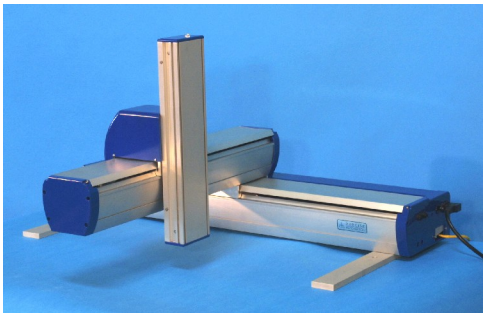
PRECISE AUTOMATION

The PrecisePlace 1300/1400 Robot



Hardware Introduction and Reference Manual

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Precise Automation Inc., 727 Filip Road, Los Altos, California 94024
www.preciseautomation.com

Document Content

Trademarks

Disclaimer

Precise Automation Inc.
727 Filip Road
Los Altos, California 94024
U.S.A.
www.preciseautomation.com

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, will 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 Robot Series includes the PrecisePlace 1300, a three-axis XYZ Cartesian robot, and the PrecisePlace 1400, a four-axis XYZTheta Cartesian Robot. Both robots include an embedded Guidance 3400 four-axis motion controller, a PrecisePower 500 Intelligent Motor Power Supply, and a 24VDC power supply located inside the X-axis of the robot.

The X and Y axes of these robots are available in a number of different lengths with the X ranging from 500 mm to 1 M and the Y from 200 mm to 400 mm. The robots were designed as tabletop units and can carry a payload of up to 3 Kg in the three axis configuration or 2 Kg in the four axis configuration. 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 these characteristics, these robots are ideal for automating applications in the Life Sciences, Medical Products, Semiconductor, and Electronics industries in clean environments.

A number of communications and hardware interfaces are provided with the basic robot. These include an RS-232 serial interface, an Ethernet interface, a number of digital input and output lines, two analog input channels, and a remote front panel interface that provides IEC Category 3 safety signals. In addition, the robot can be purchased with several types of optional Precise peripherals. These include digital cameras, remote I/O, and a remote front panel.

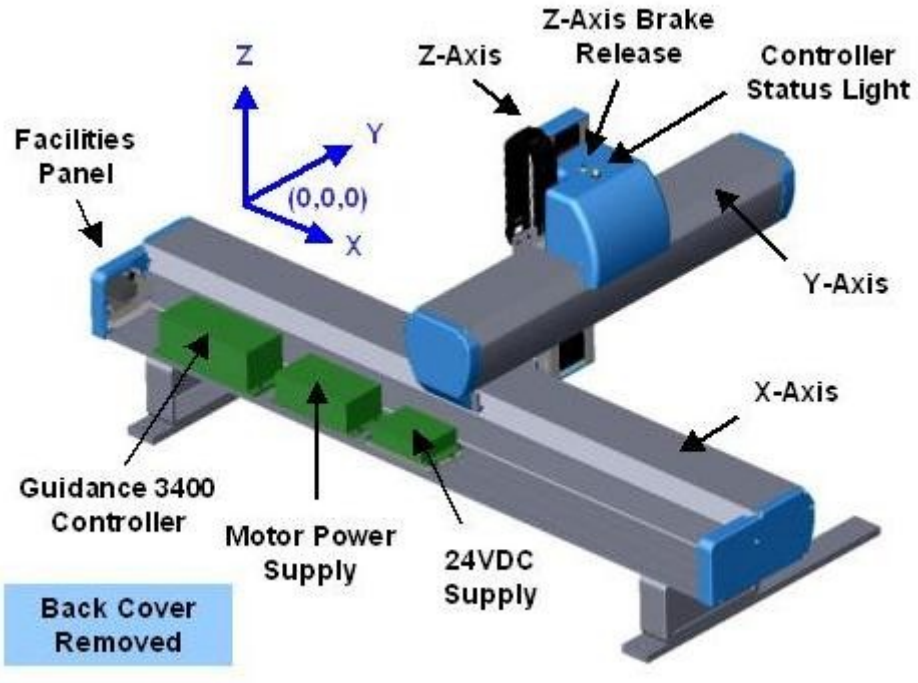
The controller is programmed by means of a PC connected through Ethernet. There are three programming modes: a Digital IO (PLC) mode, an Embedded Language mode, and a PC Control mode. When programmed in the PLC or Embedded Language mode, the PC can be removed after programming is completed and the controller will operate standalone. A PC is required for operation in the PC Control 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.

The optional machine vision system, “PreciseVision”, can execute either in a PC connected through Ethernet, or for less demanding applications, in the motion controller processor. PreciseVision requires cameras connected by means of Ethernet, which permits any processor on the network to obtain and process information from any camera on the network, and allows PreciseVision to provide the results to any networked motion controller.

System Diagram and Coordinate Systems

The major elements of the three axes PrecisePlace robot and the orientation and origin of its World Cartesian coordinate system are shown in the diagram below.



The first axis of the robot moves in the World X direction and provides the mounting points for the robot. The primary electronic components are contained beneath the back cover for the X-axis. This includes the Guidance 3400 controller, the PrecisePower 500 Intelligent Motor Power Supply and the 24 VDC logic power supply. The Guidance controller not only controls the robot but also provides extensive hardware interfaces including Ethernet and digital and analog IO.

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24VDC power supply are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **AC power to the robot must be disconnected prior to removal of the rear cover.**

When the X-carriage (and the Y-axis mounted to it) is closest to the Facilities Panel, the X-axis is approximately at its 0 position and at X=0 in the World coordinate system. As the X-carriage moves away from the Facilities Panel (to the right in the drawing above), both its joint position and the World X coordinate increase in value.

The second axis moves the tool of the robot along the Y-axis. When the Y-carriage (and the Z-axis mounted to it) is closest to the X-axis, the Y-axis is approximately at its 0 position and at Y=0 in the World coordinate system. As the Y-carriage moves away from the X-axis, both its joint position and the World Y coordinate increase in value.

The final linear axis moves the tool up and down in the Z direction. When the Z-axis is elevated as high as possible, it is approximately at its 0 position and at Z=0 in the World coordinate system. However, when this axis moves down, while its joint position increases in value, its World Z coordinate becomes more negative in value.

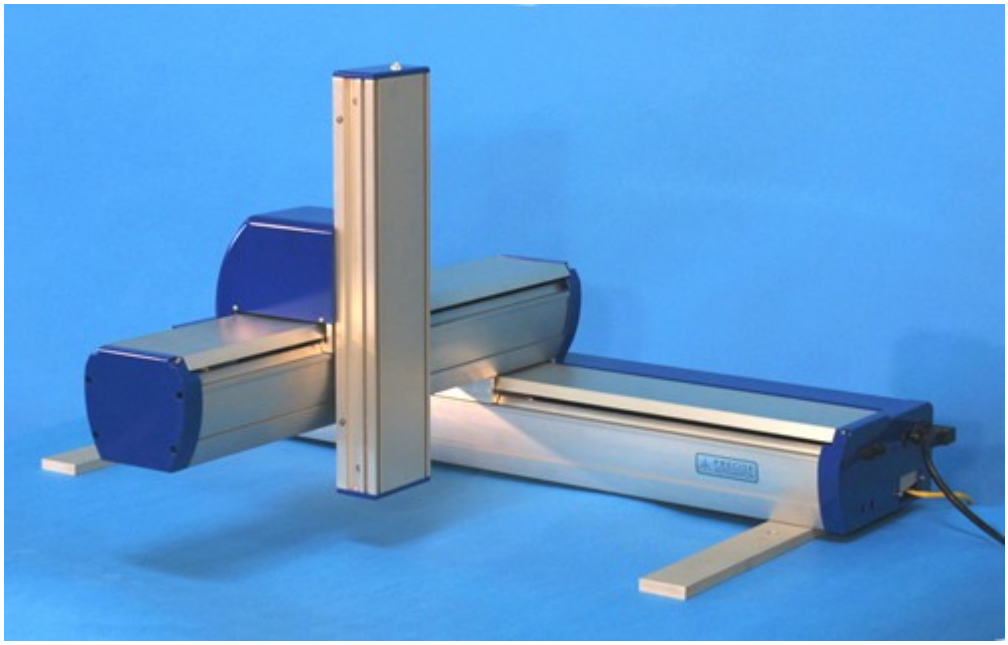
The Z-axis carriage (the section connected to the Y-axis) includes an IO board that provides electrical and air services for both a 4th axis and end-of-arm tooling. A yellow lamp is mounted at the top of the Z-axis carriage cover and blinks at a rate of once per second to indicate that the controller 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 on the top of the Z-axis carriage 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 work, 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

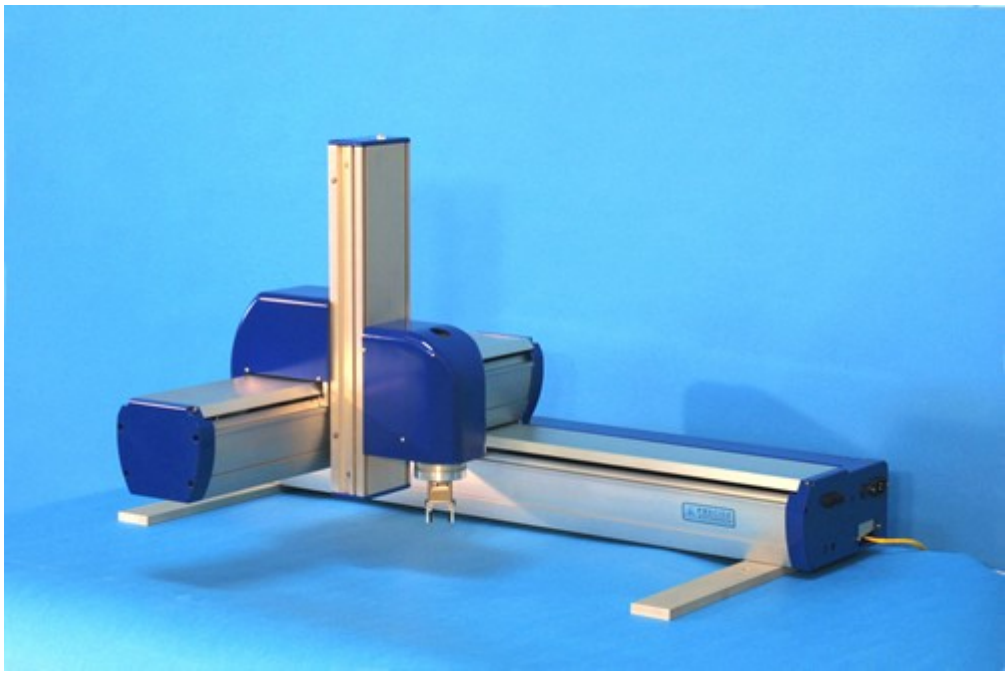
PrecisePlace 1300/1400 Robots

The PrecisePlace 1300 Robot (pictured below) is a 3-axis robot composed of an X-axis, with a stroke ranging from a minimum of 500 mm to a maximum of 1 M, a Y-axis with a stroke ranging from a minimum of 200 mm to a maximum of 400 mm, and a Z-axis with a stroke of 200mm. The Z-axis carriage contains a PCB (Z Axis IO PCB) with connectors for driving a fourth motor/brake/encoder, connectors to route digital IO signals back to the controller, and an Ethernet connector that is routed back to the controller.



The PrecisePlace 1400 Robot (pictured below) is a 4-axis robot that is constructed by adding an optional Theta axis to the PrecisePlace 1300 Robot. The theta axis has a range-of-travel of +/- 270 degrees. The

theta axis is utilized in applications where the Z angle of parts is not fixed and objects must be re-oriented as they are being handled.



Mounting Plates and Risers

Several mounting plates are optionally available with the PrecisePlace Series Robots. The Standard Mounting Plate can support the overhanging load of the robot without the need to bolt the robot to a table or other structure. The Short Mounting Plate extends just far enough to bolt down the robot.

In addition to the mounting plates, 100mm, 150mm and 200mm risers are available to elevate the robot.

Theta Axis

An optional Theta Axis may be purchased and attached to the Z-axis. The Theta Axis may be installed at the factory or in the field. This axis has +/- 270 degrees of rotation.

The Theta Axis has a 20 mm through hole (pictured below) that allows a camera mounted above on the Z-axis to view the tool tip. Alternately, cables can be routed through the hole in the cover and the axis to tooling and instrumentation attached to the Theta Axis.

Guidance 3400 Controller

The Guidance 3400 Controller is a four-axis general purpose motion controller that contains four motor drives and up to eight encoder inputs. It must be attached to a heat sink. In the PrecisePlace robots, the heat sink is provided by the X-axis extrusion. The controller includes local digital and analog IO. It also supports RS232 serial communication and an optional Precise Remote IO module. It contains one or more Ethernet ports. The controller and power supplies are shown below, from left to right: the Guidance 3400 controller, the 500 watt PrecisePower Intelligent Motor Power Supply, and the 125 watt 24VDC power supply.

