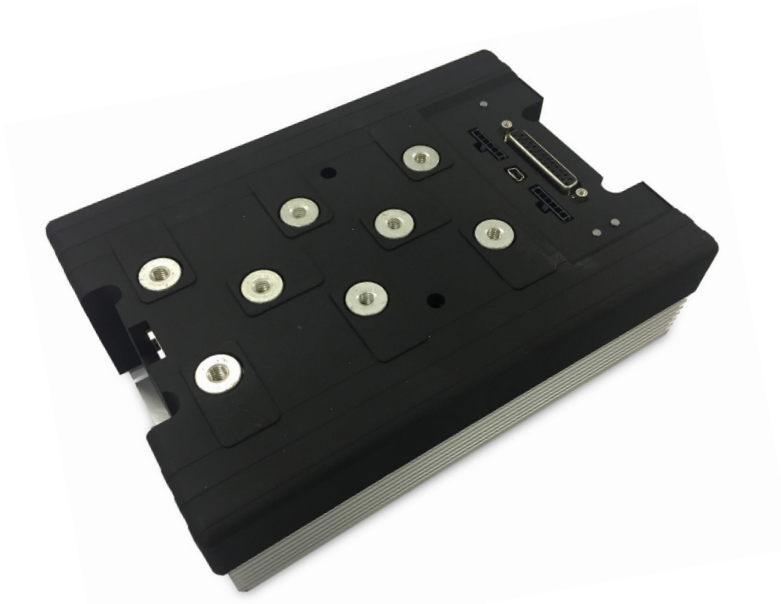
RoboteQ

# GBL26xx

## High Power Brushless Motor Controller with USB, CAN and Ethernet



Roboteq's GBL26xx is a feature-packed, high-current, dual or single channel controller for brushless Permanent Magnets AC or DC Synchronous motors. The controller also uses the Hall sensor and/or most types of Encoders to capture the Rotor position and measure traveled distance. The motors may be operated in open or closed loop speed mode, position mode or in torque mode. The GBL26xx features several Analog, Pulse and Digital I/Os which can be remapped as command or feedback inputs, limit switches, or many other functions. The GBL26xx accepts commands received from an RC radio, Analog Joystick, wireless modem, or microcomputer. For mobile robot applications, the controller's two motor channels can either be operated independently or mixed to move and steer a vehicle. Using CAN bus, up to 127 controllers can be networked at up to 1Mbit/s on a single twisted pair. An optional Ethernet port with PC allows the connection to PLCs and TCP/IP networks.

Numerous safety features are incorporated into the controller to ensure reliable and safe operation. The controller's operation can be extensively automated and customized using Basic Language scripts. The controller can be configured, monitored and tuned in real-time using a Roboteq's free PC utility. The controller can also be reprogrammed in the field with the latest features by downloading new operating software from Roboteq.

### Applications

- Automatic Guided Vehicles
- Small Electric Vehicles, Electric Bikes
- Terrestrial and Underwater Robotic Vehicles
- Police and Military Robots
- Hazardous Material Handling Robots
- Balancing Robots
- Telepresence Systems
- Animatronics

### Key Features

- USB, Serial, 0-5V Analog, or Pulse (RC radio) command modes
- One serial port
- CAN bus interface up to 1Mbit/s with multiple protocol support
- Optional RS485 interface
- Optional 10/100 Ethernet
- Auto switch between Serial, USB, CAN, Analog, or Pulse based on user-defined priority
- Built-in dual 3-phase high-power drivers for two brushless DC motor at up to 180A
- Support for 10 KOhm NTC temperature sensors through analog inputs (requires an external 10 KOhm pull-up resistor)
- Output channels can be paralleled in order to drive a single motor at up to 360A
- Multiple Motor Operating mode
  - Trapezoidal with Hall Sensors
  - Sinusoidal with Incremental Encoder
  - Sinusoidal with SSI Encoder
  - Sinusoidal with Resolver
  - Sinusoidal with Hall Sensors
  - Sinusoidal with Sin/Cos Encoder
- Field Oriented Control in Sinusoidal modes
- Full forward & reverse motor control. Four quadrant operation. Supports regeneration
- Operates from a single 10V to 60V (120V otional) power source
- Programmable current limit up to 180A (360A on single channel version) per motor for protecting controller, motor, wiring and battery.
- Separate connector for Hall Sensors

- Accurate speed and Odometry measurement using Hall Sensor or Encoder data
- Up to eight Analog Inputs for use as command and/or feedback
- Up to eight Pulse Length, Duty Cycle or Frequency Inputs for use as command and/or feedback
- Up to 10 Digital Inputs for use as Deadman Switch, Limit Switch, Emergency stop or user inputs
- Inputs for up to 3 Quadrature Encoders
- 4 general purpose 1.5A output for brake release or accessories
- Selectable min, max, center and deadband in Pulse and Analog modes
- Selectable exponentiation factors for each command inputs
- Trigger action if Analog, Pulse or Hall counter capture are outside user selectable range (soft limit switches)
- Open loop or closed loop speed control operation
- Closed loop position control with encoder, hall sensors, analog or pulse/frequency feedback
- Torque mode
- PID control loop
- Built-in Battery Voltage and Temperature sensors
- Optional 12V backup power input for powering safely the controller if the main motor batteries are discharged
- Power Control wire for turning On or Off the controller from external microcomputer or switch
- No consumption by output stage when motors stopped
- Regulated 5V output for powering RC radio, RF Modem, sensors or microcomputer
- Separate Programmable acceleration and deceleration for each motor
- Ultra-efficient 1.2 mOhm ON resistance MOSFETs (0.6 mOhm on Single Channel)
- Stall detection and selectable triggered action if Amps is outside user-selected range
- Short circuit protection
- Overvoltage and Undervoltage protection
- Watchdog for automatic motor shutdown in case of command loss
- Overtemperature protection
- Diagnostic LED indicators
- Efficient heat sinking. Operates without a fan in most applications.
- Built-in conduits for liquid cooling
- Dustproof and weather resistant. IP51 NEMA rating
- Power wiring using High Current M6 screw terminals
- 210mm x 145mm x 60mm
- -40° to +85° C operating environment
- Weight: 6.5 lbs (2940g)
- Easy configuration, tuning and monitoring using provided PC utility
- Field upgradeable software for installing latest features via the Internet Orderable Product References

