![Brooks logo]

Guidance 1000 Controllers

User Manual

Part Number 608619, Revision A

Brooks Automation

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Revision History

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A	EC147020	07/24/2023	Releasing manual at Rev. A to follow standard Brooks technical publication styles.	M. Ashenfelder

Table of Contents

1. Safety

Safety Setup

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

⚠️ **DANGER**	
Read the Safety Chapter	
Failure to review the *Safety* chapter and follow the safety warnings can result in serious injury or death. • All personnel involved with the operation or maintenance of this product must read and understand the information in this safety chapter. • Follow all applicable safety codes of the facility as well as national and international safety codes. • Know the facility safety procedures, safety equipment, and contact information. • Read and understand each procedure before performing it.	

Authorized Personnel Only

This product is intended for use by trained and experienced personnel. Operators must comply with applicable organizational operating procedures, industry standards, and all local, regional, national, and international laws and regulations.

Explanation of Hazards and Alerts

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

Safety Text

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

- Identify the hazard
- State the consequences if the hazard is not avoided
- State how to avoid the hazard.

Safety Icons

- Hazard alerts contain safety icons that graphically identify the hazard.
- The safety icons in this manual conform to ISO 3864 and ANSI Z535 standards.

Signal Words and Color

Signal words inform of the level of hazard.

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

Alert Example

The following is an example of a Warning hazard alert.
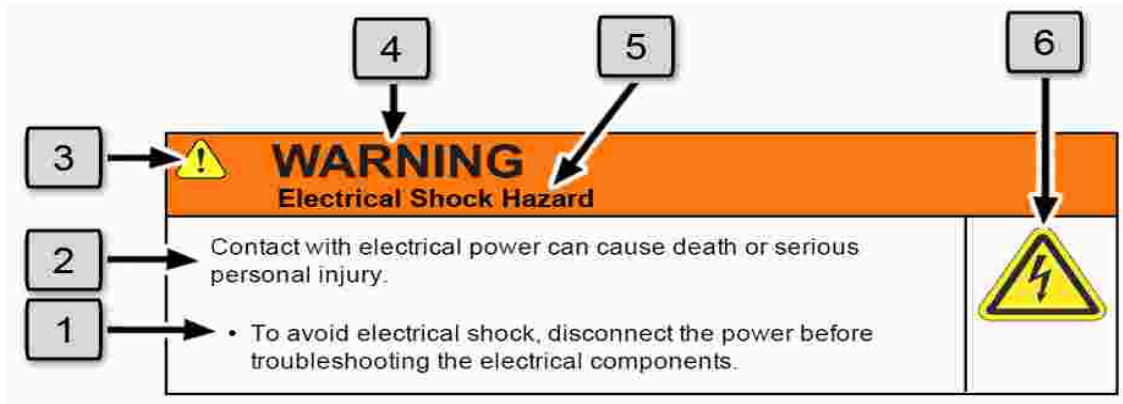
Number	Description
1.	How to Avoid the Hazard
2.	Source of Hazard and Severity
3.	General Alert Icon
4.	Signal Word
5.	Type of Hazard
6.	Hazard Symbol(s)

General Safety Considerations

⚠ WARNING	
Software	
Software is not safety rated. Unplanned motion can occur as long as power is supplied to the motors. Maximum torque could be momentarily applied that may cause equipment damage or personal injury. • Only operate the robot with its covers installed. • Guarantee that safety controller features are in place (for example, an emergency stop button and protective stop). • Regularly test safety components to prove that they function correctly.	

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

⚠ WARNING	
Do Not Use Unauthorized Parts	
Using parts with different inertial properties with the same robot application can cause the robot's performance to decrease and potentially cause unplanned robot motion that could result in serious personal injury. • Do not use unauthorized parts. • Confirm that the correct robot application is being used.	

⚠️ **WARNING**

Magnetic Field Hazard

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

- Maintain a safe working distance of 30 cm from the motor when with an energized robot if you use a cardiac rhythm management device.

⚠️ **CAUTION**

Unauthorized Service

Personal injury or damage to equipment may result if this product is operated or serviced by untrained or unauthorized personnel.

- Only qualified personnel who have received certified training and have the proper job qualifications are allowed to transport, assemble, operate, or maintain the product.

⚠️ **CAUTION**

Damaged Components

The use of this product when components or cables appear to be damaged may cause equipment malfunction or personal injury.

- Do not use this product if components or cables appear to be damaged.

- Place the product in a location where it will not get damaged.

- Route cables and tubing so that they do not become damaged and do not present a personal safety hazard.

⚠️ **CAUTION**

Inappropriate Use

Use of this product in a manner or for purposes other than for what it is intended may cause equipment damage or personal injury.

- Only use the product for its intended application.

- Do not modify this product beyond its original design.

- Always operate this product with the covers in place.

CAUTION ⚠	
Seismic Restraint	
The use of this product in an earthquake-prone environment may cause equipment damage or personal injury. • The user is responsible for determining whether the product is used in an earthquake prone environment and installing the appropriate seismic restraints in accordance with local regulations.	⚠

Mechanical Hazards

CAUTION ⚠	
Pinch Point	
Moving parts of the product may cause squeezing or compression of fingers or hands resulting in personal injury. • Do not operate the product without the protective covers in place.	⚠

WARNING ⚠	
Automatic Movement	
Whenever power is applied to the product, there is the potential for automatic or unplanned movement of the product or its components, which could result in personal injury. • Follow safe practices for working with energized products per the facility requirements. • Do not rely on the system software or process technology to prevent unexpected product motion. • Do not operate the product without its protective covers in place. • While the collaborative robotics system is designed to be safe around personnel, gravity and other factors may present hazards and should be considered.	⚠ ⚠

⚠ **CAUTION**

Vibration Hazard

As with any servo-based device, the robot can enter a vibratory state resulting in mechanical and audible hazards. Vibration indicates a serious problem. Immediately remove power.

- Before energizing, ensure the robot is bolted to a rigid metal chamber or stand.

Electrical Hazards

Refer to the specifications of the *Guidance Controller Quick Start Guide* for the electrical power.

⚠ **DANGER**

Electrical Shock Hazard

Contact with electrical power can cause personal harm and serious injury.

- To avoid electrical shock, disconnect the power before troubleshooting the electrical components.

- Check the unit's specifications for the actual system power requirements and use appropriate precautions.

- Never operate this product without its protection covers on.

⚠ **WARNING**

Electrical Burn

Improper electrical connection or connection to an improper electrical supply can result in electrical burns resulting in equipment damage, serious injury, or death.

- Always provide the robot with the proper power supply connectors and ground that are compliant with appropriate electrical codes.

⚠️ **WARNING**

Electrical Fire Hazard

All energized electrical equipment poses the risk of fire, which may result in severe injury or death. Fires in wiring, fuse boxes, energized electrical equipment, computers, and other electrical sources require a Class C extinguisher.

- Use a fire extinguisher designed for electrical fires (Class C in the US and Class E in Asia).

- It is the facility's responsibility to determine if any other fire extinguishers are needed for the system that the robot is in.

NOTICE

Improper handling of the power source or connecting devices may cause component damage or equipment fire.

- Connect the system to an appropriate electrical supply.

- Turn off the power before servicing the unit.

- Turn off the power before disconnecting the cables.

Ergonomic Hazards

⚠️ **CAUTION**

Heavy Lift Hazard

Failure to take the proper precautions before moving the robot could result in back injury and muscle strain.

- Use a lifting device and cart rated for the weight of the drive or arm.

- Only persons certified in operating the lifting device should be moving the product.

⚠️ **CAUTION**

Tipover Hazard

This product has a high center of gravity which may cause the product to tip over and cause serious injury.

- Always properly restrain the product when moving it.

- Never operate the robot unless it is rigidly mounted.

⚠ **CAUTION**	
Trip Hazard	
Cables for power and communication and facilities create trip hazards which may cause serious injury. • Always route the cables where they are not in the way of traffic.	

Emergency Stop Circuit (E-Stop)

The integrator of the robot must provide an emergency stop switch.

⚠️ **WARNING**	
Emergency Stop Circuit	
Using this product without an emergency stop circuit may cause personal injury. • Customer is responsible for integrating an emergency stop circuit into their system. • Do not override or bypass the emergency stop circuit.	⚠️

Recycling and Hazardous Materials

Brooks Automation complies with the EU Directive 2002/96/EU Waste Electrical and Electronic Equipment (WEEE).

