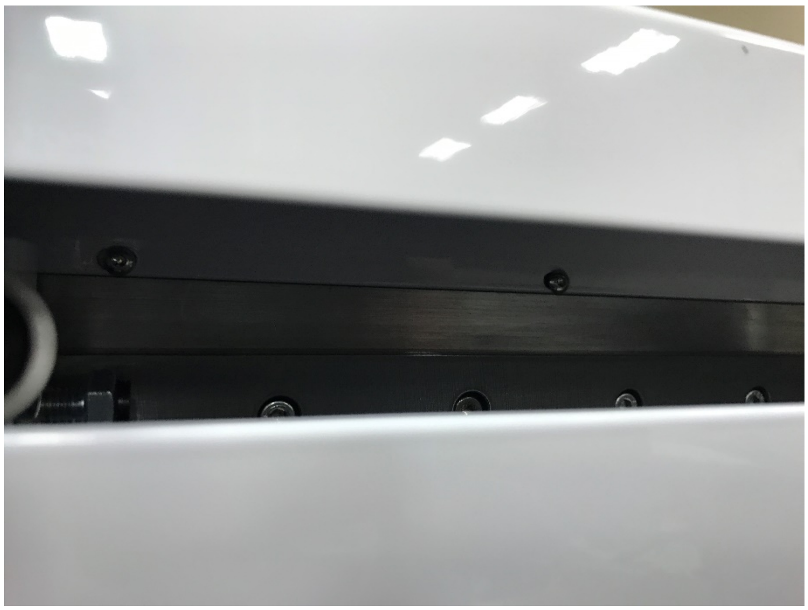
Spare Parts Required:

1. Y Axis Motor Assembly or Y axis Belt Assembly

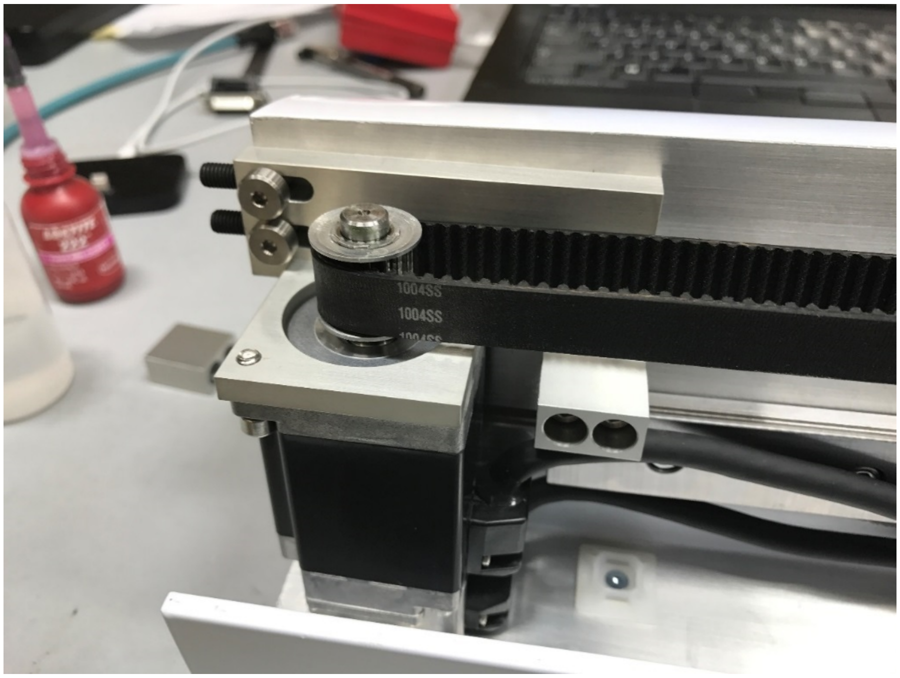
For XY robots, the Y-axis Motor Assembly is comprised of the Y axis motor, connectors, and a timing belt pulley and is located at the far end of the Y axis, attached to a yoke that also provides the belt tension for the Y belt. It plugs into cable extensions for the Y motor from the controller.

To replace the Y axis motor or belt the user must:

1. Move the Y carriage down to the X axis.
2. Remove the Y axis end cap by removing 4 M4x16 SHCS.
3. Remove the Y axis top cover by removing 3 M3x8 BHCS shown below.



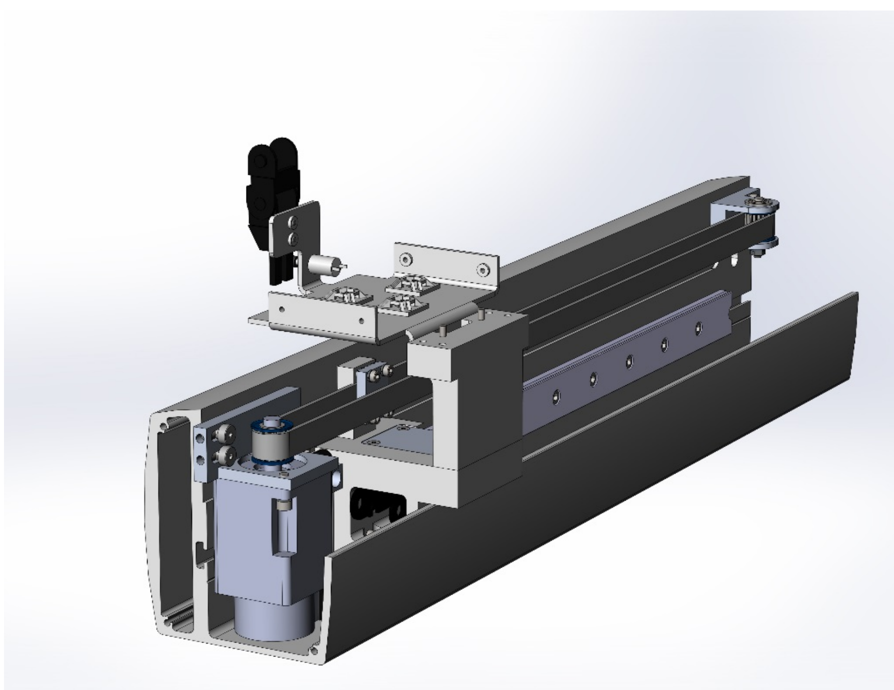
4. Release the Y axis belt tension and replace the motor.
5. Re-tension the Y axis belt per the tension table in Appendix E.
6. Replace the cover and end cap.



Replacing the Y Axis Belt Assembly (For XY robots only)

To replace the Y axis belt, the user must then

1. Loosen the belt clamp screws on the Y axis carriage and replace the belt.



Tensioning the Z axis Output Belt

Tools Required:

1. Gates Sonic Belt Tension Meter, Model 507C
2. 3.0mm hex driver or hex L wrench

To tension the Z axis Belt the user must:

1. Turn off the robot power and remove the AC power cord.
2. For the 228mm Z stroke robot, move the Z axis all the way to the top of the stroke using the brake release button. For the 260mm Z stroke robot move the Z axis so the distance from the upper belt roller to the top end of the belt is 236mm.
3. Use the belt tension meter with the settings in Appendix E to measure and adjust the belt tension. Hold the microphone perpendicular to the belt and gently pluck the belt using an L key.
4. Adjust the belt tension by turning the Tension Adjustment Screw. After adjusting the tension, run the Z axis up and down a few times using the brake release switch, then check the tension again.