## Orderable Product References

| Reference | Number of Channels | Amps/Channel | Volts | Ethernet | SSI sensors |
|---|---|---|---|---|---|
| GBL2660 | 2 | 180 | 60 | No | 2 |
| GBL2660E | 2 | 180 | 60 | Yes | 0 |
| GBL2660S | 1 | 360 | 60 | No | 1 |
| GBL2360ES | 1 | 360 | 60 | Yes | 1 |
| GBL26120 | 2 | 135 | 120 | No | 2 |
| GBL26120S | 1 | 270 | 120 | No | 1 |
| GBL26120E | 2 | 135 | 120 | Yes | 0 |
| GBL26120ES | 1 | 270 | 120 | Yes | 1 |

## Warning

**A dangerous uncontrolled motor runaway condition can occur due to various reasons, including, but not limited to: command or feedback wiring failure, configuration errors, faulty firmware, errors in user scripts or programs, or controller hardware failure.**

**Users must be aware that such failures can occur and must ensure the safety of their system under all conditions. Roboteq will not be held liable for any damage or injury resulting from product misuse or failure.**

## Important Note

**All products are not serviceable. If damage is suspected, the item must be replaced rather than repaired.**

**Attempting to service or repair the product voids any existing warranty and may pose safety risks.**

**Consult customer support for more information on replacements.**

## Power Wires Identifications and Connection

Power connections are made by means of high amperage power terminals located at the top of the controller, as shown in Figure 1:.

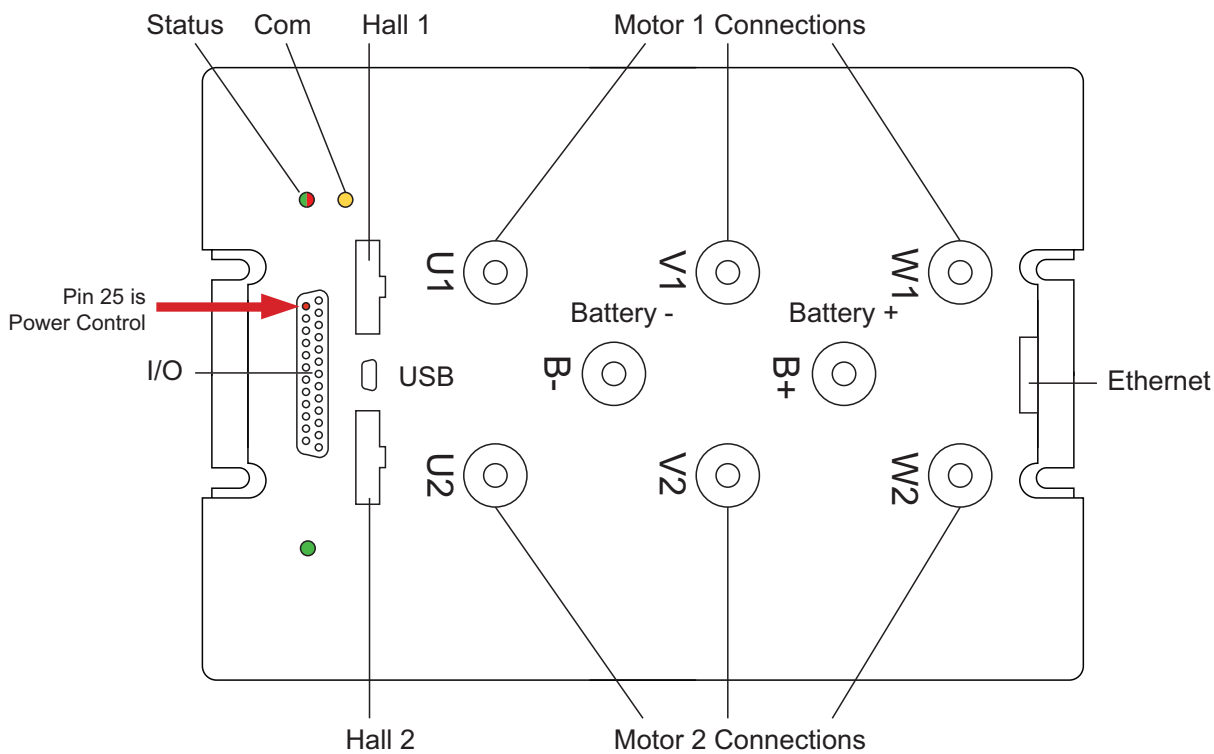



FIGURE 1. GBL26xx Rear View

The diagram in Figure 2, below, shows how to wire the controller in a dual motor configuration, and how to turn power On and Off.

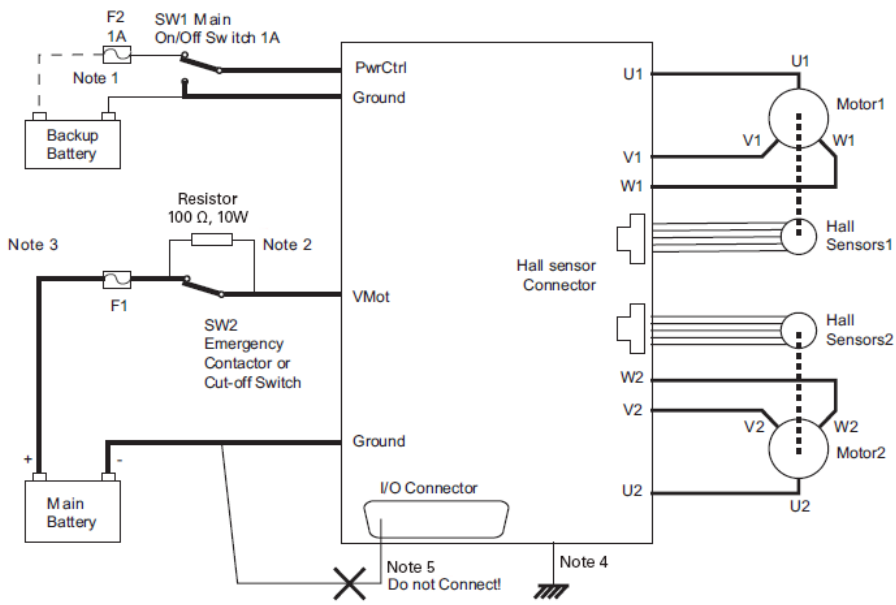



FIGURE 2. Powering the Controller. Thick lines identify MANDATORY connections

## Caution

Carefully follow the wiring instructions provided in the Power Connection section of the User Manual. The information on this datasheet is only a summary.

