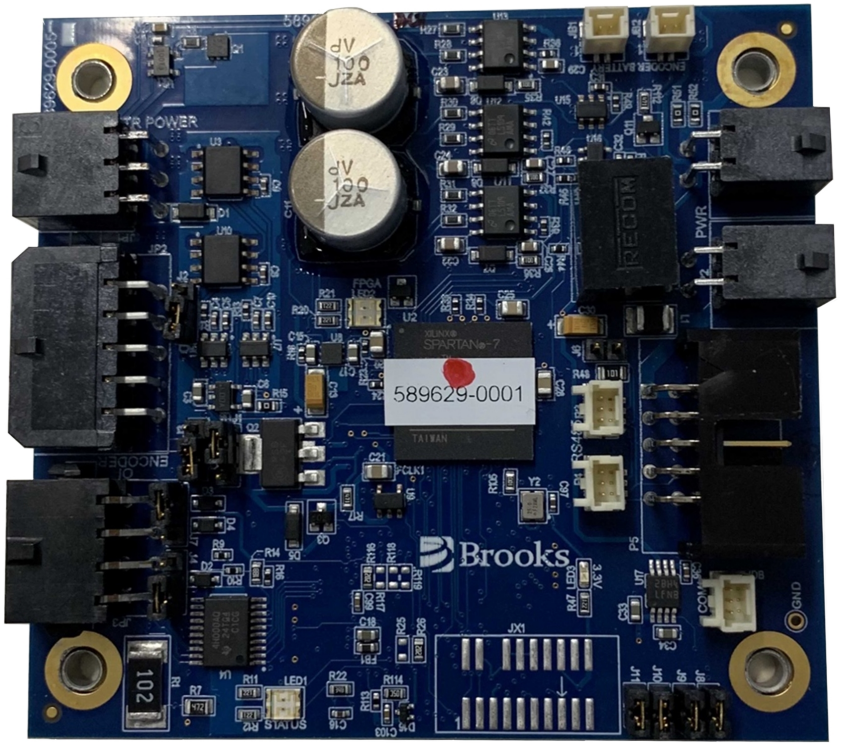


GSB User Manual

Part Number 608742, Revision B

Brooks Automation

Information provided within this document is subject to change without notice, and although believed to be accurate, Brooks Automation assumes no responsibility for any errors, omissions, or inaccuracies.

AcuLigner™, Advan Tag™, AutoTeach™, ATR™, AXM™, BiSymmetrik™, c10, c8A, CenterSmart™, Crate to Operate™, CrossingConnect™, DARTS™, Enerta™, e-RMA™, e-Spares™, e-Volution™, Falcon™, FIXLOAD™, FrogLeg™, GuardianPro™, Independent Twin Linear Exchange™, InCooler™, InLigner™, Isoport™, ITLX™, Jet™, Jet Engine™, LEAP™, LeapFrog™, LowProfile™, LPT™, M2 Nano™, Marathon 2, Marathon Express, PASIV™, Pathway™, PowerPak™, PowerTools™, PuroMaxx™, QuadraFly™, Radius™, Radient™, Radient Express™, Reliance™, Reliance ATR™, RetroEase™, SCARA™, SmartPM™, SMIF-INX™, SMIF-LPT™, SPOTLevel™, The New Pathway to Productivity™, Time Optimized Trajectory™, Time Optimal Trajectory™, Time Optimized Path™, TopCooler™, TopLigner™, VacuTran™, VersaPort™, WaferEngine™, LEAP™, Pathway™, GIO, GSB, Guidance 6600, Guidance 6430, Guidance 6420, Guidance 6410, Guidance 6000, Guidance 3400, Guidance 3300, Guidance 3200, Guidance 2600, Guidance 2400, Guidance 2300, Guidance 2200, Guidance 1400, Guidance 1300, Guidance 1200, Guidance 0200 Slave Amplifier, Guidance 0006, Guidance 0004, Guidance Controller, Guidance Development Environment, GDE, Guidance Development Suite, GDS, Guidance Dispense, Guidance Input and Output Module, Guidance Programming Language, GPL, Guidance Slave Board, Guidance System, Guidance System D4/D6, IntelliGuide, PreciseFlex™ 300, PreciseFlex™ 400, PreciseFlex™ 3400, PreciseFlex™ 1300, PreciseFlex™ 1400, PreciseFlex™ DD4, PreciseFlex™ DD6, PreciseFlex™ DDR, PreciseFlex™ G5400, PreciseFlex™ G5600, PreciseFlex™ G6400, PreciseFlex™ G6410, PreciseFlex™ G6420, PreciseFlex™ G6430, PreciseFlex™ G6600, PreciseFlex™ GSBP Slave Amp, PreciseFlex c10™, PreciseFlex c8a™, PreciseFlex™ PFD0, PrecisePlace 100, PrecisePlace 0120, PrecisePlace 0130, PrecisePlace 0140, PrecisePlace 1300, PrecisePlace 1400, PrecisePlace 2300, PrecisePlace 2400, PrecisePower 300, PrecisePower 500, PrecisePower 1000, PrecisePower 2000, PreciseVision, and RIO logos are trademarks of Brooks Automation.

Fusion®, Guardian®, MagnaTran®, Marathon®, Razor®, Spartan®, Vision®, Zaris®, and the Brooks and design logo are registered U.S. trademarks of Brooks Automation.

All other trademarks are properties of their respective owners.

This technology is subject to United States export Administration Regulations and authorized to the destination only; diversion contrary to U.S. law is prohibited.

Brooks Automation
15 Elizabeth Drive
Chelmsford, MA
01824-2400
Tel: +1 978-262-2400
Fax: +1 978-262-2500

Brooks Automation, PreciseFlex Collaborative Robots
201 Lindbergh Avenue
Livermore, CA
94551
Tel: +1-408-224-2838

Worldwide Headquarters
15 Elizabeth Drive
Chelmsford, MA 01824 U.S.A.

Brooks Automation,
PreciseFlex Collaborative Robots
201 Lindbergh Avenue
Livermore, CA 94551 U.S.A

Technical Support

Location	Contact	Website
North America	+1-800-447-5007 (Toll-Free) +1-978-262-2900 (Local) +1-408-224-2838 (PreciseFlex™)	http://www.brooks.com/
Europe	support_preciseflex@brooksautomation.com	
Japan	+81 120-255-390 (Toll Free) +81 45-330-9005 (Local)	
China	+86 21-5131-7066	
Taiwan	+886 080-003-5556 (Toll Free) +886 3-5525258 (Local)	
Korea	1800-5116 (Toll Free)	
Singapore	+65 1-800-4-276657 (Toll Free) +65 6309 0701 (Local)	

General Emails

Division	Email Address
Sales	sales_preciseflex@brooksautomation.com
Technical Support	support_preciseflex@brooksautomation.com
Technical Publications	Technical.Publications@brooksautomation.com

Brooks Automation
15 Elizabeth Drive
Chelmsford, MA
01824-2400
Tel: +1 978-262-2400
Fax: +1 978-262-2500
www.brooks.com

Brooks Locations Worldwide:

Brooks Automation
46702 Bayside Parkway
Fremont,CA 94538
Tel: +1-510-661-5000
Fax: +1-510-661-5166

Brooks Automation
AIM Servicios Administrativos
S de RL de CV
Carretera Huinalá km 2.8
Parque Industrial Las Américas
66640 Apodaca, NL Mexico
Tel: +52 81 8863-6363

Brooks Automation (Germany) GmbH
Ernst-Ruska-Ring 11
07745 Jena, Germany
Tel: +49 3641 4821 100
Fax: +49 3641 4821 4100

Brooks Automation (Germany) GmbH
Daimler-Straße 7
78256 Steißlingen, Germany
Tel: +49-7732-9409-0
Fax: +49-7732-9409-200

Brooks Automation
9601 Dessau Road, Suite 301
Austin, TX 78754
Tel: +1 512-912-2840
Toll-Free: +1 800-367-4887

Brooks Automation (Israel) Ltd.
Mevo Yerach 5
Kiryat-Gat 82000
Israel
Tel: +972 8672 2988
Fax: +972 8672 2966

Brooks Technology (Shanghai) Limited
2nd Floor, No. 72,
887 Zuchongzhi Road
Zhangjiang Hi-Tech
Park Pudong, Shanghai
China 201203
Tel: +86-21-5131-7070
Fax: +86-21-5131-7068

Brooks Japan K.K.
HEADQUARTERS
Nisso Bldg. No 16, 9F
3-8-8 ShinYokohama, Kohoku-ku
Yokohama, Kanagawa 222-0033
Tel: +81-45-477-5570
Fax: +81-45-477-5571