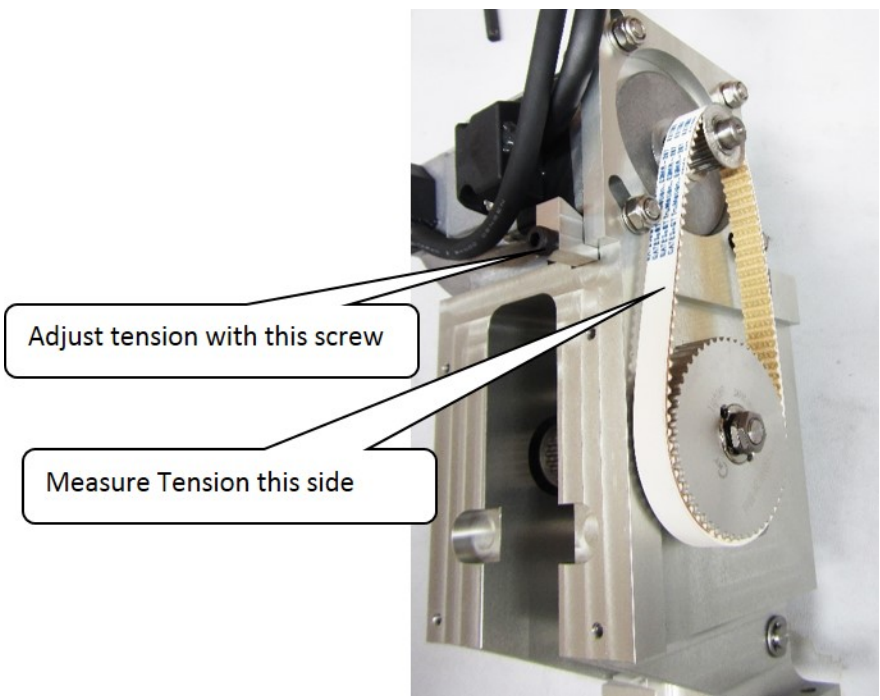
Tensioning or Replacing the Z axis Motor and Timing Belt

Tools Required:

1. Gates Sonic Belt Tension Meter, Model 507C
2. 4.0mm hex driver or hex L wrench
3. 8mm open end wrench
4. 7mm open end wrench

To tension or replace the Z axis motor or timing belt the user must:

1. Turn off the robot power and remove the AC power cord.
2. Remove the Z drive plastic cover by removing 4 M3 X 10 Button Head Screws.
3. Use the belt tension meter with the settings in Appendix E to measure and adjust the belt tension. Hold the microphone perpendicular to the belt and gently pluck the belt using an L key.
4. Adjust the belt tension by first loosening the 4 motor retaining bolts, and then adjusting the tension screw with a 3mm hex driver. After adjusting the tension and tightening the screws, run the Z axis up and down a few times using the brake release switch, then check the tension again.
5. Replace the Z drive plastic cover.
6. If the motor or belt has been replaced you must recalibrate the robot.



Replacing the Theta Axis Motor

DANGER: Before replacing this motor, the AC power should be removed.

Tools Required:

1. 3.0mm hex driver or hex L wrench
2. 2.5 mm hex driver or hex L wrench
3. 2.0mm hex driver or hex L wrench
4. Fine point tweezers
5. .06 in flat blade screwdriver

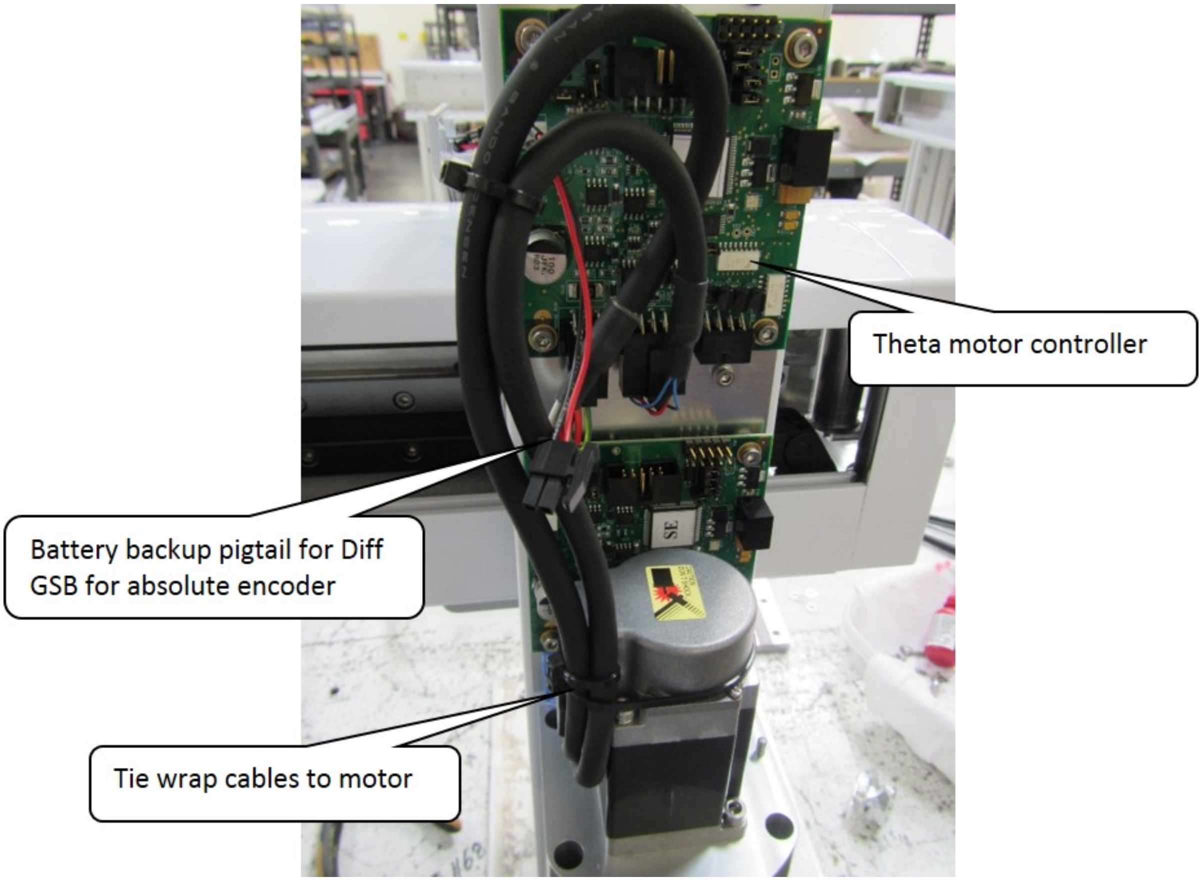
Spare Parts Required:

1. Theta Motor Assembly
2. Loctite 243

The Theta Motor Assembly is comprised of the Theta motor and connectors.

The user must:

1. Remove the theta cover by removing 2 M3 SHCS holding down the light bar and 4 M3 X 8 BHCS attaching the theta cover to the theta frame.
2. Unplug the theta motor from the GSB "Diff" board.
3. Remove the 2 M4 X 12 SHCS attaching the theta motor.
4. Loosen the 2 M3 X 8 SHCS in the helical coupling clamping the motor shaft.
5. Remove and replace the motor.
6. Replace the M4 X 12 SHCS using Loctite 243.
7. Tighten 2 M3 screws in helical coupling.
8. Plug in the motor connectors.
9. Secure the motor cables in a loop around the left side of the motor where the connectors are using tie wraps so the cables are clamped tightly to the motor as shown below.
10. Replace the cover.
11. Recalibrate the robot.



Replacing the Power Supplies or Controller

DANGER: Before replacing the power supplies or controller, the AC power should be removed.