The end user must responsibly dispose of the product and its components when disposal is required. The initial cost of the equipment does not include cost for disposal. For further information and assistance in disposal, please email Brooks Automation Technical Support at support_preciseflex@brooksautomation.com.

2. Introduction to the Hardware

System Overview

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 Brooks 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 (100 W 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 24VDC supply for the logic and IO and an external motor power supply. The motor power supply voltage can range from 12VDC to 42VDC, 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 that 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 via Ethernet. There are three (3) 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, refer to the *Guidance Programming Language, Introduction to GPL* (PN GPL0-DI-S0010) and the *Guidance Development Environment, Introduction and Reference Manual* (PN GDE0-DI-S0010).

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 motion controller. It provides a complete set of image-processing, measurement, inspection and object finder tools. For more information on vision, refer to the *PreciseVision Machine Vision System, Introduction and Reference Manual* (PN PVS0-DI-S0010).

System Diagram

The Guidance 1000 system diagram is shown in Figure 2-1. 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.
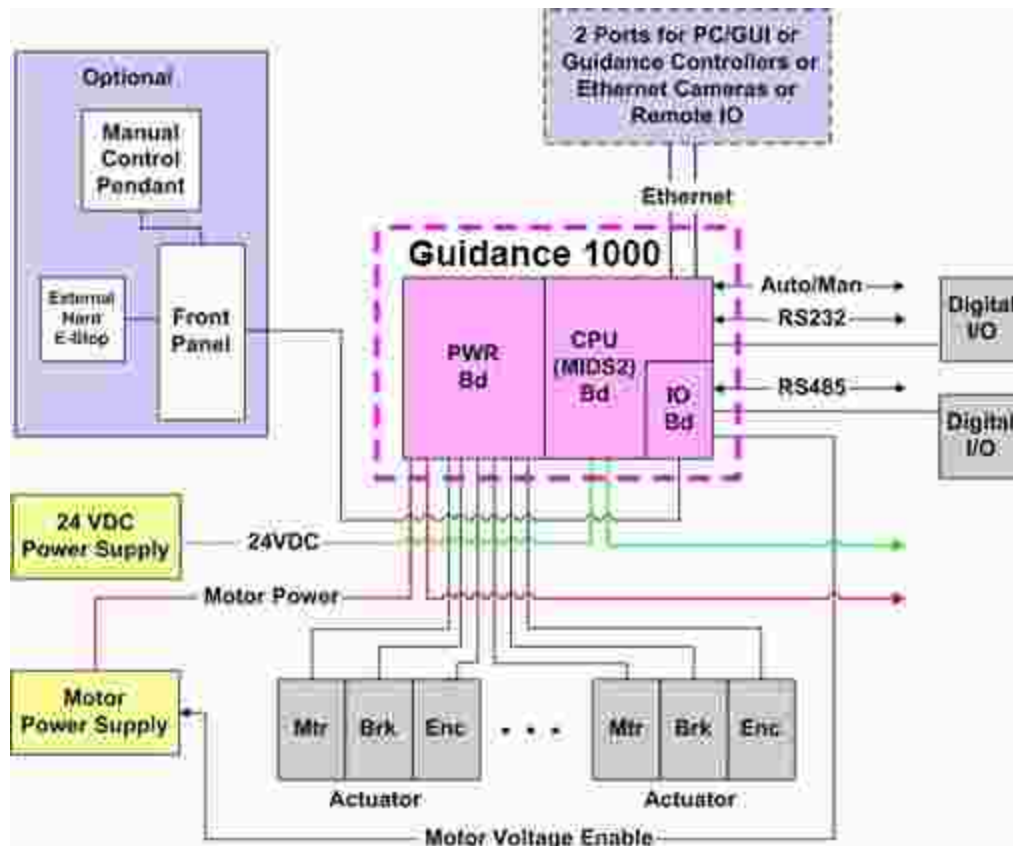
Figure 2-1: The Guidance 1000 System Diagram

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 400 Mhz high performance, low power CPU, at least 8 MB of dynamic RAM and at least 16 MB 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 (4 ALV) 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 to permit this unit to operate in a controller network:

- Two (2) 10/100Mbit Ethernet ports

- An RS-232 port

- Four (4) general purpose optically isolated digital inputs

- Four (4) general purpose optically isolated digital outputs

- Two (2) sets of Auto/Manual mode signals

The "enhanced" MIDS2 board also includes hardware support for absolute encoders.

If the optional IO daughter board is added to the MIDS2, then the following additional interfaces are provided:

- Eight (8) general purpose optically isolated digital inputs

- Eight (8) general purpose optically isolated digital outputs

- An RS-485 serial port

- Two (2) signals for externally enabling the motor power supply

- 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.	⚠

Figure 2-2: Connection Box

Low Voltage Power Supply

The Guidance Controllers require 0.7 Amps of 24VDC 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, Brooks recommends a total of 4 Amps. This voltage may be supplied by a user power supply or a 24VDC power supply may be purchased from Brooks.

A commercially available 125-watt, 24VDC Power Supply, Mean Well (PN PPS-125-24) with AC input from 90 V to 264 V, is shown in Figure 2-3.

⚠ **DANGER**	
Electrical Shock	
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.	
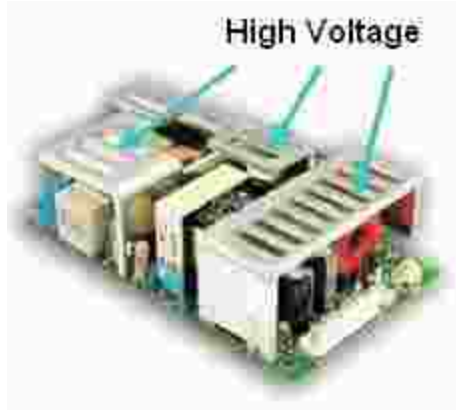
Figure 2-3: 125-watt, 24 VDC Power Supply, Mean Well P/N PPS-125-24

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

Th optional IO daughter board, if installed, 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 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 want to have an E-Stop button for their controller without a remote front panel, Brooks sells an E-Stop Box with a connector pigtail that plugs into the remote front panel connector.

For users that want to have a Manual Control Pendant (MCP) that can be carried around the workcell, Brooks offers two hardware MCPs. The standard unit weighs 0.567 kg and includes an E-Stop button.

For 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 PreciseFlex MCPs come with a 25-pin DSub connector that directly attaches to some 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.

Figure 2-4: Manual Control Pendant

Remote IO Module

For applications that require additional IO capability beyond the standard functions, a PreciseFlex™ Remote IO (RIO) module may be purchased. The RIO interfaces to any Guidance Controller via 10/100 Mb Ethernet and requires 24VDC power. Up to four (4) RIOs can be connected to a controller.

The basic RIO includes the following:

- 32 isolated digital input signals
- 32 isolated digital output signals
- One RS-232 serial line

An enhanced version of the RIO adds four (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.

⚠ WARNING	
The RIO contains unshielded 24VDC 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.	⚠

Figure 2-5: Enhanced RIO Module

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 IDS Imaging offer a variety of Ethernet machine vision cameras and industrial USB cameras.

Machine Safety

Voltage and Power Considerations

The Guidance 1000 Controllers require two (2) DC power supplies: a 24VDC 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 12VDC and 48VDC.

The PreciseFlex 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.

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.

DANGER
Electrical Shock

The standard 24VDC 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.

E-Stop Stopping Time and Distance

The control system responds to two types of E-stops: soft E-stops and hard E-stops.

Soft E-Stop

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 the motor power enabled and is therefore applicable to less severe error conditions. Leaving the 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.

Hard E-Stop

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 disabling motor power 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 1 ms 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 5000 mm/sec and the servos decelerate it at 0.4G (3920 mm/sec^2), the axis will reach a full stop in 0.26 sec after having only traveled a distance of 127 mm.

If a gravity loaded axis has 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, a short delay after the brake is actuated and before disabling motor power will allow time for the brake to engage and will prevent the axis from dropping.

Safety Zones

For all robot types, "Safety Zones" can be defined that disable motor power and halt the motion of the robot if its tool center point (TCP) violates the requirements of a user defined 3D volume.