For detailed information on the controller including interfacing information, please see the *"Guidance Controller Hardware Introduction and Reference Manual"*.

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24VDC power supply are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **AC power to the robot must be disconnected prior to removal of the rear cover.**

Low Voltage Power Supply

The Guidance 3400 requires 0.7 amps of 24 VDC for local power and 2 amps for IO power for a total of 2.7 amps. For applications using remote IO or Ethernet cameras, Precise recommends a total of 4 amps. This power is obtained from a 24 VDC power supply included with the robot.

The PrecisePlace Robots have an integrated 125-watt, 24 VDC Power Supply, Mean Well P/N PPS-125-24 that accepts a range of AC input from 90V to 264V. This power supply is shown mounted to the integrated X-axis heat sink in the "Guidance 3400 Controller" section of this document.

DANGER: In addition to exposed high voltage pins and components, **the heat sinks on the 24VDC Power Supply are not grounded and expose high voltage levels.** AC power to the robot must be disconnected prior to accessing this unit.

Intelligent Motor Power Supply

The Guidance 3400 controller can accept motor power from 24 VDC to 320 VDC. The PrecisePlace robots include a 500-watt PrecisePower Intelligent Motor Power Supply. This device is auto-ranging with dual input ranges of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz with a 320 VDC nominal output,

This intelligent power supply contains: a single relay for enabling and disabling motor power when commanded by the controller, built-in fuses, large value output filter capacitors to store deceleration energy for use when power is needed, and the ability to absorb line spikes.

This PrecisePower unit is shown mounted to the integrated X-axis heat sink in the "Guidance 3400 Controller" section of this document.

DANGER: The PrecisePower Intelligent Motor Power Supply is an open frame electrical device that has exposed unshielded high voltage pins, components and surfaces. In addition, the power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **AC power to the robot must be disconnected prior to accessing this unit.**

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. Either of these units can be plugged directly into the Remote Front Panel connector mounted on the robot's Facilities Panel. (The Facilities Panel is on the end of the X-axis.) Each of these units provides the hardware signals to permit power to be enabled and disabled.

In the future, Precise plans to offer a remote front panel that will contain a high power enable button, an auto/manual keyed selector switch, an E-Stop button, and a back panel connector for user E-Stops and interlocks.

NOTE: To enable motor power without an E-Stop Box, Hardware Manual Control Pendant or remote front panel, the jumper plug supplied with the system (pictured below) must be installed in the 25-pin Remote Front Panel connector.

For additional information on the signals provided on the Remote Front Panel connector, please see the Hardware Reference section of this manual.

Remote IO Module

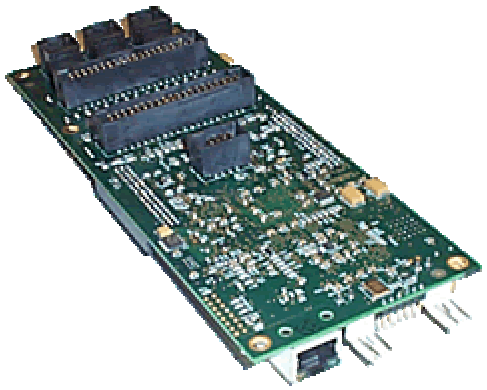
For applications that require additional IO capability beyond the standard functions provided with every PrecisePlace robot, a Precise Remote IO (RIO) module may be purchased. The RIO interfaces to any

PrecisePlace 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. In addition, expansion boards will soon be offered that cost effectively add additional isolated digital inputs and outputs in groups of 32 each to the basic RIO.

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 3000 Series controllers support the PreciseVision machine vision system. This is a vision software package than can run either on a PC for higher performance applications, or in the motion controller processor for simple applications (future development).

Cameras must be connected via Ethernet. Vendors such as DALSA already offer a variety of Ethernet machine vision cameras. In addition, vendors such as Pleora offer RS 170 to Ethernet converter boxes (iPORT PT-1000 ANL1/2/E) that allow a large variety of standard cameras to be connected to the Guidance network.

Machine Safety

Voltage and Power Considerations

The Guidance 3400 requires two DC power supplies, a 24 VDC power supply for the processor and user IO, and a separate motor power supply. The motor power supply must provide a voltage to the controller

between 24 VDC and 320 VDC. For the PrecisePlace robots, the PrecisePower Intelligent Motor Power Supply delivers 320 VDC to the controller although the motors will operate correctly at 160 VDC as well.

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24 VDC power supply 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. In the PrecisePlace robots, these units are mounted beneath the robot's back cover.

The PrecisePlace robots include a 500-watt auto-ranging PrecisePower Intelligent Motor Power Supply with a dual input range of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz and a 320 VDC output. This motor power supply contains a relay for enabling and disabling motor power from the controller.

The PrecisePower Intelligent Motor Power Supply limits inrush current to 6 Amps. It is protected against voltage surge to 2000 volts by means of MOV's at the line input. Transient over voltage (< 50 µs) may not exceed 2000 V phase to ground, as per EN61800-31996. It is protected against over current by two 6.3 amp, 250V time lag fuses, Wickman PN 1811630000.

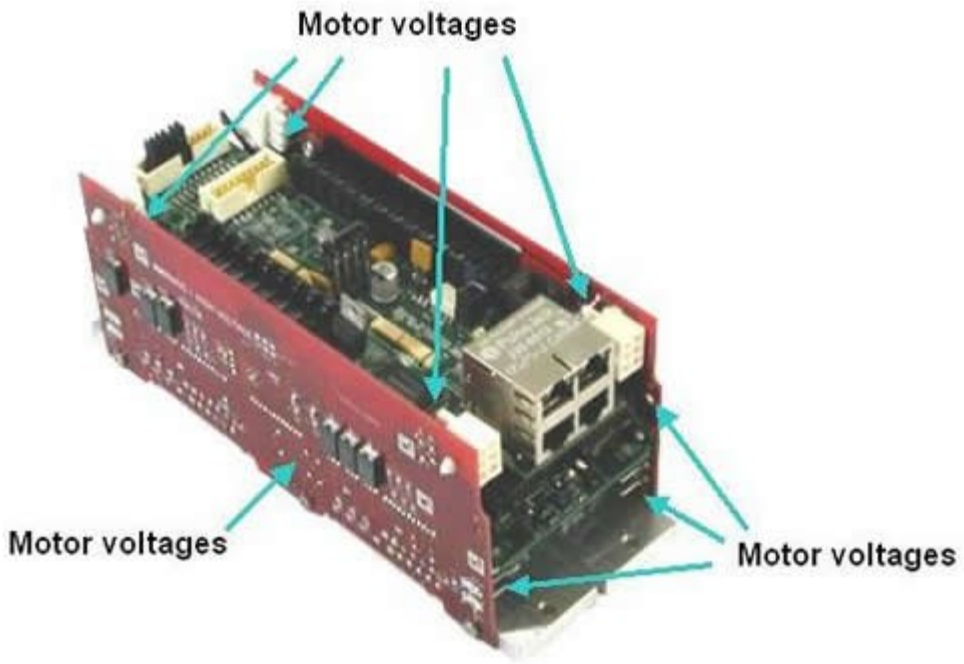
The Precise controller can monitor motor power through its datalogging function. Intermittent power dropouts can be detected by setting a trigger in the data logger which can record and time-stamp power fluctuations.

Robot Back Cover

In the PrecisePlace robots, the Guidance 3400 and its power supplies are mounted in the X extrusion under a cover that should be in place whenever power is applied to the robot.

DANGER: The PrecisePower Intelligent Motor Power Supply is an open frame supply that provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. The 24VDC power supply is also an open frame supply with high voltages terminals and heat sink surfaces exposed when the robot cover is removed. **The robot should not be operated without the back cover in place.**

DANGER: The surfaces, connectors, and leads pictured in Red below indicate exposed elements of the Guidance 3400 controller that carry motor power signals. These signals levels are 340 VDC.



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 the American National Standard for Industrial Robot Systems – Safety Requirements, published by the Robotic Industries Association (RIA) in cooperation with the American National Standards Institute. The publication, ANSI/RIA R15.06, 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, and ISO 10218 (EN 775), Manipulating Industrial Robots – Safety, particularly if the country of use requires a CE-certified installation.

Standards Compliance and Agency Certifications

The PrecisePlace 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:

EN 61000-4-2 Electrostatic Discharge (8KV air, 6KV contact)
EN 61000-4-3 Radiated Electromagnetic Field Immunity (3V/m, 27-500MHz)
EN 61000-4-4 Electrical Fast Transient/Burst Immunity (2KV)
EN 61000-4-5 Surge Immunity Test (1KV differential, 2KV common mode)

EN 61000-4-6 Conducted Disturbances Immunity (RF: 150KHz – 80MHz)
EN 50081-2 Electromagnetic Compatibility General Emissions Standard

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.

In addition to the above standards, the Guidance 3400 has been designed to comply with the following agency certification requirements (certification of compliance with these standards is currently in process):

TUV
UL
CSA
ANSI/RIA R15.06 Safety Standard

Moving Machine Safety

The PrecisePlace 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 is a light-duty robot that can only apply approximately 100 Newtons of force, it is very important for operators to keep their hands, arms and especially their head out of the robot's operating volume.

In Computer Mode the robot can move at speeds up to 2000mm per second. During Computer Mode Operation it is strongly recommended that operators be prevented from entering the robot work volume by safety barriers that are interlocked to the E-stop circuitry. Please refer to the ANSI/RIA R15.06 Safety Standard for Industrial Robots for information on recommended safe operating practices and enclosure design for robots of various sizes and payloads.

Installation Information

Environmental Specifications

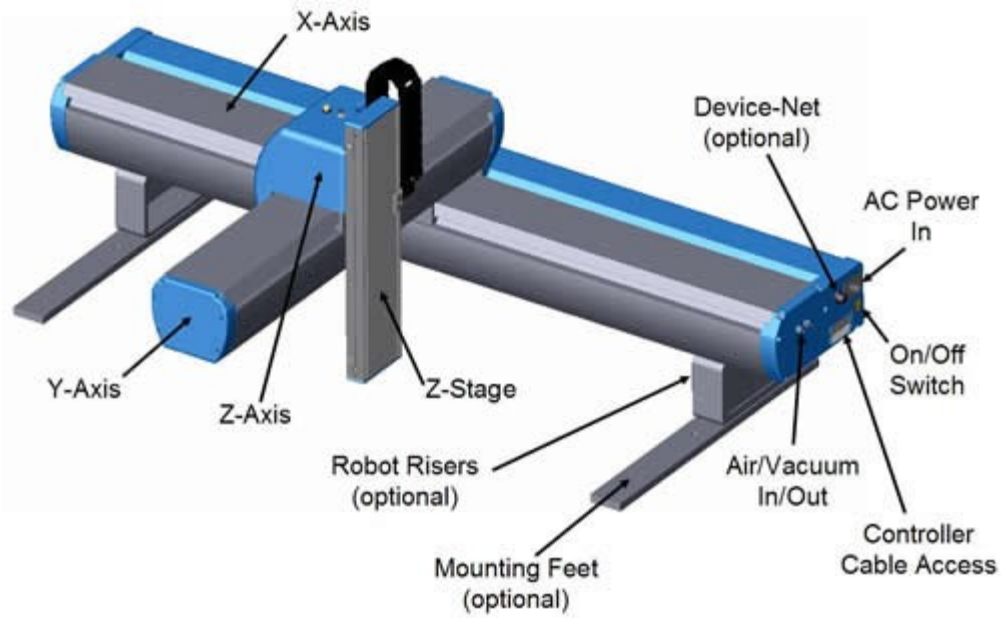
The PrecisePlace robots must be installed in a clean, non-condensing environment with the following specifications:

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

Facilities Connections

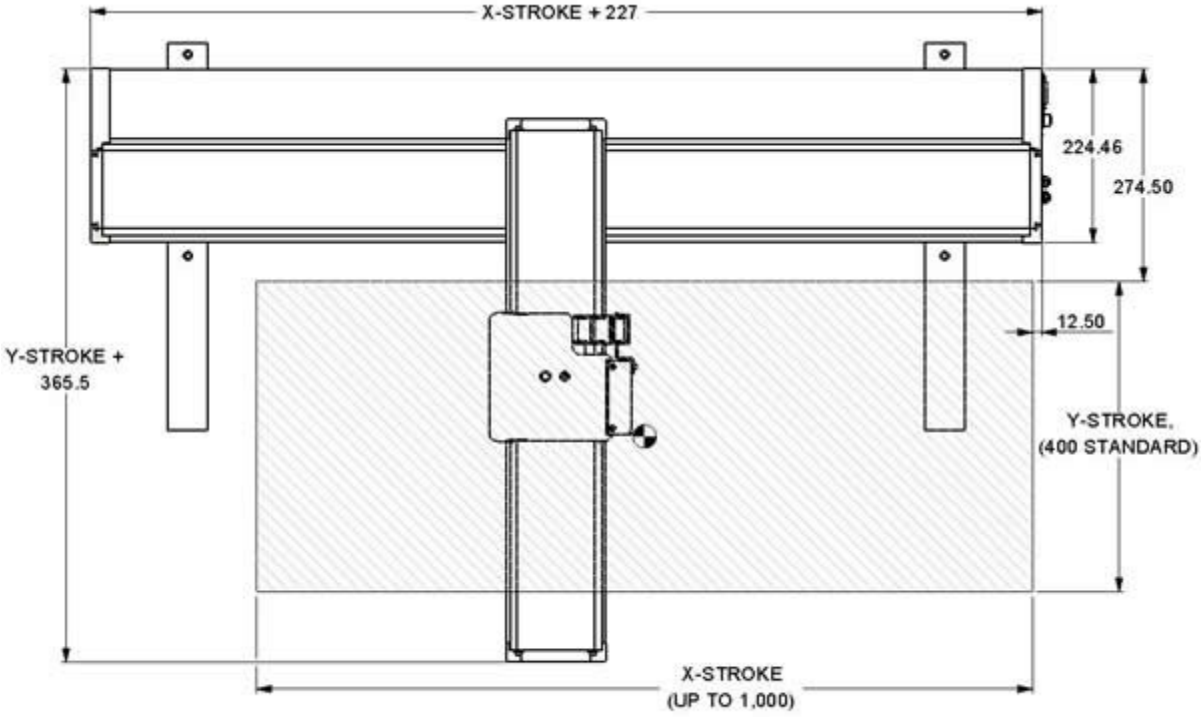
The right end cap of the X-Axis extrusion includes the following:

- System power receptacle and lighted power switch
- Two 4mm OD pneumatic tubing fittings (one-touch type tube insertion)
- Cable access opening

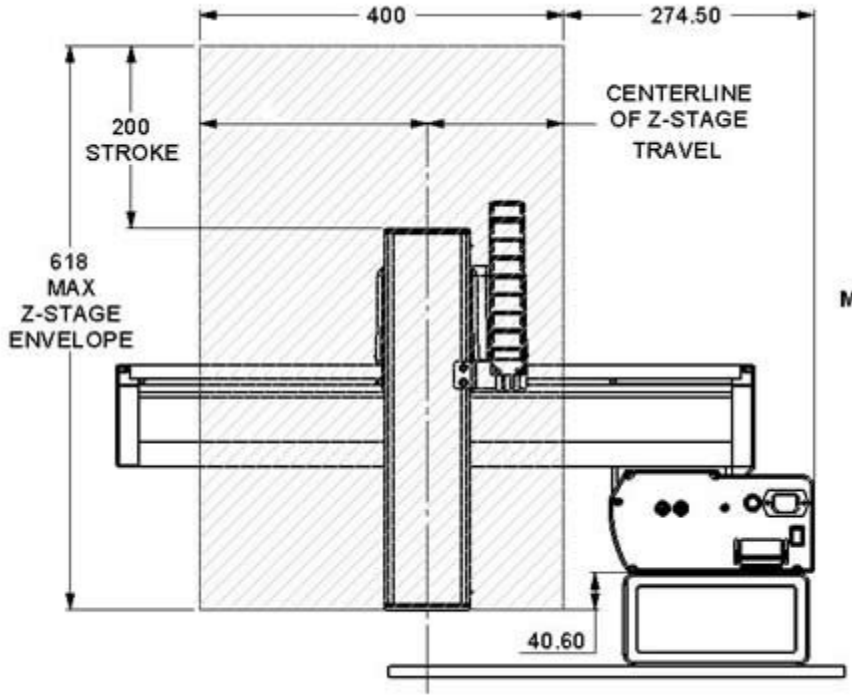


System Dimensions

Both top and right views are shown below. All dimensions are in millimeters.



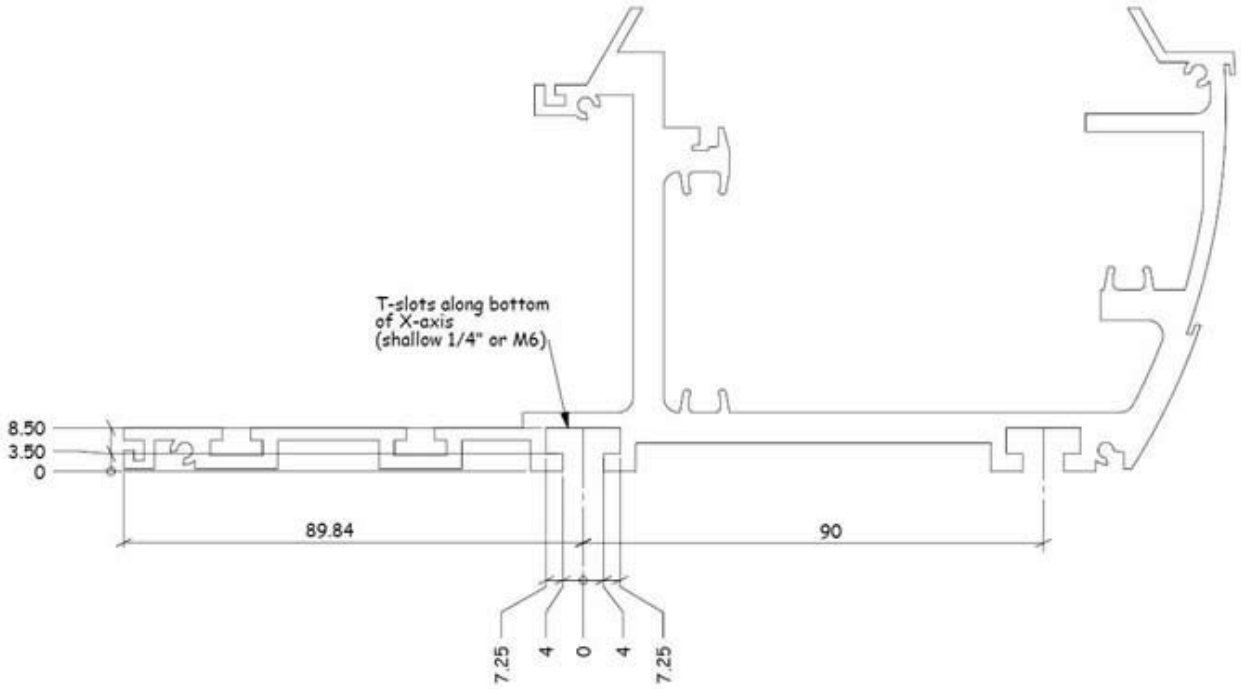
MOTION ENVELOPE, X & Y AXIS
(TOP VIEW)



MOTION ENVELOPE, Z-AXIS
(RIGHT SIDE VIEW)

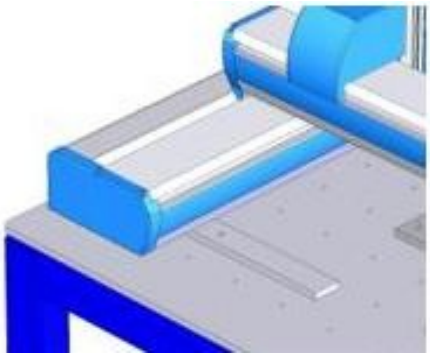
Mounting Instructions

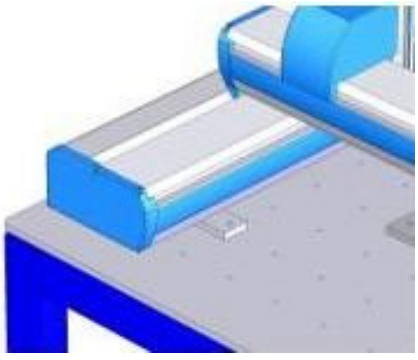
PrecisePlace robots must be attached to a rigid surface that can withstand lateral forces of 100 Newtons without moving or vibrating. The robot is supplied with 4-6 ¼-20 T nuts installed in the X extrusion for mounting. Additional T nuts can be purchased from McMaster Carr, PN 94750A588. A 6mm thread equivalent is MMC PN 90974A111. The center distance between these T nuts is 90mm. They may be slid in the extrusion to adjust the mounting positions along the X-axis. It is recommended that there be a mounting support at least every 300mm under the robot. The dimensions and locations of the mounting slots on the X extrusion are shown below.

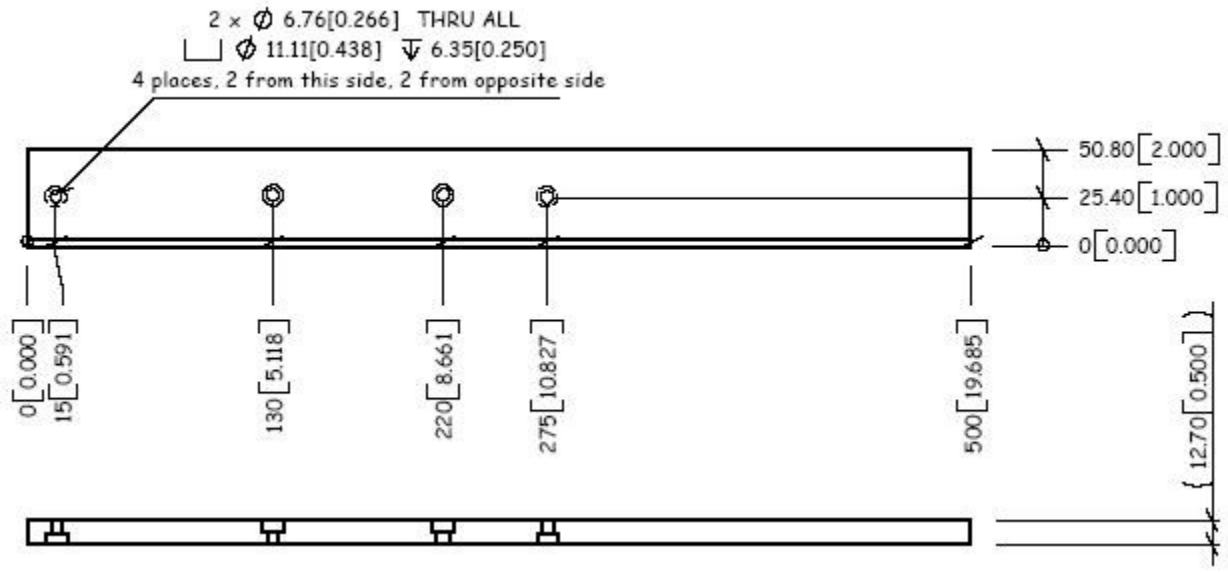


Optional mounting plates are available in a Short version for bolting down to a surface, and in a Standard version for supporting the robot so that it does not tip over when placed on a flat surface. These plates attach to the bottom of the robot with 2 ¼-20 by 0.5in Socket Head Cap Screws. The mounting plates have additional holes for ¼-20 SHCS on 260mm centers for bolting to a work surface. The robot may also be mounted on risers or brackets that can be attached to the X extrusion by means of T nuts.

Illustrations of these plates are shown below followed by a detailed drawing of the Standard plate.

