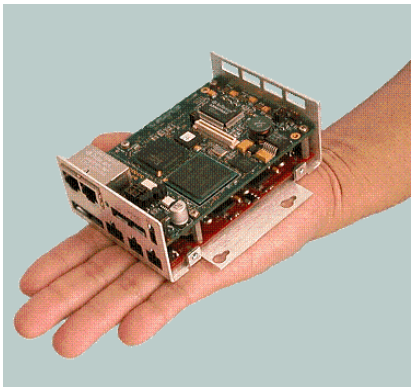
PRECISE AUTOMATION

Guidance 1000 Controllers



Hardware Introduction and Reference Manual

Version 4.0.0, June 18, 2015
FINAL RELEASE
P/N: G1X0-DI-00010

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

Document Content

Trademarks

Disclaimer

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

Warning Labels

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

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

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

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

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

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

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 1000 Controllers are the third family of controllers that Precise has introduced. As compared to the Guidance 2000 and 3000, these controllers are designed to save additional cost and space for applications that only require lower power servo motors (100W and below). Like the Guidance 2000 and 3000, the Guidance 1000 controllers offer the same powerful, compatible language options, web interface, geometric ("kinematic") modules and extensive motion control capabilities. Since these controllers only support low power motors, they do not include the safety circuits required for larger motors. However, they can be used in combination with Guidance 2000 and 3000 controllers to satisfy all safety requirements for systems with a mixture of high and lower power and voltage motors.

The Guidance 1000 Controllers include integrated motor drives. They require an external 24 VDC supply for the logic and IO and an external motor power supply. The motor power supply voltage can range from 12 VDC to 42 VDC, which is suitable for most low power motors. 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 G1000 series can include two, three or four integrated motor drives (the Guidance 1200, 1300 or 1400 respectively).

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. The Guidance 1000 can be run as a standalone robot controller or it can be a slave controller in a network of controllers where the master is a Guidance 2000 or 3000 or another Guidance 1000.

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 controller includes 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

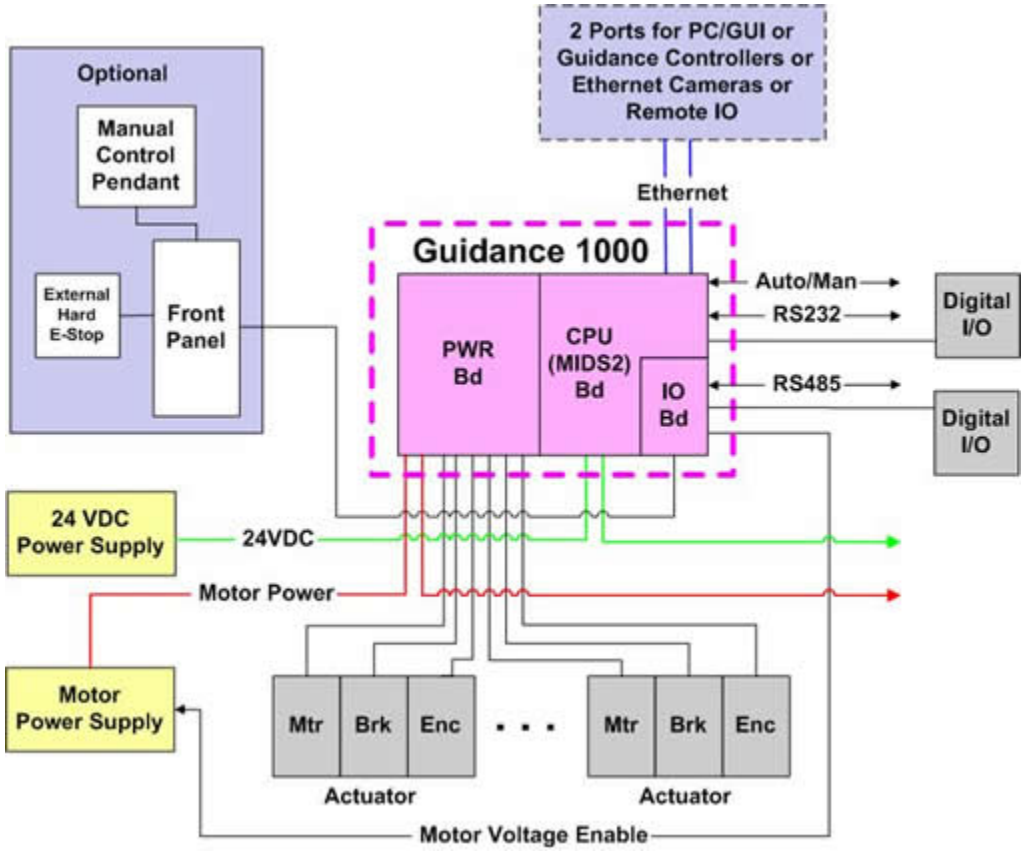
time users read the *Setup and Operation Quick Start Guide*, PN 0000-DI-00010, for instructions on interfacing a PC to a controller via the web interface and for general operating instructions.

The controller is programmed by means of a PC connected through Ethernet. There are three programming modes: a Digital IO (PLC) mode, an Embedded Language mode, and a PC Control mode. When programmed in the PLC or Embedded Language mode, the PC can be removed after programming is completed and the controller will operate standalone. A PC is required for operation in the PC Control mode. 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 controller is 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 1000 system diagram is shown below. The basic system consists of a CPU board (MIDS2) and a motor power amplifier board. When the controller is utilized as a slave in a controller network or in a less demanding application, these two boards are all that is required. To use the Guidance 1000 as a master in a controller network or in a more demanding standalone application, an optional IO daughter board can be added to the MIDS2 board.



The basic controller includes interfaces to motors, encoders, communication devices and digital signals. The optional IO board adds interfaces to additional digital signals plus a front panel. A front panel is not necessary for the operation of the system but does provide support for an MCP and an E-Stop button.

The Ethernet ports can connect the controller to a PC, other Guidance Controllers, cameras or remote IO boards. The PC can serve as the system GUI and can provide real-time commands to the controller.

System Components

Guidance 1000 Controllers

The Guidance 1000 Controller includes 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. This controller can be equipped with a motor power amplifier board (4ALV) with interfaces for 2, 3 or 4 motors and encoders (G1200, G1300, G1400). The high performance processor board (MIDS2) is available in either a standard or enhanced configuration. Both versions of the MIDS2 include the following interfaces: two 10/100Mbit Ethernet ports; a RS-232 port; four general purpose optically isolated digital inputs; four general purpose optically isolated digital outputs; and two sets of Auto/Manual mode signals to permit this unit to operate in a controller network. The "enhanced" MIDS2 board additionally includes hardware support for absolute encoders.

If the optional IO daughter board is added to the MIDS2, the following additional interfaces are provided: 8 general purpose optically isolated digital inputs; 8 general purpose optically isolated digital outputs; a RS-485 serial port; two signals for externally enabling the motor power supply; and a simplified front panel interface. The front panel interface includes: a second RS-232 for communicating with a manual control pendant (MCP); and dual E-Stop signals. This interface can connect to a simplified front panel, directly to a MCP, to a E-Stop box, or can be jumpered out if not required.

WARNING: The Guidance 1000 is powered by 24VDC and can contain voltages up to 42VDC to drive the motors. These products are intended to be mounted in a cabinet or machine chassis that is not accessible or to have its top cover installed when AC line power is on.

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. For applications using remote IO or Ethernet cameras, Precise recommends a total of 4 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 on.

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

If the optional IO daughter board has been installed, it provides an interface to a remote front panel. This interface provides dual E-Stop safety signals and a RS-232 port for use with a Manual Control Pendant (MCP). If the front panel interface is not utilized, the following pins on the front panel connector must be jumpered in order for the system to properly operate. (All controllers are shipped with these jumpers installed.)

1-2, 3-4

See the Controller Hardware Reference for a detailed description of the E-Stop and other Remote Front Panel Signals.

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.

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 robots and the Guidance System. A 25-pin Dsub to 10-pin connector adaptor cable is available for plugging the MCP into the Remote Front Panel connector of a Guidance 1000 Controller.

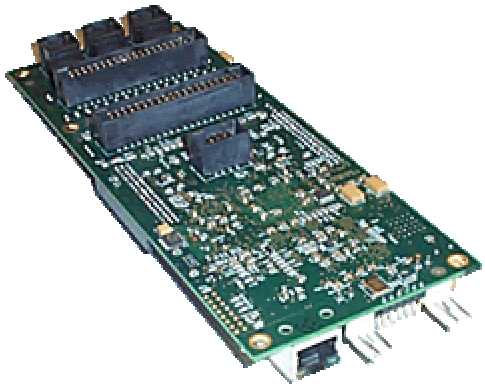
Remote IO Module

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.