Types of Safety Zones

These 3D safety zones can be used to:

1. Approximately model the volume of stationary objects or personnel working areas to prevent the robot from inadvertently entering this volume and causing a collision ("keep out zones").

2. Reduce the normal working volume of the robot to prevent the robot from reaching beyond prescribed boundaries and causing a collision ("stay within zones").

3. Verify that the robot's TCP speed (when in a specified volume) is below a specified limit so that the robot can be safely decelerated and stopped before it might pin an operator's hand to a hard surface with too high a force ("speed restrict zones").

As currently implemented, the "keep out zones" and "stay within zones" are provided as general safety features, but they do not meet the stringent Category 3 safety standards that require fail safe redundant logic. However, the "speed restrict zones" do provide the requisite redundancy and are in the process of being Category 3 certified. The "keep out zones" and "stay within zones" are collectively referred to as "uncertified zones" and the "speed restrict zones" are referred to as "certified zones".

The supported zone shapes are rectangular volumes, cylinders and spheres. To define a safety zone, the type of safety zone must be specified along with its origin and dimensions.
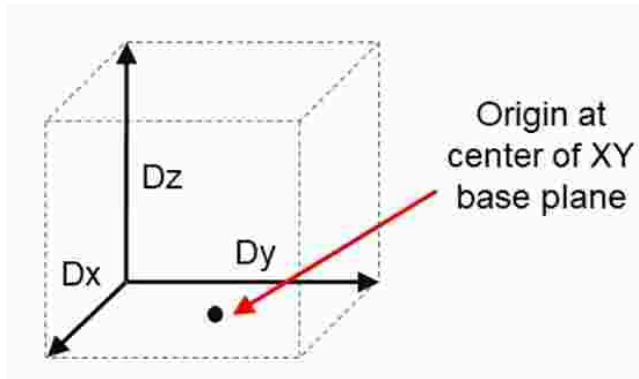
Figure 2-6: Rectangular Volume
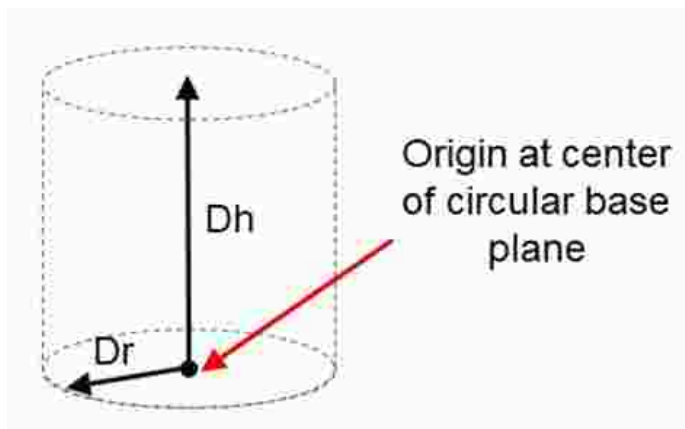
Figure 2-7: Cylinder
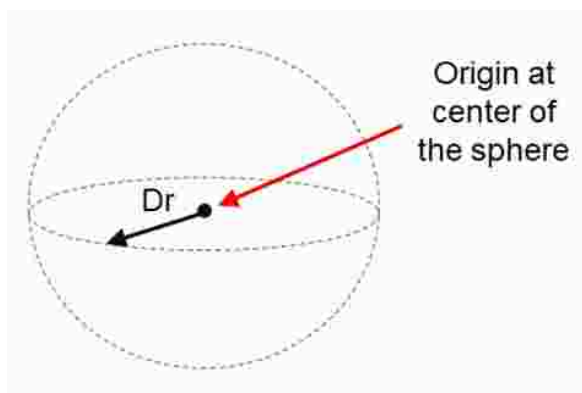
Figure 2-8: Sphere

For increased generality, uncertified zones can be arbitrarily positioned and rotated in all three dimensions. Due to implementation limitations, certified zones must be non-rotated rectangular volumes, which can be arbitrarily positioned. Up to 10 zones can be defined for each robot and any mix of certified and uncertified can be specified. Due to safety requirements, any new or modified zone specifications only go into effect after the controller is rebooted.

Safety Zone Violation Detection and Clearing

Uncertified safety zones are active in the following circumstances:

- Continuously during program-controlled motions of all types (straight line or arc Cartesian and joint interpolated).

- Continuously during manual (jog) control modes: World, Tool and Joint, but not free.

- Motion planning (final destinations only).

- Location object.KineSol method during conversions to either Cartesian or joint Locations.

Certified safety zones are only active during program-controlled motions (of all types) since this is the only circumstance where higher TCP speeds are possible.

When motor power is enabled and the robot's TCP is in violation of an uncertified safety zone, a program-controlled motion cannot be initiated. This condition can be cleared by disabling motor power and manually repositioning the robot or by manually jogging the TCP in World, Tool or Joint modes, so long as the jog motion reduces the safety zone violation distance. That is, jogging motions that increase the violation of a safety zone are not permitted.

> *NOTE:* Safety zone testing is based on the TCP of the robot. Therefore, it is very important that the position of the tool center point relative to the robot's tool mounting flange is set correctly. Please see the Robot.Tool property for information on defining the TCP.

Certified Speed Restrict Safety Zones

While the uncertified safety zones perform conventional tests on just the position of the TCP, there are two certified safety zones and these perform special tests to detect if the speed of the TCP exceeds a limit while the TCP is within the zone. The first certified safety zone tests if the Z downward speed of the TCP exceeds a specified limit. This safety zone was implemented for the PreciseFlex 400 and PreciseFlex 3400 robots since their only intrinsically non-safe motion is a high-speed downward Z motion that could trap a person's hand between the tooltip and a fixed object or horizontal surface. The second certified safety zone tests if the horizontal, XY planar, speed of the TCP exceeds a specified limit. This test was developed for the PreciseFlex™ DD robots since robots can generate excessive speeds when moving horizontally.

For both of these tests, in order to satisfy the computational redundancy requirement of the Category 3 safety regulations, the shapes of these safety zones are limited to non-rotated rectangular volumes.

Please consult the user manuals for these PreciseFlex™ robots for when speed restrict safety zones must be defined to safely operate these mechanisms.

Configuring Safe Zones

Up to 10 safety zones can be defined per robot. Each of these zones is specified by filling in one of the Parameter Database IDs 16900 to 16909, which are labeled "Safety Zone: type, x/y/z/y/p/r, dim 1/2/3". Any combination of certified and uncertified safety zones can be specified. Each of these DataIDs consists of an array of 10 numbers and the first value defines the safety zone "type". Any DataID that has a zero "type" is ignored. Table 2-1 describes the possible safety zone types:

Table 2-1: Safety Zone Types

Safety Zone Type	Description
0.	Undefined safety zone
1.	Rectangular volume, keep out zone
2.	Cylinder, keep out zone
3.	Sphere, keep out zone
4.	Rectangular volume, stay within zone
5.	Cylinder, stay within zone
6.	Sphere, stay within zone
7.	Non-rotated rectangular volume, Z downward speed restrict zone
8.	Non-rotated rectangular volume, XY speed restrict zone

Table 2-2 describes the safety zone DataIDs. When any of these DataIDs are modified, the controller must be rebooted for the change to be put in effect.

Table 2-2: Data IDs

DataID	Parameter Name	Description
16900 to 16909	Safety Zone: type, x/y/z/y/p/r, dim 1/2/3	Each safety zone definition consists of an array of 10 values. The first value is the safety zone "type". The next six values define the position of the origin of the volume of interest and its orientation. This is specified as a standard Location value: x, y, z, yaw, pitch, roll. The final three values define the size of the volume of interest. For the permitted shapes, this is interpreted as: volume: Dx, Dy, Dz Cylinder: Dh, Dr, 0 Sphere: Dr, 0, 0 For example, for a downward Z non-rotated rectangular volume speed restrict safety zone, a single DataID should be specified as follows: 7, x, y, z, 0, 0, 0, Dx, Dy, Dz Where x, y, z are the coordinates of the center of the base of the rectangular volume and Dx, Dy, Dz are the dimensions of the volume, all in mm.