Brooks Japan K.K.
YOKOHAMA TECHNICAL CENTER
852-1 Kawamuko-cho, Tsuzuki-ku
Yokohama, Kanagawa 224-0044
Tel: +81-45-477-5250
Fax: +81-45-470-6800

Brooks Japan K.K.
KUMAMOTO SERVICE OFFICE
202 Mirai Office II
312-1 Tatsudamachi Yuge
Tatsuda, Kumamoto 861-8002
Tel: +81-96-327-9720
Fax: +81-96-327-9721

Brooks CCS Japan K.K.
CONTAMINATION CONTROL SOLUTIONS
Nisso Bldg. No 16, 9F
3-8-8 ShinYokohama, Kohoku-ku
Yokohama, Kanagawa 222-0033
Tel: +81-45-477-5570
Fax: +81-45-477-5571

Brooks Automation Ltd.
TAIWANHEADQUARTERS
5F-5, No.32, Tai-Yuen Street
Chu-Pei City
Hsinchu County 302, Taiwan, R.O.C.
Tel: +886-3-552 5258
Fax (G&A): +886-3-552 5255
Fax (Sales): +886-3-552 5200

Brooks Automation Korea, Inc.
#35 Giheungdanji-Ro 121Beon-Gil
Giheung-Gu, Yongin-Si
Gyeonggi-Do, 17086
Korea
Tel : +82-31-288-2500
Fax: +82-31-287-2111

Brooks Automation CCS RS AG
Lohstampfestrasse 11
CH-8274 Tagerwilen, Switzerland
Tel: + 41 71-666-72-10
Fax: + 41 71-666-72-11

Brooks Automation Korea
#35 Giheungdanji-Ro 121Beon-Gil
Giheung-Gu, Yongin-Si
Gyeonggi-Do, 17086
Korea
Tel : +82-31-288-2500
Fax: +82-31-287-2111

Brooks Automation (S) Pte Ltd
51-18-C1 Menara BHL,
57 Jalan Ahmad Shah,
10050, Penang,
Malaysia
Tel: +60 4 3701012
Fax: +60 4 3701015

Brooks Automation (Singapore) Pte Ltd
Blk 5008 Ang Mo Kio Avenue 5
#05-08, Techplace II
Singapore 569874
Tel: +65-6836-3168
Fax: +65-6836-3177

Brooks Automation Ltd.
TAINAN OFFICE
3F., No.11, Nanke 3rd Rd., Xinshi Dist.
Tainan Science Park
Tainan City 74147, Taiwan (R.O.C.)
TEL: +886-6-505-0268
FAX: +886-6-505-5228

Brooks Automation Precise Collaborative Robotics
201 Lindbergh Drive
Livermore, CA 94551
Tel: +1-978-262-2400

Revision History

Revision	ECO	Date	Action	Author
A	EC147051	07/24/2023	Released manual at Rev. A to follow standard Brooks technical publication styles.	M. Ashenfelder
B	EC155929	07/12/2024	Updates to include GSB4 and GSB4X.	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.

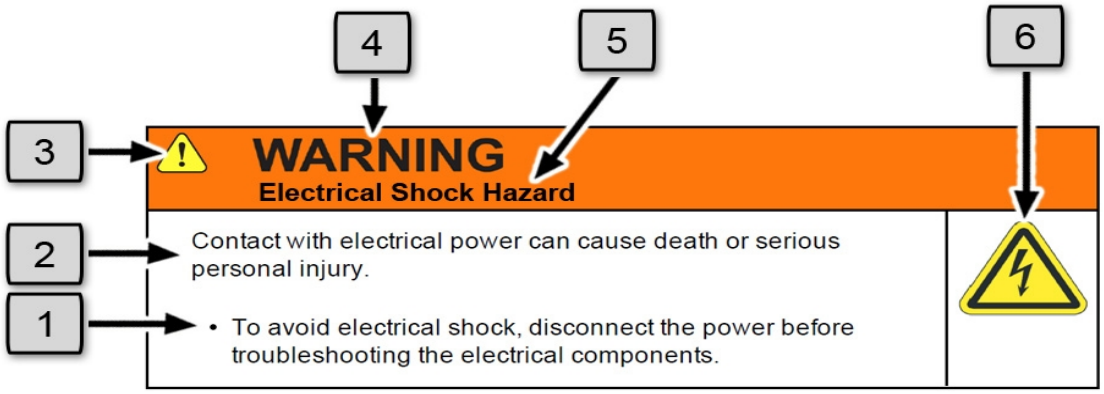
Signal Words and Color

Signal words inform of the level of hazard.

	Danger 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 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 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 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).

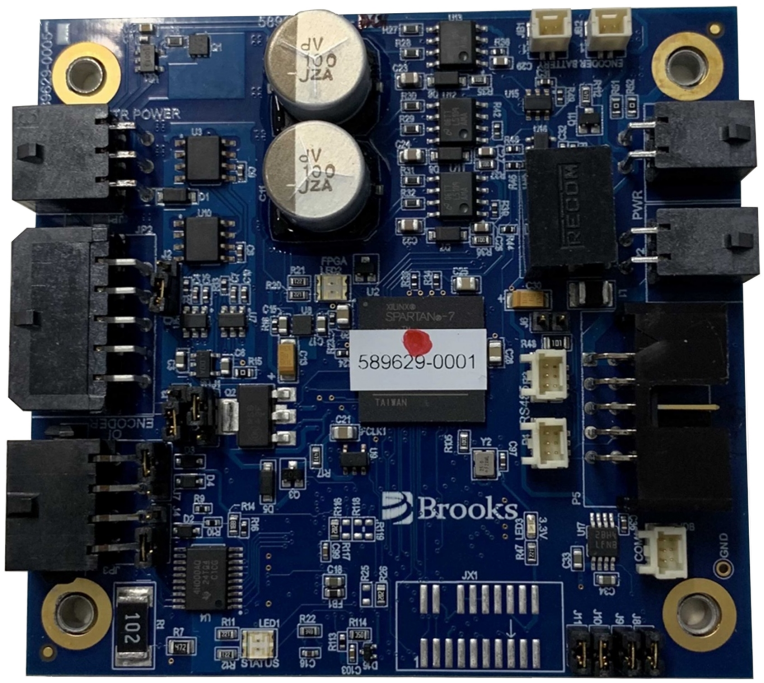
The end user must responsibly dispose of the product and its components when disposal is required. The initial cost of the equipment does not include cost for disposal. For further information and assistance in disposal, email Brooks Automation Technical Support at support_preciseflex@brooksautomation.com.

2. Introduction to the Hardware

GSB Overview

The GSB is a compact single-axis remote servo board that interfaces to PreciseFlex robots and Guidance Controllers and enables an additional motor to be controlled. This remote servo can drive a single motor rated up to 100 W (or 200 W when reduced peak speeds are acceptable). The GSB can support motor bus voltages ranging from 12 VDC to 48 VDC independent of the Guidance Controller's motor bus voltage.

GSB modules interface to a controller via a two-wire, bi-directional, daisy-chained RS-485 line and can be up to about six (6) meters from the master controller. Depending upon the timing requirements of the application and the available 24 VDC power, a mix of as many as eight (8) GSBs or Guidance Input and Output Modules (GIOs) may be connected to an RS-485 cable. (For PreciseFlex 400 Sample Handlers with Linear Rails that utilize two internal GSBs, only two (2) additional GSBs or GIOs can be connected due to 24 VDC power limitations.)