### Mandatory Connections

It is imperative that the controller is connected as shown in Figure 2, above, in order to ensure a safe and trouble-free operation. All connections shown as thick black lines line are mandatory. The controller must be powered On/Off using switch SW1on the Pwr Ctrl tab. Use a suitable high-current fuse F1 as a safety measure to prevent damage to the wiring in case of major controller malfunction.

### Emergency Switch or Contactor

The battery must be connected in permanence to the controller's VMot tabs via a high-power emergency switch or contactor SW2 as additional safety measure. The user must be able to deactivate the switch or contactor at any time, independently of the controller state.

### Electrostatic Discharge Protection

In accordance with IEC 61000-6-4, Roboteq Motor Controllers are designed to withstand ESD up to 4kV touch and 8kV air gap. This protection is implemented without any additional external connections required.

Some specifications, such as EN12895, require a higher level of protection. To maximize ESD protection, up to 8kV touch and 15kV air gap, you may connect the metallic heatsink of the controller to your battery negative terminal. See App Note 062918 for example connections.

### Precautions and Optional Connections

Note 1: Backup battery to ensure motor operation with weak or discharged batteries, connect a second battery to the Power Control wire/terminal via the SW1 switch. For the 120V model, the Power Control is mandatory for the controller's operation.

Note 2: Use precharge 100Ω, 10W Resistor to prevent switch arcing.

Note 3: The voltage generated by motors rotating while not powered by the controller can cause serious damage even if the controller is Off or disconnected.

- Use the main SW1 switch on the Power Control wire/terminal to turn Off and keep Off the controller. In this way the controller cannot be powered up under any unwanted circumstances.
- Countermeasures should be taken to deal with any regeneration power if the battery or BMS system does not support energy to return back to it.
- Disconnecting the controller from the battery while motors are rotating could lead to a serious damage. In this case a regeneration brake system is needed.

Note 4: Connect the controller's bottom plate to a wire connected to the Earth while the charger is plugged in the AC main, or if the controller is powered by an AC power supply.

Note 5: Beware not to create a path from the ground pins on the I/O connector and the battery minus terminal.

## Single Channel Wiring

On the Single Channel GBL26xxS, the each of the motor wire must be connected to both output tabs of the same letter, as shown in Figure 3, below. Use the Encoders and/or Hall sensors of Channel 1 for operation.

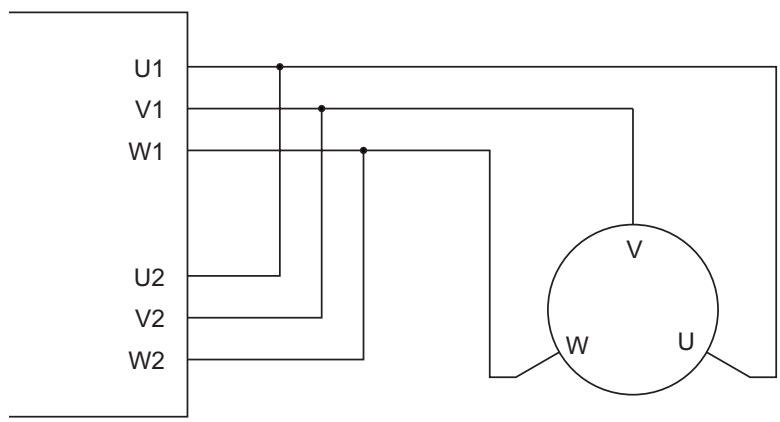



FIGURE 3. Single Channel Wiring Diagram

## Important Note

**This wiring must be done only on the single channel version of the controller. Paralleling the wires on a dual channel product will cause permanent damage. Verify that your controller is an GBL2660S or GBL26120S before you wire in this manner.**

## Use of Safety Contactor for Critical Applications

An external safety contactor must be used in any application where damage to property or injury to person can occur because of uncontrolled motor operation resulting from failure in the controller's power output stage.

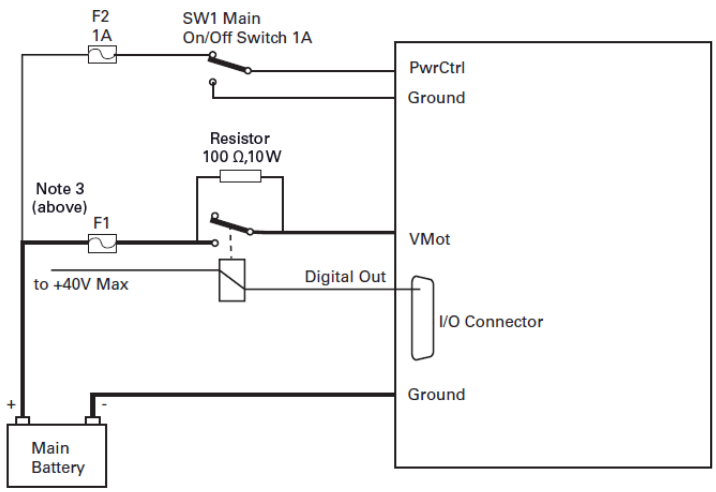



FIGURE 4. Contactor Wiring Diagram

The contactor coil must be connected to a digital output configured to activate when "No MOSFET Failure". The controller will automatically deactivate the coil if the output is expected to be off and battery current of 1A or more is measured for more than 0.5s. This circuit will not protect against other sources of failure such as those described in the "Warning" on Page 3.

## Controller Mounting

During motor operation, the controller will generate heat that must be evacuated. The published amps rating can only be fully achieved if adequate cooling is provided. Good conduction cooling can be achieved by having the bottom surface of the case making contact with a metallic surface (chassis, cabinet).

## Hall Sensors Connection

Connection to the Hall Sensors is done using a special connector on the front side of the controller. The Hall sensor connector is a 6-pin Molex Microfit 3.0, ref. 43645.

