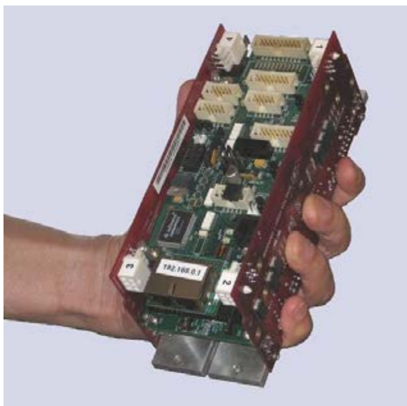
PRECISE AUTOMATION

Guidance 3000/2000 Controllers



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, 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

Table Of Contents

Introduction to the Hardware

System Overview

System Description

The Guidance family of motion controllers incorporates a distributed control architecture that utilizes Ethernet for real-time communication. Each motion controller on the network includes a motion/vision processor and one or more optional motor drives. Up to 16 motion controllers can be placed on a single network. The controllers can be wired in a daisy-chain topology to minimize the number of wires in a machine although a star topology has certain advantages and is also supported.

The Guidance 3000 Controllers include integrated motor drives. They require an external 24 VDC supply for the logic and IO and a separate external motor power supply. The motor power supply voltage can range from 24 VDC to 340 VDC, allowing a wide range of motor sizes and powers to be controlled. These motion controllers are very compact and are intended to be placed near the point of use, which in many cases means they will be installed inside the machine rather than in an external control cabinet. The 3000 Series includes a dual axis (Guidance 3200) and a four-axis (Guidance 3400) controller with integrated drives. This controller can also be provided without the motor drives and only DAC channels to allow control of up to 4 (Guidance 0004) or 6 (Guidance 0006) external amplifiers. For applications that require slightly reduced functionality at a lower price, the Guidance 2000B and 2000C series of motion controllers provide most of the same capabilities as the 3000 series. The Guidance 2000C can also be coupled to a dual axis slave amplifier (Guidance 0200C) to produced an integrated 6-axis controller (Guidance 2600C). Since the Guidance 3400 Controller is the most general product and a superset of most of the functionality contained in the other controllers, for simplicity, much of this document will focus on the 3400 model.

Motion axes can be grouped into “robots”, which are defined by a geometric (“kinematic”) model. A “robot” has a master controller that executes the kinematic model and sends out axes position commands to any slave controllers. The logical grouping of axes into robots is independent of the physical configuration of the motion controllers. For example, two single-axis controllers and one four-axis controller can be logically grouped into a six-axis robot, with one of the controllers designated as the master, and the other two as slaves. Motion can also be coordinated among robots on the same network. For example a four-axis robot can be coordinated with a two-axis robot.

Each Guidance Controller can have several types of peripherals attached to it. These include cameras, remote I/O, a hardware manual control pendant, and a remote front panel. Only one front panel is required per networked group of controllers.

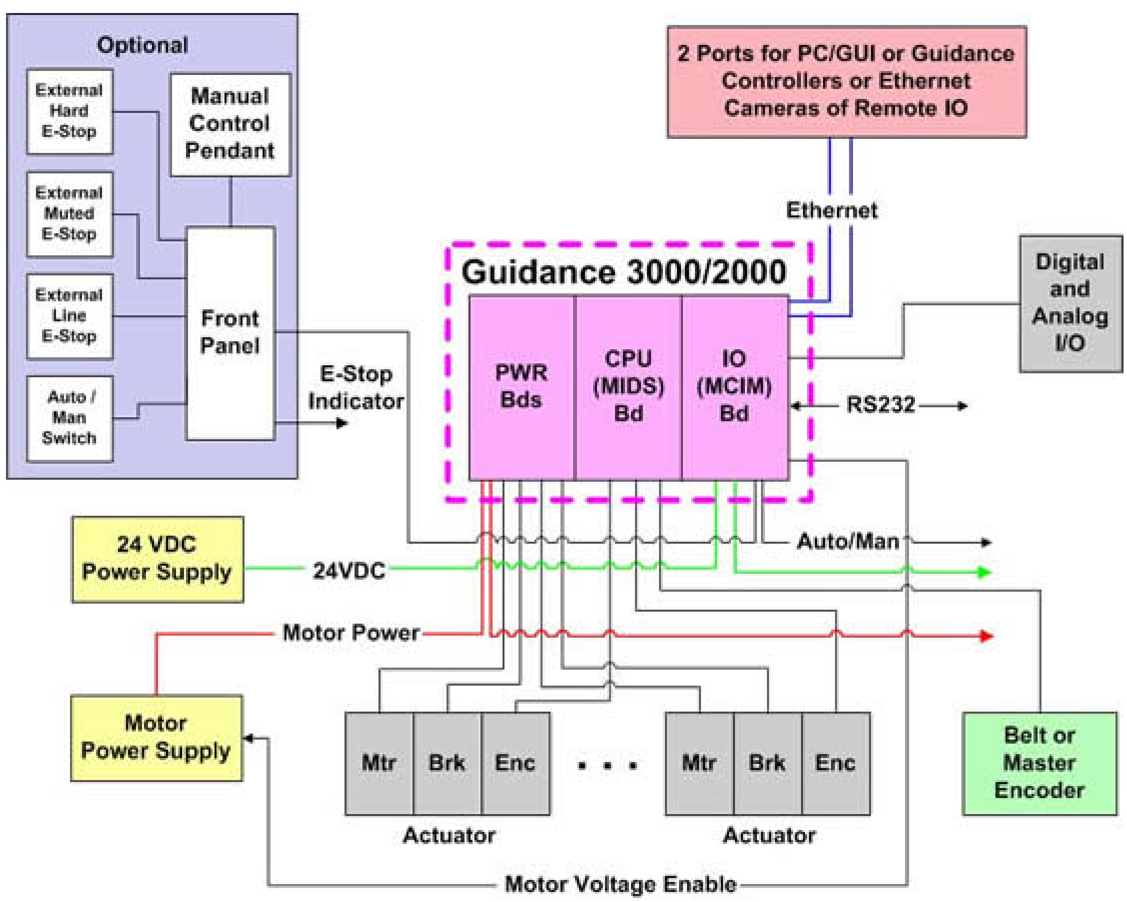
The controllers include a web based operator interface that is viewed via a standard browser. This interface is used for configuring the system, starting and stopping execution, and monitoring its operation. The web interface can be accessed over a local network or remotely via the Internet. This remote interface is of great benefit in system maintenance and debugging. It is highly recommended that first time users read the *Setup and Operation Quick Start Guide*, PN 0000-DI-00010, for instructions on interfacing a PC to a controller via the web interface and for general operating instructions.

The controllers are 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. For a complete description of the embedded language and its development environment, please refer to the *Guidance Programming Language, Introduction to GPL*, PN GPL0-DI-00010 and the *Guidance Development Environment, Introduction and Reference Manual*, PN GDE0-DI-00010.

The controllers are designed to operate with an optional, easy-to-use machine vision software package, "PreciseVision". This vision system can be executed in a PC connected through Ethernet or (in the future) in the motion controller. It provides a complete set of image-processing, measurement, inspection and object finder tools. For more information on vision, please refer to the *PreciseVision Machine Vision System, Introduction and Reference Manual*, PN PVS0-DI-00010.

System Diagram

The Guidance 3000/2000 Series system block diagram is shown below.



The controllers can be configured to support Category 3 (CAT-3) safety applications where required. An optional Front Panel will be available in the future that contains Category 3 (CAT-3) interlock circuitry as well as a keyed auto/manual switch, a high power button, and an E-Stop button. This front panel is not necessary for the system to operate. Users may wire their own E-Stop circuitry directly to a controller.

An Ethernet Switch on the the controller's IO board permits Ethernet cameras to be plugged directly into a controller where they can be accessed locally by the motion processor or remotely by a PC.

All of the extensive communication features of the controllers are described in detail in the following sections.

System Components

Guidance Controllers

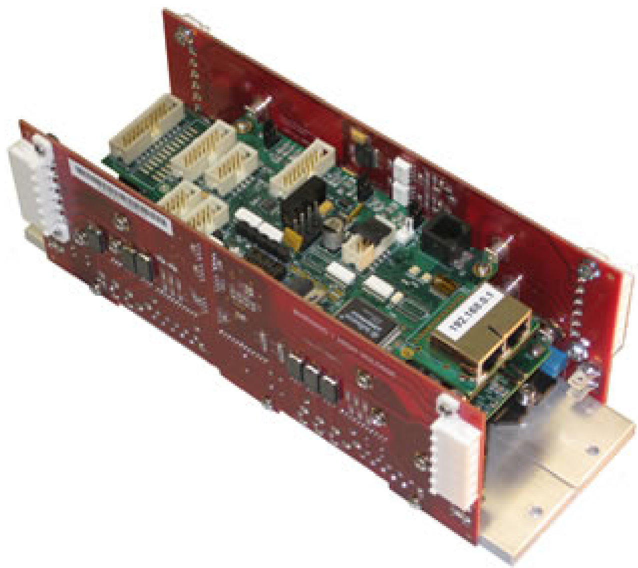
All Guidance 3000/2000 Controllers include a 400Mhz high performance, low power CPU, at least 8MB of dynamic RAM and at least 16MB of nonvolatile flash disk for storage of the OS, firmware and user program and data. In addition, these units all include the following standard features: four dedicated encoder inputs, four configurable encoder inputs, 12 general purpose optically isolated digital inputs, 8 general purpose optically isolated digital outputs, two RS-232 ports, two 10/100 Mbit Ethernet ports (four ports available on some units as a special order), and an EC Category 3 (CAT-3) compliant front panel interface with redundant E-stop circuits. Some models also offer the following optional features: 2 or 4 +/- 10 VDC analog inputs, 4 or 6 instrument grade +/- 10 VDC DAC channels that can interface to external motor amplifiers, support for SIN/COS analog encoders, and interfaces to selected absolute encoders.

For several models, the digital section of the controller consists of two boards: a standard or enhanced high performance processor (MIDS) board that is mated to one of several types of communications (MCIM) boards. In the case of the Guidance 2000C, these functions are collapsed into a single MIDS3 board that reduces the cost of the controller at the expense of fewer optional features.

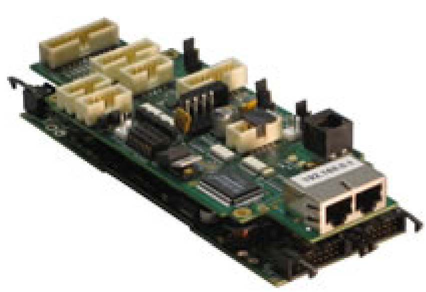
The Guidance 3000 series are the most general purpose controllers and include either two or four integrated motor drives. As with all 3000/2000 controllers, the drives can control motors that operate at bus voltages between 24 VDC and 340 VDC. The total motor power output of the controller is a function of the size of the heat sink on which it is mounted plus any forced air cooling. The four amplifier version of this controller, the Guidance 3400A, can provide either 10A or 20A peak current for each motor and is shown below.

DANGER: The Guidance Controllers are 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 following is a picture of the Guidance 3430A, which can deliver up to 30A of peak current from each of its four motor amplifiers.



For applications that require control of external 3rd party amplifiers and do not need integrated motor drives, the Guidance 0006 and 0004 are very compact, high performance controllers that include 6 or 4 DAC's at a very cost effective price. The Guidance 0006 is pictured below.



For applications that desire all of the standard features of the Guidance 3000/2000 controllers at the lowest price and do no require most of the optional features, the two board Guidance 2400C is the perfect choice. It has four integrated motor drives that can provide peak currents of 10A, 20A or 33A per motor.

If the Guidance 2000 form factor and motor drive capability is desirable but optional controller capabilities not available with the Guidance 2400C are required, the three board Guidance 2400B can provide many of the optional features of the Guidance 3000 series at a somewhat reduced price.

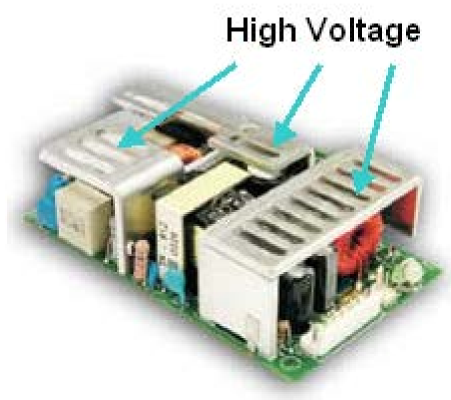
All Guidance Controllers can be networked with other Guidance Controllers to drive more than 4-axes. For 6-axis configurations that require standard features and moderate motor powers, the Enhanced Guidance G2400C is available with a Guidance G0200C Slave Amplifier (this configuration is also referred to as the Guidance G2600C) to provide a cost effective 6-axis tightly integrated control solution.

Low Voltage Power Supply

The Guidance Controllers require 0.7 amps of 24 VDC power for its logic circuits and 2 amps for IO power, for a total of 2.7 amps. An additional amp is required if this supply also drives the contactors on the motor power supply. For applications using remote IO or Ethernet cameras, Precise recommends a total of 5 amps. This voltage may be supplied by a user power supply or a 24 VDC power supply may be purchased from Precise.

A commercially available 125-watt, 24 VDC Power Supply, Mean Well P/N PPS-125-24, with AC input from 90V to 264V, is shown below.

DANGER: The 24VDC logic power supply is an open frame electrical device that has exposed unshielded high voltage pins, components and surfaces. In addition, **the heat sinks on the 24VDC Power Supply are not grounded and expose high voltage levels.** This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.



Intelligent Motor Power Supplies

The Guidance 3000/2000 Controllers are compatible with motor voltages from 24 VDC to 340 VDC. Precise offers three power supplies that have been designed to operate with these controllers: the PrecisePower 300, 500 and 2000 Intelligent Motor Power Supplies. These units include: integral relays for enabling/disabling motor power on command from the controller, large value output filter capacitors to store deceleration energy for use when power is needed, the ability to absorb line spikes, and built-in fuses.

DANGER: The PrecisePower Intelligent Motor Power Supplies are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, these power supplies provide 320VDC volts and take several minutes to bleed down after power is disconnected. 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 PrecisePower 500 is a 500-watt auto-ranging power supply with dual input ranges of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz and produces a 320 VDC nominal output. The PrecisePower 300 is a 300/600-watt power supply that accepts 90 to 264 VAC 50/60 Hz and generates a nominal output of either 160VDC or 320VDC depending on the input voltage. Both of these units include a single integral relay for enabling and disabling motor power from the controller.

PrecisePower 500W
Motor Power Supply

PrecisePower 300/600W
Motor Power Supply

As a rule-of-thumb, 500 watts from the power supply can normally drive motors with a total rating of approximately 2000 watts. This is due to the fact that motor power ratings are typically defined by the "rated torque" that can be supplied at the "rated speed" of a motor. However, in most robot applications, high torque is only required at low speed. For example, the PrecisePower 500 is being successfully used to drive a Cartesian robot at full speed where the sizes of its four motors are 750W, 400W, 200W and 100W (1450W total).

For applications requiring a larger intelligent motor power supply, the PrecisePower 2000 (shown below) delivers 2000 watts from a single-phase 208VAC service or 3400 watts from a three-phase 240VAC service. This unit includes dual integrated relays for enabling and disabling motor power on command from the controller. In addition, it has safety circuits to automatically shutdown the unit if it is switched to a short or is severely over-loaded.

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

Precise plans to offer a remote front panel that contains 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. This unit will plug into the Remote Front Panel interface of the Guidance Controller. The controller can operate without the remote front panel. When a front panel is not utilized, the following pins on the front panel connector must be jumpered. (All controllers are shipped with these jumpers installed.)

1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14

For systems that use more than one Precise Guidance Series Controller, the Auto/Manual signals can be daisy chained from controller to controller by connecting a ribbon cable from the 16-pin Auto/Manual daisy chain connector to either the front panel connector (pins 1-16) or the Auto/Manual daisy chain connector of the next controller.

For users that wish to have an E-Stop button for their controller without a remote front panel, Precise sells an E-Stop Box with a connector pigtail that plugs into the remote front panel connector and includes the necessary jumpers.

For users who wish to have a Manual Control Pendant (MCP) that can be carried around the workcell, Precise offers two hardware MCPs. The standard unit weighs 0.567 kg and includes an E-Stop button. For those applications where an operator must be inside the working volume of the robot while teaching, an alternate teach pendant with an E-Stop button and a 3-position hold-to-run button is also available. The Precise MCP's come with a 25-pin DSub connector that directly attaches to PrecisePlace and PreciseFlex robots and Guidance Systems. A 25-pin Dsub to 20-pin IDC connector adaptor cable is available for plugging a MCP into the Remote Front Panel connector of a Guidance 2000/3000 Controller. As with the E-Stop Box, the Precise MCP connector includes the necessary jumpers for the proper operation of the controller.

Remote IO Module

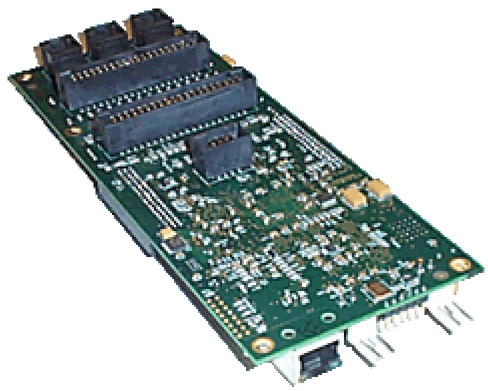
For applications that require additional IO capability beyond the standard functions provided with every Guidance Controller, a Precise Remote IO (RIO) module may be purchased. The RIO interfaces to any Guidance Controller via 10/100 Mb Ethernet and requires 24 VDC power. Up to 4 RIO's can be connected 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

All Guidance 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 (available in the future).

When PreciseVision is executed on a PC, it communicates with the motion controller via Ethernet and with cameras via either Ethernet or USB connections. Vendors such as DALSA offer a variety of Ethernet machine vision cameras and similar industrial USB cameras can be obtained from IDS Imaging.

Status LED and Status Output Signal

The controller includes a Status LED on its top board and a Status Output Signal Connector that can indicate the execution state of the controller. The digital output signal connector permits an external LED to be driven if the controller is embedded and the on-board LED is not visible.

To configure the Status Output Signal Connector or any general purpose digital output to blink in synchronization with the Status LED, the "Power State DOUT" (DataID 235) must be set equal to the signal's channel number.

The execution conditions that are indicated by the LED and the output signal (if configured) are described in the following table.

LED / Signal State	System Status	Description
Continuously Off	(1) Logic power off or (2) CPU crashed	Normally indicates that 24VDC logic power is off. In rare instances, indicates that the controller has crashed due to a system hardware or software error. The processor may be executing the firmware debugger, dBug.
Continuously On	(1) Booting or (2) CPU crashed	Typically indicates that 24VDC logic power is on and the controller is executing its startup boot sequence. If the LED turns on continuously after it has been blinking, the processor has crashed due to a system hardware or software error. The processor may be executing the firmware debugger, dBug.
Blinks 1 time per second	Normal operation, motor power off	The controller is executing in its standard operating mode and motor power is disabled.
Blinks 4 times per second	Normal operation, motor power on	The controller is executing in its standard operating mode and motor power is enabled.
Blinks 8 times per second	CPU overheating	The processor is overheating, motor power is off and you have 5 minutes to save any programs or data. After 5 minutes, the processor will shut down and needs to be rebooted.

Machine Safety

Voltage and Power Considerations

The Guidance 3000 and 2000 Controllers require two DC power supplies: a 24 VDC power supply for the logic and user IO, and a separate motor power supply. The motor power supply must provide the controller with a voltage between 24 VDC and 340 VDC.

DANGER: The Guidance 3000/2000, the PrecisePower Intelligent Motor Power Supplies, 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.

Precise offers three Intelligent Motor Power Supplies: the 300/600-watt PrecisePower 300 with an input range from 90 to 264 VAC 50/60 Hz, the 500-watt auto-ranging PrecisePower 500 with dual input ranges of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz and the 2000-watt PrecisePower 2000 that operates between 90-240VAC single or three phase, 50/60Hz. These motor power supplies contain relays that permit the controller to enable and disable motor power.

The PrecisePower Intelligent Motor Power Supplies limit inrush current to approximately 6 Amps. They are protected against voltage surge to 2000 volts by means of MOVs at the line input. Transient over voltage (< 50 µs) may not exceed 2000 V phase to ground, as per EN61800-31996. They are protected against over current by 250V fuses.

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.

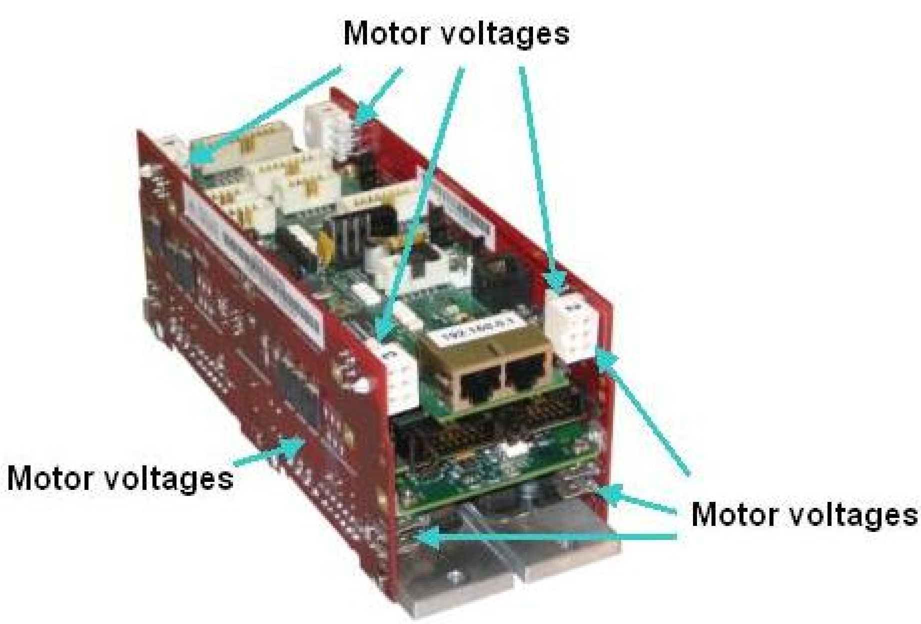
Enclosure Interlocks

If the Guidance 3000/2000 Controllers and their power supplies are mounted in a cabinet that can be opened without the use of a special maintenance tool, a high power disconnect switch should be connected to the enclosure door, such that when the door is opened, high power is disconnected from the supplies.

