

Preliminary - Subject to Change

300A, 72/96V Single Channel Brushless DC Motor Controller



Roboteq's GBL18xx is a very high-current, features-packed motor controller for brushless DC motors. The controller can operate in one of several modes in order to sense the rotor position and sequence power to the motors' 3 windings in order to generate smooth continuous rotation. The controller also uses the Hall sensor and/or Encoder information to compute speed and measure travelled distance inside a 32-bit counter.

The motors may be operated in open or closed loop speed mode, position mode or in torque mode. The GBL18xx features an Analog, and several Digital and Pulse I/Os which can be remapped as command or feedback inputs, limit switches, or many other functions. The GBL18xx accepts commands received from an RC radio, Analog potentiometer, wireless modem, or microcomputer. Using CAN bus, up to 127 controllers can be networked at up to 1Mbit/s on a single twisted pair.

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 realtime 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

- Electric vehicles
- Personnel carriers
- Golf cars
- Materials handling equipment
- Electric boats
- Automatic Guided Vehicles
- Agricultural robots

Features List

- 0-5V Analog, TTL Serial, or Pulse (RC radio) command modes
- CAN bus interface up to 1Mbit/s with multiple protocol support
- Auto switch between serial, Analog, or Pulse based on user-defined priority
- Built-in dual 3-phase high-power drivers for one brushless DC motor at up to 300A
- Full forward & reverse control. Four quadrant operation. Supports regeneration
- Operates from a single power source
- Programmable current limit up to 300A for protecting controller, motors, wiring and battery
- Built-on fuse
- Connector for Hall Sensors
- Multiple Motor Operating mode
 - Trapezoidal with Hall Sensors
 - Sinusoidal with Encoders
 - Sinusoidal with Hall Sensors
- Efficient Field Oriented Control (FOC) in sinusoidal modes
- Accurate speed and Odometry measurement using Hall Sensor data
- One Analog Input for use as command and/or feedback
- One Pulse Width, Duty Cycle or Frequency Inputs for use as command and/or feedback
- Up to 5 Digital Inputs for use as Deadman Switch, Limit Switch, Emergency stop or user inputs
- Quadrature Encoder input with 32-bit counter
- Built-in Programming language for automatic operation and/or customized functionality
- 1 general purpose 1A 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 Encoder 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
- Precise speed and position control when Encoder feedback is used
- Torque mode
- PID control loop
- Configurable Data Logging of operating parameters on Serial Output for telemetry or analysis
- Built-in Battery Voltage and Temperature sensors
- Regulated 5V output for powering Encoders, RC radio, RF Modem or microcomputer
- Programmable acceleration and deceleration
- Programmable maximum forward and reverse power
- Ultra-efficient 0.7 mOhm ON resistance MOSFETs
- Stall detection and selectable triggered action if Amps is outside user-selected range
- Overvoltage and Undervoltage protection
- Programmable Watchdog for automatic motor shutdown in case of command loss
- Overtemperature protection
- Diagnostic LED
- Efficient heat sinking using conduction bottom plate
- Dustproof and weather resistant. IP56 NEMA rating
- Power wiring via high amperage power terminals
- 5.51" (140mm) L, 7.87" (200mm) W, 2.28" (58mm) H
- -40° to +85° C operating environment
- 5.0lbs (2.3kg)
- Easy configuration, tuning and monitory using provided PC utility
- Field upgradeable software for installing latest features via the internet

Orderable Product References

TABLE 1.

Reference	Number of Channels	Amps/Channel	Volts
GBL1872	1	300	72
GBL1896	1	250	96

Accessories References

TABLE 2.

Reference	Description
GBL18-USB	USB Cable with adapter
GBL18-IO	Cable with 30-pin connector for IO and Hall Sensors

Important Safety Disclaimer

Dangerous uncontrolled motor runaway condition can occur for a number of reasons, including, but not limited to: command or feedback wiring failure, configuration error, faulty firmware, errors in user script or user program, or controller hardware failure.

The user must assume that such failures can occur and must make his/her system safe in all conditions. Roboteq will not be liable in case of damage or injury as a result of product misuse or failure.

Power Wires Identifications and Connection

Power connections are made by means of high amperage power terminals located at the top of the controller.