WARNING

The GSB contains unshielded 48 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

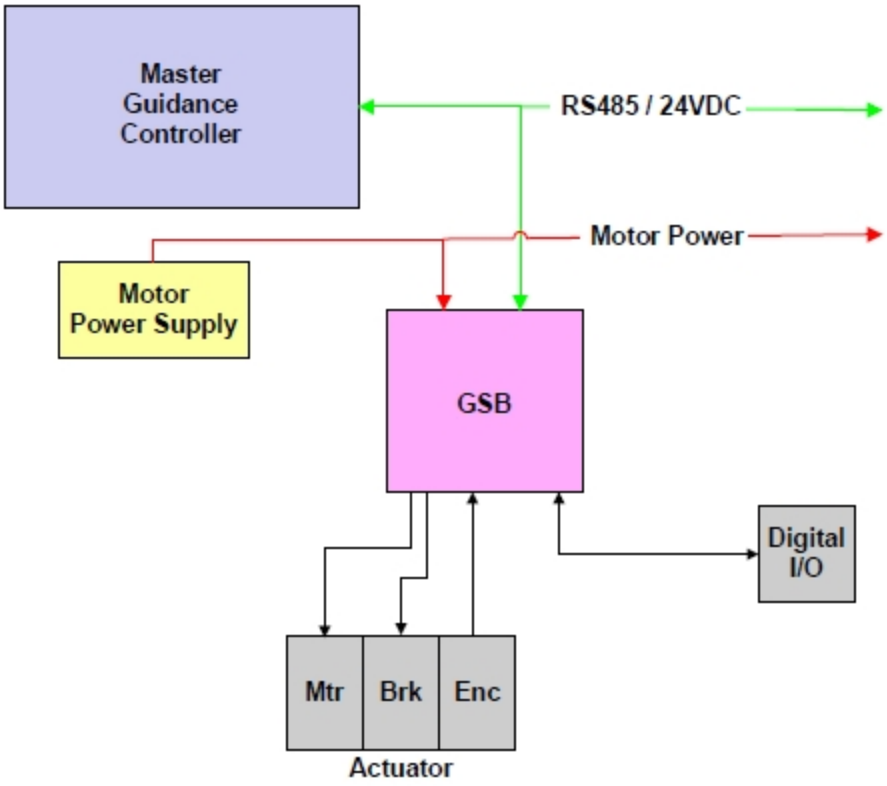
The GSB closes the current and PID loop for the motor that it controls. It relies upon the master controller to generate all trajectory setpoints and higher-level motion commands. Once a GSB is interfaced to a Guidance Controller, all communication between the remote GSB and the master controller is automatically managed by the system software.

From an application configuration and programming perspective, an axis driven by a GSB is accessed in the same manner as any of the local servoed controlled axes (although some advanced features of other Guidance servos have not been implemented on the GSB). For systems that require three (3) or more remote servoed axes or that require high voltage or higher power motors, it is recommended that the user consider utilizing a slave Guidance Controller that interfaces to the master controller via the PreciseFlex Ethernet Servo Network.

This alternate solution supports many more remote axes than GSBs and cost-effectively supports a wider range of motors and encoders. For details on the PreciseFlex Ethernet Servo Network and other controllers, refer to the *PreciseFlex Library*.

System Diagram

The image below illustrates how a GSB is interfaced to its peripherals and to a master Guidance Controller. One or more GSBs can be slaved to a master controller via a RS-485 communications line. The RS-485 cable provides the logic power for the GSB in additional to the communications.



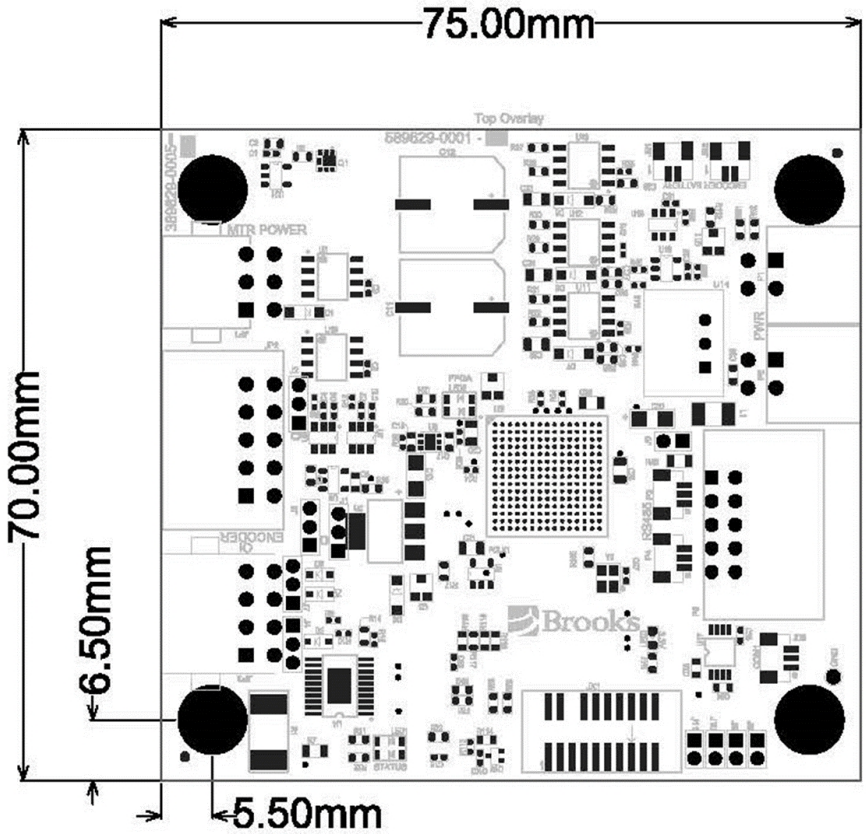
The GSB includes a limited number of general-purpose digital input and output signals, which can be interfaced to over travel. If these DIOs are not used by the GSB servo to control its axis, they may be utilized for general cell centrolineal control by GPL programs that execute on the master controller.

All the features of this slave controller are described in detail in the following chapters.

3. Installation, Configuration, and Software

Mounting and Installation

The GSB is an open frame device with exposed 48 VDC, and it must be mounted inside a cabinet or other enclosure. The mounting holes are the dark circles shown in the image below. The dimensions are in millimeters. There should be sufficient airflow across this board to ensure the components do not become excessively hot.



WARNING

The GSB contains unshielded 48 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

GSB Hardware and Software Configuration

GSB Unit Number

Up to a maximum of eight (8) GSBs or Guidance Input and Output Modules (GIOs) can be theoretically interfaced to a Guidance Controller. Therefore, this section describes how to configure and address up to eight (8) GSB or GIO boards. However, due to communication timing and 24VDC power considerations, which are described below, a maximum combination of four (4) GSBs or GIOs is a more practical limit except for special system configurations.

GSBs and GIOs can be connected to the RS-485 daisy chain in any order without altering their operation or identification. A GSB or GIO is identified by a unit number embedded in its low-level communication messages. Jumpers on the GSB specify this unit number. A GSB's unit number is automatically combined with "GSB_" to generate a keyword that is used to configure the communication protocol between the GSB and its master controller. The unit number can be arbitrary selected and does not need to be sequentially assigned, but each GSB or GIO must have a unique unit number within a given RS-485 system.

The setting of the GSB's Unit Number Jumpers is presented in the table below along with the corresponding unit number and keyword identifier.

NOTE: The Unit Number Jumpers for the GSB are J8/J9/J10 whereas the GIO board utilizes J7/J8/J9.

J8	J9	J10	GSB Unit	GSB Keyword
In	In	In	1	GSB_1
Out	In	In	2	GSB_2
In	Out	In	3	GSB_3
Out	Out	In	4	GSB_4

J8	J9	J10	GSB Unit	GSB Keyword
In	In	Out	5	GSB_5
Out	In	Out	6	GSB_6
In	Out	Out	7	GSB_7
Out	Out	Out	8	GSB_8

RS-485 Signal Termination

There is one hardware configuration option dependent on the ordering of modules in the RS-485 daisy chain. For noise immunity, termination jumpers must be installed on the GSBs or GIOs or controller on the extreme ends of the RS-485 daisy chain. The termination jumpers must be removed for all controllers or boards in between. On the GSB board, the Termination Jumper is labeled J6. Consult the hardware description for a specific master controller to determine its RS-485 termination jumper location.

Controller Software Configuration

For the master controller to communicate with a GSB, the GSB's "GSB_Keyword" must be entered into the "Servo network node identifier" (DataID 151) parameter database array in the master controller. This provides the controller with the information it requires to communicate with the GSB board. The position of the "GSB_Keyword" in the DataID 151 array assigns the board a "network node number." Within the controller's software environment, the network node number (and not the GSB's unit number) is used to reference the motor and encoder that is controlled by the GSB. By convention, the first network node is always the master controller and the first element of the DataID 151 is always the controller's serial number.

For example, if the GSB Unit Number Jumpers are set to select unit #4 (Keyword "GSB_4"), to define the GSB as the second network node, DataID 151 should be defined as follows:

DataID 151: "<master>," "GSB_4," ,"" ,"" ,"" ,"" . . .

When a GSB is added to the DataID 151 array, a blank entry cannot precede any non-blank servo node entry. (This rule does not apply to GIO modules.)

24VDC Logic Power Considerations

The GSB must be provided with 24 VDC to power both the board's logic and to drive the input and output signals. The amount of 24 VDC power available for GSBs may limit the number of boards

that can be wired in a system. As a wiring convenience, GSBs and GIOs typically draw the 24 VDC power from the same 10-pin daisy-chained ribbon cable that provides the RS-485 signals. In this configuration, the Guidance Controller and its associated 24 VDC power supply provide the logic and signal power to the GSBs and GIOs.