Tools Required:

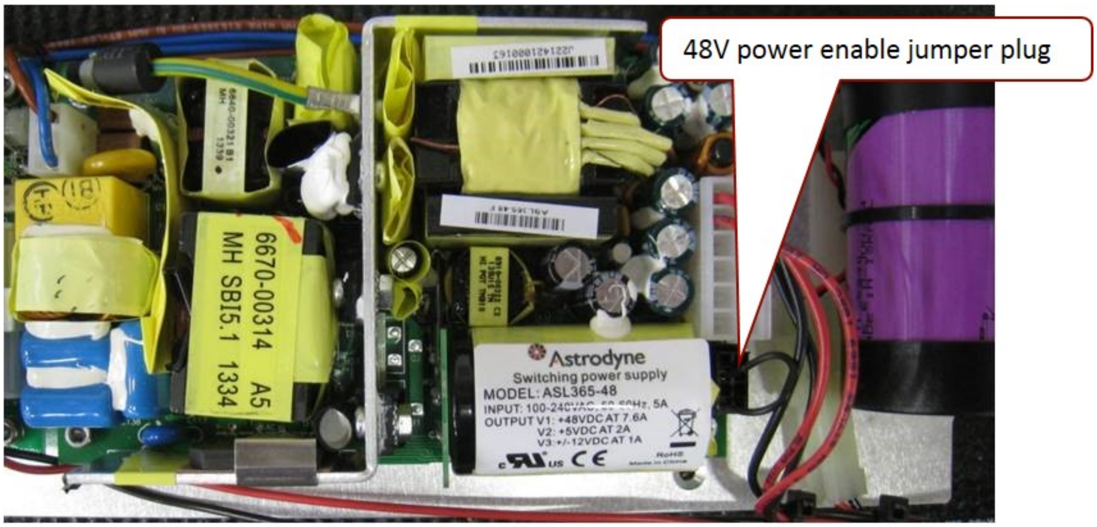
1. 2.0mm hex driver or hex L wrench
2. 2.5mm hex driver or hex L wrench
3. Tie wraps, prefer .093in by 8 in black.

Spare Parts Required:

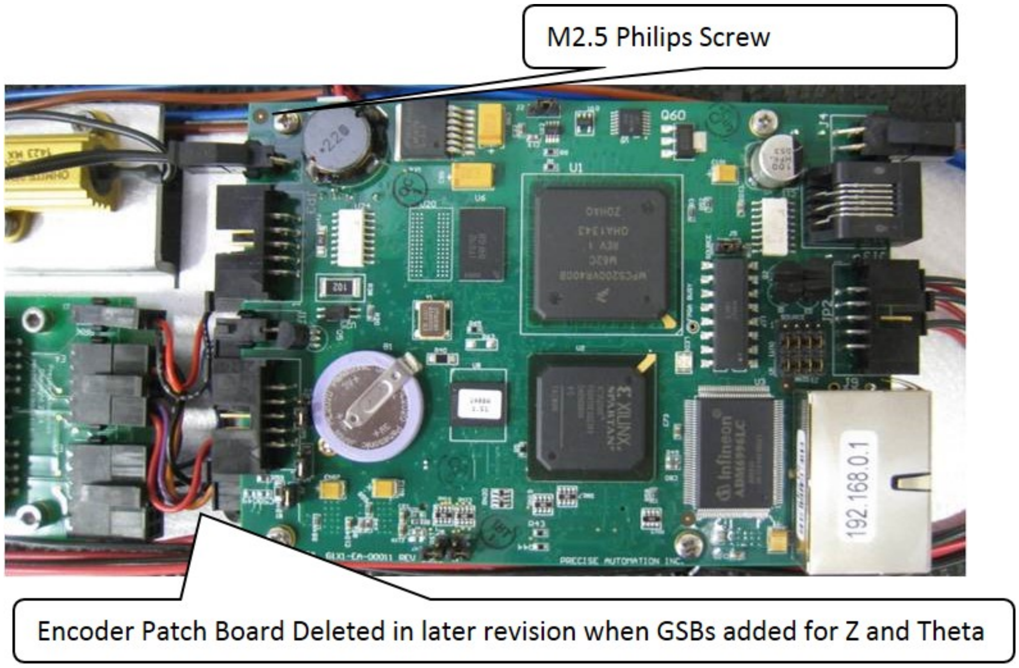
1. 24VDC power supply, PN PS10-EP-00125 or
2. 48VDC power supply, PN PS10-EP-48365 or
3. G1400D controller, PN G1XF-EA-D1400

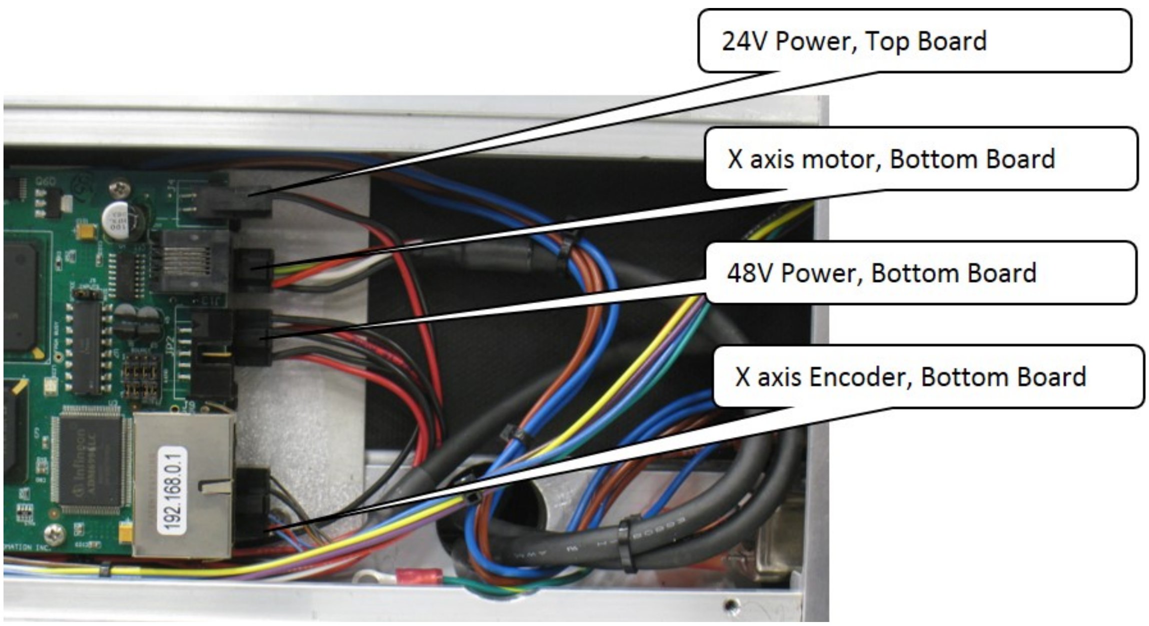
The user must:

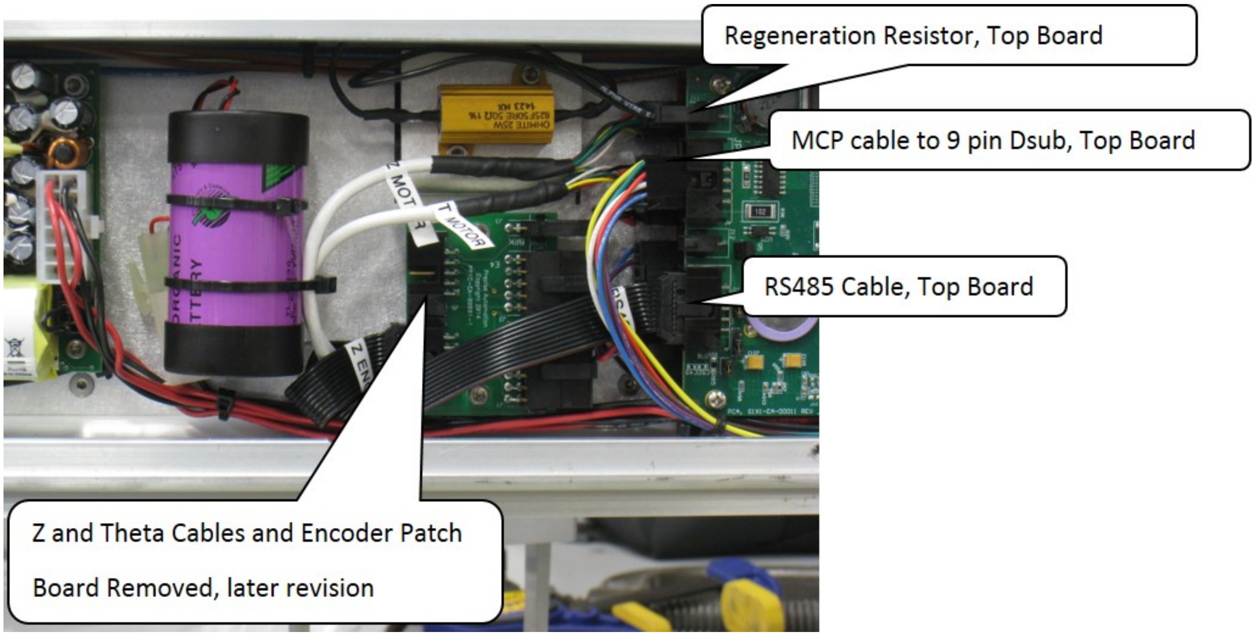
1. Turn off the robot power and remove the AC power cord.
2. Remove the rear cover from the X axis.
3. Remove the power supply or controller.
4. If replacing the 48 volt power supply, it is important to swap the power enable jumper from the old power supply to the replacement power supply. There is no power enable jumper on the 24 volt supply.