Machine Safety

Voltage and Power Considerations

The Guidance 1000 Controllers require two DC power supplies: a 24 VDC power supply for the logic and user IO, and a motor power supply. The motor power supply must provide the controller with a voltage between 12 VDC and 42 VDC.

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

WARNING: The Guidance 1000 is powered by 24VDC and can contain voltages up to 42VDC to drive the motors. These products are intended to be mounted in a cabinet or machine chassis that is not accessible or to have its top cover installed when AC line power is turned on.

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.

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 (certification of compliance with these standards is currently in process):

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.

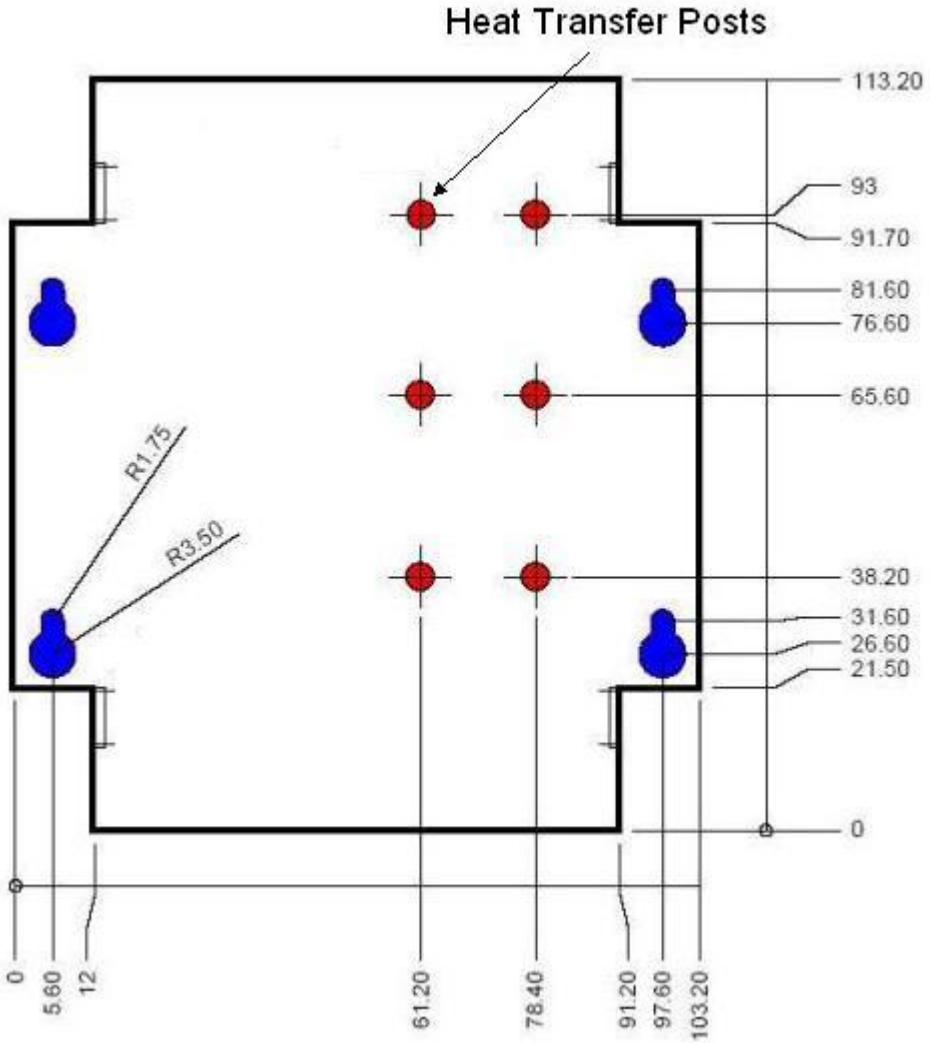
In Computer Mode, robots can achieve speeds of 2000mm per second or even greater. During Computer Mode Operation it is strongly recommended that operators be prevented from entering the robot work volume by safety barriers that are interlocked to the E-stop circuitry. Please refer to the ANSI/RIA R15.06 *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 1000 Controller has a very small footprint but can control a substantial amount of motor power. For reliable operation, it is important that the controller be properly mounted on a heat sink and cooled to dissipate the heat generated by the controller's power devices and high performance IC's.

The controller should be mounted to a heat sink with thermal grease and M3 by 6mm button head cap screws. The mounting holes are shown in **Blue** in the following drawings with dimensions in millimeters.



NOTE: The power modules on the motor power amplifier board are cooled by transferring heat to the lower case via six **Heat Transfer Posts** that are screwed into the **red threaded holes**. If the motor power amplifier board is taken out of the case and directly mounted in a robot, the six Heat Transfer Posts must be in contact with an adequate heat sink to prevent over-heating of the power modules.

The controller is supplied with a cover that removes heat from key IC's by thermally coupling these chips to the cover. If the controller is operated with the cover removed, a means for transferring the heat from these IC's may be necessary.

The size of the heat sink on which the controller should be mounted is a function of the power being dissipated. The table below may be used to estimate the required heat sink area as a function of RMS motor power, assuming the continuous motor current for each motor is set to the maximum current of 2.8A . For lower motor currents, the surface area may be scaled proportionately. In general, the thickness of the heat sink is not critical. The surface area dictates the amount of heat dissipated and the mass of the heat sink determines the time required for the heat sink to achieve a stable state. Note that the heat sink may be a robot chassis or other thermally conductive structure.

Duty Cycle	100%	50%	25%
1 Motor	0.040 m^2	0.020 m^2	0.010 m^2
2 Motors	0.080 m^2	0.040 m^2	0.020 m^2
3 Motors	0.120 m^2	0.060 m^2	0.030 m^2
4 Motors	0.160 m^2	0.080 m^2	0.040 m^2

Most robot applications implement pick and place motions that have an RMS duty cycle of 25% to 35%, as the motion is intermittent. One easy way to determine actual RMS motor power is to run the target application at full speed and full load and go to the motor diagnostics page in the Web Interface under "Setup > Hardware Tuning and Diagnostics/Motor Diagnostics" and note the duty cycle for each motor.

A good indication of whether the controller is being properly cooled is to monitor the CPU temperature after the system has operated for an hour or two at its full speed and load. The CPU temperature 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**. 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 CPU temperature. 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 reading of the CPU temperature to determine if the cooling of the controller is sufficient.

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

Recommended Motor and Encoder Wiring

Wiring Overview

In order achieve low power losses, the controller's motor drives are designed as switching amplifiers with edges that occur as fast as once every 100 nsec. While this aids in keeping the switching losses down, it can make receiving logic level signals from encoders and other sensors more difficult. This is because every PWM edge must charge and discharge the motor wiring capacitance. This can generate current spikes that can cause the motor frame to have ground bounce due to the inductance of the ground return back to the amplifier. This ground bounce and the coupling between motor harness wire and encoder harness wires can introduce noise into the system.

Fortunately, since the Guidance 1000 is limited to relatively low motor voltages, the problem of induced ground bounces is significantly mitigated. However, because other devices in the system may generate similar electrical noise, it is good practice to employ wiring methods that safeguard against such problems.

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

UL recommends the following current ratings for 80° C wire. In general, the wire Amperes should meet or exceed the RMS (rated) current of the motor since the Amperes rating is primarily a function of the heating of the wire due to the average motor current and not the peak current.

Wire Size AWG	28	26	24	22	20	18
Amperes	0.6	1.0	1.6	2.5	4.0	6.0

As an extra precaution, we recommend that the ***motor wire should be shielded*** and have a rating of 150 volts or more. 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.

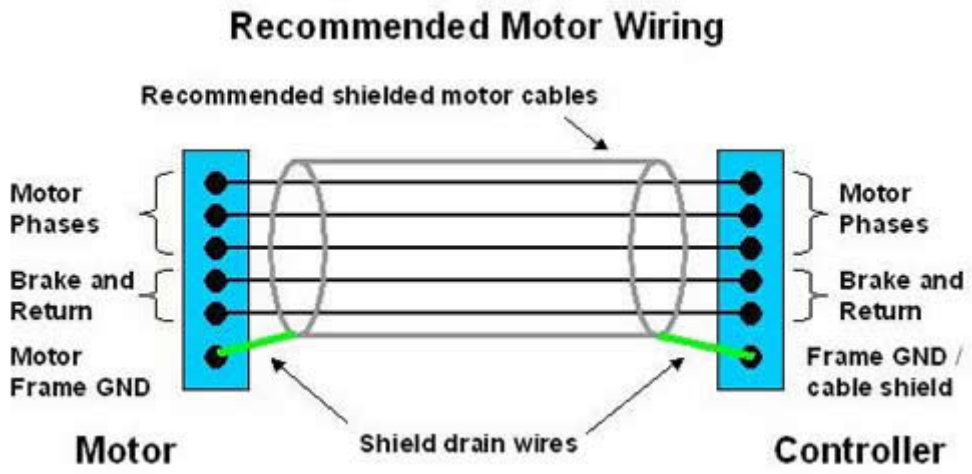
	Alpha 18 AWG	**Beldon 20 AWG**
High Flex	85803CY	
Moderate Flex	65803CY	
No Flex	3242	9963

Motor Wiring Path

Since the ground bounce of motors connected to this controller will be small due to their low voltages, the motor cables for this controller do not require ferrite beads. (“Ferrite beads” are sometimes referred to as “ferrite chokes” or “ferrite cores”.)