The minimum power requirement for the GSB's logic is 0.05 A. In the worst case, where a board's digital outputs are all driving 100 mA, the GSB could draw 0.35. In addition, it is possible for a GSB to derive its motor power from the 24 VDC logic power. Even with 2 A available from the controller, it might only be possible to support 1 or 2 GSBs. Fortunately, in a typical system, the GSB's digital outputs normally only draw 20 mA to 50 mA per channel, and the motor power is supplied from a different source. The user should expect a typical GSB to draw 0.2 A, which permits up to eight GSBs to be interfaced to a single controller.

If the controller's available power on the RS-485 cable is not sufficient for an application, an external 24 VDC power source can be wired to the GSB boards. If necessary, 48 V motor power can also be supplied through these connectors.

If GIOs are interfaced, their power consumption must be considered too.

Communication Timing Considerations

Each GSB exchanges messages with the master controller every motion control trajectory cycle. The trajectory period is determined by the parameter "Trajectory Generator update period in sec" (DataID 600) on the master controller. This parameter typically ranges from 1-4 msec and determines the delay in reading or writing input and output values on the GIO.

As the number of GSB and/or GIO boards increases, the trajectory period must also be increased to accommodate the increased transmission times. The table below shows the maximum number of GSB or GIO nodes possible for different trajectory periods.

Trajectory Period (msec)	Maximum Number of GSB or GIO Nodes
1	1
2	4
4	8

Recommended Motor and Encoder Wiring

Wiring Overview

To achieve low power losses, the board's motor drive is designed as a switching amplifier 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 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 GSB 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 in order to avoid encoder quadrature errors, zero index errors, and other noise-related problems.

Motor Cables

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

Wire Size AWG	28	26	24	22	20	18
Amperes	3	4	6	8	10	15

If even higher current ratings are required, Teflon or other high temperature insulation permits higher currents for a given wire size. For example, 22 AWG wire with Teflon insulation has a current rating of 13 A at 200C.

As an extra precaution, it is recommended 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.

	Alpha 18 AWG	SAB 22 AWG
High Flex	85803CY	7840503 5 conductor shielded cable

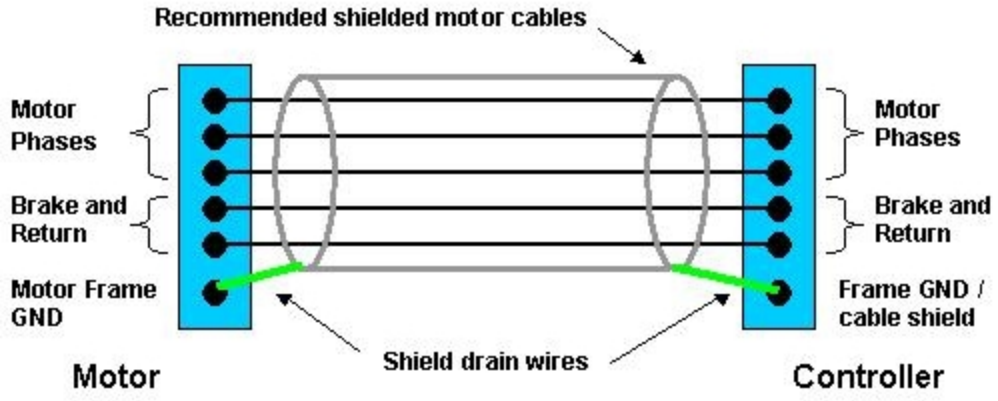
	Alpha 18 AWG	SAB 22 AWG
Moderate Flex	65803CY	
No Flex	3242	

Motor Wiring Path

Since the ground bounce of motors connected to this board 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.”)

> ***NOTE:*** If also wiring a Guidance 2000 or 6000 controller with high voltage motors, consult the wiring instruction for those controllers because their recommended wiring practices are significantly different.

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



Encoder Considerations

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

Some encoders have an open collector output or an output with only a 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 five (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 recommended that the encoder cable be shielded and contain 4 twisted pairs with a gauge of AWG 24 or AWG 26. See the table below for recommended cables.

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

	Alpha 24 AWG	Alpha 26 AWG	Beldon 24 AWG	SAB 26 AWG
High Flex	86604CY	86504CY		07890414
No Flex	5494C 5272C		88104	

One of the twisted pairs should be used for power and ground, one pair for A+ and A-, one pair for B+ and B- and one pair for Z+ and Z- (see the next section.). Connect the shield to one of the ground pins on the controller encoder connector. For encoders that are in a metal box with a metal shell connector, on the encoder end of the cable, connect the shield to the metal shell of the mating connector.

Encoder Wiring and Pin Assignments

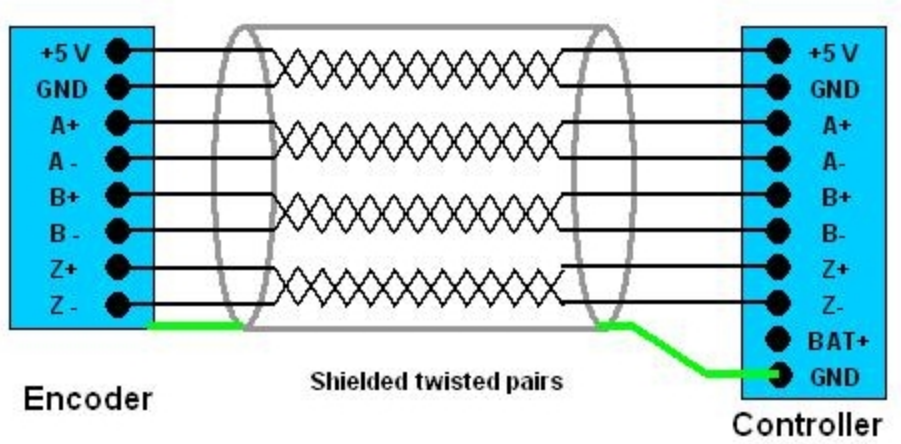
The encoder connector on the GSB provides pins for interfacing to a differential incremental encoder or an absolute encoder. This interface can also be utilized to connect to single-ended encoders. However, it is always best to select an encoder with differential signals for the greatest noise immunity.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

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

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

NOTE: Especially for high-frequency signals such as those required for serial absolute encoders, it is critical that shielded twisted pair cable be used all the way from the encoder to the controller. Even a 300 mm unshielded non-twisted pair cable from the controller to a bulkhead connector can result in significant signal corruption.

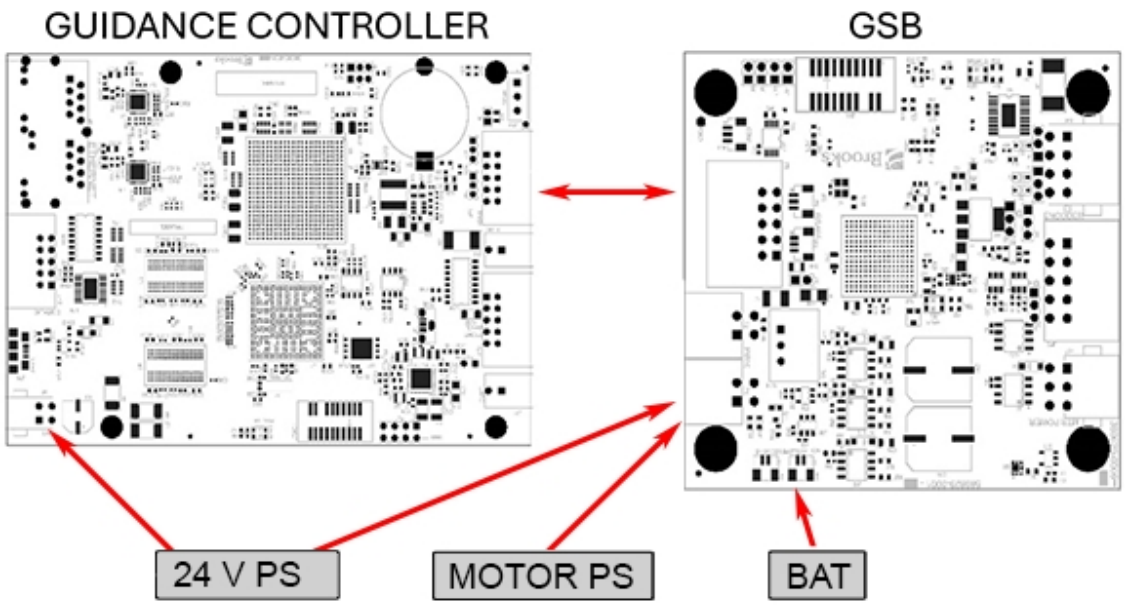
The image below illustrates how to interface to a differential encoder.