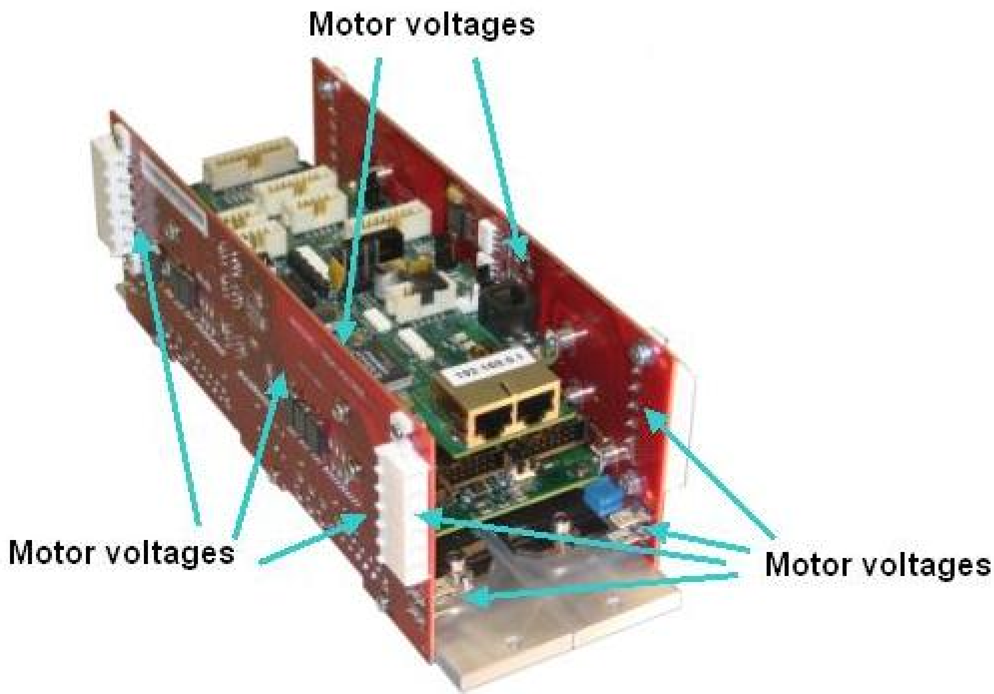
The pictures below define general areas and connectors on the controllers that have exposed high voltages and therefore pose a very high-risk when motor power is enabled.

DANGER: The surfaces, connectors, and leads pictured in **Red** below or labeled indicate exposed elements of the Guidance 3000 and 2000 Controllers that carry motor power signals. Depending upon the motor power supply, these signals levels can range from 24 VDC to 320 VDC.

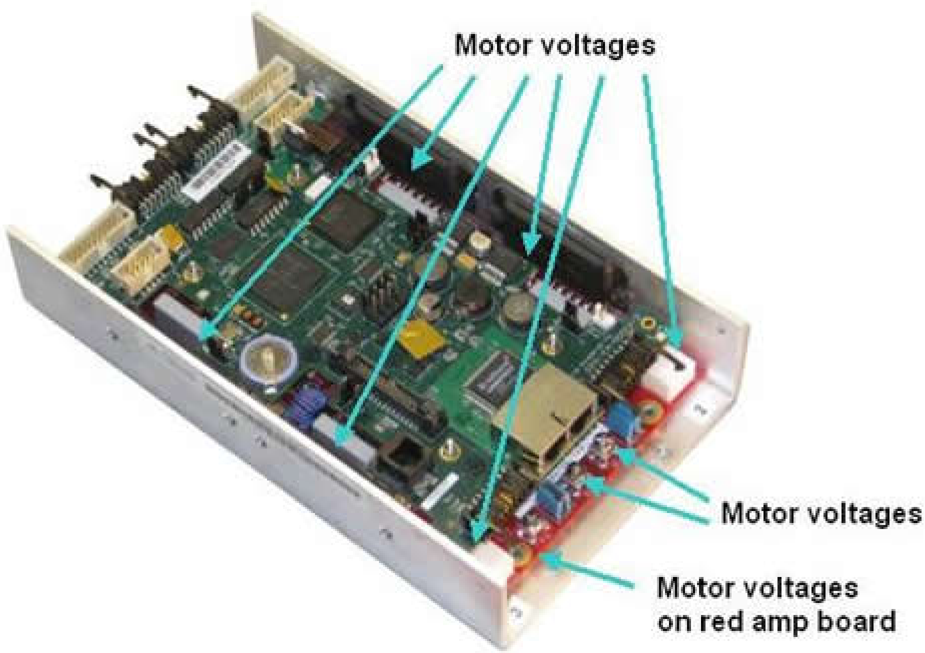
The following picture illustrates the high-risk areas of the Guidance 3410A and 3420A, 10A and 20A, controllers.



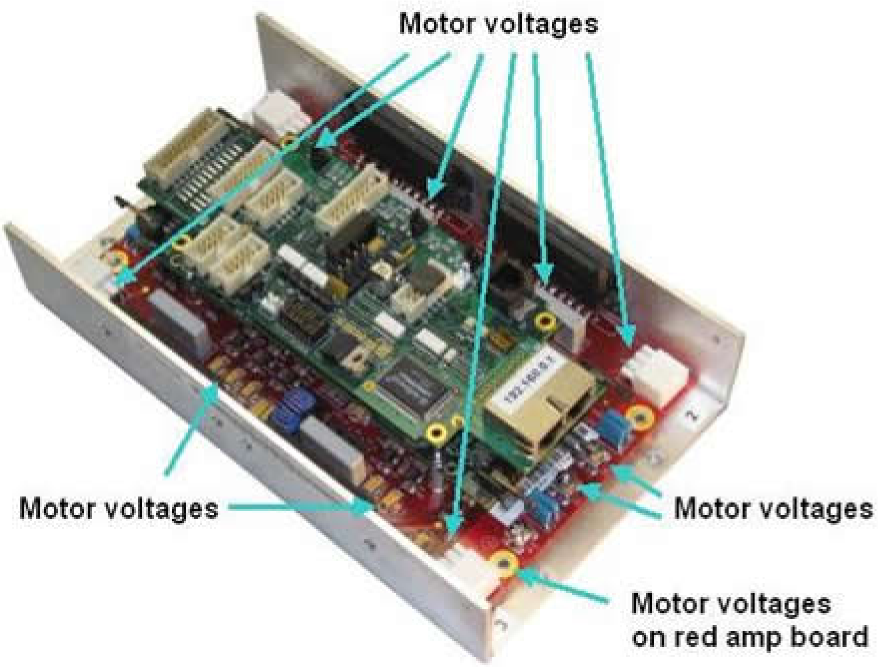
The following illustrates the high-risk areas of the Guidance 3430A, 30A controllers.



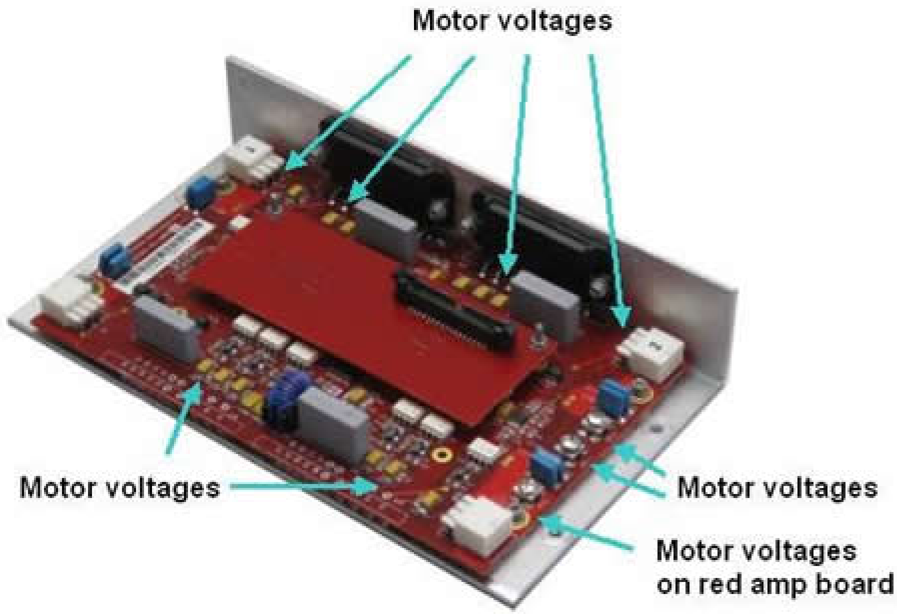
The following illustrates the high-risk areas of the two board Guidance 2410C, 2420C and 2430C, 10A, 20A or 33A, controllers.



The following illustrates the high-risk areas of the three board Guidance 2410B, 2420B and 2430B, 10A, 20A or 33A, controllers.



The following illustrates the high-risk areas of the 2-Axis 10A/20A Guidance G0200C Slave Amplifier that can be interfaced with the Enhanced Guidance G2400C to produce a tightly integrated 6-Axis controller (Guidance G2600C).



E-Stop Stopping Time and Distance

The 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 programs that are attached to a robot. This method can be used to quickly halt all robot motions in a controlled fashion when an error is detected.

This function is similar to a “Hard E-Stop” except that a Soft E-Stop leaves motor power enabled and is therefore applicable to less severe error conditions. Leaving motor power enabled is beneficial in that it prevents the robot axes from sagging and does not require motor power to be re-enabled before program execution and robot motions are resumed. This method is similar to a “Rapid Deceleration” except that a Rapid Deceleration only affects a single robot and no program error is generated.

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 firmware parameter that can delay opening the motor power supply relay for a fixed amount of time after a Hard E-Stop signal is asserted. This delay is nominally set at 0.5 seconds and 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 DataID 267 to the desired delay. If this delay is set to 0, the motor power relay will be disabled within 1ms after an input signal is asserted.

If an axis does not have a mechanical brake and motor power is disabled while the axis is moving, it may coast for a significant distance. Leaving the motor power enabled for 0.5 sec allows the servos to perform a rapid controlled deceleration of these axes. For example, if a linear axis is moving at a speed of 1000mm/sec and the servos decelerate it at 0.4G (3920mm/sec^2), the axis will reach a full stop in 0.26sec after having only traveled a distance of 127mm.

If a gravity loaded axis does have a mechanical brake but the brake takes some time to engage, if motor power is disabled immediately when a Hard E-Stop is signaled, the axis will drop before the brake takes effect. In this case, delaying for a short period of time before disabling motor power allows time for the brake to engage and prevents the axis from dropping.

Safety Standards Reference Material

Precise controllers can operate 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), *Robots for Industrial Environments – Safety Requirements*, particularly if the country of use requires a CE-certified installation.

Standards Compliance and Agency Certifications

The Precise Guidance Controllers 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 Controllers have been designed to comply with the following agency certification requirements:

CE
CSA
UL
ANSI/RIA R15.06 Safety Standard

Moving Machine Safety

The Precise Guidance Controllers drive robots that can operate in Manual Control Mode, in which an operator directly controls the motion of the robot, or in 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 should be limited in Manual Control Mode to a maximum of 250mm per second for safety as required by EN ISO 10218-1-2007.

This speed setting can be easily confirmed using the "Virtual Pendant" in the Web interface. After enabling power and homing the robot, select “Virtual Pendant” in the Web Control Panels Menu, then select a manual control mode such as “World” Mode, select the "X" axis, set the speed slider to 100% and drive the axis 250mm and time the motion. While it is possible to set a high manual control speed, this is not recommended, and should only be done after an application risk assessment.

While some light-duty robots (like the PrecisePlace) can only apply moderate forces, it is always very important for operators to keep their hands, arms and especially their head out of the robot's operating volume.

In Computer Mode, robots can achieve speeds of 2000mm per second or even greater. 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* or EN ISO 10218-2-2007, *Robots for Industrial Environments, Safety Requirements*, for information on recommended safe operating practices and enclosure design for robots of various sizes and payloads.

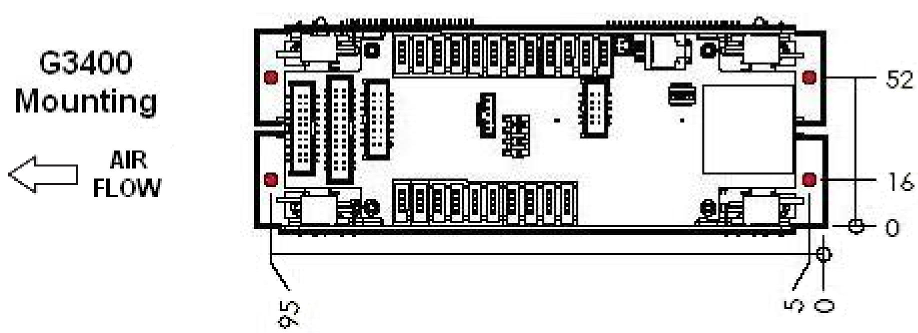
Installation Information

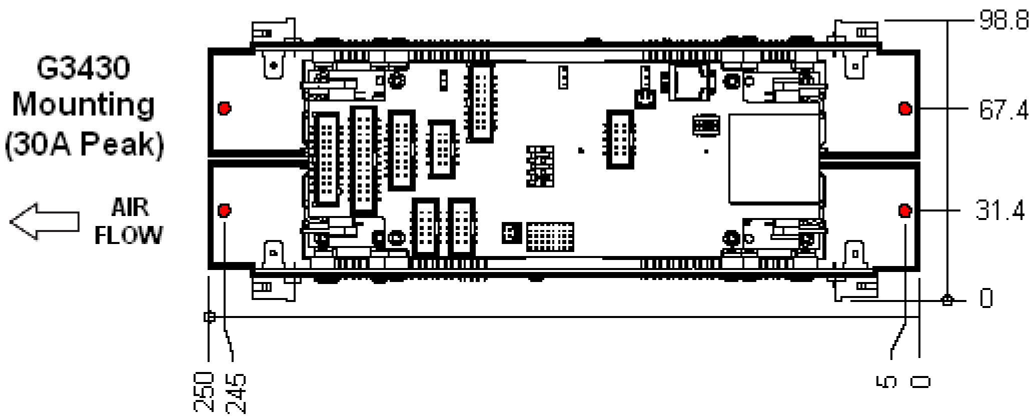
Heat Sinking and Mounting

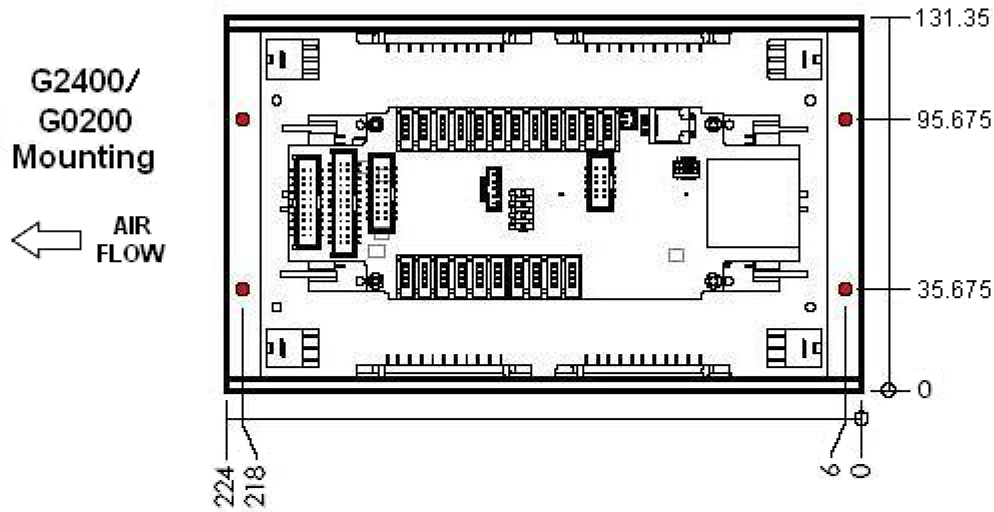
The Guidance 3000 and 2000 Controllers must be attached to a heat sink for proper operation. The size of the heat sink depends on the total motor power controlled.

For 500 watts RMS total motor power, the heat sink should be a plate that is approximately 12 mm thick with a surface area of 0.160 m^2. For 1000 watts RMS motor power, the heat sink should have a surface area of approximately 0.320 m^2. For 2000 watts motor power, a fan should typically be added to the heat sink. The fan should be at least 80 mm square and provide a minimum of 25 CFM of air blowing axially through the controller. For the heat sink, the surface area is very important for effectively dissipating the heat, but the thickness of the plate can be reduced if necessary.

The controller should be mounted to the heat sink with thermal grease and either M4 or 8-32 screws. For the Guidance 3000 and 2000 Controllers, the mounting holes are shown in **Red** in the following drawings, where all dimensions are in units of millimeters. The G3400 drawing applies to Guidance 3000 units with amplifiers that supply up to 20A peak current per motor.







A good indication of whether the controller is being properly cooled is to monitor the CPU and amplifier temperatures after the system has operated for an hour or two at its full speed and load. These temperatures can be read via the Web interface “Control Panels > System Information > System Console > Amp Temp”. **For long-term reliable operation, the CPU temperature should be 80C or lower. For the G3xxx and G2xxx controllers (except for the G3x3xA 30A), the amplifier temperatures should be 70C or lower. For the G3x3xA 30A, the amplifier temperature should be 90C or lower. Earlier versions of the G2xxx controllers did not have temperature sensors that could be read, but the chips were equipped with internal temperature monitoring to protect the power modules.** If the current ambient temperature is below the expected maximum operating temperature, add the difference between the current ambient and the maximum ambient to estimate the maximum temperatures. For example, if the current ambient is 25C and you expect to operate at the system’s maximum ambient of 40C, add 15C to the readings of the CPU and amplifier temperatures to determine if the cooling is sufficient.

For applications with high duty cycles and power or limited heat sinking or high ambient temperatures, a small fan blowing through the controller will greatly reduce the controller’s operating temperature.

Recommended Motor and Encoder Wiring

Wiring Overview

With the pressure to design high power motor drive electronics with low power losses, switching motor drive amplifiers now have edges that switch 400 volts as fast as once each 100 ns. While this helps to keep switching losses down, it has made receiving logic level signals from encoders and sensors very difficult. This is because every PWM edge must charge and discharge the motor wiring capacitance. The current spikes to do this can be as large as 4 amperes. This current flow causes the motor frame to have ground bounce on it due to the inductance of the ground return back to the amplifier. This ground bounce and the coupling between motor and encoder harness wires can introduce noise into the system. This section describes wiring techniques that will reduce the interference between motors and encoders.

NOTE: For systems that operate with a 48-volt or lower motor bus, the ferrite beads and the 600-volt wire that are described in the following sections are not needed.

It is very important that the wiring guidelines in this section be followed in order to avoid encoder quadrature errors, zero index errors, and other noise related problems.

Motor Cables

Alpha Wire recommends the following current ratings for **wire with PVC insulation at 80C**. In general, the wire ratings should meet or exceed the RMS (rated) current of the motor and not the peak current since the primary concern is over-heating the wire due to excessive average motor currents.

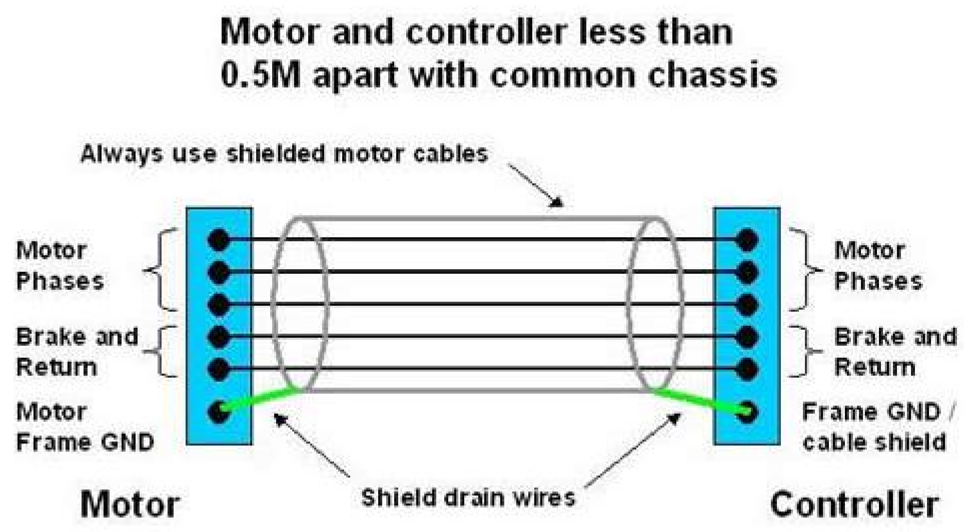
Wire Size AWG	28	26	24	22	20	18	16	14	12	10
Amperes	3	4	6	8	10	15	19	27	36	47

The ***motor wire should always be shielded*** and have a rating of 600 volts (except for 48VDC motor bus voltages and below). The typical wires that are shown in the table below have a 105° C rating. These wires do not have a drain wire, so a drain connection must be soldered to the shield.

	Alpha 16 AWG	Alpha 18 AWG	Beldon 16 AWG	Beldon 20 AWG
High Flex	85603CY	85803CY		
Moderate Flex	65603CY	65803CY		
No Flex	3247	3242	9953	9963

Motor Wiring Path

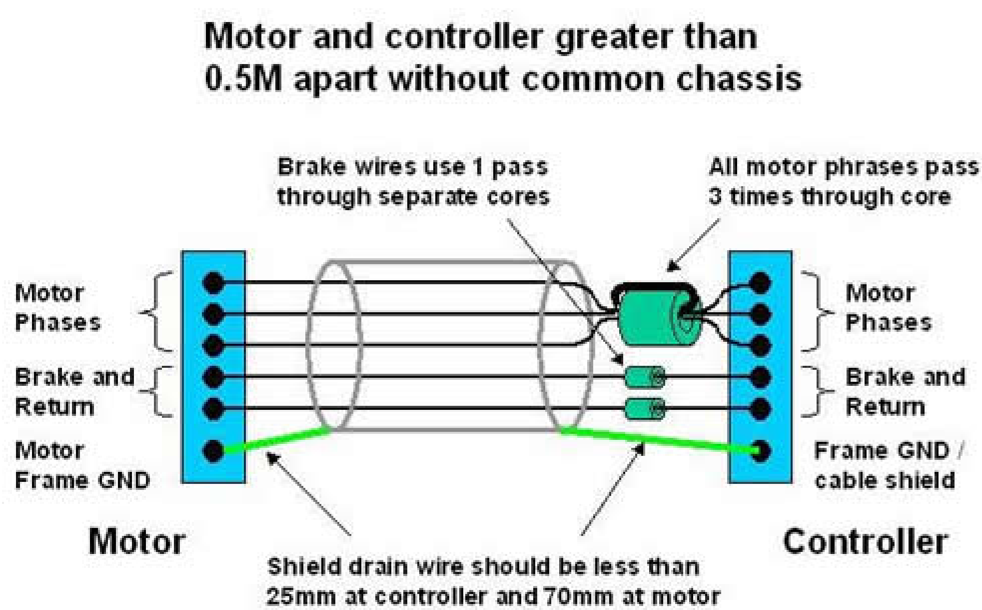
If the motor frame and the amplifier heat sink are less than 0.5 meter apart and share the same metal chassis, **use shielded wire without a shield ferrite bead.** ("Ferrite beads" are sometimes referred to as "ferrite chokes" or "ferrite cores".) In this case, the ground bounce of the motor will be small due to the short distance and the shared chassis. The shield must be connected to the amplifier at pin 5 and at the motor end, to the motor frame. The following picture illustrates how this cable should be wired.