Pin assignment are in Table 1, below.

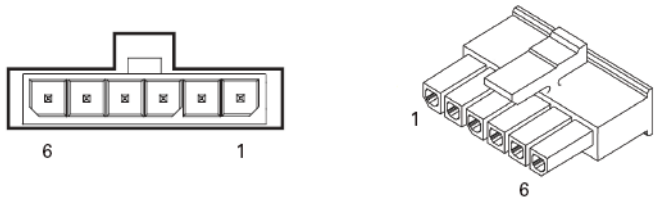



FIGURE 5. Hall Sensors Connector

TABLE 1.

| Pin Number | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Signal | Ground | Hall A | Hall B | Hall C | | 5V |

## Hall Sensor vs Motor Output sequencing

The controller requires the Hall sensors inside the motor to be 120 degrees apart. The controller's 3-phase bridge will activate each of the motor winding according to the sequence shown in the Figure 6, below.

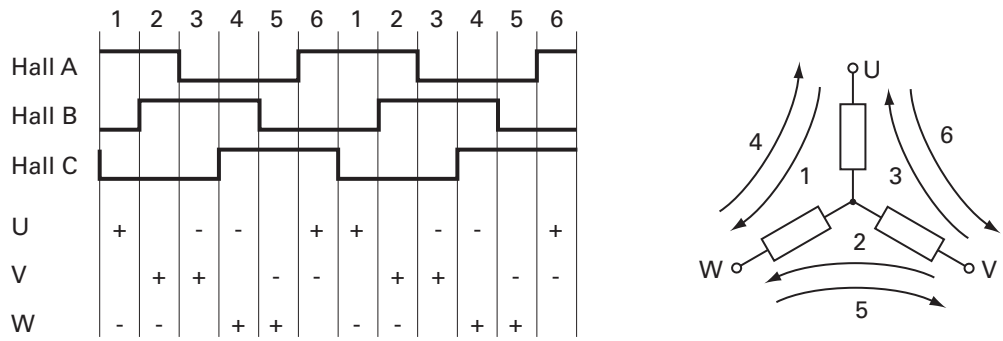



FIGURE 6. Hall Sensors Sequence

## Connection to SSI Absolute Encoder

In Sinusoidal Mode, the controller can use motors equipped with absolute angle sensors with SSI interface. When enabled, the SSI signals are found on the 6-pin Molex connector that is otherwise used for the Hall Sensors. The controller issues a clock signal to, and receives data signal from the encoder.

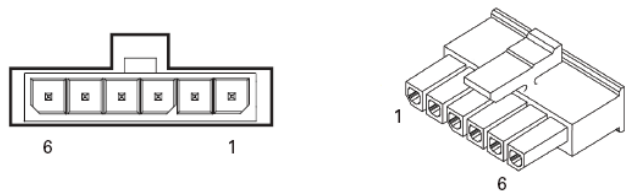



FIGURE 7. Hall Sensor Connector Used for SSI Encoders

TABLE 2.

| Pin Number | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Signal | Ground | Data + | Data – | Clock + | Clock – | 5V |

## Connection to Analog Sin/Cos Absolute Encoder

The GBL2660 has 4 high-speed analog inputs that can be used to capture absolute angle position from resolvers or magnetic sensors with sin/cos voltage outputs. The signal must be 0-5V max with the 0 at 2.500V. Table 3, below, shows the signals assignment on the 25-pin connector.

TABLE 3.

| Signal | Pin Number | Pin Name |
|---|---|---|
| Sin1 | 9 | ASIN1 |
| Cos1 | 10 | ACOS1 |
| Sin2 | 24 | ANA7/ASIN2 |
| Cos2 | 12 | ANA8/ACOS2 |

## Connecting Resolver

Resolver wiring is similar to a Sin/Cos sensor with the addition of an excitation signal. Figure 8, below, shows the necessary connections.

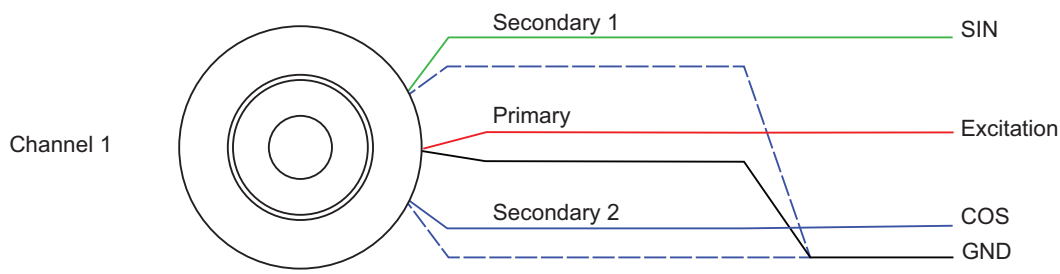



FIGURE 8. Resolver Connections

Table 4, below, shows the signals assignment on the 15-pin connector.

TABLE 4.

| Signal | Pin Number | Pin Name |
|---|---|---|
| Sin1 | 9 | ASIN1 |
| Cos1 | 10 | ACOS1 |
| Sin2 | 24 | ANA7/ASIN2 |
| Cos2 | 12 | ANA8/ACOS2 |
| Exc | 17 | ANA4/EXC |

## Commands and I/O Connections

Connection to RC Radio, Microcomputer, Joystick and other low current sensors and actuators is done via the 25 connector. The functions of many pins vary depending on controller model and user configuration. Pin assignments are found in Table 5, below.