However, if you are also wiring a Guidance 2000 or 3000 controller with high voltage motors, please consult the wiring instruction for those controllers since their recommended wiring practices are significantly different.

The following picture illustrates how the motor cable should be wired. The shield around the motor cable is optional, but a good practice to follow.



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 encoder wiring should never be run next to unshielded motor wiring or other possible noise sources.

	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**

10 on the controller 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.

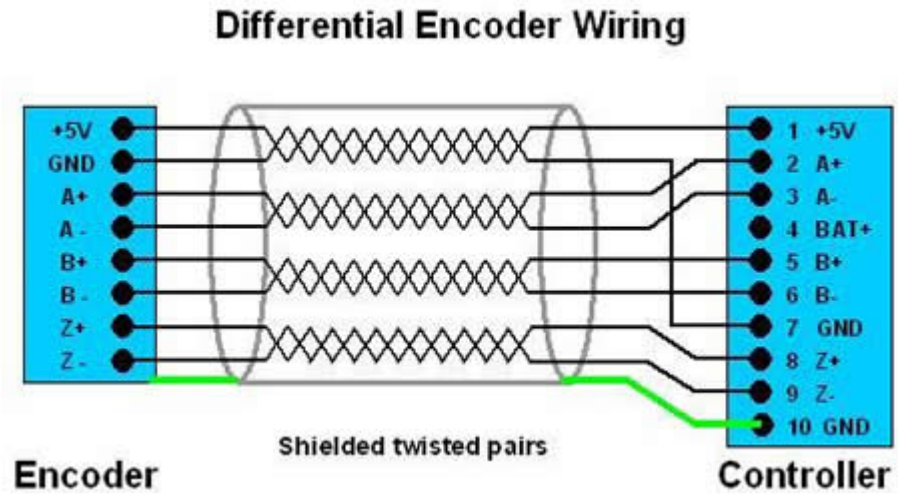
Encoder Wiring and Pin Assignments

Each encoder connector on the Guidance 1000 provides pins for interfacing to a differential incremental encoder or an absolute encoder. This interface can also be utilized to connect to single-ended encoders. However, given a choice, it is always best to select an encoder with differential signals for the greatest noise immunity. Please see the section on Third Party Equipment for specific pin assignment for absolute encoders.

If a single-end encoder is wired, a shielded twist pair cable should still be used to ensure the best possible signals and avoid crosstalk between the signals. In this case, the low side of each twisted pair should be connected to ground.

Due to pin limitations, if several wires must be connected to a single pin, a larger pin should be used.

The following drawing illustrates how to interface to a differential encoder.

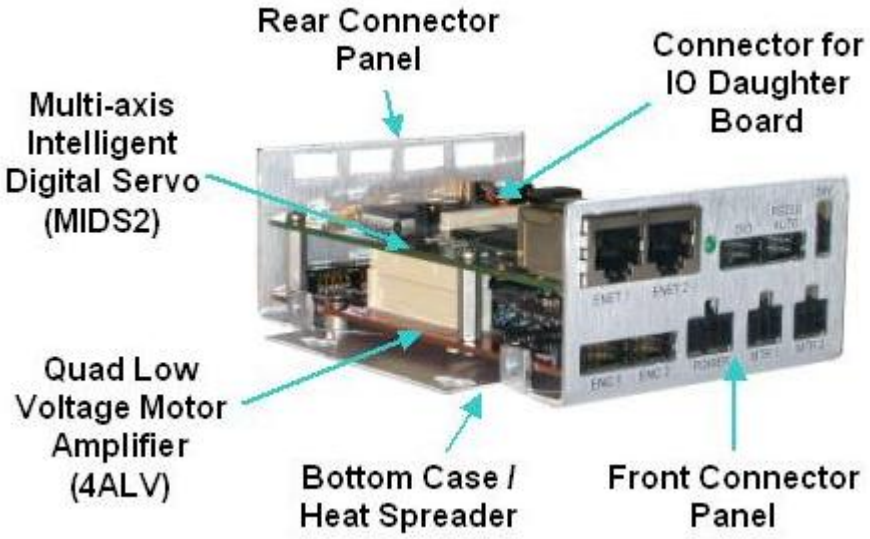


Hardware Reference

Guidance Controller Assemblies and Interfaces

Guidance Controller Major Assemblies

The Guidance 1000 Controllers are normally provided in an enclosure that contains two printed circuit board assemblies and an optional third board. These components are shown in the following picture where the top cover has been removed for clarity.



WARNING: The Guidance 1000 is powered by 24VDC and can contain voltages up to 42VDC to drive the motors. These products are intended to be mounted in a cabinet or machine chassis that is not accessible or to have its top cover installed when AC line power is on.

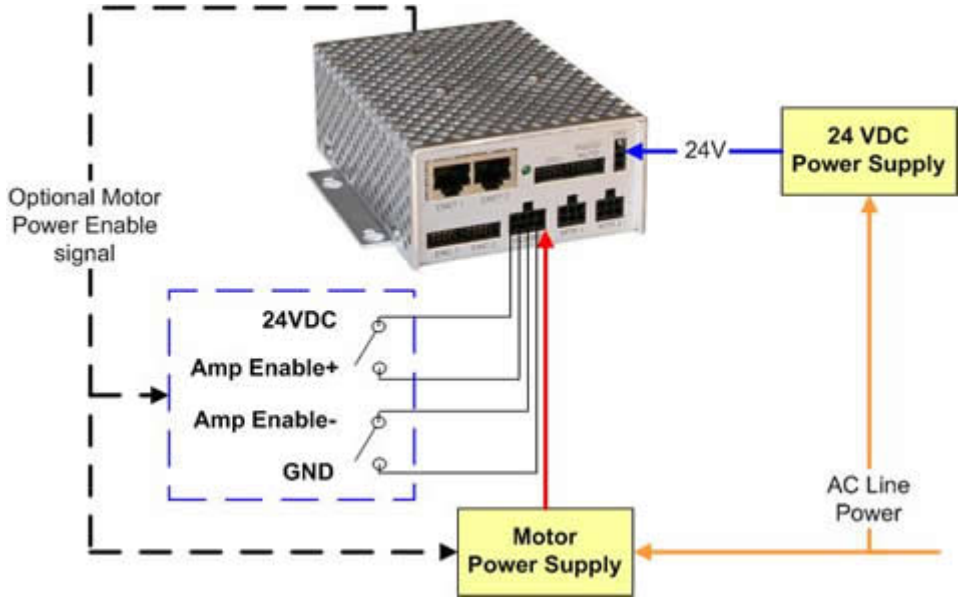
The bottom assembly is the Quad Low Voltage Amplifier Board (4ALV) that contains 2, 3 or 4 motor drives. Mounted above it is the controller's high performance processor board - the Multi-axis Intelligent Digital Servo (MIDS2). The optional third assembly is the IO daughter board.

All of the external interfaces are provided on the Front and Rear Connector Panels that are part of the Bottom Case. Each of these interfaces is described in detail later in this chapter.

The Bottom Case also serves to spread the heat generated by the motor power modules. Each power module has a post at each end that is screwed to the Bottom Case to conduct the heat to the case. The case must be mounted to a heat sink to conduct the heat away from the case and the controller.

Connecting Power and Enabling Motor Power

The Guidance 1000 Controller, motor power supply, and 24 VDC logic power supply should be connected as shown below. The 24V power supply is wired to a two pin 24VDC Logic Power Connector on the front panel. This connector provides power to the controller's high performance processor and the other logic circuits. The motor power supply is wired to an eight pin Motor Power Input Connector that includes other signals as well. When enabled, this source provides power to the motors connected to the motor amplifiers.



WARNING: The Guidance 1000 is powered by 24VDC and can contain voltages up to 42VDC to drive the motors. These products are intended to be mounted in a cabinet or machine chassis that is not accessible or to have its top cover installed when AC line power is on.

In order for the motors to be provided with power, the following conditions must all be satisfied:

- Power must be supplied to the Motor Power Input Connector.
- The Motor Power Input Connector's "Amplifier Enable+" signal must be tied to 24VDC and the "Amplifier Enable-" signal must be tied to ground.
- The controller must internally enable the amplifiers.

Since this controller only supports low motor voltages, there are several ways in which power can be safely enabled.

- The motor power supply output can be left powered on and the controller's internal logic can enable and disable power to the amplifiers as needed.