In addition, the DataID in Table 2-3 must be initialized to establish the maximum speed limits for the certified safety zones:

Table 2-3: Data IDs

DataID	Parameter Name	Description
2740	Certified safety zone, max Z/XY spd mm/sec	These parameters define the maximum speeds that are permitted for the Certified Speed Restrict Safety Zones. The first value is the maximum downward Z speed (when within the safety zone) in mm/sec. Since this is a downward speed, it should be a negative value and defaults to -200. The second value is the maximum permitted speed in the horizontal XY plane (when within the safety zone), and defaults to 200 mm/sec.

Safety Standards Reference Material

PreciseFlex 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 operating or maintaining PreciseFlex systems or who work within or near the work cell.

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.

It is also recommended that all personnel read 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 PreciseFlex 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 the following standards:

- EN 61000-4-2 Electrostatic Discharge (8 KV air, 6 KV contact)
- EN 61000-4-3 Radiated Electromagnetic Field Immunity (3 V/m, 27-500 MHz)
- EN 61000-4-4 Electrical Fast Transient/Burst Immunity (2 KV)
- EN 61000-4-5 Surge Immunity Test (1 KV differential, 2 KV common mode)
- EN 61000-4-6 Conducted Disturbances Immunity (RF: 150 KHz – 80 MHz)
- 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 manual.

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 PreciseFlex™ 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 250 mm 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, and then select a manual control mode such as **"World" Mode**. Select the **X-axis**, set the speed slider to 100% and drive the axis 250 mm 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 over 2000 mm/sec. 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. 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.

3. 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, these controllers must be properly mounted on a heat sink and cooled to dissipate the heat generated by the controller's power devices and high performance ICs. The controller should be mounted to a heat sink with thermal grease and M3 by 6 mm button head cap screws. The mounting holes are shown in **Blue** in Figure 3-1 with all dimensions in millimeters. If there is insufficient air flowing across the high performance ICs on the top processor board, forced air or some other means of conducting the heat away may be necessary.
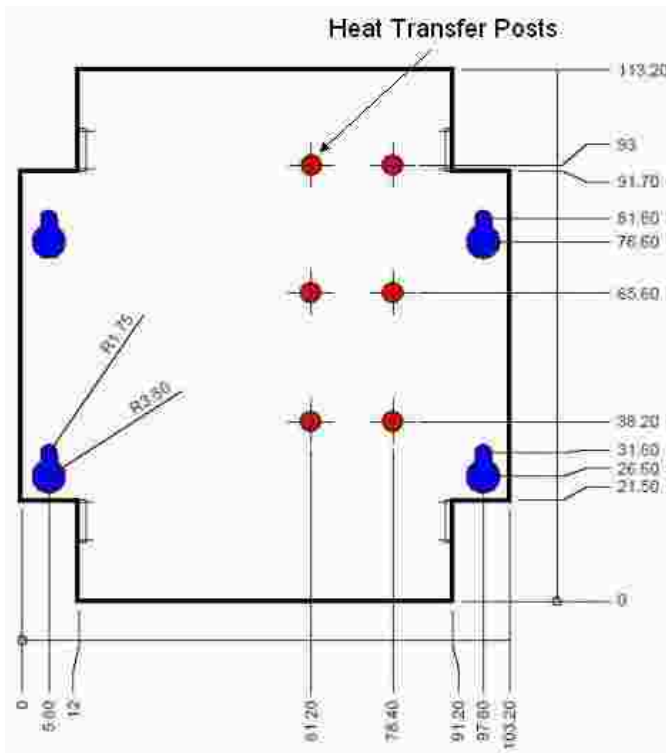
Figure 3-1: Mounting Holes Displayed in Blue

> **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 (6) 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 ICs 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 ICs may be necessary.

The size of the heat sink on which the controller should be mounted is a function of the power being dissipated. Table 3-1 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 2.8 A . 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.

Table 3-1: Estimation of the Required Heat Sink Area

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 80° C 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 25° C and the user expects to operate at the system's maximum ambient of 40° C, add 15° C 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

To 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.

> **NOTE:** It is important that the wiring guidelines in this section be followed 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.

Table 3-2: Recommended Current Ratings for 80° C Wire

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, it is recommend that the motor wire 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.

Table 3-3: Wires with a 105° C Rating

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

Figure 3-2 illustrates how the motor cable should be wired. The shield around the motor cable is optional, but a good practice to follow.
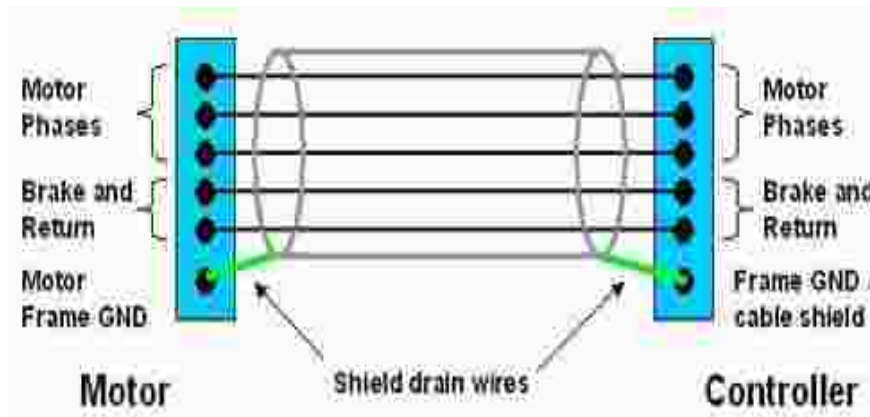
Figure 3-2: Recommended Motor Wiring

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 10 K 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 four (4) twisted pairs with a gauge of AWG 24 or AWG 26. See Table 3-4 for recommended cables.

> **NOTE:** Unshielded encoder wiring should never be run next to unshielded motor wiring or other possible noise sources.

Table 3-4: Recommended Cables

	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. 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. Figure 3-3 illustrates how to interface to a differential encoder.
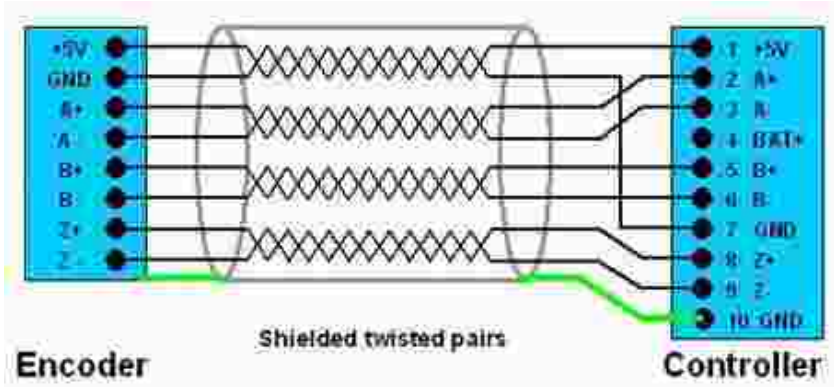
Figure 3-3: Differential Encoder Wiring

4. Hardware Reference

Guidance Controller Assemblies and Interfaces

Major Assemblies

The Guidance 1000 Controllers are normally provided in an enclosure that contains two (2) printed circuit board assemblies and an optional third board. These components are shown in Figure 4-1 where the top cover has been removed for clarity.
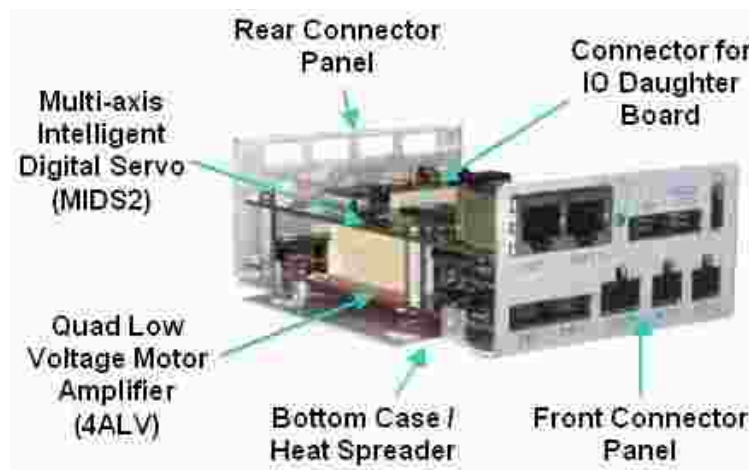
Figure 4-1: Guidance 1000 Controller

