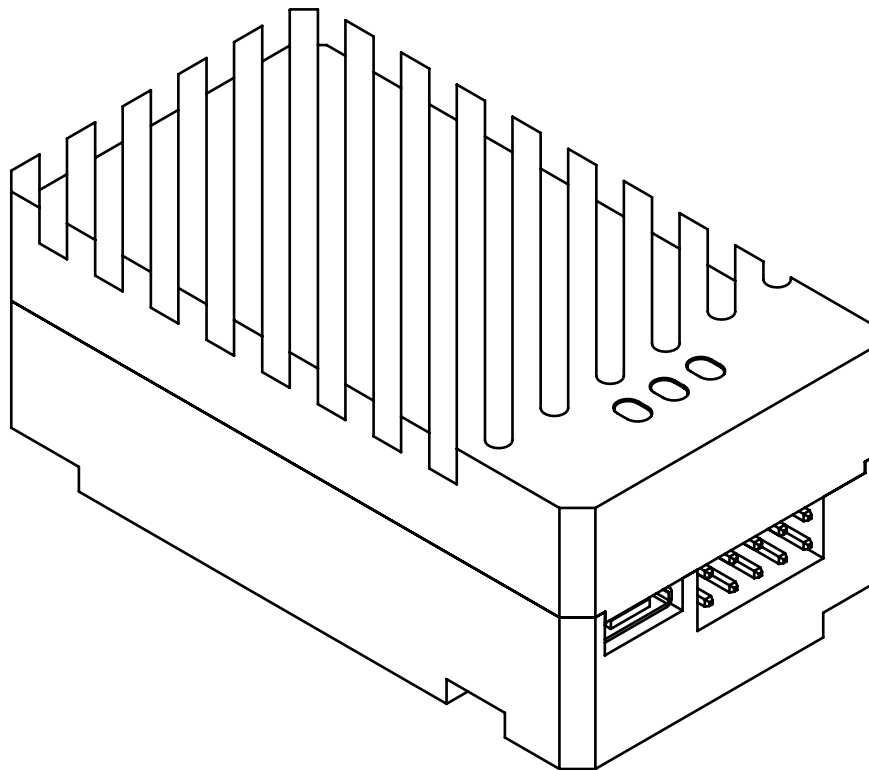# ION MOTION CONTROL

**RoboClaw Solo, 34VDC
Brushed DC Motor Controller**

Data Sheet Version 2.3

Feature Overview:

- 45 / 100 Amps Peak
- Quadrature Decoding
- 19.6 million PPS Decoding
- Multimode Interface
- TTL Serial
- USB Port
- Analog Interface
- R/C Input Control
- Up to 34VDC Operation
- Air and Conduction Cooling
- 3.3v Compliant Control Outputs
- 5v Tolerant Control Inputs
- Programmable Current Limiting
- Programmable Voltage Clamping
- Closed and Open Loop Operation
- Auto Tuning PID Feature
- Mixed Control Modes
- Data Logging
- Diagnostic LEDs
- Field Firmware Updates
- Regulated 5VDC, 1.2A User Available Output
- Over Voltage and Under Voltage Protection
- Easy Tuning, Monitor and Setup with PC utility
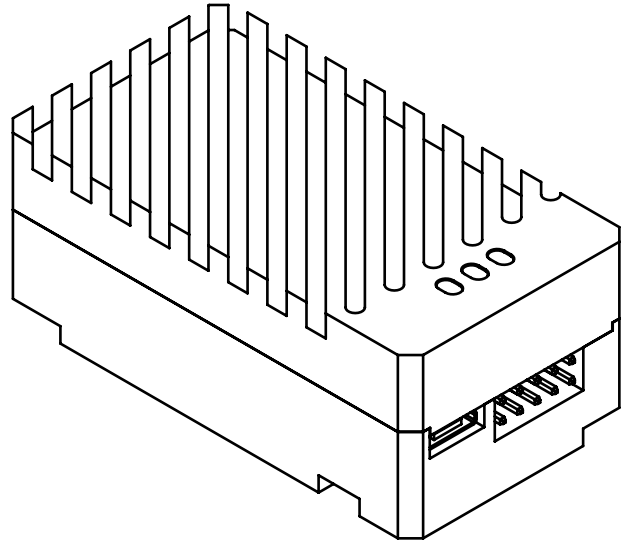
Device Overview

The RoboClaw Solo is an intelligent, high performance motor controller designed to control brushed DC motors. It can be controlled from USB, RC radio, PWM, TTL serial, analog and microcontrollers such as an Arduino or Raspberry Pi.