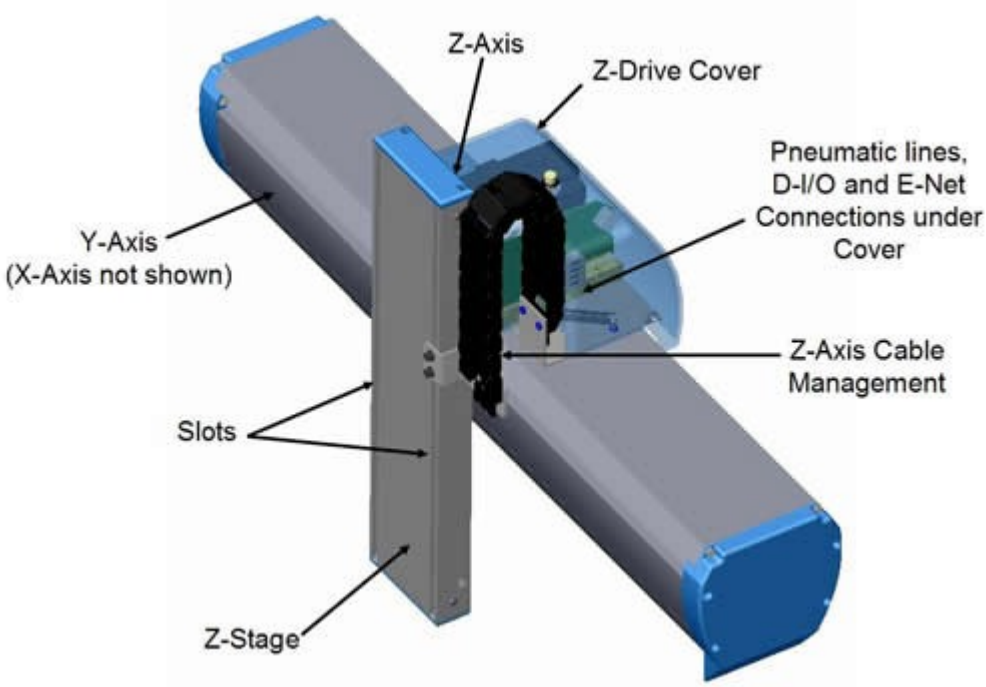




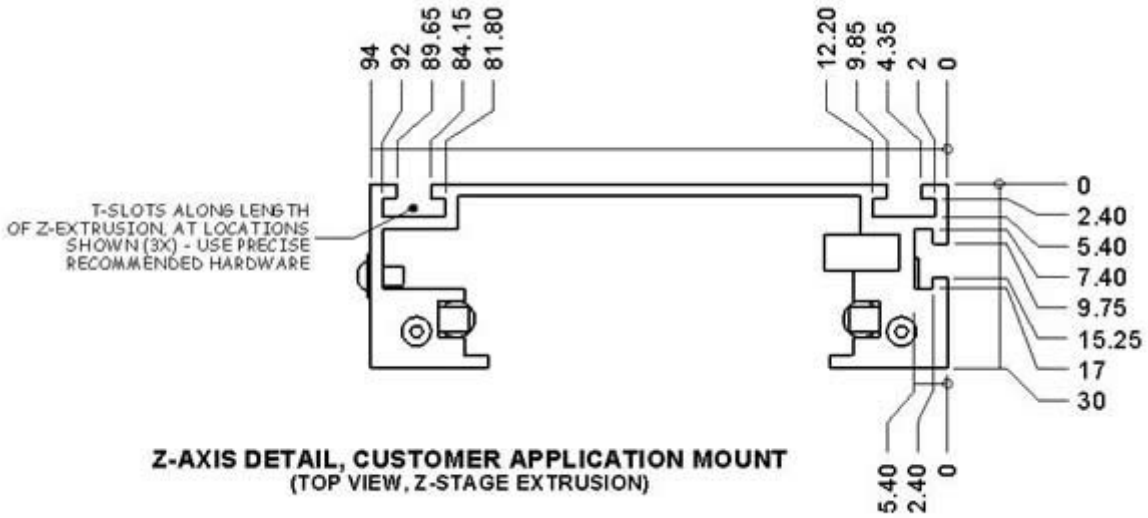


Tool Mounting - PP1300

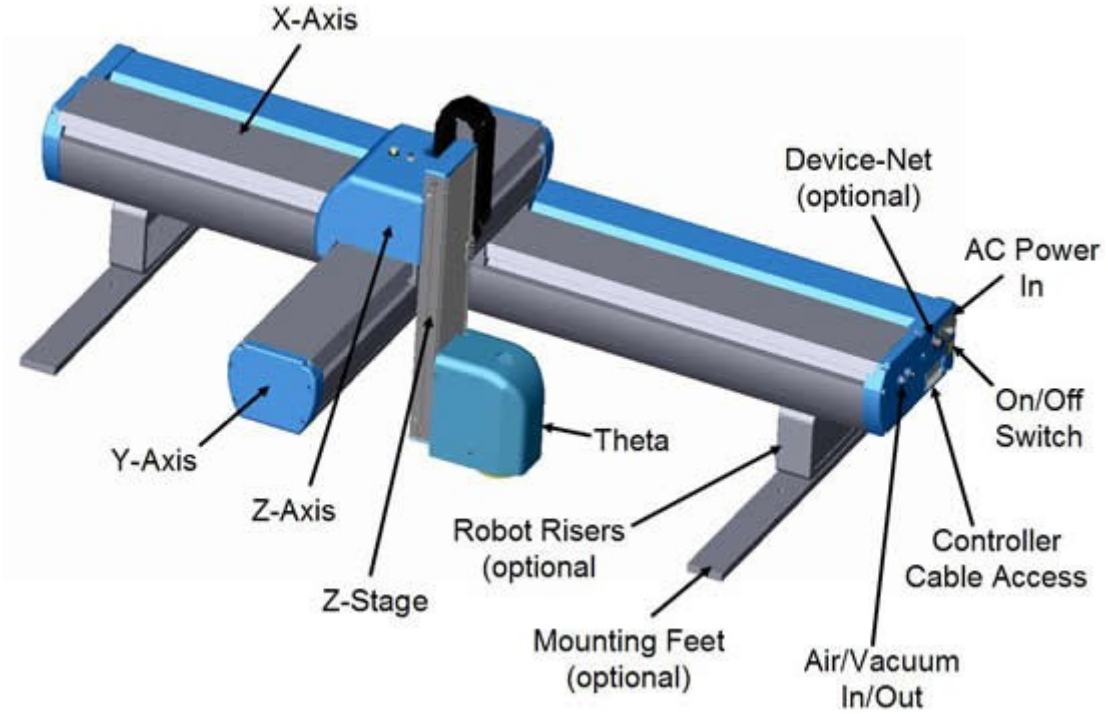
The PrecisePlace 1300 Z-Axis has been designed to mount user tooling. The face of the Z-Axis has two slots that can be used to mount the optional Theta Axis, syringe operators, grippers, cameras, or other user items. A third slot is available on the front edge of this axis. Precise supplies 4 M4 nuts in these slots. A commercial M4 nut is the Misumi HNTTBS5-4. User digital I/O signals are available on a "Z-Axis IO PCB" that is located under the Z-axis motor cover (this is described in a later section). Pneumatic connections (4mm OD, 75 PSI maximum) are located on the Y carriage and mated to internal air lines that are routed through the robot and exit at pneumatic fittings on the X-Axis right end cap.



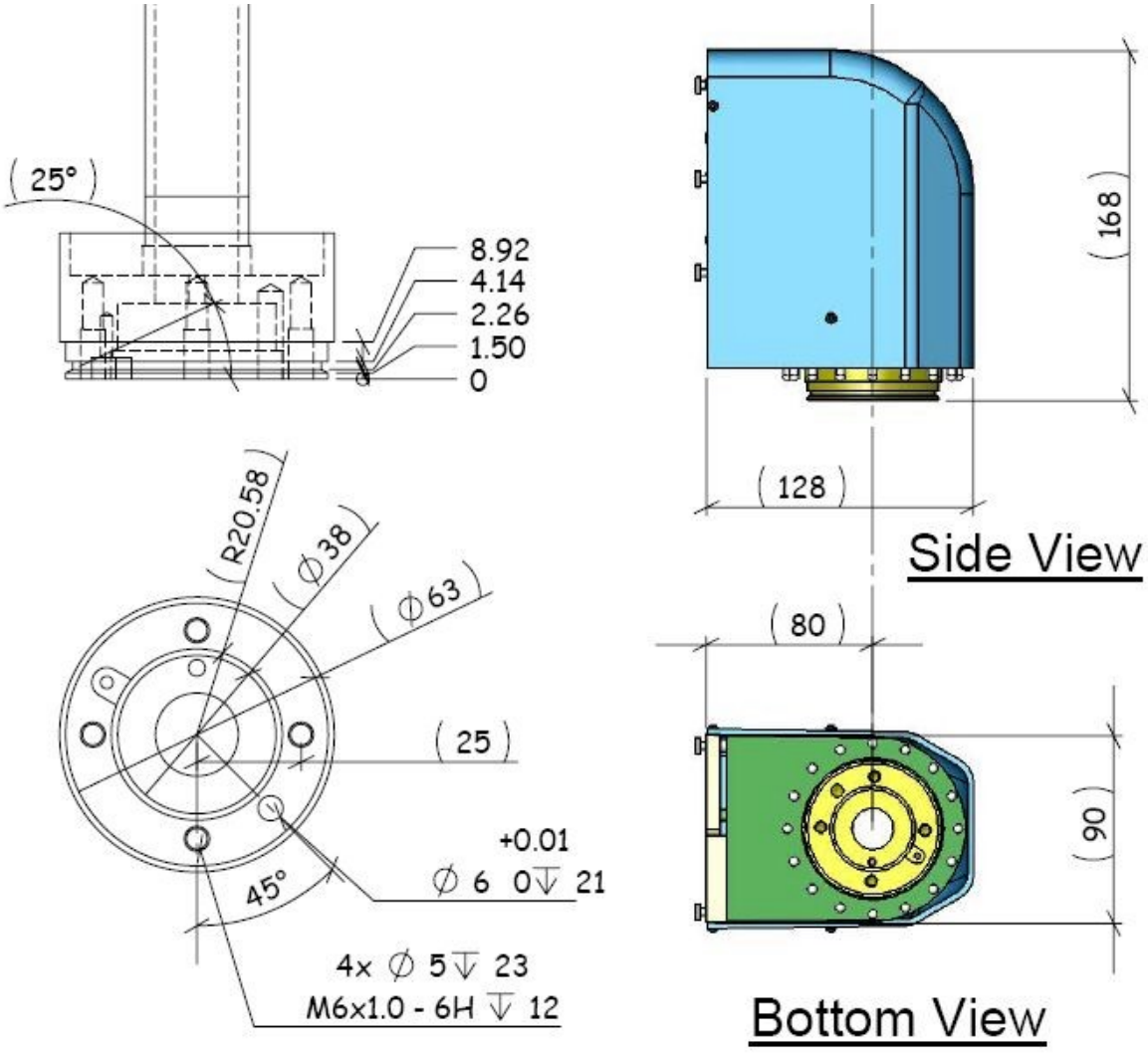
Shown below are the details of the mounting slots of the Z-Axis.



Tool Mounting - PP1400



The Theta Axis that is a component of the PrecisePlace 1400 is shown mounted on the Z-Axis using the T-slots. The dimensions of the overall Theta assembly and its tooling flange are shown below.

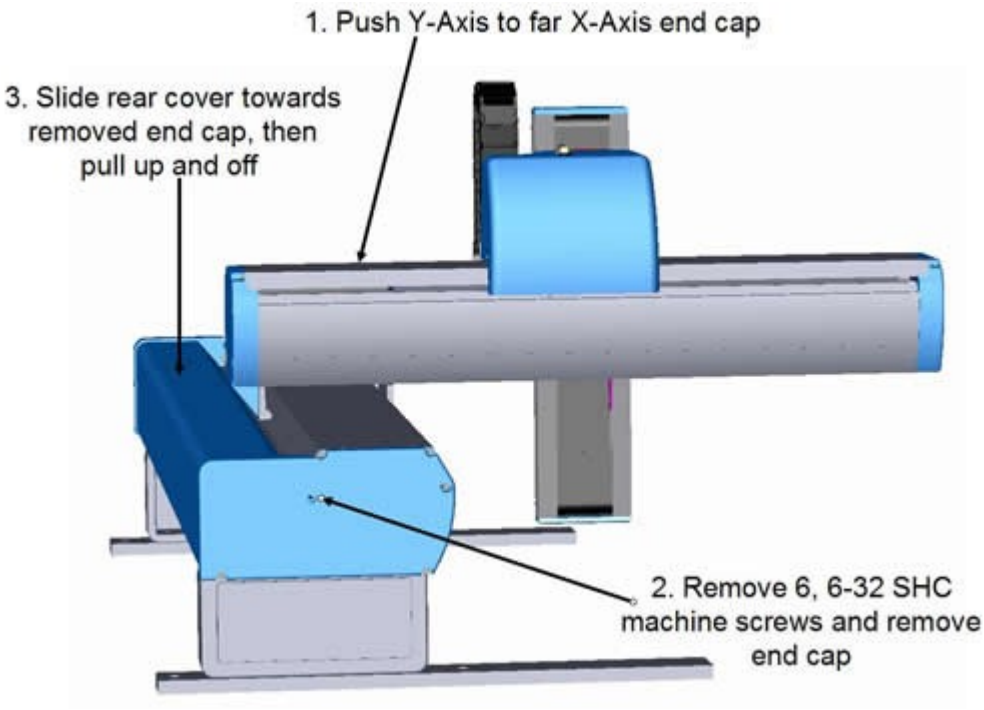


Accessing the Controller and Power Supplies

In order to interface the controller to a PC and other equipment in the work cell and to access the power supplies, you must remove the rear cover of the robot.

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24VDC power supply are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **AC power to the robot must be disconnected prior to removal of the rear cover.**

For safety purposes, removal of the cover requires detachment of the plain end cap of the robot that is opposite the end cap in which the connectors are mounted (see below). This end cap is secured with 6-32 Socket Head Cap screws. Push the Y axis all the way to its end of travel near the connector end cap. Once the plain end cap is removed the back cover may be slid a few inches to clear the Y-axis end cap and then pulled upwards to remove the engagement from the slot in the extrusion.