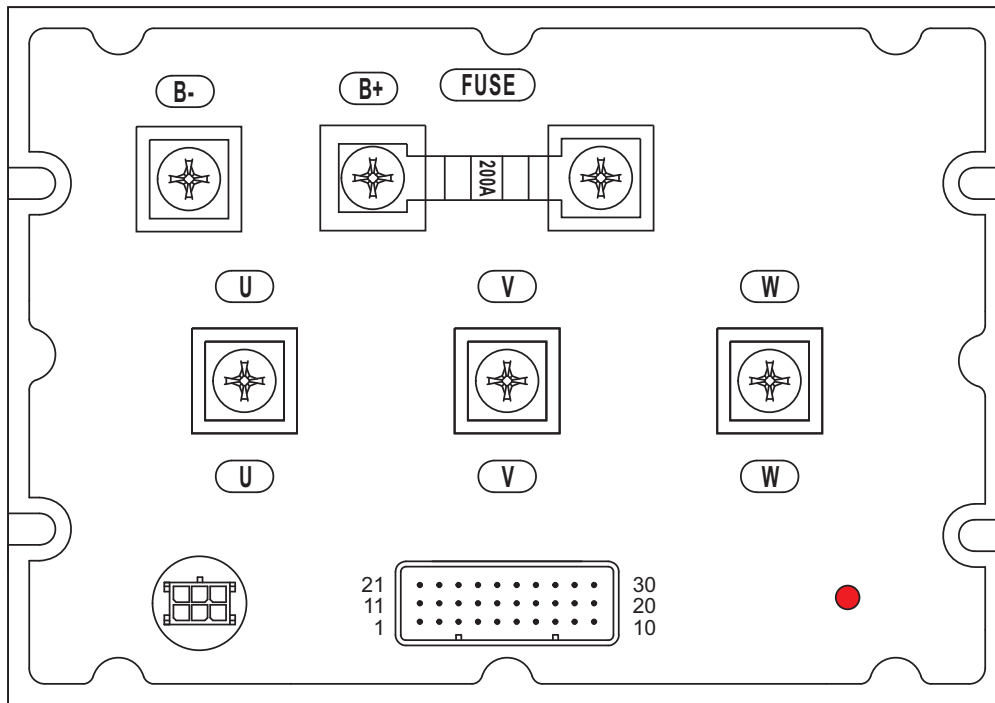


FIGURE 8. Top Controller Layout

The diagram below shows how to wire the controller and how to turn power On and Off.

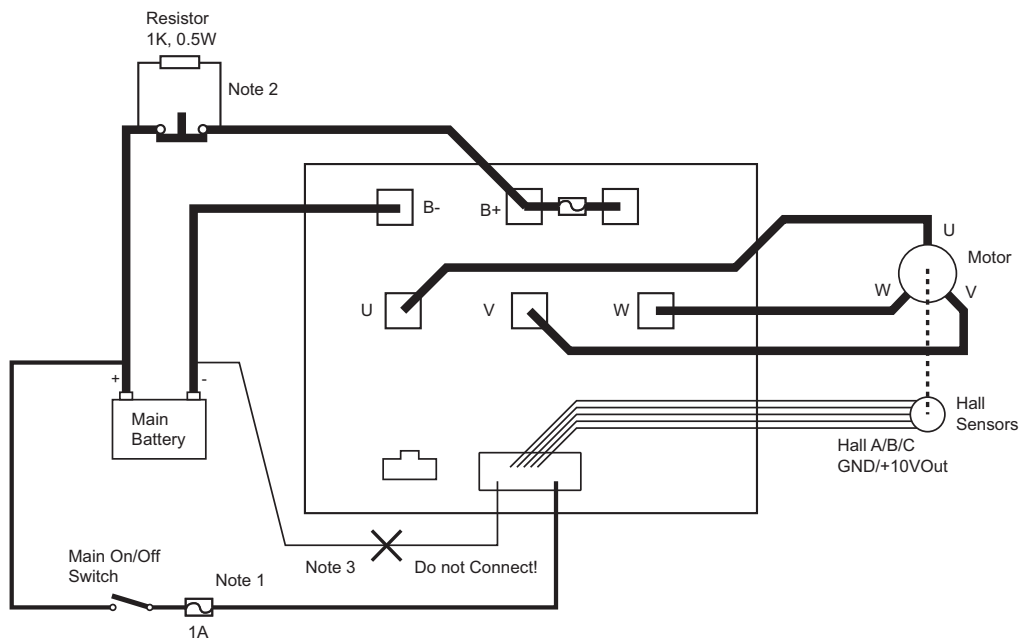


FIGURE 9. Powering the controller. Thick lines identify **MANDATORY** connections

Important Warning

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 the above diagram in order to ensure a safe and trouble-free operation. All connections shown as thick black lines are mandatory. The controller must be powered On/Off using switch SW1.