- If the IO Daughter Board is installed, the Motor Power Enable signals from the RS-485 / Motor Power Enable connector can control a relay that turns the motor power supply on and off.
- If the IO Daughter Board is installed, the Motor Power Enable signals from the RS-485 / Motor Power Enable connector can control a relay that sets the Amplifier Enable+/- signals to their required states.

If the Amplifier Enable+/- signals are not controlled by a relay, they should be hardwired to the 24VDC and ground signals to permit motor power to be enabled.

Even if the motors are energized by a 24VDC power supply, **it is strongly recommended that the motor power supply be separate from the 24VDC logic power supply**. When motors decelerate, they can regenerate significant power that flows back to the motor power supply. If the motor power supply is not designed to absorb this regenerated energy, the voltage of the motor supply can rise significantly. If this power supply is also connected to the controller's digital logic, the pumped up voltage will damage the controller.

WARNING: If the voltage supplied to the controller's digital logic exceeds 30VDC, the controller's hardware will be damaged. Motor power supply voltage pump-up from decelerating motors can significantly exceed this limit so **the motor supply should not be connected to the controller's logic** unless the supply is specifically designed to absorb this energy and limit the voltage rise.

Controller Connectors

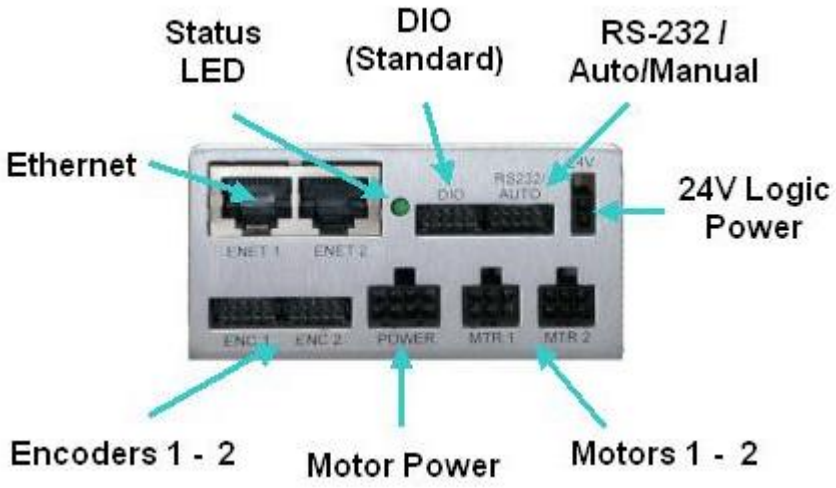
Controller Connectors

In addition to providing interfaces for up to four motors and encoders, the Guidance 1000 provides extensive communication services. The connectors for each of these interfaces are described in detail in this section. The list of the provided functionality is as follows:

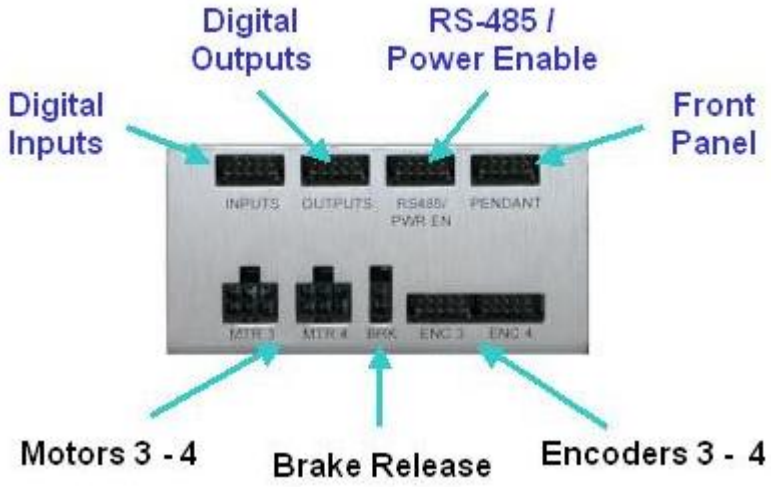
- Brake release
- Digital input and output signals (standard)
- Digital input signals (optional)
- Digital output signals (optional)
- Encoder interfaces
- Ethernet interfaces
- Motor interfaces
- Motor power input connector
- Remote front panel / Secondary RS-232 port (optional)
- RS-232, Auto/Manual
- RS-485 / Motor power enable (optional)
- Status LED
- 24VDC controller logic power connector

To simplify mounting and cabling the controller, all of the interface connectors are provided on the Front and Back Connector Panels.

The following illustrates the connectors that are mounted on the **Front Connector Panel**. To jump to the detailed information for a specific connector, click on the connector interface name or the connector in the following picture.



The following illustrates the connectors that are mounted on the **Back Connector Panel**. The optional interfaces that are provided by the IO Daughter Board are indicated by **blue labels**. To jump to the detailed information for a specific connector, click on the connector interface name 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 presented.

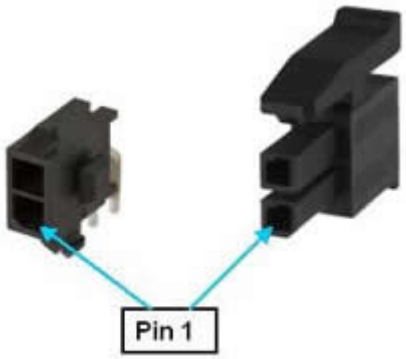
Brake Release Connector

During normal operation, any brakes attached to motors are automatically released at the appropriate time to permit the axes to move. The Brake Release connector provides two pins that can be shorted together to force the brakes to be manually released. If desired, these signals are typically connected to a momentary contact manual brake release button.

To simplify wiring, the control signals, BRAKE+ and BRAKE-, are present in each of the motor connectors. All of these signals are driven from the same source. The BRAKE+ signal is tied to 24VDC. When the brakes are not energized (released), the BRAKE- signal is permitted to float to 24VDC. To energize the brakes, the controller ties BRAKE- to ground.

This connector exposes the BRAKE- and ground signals and permits the brakes to be released by externally tying BRAKE- to ground.

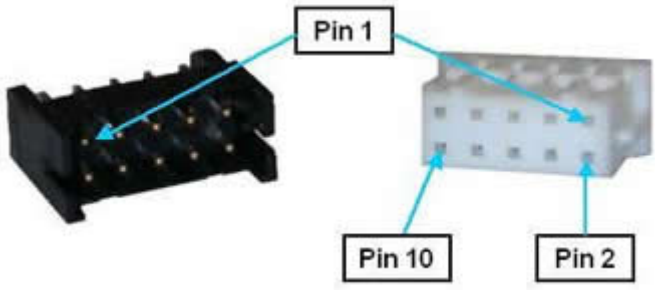
The Brake Release connector mounted on the motor drive board is a two-pin AMP 3-794618-2. The mating plug is an AMP 794617-2.



Pin	Description
1	GND
2	BRAKE-. Connect this signal to GND to release the brakes.
User Plug Part No	AMP 794617-2. Use an AMP 91501-1 hand tool and AMP 1-794610-2 sockets for wiring to the plug.

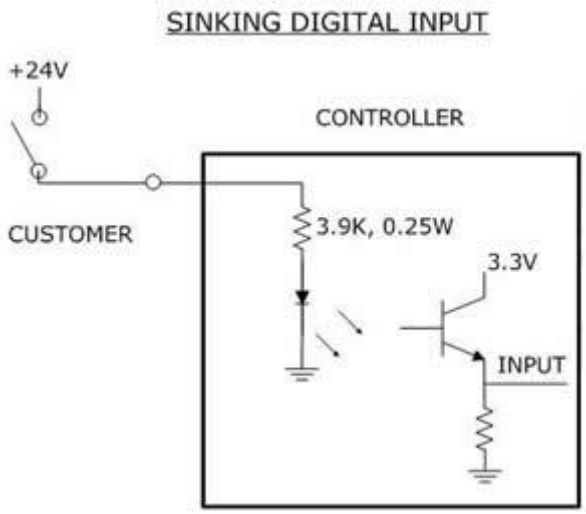
Digital Input and Output Signals (Standard)

As a standard feature, the Guidance 1000 provides 4 general purpose optically isolated digital input signals and 4 general purpose optically isolated digital output signals. These signals are presented in a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.