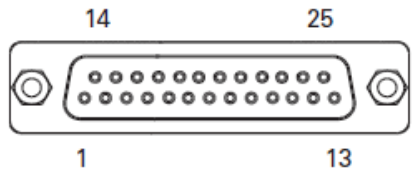



FIGURE 9. Main Connector Pin Locations

TABLE 5.

| Connector Pin | Power | Dout | Com | Pulse | Ana | Dinput | Enc | Hall (4) | Default Config |
|---|---|---|---|---|---|---|---|---|---|
| 1 | GND | | | | | | | | |
| 14 | 5VOut | | | | | | | | |
| 2 | | | RS TxD | | | | | | RS232Tx |
| 15 | | | | RC1 (3) | ANA1 | DIN1/STO1 | | Hall1A | RCRadio1 |
| 3 | | | RS RxD | | | | | | RS232Rx |
| 16 | | | | RC2 (3) | ANA2 | DIN2/STO2 | | Hall1B | RCRadio2 |
| 4 | | | | RC3 | ANA3 | DIN3 | | Hall1C | AnaCmd1 (1) |
| 17 | | | | RC4 (3) | ANA4/EXC | DIN4 | | | AnaCmd2 (1) |
| 5 | GND | | | | | | | | |
| 18 | | DOUT1 | | | | | | | Motor Brake 1 |
| 6 | | DOUT2 | | | | | | | Motor Brake 2 |
| 19 | | DOUT3 | | | | | | | Contactor |
| 7 | | DOUT4 | | | | | | | Unused |
| 20 | | | CANH | | | | | | Unused |
| 8 | | | CANL | | | | | | Unused |
| 21 | | | | RC5 | ANA5 | DIN5 | ENC2A | Hall2A | Unused |
| 9 | | | | | ASIN1 | DIN9 (2) | | | Unused |
| 22 | | | | RC6 | ANA6 | DIN6 | ENC2B | Hall2B | Unused |
| 10 | | | | | ACOS1 | DIN10 (2) | | | Unused |
| 23 | | | 485+ | | | | | | RS485+ |
| 11 | | | 485- | | | | | | RS485- |
| 24 | | | | RC7 | ANA7/ASIN2 | DIN7 | ENC1A | Hall2C | Unused |
| 12 | | | | RC8 | ANA8/ACOS2 | DIN8 | ENC1B | | Unused |
| 25 | PwrCtrl | | | | | | | | |
| 13 | GND | | | | | | | | |

Note 1: Analog command is disabled in factory default configuration.

Note 2: From v2.0a and above.

Note 3: Not recommended for MultiPWM.

## Default I/O Configuration

While the controller can be configured so that practically any Digital, Analog and RC pin can be used for any purpose, the controller's factory default configuration provides an assignment that is suitable for most applications. The figure below shows how to wire the controller to two analog potentiometers, an RC radio, and the RS232 port. It also shows how to connect two outputs to motor brake solenoids and another output to an external status LED. You may omit any connection that is not required in your application. The controller automatically arbitrates the command priorities depending on the presence of a valid command signal in the following order: 1-RS232, 2-RC Pulse, 3-None. If needed, use the Roborun+ PC Utility to change the pin assignments and the command priority order.

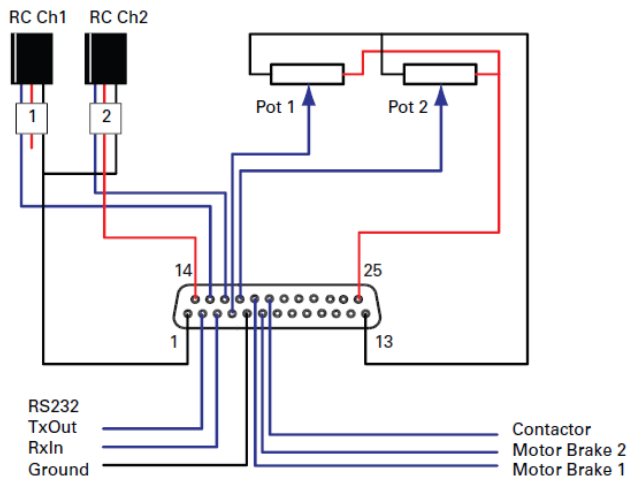



FIGURE 10. Factory Default Pin Assignment

## Enabling Analog Commands

For safety reasons, the Analog command mode is disabled by default. To enable the Analog mode, use the PC utility and set Analog in Command Priority 2 or 3 (leave Serial as priority 1). Note that by default the additional securities are enabled and will prevent the motor from starting unless the potentiometer is centered, or if the voltage is below 0.25V or above 4.75V. The drawing shows suggested assignment of Pot 1 to ANA1 and Pot 2 to ANA4. Use the PC utility to enable and assign analog inputs.

## Connecting Thermistors

10 KOhm NTC temperature sensors can be connected to the controller's analog inputs. This enables reading of motor temperature through the controller's runtime variables and allows for active temperature protection. This connection can be achieved by using a 10 KOhm pull-up resistor between the analog input and the controller's 5V output. For more information about motor temperature readings and controller parameterization, please refer to the Roboteq Controller's User Manual.

## USB communication

Use USB only for configuration, monitoring and troubleshooting. USB is not a reliable communication method when used in a electrically noisy environments and communication will not always recover after it is lost without unplugging and replugging the connector, or restarting the controller. Always prefer RS232 communication when interfacing to a computer. USB and CAN can operate at the same time on the GBL2660. Plugging USB to a computer will not disable the CAN interface.

## RS485 Communication

The GBL2xxx has a half-duplex RS485 interface. Two signals are present on the 25-pin DSub connector for connecting to RS485 networks. Connecting these two wires with the correct polarity is all that is needed to establish a connection. The RS485+ is the positive signal and RS485- is the inverted signal. Once enabled, the RS485 can be used to communicate data under the Modbus protocol, or Roboteq's native serial commands.

## Important Note

**In some models, RS485 communication requires two 10 kΩ resistors to be connected to the A and B signals of the bus as follows:**

- **One resistor should be connected from the A signal to the controller's 5V output.**
- **One resistor should be connected from the B signal to the controller's ground.**

## Ethernet Communication

Ethernet communication is only available on the E versions of the controller. The connection port is located on the top of the unit for easy and rapid access. Communication occurs via TCP/IP. Commands can be in Serial over TCP and Modbus TCP. Serial over TCP is the preferred method to access all native commands.

Two LEDs are present on the Ethernet jack, as shown in Figure 13. The left Yellow LED will be On when operating as 100 Mbps connection and Off when as 10 Mbps. The right Green LED will blink when data activity is present.

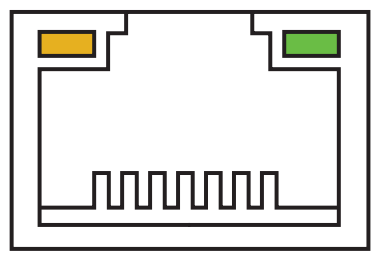


FIGURE 11. Ethernet LED Configuration

## Status LED Flashing Patterns

After the controller is powered on, the Power LED will tun on, indicating that the controller is On. The Status LED will be flashing at a 2 second interval. The flashing pattern and color provides operating or exception status information.