5. If replacing the controller, the user must carefully set all the jumpers on the replacement controller to be the same as the jumpers on the old controller. Note some jumpers may be changed from factory default settings by users to configure IO settings.
6. To replace the controller, first disconnect the cables, then remove the 4 M2.5 Philips or Socket Head Screws that attach the CPU board to the amplifier board standoffs and unplug the CPU board from the amplifier board connector. Then remove the amplifier board standoffs which attach the amplifier board to the X axis controller sheet metal standoffs.


M2.5 Philips Screw
192.168.0.1
Encoder Patch Board Deleted in later revision when GSBs added for Z and Theta


24V Power, Top Board
X axis motor, Bottom Board
48V Power, Bottom Board
X axis Encoder, Bottom Board
192.168.0.1



7. Reconnect the cables as shown above.
8. Replace the rear cover.
9. Recalibrate the robot.

Replacing the Main Harness

Replacement of the Main Robot Harness is typically only performed at the factory. The Main Robot Harness is intended to last for the life of the robot.

Replacing the Servo Gripper Controller

⚠	**DANGER:** Before replacing the Gripper Controller, the AC power should be removed.

Tools Required:

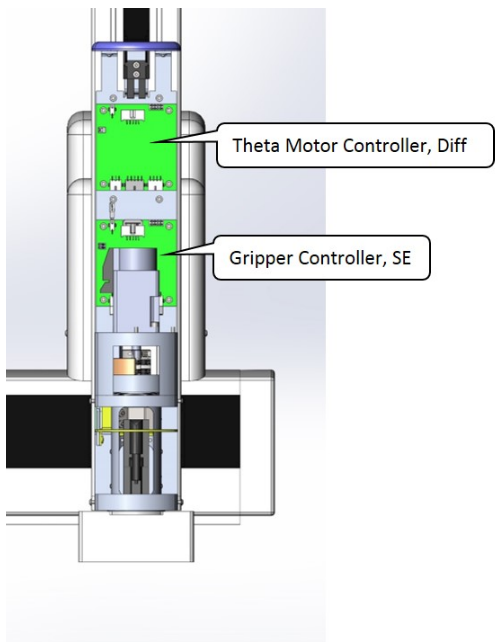
1. 2.0mm hex driver or hex L wrench
2. 2.5mm hex driver or hex L wrench

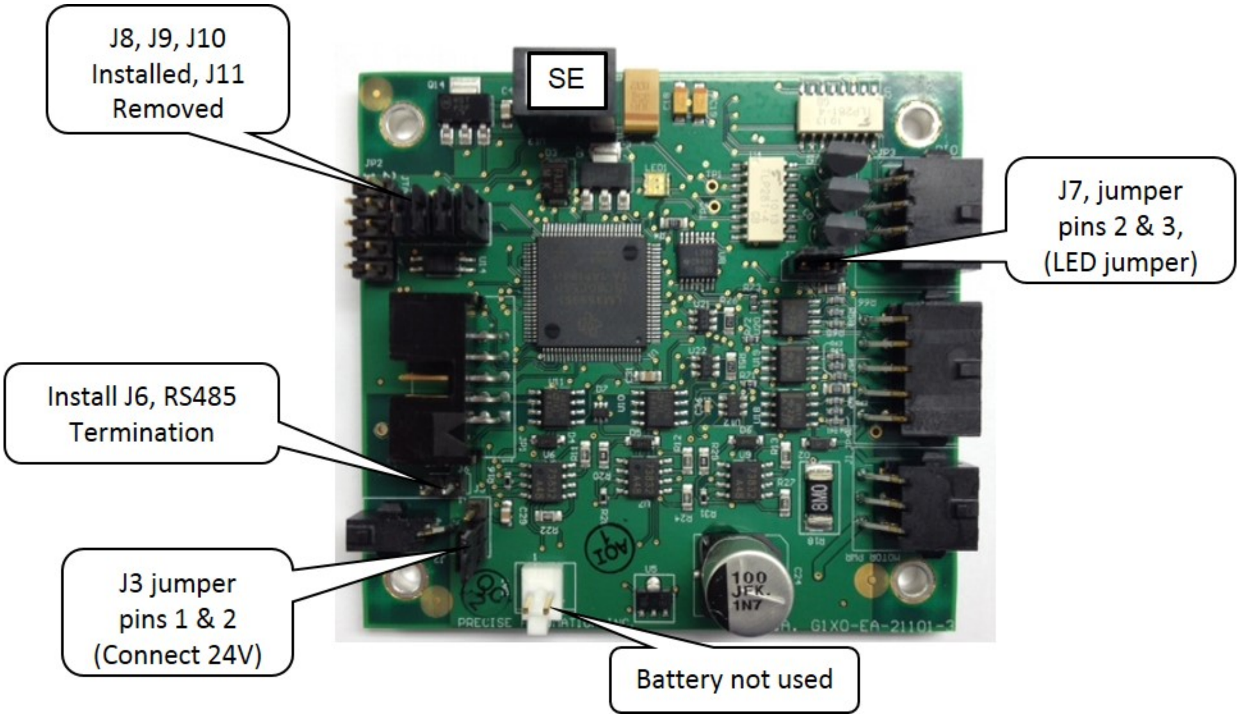
Spare Parts Required:

1. Guidance Gripper Controller P/N G1X0-EA-T1101

To replace the Gripper Controller the user must:

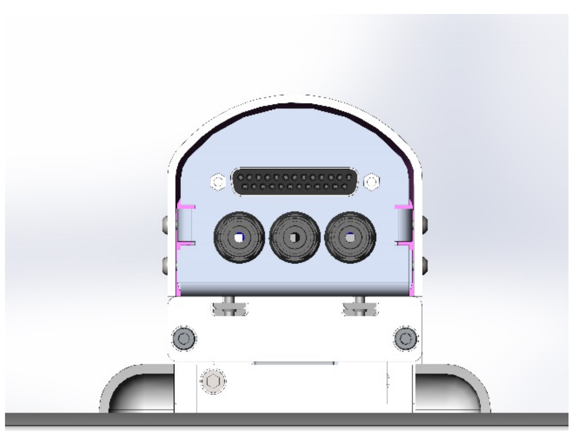
1. Turn off the robot power and remove the AC power cord.
2. Remove the Theta Cover.
3. Remove the Gripper Controller by removing 4 M3 X 8mm SHCS and unplugging the cables.
4. Replace the Gripper Controller and re-attach the harness.
5. Replace the Theta Link Cover.
6. It is not necessary to recalibrate the robot after replacing the Gripper Controller.
7. Starting January of 2013 gripper controllers are a new rev (GSB3), which replaces the address DIP switch with jumpers. To make the SW in the GSB3 work in a compatible mode with the standard PAC files, Jumper J11 must be removed.