Once the rear cover is removed, all of the connectors on the top surface of the controller, which are utilized for interfacing to external equipment, and the power supplies will be exposed. Please note that if you only need to connect the Ethernet port of the controller to a PC, this can be accomplished without removing the back cover. The robot is shipped with a ten foot Ethernet cable that is already plugged into the appropriate Ethernet connector of the controller and this cable is ready to be connected to a PC.

Please see the *"Guidance 3x00 Controller, Hardware Introduction and Reference Manual"* for detailed information on interfacing to the controller using the various input and output ports such as those for digital and analog 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.

Prior to replacing the back cover of the robot, please read the remaining sections on installing the robot since they also require access to the components mounted below the back cover.

Power Requirements

The PrecisePlace 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 does not exceed 500 watts RMS.

Normally, the robot is factory configured to operate its motors at 320 VDC, which can be automatically generated from the dual AC input ranges. However, the robot's motors can be operated at 160 VDC and the PrecisePower 500 Intelligent Motor Power Supply can be specially strapped to supply this voltage if necessary.

At the right end of the PrecisePower Intelligent Motor Power Supply, there are three sets of jumper pins labeled "90-132V", "Auto", and "180-264V". A jumper must be placed across one of these sets of pins to select the power supply operating mode. The power supply includes a voltage doubling circuit. This circuit is activated when the jumper is placed across the "90-132V" pins, disabled when the "180-264V" jumper is installed, and automatically activated when a jumper is placed across the "Auto" mode pins. The output voltage range for each jumper is illustrated in the following table. The PrecisePower unit is normally shipped with the jumper on the "Auto" setting to allow the robot to operate worldwide with the factory setting.

AC input	90-132V Jumper	Auto Jumper	180-264V Jumper
90 to 132 VAC	253-372 VDC	253-372 VDC	127-186 VDC
180 to 264 VAC	Invalid setting	253-372 VDC	253-372 VDC

Emergency Stop

It is often desirable 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 Remote Front Panel 25-pin DSub connector that is mounted on the X-axis Facilities Panel. Please see the Hardware Reference section of this manual for detailed information on the Remote Front Panel signals.

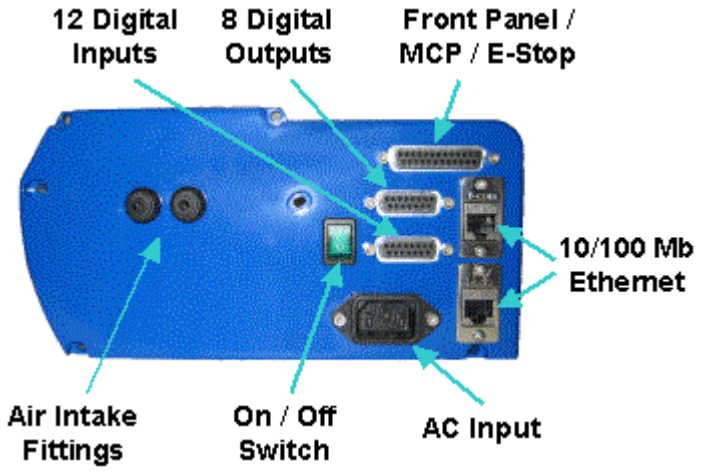
In addition, Precise sells an emergency stop button in a plastic enclosure. This E-Stop Box comes with a cable and connector that directly plugs into the Remote Front Panel connector. Alternately, you can also purchase a Precise Manual Control Pendant. The Pendant has an integrated E-Stop button and provides a convenient means for manually jogging the robot via a portable hand-held device.

Hardware Reference

X-Axis Facilities Panel

Facilities Panel

The right end-cap of the X-axis is the robot's Facilities Panel. This contains plugs and connectors for AC power, pneumatic air lines and electrical interfaces.



The AC input connector is an IEC power cord connector that mates with standard cables that can provide a wide variety of AC power plugs. The supported input voltage ranges are 90 to 132 VAC and 180 to 264 VAC, auto selecting, and the permitted input frequency is 50-60 Hz. The AC power to the robot is controlled by a green backlit On/Off Switch.

To simplify interfacing, most of the electrical interfaces provided by the robot's embedded Guidance Controller are available on the Facilities Panel. These include:

-
- Digital input signals
- Digital output signals
- Dual 10/100 Ethernet ports
- Remote Front Panel

Each of these interfaces are described in detail in the following sections. In addition, the controller that is mounted under the X-axis cover may contain additional interfaces (e.g. serial communication and analog inputs). Please refer to the *Guidance Controller, Hardware Introduction and Reference Manual* for additional information.

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24 VDC power supply are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **The main AC power should always be disconnected before the back cover of the X-axis is removed.**

As a convenience for pneumatically powered user tooling, two air lines are routed through the interior of the robot. At the Facilities Panel, these are presented as two fittings. The other end of these lines exit at the Z-axis E-Chain. When using these lines, clean, dry external air should be provided.

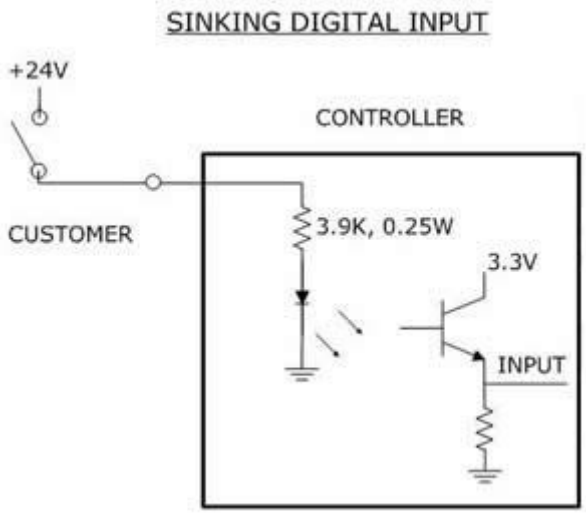
CAUTION: The maximum air pressure that can be conveyed by the air lines through the robot is **75 PSI**. Applying a pressure exceeding this level may disconnect interior connections or damage fittings or hoses. If a higher pressure is required, an external air line should be utilized.

Digital Input Signals

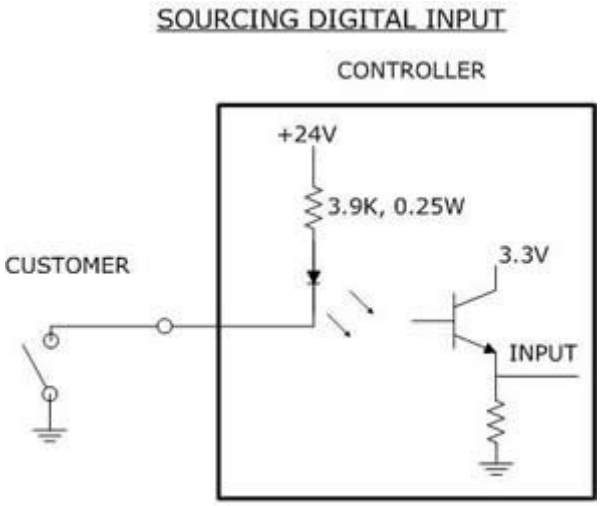
The PrecisePlace robot provides 12 general purpose optically isolated digital input signals at the Facilities Panel (in addition to those signals that are available at the Z-Axis IO Board). These lines are accessed in a single DB15 connector.

DB15 Female

These 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.



As shipped from the factory, the input signals are configured as "sourcing", i.e. the external equipment must pull a signal input pin to ground to indicate a logical high and must let the line float high to 24VDC to signal a logical low value.



Inputs can be configured as sinking or sourcing in groups of 4 signals. To configure groups of input signals, the X-axis cover of the robot must be removed and jumpers on the Guidance Controller must be changed. For more information on configuring the jumpers, please see the *Guidance Controller, Hardware Introduction and Reference Manual.*

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24 VDC power supply are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **The main AC power should always be disconnected before the back cover of the X-axis is removed.**

The pin out for the Digital Input Connector is described in the following table.

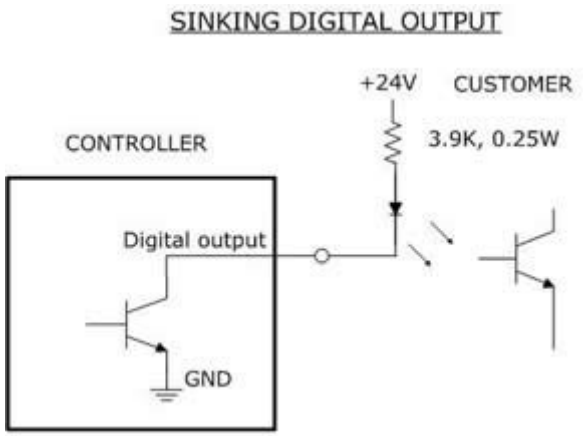
Pin	Description
1	GND
2	Digital Input 2
3	Digital Input 4
4	Digital Input 6
5	Digital Input 8
6	Digital Input 10
7	Digital Input 12
8	GND
9	Digital Input 1
10	Digital Input 3
11	Digital Input 5
12	Digital Input 7
13	Digital Input 9
14	Digital Input 11
15	24 VDC
Interface Panel Connector Part No	DB15 Female Connector
User Plug Part No	DB15 Male Plug

Digital Output Signals

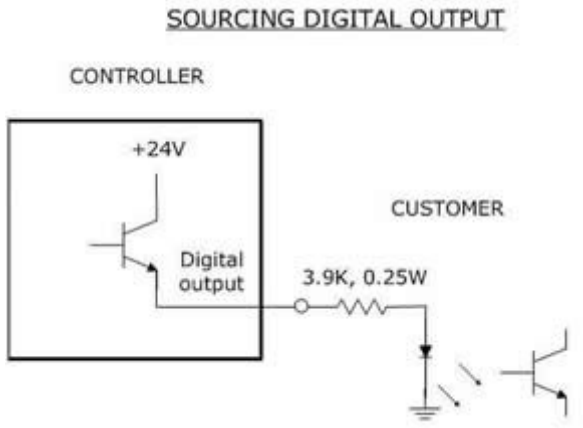
The PrecisePlace robot provides 8 general purpose optically isolated digital output signals at the Facilities Panel (in addition to those signals that are available at the Z-Axis IO Board). These lines are accessed in a single DB15 connector.

DB15 Female

These output signals can be configured as "sinking" or "sourcing". ***As shipped from the factory, the output signals are configured as "sinking"***, i.e. the external equipment must provide a 5VDC to 24VDC pull up 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. To configure the output signals, the X-axis cover of the robot must be removed and jumpers on the Guidance Controller must be changed. For more information on configuring the jumpers, please see the *Guidance Controller, Hardware Introduction and Reference Manual.*

DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24 VDC power supply are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 340VDC volts and takes about 2 minutes to bleed down after power is disconnected. **The main AC power should always be disconnected before the back cover of the X-axis is removed.**

The pin out for the Digital Output Connector is described in the following table.

Pin	Description
1	Digital Output 1 - This output signal can drive 500mA of current whereas Outputs 2-8 can only drive 100mA. Due

	to this higher drive level, even when this output is off, a small amount of current leaks. This leakage can cause some devices that are connected to this signal to always indicate that this output is on. If this occurs, a small drainage resistor should be tied to this signal.
2	Digital Output 3
3	24 VDC
4	Digital Output 5
5	Digital Output 7
6	Not used
7	Not used
8	Not used
9	Digital Output 2
10	Digital Output 4
11	GND
12	Digital Output 6
13	Digital Output 8
14	Not used
15	Not used
Interface Panel Connector Part No	DB15 Female Connector
User Plug Part No	DB15 Male Plug

Ethernet Interface

PrecisePlace robots are equipped with communication interface boards (MCIM's) that include an Ethernet switch that implements four 10/100 Mbit Ethernet ports. This capability was designed to permit the robot's controller to be interfaced to multiple Ethernet devices such as other Precise controllers, 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 X-Axis Facility Panel, only two of the four Ethernet ports are available as external RJ45 connectors.

Either Ethernet port can be used to interface to the robot. If the two ports are connected to external equipment that are communicating with each other but not the controller, the switch automatically routes the traffic between the two ports and does not send this information to the controller. For example, if an

external Ethernet camera is connected to one port and a PC is connected to the other port, the camera image data will not burden the controller CPU.

As a convenience for Ethernet devices that are mounted on the Z-axis of the robot, an Ethernet cable is routed through the interior of the robot. One end of this cable is plugged into the robot controller's Ethernet switch and the other end is under the cover for the Z-axis motor. Any device that is plugged into this cable, such as an Ethernet camera mounted on the Z-axis, can also be communicated with using either of the two plugs available on the Facilities Panel.