4. Hardware Reference

Connecting Power

The GSB must be provided with power for its logic and power to drive the motor. The typical method for wiring the power sources to this board is shown below.



WARNING

The GSB contains unshielded 48 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

The GSBs logic is powered by a 24VDC source, which, as a wiring convenience, can be supplied by the master Guidance Controller via the RS-485 / 24 VDC cable. (The one exception to this rule is when multiple GSBs and GIOs are drawing too much power from this cable, the 24 VDC should be wired separately through the External Power Input Connector.)

Motor power is provided by a separate power supply connected to the GSB's External Power Input Connector. Motor Voltage can range from 12 VDC to 48 VDC.

NOTE: Even if the motor power supply is 24 VDC, keep the motor power supply separate from the 24 VDC 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 can damage the controllers in the system or can cause the 24 VDC power supply to shut down due to an over-voltage error.

WARNING

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

Even when separate logic and motor power supplies are utilized, regenerated energy flowing back to the motor power supply may still cause problems. Unless the motor power supply is designed to absorb this energy, a significant voltage rise in the motor power supply may shut down this power supply or the GSB may disable power to its motor to prevent the motor power amplifier from being damaged. If a significant voltage rise is possible, an external Power Regeneration (Dump) circuit should be added to the motor power supply.

Both the 24 VDC logic power and the motor power should be continuously enabled when the GSB is operational. The GSB automatically internally manages connecting and disconnecting the motor voltage from its power amplifier whenever motor power is enabled or disabled.

In addition to the logic and motor power supplies, when certain types of absolute encoders are used, battery power must be supplied to the encoders when the controller is powered down for them to retain their multiple turn counters. In this case, an external battery should be connected to the Abs Encoder Battery Connector. Refer to the Third Party Equipment section for more information on absolute encoders and their battery requirements.

WARNING

The GSB contains unshielded 48 VDC signals and pins. This product is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

WARNING

If the voltage supplied to a controller's digital logic exceeds 26.4 VDC, the controller's hardware will be damaged. Motor power supply voltage pump-up from decelerating motors can significantly exceed this limit so the motor supply should not be connected to the controller's logic unless the supply is specifically designed to absorb this energy and limit the voltage rise.

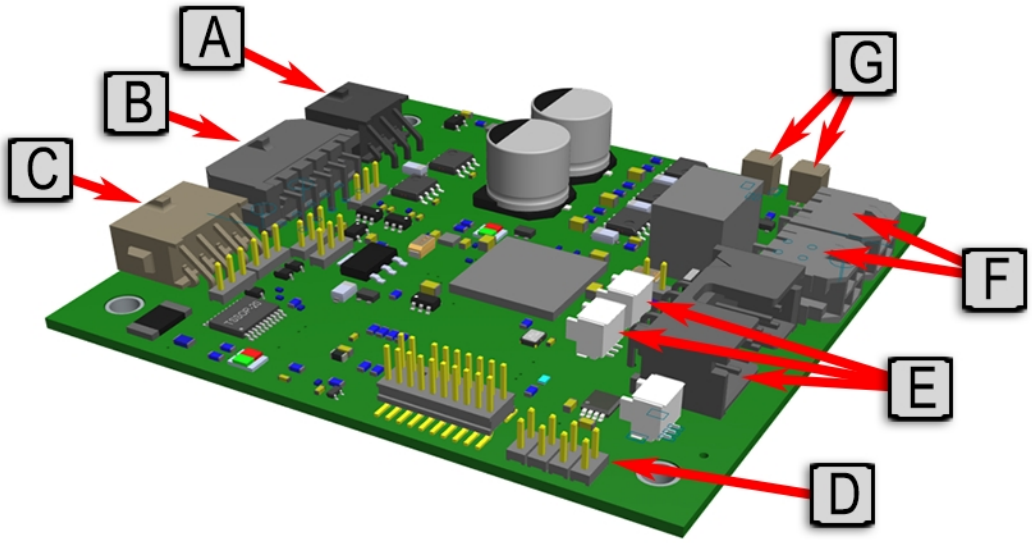
Controller Connectors

In addition to the motor and encoder interfaces, the GSB includes a limited number of other IO for interfacing to limit switches and other devices. Detailed information for all of the GSB's interfaces and the board's configuration hardware is provided in this section.

WARNING

The GSB contains unshielded 48 VDC signals and pins. It is intended to be mounted in a cabinet or machine chassis that is not accessible when power is turned on.

The graphic below shows the top surface of the GSB and identifies each of the user's connectors and the major configuration components.



Letter	Description
A	Motor Power
B	Encoder
C	Digital Input/Output
D	Unit/Compatibility Jumpers
E	RS-485
F	Logic 24 VDC and Motor Power
G	Encoder Battery

In the following sections, pinouts for the connectors and the settings for the jumpers are described.

Abs Encoder Battery Connector

Many commercially available absolute encoders require modest battery power to retain their multiple turn counters when the controller is powered down. If the motor that is connected to the GSB is equipped with this type of encoder, a suitable battery source must be connected to the GSB's encoder battery connector.

Molex Pico-clasp 504449-0207

From the Abs Encoder Battery Connector, the battery power flows to pins in the encoder connector. Refer to the reference pages for the Encoder Interfaces for additional information. Refer to the specific information for the encoder for the recommended battery voltage and capacity.

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

For several types of absolute encoders, a 3.6 V lithium ion backup battery such as a Tadiran TL-5903 can be used to power the multi-turn counters when the controller's power is turned off. This is a AA battery that should last for ten years for one encoder load.

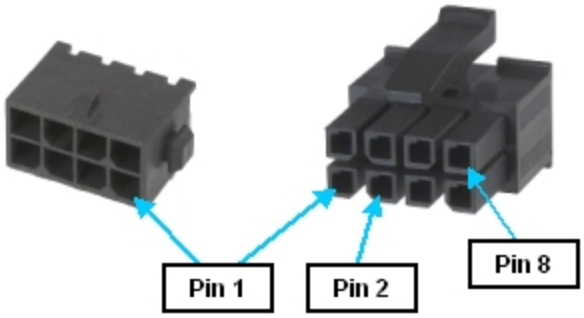
Pin Descriptions

Pin	Description
1	+VBAT
2	GND
User Plug Part for Molex 504449-0207	Housing: Molex 5013300200, Sockets: Molex 5011933000

Digital Input and Output Connector

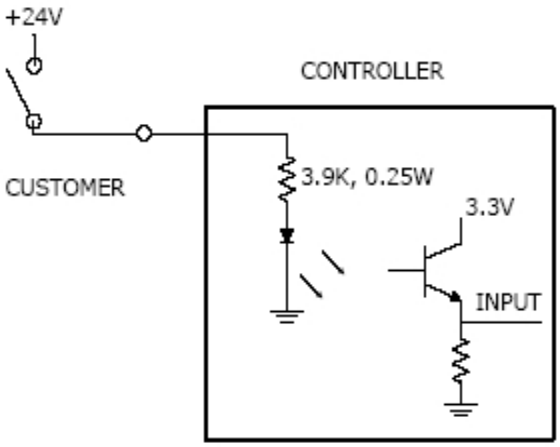
The GSB provides three (3) general purpose input signals which can be used as digital inputs or analog inputs and three (3) general purpose digital output signals. These IO can be utilized as remote DIO by the master Guidance Controller for general workcell interfacing; driving an LED, encoder latching inputs for conveyor tracking or camera synchronization; inputs to the GSB servo for homing or limit stops; etc. These signals are presented in an 8-pin AMP 3-794618-8 that mates

with an AMP 794617-8 plug. This type of connector permits these signals to be easily interfaced to other devices..