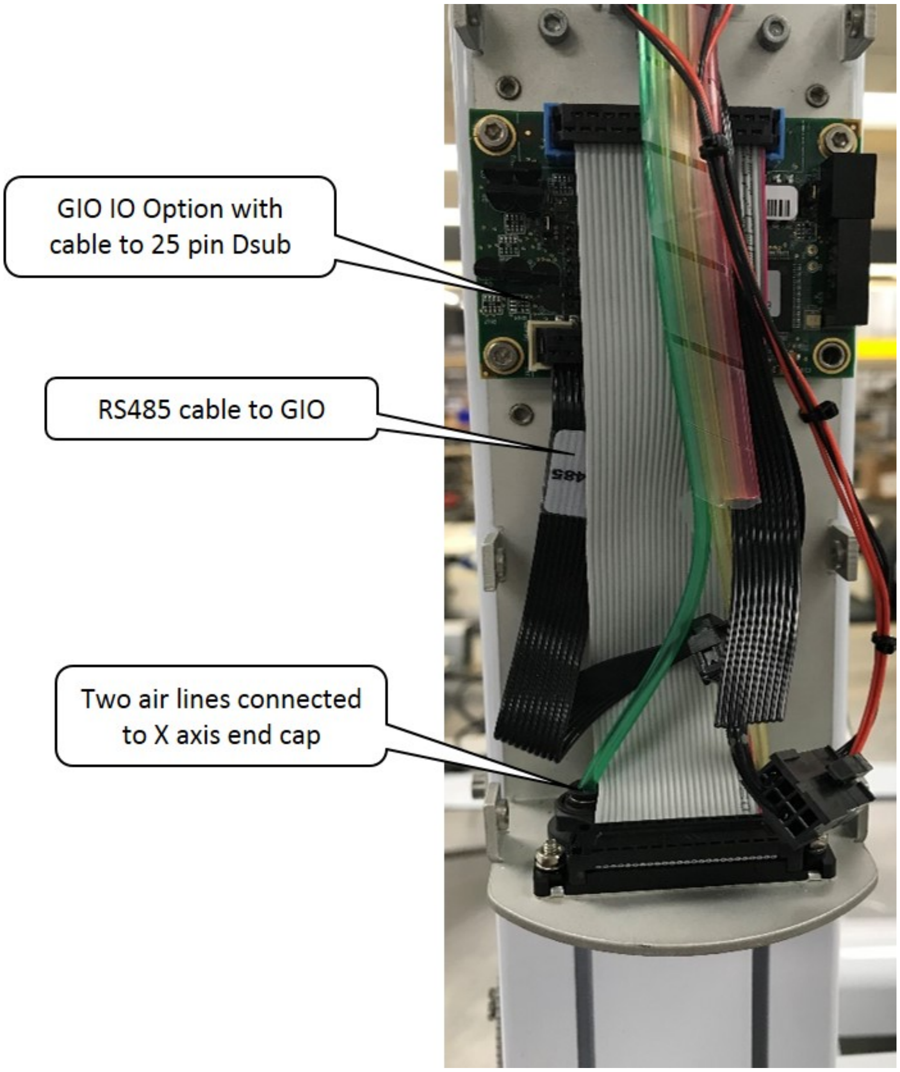




Wiring for Pneumatic Gripper

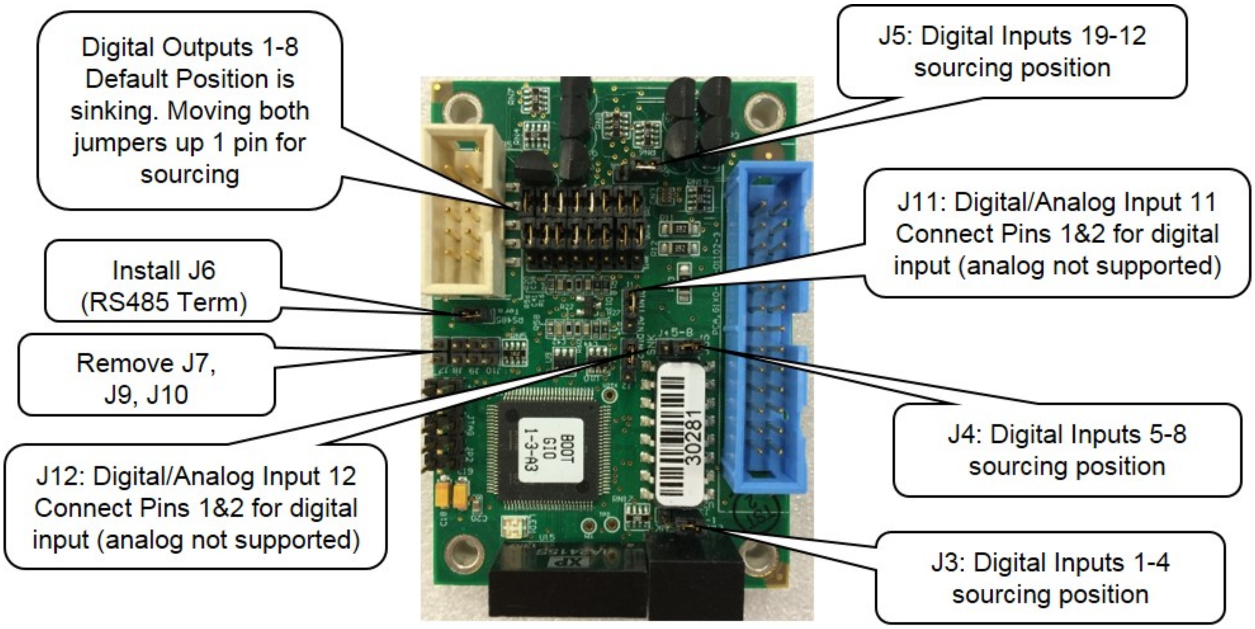
The PP100 can be ordered without the theta axis and servo gripper, or with the theta axis and without the servo gripper. In this case the optional remote IO board "GIO" is installed on the Z axis and a cable from this board to a 25 pin Dsub on the bottom of a shorter Z axis cover is installed. Also, 2 air lines are connected from the X axis end cap to the two outer Legris fittings on the bottom of the Z axis cover, as shown in the images below.





To specify a GIO's general-purpose digital I/O signal from the master controller, multiply the GIO's network node number (not the GIO's unit number) by 100000 and add the I/O signal's number. For example, to access a GIO board configured as the 2nd or nth network node, add 200000 or 100000*n to the signal number. **Node**	**Signal Offset**	**Outputs (8)**	**Inputs (12)**
2	200000	200013-200020	210001-210012
n	100000*n	n00013-n00020	n10001-n10012

For this GIO, it is configured as "GIO6" so the 8 outputs will be addressed as 600013-600020 and the 12 inputs will be addressed as 610001-6100012. See jumpers below. Inputs and outputs are 24VDC with outputs limited to 100mA. For pin assignments on the 25 pin Dsub, see "RS485 Remote IO Module (GIO)".