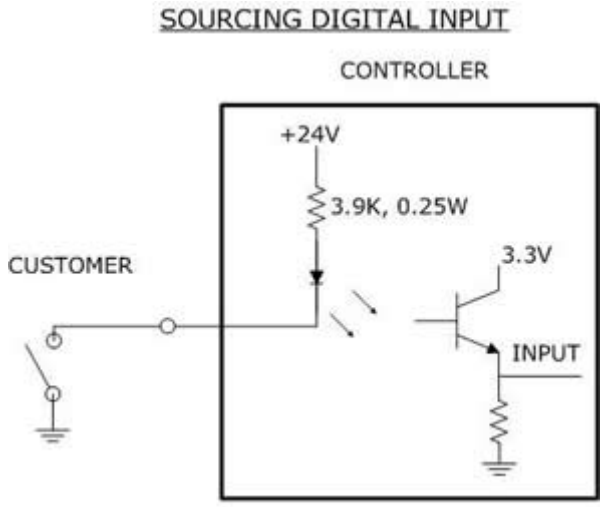


By setting Jumpers on the CPU (MIDS2) board, the four output signals can be individually configured as "sinking" or "sourcing" and the four digital inputs can be configured as a group to all operate as either sinking or sourcing.

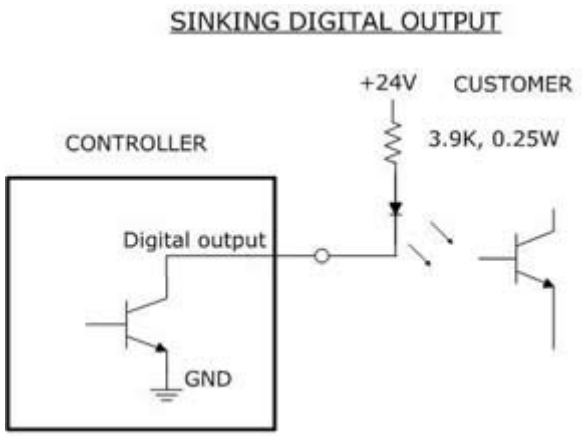
If an **input signal** is configured as "sinking", the external equipment must provide a 5VDC to 24VDC voltage to indicate a logical high value or no voltage for a logical low. This configuration is compatible with "sourcing" (PNP) sensors.



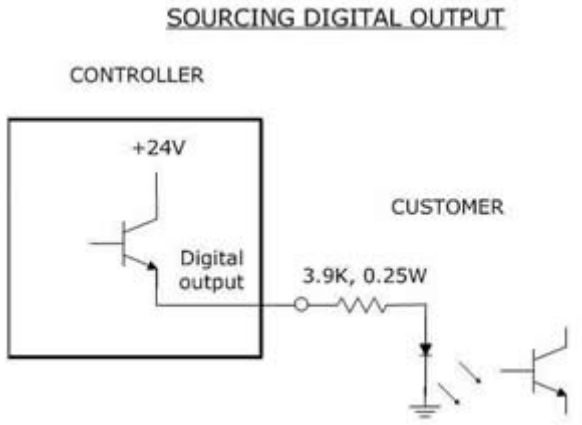
If an **input signal** is configured as "sourcing", the external equipment must pull the signal input pin to ground to indicate a logical high and must let the line float high to 24VDC to signal a logical low value. This configuration is compatible with "sinking" (NPN) sensors.



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 inputs are normally configured as "sourcing" and all outputs are configured as "sinking".

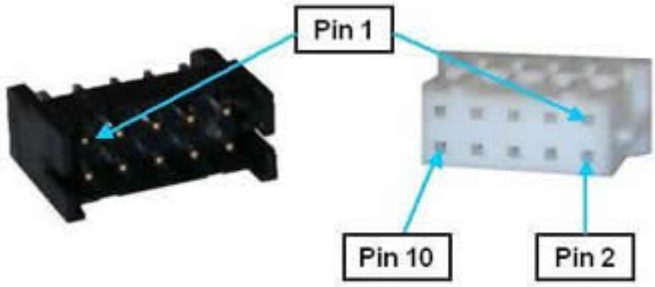
The pin out for the Digital Input and Output Connector and the corresponding GPL signal numbers are described in the following table.

Pin	GPL Signal Number	Description
1	13	Digital Output 1
2	14	Digital Output 2
3	15	Digital Output 3
4	16	Digital Output 4
5		GND
6		24 VDC output
7	10001	Digital Input 1
8	10002	Digital Input 2

9	10003	Digital Input 3
10	10004	Digital Input 4
User Plug Part No		JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

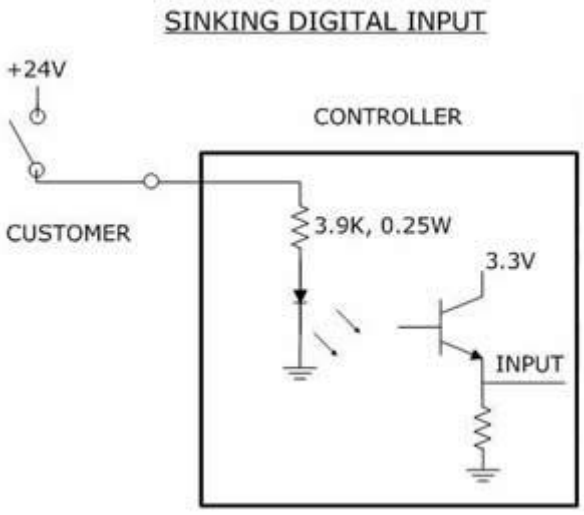
Digital Input Signals (Optional)

(REQUIRES IO DAUGHTER BOARD) As an optional feature, the Guidance 1000 can include an additional 8 general purpose optically isolated digital input signals. These signals are presented in a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.

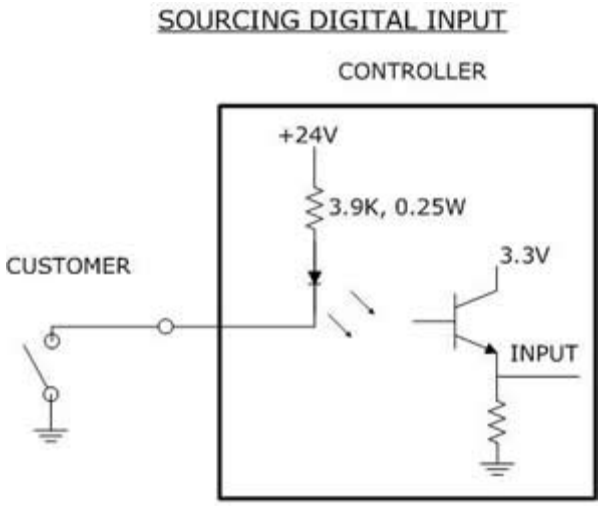


The configuration of these signals for "sinking" or "sourcing" is TBD.

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.



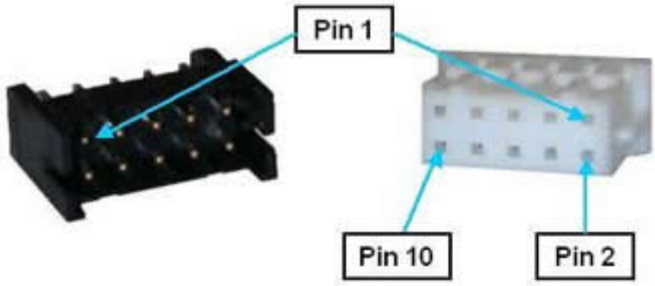
As shipped from the factory, all digital inputs are normally configured as "sourcing".

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

Pin	GPL Signal Number	Description
1	10005	Digital Input 5
2	10006	Digital Input 6
3	10007	Digital Input 7
4	10008	Digital Input 8
5		GND
6		24 VDC output
7	10009	Digital Input 9
8	10010	Digital Input 10
9	10011	Digital Input 11
10	10012	Digital Input 12
User Plug Part No		JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

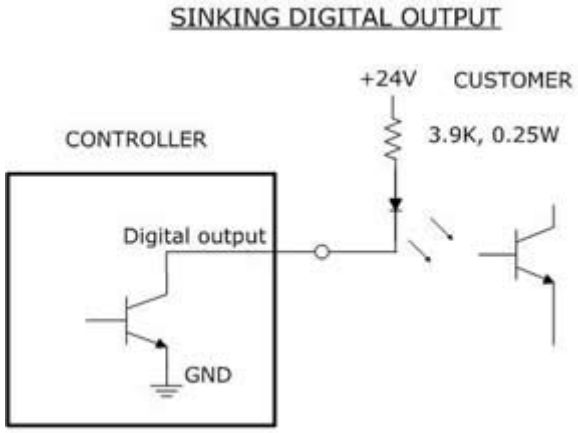
Digital Output Signals (Optional)

(REQUIRES IO DAUGHTER BOARD) As an optional feature, the Guidance 1000 can include an additional 8 general purpose optically isolated digital output signals. These signals are presented in a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.