Emergency Switch or Contactor

The battery must be connected in permanence to the controller's B+ terminal 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.

Precautions and Optional Connections

Note 1: A separate power supply may be used to power the controller's internal logic to keep the controller alive in case of voltage drop because of motor load.

Note 2: Use precharge 1K, 0.5W Resistor to prevent switch arcing.

Note 3: Beware not to create a path from the ground pins on the I/O connector and the battery minus terminal.

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. Always operate the controller in a well ventilated space so

that air can flow around the unit. Additional conduction cooling can be achieved by having the bottom side of the case making contact with a metallic surface (chassis, cabinet).

Sensor and Commands Connection

Connection to RC Radio, Microcomputer, Potentiometer and other low current sensors and actuators is done via the 30 and 6 pin connectors located at the top of the controller. The functions of many pins vary depending on controller model and user configuration. Pin assignment is found in the tables below,

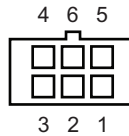


FIGURE 10. 6-pin connector S1

TABLE 4.

Pin Number	6	5	4
Signal	Res	Res	Res

TABLE 5.

Pin Number	3	2	1
Signal	TxD	RxD	GND

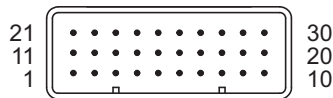


FIGURE 11. 30-pin main connector S2

TABLE 6.

Pin Number	21	22	23	24	25	26	27	28	29	30
Signal	GND	Res	Res	Res	Res	AGND	AIN1	5VOut	5VOut	DIN/RC1

Pin Number	11	12	13	14	15	16	17	18	19	20
Signal	HA/EncA	HB/EncB	HC	H+	Res	DINRC3	DIN5/EncB	DOut	DIN4/EncA	Res

Pin Number	1	2	3	4	5	6	7	8	9	10
Signal	CANL	CANH	Temp	GND	GND	GND	Res	GND	Res	VBat

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 below.

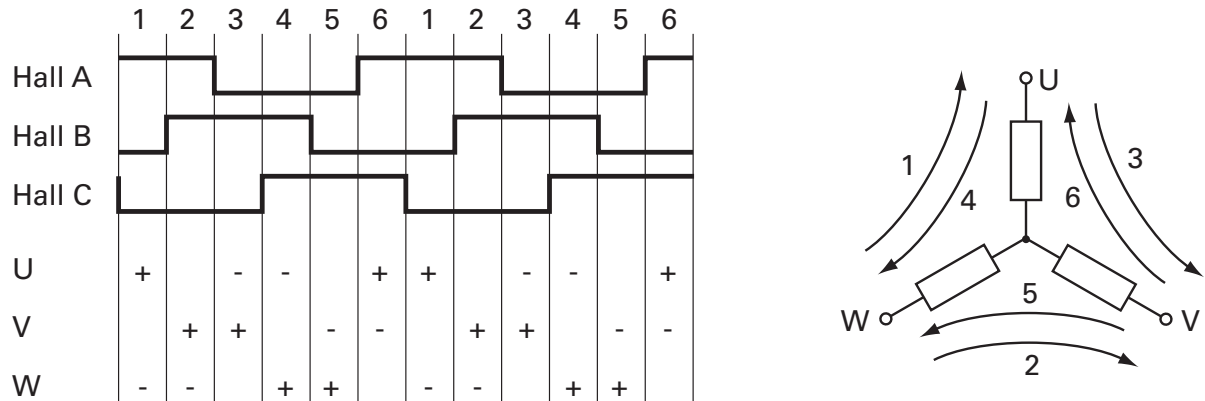


FIGURE 12. Hall Sensors sequence

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. Use the PC utility to enable and assign analog inputs.

CAN Bus Operation

The controller can interface to a standard CAN Bus network, using 4 possible protocols: Standard CANOpen, a simple and efficient meshed networking scheme (RoboCAN), and two simplified proprietary schemes (MiniCAN and RawCAN). Please refer to the User Manual for details.