GIO Jumpers, GIO_6

Replacing the Gripper Spring or Cable

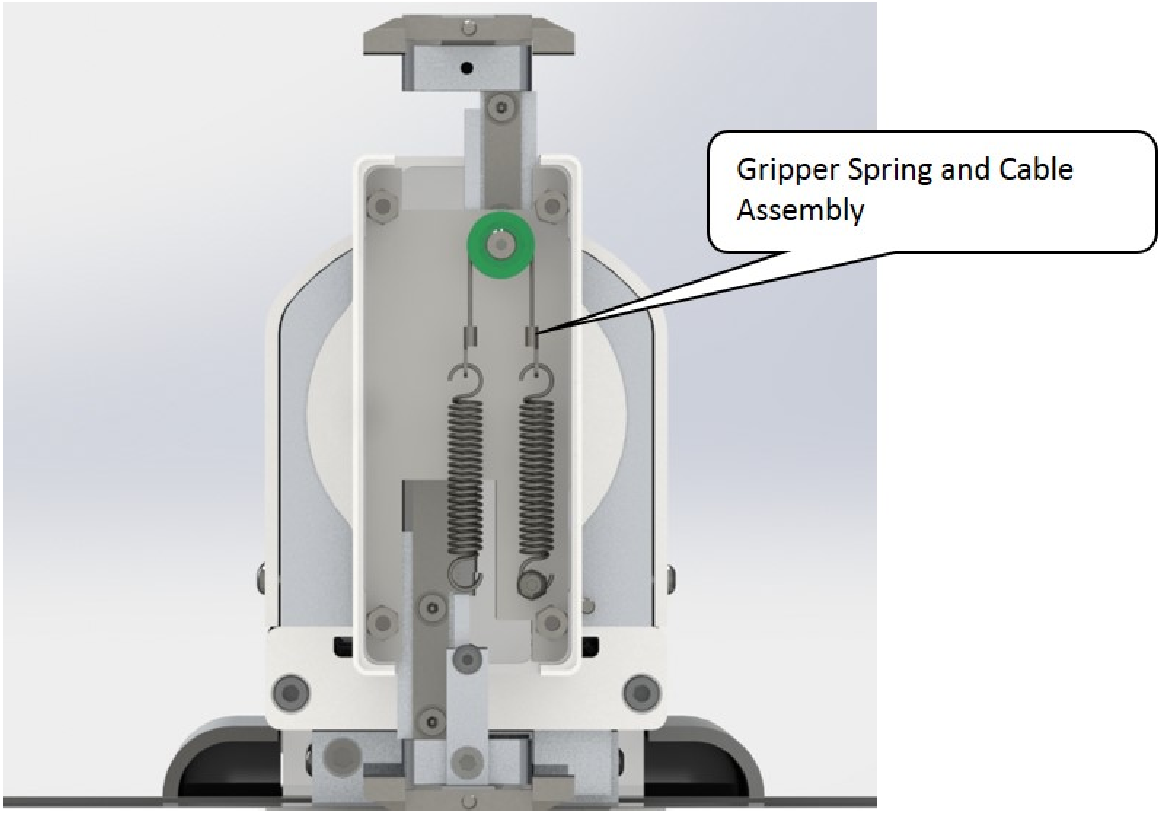
Tools Required:

1. 2.0mm hex driver
2. 2.5mm hex driver

Spare Parts Required: Spring or Cable Assembly

To replace the spring or cable the user must:

1. Remove the Gripper Cover by removing 4 M3 X 6mm FHCS.
2. Remove the spring cable assembly by unhooking it as shown below.
3. Replace the spring cable assembly and replace the cover. Do not use Loctite on screws.



Adjusting the Gripper Backlash

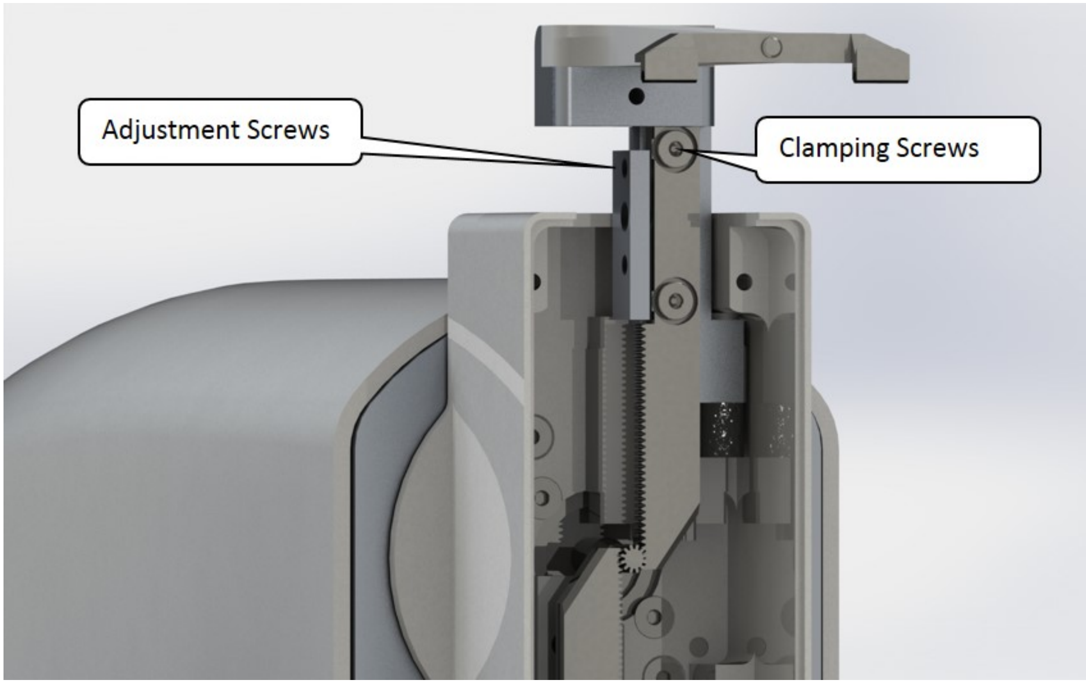
Tools Required:

1. 1.3mm “stubby” hex L wrench
2. 1.5mm “stubby” hex L wrench
3. 2.0mm hex driver or L wrench
4. Loctite 243 medium strength screw lock
5. Mobil 222 HP grease if needed.

Spare Parts Required: none

To adjust the gripper backlash the user must:

1. Remove the Gripper Cover by removing 4 32 X 6mm FHCS.
2. Unhook the gripper spring assembly and remove it.
3. Remove the gripper spring plate by removing 4 M3 standoffs that attach the plate.
4. Move the racks back and forth to determine which rack has backlash and where it is located on the rack.
5. Loosen the 2 M3 X 8 LHCS clamping the rack to the finger mount.
6. Adjust the M2 SHCS and M3 set screws to adjust the rack backlash.
7. Remove the 2 M3 X 8 SHCS one at a time, apply Loctite 243 screwlock, reinstall and tighten.



Replacing the Gripper Harness

> **DANGER:** Before replacing the Gripper Harness, the AC power should be removed.

Tools Required:

1. 2.0 mm hex driver or hex L wrench
2. .093in by 8 in tie wraps, preferably black

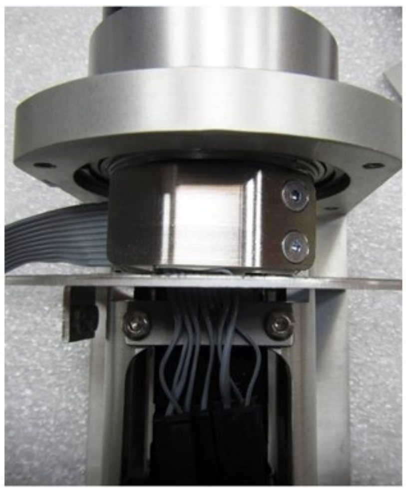
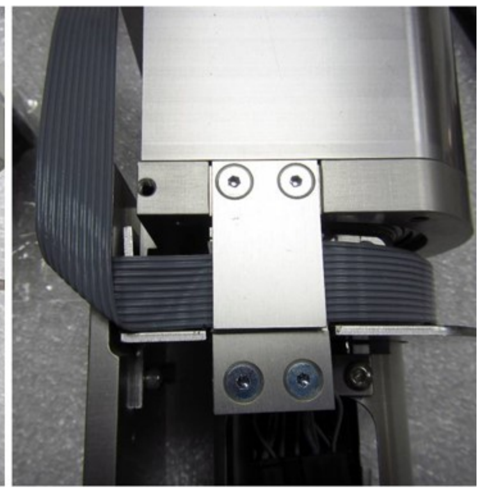
Spare Parts Required:

1. Gripper Harness

To replace the Gripper Harness the user must:

1. Turn off the robot power and remove the AC power cord.
2. Remove the Theta Cover.
3. Unplug the gripper harness from the gripper controller.
4. Remove the gripper harness clamp plate from the theta frame.

5. Un-coil the gripper harness from around the theta housing.
6. Remove the gripper harness clamp plate from the theta housing.
7. Clip the tie wraps holding the gripper harness connectors and gripper motor cables to the gripper motor, and unplug the old gripper harness from the gripper motor.
8. Replace the old gripper harness with the new one and replace tie wraps to clamp gripper harness to gripper motor inside theta housing.
9. Replace the gripper harness clamp plate on the theta housing.
10. Rotate theta clockwise when looking down from top of the theta until it hits hard stop.
11. Coil gripper harness 5 turns around theta housing when theta is against hard stop.
12. Clamp free end of harness with harness clamp plate on theta frame.
13. Fold harness and thread up behind theta frame to gripper controller and plug back into gripper controller.