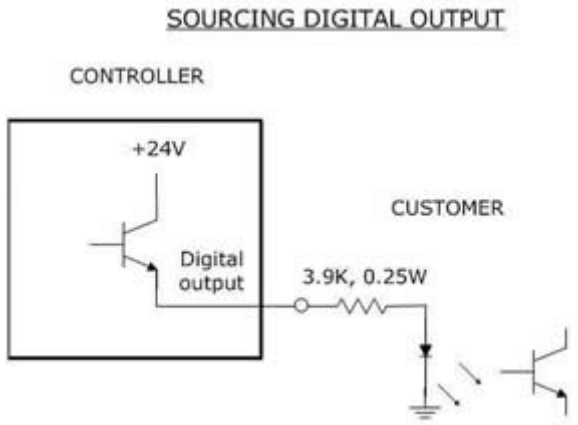


The configuration of these signals for "sinking" or "sourcing" is TBD.

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.



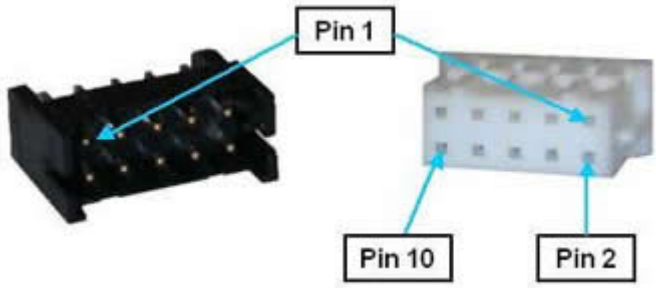
As shipped from the factory, all outputs are normally configured as "sinking".

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	17	Digital Output 5
2	18	Digital Output 6
3	19	Digital Output 7
4	20	Digital Output 8
5		GND
6		24 VDC output
7	21	Digital Output 9
8	22	Digital Output 10
9	23	Digital Output 11
10	24	Digital Output 12
User Plug Part No		JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

Encoder Interfaces

Guidance 1000 controllers are equipped with 2, 3 or 4 encoder interfaces to match the number of motor drives included. Each interface is provided in a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.



Each interface can be configured for a differential or single-ended incremental encoder or a variety of absolute encoders. Since many absolute encoders require external battery backup power to retain the memory of their revolutions counters, each encoder interface includes a battery power line that is directly connected to the Motor Power In Connector. Please see the "Third Party Equipment" section of this manual for more information on configuring and wiring absolute encoders. Also, note that certain absolute encoders require the "Enhanced" version of the Guidance Controller due to special hardware requirements.

It is strongly advised that you review the Installation section of this manual for recommendations on best practices for wiring encoders. Following the provided instructions will significantly reduce the likelihood of any problems due to noise in the encoder signals.

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

Pin	Description
1	5 VDC output provided to power encoders. The sum of the current drawn from all four encoder connectors is limited to 360 mA.
2	Encoder A+
3	Encoder A-
4	Absolute encoder battery+ output
5	Encoder B+
6	Encoder B-
7	GND
8	Encoder Z+
9	Encoder Z-
10	GND
User Plug Part No	JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

Ethernet Interface

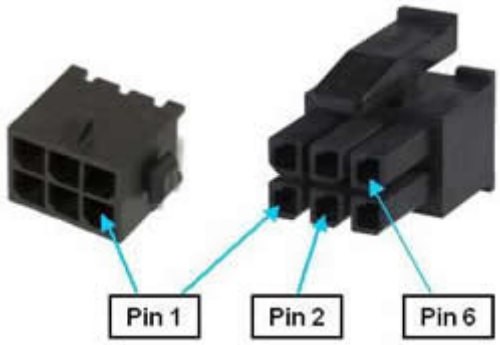
The controller includes an Ethernet switch that implements two 10/100 Mbit Ethernet ports. This capability was designed to permit the controller to be interfaced to devices such as other Precise controllers, remote I/O units, and Ethernet cameras. The Ethernet switch automatically detects the sense of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

Either Ethernet port can be used to interface to the Guidance controller. If the two ports are connected to external equipment that are communicating with each other but not the controller, the switch automatically routes the traffic between the two ports and does not send this information to the controller. For example, if an Ethernet camera is connected to one port and a PC is connected to the other port, the camera image data will not burden the controller's CPU.

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

Motor Interfaces

Guidance 1000 controllers are equipped with 2, 3 or 4 motor drives. The motor interface for each drive is provided in a single 6-pin AMP 3-794618-6 connector that mates with a AMP 794617-6 plug.



As a wiring convenience, each of the motor connectors includes brake control signals for energizing (releasing) a brake. Internally, all of these brake signals are controlled by the same logic, so all brakes are released together rather than on an individual basis. If individual brake control is required, the general purpose digital output lines can be configured for this function. The system also includes a input for manually releasing the brakes (see the Brake Release Connector).

It is strongly advised that you review the Installation section of this manual for recommendations on best practices for wiring motors. Following the provided instructions will significantly reduce the likelihood of the motors generating undesirable electrical noise.

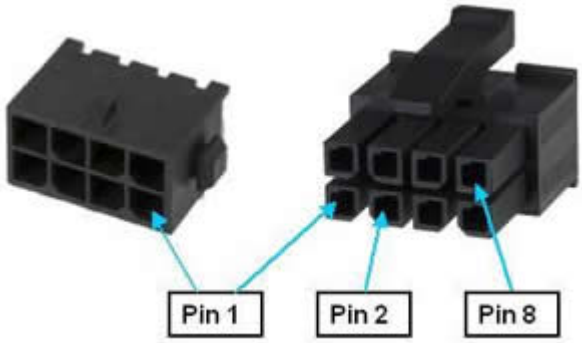
The pin out for the Motor Connector is described in the following table.

Pin	Description
1	Brake power output, 24VDC, maximum current 2A total for all brakes
2	Motor phase V
3	Motor phase W
4	Brake power return. Set to ground to energize (release) brakes otherwise 24VDC.
5	Motor frame ground/cable shield
6	Motor phase U
User Plug Part No	AMP 794617-6. Use an AMP 91501-1 hand tool and AMP 1-794610-2 sockets for wiring to the plug.

Motor Power Input Connector

The power to drive the motors must be supplied separately from the logic power. The logic power must be 24VDC and must be continuously on while the controller is operational. The motor power can range from 12VDC to 42VDC and is turned on and off whenever the robot is enabled or disabled.

The power to drive the motors and any required battery backup power needed for absolute encoders is supplied via the Motor Power Input Connector. This connector is an 8-pin AMP 3-794618-8 that mates with a AMP 794617-8 plug.



As a convenience, this connector includes "Enable amplifier +/-" signals that permit the motor power supply to be left on continuously. These signals can disable the power amplifiers and internally cut off power to the motors. This is convenient if you wish to power both the logic and the motors from the same 24VDC power supply and the supply is able to absorb the energy pump up when the robot is decelerating.

To enable the motor amplifiers, the following signals pins must be connected:

2-3, 6-7

Please see the Connecting Power and Enabling Motor Power section of this manual for general information concerning enabling motor power.

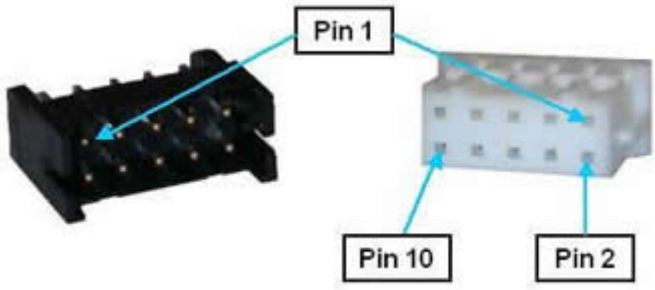
Since many absolute encoders require external battery backup power to retain the memory of their revolutions counters, this connector provides a means for connecting a battery to the system. Any battery power provided on these pins is directly routed to each Encoder Interface Connector. Please see the "Third Party Equipment" section of this manual for more information on configuring and wiring absolute encoders. Also, note that certain absolute encoders require the "Enhanced" version of the Guidance Controller due to special hardware requirements.

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

Pin	Description
1	Motor power input, 12VDC to 42VDC nominal.
2	24 VDC output.
3	Motor amplifier enable+. Connected to pin 2 to enable the amplifiers.
4	Absolute encoder battery+ input
5	GND
6	GND.
7	Motor amplifier enable-. Connected to pin 6 to enable the amplifiers.
8	Absolute encoder battery- input
User Plug Part No	AMP 794617-8. Use an AMP 91501-1 hand tool and AMP 1-794610-2 sockets for wiring to the plug.

Remote Front Panel / Secondary RS-232 Port Connector (Optional)

(REQUIRES IO DAUGHTER BOARD) The remote front panel interface includes a serial port for connecting to a Manual Control Pendant (MCP) and redundant E-Stop inputs for receiving an hardware E-Stop signal. These signals are all that is needed to implement a remote front panel that is proper for a low voltage, low power control system. These signals are provided on a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.



If a Manual Control Pendant is not connected to the RS-232 port, this serial interface can be accessed via a GPL procedure as device /dev/com2 for general communications purposes.