If the distance is more than 0.5 meter, **use a shield bead around the motor phase wires at the amplifier end of the harness to reduce the charging current spikes**. The phase wires as a group must pass thru the bead core three times. The ground or brake wires must **NOT** pass thru the bead core.

Another special consideration is if there is **no** chassis between motor and amplifier, the length of the shield drain wire must be kept as short as possible, probably no more than 25 mm at the amplifier connector end of the cable and no more than 70 mm at the motor end. This will cause the bead to be adjacent to the shield, in order to keep drain wire short.

The following picture illustrates how this cable should be wired.



Motor Ferrite Beads

Based upon the wire and insulation thickness, the following are typical ferrite cores that can be utilized.

Wire and Insulation Thickness	Ferrite Bead
Wires up to 1.5mm	FAIR-RITE #2631540002
Wires up to 2.9mm	FAIR-RITE #2631102002

Thermal rises of up to 40° C in the bead temperatures are acceptable. However, if the bead gets hotter, use the next size core of material 31 or one less turn through the bead. Never use more than 3 turns through the core to avoid diminishing the effectiveness of the ferrite. This is caused by adjacent wires capacitively coupling and passing the spikes through the core.

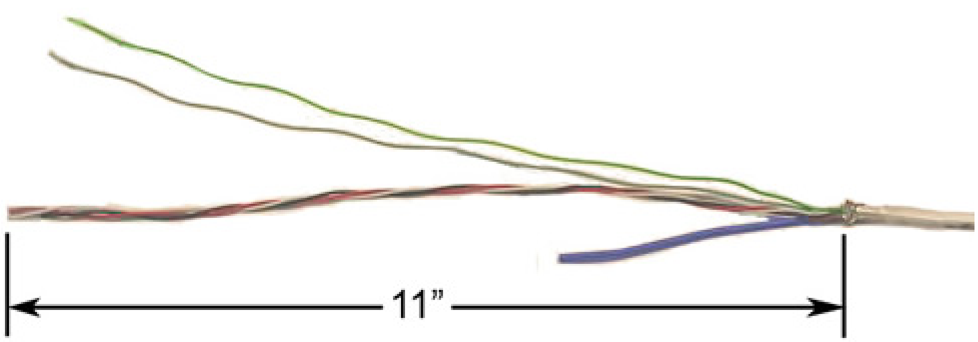
The effectiveness of the cores can be determined with a current probe with a window large enough to pass all the motor phases of the motor in question through the probe in the same direction. Put the probe on the amplifier side of the harness. This will measure the common mode ground current. Use just enough turns to reduce the amplitude of the current spike without causing any additional ringing. Usually you can achieve a 30-50% reduction in the spike amplitude.

Brake Wiring

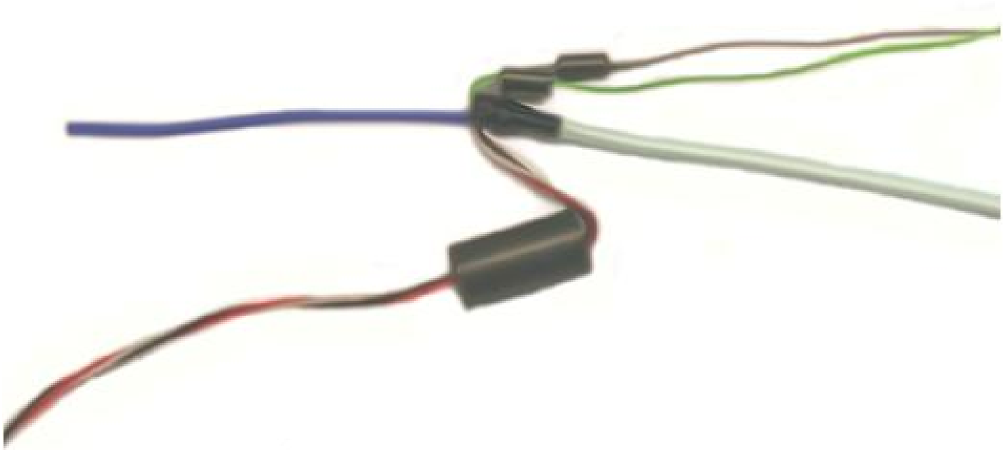
If the brake wires are in the shielded cable with the motor wires, then a separate bead must be used for each brake wire at the controller side of the harness. Use FAIR_RITE # 2673021801. One wiring pass straight through the bead is adequate.

Ferrite Bead Installation Illustration

The following series of pictures illustrate the process of installing a ferrite bead onto the harness at the **controller end** of the motor cable.   In the first picture, the dark blue wire is the shield drain wire that has already been soldered to the shield. The shield was then covered with shrink tubing. This example also shows the optional beads on the brake wires.

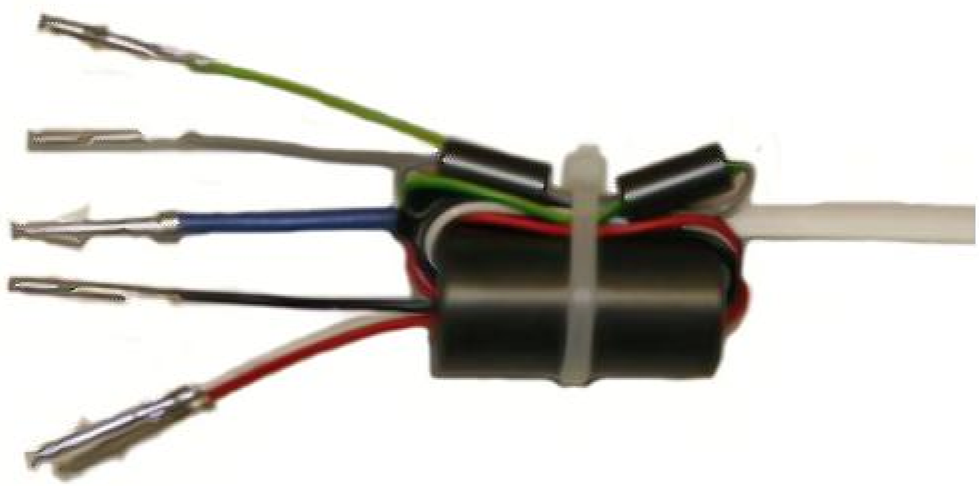


Step 1: Blue drain soldered to shield and wires cut to length

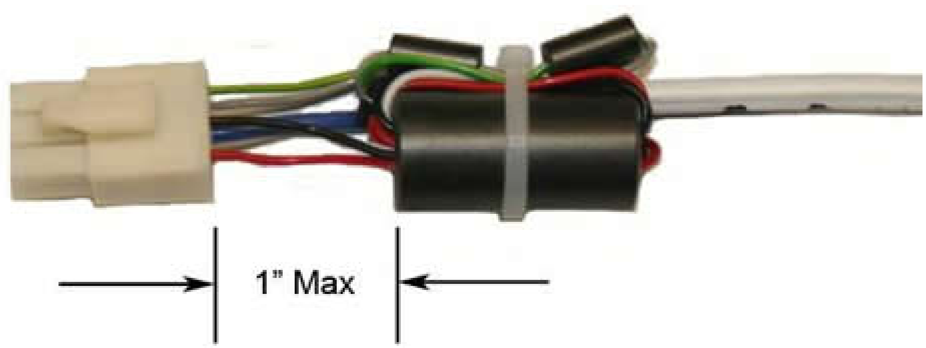


Step 2: Three motor wires through large core, brakes through small cores

Step 3: Three motor wires looped three times through large core



Step 4: All wires leads crimped to pins



Step 5: Final assembled cable with controller motor connector

Encoder Considerations

The preferred encoder should have a differential cable driver built in. The differential signal will cancel out much of the common mode noise that encoder wiring can pick up and, when used with twisted pair wire, will cancel out the magnetic pick up from the motor harness.

Some encoders have an open collector output or an output with only a 10K pull up resistor. These encoders should only be used with a cable driver IC such as a DS26C31 mounted nearby the encoder or the encoder should be mounted within 5 feet of controller and wired with shielded cable.

If an encoder's code wheel or linear mask is made with etched metal or other conductive material, **the encoder should not be used** if it is mounted to any housing or chassis that has ground bounce on it. For example, if such an encoder is directly mounted to a motor frame without electric insulation, its use could result in quadrature errors and other noise problems.

Encoder Cables

It is highly recommended that the encoder cable be shielded and contain 4 twisted pairs with a gage of AWG 24 or AWG 26. See the table below for recommended cables.

Unshielded non-twisted pair encoder wiring should never be run next to unshielded motor wiring or other sources of noise.

	Alpha 24 AWG	Alpha 26 AWG	Beldon 24 AWG	Beldon 26 AWG
High Flex	86604CY	86504CY		
No Flex	5494C 5272C		88104	

One of the twisted pairs should be used for power and ground, one pair for A+ & A-, one pair for B+ & B- and one pair for Z+ & Z-. (See the next section for specific pin assignments.) **Connect the shield to pin 7 on the MIDS encoder connector.** On some encoders that are in a metal box with a metal shell connector, on the encoder end of the cable, connect the shield to the metal shell of the mating connector.

Encoder Wiring and Pin Assignments

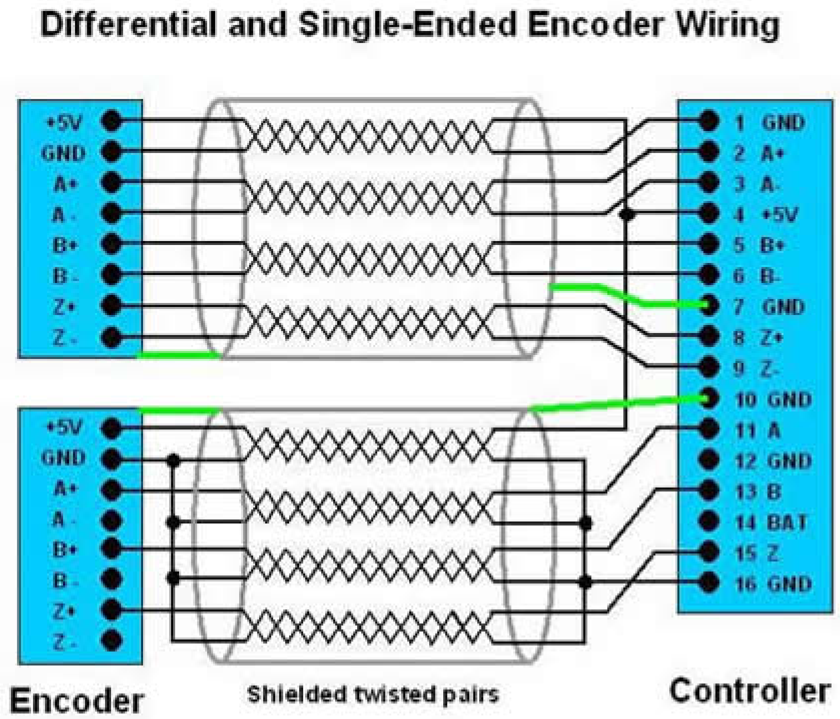
The encoder connectors on the MIDS board can each be cabled to a differential encoder and an optional single-ended encoder. If a single-end encoder is not interfaced, these pins can be configured for use with hall effect sensors or end-of-travel/home switches. Whenever possible, the differential encoder inputs should be used instead of the single-end encoder inputs to achieve greater noise immunity.

If a single-end encoder is connected using twisted pair wire, the low side of both ends of each twisted pair should be connected to ground, and the A-, B-, and Z- signals of the controller's differential encoder inputs should each be pulled to 5V through a 2K resistor. The A+, B+ and Z+ signals should be connected without any special modifications. For high volume OEM applications, surface mounted pull-up resistors can be installed at Precise's factory to configure specific encoder channels for single-ended encoders. For qualified applications, please contact Precise Sales to discuss this option.

If several wires must be connected to a single pin, a larger crimp pin should be used.

> **NOTE:** If crimp style plugs are utilized, ensure that the crimp pins are **gold plated** and designed for **high compression forces**. Using tin plated pins or those with low contact forces can result in intermittent signals if there is any movement of the cables.
>
> Especially for high frequency signals, such as those required for serial absolute encoders, it is critical that **shielded twisted pair cable** be used all the way from the encoder to the controller. Even a 300mm unshielded non-twisted pair cable from the controller to a bulkhead connector can result in significant signal corruption.

The following illustrates how to interface differential and single-ended encoder input signals.


Differential and Single-Ended Encoder Wiring
+5V
GND
A+
A-
B+
B-
Z+
Z-
+5V
GND
A+
A-
B+
B-
Z+
Z-
1 GND
2 A+
3 A-
4 +5V
5 B+
6 B-
7 GND
8 Z+
9 Z-
10 GND
11 A
12 GND
13 B
14 BAT
15 Z
16 GND
Encoder
Shielded twisted pairs
Controller

Hardware Reference

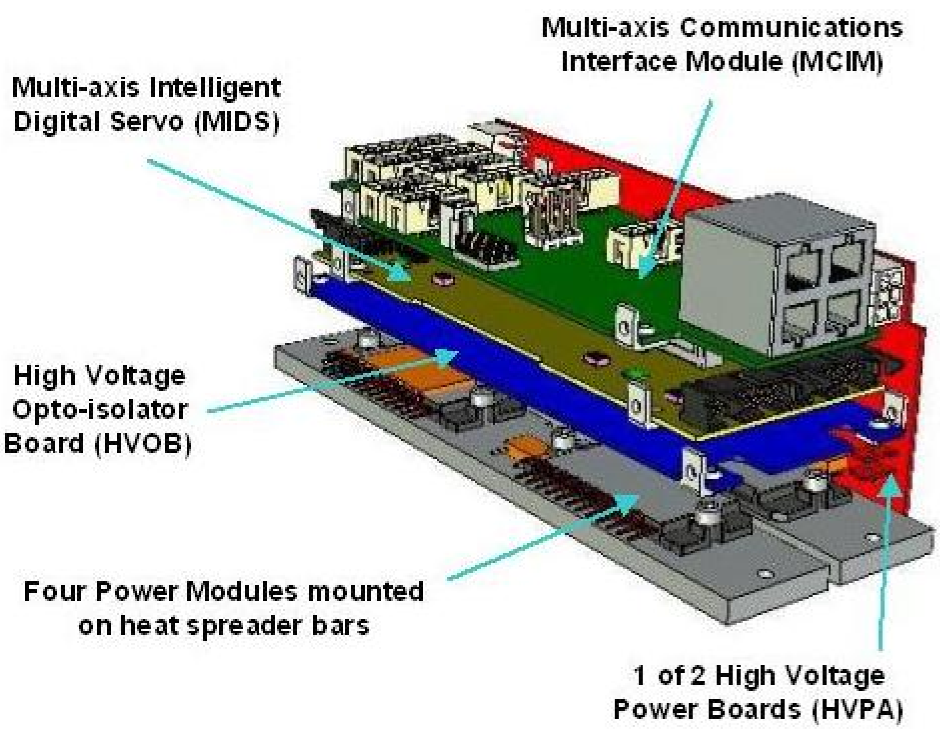
Guidance Controller Assemblies and Interfaces

Guidance Controller Major Assemblies

The Guidance Controllers are constructed from a number of major assemblies, several of which are common among the various types of controllers. Due to the extremely compact design of these controllers and the number of device interface options, connectors for services are mounted on several assemblies. Each of the major assemblies and their interfaces to other equipment are described in this section.

All of the Guidance 3000 Controllers contain a Multi-axis Communications Interface Module (MCIM), on which are mounted most of the communication connectors, and a Multi-axis Intelligent Digital Servo (MIDS) board, which has the CPU and computational functions. If the controller has integrated amplifiers, it also has a High Voltage Opto-isolator Board (HVOB), to separate the digital logic from the power logic, and one or two High Voltage Power Amplifier (HVPA) boards and their associated power modules.

The picture below illustrates the primary assemblies of the Guidance 3000 Controller. For clarity, one of the two identical vertical HVPA's has been removed.



DANGER: The Guidance 3000 and 2000 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 Guidance 2000 Controllers have the same conceptual hardware architecture as the 3000 series and provide similar functionality but at a lower cost.

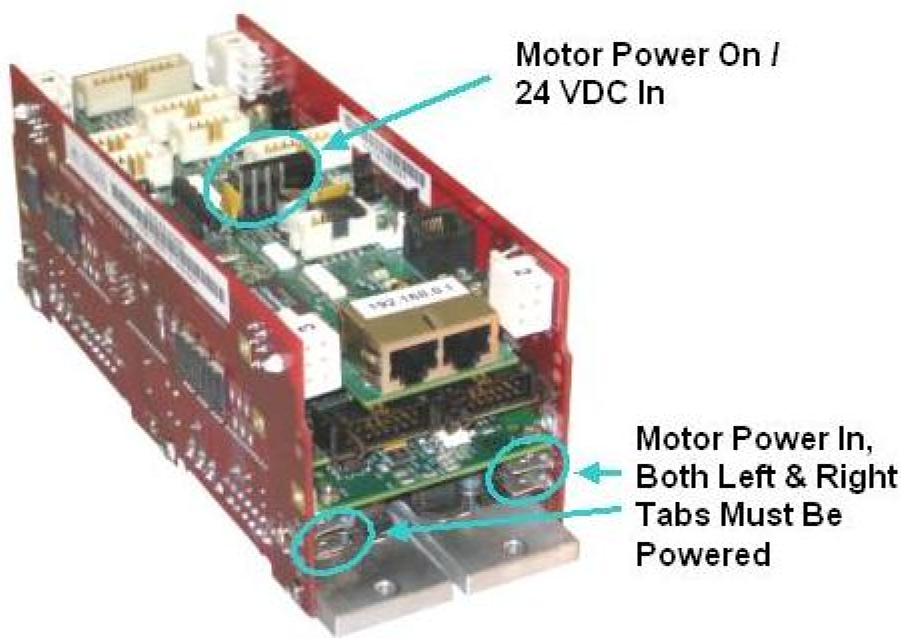
The Guidance 2400B Controller contains the standard MCIM and MIDS boards but combines the functions of the High Voltage Opto-isolator board and two High Voltage Power Amplifiers into a single four-axis high voltage power amplifier board. This results in a lower cost and package height, but the footprint is slightly increased. As a further cost reduction, the Guidance 2400C Controller combines the MCIM and MIDS into a single board (MIDS3) at the expense of some reduced functionality and options.

Power Connectors and Grounding

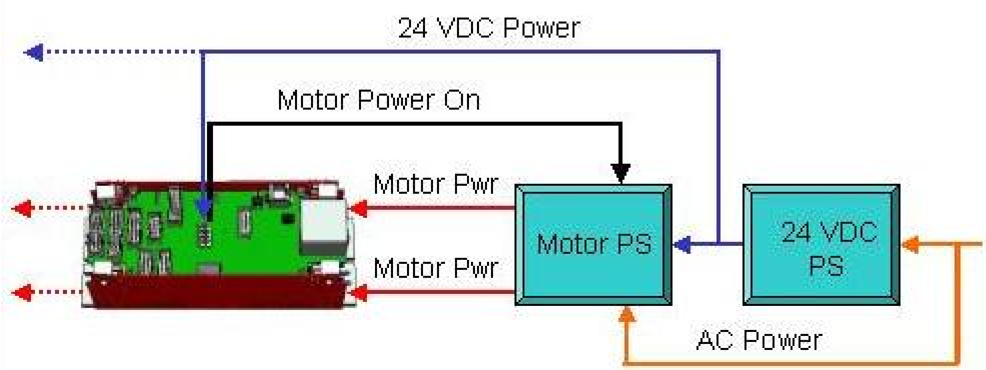
The Guidance 3000 Controller, Motor Power Supply, and 24 VDC Power Supply should be wired as shown below. All of the Guidance 3000/2000 Controllers provide a single connector on their top board that both receives the 24 VDC to power their logic sections and outputs redundant signals that enable the output section of the motor power supply.

For the Guidance 3000, motor power must be provided to both vertical HVPA boards. Motor power tabs are available on both ends the each HVPA. The redundant tabs permit the motor power to be daisy chained to another controller. If a single controller is being powered, either set of tabs can be connected to using Amp 3-520133-2 Faston receptacles or equivalent hardware.

Frame ground is conducted continuously around the Guidance 3000 Controller by means of grounding pads and fastening lugs and screws. The frame ground continues through the heat sink.

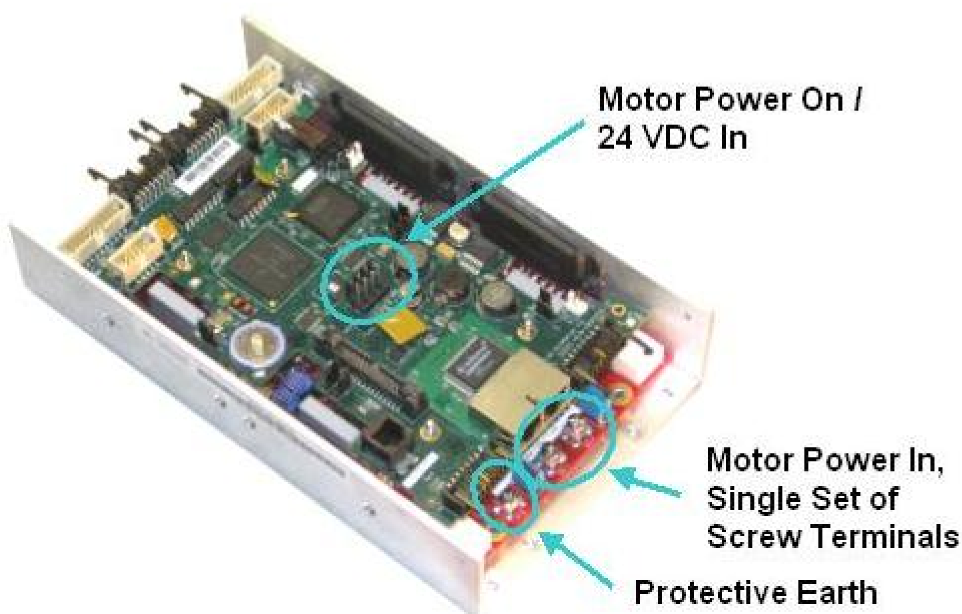


DANGER: The Guidance 3000 is an open frame electrical device that contains unshielded high voltage pins, components and surfaces. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.



As a convenience, if you purchase a Guidance Controller, a Precise 24 VDC Power Supply and a PrecisePower Intelligent Motor Voltage Power Supply, you can also purchase a Guidance Controller Power Harness. This harness provides all of the connections between AC power, the two power supplies and the controller. These power and signal paths are illustrated in solid lines in the drawing above.