Replacing the Gripper

> **DANGER:** Before replacing this motor, the AC power should be removed.

Tools Required:

1. 2.5 mm hex driver or hex L wrench
2. 2.0mm hex driver or hex L wrench

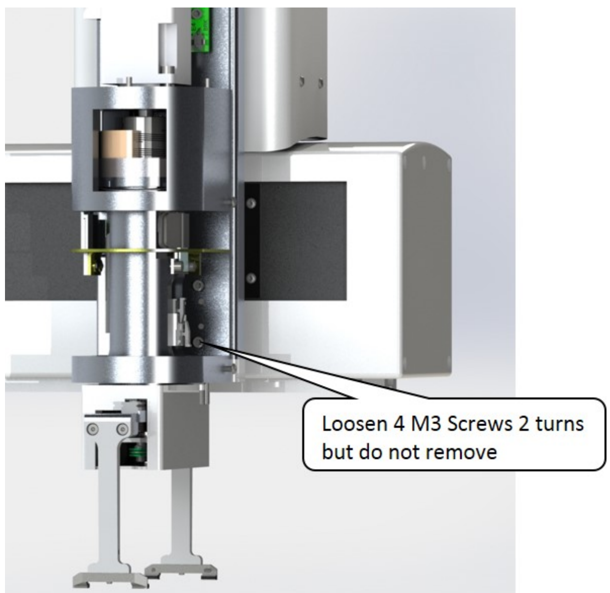
Spare Parts Required:

1. Theta/Gripper assembly

The gripper is tightly integrated into the theta housing to conserve space. Therefore replacing the gripper only is not a recommended field service procedure. If the gripper motor fails for any reason, the entire gripper theta assembly should be replaced.

The user must:

1. Turn off the robot power and remove the AC power cord.
2. Remove the Theta axis cover.
3. Unplug the harness from the theta motor, encoder interface board and gripper controller.
4. Disconnect the Echain from the theta/gripper mount plate by removing 2 M3 X 6 FHCS.
5. Remove the entire Theta/Gripper assembly by loosening 4 M3 X 10 SHCS 2 turns and sliding the assembly up and out of the T slots in the Z axis extrusion.
6. Install a new assembly and re-assemble.
7. Recalibrate the robot.



Installing the Optional GIO Board

Precise sells a digital IO board that provides 12 inputs and 8 outputs as an option. This board may be installed on the rear cover of the X axis if desired.

This board is provided with a 150mm pigtail harness to a 25 pin Dsub connector. The board is attached with 4 M3 X 10 SHCS and the 25 pin Dsub is attached with standard D-sub 4-40 mounting standoffs.

This board is typically installed at the factory, but can be installed by a user per below.

To install the GIO in a robot:

Tools Required:

1. 2.0mm hex driver or hex L wrench
2. 2.5 mm hex driver
3. M5 socket driver
4. M5 open end wrench

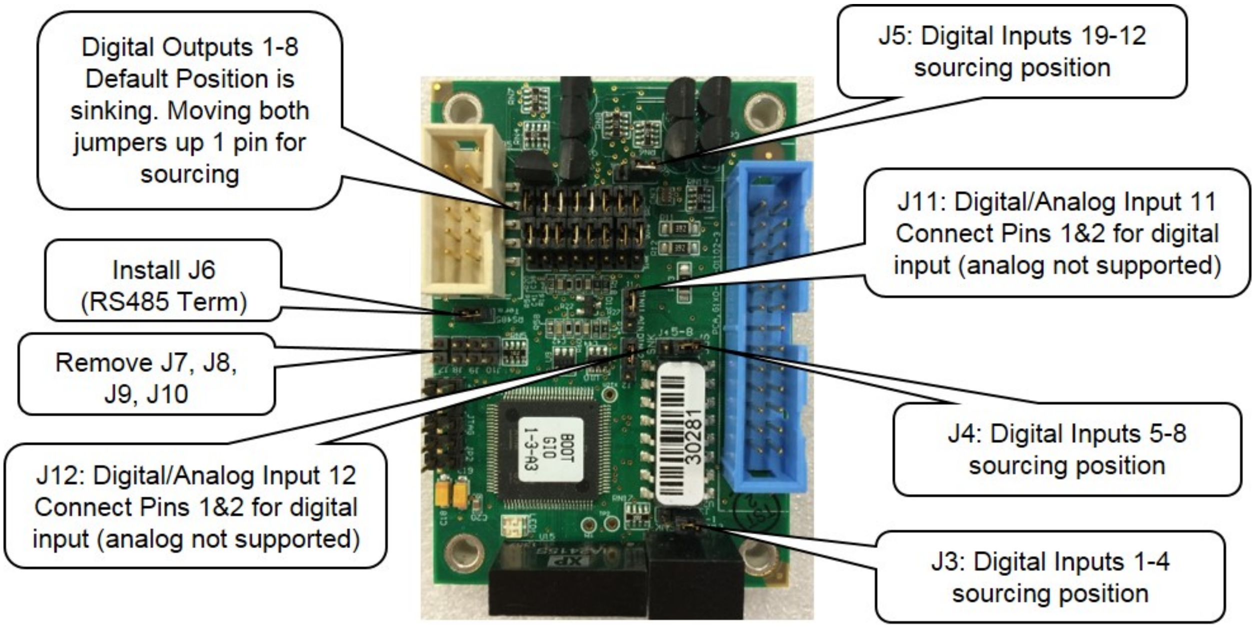
Spare Parts Required:

1. GIO Digital IO Board see “Spare Parts List”

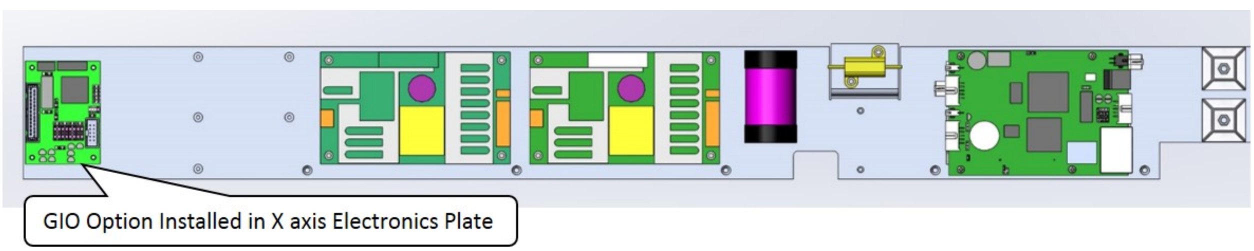
To install the GIO Board in a robot the user must:

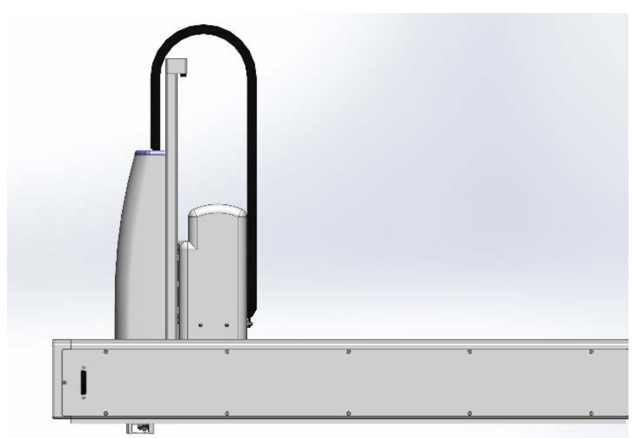
1. Remove the rear cover from the X-axis.
2. Attach the GIO board to the PEM standoffs on the left end of the 10 pin IDC connector towards the controller as shown below.
3. Plug in the 26 pin IDC connector on GIO to 25pin Dsub pigtail harness into the GIO board and attach the 25 pin Dsub connector to the rear cover cutout after removing the blanking panel from the cutout.
4. Fold the 25 pin ribbon cable pigtail into a loop fold between the GIO board and the 25 pin Dsub connector.
5. Plug the RS485 10 conductor ribbon cable pigtail into the GIO board on the electronics plate.
6. **Remove J7, J8, J9, and J10 address jumpers on the GIO board J7-J10, see picture below.**
7. **You must set value 8 in Data ID 151 to the correct value “GIO_8”.** This parameter may be found in Setup/Parameter Database/Controller/System ID.
8. **For example, for an XYZT, with servo gripper robot this ID should read “<Controller Serial No>”, “GSB_1”, “GSB_2”, “GSB_3”, “”,””, “”,” GIO_8”. For other robot configurations, the content of values 2-7 may vary.**
9. When adding the GIO at the controller end of the RS485 daisy chain, you must remove the J6 RS485 termination jumper from the top board of the controller, located next to the RS485 10 pin ribbon cable connector in the controller.
10. GIO signals may then be checked under Control Panels/Remote IO/Network Node 8. Software addresses are described in the RS485 Remote IO Module (GIO) section. Set other jumpers as desired for sourcing and sinking, see below.
11. Attach rear panel.