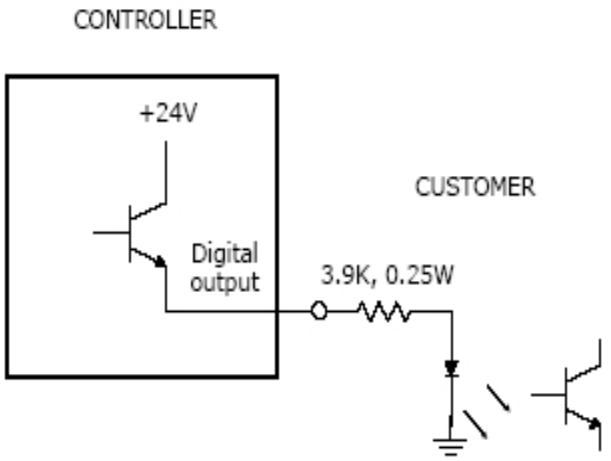
AMP 3-794618-8 and AMP 794617-8 Connectors

The three (3) digital input signals are configured as "sinking." That is, the external equipment must provide a 5 VDC to 24 VDC voltage to indicate a logical high value or must allow it to float to no voltage for a logical low. For convenience, the 8-pin connector supplies 24 VDC. These inputs are compatible with "sourcing" (PNP) sensors. These three inputs can also be used as analog inputs from 0 V to 3.3 V.



DIO Sinking Input

The (3) three digital output signals are configured as "sourcing." That is, the external equipment must pull-down an output pin to ground, and the GSB pulls this pin to 24 VDC when the signal is asserted as true. Each output signal can supply a maximum of 100 mA. For convenience, a ground pin is supplied in the 8-pin connector. These outputs are compatible with "sinking" (NPN) devices.



DIO Sourcing Output

As a convenience for driving an LED, the GSB includes a built-in 1 K resistor that is in series with the output of the 3rd DOUT signal. This permits a typical 3 V 20 mA LED to be driven directly with no additional components.

> ***NOTE:*** The internal 1 K resistor on digital output 3, which was designed to simplify interfacing to an LED, limits the amount of voltage and current that this signal can externally drive.

To support capability required by the PreciseFlex 400 robot, the connector pins for digital input #1 and digital output #3 can be jumpered to connect their signals directly to two pins, RXD and TXD, on the RS-485 connector. When these pins are jumpered, the corresponding digital input and output signals are unconnected. For most configurations, these jumpers should be left in their default positions to permit all 6 DIO signals to operate properly.

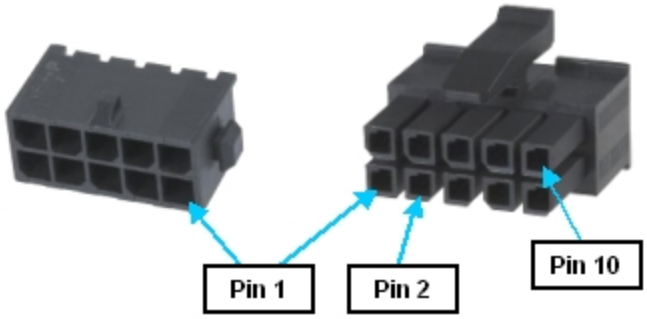
The pin out for the Digital Input and Output Connector and the corresponding GPL signal numbers are described in the following table. For the GPL signal numbers "n" is the GSB's Network Node number that is defined when configuring the master controller, not the GSB's unit number.

Pin	GPL Signal Number	Description
1	n00013	Digital Output 1
2	n00014	Digital Output 2
3	n00015	Digital Output 3. This signal is intended to drive a low voltage/low current LED. It has a 1 K resistor in series with this signal, which limits the output to 3 V and 20 mA for a typical LED. This pin can be optionally jumpered to connect to the TXD pin in the RS-485 connector.
4		24 VDC output

Pin	GPL Signal Number	Description
5		GND
6	n10001	Digital Input 1. This pin can be optionally jumpered to connect to the RXD pin in the RS-485 connector.
7	n10002	Digital Input 2
8	n10003	Digital Input 3
User Plug Part No		AMP 794617-8. Use an AMP 91501-1 hand tool and AMP 794610-1 sockets for wiring to the plug.

Encoder Interfaces

The GSB includes an encoder connector that supports an interface to one digital incremental quadrature encoder or one serial absolute encoder or one serial absolute encoder plus a digital incremental quadrature encoder with no index signal. The signals for the encoder interfaces are provided in a ten-pin Amp 4-794620-0 connector that mates with an Amp 1-794617-0 plug.



Ten-pin Amp 4-794620-0 Connector and Amp 1-794617-0 Plug

The encoder 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, the encoder interface includes a battery power line that is directly connected to the Abs Encoder Battery Connector. Refer to the Third Party Equipment section of this manual for more information on configuring and wiring absolute encoders.

If the GSB is jumpered to operate in compatibility mode, quadrature incremental encoders only produce 2 encoder counts for each A-B signal sequence. If the GSB is jumpered to operate in its native mode, 4 encoder counts are generated for each A-B signal sequence. For example, if an encoder has 1000 lines, a GSB2 or GSB3 in compatibility mode will receive 2000 counts per encoder rotation and a GSB3 in native mode will receive 4000 encoder counts.

NOTE: It is strongly advised that the user 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 each Encoder Connector is described in the table below.

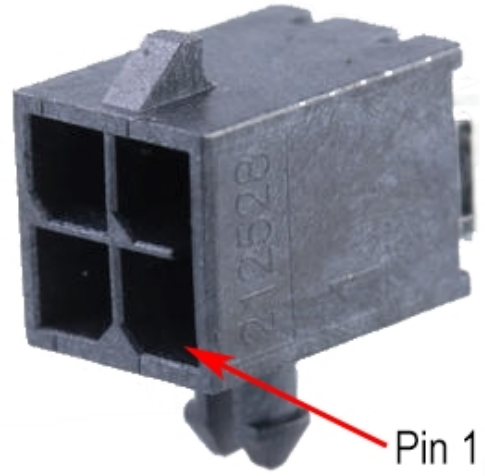
Pin	Description
1	GND
2	Encoder Z+
3	Encoder B-
4	Absolute encoder battery+ output
5	Encoder A+
6	Encoder Z-
7	GND / Absolute encoder battery-
8	Encoder B+
9	Encoder A-
10	5 VDC output provided to power encoders. The current drawn is limited to 250 mA.
User Plug Part No	Amp 1-794617-0. Use an AMP 91501-1 hand tool and AMP 1-794610-2 sockets for wiring to the plug.

External Power Input Connector

The power to drive the motor is normally supplied separately from the logic power. Even though the 24 VDC logic power can be used from the RS-485 / 24 VDC connector, motor power is always supplied on a separate connector.

The motor power is provided via the External Power Input connector. This input permits higher power to be supplied to the motor with voltages ranging from 12 VDC to 48 VDC. Logic power can also be supplied on this External Power Connector.

The power for GSB4 is provided via a four-pin AMP 3-794620-2 connector. The mating plug is an AMP 794617-2. The Power for GSB4X is provided via a 4-pin Molex 2125280400 connector. The mating plug is Molex 2064610400



Molex 2125280400

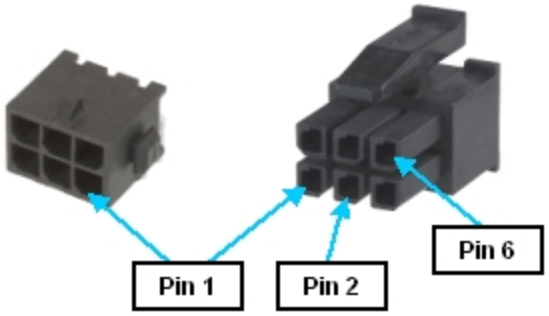
As with the 24 VDC logic power, the motor power provided on this connector should be supplied continuously, independent of whether the motor is enabled or disabled. The GSB automatically manages switching on and off the power to the motor power amplifiers as required.

The pin out for the External Motor Power Connector is described below.

Pin	Description
1	Motor power input, 24 VDC to 48 VDC.
2	Logic Power 24 VDC
3, 4	GND
For GSB4 Use	AMP 794617-2. Use an AMP 91501-1 hand tool and AMP 794610-1 sockets for wiring to the plug.
For GSB4X Use	Molex 2064610400 housing with Molex 2064600021 or 2064600031 or 2064600041

Motor Interface

The GSB is equipped with a single motor drive. The motor drive interface on GSB4 is provided in a 6-pin AMP 3-794618-6 connector that mates with an AMP 794617-6 plug. The motor drive interface on GSB4X is provided on a 6-pin Molex 2125280600 connector that mates with 2064610600.



AMP 3-794618-6 Connector and AMP 794617-6 Plug for GSB4 OR Molex 2125280600 and Molex 2064610600 for GBS4X

As a wiring convenience, the motor connector includes a brake control signal for energizing (releasing) a brake.

Review the Installation section of this manual for recommendations on best practices for wiring motors. Following the provided instructions will significantly reduce the likelihood of the motors generating undesirable electrical noise.