DANGER: For the Guidance 3000/2000 controllers, the 24VDC also provides power to the logic in the Power Amplifiers. If the 24VDC is turned off and motor power remains enabled, the Power Amplifiers will be severely damaged and can cause a hazardous condition.



The Guidance 2000 (shown above) and the Guidance Slave Amplifier are wired in the same manner as the Guidance 3000 except that a single pair of screw terminals are provided for connecting DC motor power to the integrated motor drives. Also, a third screw terminal is provided and must be connected to the AC mains earth ground (green wire) for both safety and some increased noise immunity.

DANGER: The Guidance 2000/0200 are open frame electrical devices that contains unshielded 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.

Since the Guidance 0006 and 0004 controllers do not have integrated motor drives, they only require that power be provided on the "24 VDC power in" connector in order to operate.

Communication Interfaces

MCIM And MIDS3 Board Interfaces

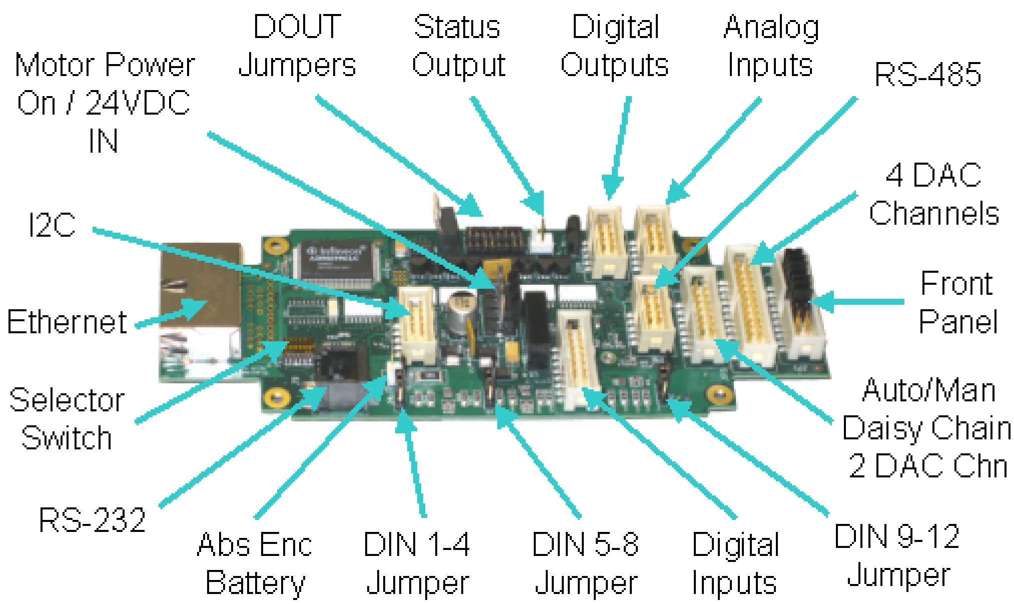
Depending upon the controller model, either the Multi-axis Communications Interface Module (MCIM) or the Multi-axis Intelligent Digital Servo-3 (MIDS3) board contains the connectors that implement interfaces to external equipment. The following list defines all of the possible interfaces. Please see the Product Specifications for detailed information on which interfaces are available with each controller model.

- Absolute encoder battery
- Analog inputs channels
- Analog output (DAC) channels
- Auto/Manual daisy chain & 2 additional DAC channels
- Digital inputs DIN 1 through Din 12
- Digital outputs DOUT 1 through DOUT 8
- Digital input and output jumpers
- Ethernet
- I2C (not available for general use)
- Motor power-on enable / 24VDC controller power input
- Remote Front panel (with ESTOP and MCP/Secondary RS-232 serial port)
- Primary RS-232 serial port
- RS-485 multi-drop serial port (not available with Precise robots)
- Selector switch / jumpers
- Slave Amplifier
- Status LED and status output signal

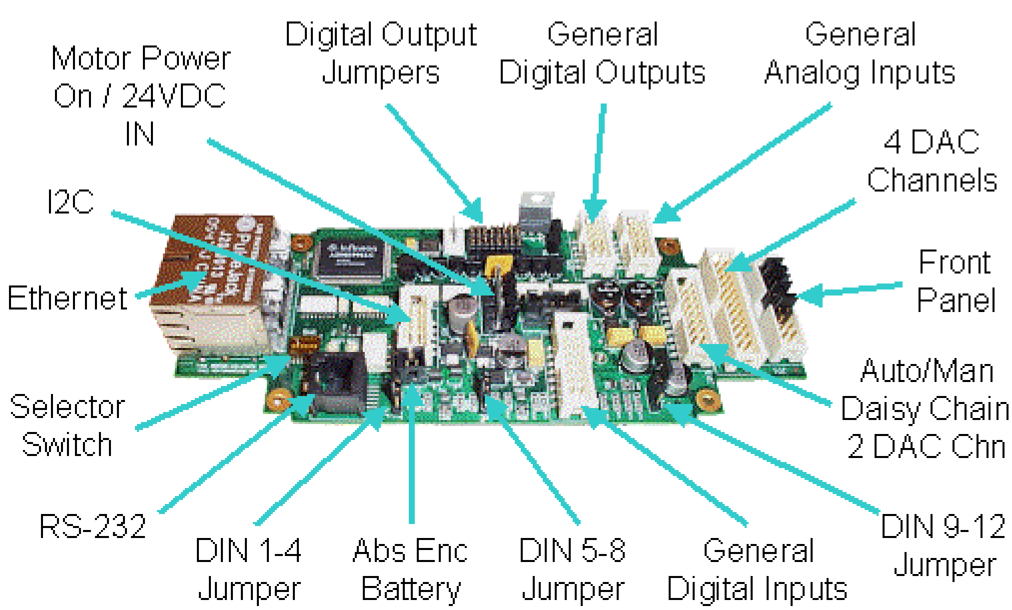
There are two versions of the MCIM that are currently being shipped. These boards offer very similar functionality except that one board includes an RS-485 serial interface.

DANGER: The High Voltage Power Boards (HVPAs) and the Motor/Brake connectors and their leads contain unshielded high voltage pins that are positioned next to the MCIM/MIDS3 connectors. It is intended that the Guidance Controller with these components be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.

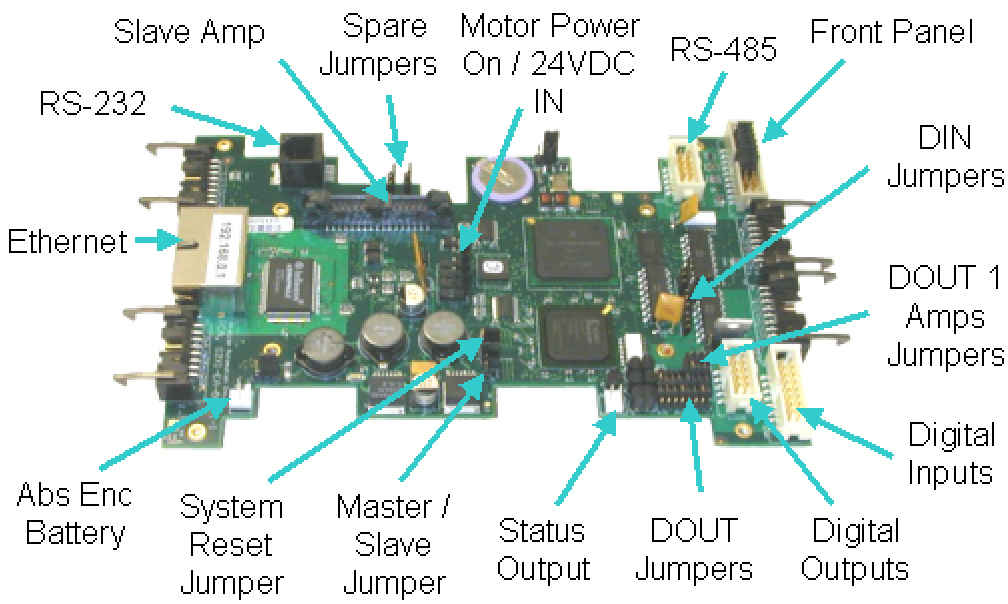
The MCIM with a RS-485 connector is shown below. To jump to the detailed information for a specific interface, click on the interface label or the connector in the following picture.



The MCIM without an RS-485 interface is shown below. To jump to the detailed information for a specific interface, click on the interface label or the connector in the following picture.



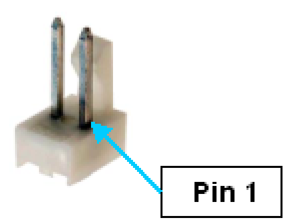
To reduce the price, the MIDS3 combines most of the functions of the MCIM and MIDS into a single assembly. This board is available in the Guidance 2000C series of controllers. In the picture below, the MIDS3's four horizontal encoder connectors with latches are not labeled since these are discussed in the MIDS section of this documentation. To jump to the detailed information for a specific interface, click on the interface label or the connector in the following picture.



In the following sections, the pin-outs for each of the connectors plus the part numbers for the mating plugs are described.

Abs Encoder Battery Connector

Many commercially available absolute encoders require a modest amount of battery power in order to retain their counters when the Guidance controller is powered down. If your system is equipped with this type of encoder, a suitable battery source must be connected to the encoder battery connector that is located on the communications board.



Molex 22-11-2022

From the communication board, the battery power flows down to the MIDS board and then connects to pins on the encoder connectors. Please see the reference pages for the MIDS Encoder connectors for additional information. Also, please refer to the specific information for the encoder for the recommended battery voltage and capacity.

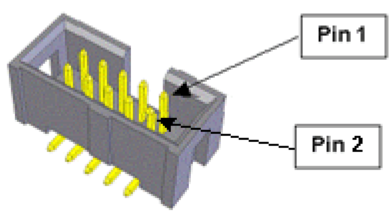
NOTE: Due to the low voltage of batteries and the very low current drain of encoders in standby mode, a poor or higher resistance connection between the battery and the encoder can result in a momentary loss of power to the encoder. Even a very short loss of power can result in an absolute encoder loosing its calibration data and signaling a low battery voltage error. So, all connectors from the battery, through the controller and out to the encoder must be gold plated with high compression forces and all wires must have very low resistance.

Pin	Description
1	+VBAT
2	GND
User Plug Part for Molex 22-11-2022	Housing: TE 1375820-2, Sockets: TE 1375819-2

Analog Inputs

For controllers equipped with a MCIM, these boards provide two or four general purpose analog input channels that are conveyed though a single connector.

The Analog to Digital Converter has a 12-bit resolution and a conversion delay of 3.2 microseconds per channel. The ADC channels are continuously scanned in sequence, so a new reading is available for each channel every 6.4 microseconds (for two channel boards) or 12.8 microseconds (for four channel boards). The input impedance of the analog conversion circuit is 20,000 ohms. There is a 4 KHz noise filter on each input.



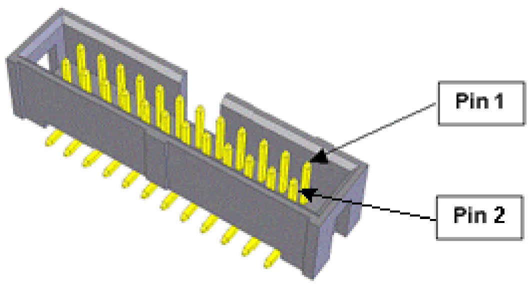
The following table details the pin out for the analog input connector.

Pin	Description
1	24 VDC
2	24 VDC
3	24 VDC
4	24 VDC (+/- 10 VDC input signal, channel 3 on selected controllers)
5	GND
6	+/- 10 VDC input signal, channel 2
7	GND

8	+/- 10 VDC input signal, channel 1
9	GND
10	GND (+/- 10 VDC input signal, channel 4 on selected controllers)
User Plug Part No	AMP 746285-1 or Molex 22-55-2101 or 90142-0010. For the Molex plug, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Analog Output, 4 Channels

Many Guidance Controllers can be optionally supplied with either 4 or 6 instrument grade Digital to Analog Converter (DAC) output channels. These DACs are primarily intended to interface the controller to 3rd party, external motor amplifiers (although they can be utilized as general analog output signals). These external amplifiers can be used in place of or in combination with the controller's integrated motor drives. The signals for the first four DAC channels are provided on a single connector. If supplied, the signals for the next two DAC channels are provided on the Auto/Man Daisy Chain connector.

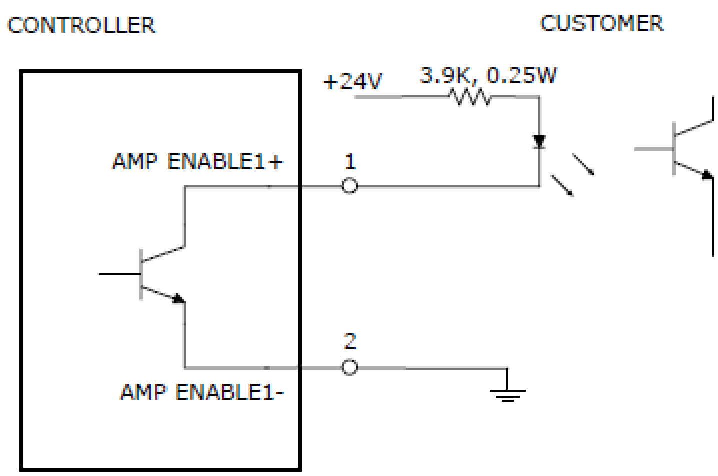


Each of the DAC's has an output range of +/- 10VDC. The DAC values have a resolution of 16 bits and are monotonic to 16 bits as well.   They have a settling time of approximately 10 usec.

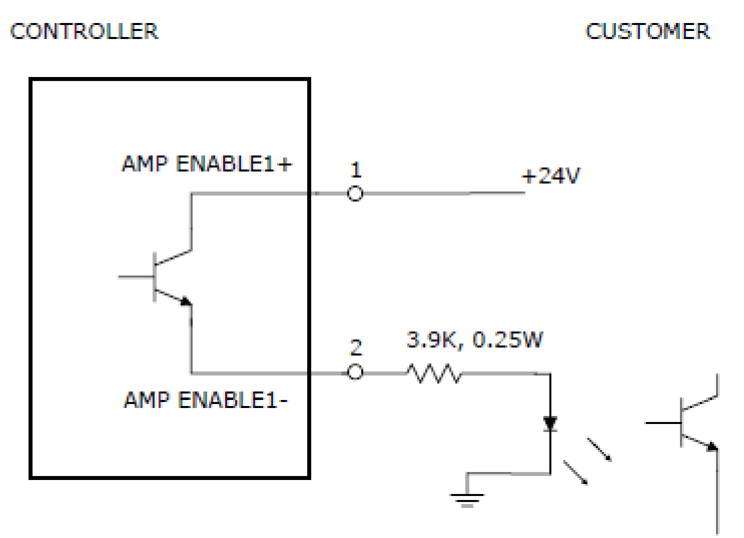
Associated with each DAC channel is an "AMP ENABLE " digital output signal and an "AMP FAULT " digital input signal. The amp enable allows the controller to individually turn on the power to motors. The amp fault signals aid in isolating hardware problems. For the amp enable and amp fault signals, high values are at 24 VDC.

The following drawings illustrate how to wire the AMP ENABLE digital output signals for the first channel in both sinking and sourcing configurations. The AMP ENABLE signals for channels 2 to 6 can be wired in an analogous manner.

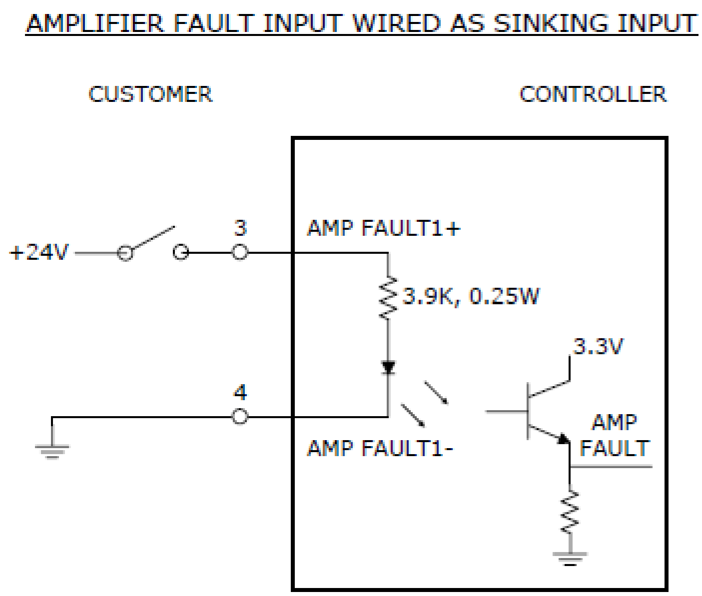
AMPLIFIER ENABLE OUTPUT WIRED AS SINKING OUTPUT

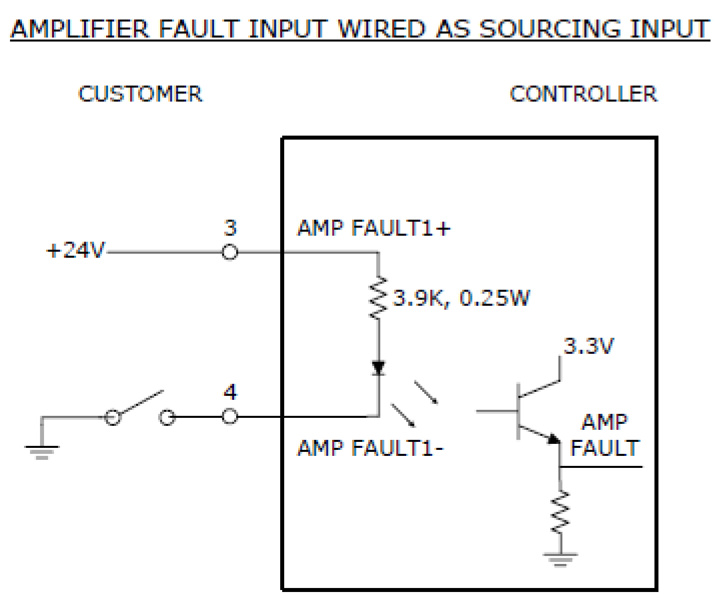


AMPLIFIER ENABLE OUTPUT WIRED AS SOURCING OUTPUT



The following drawings illustrate how to wire the AMP FAULT input signals for the first channel in both sinking and sourcing configurations. The AMP FAULT signals for channels 2 to 6 can be wired in an analogous manner.





The following table details the pin out for the primary analog output connector.

Pin	Description
1	24 VDC AMP ENABLE1 +
2	24 VDC AMP ENABLE1 -
3	24 VDC AMP FAULT1 +
4	24 VDC AMP FAULT1 -
5	+/- 10 VDC DAC1+
6	+/- 10 VDC DAC1-

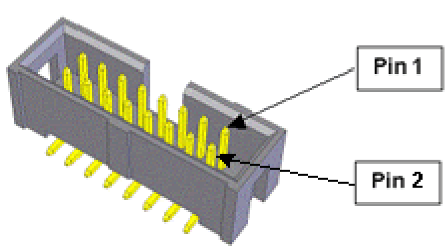
7	24 VDC AMP ENABLE2 +
8	24 VDC AMP ENABLE2 -
9	24 VDC AMP FAULT2 +
10	24 VDC AMP FAULT2 -
11	+/- 10 VDC DAC2+
12	+/- 10 VDC DAC2-
13	24 VDC AMP ENABLE3 +
14	24 VDC AMP ENABLE3 -
15	24 VDC AMP FAULT3 +
16	24 VDC AMP FAULT3 -
17	+/- 10 VDC DAC3+
18	+/- 10 VDC DAC3-
19	24 VDC AMP ENABLE4 +
20	24 VDC AMP ENABLE4 -
21	24 VDC AMP FAULT4 +
22	24 VDC AMP FAULT4 -
23	+/- 10 VDC DAC4+
24	+/- 10 VDC DAC4-
User Plug Part No	Amp 746285-5 or Molex 22-55-2241 or Molex 90142-0024. For the Molex plugs, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Auto/Manual Daisy Chain & 2 DAC Channels

This connector carries a combination of signals: redundant Auto/Manual safety signals and the signals associated with the optional 5th and 6th DAC channels.

The Auto/Manual signals replicate the state of the Auto/Manual signals that are received on the Remote Front Panel Interface. This connector permits these signals to be easily propagated to other networked controllers. When the robot is manually operated, these signals should force all networked controllers to automatically go into a safe, low speed mode.

The DAC channels and their associated signals operate in the same manner as the first four channels that are provided on the Analog Output, 4 Channel connector. Please see the documentation on the first four DAC channels for details on the DAC specification, a description of the associated signals, and sample wiring diagrams.

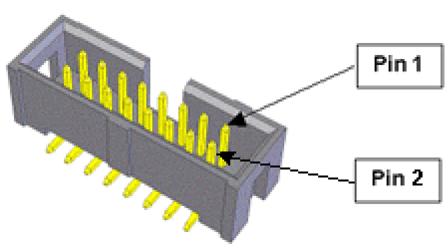


For the Auto/Manual and Amp Enable/Fault signals, high values are at 24 VDC.

Pin	Description
1	AUTO_MAN2
2	24 VDC
3	AUTO_MAN1
4	24 VDC
5	24 VDC AMP ENABLE6 +
6	24 VDC AMP ENABLE6 -
7	24 VDC AMP FAULT6 +
8	24 VDC AMP FAULT6 -
9	+/- 10 VDC DAC6+
10	+/- 10 VDC DAC6-
11	24 VDC AMP ENABLE5 +
12	24 VDC AMP ENABLE5 -
13	24 VDC AMP FAULT5 +
14	24 VDC AMP FAULT5 -
15	+/- 10 VDC DAC5+
16	+/- 10 VDC DAC5-
User Plug Part No	Amp 746285-3 or Molex 22-55-2161 or Molex 90142-0016. For the Molex plugs, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

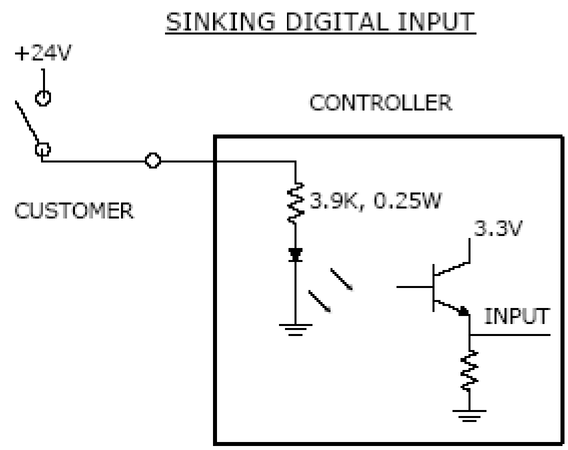
Digital Inputs

All communication interface boards provide 12 general purpose optically isolated digital input signals that are accessed in a single IDC connector. This type of connector permits these signals to be easily interfaced to other devices.