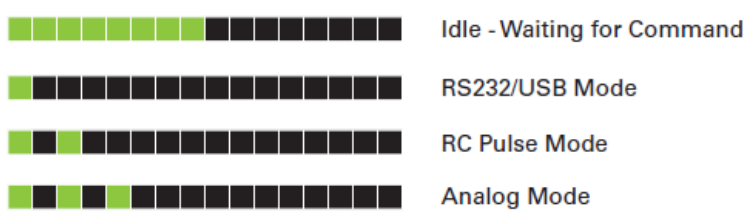



FIGURE 12. Normal Operation Flashing Patterns

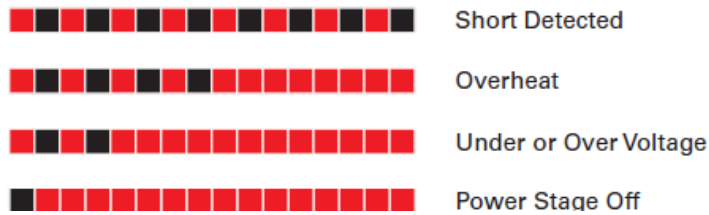



FIGURE 13. Exception or Fault Flashing Patterns

Additional status information may be obtained by monitoring the controller with the PC utility.

The communication LED gives status information on the CAN and USB.

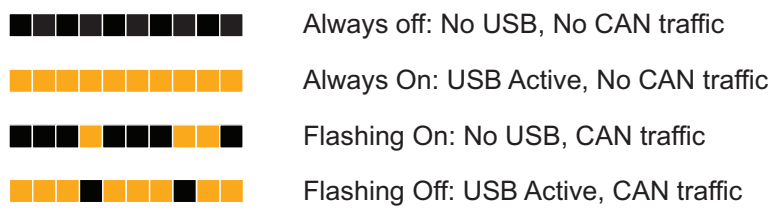



FIGURE 14. Communication LED Flashing Patterns

## Battery Backed Clock and Variables

The controller includes a real-time clock/calendar and RAM storage for user variables. Both the clock and the RAM storage require a battery to continue running and for the stored data not to be lost while the controller is powered down. The battery is not installed by Roboteq. Users who wish to use the clock and/or battery backed RAM variables must install a battery themselves. The battery socket can be reached by removing the 6 screws that are holding the cover. Lift the cover to reach the board and insert a 3V, 12.5mm coin-style battery. Use battery type CR1225 or equivalent.

## Measured Amps

The controller includes Amps sensors in line with the motor terminals and on the battery ground terminals. Both Motor Amps and Battery Amps are therefore measured with precision.

# Electrical Specifications

## Absolute Maximum Values

The values Table 6, below, should never be exceeded, permanent damage to the controller may result.

TABLE 6.

| Parameter | Measure point | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Reverse Voltage on Battery Leads | Ground to VBat | -1 | | | Volts |
| Power Control Voltage | Ground to Pwr Control wire | | | 63 | Volts |
| Motor Leads Voltage | Ground to U, V, W wires | | | 63 (1) | Volts |
| Digital Output Voltage | Ground to Output pins | | | 60 | Volts |
| Analog and Digital Inputs Voltage | Ground to any signal pin on 15-pin & Hall inputs | | | 30 | Volts |
| RS232 I/O pins Voltage | External voltage applied to Rx/Tx pins | | | 30(2) | Volts |
| Case Temperature | Case | -40 | | 85 | ºC |
| Humidity | Case | | | 100 (2) | % |
| Note 1: Maximum regeneration voltage in normal operation. Never inject a DC voltage from a battery or other fixed source | | | | | |
| Note 2: No voltage must be injected on TxD pin | | | | | |

## Power Stage Electrical Specifications (at 25ºC ambient)

TABLE 7.

| Continuous Max Current per channel | Measure point | Model | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Battery Leads Voltage | Ground to VBat | GBL2660x | 0 (1) | | 63 | Volts |
| | | GBL26120x | 0 (1) | | 120 | Volts |
| Motor Leads Voltage | Ground to U, V, W wires | All | 0 (1) | | 63 (2) | Volts |
| Power Control Voltage | Ground to Power Control wire | All | 0 (1) | | 65 | Volts |
| Minimum Operating Voltage | VBat or Pwr Ctrl wires | All | 9 (3) | | | Volts |
| Over Voltage protection range | Ground to VBat | All | 5 | 60 (4) | 63 | Volts |
| Under Voltage protection range | Ground to VBat | All | 0 | 5 (4) | 63 | Volts |
| Idle Current Consumption | VBat or Pwr Ctrl wires | All | 50 | 100 (5) | 150 | mA |
| ON Resistance (Excluding wire resistance) | VBat to U, V or W. Ground to U, V or W | GBL2660 | | 1.2 | | mOhm |
| | | GBL2660S | | 0.6 | | mOhm |
| | | GBL26120 | | 2.4 | | mOhm |
| | | GBL26120S | | 1.2 | | mOhm |
| Max Current for 30s | Motor current | GBL2660 | | | 180 | Amps |
| | | GBL2660S | | | 360 | Amps |
| | | GBL26120 | | | 135 | Amps |
| | | GBL26120S | | | 270 | Amps |

TABLE 7.