⚠ 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 (4 ALV) 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 24VDC 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.
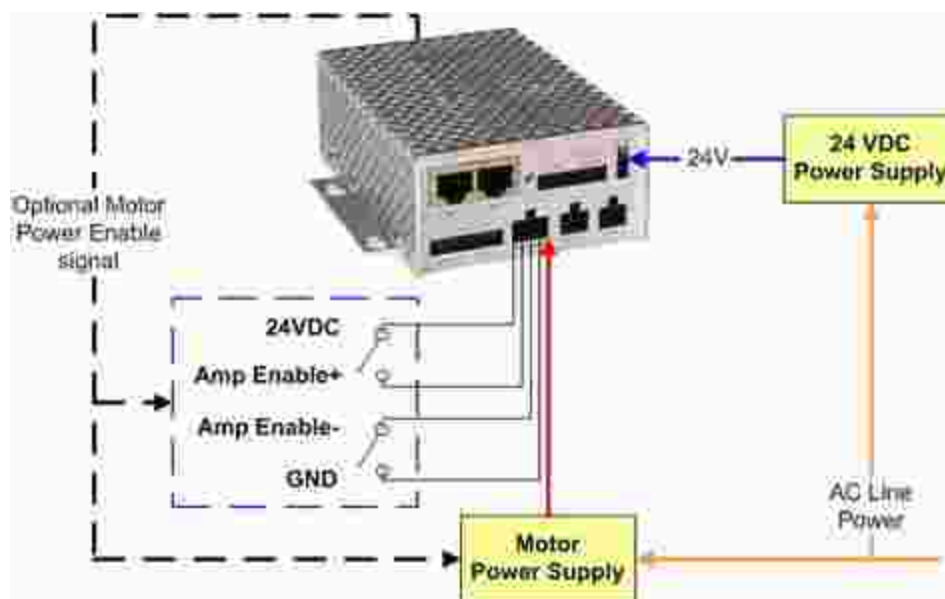
Figure 4-2: Connector and Connections

⚠ 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.	⚠

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.

> **NOTE:** Even if the motors are energized by a 24VDC power supply, 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.

<table>
<tr><td colspan="2">⚠ WARNING</td></tr>
<tr><td>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 logicunless the supply is specifically designed to absorb this energy and limit the voltage rise.</td><td>⚠</td></tr>
</table>

Controller Connectors

In addition to providing interfaces for up to four (4) 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
- 24 VDC 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 Figure 4-3.
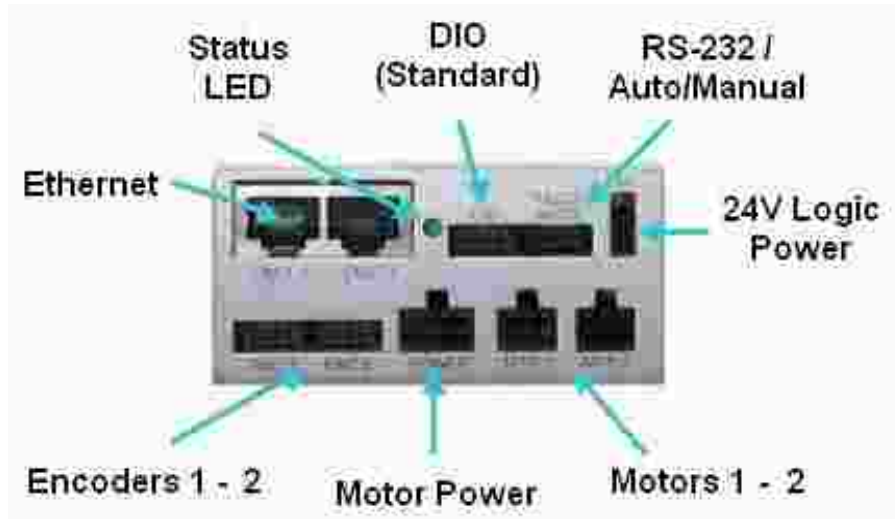
Figure 4-3: Front Connector Panel

Figure 4-4 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 of the connector in Figure 4-4.
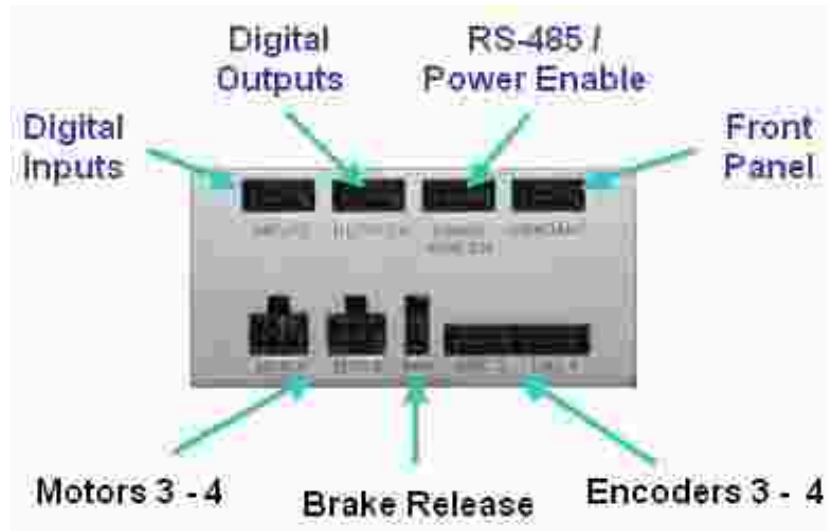
Figure 4-4: Back Connector Panel

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.
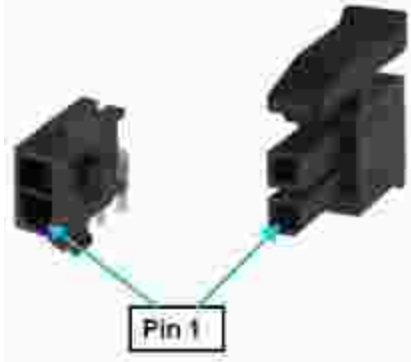
Figure 4-5: Two-pin AMP 3-794618-2 and mating plug AMP 794617-2

Table 4-1: Pin Assignments

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 four general-purpose, optically isolated digital input signals and four-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.

Figure 4-6: JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug

By setting Jumpers on the CPU (MIDS2) board, the four (4) 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.
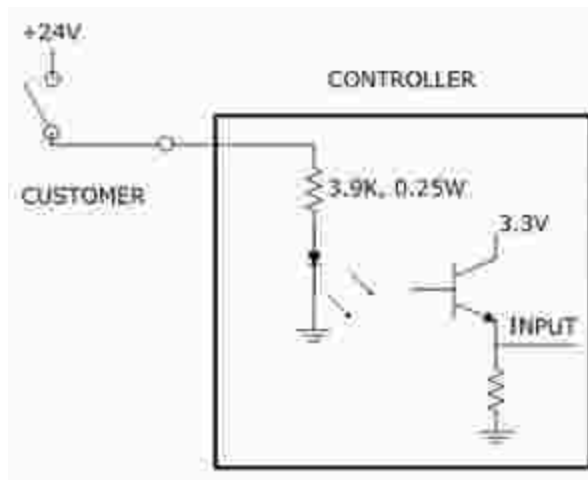
Figure 4-7: Sinking Digital Input

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.
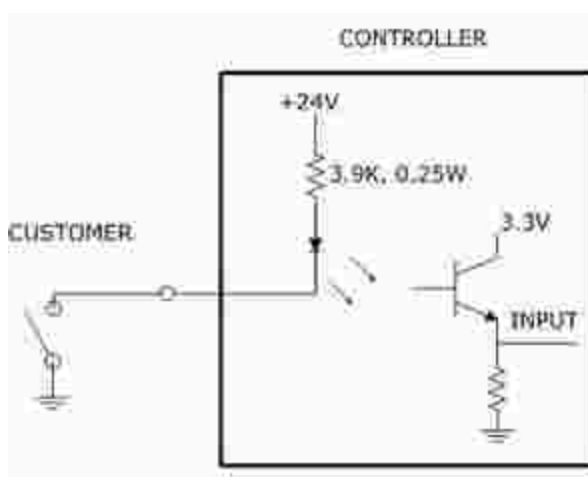
Figure 4-8: Sourcing Digital Input