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

Remote Front Panel / MCP / E-Stop Interface

The remote front panel interface includes all of the signals necessary to implement a fully compliant EC Category 3 Safety front panel that includes a Manual Control Pendant. In particular, this connector provides signals (including redundancy as necessary) for implementing an E-Stop circuit, an auto/manual switch, a high power "on" button with a high power "on" indicator lamp, and a RS-232 interface for a Manual Control Pendant (MCP). These signals are provided in a DB25 female connector mounted on the robot's Facilities Panel.

DB25 Female

In the future, Precise will offer a Remote Front Panel option that plugs into this connector. Alternatively, customers can develop their own custom front panels (please see the section on "Safety Circuits For Remote Front Panel" in the *Controller Hardware Manual* for a suggested design). Or, if your application does not require a fully compliant Category 3 front panel, the robot can be operated without a front panel or with a Precise hardware MCP or a Precise E-Stop box. Both the Precise MCP and the E-Stop box can plug directly into the Remote Front Panel connector and provide a hardware emergency stop capability via the connector's redundant E-stop signals.

When a front panel, hardware MCP or E-Stop box is not utilized, the following pins on the front panel connector must be jumpered in order for the controller to operate properly. (The robot is shipped with a jumper plug that satisfies these requirements.)

1-14, 2-15, 3-16, 4-17, 5-18, 6-19, 7-20

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.

Pin	Description

1	Auto/Manual 2 (If no front panel or Auto mode, connect to pin 14). Input signal that is high to indicate that the system is being operated in a fully automatic mode or low or open for manual operation. This is normally controlled by a key switch on the Remote Front Panel. The Auto/Manual signal must be daisy chained to all amps on a controller network.
2	Auto/Manual 1 (If no front panel or Auto mode, connect to pin 15). Redundant Auto/Manual input signal.
3	ESTOP_L 2 (If no front panel or E-Stop not asserted, connect to pin 16). Input signal that is low or open to indicate that a hardware E-Stop condition has been asserted by any source. Set high if no E-Stop condition is asserted. The controller hardware will not permit motor power to be enabled when an E-Stop condition exists.
4	ESTOP_L 1 (If no front panel or E-Stop not asserted, connect to pin 17). Redundant ESTOP input signal.
5	External ESTOP_L (If no front panel or not an External ESTOP, connect to pin 18). Diagnostic input signal that is low when an E-Stop is generated from an external source. This allows the System Software to display different error messages to alert the operator as to the source of the E-Stop condition.
6	High Power Lamp Fail (If no front panel, jumper to pin 19). Input signal that is set high or open if the Remote Front Panel lamp, which indicates when motor power is enabled, has failed. When this signal is high, motor power cannot be enabled.
7	High Power Enable (If no front panel, jumper to pin 20). Input signal that must transition from low to high during the EC Category 3 power enable sequence to request that motor power be enabled. This is normally connected to a momentary contact "Enable power" push button on the Remote Front Panel.
8	Not used
9	MCP RXD. RS-232 receiver serial line from the Manual Control Pendant or external device.
10	5 VDC
11	Not used
12	Not used
13	Not used
14	24 VDC
15	24 VDC
16	Force ESTOP_L. Output signal that, when low, indicates that the Remote Front Panel should force ESTOP_L 1 and ESTOP_L 2 to be asserted (low). The System Software toggles this signal low at startup to verify that the ESTOP_L 1, ESTOP_L 2, and External ESTOP circuits are properly working. The System Software also uses this as a means for asserting a hardware E-Stop condition during normal operation. This signal is normally held high.
17	Force ESTOP_L. Redundant Force ESTOP_L output signal.
18	Force ESTOP_L. Redundant Force ESTOP_L output signal.
19	GND
20	GND

21	High Power Status. Output signal that is asserted (high) when high power to the motor is enabled. This is typically connected to a relay that turns on the High Power Lamp in the Remote Front Panel.
22	MCP TXD. RS-232 transmitter serial line to the Manual Control Pendant or external device.
23	5 VDC
24	Not used
25	Not used
Interface Panel Connector Part No	DB25 Female Connector
User Plug Part No	DB25 Male Plug

X and Y Axes

The X and Y axes are composed of an extrusion, covers, end caps, linear bearing rods, a linear encoder, and a motor carriage. The motor carriage employs a traction drive to move along the extrusion on the bearings. The motor includes an encoder for motor commutation. Separate linear encoders attached to the X and Y extrusions are used to determine the position of these axes. These linear encoders contain a periodic calibration code that is read when the axis is moved just a few millimeters during the robot "homing" process.

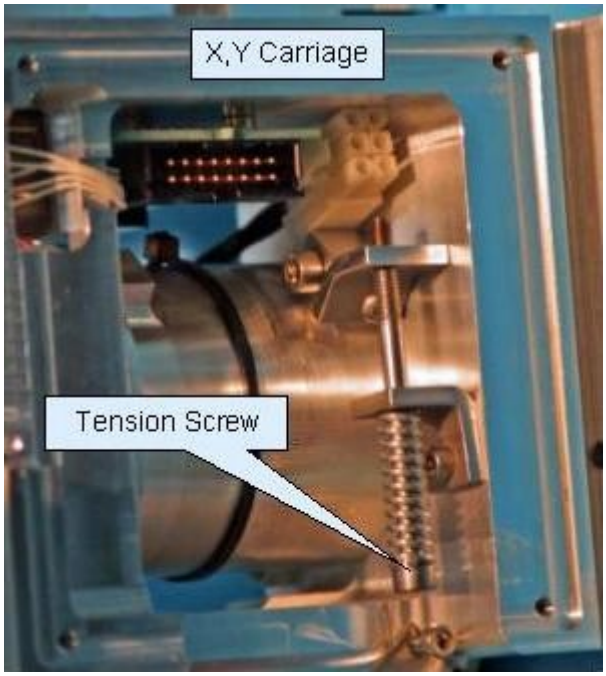
The motor contains a friction wheel which is spring loaded against the extrusion. The spring tension is adjusted by means of an M4 Socket Head Cap Screw, shown below. Nominal tension is set at 3 complete turns of this screw. This provides about 100 Newtons of traction before the drive slips. Under normal operation, motor thrust should not exceed 80 Newtons peak. After extended periods of time, it may be necessary to increase the spring load by one or two additional turns to compensate for friction wheel wear. This will be application dependent, but typically should not occur before 10,000 hours of operation. If the drive does slip, high power will be turned off, and the robot will stop. In this case, the robot does not lose calibration, however, high power must be re-enabled. To continue from that point either a lower acceleration must be employed or the spring load may be adjusted. Commanding accelerations that result in more than 80 Newtons of traction force may cause slipping. 80 Newtons will give about 0.6G of acceleration for the X-axis, and about 1G of acceleration for the Y-axis with typical payloads.

The linear bearings are lubricated for the life of the product with special oilers containing oil in a polymer matrix bar that is formed to perform both as a wiper for contaminant removal and as a continuous lubricator for the linear bearing.

The wire and air harness is routed through the carriage, where the motor and encoder connections are terminated. The rest of the harness continues on to the outer axes. The X and Y axis carriage and tension screw are shown below.

DANGER: All of the motors for the PrecisePlace robot are operated at 320 VDC. As such, the motor wires present a high risk and unshielded pins and conductors should not be touched unless the main AC power to the robot is first disconnected.

The back cover can be removed to access the controller by removing the left end cap, which is the end cap opposite the cable entry end cap. Please see the Installation Information section for more information on this procedure. The top cover can be removed to access the X carriage by sliding the carriage to one end of its travel, and removing the 4 screws in the end caps that attach the top cover extrusion.



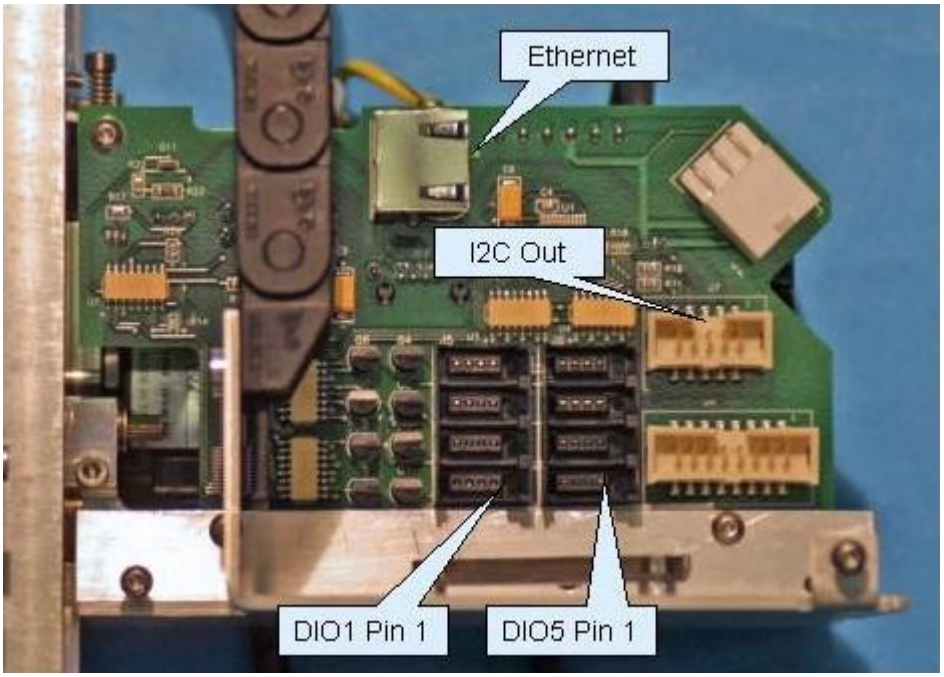
DANGER: The Guidance 3400, the PrecisePower Intelligent Motor Power Supply, and the 24 VDC power supply are all open frame electrical devices that contain unshielded high voltage pins, components and surfaces. The main AC power should always be disconnected before the back cover of the X axis is removed.

Z-Axis and Z-Axis IO PCB

The Z-axis is composed of a motor carriage, an extrusion, end caps, a sliding cover, and an IO Printed Circuit (ZIO) Board. The Z motion drive is a rack and pinion. The Z motor contains a fail-safe brake that can be manually released using a button on the top of the Z-axis carriage cover.

The Z-axis includes the “Z-Axis IO (ZIO) PCB” that provides user signals. These include an Ethernet connector for an Ethernet camera, and 8 user IO connectors that are interfaced to the controller by means of an I2C serial connection with roughly a 5ms scan rate.

DANGER: The Z-Axis IO board contains an optional motor connector that provides a bus voltage of 320 VDC. As such, this board represents a high risk and should only be accessed when the main AC power to the robot is disconnected.



The 8 user IO connectors provide 8 digital input and 8 digital output signals. The pin outs for each connector is displayed in the table below. For each connector, the digital output signal on Pin 2 is configured as sourcing and its return should be connected to Pin 1. The digital input signal on Pin 3 is configured as sinking and it should be connected to the 24VDC on Pin 4 to indicate a high state.

DIO Connector	Description
1	Ground
2	Switched 24VDC Output, connect return to pin 1
3	24VDC Input from switch, connect switch to pin 4
4	24VDC

Software Reference

Controller Software Extensions

This section discusses extensions to the standard Guidance Controller software that are specific to the PrecisePlace Robot.

Z-Axis General Digital Inputs and Outputs

The Z-Axis IO (ZIO) PCB adds 8 general digital outputs and 8 general digital inputs to the standard digital I/O found on the Guidance Controller. Like the other general inputs and outputs, they can be assigned for various control purposes during system setup, or they can be used directly by a GPL procedure.

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.

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

Signal Number	I/O	Label	Description
33	O		Z I/O board output 1
34	O		Z I/O board output 2
35	O		Z I/O board output 3
36	O		Z I/O board output 4
37	O		Z I/O board output 5
38	O		Z I/O board output 6
39	O		Z I/O board output 7
40	O		Z I/O board output 8
10033	I		Z I/O board input 1
10034	I		Z I/O board input 2
10035	I		Z I/O board input 3
10036	I		Z I/O board input 4
10037	I		Z I/O board input 5
10038	I		Z I/O board input 6
10039	I		Z I/O board input 7
10040	I		Z I/O board input 8

Z-Axis Dedicated Digital Outputs

The Z-Axis IO (ZIO) PCB adds 2 dedicated digital outputs to the standard digital outputs found on the Guidance Controller, as shown in the table below:

Signal Number	I/O	Label	Description
8039	O		Encoder power enable. Set to 1 to enable Z-axis encoder power. This signal should not be changed by the user.
8040	O		Z-axis lamp. Set to 1 to turn on lamp. Normally parameter “Power State DOUT” (DataID 235) is set to this signal number so that the Z-axis lamp displays the robot power state.