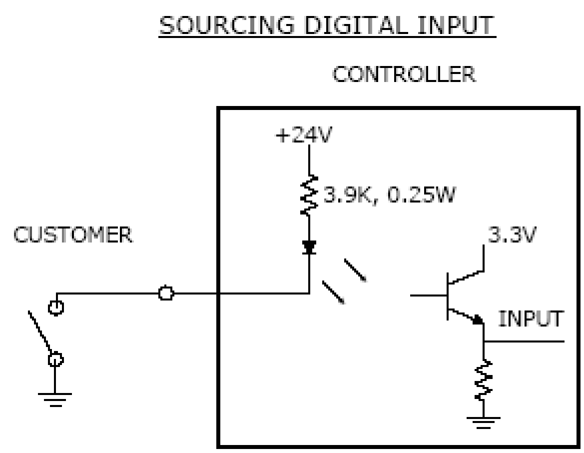


By setting three sets of Sinking Versus Sourcing Jumpers, these inputs can be configured as either "sinking" or "sourcing" in groups of 4 signals.

If an input signal is configured as "sinking", the external equipment must provide a 5VDC to 24VDC voltage to indicate a logical high value or no voltage for a logical low. This configuration is compatible with "sourcing" (PNP) sensors.



If an input signal is configured as "sourcing", the external equipment must pull the 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. This configuration is compatible with "sinking" (NPN) sensors.



As shipped from the factory, all digital inputs are normally configured as "sourcing".

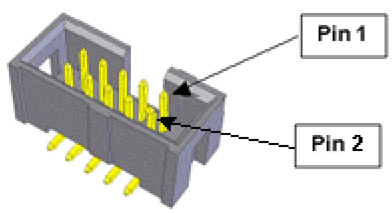
The pin out for the Digital Input Connector and the corresponding GPL signal numbers are described in the following table.

Pin	GPL Signal Number	Description
1		24 VDC
2		GND
3	10001	Digital Input 1
4	10002	Digital Input 2
5	10003	Digital Input 3
6	10004	Digital Input 4
7	10005	Digital Input 5
8	10006	Digital Input 6
9	10007	Digital Input 7

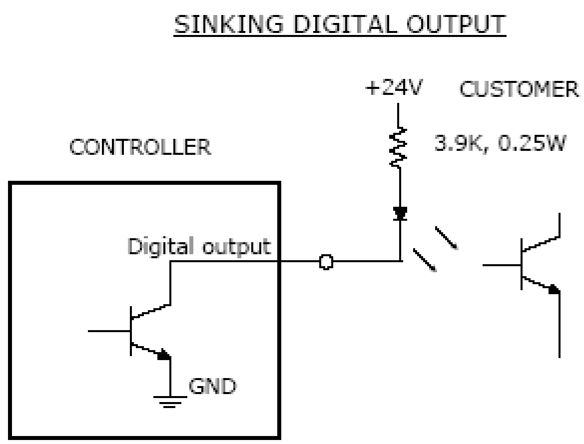
10	10008	Digital Input 8
11	10009	Digital Input 9
12	10010	Digital Input 10
13	10011	Digital Input 11
14	10012	Digital Input 12
15		24 VDC
16		GND
User Plug Part No		Amp 746285-3 or Molex 22-55-2161 or Molex 90142-0016. For the Molex plugs, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Digital Outputs

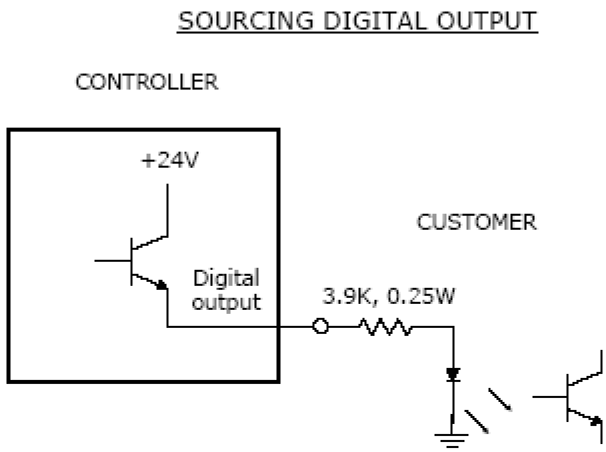
All communication interface boards provide 8 general purpose optically isolated digital output signals that are accessed in a single IDC connector. This type of connector permits these signals to be easily interfaced to other devices.



By setting eight sets of Sinking Versus Sourcing Jumpers, each output can be individually configured as either "sinking" or "sourcing". If an output signal is "sinking", the external equipment must provide a 5VDC to 24VDC pull-up voltage on the output pin and the controller pulls this pin to ground when the signal is asserted as true. This configuration is compatible with "sourcing" (PNP) devices.



If an output signal is "sourcing", the external equipment must pull-down the output pin to ground and the controller pulls this pin to 24VDC when the signal is asserted as true. This configuration is compatible with "sinking" (NPN) devices.



As shipped from the factory, all digital outputs are normally configured as "sinking".

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

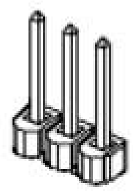
Pin	GPL Signal Number	Description
1	13	Digital Output 1 - For most controllers, when configured as sourcing, this output drives 500mA, whereas Outputs 2-8 drive 100mA. Starting in 2013, for the G2xxxC controllers only, jumpers were added to permit this signal to drive 500ma or 100ma. For this controller, by default, this signal is jumpered for 100mA. If this output is configured for 500mA current, 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	14	Digital Output 2
3	15	Digital Output 3
4	16	Digital Output 4
5		24 VDC
6		GND
7	17	Digital Output 5
8	18	Digital Output 6
9	19	Digital Output 7
10	20	Digital Output 8
User Plug Part No		AMP 746285-1 or Molex 22-55-2101 or 90142-0010. For the Molex plug, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Digital I/O: Sinking Versus Sourcing and DOUT1 Jumpers

When referring to digital input and output signals, "sinking" and "sourcing" indicates whether the external equipment or the controller provides current to power the signaling operation. The selection of sinking or sourcing is controlled by a series of hardware jumpers on the communication board.

For digital inputs, if the controller is "sinking", the external equipment must connect the input signal to a voltage to indicate a logical high value. This configuration is compatible with "sourcing" (PNP) sensors. If the controller is "sourcing", the external equipment must connect the input signal to ground to indicate a logical high value. This configuration is compatible with "sinking" (NPN) sensors.

The digital input signals can be configured as sinking or sourcing in groups of 4 signals. This configuration is performed using three sets of three jumper posts labeled J4, J5 and J6. The locations of these posts are illustrated in the diagram of the communication boards and are identified by stenciled labels on the surface of the boards. ***As shipped from the factory, all digital inputs are normally configured as "sourcing".***

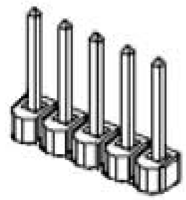


The following table indicates how the pins of each set of posts must be shorted ("jumpered") in order to achieve the specified configuration. For the MIDS3 (G2xxxC controllers), pins 1 are closest to the edge of the board. For the MCIM (G3xxx and G2xxxB controllers), pins 1 are closest to the center of the board.

Digital Input Signals	For Sinking Inputs	For Sourcing Inputs
Inputs 1 to 4	J4-3 TO J4-2	J4-2 TO J4-1
Inputs 5 to 8	J5-3 TO J5-2	J5-2 TO J5-1
Inputs 9 to 12	J6-3 TO J6-2	J6-2 TO J6-1

For digital outputs, if the controller is "sinking", the external equipment must connect the output signal to a pull-up voltage. This configuration is compatible with "sourcing" (PNP) devices. If the controller is "sourcing", the external equipment must connect the signal to a pull-down to ground. This configuration is compatible with "sinking" (NPN) devices.

The digital output signals can be individually configured as sinking or sourcing. This configuration is performed using a block of 8 rows of jumper posts, 5 pins per roll, labeled J7. The locations of these posts are illustrated in the diagram of the communication boards and are identified by stenciled labels on the surface of the boards. ***As shipped from the factory, all outputs are configured as "sinking".***



For the MIDS3 board (G2xxxC controllers), the row closest to the Ethernet connector is for DOUT8. For the MCIM board (G3xxx and G2xxxB controllers), the row closest to the Ethernet connector is for DOUT 1. For both the MIDS3 and the MCIM, within each row, pins 1 are closest to the edge of the board and pins 5 are closest to the center of the board.

Digital Output Signals	For Sinking Outputs	For Sourcing Outputs
One row of 5 pins for each DOUT signal	Pins 2 TO 3 and 4 TO 5	Pins 1 TO 2 and 3 TO 4

Digital output #1 (DOUT1) formerly drove 500mA of current on all controller models when configured as sourcing, whereas digital outputs 2-8 drive 100mA. When configured for 500mA, even when the output signal 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 unless a drainage resistor is added.

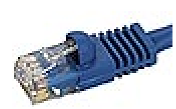
In early 2013, the MIDS3 (G2xxxC Controllers only) was modified to add three sets of three jumper posts, labeled J16, J17, J18, that configure whether DOUT1 drives 500mA or 100mA. The locations of these posts are illustrated in the diagram of the communication boards and are identified by stenciled labels on the surface of the boards. ***As shipped from the factory, DOUT1 is configured to drive 100mA on G2xxxC Controllers.***

For each jumper, pin 1 is closest to the center of the board and pin 3 is closest to the edge of the board.

Digital Output #1 Current Output	100 mA	500 mA
J16, J17, J18	Pins 2 TO 3	Pins 1 TO 2

Ethernet Interface

In order to simplify networking equipment together via Ethernet, the Guidance Controllers contain two 10/100 BaseT Ethernet RJ45 connectors (four ports are available as a special order). Any of the ports can be utilized with either a straight-thru or a cross-over Ethernet cable to connect to other equipment.

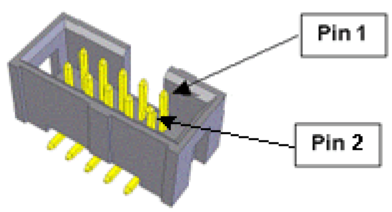


All of the ports are interfaced to a built-in 10/100 Mbit Ethernet Switch that auto detects the sense of each cable. If two ports are connected to equipment that are communicating with each other but not the controller, the Ethernet switch automatically routes the traffic between the two ports and does not send this information to the controller. For example, if an Ethernet camera is connected to one port and a PC is connected to another port, the camera image data will not burden the controller's CPU.

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

I2C Interface

Some communication boards provide an I2C interface connector. This is a high-speed serial protocol that can be daisy-chained to interconnect multiple I2C devices. Currently, I2C is utilized internally in the controller to interface to a clock/calendar chip, the MCIM dip switches, and a series of temperature sensors. In the PrecisePlace 1300/1400 robots, I2C is used to interface the controller to the robot's Z-axis IO board. For the 2000W PrecisePower Intelligent Motor Power Supply, an I2C connection provides power supply status information to the Guidance controller.

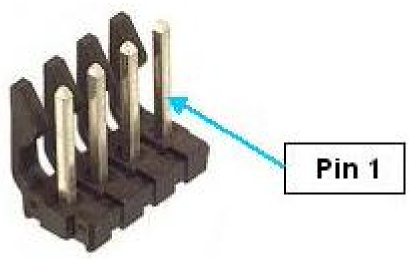


Pin	Description
1	24 VDC
2	24 VDC
3	GND
4	GND
5	GND
6	GND
7	SDA
8	VCC
9	SCL
10	GND
User Plug Part No	Molex 22-55-2101. For this Molex plug, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Motor Power On/24 VDC IN

This is a 4-pin header that is used to: (1) output signals that control turning on and off the external motor power supply and (2) input the 24 VDC that powers the digital section of the controller. If you purchase a

PrecisePower Intelligent Motor Power Supply, Low Voltage Power Supply, and the Power Harness, there is a single cable that plugs into this header.



The motor "power on" signals are configured as a redundant pair of sinking signals. These should be wired to a pair of relays that are connected in series to enable and disable the motor power supply. Normally, 5 to 24 VDC is applied to this control circuit. The external motor power supply should be turned on when the controller's logic switches the "power on" signals to ground. These signals are automatically opened when an E-Stop or other condition occurs that requires that the amplifiers be shutdown.

The 24 VDC power input and ground pins should be connected to a low voltage power supply that remains on independently of whether the motors are enabled. Turning off the 24 VDC will completely shutdown the controller.

The mating plug for this header is a Molex 09-50-3041 and the crimp style pins for this connector are 08-50-0105. The pin designations for this plug are as follows:

Pin	Description
1	GND
2	+24 VDC input
3	Motor power enable. Switched to ground when power is being enabled. Capable of sinking 2A at 24 VDC.
4	Motor power enable (Redundant signal). Provided to comply with safety standards.
User Plug Part No	Molex 09-50-3041. For this Molex plug, use Molex pins 08-50-0105 and Molex crimp tool 63811-2200.

Remote Front Panel Interface & Secondary RS-232 Port

The remote front panel interface includes all of the signals necessary to implement a fully compliant EC Category 3 (CAT-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 to a Manual Control Pendant.

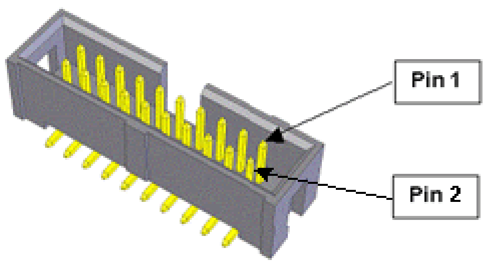
In the future, Precise will offer a Remote Front Panel option that plugs into this connector. Alternatively, customers can develop their own custom front panels (please see the section on "Safety Circuits For Remote Front Panel" for a suggested design). Or, if your application does not require a fully compliant

Category 3 (CAT-3) front panel, the controller can be operated without a front panel or with only a simple E-Stop button or a Manual Control Pendant with an E-stop button.

When a front panel is not utilized, the following pins on the front panel connector must be jumpered in order for the controller to operate properly. (The controller is shipped with these jumpers installed.)

1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14

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.

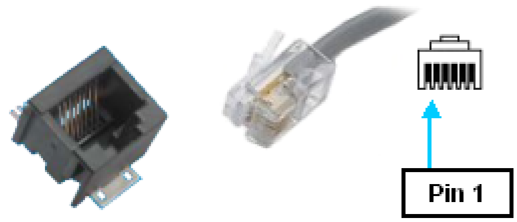


Pin	Description
1	Auto/Manual 2 (If no front panel or Auto/Manual switch, connect to pin 2). Input signal that is high to indicate that the system is being operated in a fully automatic mode or low or open for manual operation. This is normally controlled by a key switch on the Remote Front Panel of the master controller. During Manual Mode, only Jog mode motions are permitted and the servos restrict the axes to special "Manual mode max torque %" and "Manual mode speed limits" to ensure that the system can be safely manually operated. When this signal changes from Auto to Manual, motor power is automatically turned off and must be re-enabled to move the robot. The Auto/Manual signal is daisy chained to all controllers in the servo network.
2	24 VDC
3	Auto/Manual 1 (If no front panel or Auto/Manual switch, connect to pin 4). Redundant Auto/Manual input signal.
4	24 VDC
5	ESTOP_L 2 (If no front panel or E-Stop not asserted, connect to pin 6). An input signal that is low or open indicates that a hardware E-Stop condition has been asserted by some 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.
6	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.
7	ESTOP_L 1 (If no front panel or E-Stop not asserted, connect to pin 8). Redundant ESTOP input signal.

8	Force ESTOP_L. Redundant Force ESTOP_L output signal.
9	External ESTOP_L (If no front panel or not an External ESTOP, connect to pin 10). 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.
10	Force ESTOP_L. Redundant Force ESTOP_L output signal.
11	High Power Lamp Fail (If no front panel, jumper to pin 12). 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.
12	Ground
13	High Power Enable (If no front panel, jumper to pin 14). Input signal that must transition from low to high during the EC Category 3 (CAT-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.
14	Ground
15	Spare.
16	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.
17	MCP RXD. RS-232 receiver serial line from the Manual Control Pendant or external device.
18	MCP TXD. RS-232 transmitter serial line to the Manual Control Pendant or external device.
19	5 VDC. WARNING - This voltage is provided as a convenience but is limited in the current that can be supplied. Drawing excessive current can damage the controller. Consult Precise if there is any question about the use of this voltage.
20	5 VDC. WARNING - This voltage is provided as a convenience but is limited in the current that can be supplied. Drawing excessive current can damage the controller. Consult Precise if there is any question about the use of this voltage.
User Plug Part No	Amp 746285-4 or Molex 22-55-2201 or Molex 90142-0020. For the Molex plugs, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Primary RS-232 Serial Interface

The primary RS-232 serial communication line connector is a RJ-11 modular jack, CablesNMor T23750. The plug is a standard RJ-11 phone plug, such as an Jameco 115617CH. This port is used as the serial console port and can also be accessed by GPL procedures as device /dev/com1.



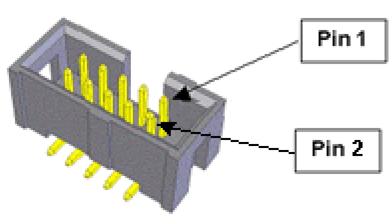
Pin	Description
1	CTS - clear to send
2	RTS - ready to receive
3	Ground
4	RXD - controller receive data
5	TXD - controller transmit data
6	Not Connected
User Plug Part No	RJ-11 phone plug

RS-485 Serial Interface

RS-485 is a multi-drop serial communication interface. At the application level, it can transmit and receive data in a manner similar to a RS-232 interface with the added benefit that the communication lines can be daisy chained between multiple nodes instead of requiring point-to-point wiring. Within GPL application programs, this port is referenced as "/dev/com4".

For reliable communications, RS-485 lines must be terminated at both ends of the daisy chain and must not have any termination at interior nodes. The controller's RS-485 interface includes hardwired termination. Therefore, ***the controller must always be at one end of the RS-485 daisy chain.***

The RS-485 interface is ***not available for interfacing to 3rd party devices*** when the controller is embedded in a Precise robot such as the PrecisePlace and PreciseFlex. In these robots, this interface is dedicated to communicating with the built-in Serial I/O boards.

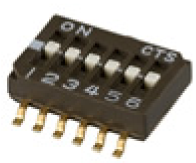


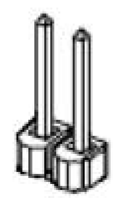
<table>
<tr><th>Pin</th><th>Description</th></tr>
<tr><td>1</td><td rowspan="2">24 VDC. Starting in early 2013, all Guidance Controllers can output a maximum of 2A at 24VDC on the RS-485 connector assuming that the controller's 24VDC power supply has sufficient power. Prior to early 2013, this was limited to only 1.35A.</td></tr>
<tr><td>2</td></tr>
</table>

3	GND
4	GND
5	GND
6	VCC
7	GND
8	RS485+
9	RS485-
10	GND
User Plug Part No	AMP 746285-1 or Molex 22-55-2101 or 90142-0010. For the Molex plug, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.

Selector Switch / Jumper Settings

On the MCIM boards, a 6-position selector switch provides a software system reset function and specifies controller configuration options. On the MIDS3 boards, these same functions are provided by several 2-pin jumper posts.





For normal operation, all switches should be set to ON and jumper plugs should NOT be installed on the jumper posts.

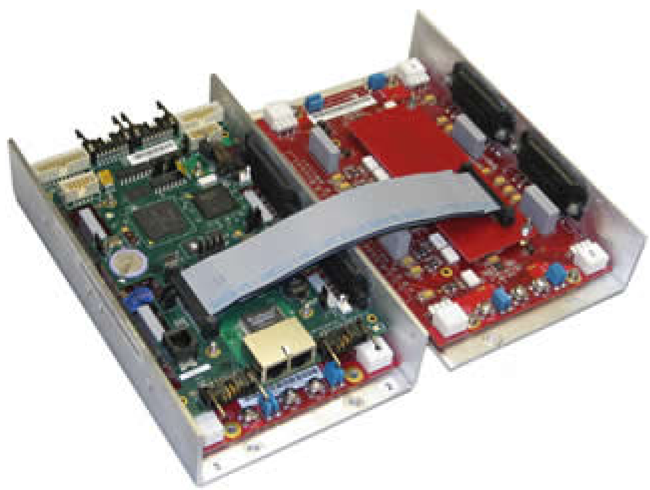
The slider switch assignments on the selector switch and the board designators for the jumper posts are defined as follows:

Switch	Jumper Posts	Description
1	J10	Software Reset. Set to ON for normal operation. Set to OFF to ignore the standard configuration files. If set to OFF when the system is restarted, the default configuration files (*.PAC) are applied instead of the standard files. This setting is utilized if a configuration file becomes corrupted or a setting inadvertently makes the system unusable.
2	J8	Master or Slave node in a multiple controller servo network. This switch is normally set to ON to indicate the controller is operating standalone or is the Master in a servo network. Must be set to OFF to indicate that the controller is to startup as a Slave in a servo network.
3		TBD. Should be set to ON.
4		TBD. Should be set to ON.
5		TBD. Should be set to ON.

6		TBD. Should be set to ON.

Slave Amplifier Connector

For 6-axis robot configurations that only require the standard communication interfaces and motors sizes up to 750W, a dual Slave Amplifier (G0200C) can be interfaced to the Enhanced Guidance G2400C controller to produce a six-axis Guidance G2600C controller. This configuration provides six tightly coupled motor drives at a lower price than networking two controllers. The following is a picture of this controller.



The Enhanced G2400C is on the left and the G0200C is on the right. The Slave provides two motor connectors that have the same pin out as those provided on the G2400C. The Slave also contains the same motor power input posts and protected earth pin as the G2400C and these are normally jumpered to the G2400C. All encoders must be interfaced to the four encoder connectors provided on the G2400C.

The G2400C and the G0200C communicate over a single ribbon cable that plugs into two identical Slave Amplifier Connectors that are located on each control unit. This connector is a Samtec EHT-117-01-S-D-SM-P and is pictured below.

An off-the-shelf straight-through cable for connecting the two Samtec connectors is provided with the G0200C. The specification for this cable is presented in the table below.

NOTE: If the execution of 6 servo processes is consuming too much of the available CPU capacity and there is not adequate time for executing your application program, the servo load can be reduced by doing any of the following:

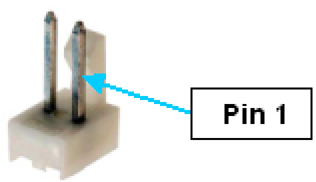
- Increase the "Trajectory Generator update period in sec" (DataID 600) to 0.004 or longer.
- Increase the "Servo update period in sec" (DataID 603) from the default of 0.000125 to 0.000250.
- Increase the "Position loop update rate" (DataID 10021) from 0.0005 to 0.001.

Pin	Description
Straight-through Cable For Slave Amplifier Connector	Samtec TCSD-17-D-21.00-01-N (21 inch length)

Status LED and Status Output Signal Connector

The communication boards include an LED that indicates the status of the controller by blinking. The execution conditions that are indicated by the LED are described in the Status LED and Status Output Signal section of this manual.