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.
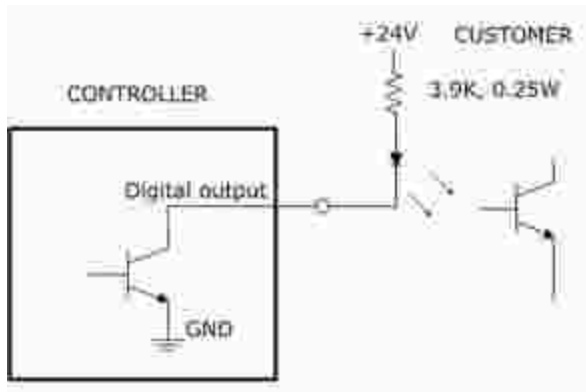
Figure 4-9: Sinking Digital Output

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.
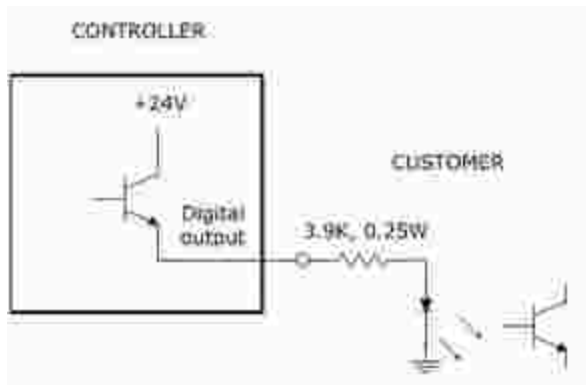
Figure 4-10: Sourcing Digital Output

NOTE: 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 Table 4-2.

Table 4-2: Pin Out & GPL Signal Numbers

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		24VDC 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 eight (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.
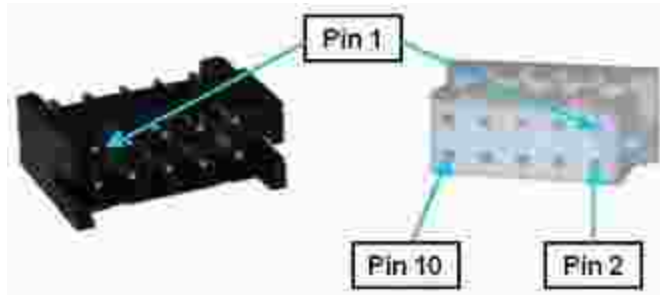
Figure 4-11: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug

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.
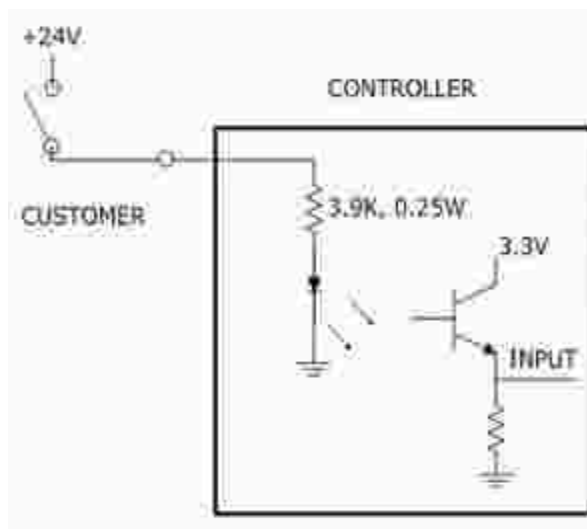
If an input signal is configured as "sourcing," the external equipment must pull the signal input pin to ground to indicate a logical high and must let the line float high to 24VDC to signal a logical low value. This configuration is compatible with "sinking" (NPN) sensors.
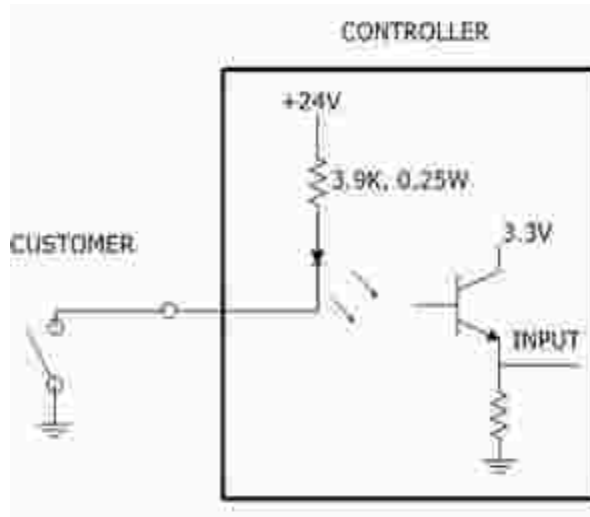
NOTE: As shipped from the factory, all digital inputs are normally configured as "sourcing."

The pin out for the optional Digital Input Connector and the corresponding GPL signal numbers are described in Table 4-3.

Table 4-3: Pin Out & GPL Signal Numbers

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		24VDC 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.
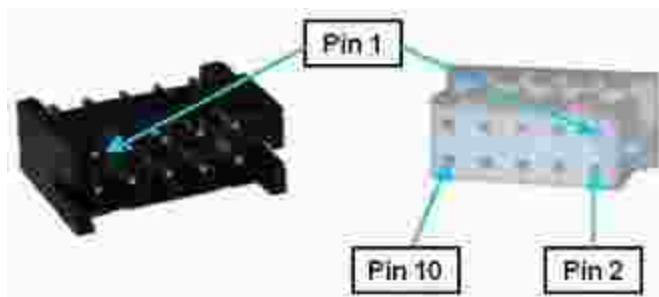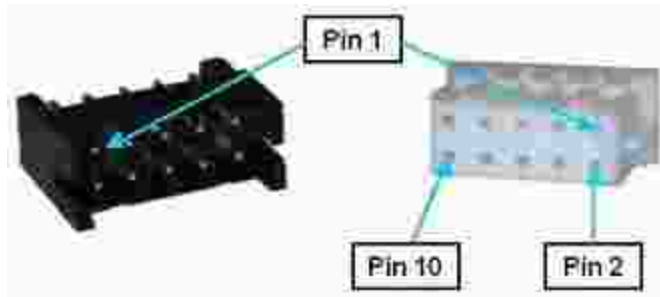

Figure 4-12: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug

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.
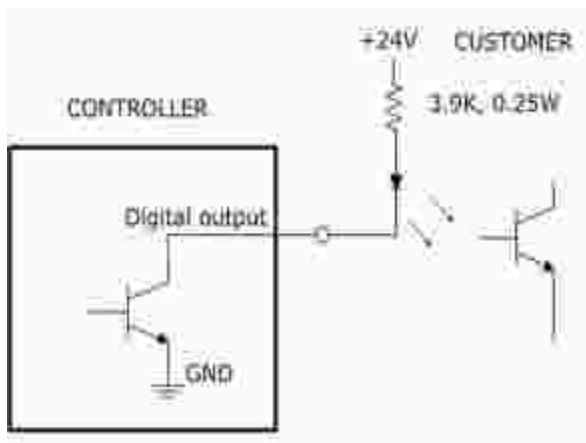
If an output signal is "sourcing," the external equipment must pull-down the output pin to ground and the controller pulls this pin to 24VDC when the signal is asserted as true. This configuration is compatible with "sinking" (NPN) devices.
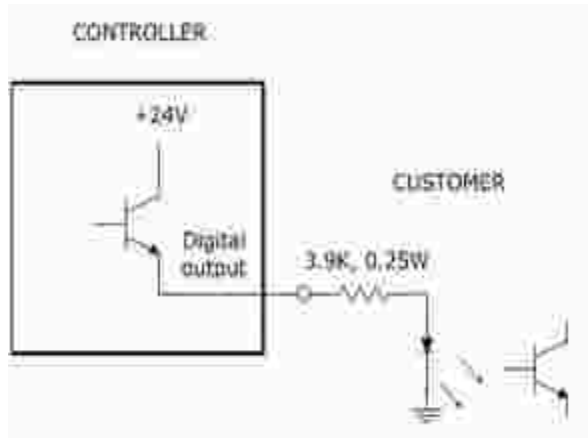
NOTE: As shipped from the factory, all outputs are **normally** configured as "sinking."