Service Procedures

Trouble Shooting

Symptom	Recommended Action
System error message generated	
“Amplifier Fault”	Slow down the robot. Check harness and motor for shorts.
“Encoder quadrature error”	For errors on the X or Y axis (joints 1 or 2): Clean linear scale with denatured alcohol
	For error on the Z axis (joint 3): In the U.S. change the PrecisePower Intelligent Motor Power Supply voltage jumper to “180-264V”
“Excessive dual encoder slippage”	Tighten M4 Tension screw one turn, lower acceleration
"Illegal zero index"	See "Encoder quadrature error"
"i2c device failure"	Check Z motor cable to ensure it is not touching the ZIO Board
"Missing zero index"	See "Encoder quadrature error"
“Motor duty cycle exceeded”	Reduce speed or acceleration of robot
“Soft Envelope Error”	Make sure robot not pressing against surface
Physical or audible problem	
Brown streaks on linear bearings	Clean with alcohol and check oiler contact
“Clunking” when reversing direction	Remove carriage. Check motor mounting screws. Screws should be tight enough to allow motor spring tension to work, but not loose. If loose, apply Loctite and re-tighten. Check 8mm bearing pins under linear encoder for loosening.
Mechanical noise from carriage	Check carriage bearings for failure

X & Y Linear Scale Cleaning and Replacement

The PrecisePlace Robot is intended for use in clean environments. Excessive dust or oil on the linear encoder scales can cause Quadrature or Zero Index Errors. The scales can be cleaned with a lint-free cloth and denatured alcohol. The scales can usually be cleaned without removing them.

> NOTE: Do not use rubbing alcohol as this typically contains 30% water and can leave a film as it evaporates.

The scales can be removed and replaced by removing the vinyl spline retaining the scale in the extrusion. A new scale may be cut to length with a pair of scissors. When a scale is replaced, care must be taken that the emulsion side is facing the back side of the robot on the X-axis (the controller side) and facing the side of the Y-axis opposite the Z-axis. The emulsion side is the side from which the Precise Automation label can be read correctly. So in the case of the X-axis, you should be able to read Precise Automation when standing behind the robot by the controller, and in the case of the Y-axis, when standing on the side opposite the Z-axis.

To install an encoder scale, move the carriage to one end of its travel and slide the scale into the groove in the extrusion and through the carriage. You may need to wiggle the scale a bit as it goes through the carriage to get the scale through the encoder read head gap. Once the scale is lying in the encoder groove, position the scale so that the read head does not run off the end of the scale at either extreme of travel of the carriage. Then install the spline by pressing it down into the groove on the non-emulsion side of the scale.

> NOTE: Press the spline down vertically, don't stretch it by running your thumb down the spline – this can cause the scale to creep.

The spline can be installed in several pieces. Typically the carriage is moved to one end of travel and a length of spline installed in the groove that is not under the carriage, then the carriage is moved down and a second piece of spline installed in the groove that was under the carriage.

When a linear scale is removed, it is necessary to re-establish the encoder zero positions in order for the homing sequence to work properly. See the section below for instructions on executing the Cal_PP program to set the encoder zero positions.

Setting the Encoder Zero Positions

Cal_PP is a service program that must be run to set the zero positions of the X and Y axis linear scales, and the Z and Theta motor encoders. The zero positions must be re-established if the X or Y axis linear scales or the Z or Theta motors are replaced.

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 the *Guidance System Setup and Operation, Quick Start Guide*).

The following describes the procedure for defining the zero positions of the PrecisePlace 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 disabled.**
2. Load Cal_PP into the controller's memory using either the Guidance Development Environment (GDE) or the web Operator Control Panel.
3. Manually move the X, Y and Z axes to a position more than one zero index away from their lower hard stop limits. As you face the robot with the power cord on the right, the X-axis lower stop limit is to the far right, the Y-axis lower stop limit is with the axis fully retracted, and the Z-axis lower stop limit is with the axis all of the way up. For the X and Y axes, a zero index distance is approximately 10 mm. For the Z-axis, a zero index distance is approximately 100 mm. Positioning

an axes further away will not cause a problem but a shorter distance may cause this procedure to fail.

4. Manually move the X, Y and Z axes to their lower hard stop limits. This motion will ensure that at least one zero index for each of these three axes is detected by the controller. The final location of each axis will define the physical position that will correspond to their lower hard stop positions.
5. If your robot is equipped with a Theta axis, rotate the axis to a position that is at least one full rotation away from the joint's mid-range of travel.
6. Move the Theta axis exactly to its zero (mid-range) position.
7. Execute the Cal_PP program using GDE or the web Operator Control Panel. This program will execute for approximately 15 seconds. During this time, it will compute the data required by the homing operation and will save it on the flash disk. While this program is executing, the Operator Control Panel will display "System Running".
8. Check the Operator Control Panel for any error messages.
9. Enable the power to the robot's motors and execute the homing sequence. The new encoder zero positions will take effect when the robot is homed.

The zero position for each of the robot's axes will now be defined and the data required by the homing operation will be stored in the controller's flash disk.

Removing the X-Axis Carriage

In order to change the motor or bearings on the X carriage, it is necessary to remove the X carriage. This can be done without removing the Z-axis and Y carriage from the Y-axis.

DANGER: All of the motors for the PrecisePlace robot are operated at 320 VDC. As such, the motor wires present a high risk and unshielded pins and conductors should not be touched unless the main AC power to the robot is first disconnected.

To remove the X carriage, remove the left end cap (opposite the cable entry) by removing six 6-32 SHC machine screws. Remove the X cover by removing 2 more 6-32 screws from the right end cap. Remove the Y cover by removing four 6-32 SHC machine screws from the Y end caps. Remove the Y end cap closest to the X-axis.

Place a support under the Y-axis so it does not drop when the bolts are removed. Remove the Y-axis from the X carriage by removing 4 M4 X 12mm Socket Head Cap Screws. Slide the Y-axis forward away from the X-axis taking up slack in the harness service loop in the Y-axis. Remove the X-axis carriage cover by removing 4 M3 X 6mm Button Head Screws. Unplug the X motor and X encoder from the harness and remove the harness clamp where the harness enters the X carriage by removing 2 M3 X 12mm Socket Head Cap Screws. Remove the air transfer harness clamp from the X carriage by removing 2 M3 X 10mm Low Profile Socket Head Cap Screws and 2 M3 X 10mm Socket Head Cap Screws.

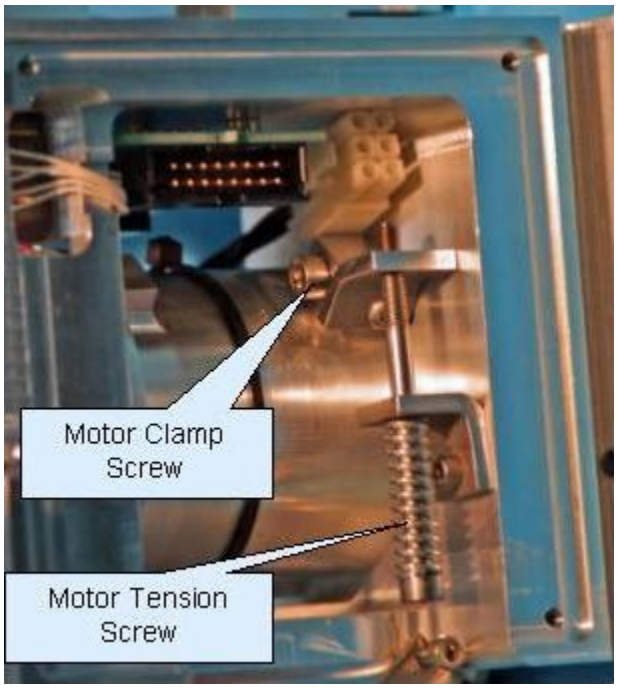
Now lift the harness out of the X carriage. Pick up the entire Y, Z and (Theta) axis assembly and lay it down in front of the X-axis with the end of the Y-axis close the the left end of the X-axis. This will allow the harness to lay flat out the end of the X-axis.

Slide the X carriage out of the left end of the X-axis.

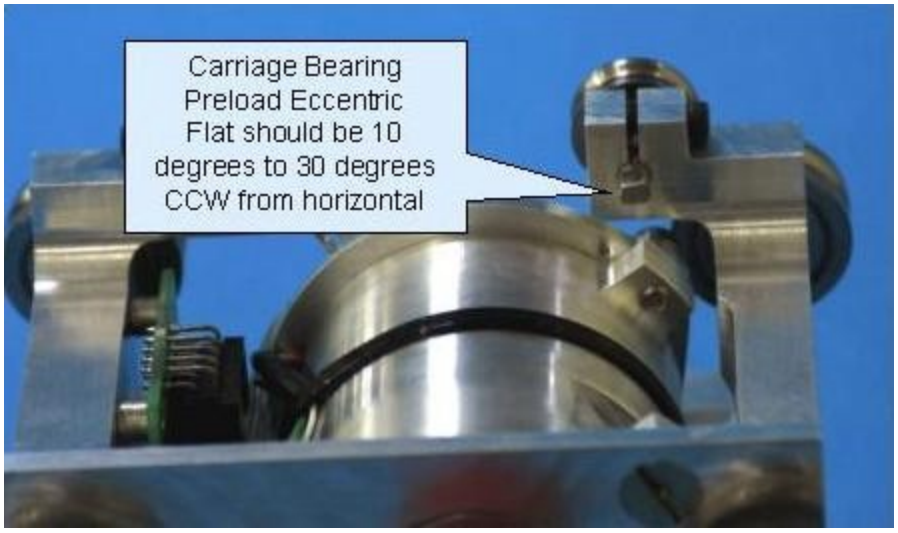
Installing and Adjusting the X-Axis Carriage

In preparation for installing the X-carriage into the X-axis, first verify that the M4 X 55mm SHCS tension spring screw is backed out enough so that the friction wheel is not in compression when the carriage is installed. The X motor should be able to slide against the end of the adjustment slot in the motor mounting tab and the tension screw should not project more than 2 mm beyond the back of the motor tension flange.

Compress the spring loaded oilers and slide the X carriage into the X-axis. Be very careful that the floating bearings on the friction wheel side of the carriage are centered on the bearing rods and not jammed. When the carriage is installed and the motor friction wheel is not engaged, it should be possible to push the carriage along the axis with between 5 to 10 Newtons (1 to 2 lbs) of force. If the force is higher than this, it is likely the floating bearings are not aligned properly or the small preload bearings are not adjusted correctly.



The carriage bearing preload is adjusted at the factory and it should not be necessary to adjust it in the field. However if the carriage becomes loose or too tight, the preload bearings on the 5mm eccentric shafts can be adjusted by loosening the M3 X 14mm SHCS and rotating the eccentric pin a few degrees. The flat on the eccentric pin should be oriented about 20 degrees counterclockwise from horizontal, plus or minus 10 degrees. Rotating the pin counterclockwise increases the preload. The preload should be set so the carriage has a slight spring to it (.3 to .4mm) as it is inserted into the X-axis. With the oilers installed and friction wheel disengaged, the force to push the carriage should not exceed the number in the paragraph above.



Once the X carriage is installed, the motor tension adjusting screw should be tightened until the friction wheel touches the drive surface and the spring starts to compress, and then turned 3 more full turns.

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Once the robot has been reassembled, the tension adjustment and friction can be checked by turning on the robot and pushing on the X-axis quickly (less than 2 seconds) with a force gauge with a force of 80 Newtons or 16lbs. The X motor should resist this peak force for a period of 2 seconds, and then a “Duty Cycle Exceeded” Error will be generated and turn off power. If the friction wheel slips before 80 Newtons of force is reached, the tension screw should be tightened one half turn at a time.

Removing and Installing the Y-Axis Carriage

In order to remove the Y-axis carriage, the Z-axis cover must be removed; the Z-axis cables unplugged; the 4 M4 Screws attaching the Z-axis to the Y-axis carriage removed; and the Z-axis removed. Then the Y end cap opposite the X-axis is removed, and the harness is removed from the Y carriage in a manner similar to the X carriage and the Y carriage can be slid out the end of the Y axis.

Installing the Y carriage is similar to installing the X carriage.

DANGER: The Z-Axis IO board contains an optional motor connector that provides a bus voltage of 320 VDC. As such, this board represents a high risk and should only be accessed when the main AC power to the robot is disconnected.

DANGER: All of the motors for the PrecisePlace robot are operated at 320 VDC. As such, the motor wires present a high risk and unshielded pins and conductors should not be touched unless the main AC power to the robot is first disconnected.