If the controller is embedded, an external LED can be connected to a General Digital Output Signal and the blinking function can be mapped to the signal. As a convenience, the 8th General Digital Output Signal is duplicated in a 2 pin header. This permits an LED to be easily wired to the controller without having to breakout this one signal from the General Digital Outputs Connector.

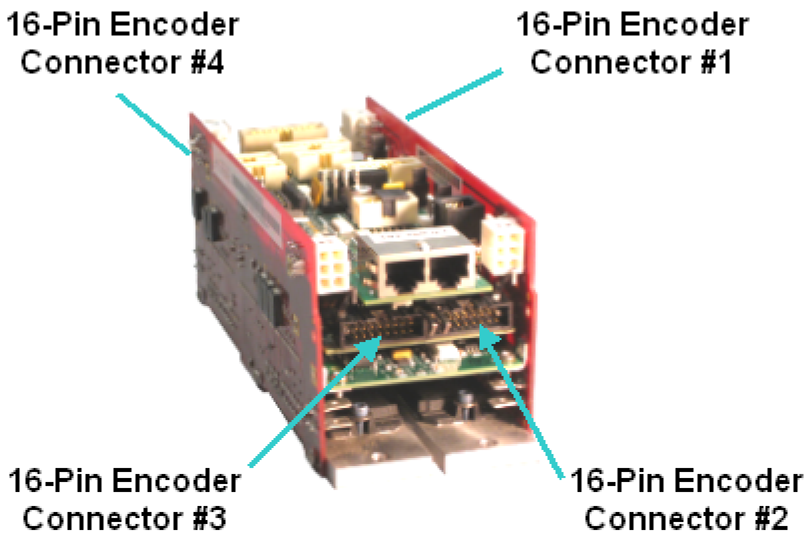


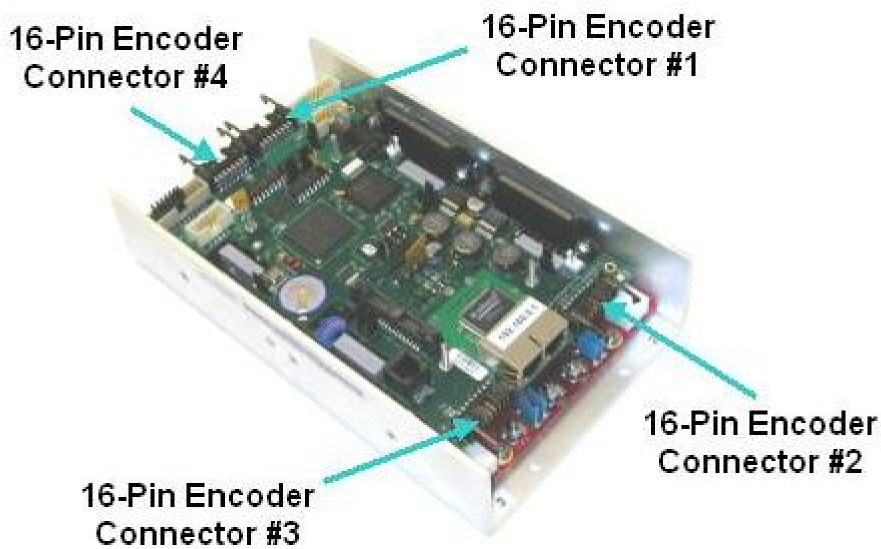
To configure the 8th Digital Output Signal to blink in synchronization with to the controller status, the "Power State DOUT" (DataID 235) value in the controller's Parameter Database should be set to "8". In addition, as shipped from the factory, the 8th Digital Output Signal is configured as "sinking". In order to drive an LED, this signal must be configured as "sourcing". Please see the section on Sinking Versus Sourcing Jumpers for information on reconfiguring this signal.

Pin	GPL Signal Number	Description
1	20	Digital Output 8
2		GND
User Plug Part No		Molex 22-01-2021 mates to Molex 22-23-2021 Header

MIDS Board Encoder Interfaces

There are four identical 16-pin encoder connectors on the MIDS board for the Guidance 3000 and the MIDS3 for the Guidance 2000C. There are two encoder connectors mounted on each end of these boards. These connectors are numbered in the same order as the labeled motor connectors. The following illustrates the positions of the encoder connectors in both controllers.

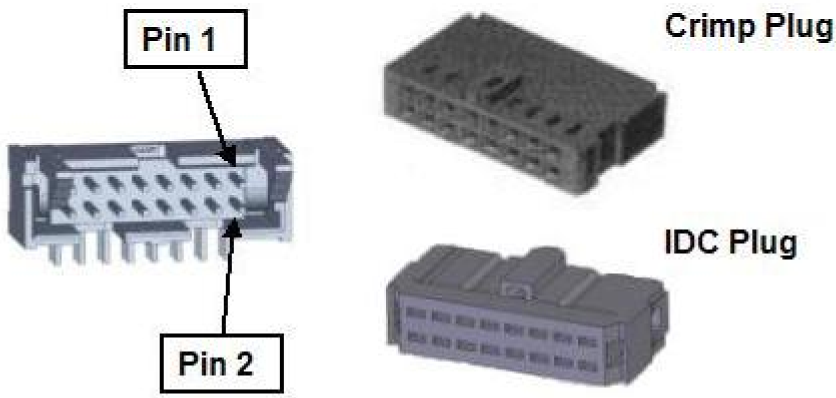




The encoder connectors are configured so that a variety of incremental or absolute encoders can be connected to the controller. Pins 2, 3, 5, 6, 8 and 9 will accept either a standard digital or an optional analog sin wave encoder signal (only supported in selected controller models). For analog encoder signals, an optional 12-bit ADC is used to digitize the signals. This ADC can also interpolate the analog encoder signals to increase the effective resolution of the encoder. Absolute encoders are interfaced via these same signal pins. (See the "Third Party Equipment" section of this manual for information on connecting supported absolute encoders.) Either single-ended or differential encoder signals can be connected to this primary encoder interface. (Analog and absolute encoder interfaces are only available on some "Enhanced" versions of the Guidance Controllers due to special hardware requirements.)

In addition to the primary encoder interface, there are 3 digital inputs available in each encoder connector. These can be configured for hall-effect sensors or two over-travel sensors plus a homing sensor. When configured for these functions, they should be treated as standard 5VDC sourcing digital inputs connections. Alternatively, these 3 digital signals can interface to a second, single-ended encoder.

This single-ended encoder can be used independently of the primary encoder or the two encoders can be used together to implement dual encoder loop servo control of an axis of motion.



The following table defines the connector pin outs. The second column should be used when the 3 digital inputs are configured for hall-effect sensors or over-travel switches and a homing sensor. The third column describes the pin outs when a second, single-ended encoder is utilized.

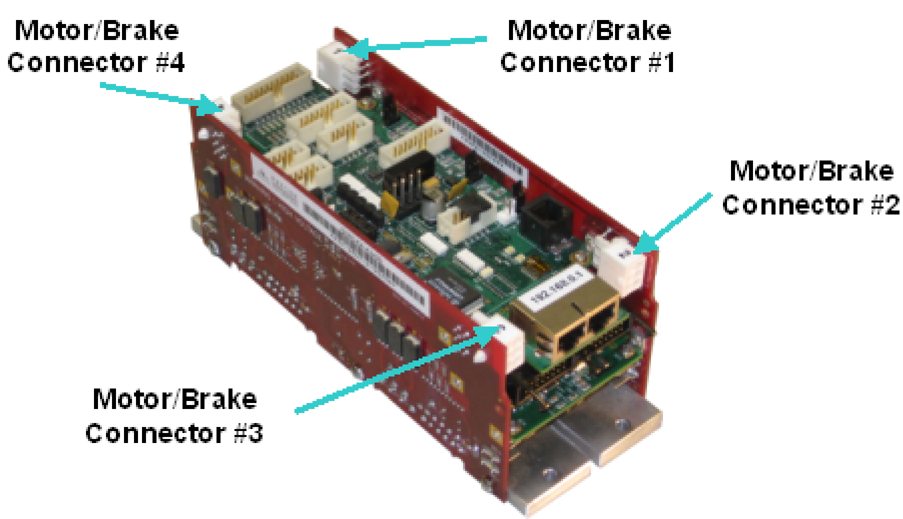
Pin	3 Digital Inputs (5 VDC)	2nd Encoder (5 VDC)
1	Gnd	
2	Encoder 1 A+ (Digital or Analog)	
3	Encoder 1 A- (Digital or Analog)	
4	5VDC provided to power encoders. The sum of the current drawn from all four encoder connectors is limited to 1 amp.	
5	Encoder 1 B+ (Digital or Analog)	
6	Encoder 1 B- (Digital or Analog)	
7	Gnd	
8	Encoder 1 Z+ (Digital)	
9	Encoder 1 Z- (Digital)	
10	Gnd	
11	Digital Input #1 Hall #1 or Homing Switch	Encoder 2 A+
12	Gnd (Reserved for Abs Encoder Bat Gnd)	
13	Digital Input #2 Hall #2 or Positive Over-Travel	Encoder 2 B+
14	Vcc (Reserved for Abs Encoder Bat Pwr)	
15	Digital Input #3 Hall #3 or Negative Over-Travel	Encoder 2 Z+
16	Gnd	
Board Header	Amp 104315-03-3-o-s	

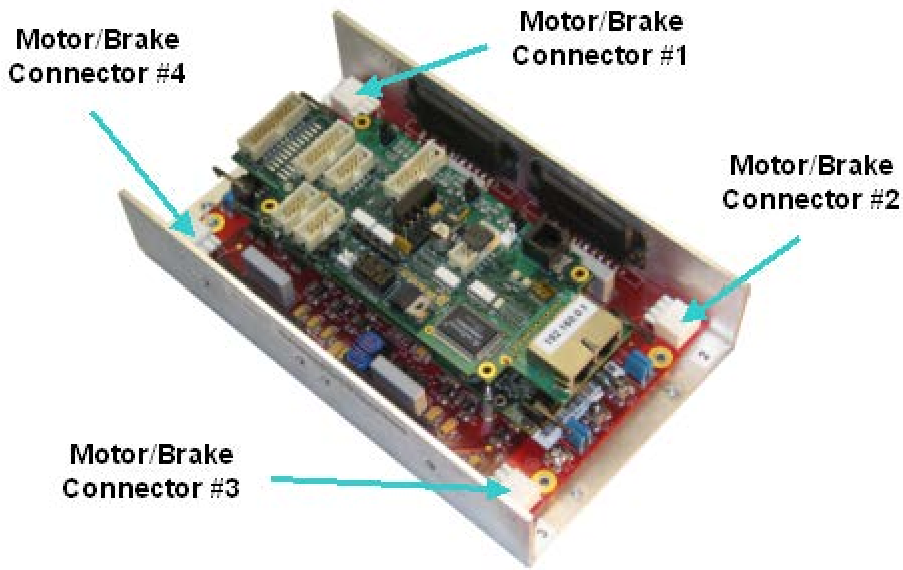
Crimp Plugs	Amp 102387-3 or Molex 90142-0016. For the Amp plug, use Amp pins 102128-1 and AMP crimp tool 91517-1. For the Molex plug, use Molex pins 16-02-0103 and Molex crimp tool 63811-1000.
Alternate IDC Plug	Amp 746285-3

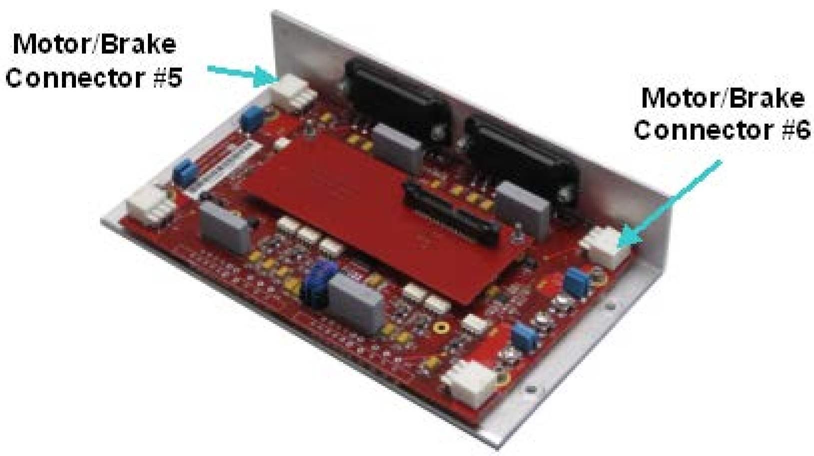
HVPA/LVPA Motor/Brake Interfaces

There are identical motor/brake connectors located on the High Voltage Power Amplifiers (HVPA) of the Guidance 3000 (excluding the 30A version, see below), the 4-Axis High Voltage Power Amplifier (4AHV) for the Guidance 2000, and the 2-Axis Slave High Voltage Power Amplifier (2AHV) for the Guidance 2600. Each HVPA has two motor drivers per board with two connectors mounted at the top edge. Each 4AHV has four motor drives with a connector mounted at each corner. Each 2AHV has two motor drives with a connector at each corner of the high side of the sheet metal. These connectors are numbered on their tops and are illustrated below for each type of controller.

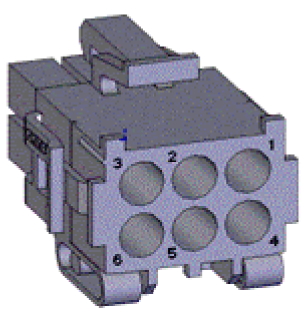
DANGER: The High Voltage Power Amplifiers (HVPA/_AHV) and the Motor/Brake connectors and their leads contain unshielded high voltage pins, components and surfaces. It is intended that the Guidance Controllers with these components be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.







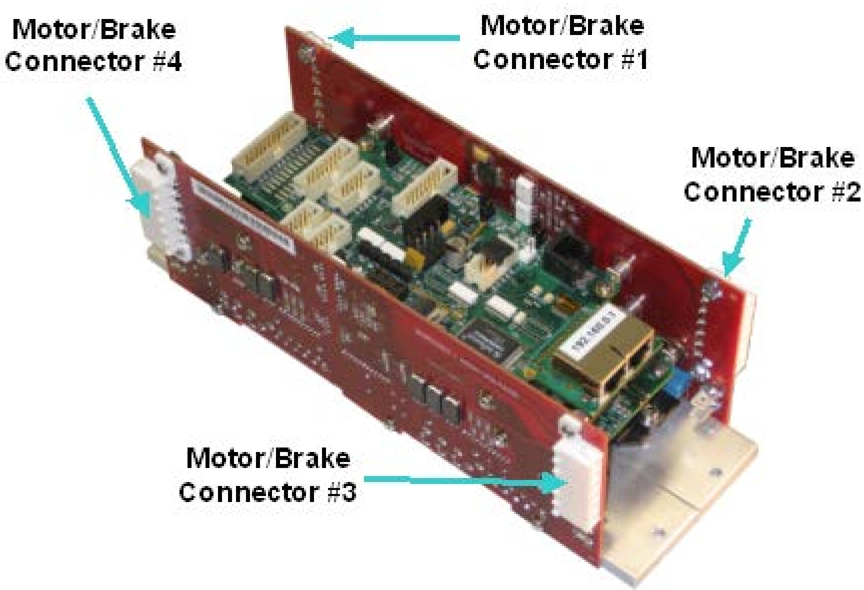
Mating plugs and pins for the motor/brake connectors are shown below. See the Amp Catalog 82181 page 91 for other wire gauges. Please note that although all of the motor/brake connectors have a brake signal, this is only provided as a wiring convenience. The Guidance Controllers turn all brakes on and off at one time, so independent brake control for each motor is not supported via the dedicated IO lines available in this connector. If required, individual brake control can be implemented using general purpose digital output signals.



WARNING: While many brakes draw less than 0.5A, for some large motors, the current draw can be much larger. If more than 2A is required for all brakes, an external relay should be used to separately power the brakes to avoid damaging the controller.

Pin	Description
1	Brake Power 24VDC, maximum current 2A total for all brakes
2	Motor Phase V
3	Motor Phase W
4	Brake Power Return
5	Motor Frame Ground/Cable Shield
6	Motor Phase U
Board Connector Part No	AMP Mini Universal Mate-N-Lok 2 6 pin 770969-1
User Plug Part No	Amp 794190-1 (pins AMP 794231-1)
User Socket Part No	Amp 794231-1 for 16-20 gauge wire
Crimp Tool	Amp 91594-1

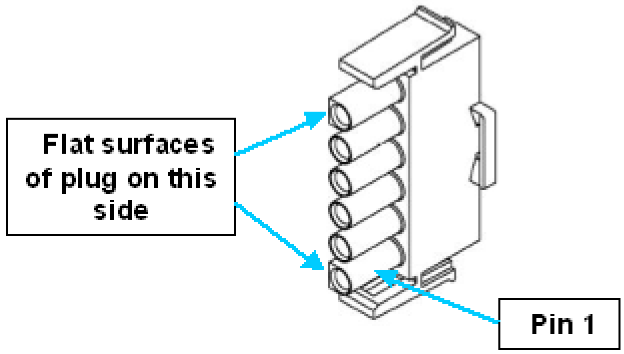
The 30A version of the Guidance 3400 controller, the Guidance 3430, utilizes a different motor/brake connector that can support larger gage wires and higher motor currents. Each of the High Voltage Amplifier (HVPA2) boards has two motor drives and two connectors mounted on the side of the board. The numbering for the motor/brake connectors is illustrated below.



DANGER: The High Voltage Power Amplifiers and the Motor/Brake connectors and their leads contain unshielded high voltage pins, components and surfaces. It is intended that the Guidance

Controllers with these components be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.

Mating plugs and pins for the motor/brake connectors are shown below. Please note that although all of the motor/brake connectors have a brake signal, this is only provided as a wiring convenience. The Guidance Controllers currently turn all brakes on and off at one time, so independent brake control for each motor is not supported via the dedicated IO lines available in this connector. If required, individual brake control can be implemented using general purpose digital output signals.



Pin	Description
1	Motor Phase W
2	Motor Phase V
3	Motor Phase U
4	Motor Frame Ground/Cable Shield
5	Brake Power Return
6	Brake Power 24VDC, maximum current 2A total for all brakes
Board Connector Part No	Tyco Electronics 640587 Universal Mate-N-Lok
User Plug Part No	Tyco Electronics 640585 6 Circuit Universal Mate-N-Lok
User Socket Part No	AMP 350550-1 for 14-20 gauge wire
Crimp Tool	AMP 90546-1

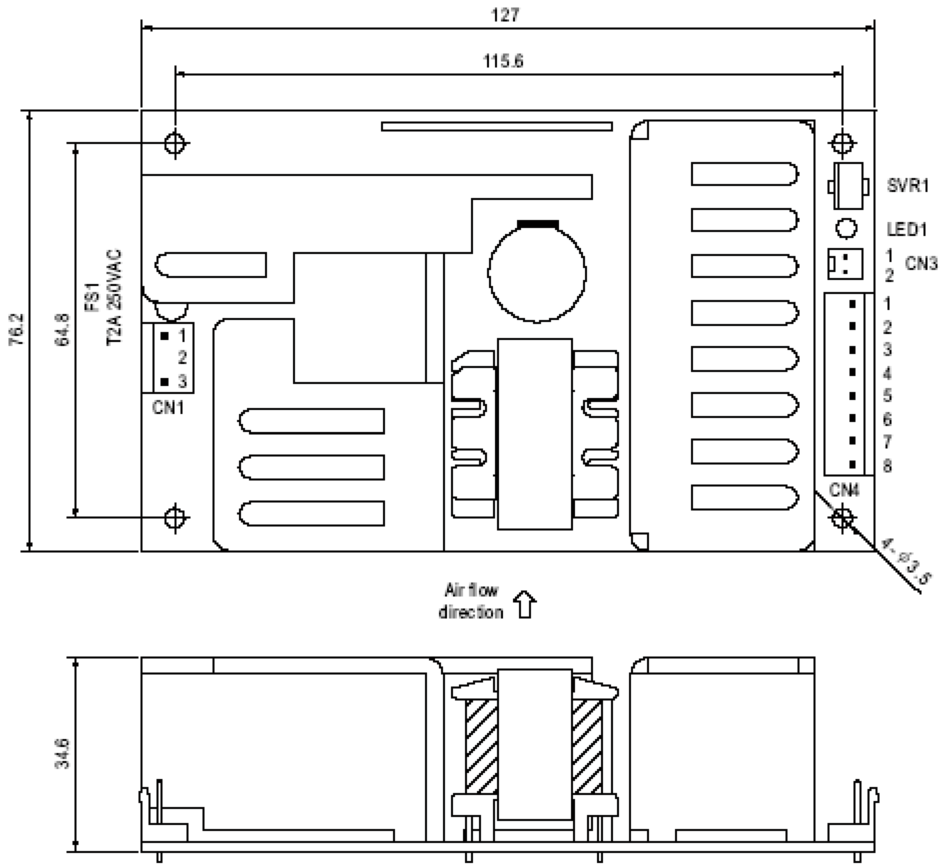
Low Voltage Power Supply

The Guidance Controller requires a minimum of 2.7 amps and preferably 4 amps of 24 VDC power for the logic and IO. An additional 1 amp is required to operate the dual safety contactors on the 2000W PrecisePower Intelligent Motor Power Supply.

A commercially available 24VDC power supply, the Mean Well P/N PPS-125-24 is shown below. This is a frameless supply that should be mounted on 4mm high standoffs. Mounting holes are 4mm diameter and will clear 3mm or 6-32 screws. They are located on 64.8mm and 115.6mm centers. The AC input connector is a JST VHR-3N and the DC output connector is a JST VHR-8N. Pins 1-4 on the DC connector are GROUND and pins 5-8 are 24VDC. This unit weights approximately 0.369 kg.

For the JST VHR connectors, use pins SVH-21T-1.1 and JST crimp tool WC-160.

DANGER: The Mean Well 24 VDC power supply is an open frame electrical device that contains unshielded high voltage pins, components and surfaces. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.



General Specification	Range
Input voltage	90 - 264 VAC
Input frequency	47 - 63 Hz
Output voltage	24 VDC
Output power	125 watts
Operating temperature	0 - 40 deg C
Storage temperature	-20 - 85 deg C
Dimensions	127 x 76.2 x 34.6 mm

Precise Part Number	PS10-EP-00125

Motor Voltage Power Supplies

Motor Voltage Power Supplies

The Guidance 3000 and 2000 Controllers can operate with motor bus voltages ranging from 24 VDC to 340 VDC. Users may employ their own DC motor power supply or may purchase an intelligent motor power supply from Precise. Precise offers three Intelligent Motor Power Supplies: the PrecisePower 300 (300 or 600-watts RMS), the PrecisePower 500 (500-watts RMS) and the PrecisePower 2000 (2000-watts to 3400-watts RMS).   These units include: integral relays for enabling/disabling motor power on command from the controller, large value output filter capacitors to store deceleration energy for use when power is needed, the ability to absorb line spikes, and built-in fuses.