Serial Communication

The serial interface uses non-inverted TTL signals. An external TTL to RS232 adapter must be used if communication to RS232 is required. Use the Roboteq USB to serial cable adapter for connection to a PC.

Status LED Flashing Patterns

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



FIGURE 13. Normal Operation Flashing Patterns

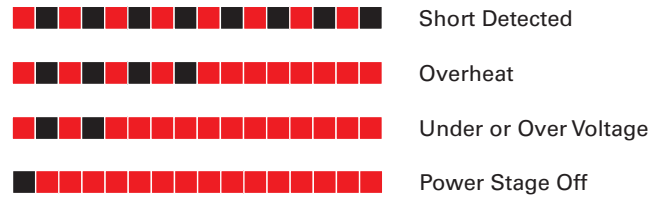


FIGURE 14. Exception or Fault Flashing Patterns

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

Electrical Specifications

Absolute Maximum Values

The values in the table below should never be exceeded, Permanent damage to the controller may result.

TABLE 7.

Parameter	Measure point	Model	Min	Typ	Max	Units
Battery Leads Voltage	Ground to VBat	GBL1872			80	Volts
		GBL1896			100	Volts
Reverse Voltage on Battery Leads	Ground to VBat	All	-1			Volts
Motor Leads Voltage	Ground to M+, M-	GBL1872			80	Volts
		GBL1896			100	Volts
Digital Output Voltage	Ground to Output pins	All			100	Volts
Analog and Digital Inputs Voltage	Ground to any signal pin on I/O connectors	All			15	Volts
Serial I/O pins Voltage	External voltage applied to Rx/Tx pins	All			5	Volts
Temperature	Board	All	-40		85	oC
Humidity	Board	All			100 (2)	%

Note 1: Maximum regeneration voltage in normal operation. Never inject a DC voltage from a battery or other fixed source
 Note 2: Non-condensing

Power Stage Electrical Specifications (at 25oC ambient)

TABLE 8.

Parameter	Measure point	Model	Min	Typ	Max	Units
Battery Leads Voltage	Ground to VBat	GBL1872	20 (1)		80	Volts
		GBL1896	20 (1)		100	Volts
Motor Leads Voltage	Ground to M+, M-	GBL1872			80 (2)	Volts
		GBL1896			100 (2)	Volts
Over Voltage protection range	Ground to VBat	GBL1872	5	72	80 (2)	Volts
		GBL1896		96	100 (2)	Volts
Under Voltage protection range	Ground to VBat	All	20	20 (4)		Volts

TABLE 8.

Parameter	Measure point	Model	Min	Typ	Max	Units
Idle Current Consumption	VBat or Pwr Ctrl wires	All		50 (5)	100	mA
ON Resistance (Excluding wire resistance)	VBat to A/B/C , plus A/ B/C to Ground	All		1.4		mOhm
Max Current for 30s	Motor current	GBL1872			300	Amps
		GBL1896			250	Amps
Continuous Max Current	Motor current	GBL1872			200 (6)	Amps
		GBL1896			150 (6)	Amps
Current Limit range	Motor current	GBL1872	10	250 (7)	300	Amps
		GBL1896	10	200 (7)	250	Amps
Motor Acceleration/Deceleration range	Motor current	All	100	500 (8)	65000	milli-seconds

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 heatsink 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 for power to go from 0 to 100%

Command, I/O and Sensor Signals Specifications

TABLE 9.

Parameter	Measure point	Min	Typ	Max	Units
Hall Supply Voltage	Ground to Output	8.0	9.0	10	Volts
5V Out Voltage	Ground to 5V pin	5.0	5.4	5.7	Volts
5V Output Current	Output to ground			100	mA
Digital Output Voltage	Ground to Output pins			100	Volts
Digital Output Current	Output pins, sink current			1	Amps
Digital Input 0 Level	Ground to Input pins	-1		1	Volts
Digital Input 1 Level	Ground to Input pins	3		15	Volts
Analog Input Range	Ground to Input pins	0		5.1	Volts
Analog Input Precision	Ground to Input pins		0.5		%
Pulse durations	Pulse inputs	20000		10	us
Pulse repeat rate	Pulse inputs	50		250	Hz
Pulse Capture Resolution	Pulse inputs		1		us
Frequency Capture	Pulse inputs	100		10000	Hz
Encoder count	Internal	-2.147		2.147	10 ⁹ Counts
Encoder frequency	Encoder input pins			50kHz	Counts/s

Operating & Timing Specifications

TABLE 10.