The pin out for the Digital Output Connector and the corresponding GPL signal numbers are described in Table 4-4.

Table 4-4: PIn Out & GPL Signal Numbers

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		24VDC 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.
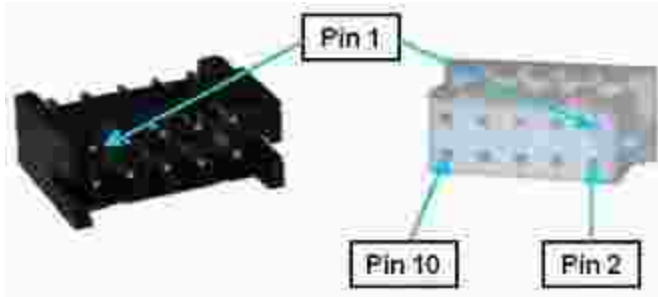
Figure 4-13: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug

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. 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.

> **NOTE:** 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 Table 4-5.

Table 4-5: Encoder Connector Pin Out

Pin	Description
1	5VDC 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+

Pin	Description
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 PreciseFlex controllers, remote I/O units, and Ethernet cameras. The Ethernet switch automatically detects the sense of each connection, so either straight-through or cross-over cables can be used to connect the controller to any other Ethernet device.

 Figure 4-14: Ethernet Ports and Cable

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.
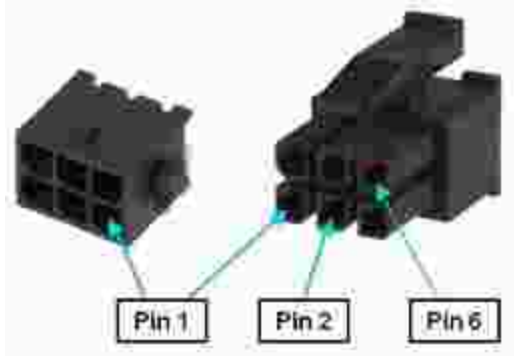
Figure 4-15: Six-pin AMP 3-794618-6 connector and AMP 794617-6 Plug

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).

> **NOTE:** Review the Installation section of this manual for recommendations on best practices for wiring motors.

Following the instructions will significantly reduce the likelihood of the motors generating undesirable electrical noise. The pin out for the Motor Connector is described in Table 4-6.

Table 4-6: Motor Connector Pin Out

Pin	Description
1	Brake power output, 24VDC, maximum current 2 A 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.
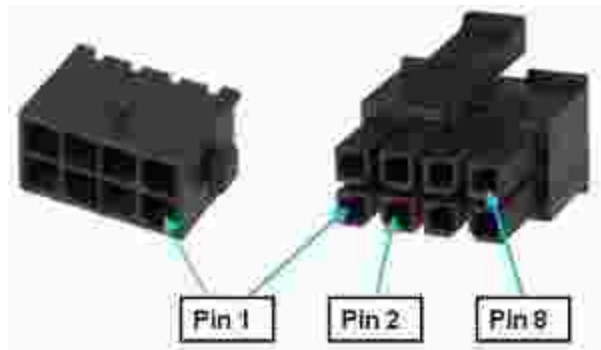
Figure 4-16: Eight-pin AMP 3-794618-8 Connector and AMP 794617-8 Plug

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 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:

<div align="center">

2-3, 6-7

</div>

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. See the "Third Party Equipment" section of this manual for more information on configuring and wiring absolute encoders. 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 Table 4-7.

Table 4-7: Motor Power Input Connector Pin Out

Pin	Description
1	Motor power input, 12VDC to 42VDC nominal.
2	24VDC 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.

Figure 4-17: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and 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 Table 4-8.

Table 4-8: Remote Front Panel Connector Pin Out

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	24VDC 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.
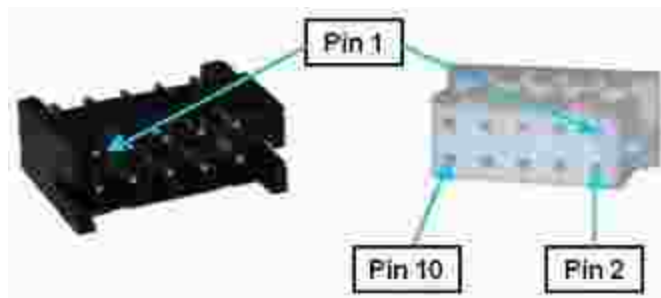

Figure 4-18: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug

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 Table 4-9.

Table 4-9: RS-232 Auto/Manual Connector Pin Out

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).

Pin	Description
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.

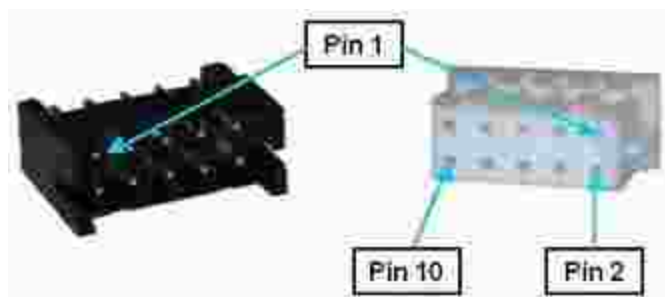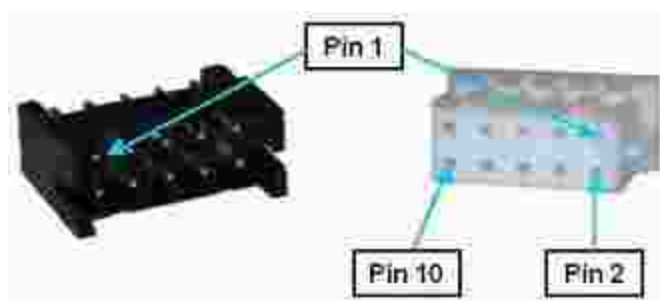**Figure 4-19: Ten-pin JST S10B-PHDSS(LF)(SN) Connector and JST PHDR-10VS Plug**

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 24VDC 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. 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 Table 4-10.

Table 4-10: RS-485 / Motor Power Enable Connector Pin Out

Pin	Description
1	Motor power enable. Switched to ground when power is being enabled. Capable of sinking 2 A at 24VDC.
2	Motor power enable (Redundant signal). Provided to comply with safety standards.
3	RS-485+
4	RS-485-
5	Reserved
6	Reserved
7	24VDC output
8	GND
9	5VDC 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.

Table 4-11: Status LED State

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. See the Guidance 1000 product specifications for information on the number of amperes that must be supplied. The connector is a two-pin AMP 3-794618-2, and the mating plug is an AMP 794617-2.
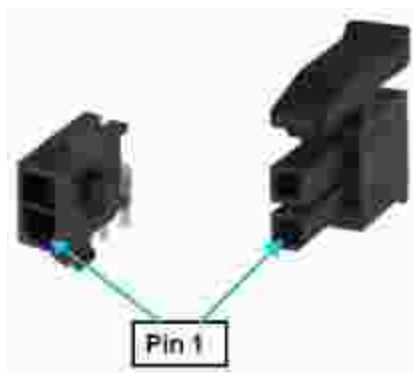
Figure 4-20: Two-pin AMP 3-794618-2 Connector and AMP 794617-2 Plug

Table 4-12: Pin Descriptions

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 jumper type, there may be two, three, or five posts. Posts are tied (shorted) together using black jumper plugs. The five wide jumper posts for configuring the digital output signals are shown in Figure 4-21.