If a remote front panel, MCP with E-Stop or a E-Stop button is not interfaced to this connector, 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

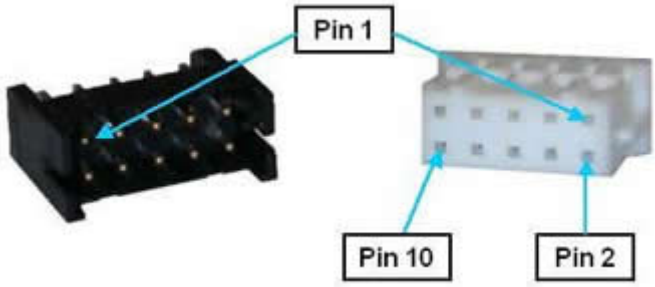
The pin out for the Remote Front Panel Connector is described in the following table.

Pin	Description
1	ESTOP_L 1 (If no front panel or E-Stop not asserted, connect to pin 2). 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.
2	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 and ESTOP_L 2 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.
3	ESTOP_L 2 (If no front panel or E-Stop not asserted, connect to pin 4). Redundant ESTOP input signal.
4	Force ESTOP_L. Redundant Force ESTOP_L output signal.
5	MCP RXD - controller receive data.
6	MCP TXD - controller transmit data
7	24 VDC output
8	GND

9	5 VDC output
10	GND
User Plug Part No	JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

RS-232, Auto/Manual Connector

The RS-232/Auto/Manual connector is a multi-function interface that provides both an RS-232 serial port and Auto/Manual signals that are part of the safety system for a multiple controller network. These signals are provided on a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.



The RS-232 port is the primary serial console port and can also be accessed by GPL procedures as device /dev/com1.

The Auto/Manual signals are normally connected to an Auto/Manual key switch on the front panel for the master controller in a fully compliant Category 3 (CAT-3) Safety system for large robots. Since most applications of the Guidance 1000 are limited to low power mechanisms, this level of safety is not required and jumpers should be installed on the following pins to permit the controller to operate (the controller is shipped with these jumpers installed).

1-2, 3-4

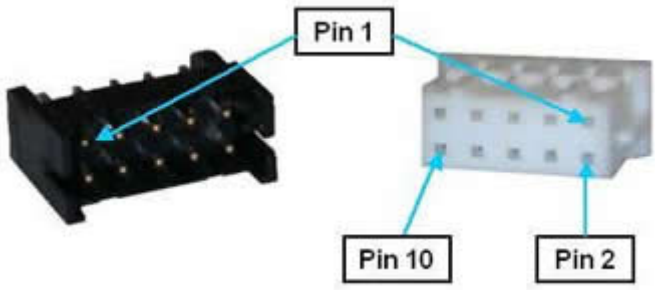
The pin out for the RS-232/Auto/Manual Connector is described in the following table.

Pin	Description
1	Auto/Manual 1 (If no Auto/Manual switch, connect to pin 2). Input signal (0-24VDC) 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	Test Auto/Manual 1. Output signal that, when low, forces the Auto/Manual 1 signal to Manual mode. The System Software toggles this signal low at startup to verify that the Auto/Manual inputs are properly working. This signal is normally held high (24VDC).

3	Auto/Manual 2 (If no Auto/Manual switch, connect to pin 4). Redundant Auto/Manual input signal.
4	Test Auto/Manual 2. Redundant Auto/Manual test signal.
5	Auto/Manual 1 daisy chain. This pin is tied to pin 1 and is provided to allow the Auto/Manual 1 signal to be easily daisy chained to the next controller in the servo network.
6	Auto/Manual 2 daisy chain. This pin is tied to pin 3 and is provided to allow the Auto/Manual 2 signal to be easily daisy chained to the next controller in the servo network.
7	TXD - controller transmit data
8	GND
9	RXD - controller receive data
10	GND
User Plug Part No	JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

RS-485 / Motor Power Enable (Optional)

(REQUIRES IO DAUGHTER BOARD) This optional multi-function interface provides a general purpose RS-485 serial port and redundant output signals that can control turning on and off the external motor power supply. These signals are provided on a single 10-pin JST S10B-PHDSS(LF)(SN) connector that mates with a JST PHDR-10VS plug.



The motor power enable 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 enable " signals to ground. These signals are automatically opened when an E-Stop or other condition occurs that requires that the amplifiers be shutdown.

Please see the Connecting Power and Enabling Motor Power section of this manual for general information concerning enabling motor power.

The pin out for the RS-485 / Motor Power Enable Connector is described in the following table.

Pin	Description
1	Motor power enable. Switched to ground when power is being enabled. Capable of sinking 2A at 24 VDC.
2	Motor power enable (Redundant signal). Provided to comply

	with safety standards.
3	RS-485+
4	RS-485-
5	Reserved
6	Reserved
7	24 VDC output
8	GND
9	5 VDC output
10	GND
User Plug Part No	JST PHDR-10VS. For this plug, use JST SPHD-002T-P0.5 pins.

Status LED

The Status LED indicates whether the controller's CPU is operating in its normal mode and if motor power has been enabled.

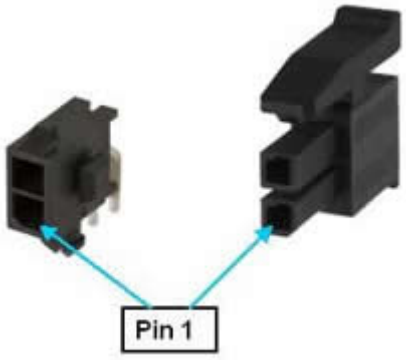
LED State	Description
Continuously Off	Logic power off or processor crashed. Either the 24VDC logic power is off or the processor has crashed due to a system hardware or software error. If the processor has crashed, it may be executing the firmware debugger, Dbug.
Continuously On	Processor crashed. The processor has crashed due to a system hardware or software error. The processor may be executing the firmware debugger, Dbug.
Blinks 1 times per second	Normal operation, motor power off.
Blinks 4 times per second	Normal operation, motor power on.

24VDC Controller Logic Power Connector

All of the controller's logic functions, the digital input and output signals and the motor brakes are supplied power by the 24VDC Controller Logic Power Connector. As soon as this power is provided, the system begins its booting process.

Please see the Guidance 1000 product specifications for information on the number of amperes that must be supplied.

The logic input power connector is a two-pin AMP 3-794618-2. The mating plug is an AMP 794617-2.

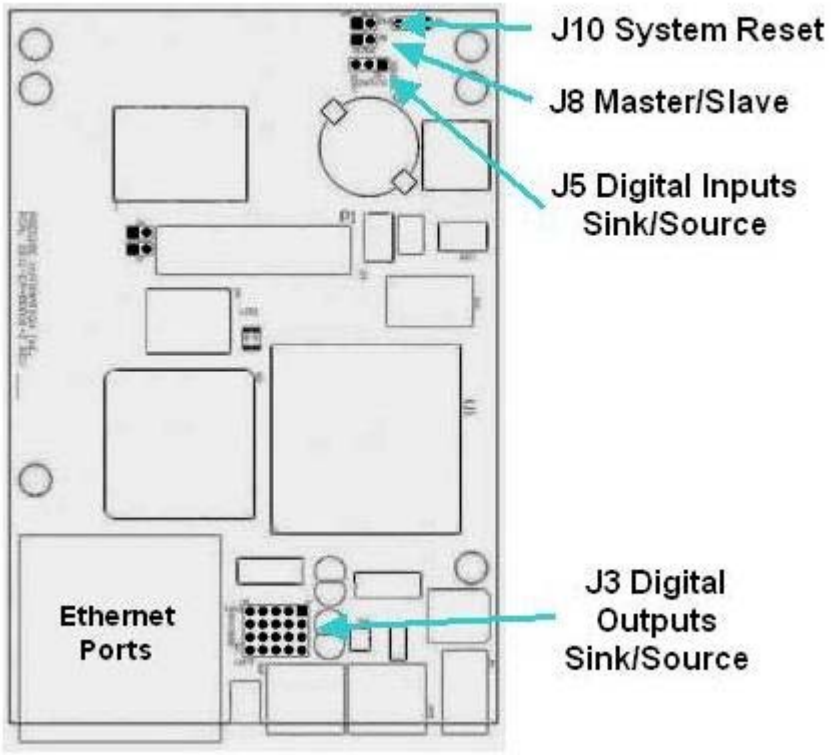


Pin	Description
1	+24VDC input
2	GND
User Plug Part No	AMP 794617-2. Use an AMP 91501-1 hand tool and AMP 1-794610-2 sockets for wiring to the plug.

Processor Board (MIDS2) Jumpers

The high performance processor board (MIDS2) has a number of hardware jumpers that determine the configuration of some basic system hardware and software functions. Depending upon the type of jumper, there may be two, three or five jumper posts. Posts are tied (shorted) together using black jumper plugs. The five wide jumper posts for configuring the digital output signals are shown below.