Parameter	Measure Point	Min	Typ	Max	Units
Command Latency	Command to output change	0	1	2	ms
PWM Frequency	Motor outputs	10	16	20	kHz
Closed Loop update rate	Internal		1000		Hz
Serial baud rate	Rx & Tx pins		115200 (1)		Bits/s
Serial 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					

Scripting

TABLE 11.

Parameter	Measure Point	Min	Typ	Max	Units
Scripting Flash Memory	Internal		16384		Bytes
Max Basic Language programs	Internal		4000	5000	Lines
Integer Variables	Internal			1024	Words (1)
Boolean Variables	Internal			1024	Symbols
Execution Speed	Internal	50000	100000		Lines/s
Note 1: 32-bit words					

Thermal Specifications

TABLE 12.

Parameter	Measure Point	Min	Typ	Max	Units
Board Temperature	PCB	-40		85 (1)	oC
Thermal Protection range	PCB	70		80 (2)	oC
Thermal resistance	Power MOSFETs to heats sink			2	oC/W
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	Typ	Max	Units
Weight	Board		2340 (5.0)		g (lbs)
Power Terminals	Connection		M5		Thread

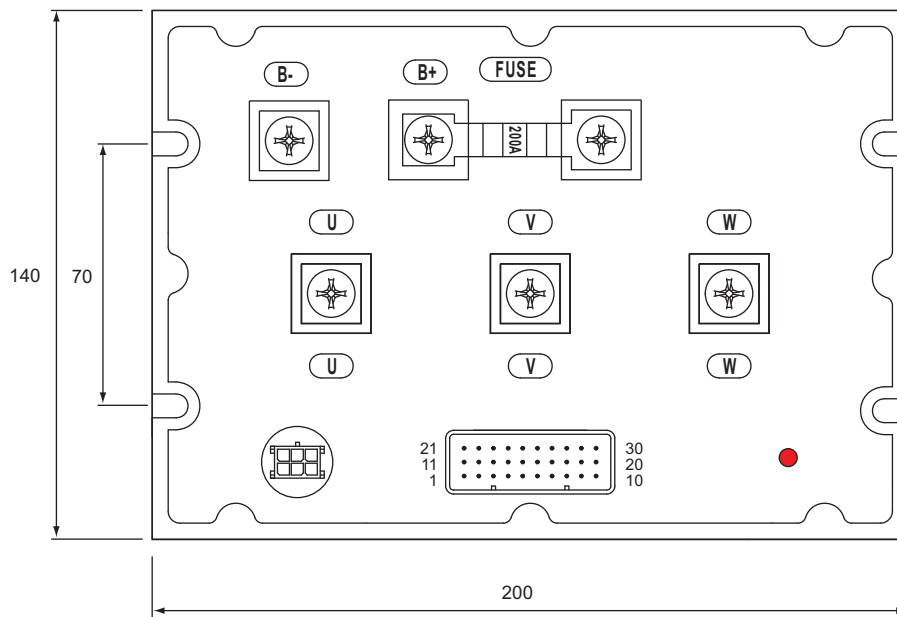


FIGURE 15. GBL18xx top view and dimensions

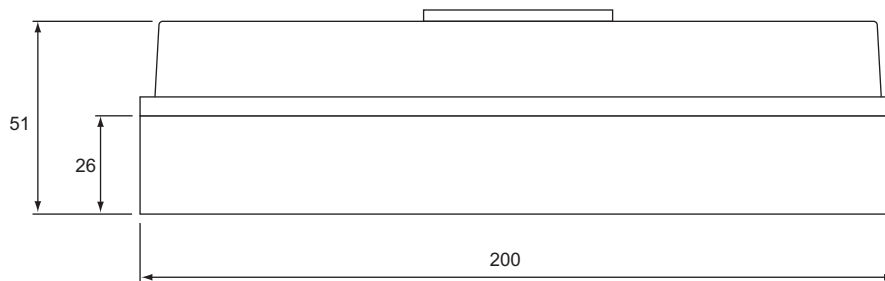


FIGURE 16. GBL18xx side view and dimensions