Replacing the X and Y Motors

The X and Y motors are identical and will be referred to as the XY motor. This motor can be replaced by removing the tension screw and spring, the M4 X 16mm SHCS in the slotted motor tab, and the M3 X 10mm SHCS in the clevis pin pressed into the carriage. Both motor mounting screws have a Belleville spring washer under the screw head, pressing against a flat washer. Compressed flat, these spring washers supply 40 lbs of spring pressure. When reinstalling the motor, it is very important to use Loctite in the M3 screw in the clevis pin, and to tighten the screw until the spring washer is almost flat while still allowing the motor to rotate on the clevis. The M4 screw has a nylon insert to prevent it from working loose.

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Again, it is very important to tighten this screw until the spring washer is almost flat while still allowing the motor to pivot under the tension from the tension spring and tension screw.

Replacing the X and Y Encoder Read Heads

The X and Y axes use a dual encoder system with one read head on the carriage for position information and a second read head on the motor for motor commutation and control. These read heads are different and cannot be interchanged. They each have a wire pigtail and connector. These two connectors plug into a 10-pin header mounted on a PCB. The motor pigtail plugs into the header pins closest to the motor, with Pin 1 (denoted by a small arrow on the connector) closest to the encoder end of the motor. The linear encoder read head connector plugs into the pins closest to the surface of the PCB, with Pin 1 closest to the encoder end of the motor.

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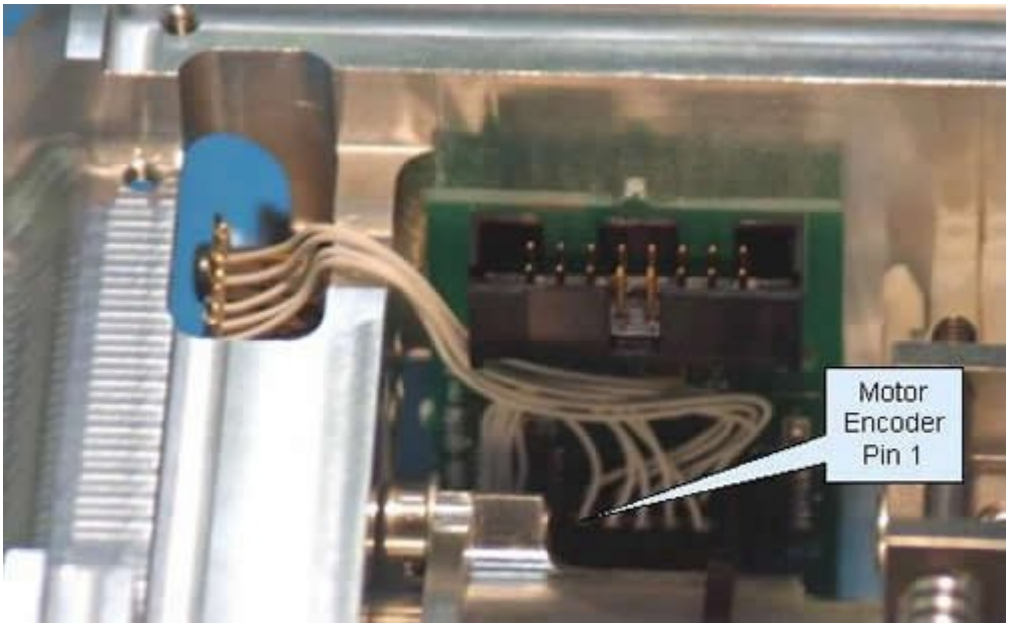

Replacing the X and Y Carriage Bearings

The X and Y carriage each have two different sizes of carriage bearings. The main load bearings are Precise PN PP1A-MC-B0002, which have a 24mm OD and a 8mm bore. The carriage preload bearings are Precise PN PP1A-MC-B0001, which have a 17mm OD and a 5mm bore. These bearings are retained by snap rings and can be replaced by removing the snap rings.

Replacing and Adjusting the Z Motor and Z-Axis Bearings

The Z-axis is driven by a rack and pinion. The Z motor assembly includes a motor, brake, encoder and spur gear pinion in a single unit. It can be replaced by removing 2 M5 X 8mm shoulder screws. The lower right shoulder screw serves as a pivot, and the upper left shoulder screw slides in a slot so that the Z rack and pinion backlash can be adjusted.

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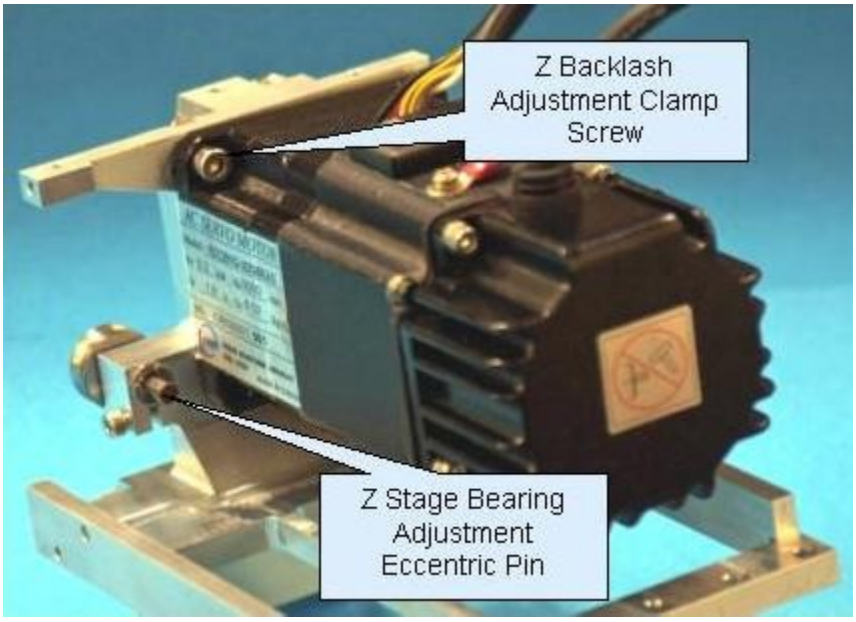
DANGER: The Z-Axis IO board contains an optional motor connector that provides a bus voltage of 320 VDC. As such, this board represents a high risk and should only be accessed when the main AC power to the robot is disconnected.



To adjust the Z-axis linear bearing preload, the eccentric pin shown above should be rotated after loosening its clamp screw.

Appendix A: Product Specifications

PrecisePlace 1300/1400 Specifications

General Specification	Range
Range of Motion & Resolution	
X-Axis	Configurations from 500 mm to 1 m
Y-Axis	Configurations from 200 mm to 400 mm
Z-Axis	200 mm
Optional Theta Axis	+/- 270 degrees
Resolution	+/- 0.008 mm in X, Y, and Z standard +/- 0.001 mm in X, Y, and Z available with high resolution option
Repeatability	+/- 0.050 mm, 68 – 78 degrees F, limited by aluminum structure expansion
Performance and Payload	
Maximum acceleration	0.6G
Maximum speed	2000 mm/sec
Z Force	Continuous upwards Z force - 40N Continuous downwards Z force - 45N
Payload	PrecisePlace 1300: 3 kg PrecisePlace 1400: 2 kg
Controller	*AVAILABLE GUIDANCE CONTROLLERS*: Guidance 3400 (G3X0-EA-03400), Guidance 3404 (G3X0-EA-03404), Guidance 3406 (G3X0-EA-03406)
Interfaces	
General Communications	RS-232 channel, Ethernet ports, remote front panel
Digital I/O Channels	12 optically isolated inputs, 8 optically isolated outputs included on controller. Additional 8 isolated inputs and 8 isolated outputs provided on the Z-axis. Remote I/O also available.
Analog I/O Channels	2 analog inputs included 4 or 6 analog outputs optionally available
Pneumatic Lines	Two air lines, each 75 PSI maximum, provided at Z-axis drive and routed internally to fittings on the X-axis end cap.
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 via Windows

	DLL.
Required Power	Dual range: 90 to 132 VAC and 180 to 264 VAC, auto selecting, 50-60 Hz, 500 watts maximum
Weight	30 kg typical, will vary with size

Appendix B: FAQ

Frequently Asked Questions

This section contains a compilation of frequently asked questions related to PrecisePlace 1300/1400 robots.

A. Robot Hardware

1. How do you operate the robot when plugged into a GFI circuit?

A. Robot Software

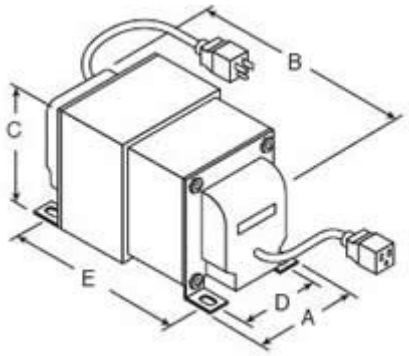
1. How do you switch between a 3 and 4 axis configuration?

Robot Hardware

How do you operate the robot when plugged into a GFI circuit?

In almost all situations, to power a PrecisePlace robot, all that is required is that the robot be plugged into a standard AC service. However, if you plug the robot into an electrical service that has a GFI (Ground Fault Interrupter) circuit, the GFI may be tripped when motor power is enabled. If this occurs, the problem can be easily remedied by plugging the robot into an isolation transformer that is capable of supplying at least 500 VA and plugging the isolation transformer into the GFI circuit.

Isolation transformers of this type are readily available and cost approximately $100-$150. For example, the following transformer, a Hammond 171E is available from www.mouser.com as part number 546-171E for $130.



Robot Software

How do you switch between a 3 and 4 axis configuration?

The Theta axis for the PrecisePlace robot is designed to be easily added or removed from the robot in the field. You may need to do this if you find that your application unexpectedly needs to accommodate part rotations or if you need additional Z payload capability and the theta is not required.

The procedure for mechanically installing or removing the Theta axis is described elsewhere. This document presents instructions for reconfiguring the software for this change.

The system software that is already loaded into your controller will operate either the PrecisePlace 1300 or 1400 robot. To change the robot type, you simply need to provide new configuration information in the form of the "Configuration and Parameter Database Disk Files", i.e. the PAC files.

Before superceding the configuration files in a controller, it is strongly recommended that you first either copy the controller's configuration to a host computer or use the web interface to create a backup set of configuration files in the flash disk.

When you are ready to load the new configuration files to your controller, please perform the following procedure.

1.
2. Obtain the PAC files for the new robot configuration. These can normally be found on the "Guidance Controller System Software CD" that came with your system. The files are located in the PAC folder in the subfolder with the name of the robot that you wish to configure. Alternately, you can contact Precise for the appropriate files.
3. Start up GPL on your Guidance controller.
4. Connect to the controller using a web browser and login.
5. Click on the tab labeled "Utilities" .
6. Click on the words "Backup and Restore" in the left-hand panel.
7. Click the button "Start File Manager" to open a FTP window. This should open the /flash/ folder.
8. Double click the "config" folder to display its contents.
9. Open the folder that you identified in Step #1 that contains the new configuration files.
10. Drag the **"robot01.pac"** and the **"calib01.pac"** file from the host computer folder to the controller's FTP window and drop them.
11. Wait until the copy operation is completed.

WARNING: Always wait 10 seconds after writing to the flash before you power down the controller, otherwise, you may corrupt the flash disk.

12. Close the FTP window and return to the "Backup and restore" panel.
13. Restart the controller to put the new configuration information into effect.

At this point, your robot will be operational, but the zero positions for each of the axes will be incorrect. To set the zero positions, please see the "PrecisePlace 1300/1400 Robot, Hardware Introduction and Reference Manual" for instructions on executing the Cal_PP procedure.

Appendix C: Spare Parts Lists

Spare Parts Lists

Description	Part Number
805mm Linear Encoder Scale	0000-MC-E0005
Linear Encoder Read Head Assembly	PP1A-MC-E0001
832 Theta Encoder Disk	PP14-MC-E0001
832 Theta Encoder Read Head Assembly	0000-MC-E0004
XY Motor Assembly	PP1A-MA-00006
Z Motor Assembly	PP10-MC-D0001+PP13-MC-G0001
Theta Motor Assembly	PP1A-MA-00006
24mm Carriage Bearing and Snap Ring	PP1A-MC-B0002+0000-HC-P0005
17mm Carriage Bearing and Snap Ring	PP1A-MC-B0001+0000-HC-P0002
Oiler Block	PP10-MC-X0006
Oiler Spring	PP13-MC-X0028
G3400 Controller (G3400, G3404 or G3406)	G3X0-EA-03400, G3X0-EA-03404 or G3X0-EA-03406
500 Wt PrecisePower Intelligent Motor Power Supply	PS10-EA-00500
100 Wt 24VDC Power Supply	PS10-EP-00024
ZIO Board	PP13-EA-00001
Dual Encoder Buffer Board	PP1A-EA-00001
Fuse, PrecisePower Motor Power Supply	Wickman PN 1811630000
X-axis T nuts, ¼-20 Thd	McMaster Carr PN 94750A588
Z-axis T nuts, M4	Misumi PN HNTTBS5-4
Mounting Plate, Extended (no tip version)	PP10-MC-M0006