The locations of each of the sets of jumpers of interest are illustrated in the following diagram and are identified by stenciled labels on the surface of the MIDS2 board.



The following table describes each of the sets of jumpers and how the pins must be shorted ("jumpered") in order to set a specific configuration. When a direction (e.g. left verses right) is described, it is with respect to the MIDS2 board oriented as shown in the picture above.

Jumpers	Description	Setting
J10 System Reset	If a jumper is installed on these two posts, 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. **As shipped from the factory, this jumper is not installed.**	Install jumper J10 to reset the system.
J8 Master / Slave	This jumper determines if the controller operates in Master or Slave node in a multiple controller servo network. If the controller operates by itself, it should be set in Master mode **As shipped from the factory, this jumper is not installed and indicates Master mode.**	Install jumper J8 to select Slave mode
J5 Digital Inputs Sink/Source	These jumpers determine if all four of the Standard General Purpose Digital Input Signals are "sinking" or "sourcing". There is just one set of three posts and their setting dictates the behavior of all four inputs. Pin 1 is to the right-most post and pin 3 is to the left-most. **As shipped from the factory, the inputs are set**	For Sinking, J5-3 TO J5-2 For Sourcing, J5-2 TO J5-1

	to sourcing.	
J3 Digital Outputs Sink/Source	These jumpers determine if each of the Standard General Purpose Digital Output Signals is "sinking" or "sourcing". These jumpers consist of four rows of five posts. Each row determines the setting for a single digital output. The top row corresponds to the first digital output signal. Two jumpers must be set in each row. Within each row, pin 1 is the right-most post and pin 5 is the left-most. **As shipped from the factory, the outputs are set to sinking.**	For Sinking, J3-5 TO J3-4 J3-3 TO J3-2 For Sourcing, J3-4 TO J3-3 J3-2 TO J3-1

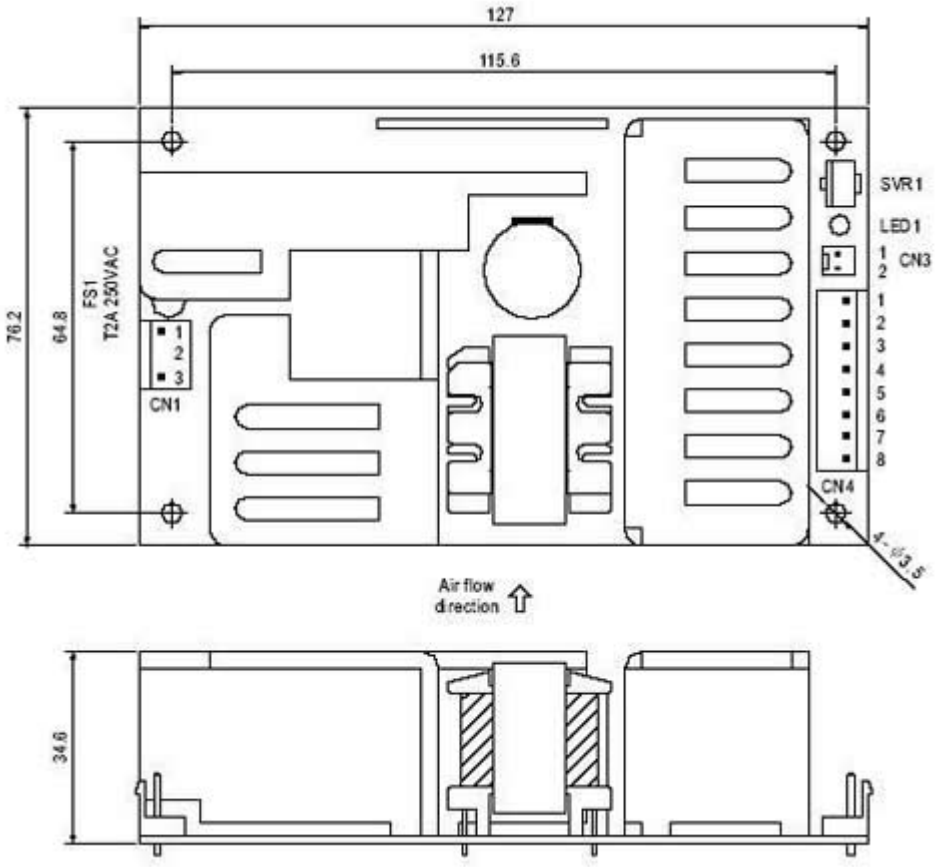
Low Voltage Power Supply

The Guidance Controller requires a minimum of 2.7 amps and preferably 4 amps of 24 VDC power for the logic and IO.

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.

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

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 are only supported on the "Enhanced" versions of the Guidance Controllers.

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

The following are the wiring instructions for the **Encoder Connectors**.

Encoder Connector Pin	Wire Color	Signal Name	G1000 Connector Pin
1	RED	BATTERY+	4
2	PINK	BATTERY -	7
3	GREEN	FG	
4	BLUE	PS+	2
5	VIOLET	PS-	3
6	NC	NC	
7	WHITE	VCC	1
8	BLACK	GND	7
9	NC	NC	

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

Motor Connector Pin	Wire Color	Signal Name	G1000 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 Motor Power Input Connector. 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 are only supported on the "Enhanced" versions of the Guidance Controllers.

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

The following are the wiring instructions for the **Encoder Connectors**.

Wire Color	Signal Name	G1000 Connector Pin
BROWN	BATTERY+	4
BROWN/BLACK	BATTERY -	7
GRAY	FG	10
BLUE	PS+	2

BLUE/BLACK	PS-	3
RED	VCC	1
BLACK	GND	7

If the encoder is to be used in absolute mode, a battery must be connected to the Motor Power Input Connector. 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 Serial Absolute Encoder

This section provides wiring instructions for a Yaskawa motor equipped with a Yaskawa Sigma II Serial Absolute Encoder. The encoder can have 16-bits, 17-bits or 20-bits 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 are only supported on the "Enhanced" versions of the Guidance Controllers.

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

The following are the wiring instructions for the **Encoder Connectors**.

Encoder Connector Pin	Wire Color	Signal Name	G1000 Connector Pin
1	RED	5V	1
2	BLACK	GND	7
3	ORANGE	BATTERY +	4
4	WHITE/ORANGE	BATTERY -	7
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	G1000 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 Motor Power Input Connector. 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 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

Appendix A: Product Specifications

Guidance 1000 Controller Specifications

General Specification	Range & Features
Computational Hardware	
CPU and Dynamic Memory	400Mhz high performance, low-power CPU with a minimum of 8MB of dynamic RAM
Nonvolatile Memory	Flash disk with a minimum of 16MB of storage for OS, firmware and user program and data storage
Software	
Programming Interface	Three programming methods available: DIO MotionBlocks (PLC) Embedded Guidance Programming Language (GPL) PC/Unix controlled over Ethernet
Operator Interface	Web based operator interface supports local or remote control via browser connected to embedded web server
Motion Control	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 Optional conveyor belt tracking Optional kinematic models for various robot geometries
Optional: Machine Vision	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	Up to four integrated motor drives: 5A peak/2.8A RMS per channel Bus voltage & total power for all drives: 12VDC to 42VDC, 470W total
Position Sensors Interface	Four differential digital encoder interfaces Support for selected absolute encoders (requires "Enhanced" controller)
Control Signals	Brake signals (Up to 1A at 24VDC available for releasing motor brakes)
Communications Interfaces	

General Communications	Two 10/100 Mbps Ethernet ports RS-232 port Optional - remote front panel interface with second RS-232 port.
Digital Input Channels	4 general purpose optically isolated inputs, configurable as sinking or sourcing, signals transition to a high or low in 4 usec (8 additional inputs optionally available for a total of 12), 5VDC to 24VDC for logic high if sinking 24VDC supplied for logic high if sourcing Additional remote I/O available via Precise RIO modules, 3rd party MODBUS/TCP devices, or 3rd party EtherNet/IP devices
Digital Output Channels	4 general purpose optically isolated outputs, individually configurable as sinking or sourcing, signals turn on in 3 usec and turn off within 400 usec (8 additional outputs optionally available for a total of 12), 24VDC maximum pull up if sinking 24VDC supplied if sourcing 100mA maximum per channel Additional remote I/O available via Precise RIO modules, 3rd party MODBUS/TCP devices, or 3rd party EtherNet/IP devices
General	
Size and Weight	83mm (W) x 133mm (L) x 44mm (H) 103.2mm (W) x 133mm (L) x 44mm (H), 0.311 kg including mounting bracket
Low Voltage Logic Power	24VDC ±5%, power required for logic and I/O 2.7A minimum 4A recommended for typical use of digital I/O

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)

Appendix B: FAQ

Frequently Asked Questions

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

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 a general digital input signal.

The number of the DIN signal should be set as the "Power enable DIN" (DataID 242) parameter database value.

Power will then 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.