| Continuous Max Current per channel | Measure point | Model | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Continuous Max Current per channel | Motor current | GBL2660 | | | 120 (6) | Amps |
| | | GBL2660S | | | 240 (6) | Amps |
| | | GBL26120 | | | 100 | Amps |
| | | GBL26120S | | | 200 | Amps |
| Current Limit range | Motor current | GBL2660 | 10 | 120 (7) | 180 | Amps |
| | | GBL2660S | 20 | 240 (7) | 360 | Amps |
| | | GBL26120 | 10 | 100(7) | 135 | Amps |
| | | GBL26120S | 20 | 200(7) | 270 | Amps |
| Stall Detection Amps range | Motor current | GBL2660 | 10 | 180 (7) | 180 | Amps |
| | | GBL2660S | 20 | 360 (7) | 360 | Amps |
| | | GBL26120 | 10 | 135(7) | 135 | Amps |
| | | GBL26120S | 20 | 270(7) | 270 | Amps |
| Stall Detection timeout range | Motor current | All | 1 | 500 (8) | 65000 | ms |
| Short Circuit Detection threshold (9) | Between Motor wires or Between Motor wires and round | GBL26XX | | | 330 (10) | Amps |
| | | GBL26XXS | | | 660 (10) | Amps |
| Short Circuit Detection threshold | Between Motor wires and VBat | All | No Protection. Permanent damage will result | | | |
| Motor Acceleration/Deceleration range | Motor Output | All | 100 | 500 (11) | 65000 | ms |

Note 1: Negative voltage will cause a large surge current. Protection fuse needed if battery polarity inversion is possible
Note 2: Maximum regeneration voltage in normal operation. Never inject a DC voltage from a battery or other fixed source
Note 3: Minimum voltage must be present on VBat or Power Control wire
Note 4: Factory default value. Adjustable in 0.1V increments
Note 5: Current consumption is lower when higher voltage is applied to the controller's VBat or PwrCtrl wires
Note 6: Estimate. Limited by case temperature. Current may be higher with better cooling
Note 7: Factory default value. Adjustable in 0.1A increments
Note 8: Factory default value. Time in ms that Stall current must be exceeded for detection
Note 9: Controller will stop until idle command given in case of short circuit detection
Note 10: Approximate value
Note 11: Factory default value. Time in ms for power to go from 0 to 100%

## Command, I/O and Sensor Signals Specifications

TABLE 8.

| Parameter | Measure point | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Main 5V Output Voltage | Ground to 5V pins on | 4.6 | 4.75 | 4.9 | Volts |
| 5V Output Current | 5V pins on RJ45 and DSub15 | | | 200 (1) | mA |
| Digital Output Voltage | Ground to Output pins | | | 30 | Volts |
| Output On resistance | Output pin to ground | | 0.25 | 0.5 | Ohm |
| Output Short circuit threshold | Output pin | 1.7 | | 3.5 | Amps |
| Digital Output Current | Output pins, sink current | | | 1.5 | Amps |
| Input Impedances (except DIN11-19) | AIN/DIN Input to Ground | | 53 | | kOhm |
| Digital Input 0 Level | Ground to Input pins | -1 | | 1 | Volts |
| Digital Input 1 Level | Ground to Input pins | 3 | | 30 | Volts |
| Analog Input Range | Ground to Input pins | 0 | | 5.1 | Volts |
| Analog Input Precision | Ground to Input pins | | 0.5 | | % |
| Analog Input Resolution | Ground to Input pins | | 1 | | mV |
| Pulse durations | Pulse inputs | 20000 | | 10 | us |
| Pulse repeat rate | Pulse inputs | 50 | | 250 | Hz |
| Pulse Capture Resolution | Pulse inputs | | 1 | | us |
| Minimum Pulse on or Pulse off duration | Pulse inputs | 25 | | | us |
| Frequency Capture | Pulse inputs | 100 | | 1000 | Hz |
| Encoder Frequency | | | | 200 | kHz |
| Note 1: Sum of all 5V Out outputs | | | | | |

## Operating & Timing Specifications

TABLE 9.

| Parameter | Measure Point | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Command Latency | Command to output change | 0 | 0.5 | 1 | ms |
| Maximum PWM duty cycle | Motor Output | | | 93.8 | % |
| Closed Loop update rate | Internal | | 1000 | | Hz |
| RS232 baud rate | Rx & Tx pins | | 115200 (1) | | Bits/s |
| RS232 Watchdog timeout | Rx pin | 1 (2) | | 65000 | ms |
| Note 1: 115200, 8-bit, no parity, 1 stop bit, no flow control | | | | | |
| Note 2: May be disabled with value 0 | | | | | |

## Motor Characteristics Requirement for FOC current control

For proper FOC current control and motor operation under sinusoidal commutation, it is necessary for the motor to meet a minimum load inductance, minimum load L/R and maximum electric operating speed requirements. The minimum required inductance is necessary in order to ensure low Total Harmonic Distortion (THD) of the motor current. Furthermore, to achieve proper current response and stability, the controller's current loop sampling rate will limit the minimum permissible motor time constant $\tau$=L/R and the maximum operating electric speed.

TABLE 10.

| Parameter | Input DC Voltage (V) | Value | Units |
|---|---|---|---|
| Minimum load phase inductance (1) | 12 | 25 | uH |
| | 24 | 40 | uH |
| | 48 | 60 | uH |
| | 60 | 80 | uH |
| | 96 | 110 | uH |
| | 120 | 150 | uH |
| Minimum load inductance/resistance ratio (1) | 0 - 120 | 1 | msec |
| Maximum operating electric speed (2) | 0 - 120 | 15000 | RPM |
| Note 1: Star connected three phase load considered. In case the motor phase inductance does not fulfill the above requirements (minimum phase inductance and inductance/resistance ratio) an external AC inductor with proper inductance value is recommended to be added.<br>Note 2: Maximum rotor speed is calculated from the maximum operating electric speed and pole pairs. For example, in a motor with 4 pole pairs the maximum operating rotor speed is 15000/4 = 3750 rpm | | | |

## Scripting

TABLE 11.

| Parameter | Measure Point | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Scripting Flash Memory | Internal | | 32000 | | Bytes |
| Integer Variables | Internal | | 4096 | | Words (1) |
| Boolean Variables | Internal | | 8192 | | Symbols |
| Execution Speed (2) | Internal | 30,000 | | 70,000 | Lines/s |
| Note 1: 32-bit words<br>Note 2: Execution Speed was calculated based on low communication load with the controller. In high communication workload, minimum time might be reduced drastically. | | | | | |

## Thermal Specifications

TABLE 12.

| Parameter | Measure Point | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Case Temperature | Case | -40 | | 85 (1) | °C |
| Thermal Protection range | Case | 80 | | 90 (2) | °C |
| Power Dissipation | Case | | | 70 | Watts |
| Thermal resistance | Power MOSFETs to case | | | 0.6 | °C/W |
| Humidity | Case | | | 100(3) | % |
| Note 1: Thermal protection will protect the controller power | | | | | |
| Note 2: Max allowed power out starts lowering at minimum of range, down to 0 at max of range | | | | | |