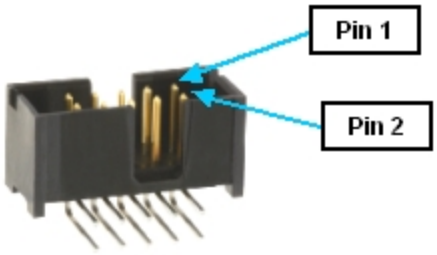
The pinout for the Motor Connector is described below.

Pin	Description
1	Brake power output, 24 VDC, maximum current 1 A total for the brake
2	Motor phase V
3	Motor phase W
4	Brake power return. Set to ground to energize (release) brakes otherwise 24 VDC.
5	Motor frame ground/cable shield
6	Motor phase U
For GSB4 Use	AMP 794617-6. Use an AMP 91501-1 hand tool and AMP 794610-1 sockets for wiring to the plug.
For GSB4X Use	Molex 2064610600 housing with Molex 2064600021 or 2064600031 or 2064600041

RS-485 Signal / 24 VDC Power Connector

The GSB communicates with a Guidance Controller using an RS-485 interface. RS-485 is a two-wire, bi-directional, multi-drop, daisy chained, high-speed serial interface. Once the GSB and controller are connected and configured, the controller's operating system automatically manages communicating motion control messages with the GSB at a regular interval without requiring special user programming.

The RS-485 signals are provided in an IDC connector. To simplify wiring, this connector also provides the 24 VDC logic power and ground lines that are necessary to operate the GSB. If a single GSB module is interfaced to a Guidance Controller, a simple ribbon cable with an IDC connector on each end can connect the GSB to the controller and provide both communication signals and logic power to the GSB.



For reliable communications, termination jumpers must be installed on the GSBs, GIOs or controllers on the extreme ends of the RS-485 daisy chain. The termination jumpers must be removed for all controllers or boards in between.

To support future capability required by the PreciseFlex robot, two of the pins on this connector, TXD and RXD, can be jumpered to pass through signals from the Digital Input and Output Connector.

The pin out for the RS-485/24 VDC Power Connector is described below.

Pin	Description
1	24 VDC. A minimum of 0.05 Amps is required for the GSB's logic power. A maximum of 0.3 Amps additional is required when all 3 digital outputs are driving 100 mA each. If the digital outputs are driving less than 100 ma each, the additional 0.3 Amps will be reduced accordingly. In a typical system, sourcing outputs normally drive 20 mA to 50 mA. If the board is configured to drive the motor from the 24 VDC logic power provided by this connector or if the motor has a brake, the additional power must be factored into the current requirements.
2	
3	RXD. This can be optionally jumpered to pass through the signal that is normally directed to Digital Input #1. If not jumpered, this pin is unconnected.
4	TXD. This can be optionally jumpered to pass through the pin that is normally driven by Digital Output #3. If not jumpered, this pin is unconnected.

Pin	Description
5	GND
6	Not connected
7	GND
8	RS485+
9	RS485-
10	GND
User Plug Part No	AMP 746285-1 or Molex 22-55-2101 or 90142-0010. For the Molex plug, use Molex sockets 16-02-0103 and Molex crimp tool 63811-1000.

RS-485 Termination Jumper

For the RS-485 daisy chained serial bus to operate properly, the ends of the bus must be electrically terminated. This electrical termination prevents transmitted signals from being reflected into the cable and corrupting valid data. However, interior boards in the daisy chain must not have any electrical termination.

To allow a GSB to be placed anywhere in an RS-485 daisy chain, this board includes configurable bus termination that is controlled by two jumper posts at position J6 on the top surface of the board.

When a GSB is placed at either end of an RS-485 daisy chain, the two (2) posts must be jumpered together to terminate the bus. When a GSB is placed at an interior node of a chain, the jumper must be removed. As shipped from the factory, the jumper is installed and the GSB is ready to be connected at either end of a chain.

Status Red/Green LED

The GSB module includes a Status LED mounted on its top surface. This indicates the power and execution state of the board. The interpretation of this red and green LED is described in this table.

LED State	System Status	Description
Continuously off or on	(1) Logic power off or (2) CPU crashed	Normally indicates that 24 VDC logic power is off. In rare instances, indicates that the GSB CPU has crashed due to a system hardware or software error.
Alternating red and green	Board booting	The 24 VDC logic power has been turned on and the GSB board is being initialized. If this state continues for more than a minute or two, it usually indicates a hardware failure.
Blinking red single	Board operating, waiting for communications.	The GSB CPU has completed it startup process and is operational. The GSB is waiting for RS-485 communication with the master Guidance Controller to be established.
Blinking red double	Board idle, not communicating	The GSB did not connect to the master controller within 1 minute of boot and is no longer listening to the RS-485. It will not connect until it has been rebooted.
Blinking green	Normal operation, drive ready or active	The GSB is operational and is actively communicating with the master Guidance Controller. The board can servo control an attached motor.

Unit Number / Compatibility Jumpers

In the low-level RS-485 communications, the "unit number" determines which GSB is the originator or recipient of each message, not the position of the GSB board in the RS-485 daisy chain. This unit number is configurable using a group of three jumper posts on the top of the GSB board. The unit numbers can be arbitrarily assigned and do not have to be sequential, but they do have to be unique within a controller system.

The unit number also determines a keyword ("GSB_<unit_number>") that is specified to configure a GSB board as a node in a controller's Servo Network.

> ***NOTE:*** At the software application level, the network node number and not the GSB board unit number determines how the GSB's motor and encoder are addressed.

In addition, this block of jumper posts include a pair of posts (J11) that determine if the GSB operates in "native" mode (jumper installed) or "compatibility" mode (jumper removed). If a GSB3 is replaced with GSB4, the J11 jumper on GSB4 should be the same as J11 on GSB3. If a GSB2 is

replaced with GSB4 (a rare case), the J11 jumper must be removed on GSB4. Also, it is required to update GPL to 4.2k1.

For more information on node numbers and configuring the controller, refer to the Hardware and Software Configuration section.

In the table below, the interpretation of the Unit Number Jumpers (J8, J9, J10) is provided. As shipped from the factory, all of the jumpers are installed, which indicates GSB unit #1.

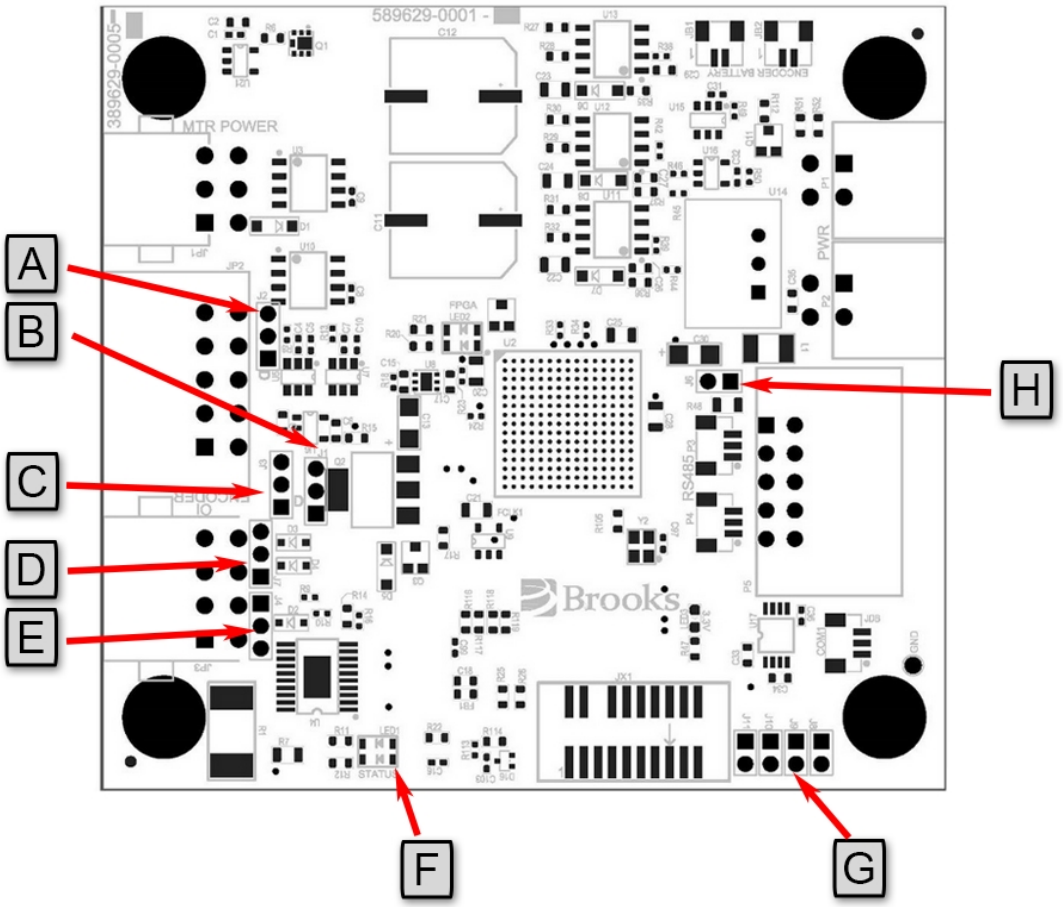
NOTE: The Unit Number Jumpers for the GSB are J8/J9/J10 whereas the GIO board utilizes J7/J8/J9.