To permit the Guidance Controller to enable and disable motor power, the power supply must be equipped with either one or two (redundant) relays. These relays should be wired to the "Motor power enable" signals provided on the Motor Power On/24VDC header on the controller.

If you purchase a PrecisePower unit and Precise's standard low voltage power supply, you can also obtain a Guidance Controller Power Harness that interconnects the two power supplies and the Guidance Controller (see the section on Power Connectors and Grounding).

Regarding the sizing of the motor power supply, as a rule-of-thumb for typical robotic application, a motor power supply can drive a group of motors whose total rating is approximately 4 times the rating of the motor power supply. For example, the 500-watt PrecisePower 500 can normally drive motors with a total rating of 2000-watts. This is due to the fact that motor power ratings are typically defined by the "rated torque" that can be supplied at the "rated speed" of the motor. However, in most robot applications, high torque is only required at low speed. As a case in point, the PrecisePower 500 is being successfully used to drive a Cartesian robot at full speed where the size of its four motors are 750W, 400W, 200W and 100W (1450W total).

PrecisePower 300 Intelligent Motor Power Supply

The PrecisePower 300 is an Intelligent Motor Power Supply with an input range from 90 to 264 VAC 50/60 Hz. The motor power output voltage is a multiple of the input line voltage (output = 1.41*RMS_VAC_input-2 volts). With 120 VAC input, this power supply generates approximately 167 VDC and 300-watts RMS. With 240 VAC input, the output is approximately 337 VDC and 600-watts RMS. This unit includes a single integral relay for enabling and disabling motor power from the controller, large value output filter capacitors to store deceleration energy for use when power is needed, the ability to absorb line spikes, and built-in fuses.

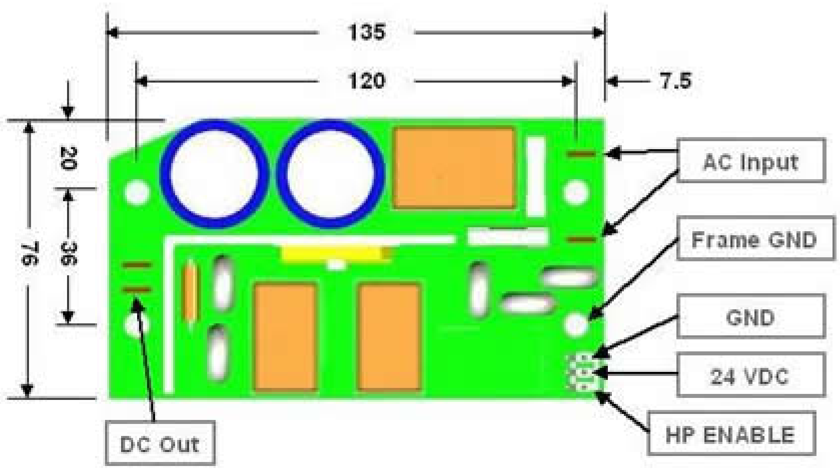
To enable the power supply's relay, a three conductor cable must connect the controller's Motor Power On/24 VDC connector to the three pin header pictured below in the bottom right of the power supply. This cable should connect the controller's "Motor power enable" signal, 24VDC and ground to the corresponding pins on the motor power supply. The 24VDC and ground signals must in turn be connected to the 24 VDC power supply, which provides low voltage power to both the controller and the motor power supply. To connect to the three pin header to the motor power supply, a Molex 09-50-3031 or compatible plug can be utilized.

This motor power supply includes push on tabs for the input AC power and the output DC power. The DC output is provided as a pair of output terminals that should be connected to the DC input terminals on the vertical (HVPA) power amplifier circuit boards of the Guidance 3000 Controller or the pair of screw terminals of the horizontal 4AHV for the Guidance 2000 (see the section on Power Connectors and Grounding). Both the DC output terminals of the power supply and the AC input terminals use tabs compatible with Amp 3-520133-2 Faston receptacles.

For mounting purposes, the power supply has four 4.1mm through holes as illustrated in the drawing below.

This power supply limits inrush current to 6 Amps. It is protected against voltage surge to 2000 volts common mode by means of MOVs at the line input. It is protected against over current by two 6.3 amp, 250V quick acting fuses, Wickman PN 1941630000.

DANGER: The PrecisePower 300 Intelligent Motor Power Supply is an open frame electrical device that contains unshielded high voltage pins, components and surfaces. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.



PrecisePower 500 Intelligent Motor Power Supply

The PrecisePower 500 is a 500-watt auto-ranging Intelligent Motor Power Supply with dual input ranges of 90 to 132 VAC and 180 to 264 VAC 50/60 Hz and a 320 VDC output.   This unit includes a single integral relay for enabling and disabling motor power from the controller, large value output filter capacitors to store deceleration energy for use when power is needed, the ability to absorb line spikes, and built-in fuses.

To enable the power supply's relay, a three conductor cable must connect the controller's Motor Power On/24 VDC connector to the three pin header pictured below in the top right of the power supply. This cable should connect the controller's "Motor power enable" signal, 24VDC and ground to the corresponding pins on the power supply. The 24VDC and ground signals must in turn be connected to the 24 VDC power supply, which provides low voltage power to both the controller and the motor voltage power supply. To connect to the three pin header to the motor power supply, a Molex 09-50-3031 or compatible plug can be utilized.

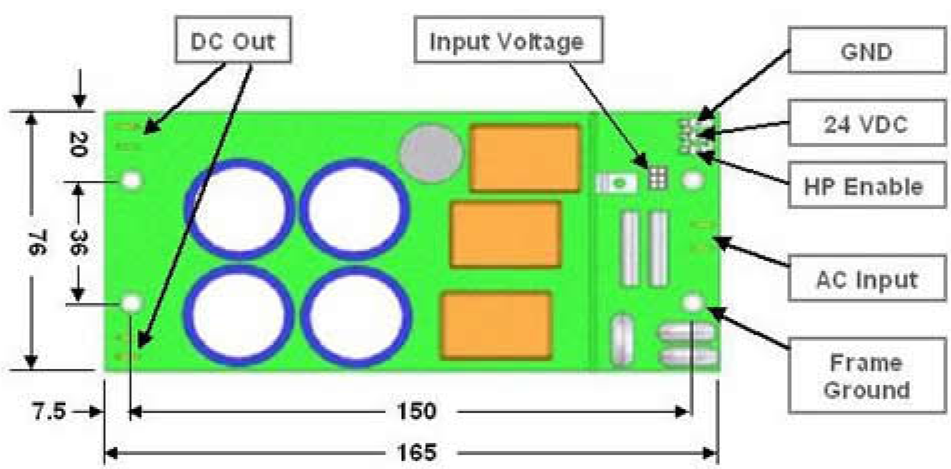
This motor power supply includes push on tabs for the input AC power and the output DC power. The DC output is provided on two pairs of output terminals that should be connected to the DC input terminals on the vertical (HVPA) power amplifier circuit boards of the Guidance 3000 Controller or the pair of screw terminals of the horizontal 4AHV for the Guidance 2000 (see the section on Power Connectors and Grounding). Both the DC output terminals of the power supply and the AC input terminals use tabs compatible with Amp 3-520133-2 Faston receptacles.

For mounting purposes, the power supply has four 4.1mm through holes as illustrated in the drawing below.

This power supply limits inrush current to 6 Amps. It is protected against voltage surge to 2000 volts common mode by means of MOVs at the line input. It is protected against over current by two 6.3 amp, 250V quick acting fuses, Wickman PN 1811630000.

To configure this unit, at the right end of the power supply, there are three sets of jumper pins labeled "90-132V", "Auto", and "180-264V" and indicated as "Input Voltage" in the picture below. 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 power supply is normally shipped with the jumper on the "Auto" setting to allow it to generate a nominal voltage of 320 VDC worldwide with the factory setting.

AC input	90-132V (2X) Jumper	Auto Jumper	180-264V (1X) 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



> **DANGER:** The PrecisePower 500 Intelligent Motor Power Supply is an open frame electrical device that contains unshielded high voltage pins, components and surfaces. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.

PrecisePower 2000 Intelligent Motor Power Supply

For applications requiring an even larger intelligent motor power supply, the PrecisePower 2000 delivers 2000-watts of power from a single-phase 208VAC service or 3400 watts from a three-phase 240VAC service.   This unit includes dual integrated relays for enabling and disabling motor power on command from the controller, large value output filter capacitors to store deceleration energy for use when power is needed, the ability to absorb line spikes, the ability to limit the peak output voltage, and built-in fuses. In addition, it has safety circuits to automatically shutdown the unit if it is switched to a short or is severely over-loaded.

In order to power the logic in this unit, 24VDC must be provided from a separate 24VDC power supply. As a wiring convenience, the AC line voltage input to the PrecisePower 2000 is presented on two pins that can be utilized to power the 24VDC supply. For these pins as well as two other headers, mating cables can be connected to the PrecisePower via a Molex 09-50-3031 or compatible plug.

To enable the PrecisePower's motor power output, its redundant dual relays must be connected to the Motor Power On/24VDC header of the controller and be enabled by the controller. A four conductor cable should be used to connect the two "Motor power enable" signals, 24VDC and ground. The 24VDC pin on the controller header is the DC input that provides power for the controller's logic. The PrecisePower routes its 24VDC input to the controller via this cable to simplify system wiring. If the PrecisePower is automatically shutdown by a fault condition detected by its safety circuits, this motor power supply can be reset by cycling the 24VDC power.

To satisfy IEC Category 3 (CAT-3) requirements and to report power supply errors to the controller, a 10-pin 26AWG ribbon cable should be routed from the PrecisePower unit to the I2C plug on the Guidance Controller.

This intelligent motor power supply includes push on tabs for the input AC power and the output DC power. The DC output is provided on two pairs of output terminals that should be connected to the DC input terminals on the vertical (HVPA) power amplifier circuit boards of the Guidance 3000 Controller or the pair of screw terminals of the horizontal 4AHV for the Guidance 2000 (see the section on Power Connectors and Grounding). Both the DC output terminals of the power supply and the AC input terminals use tabs compatible with Amp 3-520133-2 Faston receptacles.

For mounting purposes, the power supply has four 4.2mm through holes as illustrated in the drawing below.

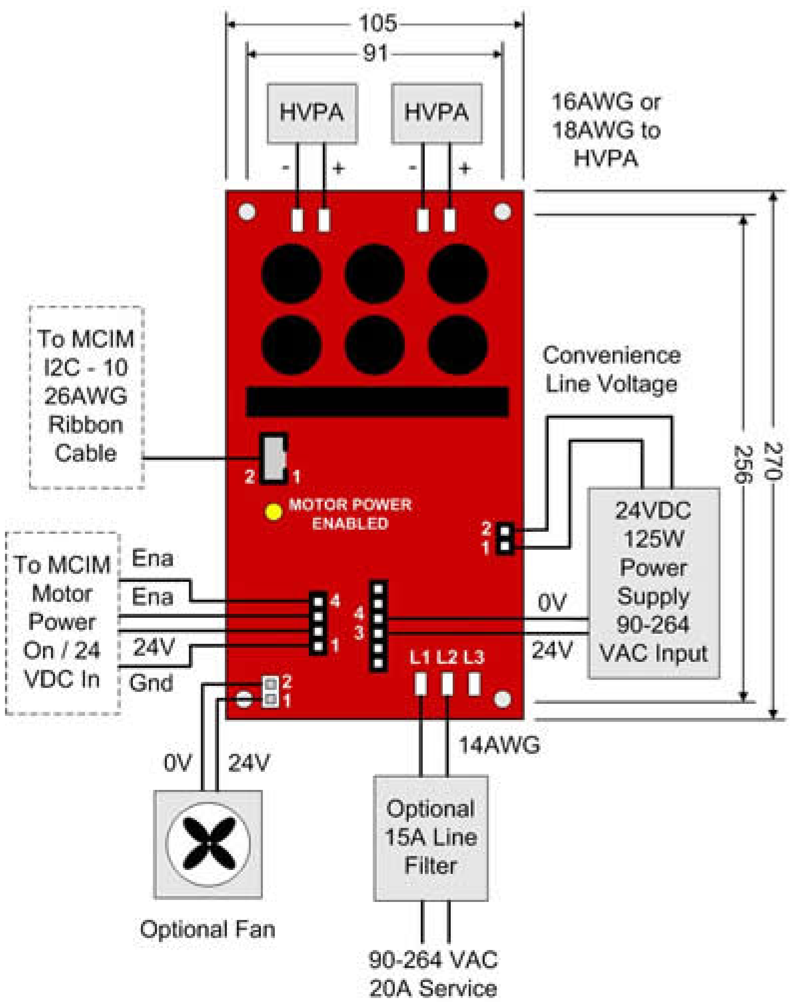
This power supply can accept line voltages from 90VAC to 240VAC. The motor power output voltage is a multiple of the input line voltage (output = 1.41*RMS_VAC_phase_to_phase_input-2 volts). For example, a 120 VAC input will produce 167 VDC output, whereas a 240 VAC input will generate a 337 VDC output. The maximum RMS power output of the unit is 2000-watts at 240VAC single phase or 3400-watts at 240VAC 3-phase. The single phase AC voltage is available worldwide.

To connect this power supply to a 3-phase AC source, simply connect the 3rd phase to the L3 Faston tab. The 3-phase voltage compatible with this unit is only available in certain countries, notably the U.S., Japan and other parts of Asia.

> **WARNING:** For this unit, the voltage from PHASE-TO-PHASE must not exceed 240VAC. Some countries specify their power in terms of the voltage of each phase relative to ground. A 3-PHASE POWER SOURCE SPECIFIED AT 220VAC WILL DAMAGE THE POWER SUPPLY IF THE PHASE-TO-PHASE VOLTAGE EXCEEDS 240VAC.

In order for the controller to test if the power supply is correctly receiving single phase or 3 phase AC input, a jumper labeled J4 (3PH) is provided on the vertical control board. If this jumper is installed and 3 phase AC is not detected, a warning message will be displayed by the controller when motor power is enabled. If the power supply is only connected to single phase AC, this jumper should be removed to suppress the warning message.

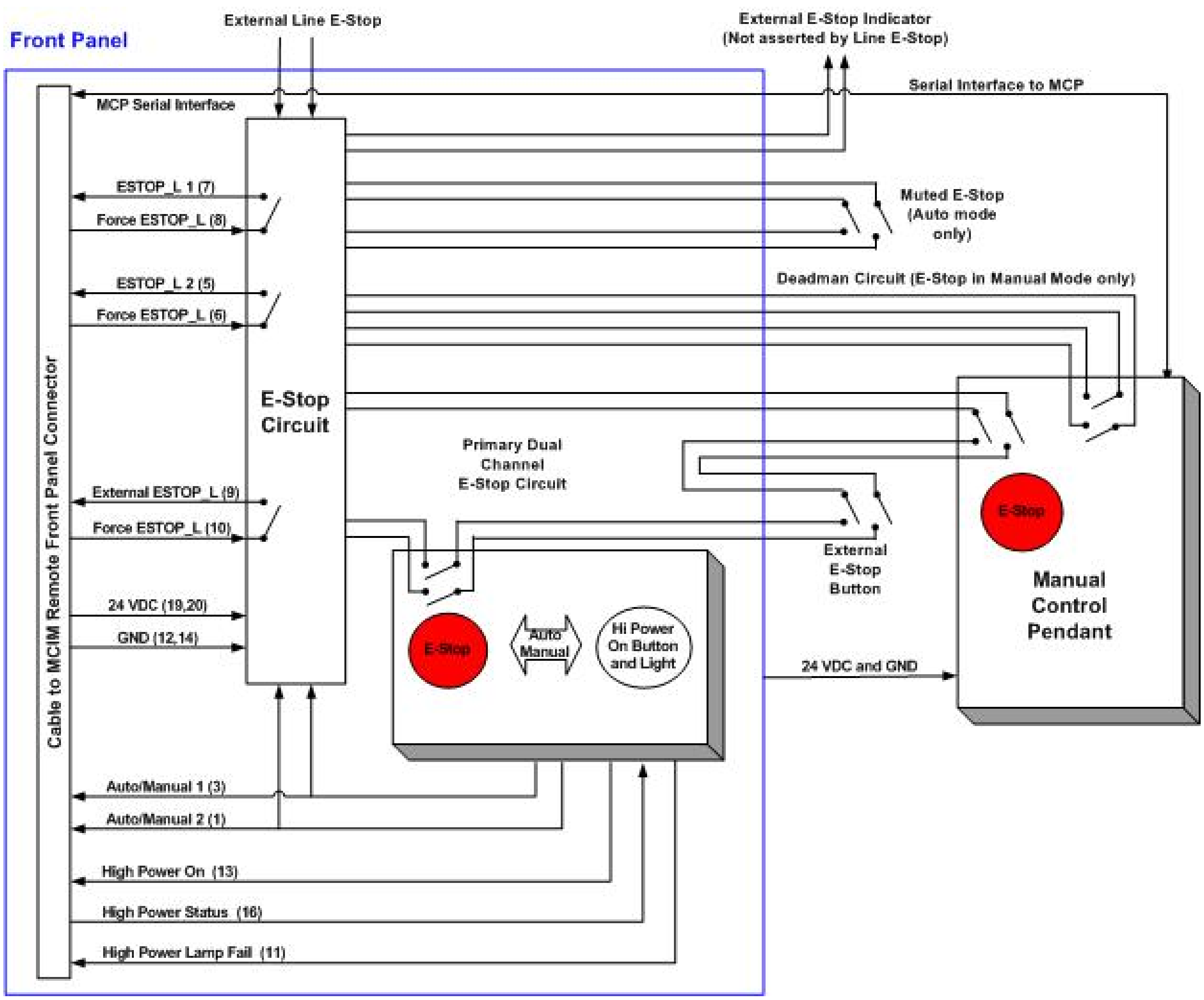
For 2000-watts and above, forced air is required to cool the PrecisePower. A 24VDC output connector is provided to powering an optional fan.



DANGER: The PrecisePower 2000 Intelligent Motor Power Supply is an open frame electrical device that contains unshielded high voltage pins, components and surfaces. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when AC line power is turned on.

Safety Circuits For Remote Front Panel

The diagram below presents an example of a Category 3 (CAT-3) compliant user front panel and manual control pendant that can be interfaced to the Remote Front Panel Connector provided on the communication interface board. For the signals that route to the Remote Front Panel Connector, the pin numbers are denoted in parentheses.



Should your application not require this level of operator interaction or compliance with full Category 3 (CAT-3) safety regulations, the Remote Front Panel Connector documentation provides directions on how to jumper this connector for proper operation of the controller without a front panel.

Some of the features of the example Remote Front Panel Safety Circuit are briefly described in the following paragraphs.

The example Remote Front Panel circuit supports several different sources of E-Stop signals. Some of these E-Stops are always active while others are only active in certain modes of operation. Whenever an active E-Stop is asserted, the result is that the **ESTOP_L 1** and **ESTOP_L 2** signals are asserted by disconnecting them from the **Force ESTOP_L** signals. The possible E-Stop sources include the following:

> **External E-Stop Button**. Normally connected to an E-Stop button or series of E-Stop buttons that are placed around the work cell.
>
> **External Line E-Stop**. Typically utilized by external equipment in the cell or the manufacturing line to E-Stop the controller as well as other devices. In order to avoid a dead-lock condition, the **External E-Stop Indicator Signal** is asserted when any E-Stop source other than the **External Line E-Stop** is asserted. The **External E-Stop Indicator** should not be asserted by the **External Line E-Stop** signal to avoid a dead lock condition that could occur if an external device (such as a line control PLC) were to loop back the **External E-Stop Indicator** to the **External Line E-Stop** signal.
>
> **Muted E-Stop.** This signal only generates an E-Stop Condition in Auto Mode. This allows the **Muted E-Stop** to be connected to a safety gate that surrounds the equipment. Opening the safety gate during normal automatic operation will turn off high power. However, during Manual Mode, an operator can open the gate and enter the cell without disabling high power.
>
> **MCP Deadman's Circuit.** This circuit must be closed in order to operate the system during Manual Mode. A Deadman's circuit is typically connected to a 3 position hold-to-run switch integrated into the MCP. The Deadman's circuit is ignored during Auto Mode.

The **Auto/Manual** signals are connected to a key switch that sets whether the system is being operated in automatic mode or manual mode. The setting of this switch also effects the **Muted E-Stop** and the **MCP Deadman's Circuit**.

The **High Power Status** signal that is output from the communication interface connector is routed to a relay that turns on a lamp that indicates if motor power is enabled. Normally, this signal blinks at a rate of 1Hz when motor power is enabled. If this lamp fails, the **High Power Lamp Fail** signal is asserted and motor power cannot be enabled until this problem is corrected.

The **High Power On Button** is a momentary contact switch that transitions the **High Power On** signal from low to high during the Category 3 (CAT-3) power enable sequence.

For the example front panel and signal diagram that is shown above, the following table summarizes how the various signals should interact to generate the controller's Remote Front Panel Interface input signals.

Controller's Remote Front Panel Input Signals	Input State Determined As Follows

ESTOP_L 1 and 2	Asserted if the following signals or statements are true: [**Primary Dual Channel E-Stop**] OR [**External Line E-Stop**] OR [**Muted E-Stop** AND (**Auto/Manual** set to Auto)] OR [**Dead Man Circuit** AND (**Auto/Manual** set to Manual)] OR [**Force E-Stop**]
External ESTOP_L	Asserted if the following signals are true: [**External Line E-Stop**] OR [**Force E-Stop**]
Auto / Manual 1 and 2	Asserted if the Auto / Manual key switch is set to Auto, off when the key switch is set to Manual
High Power On	Momentarily asserted when **High Power On Button** is pressed
High Power Lamp Fail	Asserted if the High Power On status light fails

Third Party Equipment

Third Party Equipment

This section contains instructions on interfacing to 3rd party equipment that is commonly utilized in combination with the Guidance Controllers. For detailed information on each of these products, please refer to the manuals provided by the manufactures of these components.

Panasonic A4 Serial Incremental/Absolute Encoder

This section provides wiring instructions for a Panasonic motor equipped with a Panasonic A4 17-bit serial incremental/absolute encoder or a 10000 count serial incremental encoder. These encoders transmit their position data as a serial bit stream via RS-485 lines rather than A-B incremental pulses. These encoders can be utilized as high resolution incremental encoders that provide either 17-bits or 10000 counts per revolution. In addition, if the 17-bit encoder is provided with continuous power with a battery backup, it functions as a high resolution absolute encoder that provides 33-bits of encoder position information. The continuous power is used to maintain a 16-bit "turns count" register that augments the 17-bits per turn data.

Due to the additional capabilities needed to process the absolute encoder signal, these encoders may require the "Enhanced" versions of the Guidance Controllers. Please contact Precise for the current hardware requirements for interfacing to these types of encoders.

For information on configuring this type of encoder, please see the *Software Setup* section of the *Controller Software* section of the *Documentation Library*.