## Mechanical Specifications

TABLE 13.

| Parameter | Measure Point | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Weight | Board | | 2940 (6.5) | | g (lbs) |
| Power Terminals | Terminal | | M6 | | |
| Torque | D-sub standard connector | | 0.4 (3.54) | | Nm (in-lbs) |
| Torque | Terminal block | | 0.8 (7.10) | | Nm (in-lbs) |
| Torque | Mounting screws (4/M2.5) | | 0.36 (3.2) | | Nm (in-lbs) |

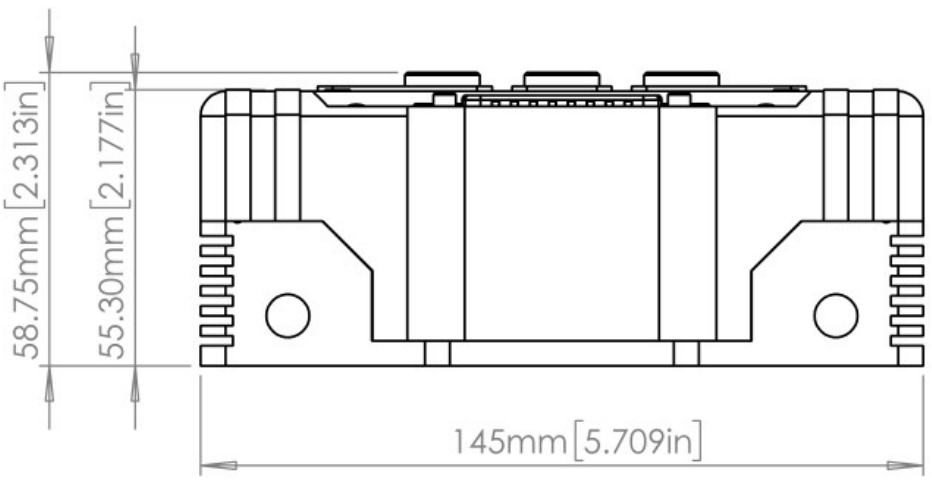



FIGURE 15. Gbl26xx side view

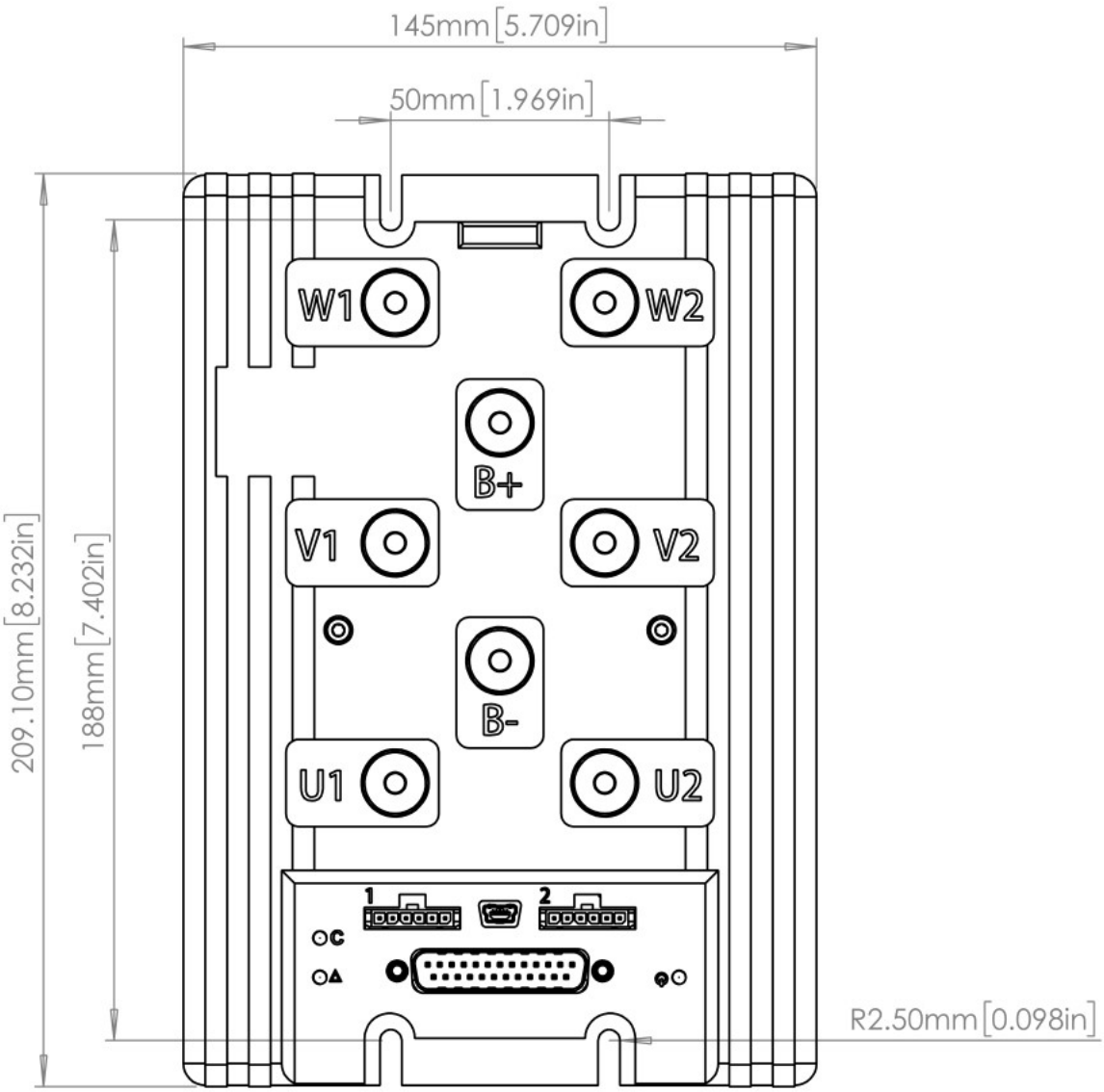



FIGURE 16. GBL26xx top view