J8	J9	J10	GSB Unit	GSB Keyword
In	In	In	1	GSB_1
Out	In	In	2	GSB_2
In	Out	In	3	GSB_3
Out	Out	In	4	GSB_4
In	In	Out	5	GSB_5
Out	In	Out	6	GSB_6
In	Out	Out	7	GSB_7
Out	Out	Out	8	GSB_8

GSB Board Jumpers

The GSB has several hardware jumpers that determine the configuration of various hardware functions. Depending upon the type of jumper, there may be two or three jumper posts. Posts are tied (shorted) together using black jumper plugs. The three wide jumpers for configuring the motor drive voltage are shown below.

The location of each key jumper set is illustrated below and identified by stenciled labels on the GSB board's surface.



Letter	Description
A	J2-Channel A DIFF/SE

Letter	Description
B	J1 Channel Z DIFF/SE
C	J3 Channel B DIFF/SE
D	J7 DOUT3 to TXD
E	J4 DIN1 to RXD
F	Status LED
G	J8-J11 Unit #/Compatibility Jumpers
H	J6 RS485 Termination

The table below 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 GSB board oriented as shown above.

Jumpers	Description	Setting
J8/J9/J10/J11 Unit Number / Compatibility	The right-most jumper in this group (J11) determines if a GSB4 board operates compatibly with a GSB2 and can execute properly with the same set of controller configuration (*.PAC) files. If this jumper is not installed in a GSB4, the GSB4 operates in compatibility mode. When a new robot is being configured for the first time, native (non-compatibility) mode should generally be selected since this makes use of all the features of the GSB4. The setting of the compatibility mode jumper is especially important when an incremental quadrature encoder is utilized. As shipped from the factory, this jumper is installed.	Remove right-most jumper (J11) in GSB4 to execute compatibly with GSB2. Install for native mode.
	In the low-level RS-485 communication protocol, the Unit Number (J8/J9/J10) determines which GSB is the originator or recipient of each message, not the position of the GSB board in the RS-485 daisy chain. See the Unit Number /Compatibility Jumpers section for a description of these jumpers. The left most jumper is J8. As shipped from the factory, all three (3) of these jumpers are installed and the board is set to unit #1.	Install or remove left 3 jumpers to define GSB Unit Number.
J7 DOUT3 to TXD	This jumper is provided to support the future capability of the PreciseFlex 400 robot. It determines whether pin 3 of the GSB Digital Input and Output Signal connector conveys the 3rd local digital output signal DOUT3 (standard configuration) or whether this pin is connected to the TXD pin of the RS-485 connector. ***NOTE:*** *In the standard configuration, DOUT3 has a 1k resistor in series with its output. This limits the current and voltage that can be output by this signal and was designed to permit a LED to be directly driven by DOUT3. As shipped from the factory, this jumper selects DOUT3 to output.*	Always jumper J7-2 to J7-3 (left most pins) to enable DOUT3 Jumper J7-1 to J7-2 (right most pins) to connect the DOUT3 pin to the TXD pin

Jumpers	Description	Setting
J6 RS-485 Bus Termination	This jumper controls if RS-485 Bus Termination is enabled on this board. For reliable communications, if a GSB is at the end of a RS-485 daisy chain, this jumper must be installed to terminate the communication line. If a GSB is in the middle of a RS-485 daisy chain, this jumper must be uninstalled to disable the termination. As shipped from the factory, this jumper is installed and the GSB should be installed at the end of the RS-485 daisy chain.	Install jumper J6 to terminate the RS-485 communication lines.
J4 DIN1 to RXD	This jumper is provided to support a future capability of the PreciseFlex 400 robot. It determines whether pin 6 of the GSB Digital Input and Output Signal connector in connected to the first local digital input signal DIN1 (standard configuration) or whether this pin is connected to the RXD pin of the RS-485 connector. **As shipped from the factory, this jumper selects DIN1 input.**	Always jumper J4-2 to J4-3 (top most pins) to enable DIN1 Jumper J4-1 to J4-2 (bottom pins) to connect the DIN1 pin to the RXD pin
Status LED	This is a green and red LED that blinks to indicate the operational status of the controller.	

5. Third Party Equipment

This section contains instructions on interfacing to 3rd party equipment commonly used with the GSB. For detailed information on each of these products, please refer to the manuals provided by the manufacturers of these components.

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 a 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.

For information on configuring this type of encoder, refer to the *Software Setup* section of the *Controller Software* section of the *PreciseFlex Library*.

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

Tamagawa Motor Pin	Wire Color	Signal Name	GSB Connector Pin
A4	BROWN	BATTERY+	4
B4	BROWN/BLACK	BATTERY -	7
B6	BLACK	FG	1
A3	BLUE	PS+	5
B3	BLUE/BLACK	PS-	9
A5	RED	VCC	10
B5	BLACK	GND	7

This table lists the wiring instructions for the Motor Power Connectors.

Motor Connector Pin	Wire Color	Signal Name	GSB 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 Abs Encoder Battery Connector. Refer to the information on that connector for detailed pin outs and plug types. The table below contains information on the required battery power.

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

Appendix

Appendix A: Product Specifications

General Specification	Range & Features
Interface to Master Guidance Controller	
Communications Interface	Interfaces via a two-wire, bi-directional, daisy chained RS-485 line and can be located up to approximately 6 meters away from the controller.
Communications Protocol	Operates as part of the PreciseFlex Servo Network.
Motion Setpoint Command Rate	Motion setpoints commands and higher level returned sampled data are updated at the rate set by the "Trajectory Generator update period in sec" (DataID 600) of the master controller. This update rate is typically 1-4 msec.
Number of units	A combination of up to eight (8) GSBs and GIOs can theoretically be simultaneously interfaced to a Guidance Controller. The actual maximum is a function of the "Trajectory Generator update period in sec" (DataID 600) of the master controller and the available 24VDC power. In typical systems, a maximum of four (4) GSB or GIO boards can be simultaneously operated.
Motion Control	
Motor Drive	One drive: 10.31 A peak/4 A RMS/5.6 A stall Bus voltage & total power: 12 VDC to 48 VDC Suitable for up to 100W low voltage motors or 200W motors with reduced peak speeds.
Position Sensors Interface	One differential or single-ended digital quadrature encoder interface (factory configured) Support for selected absolute encoders
Control Signals	Brake signal (Up to 1 A at 24 VDC available for releasing motor brake)
Input and Output Interfaces	
Digital Input Channels	3 optically isolated digital inputs configured as sinking 5 VDC to 24 VDC for logic high
Digital Output Channels	3 optically isolated digital outputs configured as sourcing 24 VDC maximum pull up
General	
Size and Weight	70 mm (W) x 75 mm (L) x 16.2 mm (H), 0.040 kg

General Specification	Range & Features
Low Voltage Logic Power	24 VDC required for logic and input/output functions
	A minimum of 0.05 Amps is required for the GSB's logic power. A maximum of 0.3 Amps additional is required when all 3 digital outputs are driving 100 mA each. If the digital outputs are driving less than 100 ma each, the additional 0.3 Amps will be reduced accordingly. In a typical system, sourcing outputs normally drive 20 mA to 50 mA. If the board is configured to drive the motor from the 24 VDC logic power or if the motor has a brake, the additional power must be factored into the current requirements.

GSBs must be installed in a clean, non-condensing environment with the following specifications.

General Specification	Range & Features
Ambient temperature	5ºC to 40ºC
Storage and shipment temperature	-25ºC to +55ºC
Humidity range	5 to 90%, non-condensing
Altitude	Up to 3000 m
Free space around controller	6mm sides and top
Chassis protection class	IP20 (NEMA Type 1)
For EU or EEA countries	IP22 minimum, must meet EN 60204 (IEC 204)