Figure 4-21: Jumper Posts

The locations of each of the sets of jumpers of interest are illustrated in Figure 4-22 and are identified by stenciled labels on the surface of the MIDS2 board.
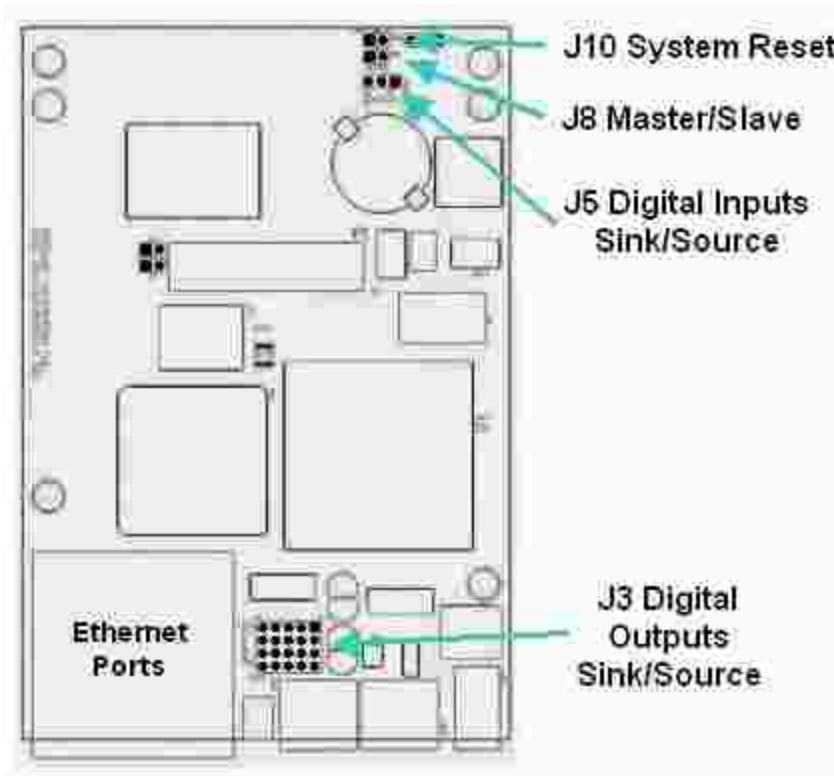
Figure 4-22: Jumper Locations

Table 4-13 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 Figure 4-22.

Table 4-13: Jumpers & How Pins Must Be Shorted

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

Jumpers	Description	Setting
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 to sourcing.	For Sinking, J5-3 TO J5-2 For Sourcing, J5-2 TO J5-1
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 24VDC 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 4 mm high standoffs. Mounting holes are 4 mm diameter and will clear 3 mm or 6-32 screws. They are located on 64.8 mm and 115.6 mm 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**	
Electrical Shock	
The Mean Well 24VDC 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.	⚡
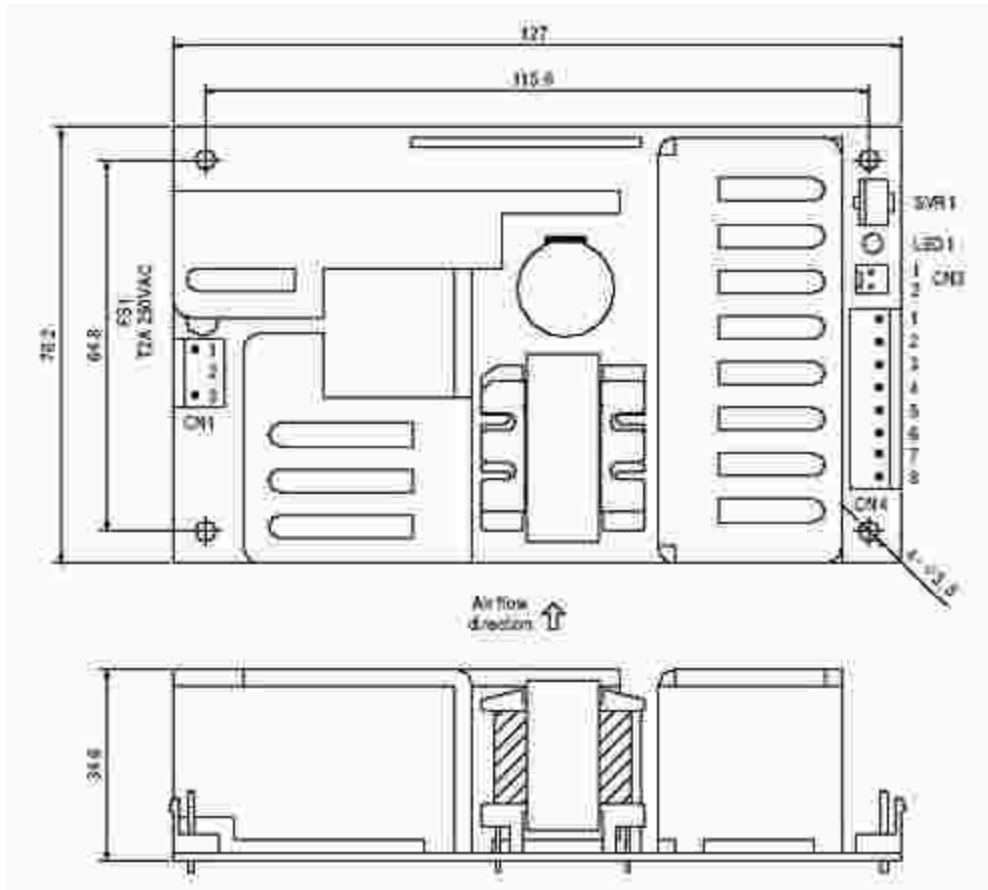
Table 4-14: Mean Well P/N PPS-125-24 Specifications

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
PreciseFlex Part Number	PS10-EP-00125

5. 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, 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, see the *Software Setup* section of the *Controller Software* section of the *PreciseFlex Library*

The following are the wiring instructions for the Encoder Connectors.

Table 5-1: Encoder Connectors Wiring Instructions

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

Encoder Connector Pin	Wire Color	Signal Name	G1000 Connector Pin
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:

Table 5-2: Motor Power Connectors Wiring Instructions

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. See the information on that connector for detailed pin outs and plug types. The following table contains information on the required battery power.

Table 5-3: Required Battery Power

External Battery Specification	
Maximum voltage	4.75 V
Typical voltage	3.6 V
Alarm trigger voltage	3.1 V
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, see the *Software Setup* section of the *Controller Software* section of the *PreciseFlex Library*.

Table 5-4 shows the wiring instructions for the Encoder Connectors.

Table 5-4: Encoder Connectors Wiring Instructions

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. See the information on that connector for detailed pin outs and plug types. Table 5-5 contains information on the required battery power.

Table 5-5: Required Battery Power

External Battery Specification	
Maximum voltage	4.75 V
Typical voltage	3.6 V

External Battery Specification	
Alarm trigger voltage	3.1 V
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, see the *Software Setup* section of the *Controller Software* section of the *PreciseFlex Library*.

Table 5-6 shows the wiring instructions for the Encoder Connectors.

Table 5-6: Encoder Connectors Wiring Instructions

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

Table 5-7 shows the wiring instructions for the Motor Power Connectors.

Table 5-7: Motor Power Connectors Wiring Instructions

Motor Connector Pin	Wire Color	Signal Name	G1000 Connector Pin
1	RED	U	6
2	WHITE	V	2

Motor Connector Pin	Wire Color	Signal Name	G1000 Connector Pin
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. See the information on that connector for detailed pin outs and plug types. Table 5-8 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.

Table 5-8: Required Battery Power

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

6. Appendices

Appendix A: Product Specifications

Table 6-1: Guidance 1000 Controller Specifications

General Specification	Range & Features
Computational Hardware	
CPU and Dynamic Memory	400Mhz high performance, low-power CPU with a minimum of 8 MB 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 Specification	Range & Features
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 PreciseFlex 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 PreciseFlex RIO modules, 3rd party MODBUS/TCP devices, or 3rd party EtherNet/IP devices
General	
Size and Weight	83 mm (W) x 133 mm (L) x 44 mm (H) 103.2 mm (W) x 133 mm (L) x 44 mm (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

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

Table 6-2: Guidance Controller Environmental 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	6 mm sides and top
Chassis protection class	IP20 (NEMA Type 1)
For EU or EEA countries	IP54, must meet EN 60204 (IEC 204)

Appendix B: Frequently Asked Questions

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

1. [How do you connect a robot power enable button?](#)

2. [How do you release the motor brakes in a 1 or 2 axis system?](#)

3. [Why should grippers be wired to release when digital signals are ON?](#)

How do you connect a robot power enable button?

To connect a momentary contact button to enable robot power, 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 a 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.