In addition to the following table of **Encoder Connections**, please review the Installation Information for important recommendations on the use of twisted pair wires and shield grounding.

Encoder Connector Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
1	RED	BATTERY+	14
2	PINK	BATTERY -	12
3	GREEN	FG	7
4	BLUE	PS+	2
5	VIOLET	PS-	3
6	NC	NC	
7	WHITE	VCC	4
8	BLACK	GND	1
9	NC	NC	

For controllers that require interfaces to six absolute encoders, such as an Enhanced Guidance G2400C connected to a 2-Axis G0200C Slave Amplifier (Guidance G2600C), **the 1st and 2nd Encoder Connectors support additional signals to interface to absolute encoders for motors 5 and 6, respectively**. In this situation, the battery, power and ground signals are shared by the encoders wired to the same connector.

2nd Encoder Connector Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
3	GREEN	FG	16
4	BLUE	PS+	5
5	VIOLET	PS-	6

The following are the wiring instructions for the **Motor Power Connectors**:

Motor Connector Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
1	RED	U	6
2	WHITE	V	2
3	BLACK	W	3
4	GREEN	GND	5
1	YELLOW	BRAKE+	1
2	YELLOW	BRAKE-	4

If the encoder is to be used in absolute mode, a battery must be connected to the Absolute Encoder Battery Connector on the MCIM/MIDS3 boards. Please see the information on that connector for detailed pin outs and plug types. The following table contains information on the required battery power.

External Battery Specification	
Maximum voltage	4.75V
Typical voltage	3.6V
Alarm trigger voltage	3.1V
Current for each encoder	3.6 uA

Tamagawa Serial Incremental/Absolute Encoder

This section provides wiring instructions for a motor equipped with a Tamagawa SA35-17/33Bit-LPS (TS5667N120/N127) absolute encoder. This encoder transmits its position data as a serial bit stream via RS-485 lines rather than A-B incremental pulses. This encoder can be utilized as high resolution incremental encoder that provides 17-bits of resolution per revolution. In addition, if this encoder is provided with continuous power with a battery backup, it functions as a high resolution absolute encoder that provides 33-bits of encoder position information. The continuous power maintains a 16-bit "turns count" register that augments the 17-bits per turn data.

Due to the additional capabilities needed to process the absolute encoder signal, these encoders may require the "Enhanced" versions of the Guidance Controllers. Please contact Precise for the current hardware requirements for interfacing to these types of encoders.

For information on configuring this type of encoder, please see the *Software Setup* section of the *Controller Software* section of the *Documentation Library*.

In addition to the following table of **Encoder Connections**, please review the Installation Information for important recommendations on the use of twisted pair wires and shield grounding.

Tamagawa Motor Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
A4	BROWN	BATTERY+	14
B4	BROWN/BLACK	BATTERY -	12
B6	GRAY	FG	7
A3	BLUE	PS+	2
B3	BLUE/BLACK	PS-	3
A5	RED	VCC	4
B5	BLACK	GND	1

For controllers that require interfaces to six absolute encoders, such as an Enhanced Guidance G2400C connected to a 2-Axis G0200C Slave Amplifier, **the 1st and 2nd Encoder Connectors support additional signals to interface to absolute encoders for motors 5 and 6, respectively**. In this situation, the battery, power and ground signals are shared by the encoders wired to the same connector.

Tamagawa Motor Pin	2nd Encoder Wire Color	Signal Name	G3000/G2000 Connector Pin
B6	GRAY	FG	16
A3	BLUE	PS+	5
B3	BLUE/BLACK	PS-	6

If the encoder is to be used in absolute mode, a battery must be connected to the Absolute Encoder Battery Connector on the MCIM/MIDS3 boards. Please see the information on that connector for detailed pin outs and plug types. The following table contains information on the required battery power.

External Battery Specification	
Maximum voltage	4.75V
Typical voltage	3.6V
Alarm trigger voltage	3.1V
Current for each encoder	3.6 uA

Yaskawa Sigma II/III Serial Absolute Encoder

This section provides wiring instructions for a Yaskawa motor equipped with a Yaskawa Sigma II/III Serial Absolute Encoder. The encoder can have 16-bits (Sigma II), 17-bits (Sigma II/III) or 20-bits (Sigma II/III) of resolution per revolution plus a battery backed-up multiple turns counter. This encoder transmits its position as a serial bit stream via RS-485 lines instead of A-B incremental pulses.

Due to the additional capabilities needed to process the absolute encoder signal, these encoders may require the "Enhanced" versions of the Guidance Controllers. Please contact Precise for the current hardware requirements for interfacing to these types of encoders.

For information on configuring this type of encoder, please see the *Software Setup* section of the *Controller Software* section of the *Documentation Library*.

In addition to the following table of **Encoder Connections**, please review the Installation Information for important recommendations on the use of twisted pair wires and shield grounding.

Encoder Connector Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
1	RED	5V	4
2	BLACK	GND	7
3	ORANGE	BATTERY +	14
4	WHITE/ORANGE	BATTERY -	12
5	LIGHT BLUE	DATA+	5
6	WHITE/LIGHT BLUE	DATA -	6

The following are the wiring instructions for the **Motor Power Connectors**:

Motor Connector Pin	Wire Color	Signal Name	G3000/G2000 Connector Pin
1	RED	U	6
2	WHITE	V	2
3	BLUE	W	3
4	GREEN/YELLOW	FG	5
1	RED	BRAKE+	1
2	BLACK	BRAKE-	4

For the multi-turn counter to operate properly, a battery must be connected to the Absolute Encoder Battery Connector on the MCIM/MIDS3 board. Please see the information on that connector for detailed pin outs and plug types. The following table contains information on the required battery power.

> **NOTE**: Unlike other absolute encoders, the Sigma II/III does not have an internal battery or capacitor that can retain the multi-turn data. Therefore, if the

external battery is disconnected while the controller's power is off or the cable from the controller to the encoder is disconnected at anytime, the multi-turn data will be lost and the absolute position of the motor and encoder will have to be reestablished.

External Battery Specification	
Typical voltage	3.6V
Alarm trigger voltage	2.7V
Current for each encoder	20 uA

Nikon A / Sanyo Denki Serial Absolute Encoders

This section provides wiring instructions for a motor equipped with a Nikon A 2.5Mhz, a Nikon A 4Mhz, or a Sanyo Denki PA035C 2.5Mhz serial absolute encoder. These encoders transmit their position data using a specialized serial bit stream protocol via a RS-485 pair rather than A-B incremental quadrature pulses. When these encoders are provided with a battery backup source, they function as a high resolution absolute encoder that returns 17-bits of resolution per revolution and a 16-bit "turns count" battery backed-up register for a total of 33-bits of encoder position information.

Due to the additional capabilities needed to process the absolute encoder signal, these encoders may require the "Enhanced" versions of the Guidance Controllers. Please contact Precise for the current hardware requirements for interfacing to these types of encoders.

For information on configuring this type of encoder, please see the *Software Setup* section of the *Controller Software* section of the *Documentation Library*.

In addition to the following table of **Encoder Connections**, please review the Installation Information for important recommendations on the use of twisted pair wires and shield grounding.

Wire Color	Signal Name	G3000 / G2000 Connector Pin
BROWN	ES +	2
BLUE	ES -	3
RED	5V	4
BLACK	GND	1
PINK	EBAT +	14
PURPLE	EBAT -	12

For the multi-turn counter to operate properly, a battery must be connected to the Absolute Encoder Battery Connector on the MCIM/MIDS3 board. Please see the information on that connector for detailed pin outs and plug types. The following table contains information on the required battery power.

NOTE: Please be aware that if the external battery is disconnected while the controller's power is off or the cable from the controller to the encoder is disconnected at anytime, the multi-turn data may be lost and the absolute position of the motor and encoder will have to be reestablished.

External Battery Specification	
Typical voltage	3.6V
Alarm trigger voltage	3.0V

EnDat / SII /BiSS Serial Absolute Encoders

This section provides wiring instructions for motors equipped with one of the following types of serial absolute encoders:

- Heidenhain EQN1135, EnDat 2.2, 23-bits/revolution, 12-bit multiple turns counter
- Heidenhain EQI1130, EnDat 2.1, 18-bits/revolution, 12-bit multiple turns counter
- SSI with 24-bit position counter
- BiSS with 26-bit or 32-bit position counter

These encoders transmit their position data using different specialized serial bit stream protocols (via a RS-485 pair) rather than A-B incremental quadrature pulses. Unlike other absolute encoders, these devices also require a second RS-485 pair to transmit a data clocking signal from the controller to the encoder. In general, these encoder types do not require a battery backup source to maintain their multiple turns counter.

Due to the additional capabilities needed to process the absolute encoder signal, these encoders may require the "Enhanced" versions of the Guidance Controllers. Please contact Precise for the current hardware requirements for interfacing to these types of encoders.

For information on configuring these types of encoder, please see the *Software Setup* section of the *Controller Software* section of the *Documentation Library*.

In addition to the following table of **Encoder Connections**, please review the Installation Information for important recommendations on the use of twisted pair wires and shield grounding.

Signal Name	**G3000/G2000 Connector Pin**
DATA +	2
DATA -	3
5V	4
GND	7
CLOCK +	5
CLOCK -	6

Appendix A: Product Specifications

Guidance 3000 and 2000 Controller Specifications

The following table contains the specifications for the various models of the Guidance 3000 and 2000 Controllers. "S" indicates a standard feature, "O" indicates an available optional feature, "-" denotes that the feature is not available for a specific controller model and a number indicates the number of facilities available.

General Specification	3000A	3030A	2000B	2000C	0000	Range & Features
Computational Hardware						
CPU and Dynamic Memory	S	S	S	S	S	400Mhz high performance, low-power CPU with a minimum of 8MB of dynamic RAM
Nonvolatile Memory	S	S	S	S	S	Flash disk with a minimum of 16MB of storage for OS, firmware and user program and data storage
NVRAM	-	-	-	S	-	8KBytes of NVRAM for storing key dynamic status and state information including error logs (available on controllers shipped starting in 2013 Q3).
Software						
Programming Interface	S	S	S	S	S	Three programming methods available: DIO MotionBlocks (PLC) Embedded Guidance Programming Language (GPL) PC/Unix/Linux controlled over Ethernet
Operator Interface	S	S	S	S	S	Web based operator interface supports local or remote control via browser connected to embedded web server
Motion Control	S	S	S	S	S	Extensive robotic and low-level motion control available Continuous path following, s-curve profiling Straight-line and circular motions Torque and velocity control Control of up to 32 axes via networked distributed control organized into up to 12 multi-axis robots Distributed control network can consist of up to 16 controllers
	O	O	O	O	O	Conveyor belt tracking Kinematic models for various robot geometries Advanced Controls License - Enables enhanced motion control modes including: high speed position latching, real-time trajectory modification, analog

						output controlled by robot speed, and support for EtherNet/IP
Machine Vision	O	O	O	O	O	Provides controller with a complete set of image-processing, measurement, inspection and finder tools. A powerful patented Object Locator finds parts in any orientation and at different scales within milliseconds.
Motion Control						
Motor Drives	S	S	S	S	-	Up to four integrated motor drives Bus voltage 24VDC to 340VDC Total power several KW, a function of system cooling
	S	-	S	S	-	Current per motor: 10A peak/5.5A RMS/3.5A stall
	O	-	O	O	-	Current per motor: 20A peak/10A RMS/6.5A stall
	-	-	O	O	-	Current per motor: 33.3A peak/10A RMS/6.5A stall
	-	S	-	-	-	Current per motor: 30A peak/15A RMS/10A stall
	-	-	-	O	-	Additional two 10A/20A/33.3A motor drives (for a total of 6 integrated drives) available via Guidance Slave Amplifiers
3rd Party Amplifiers	O	O	O	-	S	Four or six +/- 10VDC 16-bit DAC channels available for controlling external amplifiers
Position Sensors Interface	S	S	S	S	S	Four differential digital encoder interfaces Four configurable single-ended digital encoder interfaces
	O	O	O	O	O	Support for selected absolute encoders (may require "Enhanced" controller)
	O	O	O	-	O	Support for analog incremental encoders with interpolation for increased resolution (requires "Enhanced" controller)
Control Signals	S	S	S	S	S	Configurable limit stop, home, and hall-effect signals. Signal lines shared among several functions.
Brake Signals	S	S	S	S	S	Up to 1A at 24VDC available for releasing motor brakes
Communications Interfaces						
Serial Communication	S	S	S	S	S	RS-232 port with hardware flow control
Remote Front Panel Intf.	S	S	S	S	S	Remote front panel interface with second RS-232 port (no hardware flow control), compliant with IEC Category 3 (CAT-3) safety standards
Ethernet Ports	2	2	2	2	2	10/100 Mbps Ethernet ports (4 ports available on certain models as a special order)
Digital Input Channels	S	S	S	S	S	12 general purpose optically isolated inputs, configurable in groups of four as sinking or sourcing, signals transition to a high or low in 4 usec. 5VDC to 24VDC for logic high if sinking 24VDC supplied for logic high if sourcing
	O	O	O	O	O	Additional remote I/O available via Precise RIO modules, 3rd party MODBUS/TCP devices, or 3rd party EtherNet/IP devices

Digital Output Channels	S	S	S	S	S	8 general purpose optically isolated outputs, individually configurable as sinking or sourcing, signals turn on in 3 usec and turn off within 400 usec. 24VDC maximum pull up if sinking 24VDC supplied if sourcing 100mA maximum per channel for channels 2-8, 500mA maximum for channel 1 (jumper configurable on G2xxxC controllers)
	O	O	O	O	O	Additional remote I/O available via Precise RIO modules, 3rd party MODBUS/TCP devices, or 3rd party EtherNet/IP devices
Analog I/O Channels	S	S	S	-	S	2 OR 4 analog +/- 10VDC 12-bit inputs
	O	O	O	-	S	4 or 6 analog outputs optionally available
Multi-Drop Serial I/O	S	S	S	S	S	RS-485 multi-drop serial communications. Not available on controllers embedded in Precise Robots
Non-user Accessible IO	S	S	S	-	S	I2C multi-drop serial communications
General						
Size and Weight	S	-	-	-	-	200mm (L) x 80mm (W) x 72mm (H), 0.737 kg
	-	S	-	-	-	250mm (L) x 99mm (W) x 82mm (H), 1.134 kg
	-	-	S	-	-	224mm (L) x 138mm (W) x 56mm (H), 0.907 kg
	-	-	-	S	-	224mm (L) x 138mm (W) x 46mm (H), 0.794 kg (Double width and weight for 6-axis Guidance G2600C)
	-	-	-	-	S	200mm (L) x 80mm (W) x 49mm (H), 0.227 kg
Low Voltage Logic Power	S	S	S	S	S	24VDC ±5%, power required for logic and I/O 2.7A minimum 4A recommended for typical use of digital I/O 1A additional required for 2KW PrecisePower Intelligent Motor Power Supply contactors

Guidance Controller Environmental Specifications

The Guidance Controllers 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
Free space around controller	6mm sides and top
Chassis protection class	IP20 (NEMA Type 1)
For EU or EEA countries	IP54, must meet EN 60204 (IEC 204)

PrecisePower 300 Intelligent Motor Power Supply Specifications

General Specification	Range & Features
Input Specifications	
Input voltage	90-264VAC Single phase
Input frequency	50 - 60 Hz
Input inrush current	6.8 A at 240 VAC in
Output Specifications	
Output voltage	DC no load = (1.41 X VAC RMS input) - 2 Volts DC full load @ 300W = (DC no load) X 0.96 DC full load @ 600W = (DC no load) X 0.93 Nominal range of 167 VDC to 337 VDC
Output power	300 watts RMS @ 120VAC 600 watts RMS @ 240VAC
General	
Size and Weight	135 mm (L) x 76 mm (W) x 60 mm (H), 0.312 kg
Precise Part Number	PS1D-EA-00300

PrecisePower 500 Intelligent Motor Power Supply Specifications

General Specification	Range & Features
Input Specifications	
Input voltage	Dual range: 90 to 132 VAC and 180 to 264 VAC single phase, auto selecting
Input frequency	50 - 60 Hz
Input inrush current	3.4 A at 120 VAC in and 6.8 A at 240 VAC in
Output Specifications	
Output voltage	DC no load doubling = (2.82 X VAC RMS input) - 2 Volts DC full load doubling = (DC no load doubling) X 0.90 DC no load non-doubling = (1.41 X VAC RMS input) - 2 Volts DC full load non-doubling = (DC no load non-doubling) X 0.96 320 VDC nominal for dual input range with typical setting. 160 VDC nominal when input is 90 to 132 VAC and "180-264V" jumper selected.
Output power	500 watts RMS
General	
Size and Weight	165 mm (L) x 76 mm (W) x 58 mm (H), 0.425 kg
Precise Part Number	PS10-EA-00500

PrecisePower 2000 Intelligent Motor Power Supply Specifications

General Specification	Range & Features
Input Specifications	
Input voltage	90-240VAC Single phase or three phase
Input frequency	50 - 60 Hz
Input inrush current	6.7A at 240VAC input
Input current	12.4A RMS, 30A peak at 240VAC single phase & 2000 DC watts output
Output Specifications	
Output voltage, no load	DC no load = (1.41 X VAC RMS phase-to-phase input) - 2 Volts DC full load single phase = (DC no load) X 0.93 DC full load three phase = (DC no load) X 0.97 Nominal range of 167 VDC to 337 VDC
Output power	1000 Watts free air @ 240VAC single phase input 2000 Watts forced air @ 240VAC single phase input 2100 Watts forced air @ 208VAC 3 phase input 3400 Watts forced air @ 240VAC 3 phase input
% Regulation	5 to 7%
Maximum energy dump average power	100 Watts
Peak energy dump voltage	408 VDC +/- 2% (prior to 10/2011: 438 VDC +/- 2%)
Dump release voltage	382 VDC +/- 2% (prior to 10/2011: 411 VDC +/- 2%)
General	
Cat-3	Yes, when used with Precise Automation software and I2C communication
Fault detection	Output short circuit, output overload, missing third AC phase
Size and Weight	270 mm (L) x 105 mm (W) x 76 mm (H), 0.907 kg
Precise Part Number	PS10-EA-02000

Appendix B: FAQ

Frequently Asked Questions

This section contains a compilation of frequently asked questions related to the family of Guidance Controllers.

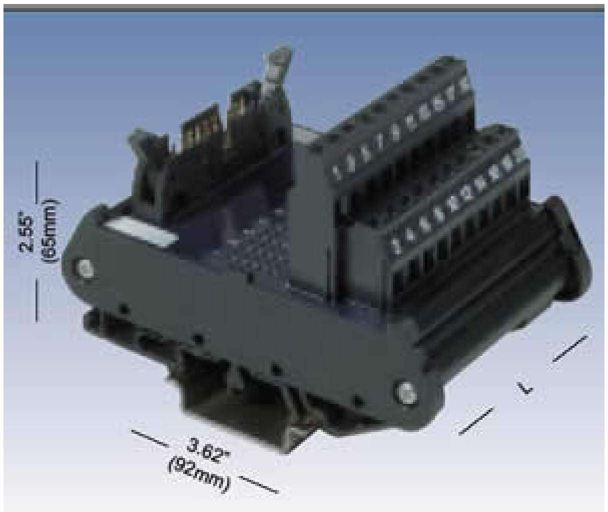
1. Is there an alternative to purchasing crimping tools for connectors?
2. How do you connect a robot power enable button?
3. How do you release the motor brakes in a 1 or 2 axis system?
4. Why should grippers be wired to release when digital signals are ON?
5. What are the restrictions on assigning encoder and amplifier channels?

Is there an alternative to purchasing crimping tools for connectors?

If you do not wish to purchase and use the crimping tools required for the various Guidance Controller pin connectors, but you would still like a convenient means for breaking out the signals, you can purchase a module that converts a ribbon cable to a terminal block.

The unit displayed below is from Automation Systems Interconnect, Inc. (www.asi-ez.com) and is a "Standard Ribbon Cable DIN Rail Interface Module", Type IMRC. This accepts a terminated ribbon cable that connects to the Guidance Controller via an IDC connector.

For more information on this module, please see https://www.asi-ez.com/products_and_solutions/interface_modules/



Similar terminal blocks are also available from Phoenix Contact and are designed for ribbon cables that contain from 10 to 64 pins (http://www.phoenixcon.com/products/interface/varioface/indexmain.asp).

How do you connect a robot power enable button?

If you wish to connect a momentary contact button to enable robot power, you can wire the button to either a general digital input signal or use the dedicated input signal provided in the Remote Front Panel Connector.

If you connect the button to a general DIN, the number of the DIN signal should be set as the "Power enable DIN" (DataID 242) parameter database value. If you connect the button to the Remote Front Panel Connector "High Power On" input, the value of the dedicated input signal (DIN 18007) should be set as the value of DataID 242.

In either case, power will be enabled when the signal toggles from the OFF to the ON state.

How do you release the motor brakes in a 1 or 2 axis system?

For the integrated motor amplifiers of the Guidance Controllers, the brake signals that are presented in the four motor connectors are all tied together internally and are operated by the software that controls the 3rd axis/motor. This works correctly for 3 or 4 axis systems where the 3rd axis is the one that is affected by gravity.

If your system only has one or two axes, to configure the first or second axis to control the brake signals, set the "Auxiliary brake release DOUT channel" (DataID 10625) Parameter Database value for the appropriate axis to "8331". "8331" is the DOUT channel number for the dedicated DIO that controls the brake signal.

Why should grippers be wired to release when digital signals are ON?

Grippers or other tooling should always be wired to digital output signals such that an active (ON) state will release a part. This is an important practice since if the controller loses power and is restarted, all output signals are turned OFF by default. If a gripper is wired to release a part with an OFF signal, any parts left in a gripper from a previous operation would be dropped when the controller is restarted.

What are the restrictions on assigning encoder and amplifier channels?

Due to restrictions in the controller's firmware, in general, the encoder signals used to commutate a motor must be connected to the encoder connector that matches the amplifier connector for the motor. For example, if the leads of a motor are wired to the 2nd amplifier connector, the encoder that commutates the motor must be wired to an input of the 2nd encoder connector. (For all configurations except for dual-loop encoders, a single encoder is utilized to both commutate the motor and close the PID loop.)

For incremental quadrature encoders, the encoder can be interface to either the differential or the single-ended encoder inputs of the required encoder connector. However, the differential inputs are strongly recommended due to their much greater noise immunity.

For the first four serial absolute encoders, encoders from different manufacturers must be connected to specific pins in the required encoder connectors (please see the Controller's Third Party Equipment section for more details).

For a six-axis controller, the absolute encoders for the 5th and 6th motors must be connected to specific pins in the 1st and 2nd encoder connectors, respectively.

Once encoders and motors have been properly wired to controller connectors, the encoder and motor pair can be arbitrarily mapped to logical axes of a robot. For example, an encoder and motor can be wired to the 4th encoder and motor connectors, but can be assigned to the 2nd axis of a kinematic module.