For this GIO, it is configured as “GIO8” so the 8 outputs will be addressed as 800013-800020 and the 12 inputs will be addressed as 810001-8100012. See jumpers below. Inputs and outputs are 24VDC with outputs limited to 100mA. For pin assignments on the 25 pin Dsub, see “RS485 Remote IO Module (GIO)”.



GIO Board Jumpers, GIO_8





GIO Board Installed

Appendix A: Product Specifications

PrecisePlace 100 Specifications

General Specification	Range
Range of Motion & Resolution	
J1 (X) Axis	635mm or 1270mm for XZ version, 500mm or 1090mm for XYZ version
J2 (Y) Axis	350mm
J3 (Z) Axis	229mm with XZ version or 260mm with XYZ version
J4 (Theta) Axis	+/- 270 degrees
Gripper Travel	76 to 136mm
Spring Gripper Force	2-23 Newtons closing, 2-10 Newtons opening, 7 Newtons power off
Resolution	10 microns typical
Repeatability	+/- 0.100 mm overall in x,y & z directions at 18-22C
Performance and Payload	
Maximum acceleration	10,000mm/sec^2 with 1000gm payload
Maximum speed	1,500 mm/sec with 1000gm payload for XZ, 1,000mm/sec for XYZ typ
Controller	*AVAILABLE GUIDANCE CONTROLLERS*: Guidance 1400D, Guidance 1100T Slave Amp, GIO optional IO Board
Interfaces	
General Communications	RS-232 channel, 100Mb Ethernet
Digital I/O Channels	4 optically isolated 5-24V inputs, 4 optically isolated 24V outputs at 100ma available on facilities panel at end cap. Additional 12 isolated inputs and 8 isolated outputs available as option at back panel. Remote I/O also available.
Pneumatic Lines	One air line, 75 PSI maximum, provided at outer link and routed internally to fittings on the Facilities Panel if Pneumatic Option selected.
Operator Interface	Web based operator interface supports local or remote control via browser connected to embedded web server.
Programming Interface	Three methods available: DIO MotionBlocks (PLC), embedded Guidance Programming Language (standalone), PC controlled over Ethernet using TCP/IP.
Required Power	Dual range: 90 to 132 VAC and 180 to 264 VAC, auto selecting, 50-60 Hz, 365 watts maximum
Weight, XZTG version	22 kg for 635mm travel version, 32 kg for 1270mm version

Appendix B: Environmental Specifications

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

General Specification	Range & Features
Ambient temperature	5ºC to 40ºC
Storage and shipment temperature	-25ºC to +55ºC
Humidity range	5 to 90%, non-condensing
Altitude	Up to 3000m

Appendix C: Spare Parts List

Description	Part Number
Absolute Encoder Battery Assembly, D cell	PF00-EA-00002
X Axis Motor Assembly	PP00-MA-00053
Y Axis Motor Assembly	PP00-MA-00201
Z Motor Assembly	PP00-MA-00051
Theta Motor Assembly	PF03-MA-00001-E3
Gripper Motor Assembly	PF04-MA-00004-E2
X Axis 12mm belt 635mm X travel, for XZ robot	PP00-MC-X0006 1588mm length
X Axis12mm belt 1270mm X travel, for XZ robot	PP00-MC-X0006 2855mm length
X Axis 15mm belt 500mm X travel, for XYZ robot	PP00-MC-X0034-5
X Axis 15mm belt 1090mm X travel, for XYZ robot	PP00-MC-X0034-9
Y Axis belt 350mm travel	PP00-MC-X0006
Z Axis motor belt	PP00-MC-X0028
Z axis output belt, 229mm travel	PP00-MC-X0029
Z axis output belt, 260mm travel	PP00-MC-X0029
Gripper Spring and Cable Assembly	PP00-MA-00055
G1400D Controller	G1XF-EA-D1400
G1100T Slave Controller SE (“GSB3”)	G1X0-EA-T1101
G1100T Slave Controller Diff (“GSB3”)	G1X0-EA-T1101-4D
GIO Digital IO Board with pigtails	GIO1-EA-01104
24 VDC Supply	PS10-EP-00125
48 VDC Motor Supply	PS10-EP-48365
Estop Box	PP10-EA-00022
Pendant	PP10-EA-00013
Harness, Gripper	PP0H-MA-00001
Encoder Wiring PCA	PP1C-EA-00001

Appendix D: Preventive Maintenance

Frequency	Description
Every year	Check belt tension all belts, re-tension if necessary
Every year	Check all joints in “free mode” for low bearing friction
Every three years	Replace all timing belts for high duty cycle applications

Appendix E: Belt Tensions, Gates Tension Meter

In some cases it may be desirable to confirm the belt tension of one of the axes in the robot. However in the case of the long belts it is possible that after a period of operation, the belt may stretch enough that the tension spring pre-load screw may need to be adjusted. The tension can be checked with a Gates Sonic Tension Meter, Model 507C.

To use the tension meter

1. Turn on the power
2. Press the “Mass” button and enter the belt mass from the table below.
3. Press the “Width” button and enter the belt width from the table below.
4. Press the “Span” button and enter the belt free span from the table below.
5. Make sure the actual span of the belt in the robot is set to the value entered for “Span”. For longer belts it is recommended that carriage of the robot be moved so the span does not exceed 500mm or the belt frequency will be so low it will be difficult to get a reading on the tension meter.
6. Press “Select” to record the data.
7. Press “Measure” to take a tension reading.
8. Place the microphone near the belt, typically within 3mm or so. Gently pluck the belt so that it vibrates. The tension meter will calculate the belt tension from the acoustic vibrations and display the tension in Newtons. Compare the tension to the table below. Adjust the belt tension preload screws if necessary.

Belt	*Mass (g/m)*	*Width (mm)*	*Span (mm)*	*Min Tension (N)*	*Max Tension (N)*	*Frequency Min Hz*	*Frequency Max Hz*
X axis	2.8	12	500	100	130	55	62
X axis, XYZ	2.8	15	500	100	130	49	56
Y axis	2.8	12	300	100	130	91	104
Z output	2.8	20	236	100	130	90	102
Z motor	2.8	9	80	50	70	278	329

Revisions

Rev 0, 141101

Rev 1, 150603

1. Updated X axis belt tension instructions for Pilot Design P59
2. Updated X motor replacement P59
3. Added CSA certification P7
4. Added decel info P9
5. Confirmed digital input factory configuration as sinking
6. Updated joint positions at Calibration P53
7. Added cal pin location P54
8. Edited GIO option installation P74
9. Added pictures for gripper harness replacement P74

Rev 1.2, 150630

1. Confirmed theta calibration angle at pin, P53.

Rev 1.4.180317

1. Many changes to reflect change to GSB controllers for Z axis and Theta axis
2. Added detail for XZ configurations
3. Added detail for no gripper configurations
4. Added detail for GIO option on rear cover
5. Added detail for Y axis service

Rev 1.5 180405

1. Updated GIO addresses

Rev 1.6 180416

1. Updated spares parts list

Rev 1.7 180618

1. Updated default IO settings