RoboClaw automatically supports 3.3V or 5V logic levels, travel limit switches, home switches, emergency stop switches, power supplies, braking systems and contactors. A built-in switching mode BEC supplies 5VDC at up to 1.2 Amps for powering user devices. In addition power supplies can be utilized by enabling the built in voltage clamping control feature.

A wide variety of feedback sensor are supported. This includes quadrature encoders, potentiometers and absolute encoders which can be easily configured using the available auto tune function. With sensors, a brushed DC motor can be controlled in closed loop mode allowing precise control over position and speed. With the ability to use potentiometers, servo systems can be created and controlled from any of RoboClaw's interface modes.

For greater control, built-in commands are available for controlling acceleration, deceleration, distance, speed, current sense, voltage and more. In addition, RC and analog modes can be configured by user defined settings to control acceleration and deceleration rates.

RoboClaw incorporates several protection features including temperature, current, over voltage and under voltage limits. The protection features are self monitoring and can help protect RoboClaw from damage. Several user definable settings such as maximum current limit, maximum and minimum battery voltages are provided for more refined control.

RoboClaw's regenerative capabilities will charge a supply battery during slow down or breaking. It's advance circuitry can change direction during full throttle without damage! RoboClaw also incorporates a LiPo cutoff mode to prevent battery damage.

Multi Voltage Interface

RoboClaw can interface to 3.3VDC and 5VDC logic. RoboClaws I/O output 3.3VDC for a high signal. This allows RoboClaw to interfaced with 5V or 3V with no voltage translation circuits. RoboClaw can be connected directly to a Raspberry Pi or Arduino. All of RoboClaw's inputs are internally pulled-up to prevent false triggers. Most inputs are multi functional and can be configured using the Ion Studio application.

User Regulated Power Output

RoboClaw provides regulated power for user devices. A high efficiency switching regulator supplies 5VDC at up to 1.2Amps. This voltage can be used to power external sensors, encoders, MCU and other electronics. The regulated user power is automatically current limited and thermally protected.

Main Battery

The peak operational input voltage for RoboClaw Solo is 34VDC. The maximum input voltage can not be exceeded. Fully charged batteries can exceed their rated voltage and intern exceed the connected RoboClaw maximum voltage. In addition RoboClaw is a regenerative motor controller. During periods of motor slow down regenerative voltages will be created, these voltages can peak over the RoboClaws maximum rated voltage. This can potentially cause damage.

Logic Battery

RoboClaw accepts a logic battery. The logic battery is also known as a backup battery. The user regulated power output (BEC) is by default powered from the main battery unless a logic battery is detected. The logic battery source is coupled to the main battery through a simple diode circuit. If the main battery voltage drops below the logic battery input level, the logic circuit and user regulated power output will be drawn from the logic battery.

Software

RoboClaw can be easily configured using free downloadable software. The software can be used during run time to monitor and control several operational parameters. The configuration software is available from the Ionmc.com website. It can be found in the downloads section of the site.

User Manual

This data sheet only covers model specific information and basic wiring. To properly setup and use RoboClaw refer to the RoboClaw User Manual available for download from http://www.ionmc.com.

Cooling

RoboClaw will generate heat. The maximum current ratings can only be achieved and maintained with adequate heat dissipation. The motor controller should be mounted to ensure sufficient airflow is maintained. Proper airflow will assist in dissipating heat away from the motor controller during operation. Some models of RoboClaw include built-in automatic cooling fan control which can be used to maintain continuous currents.

Emergency Stop

The motor controller should be wired using an external contactor or relay to control the main power input. A second power source should be used to power the logic section in situations where the main power will be under heavy load. Voltage drops can occur from constant full load or high speed direction changes. Voltage drop can cause logic brown outs if only a main battery is used without a logic battery.

USB

The motor controllers USB port should be used for configuration and debugging. The USB protocol is not designed for electrically noisy environments. The USB port will likely disconnect and not automatically recover during operation in electrically noisy environments. To recover from a dropped USB port, the motor controllers USB cable may require being unplugged and re-plugged in. The TTL serial control should be the preferred method of control in electrically noisy environments.

Firmware Updates

Firmware updates will be made available to add new features or resolve any technical issue. Before using RoboClaw for the first time it is recommended to update to the latest firmware. Download and install Ion Studio. Refer to the RoboClaw User Manual for updating the RoboClaw firmware.

Hardware Overview:
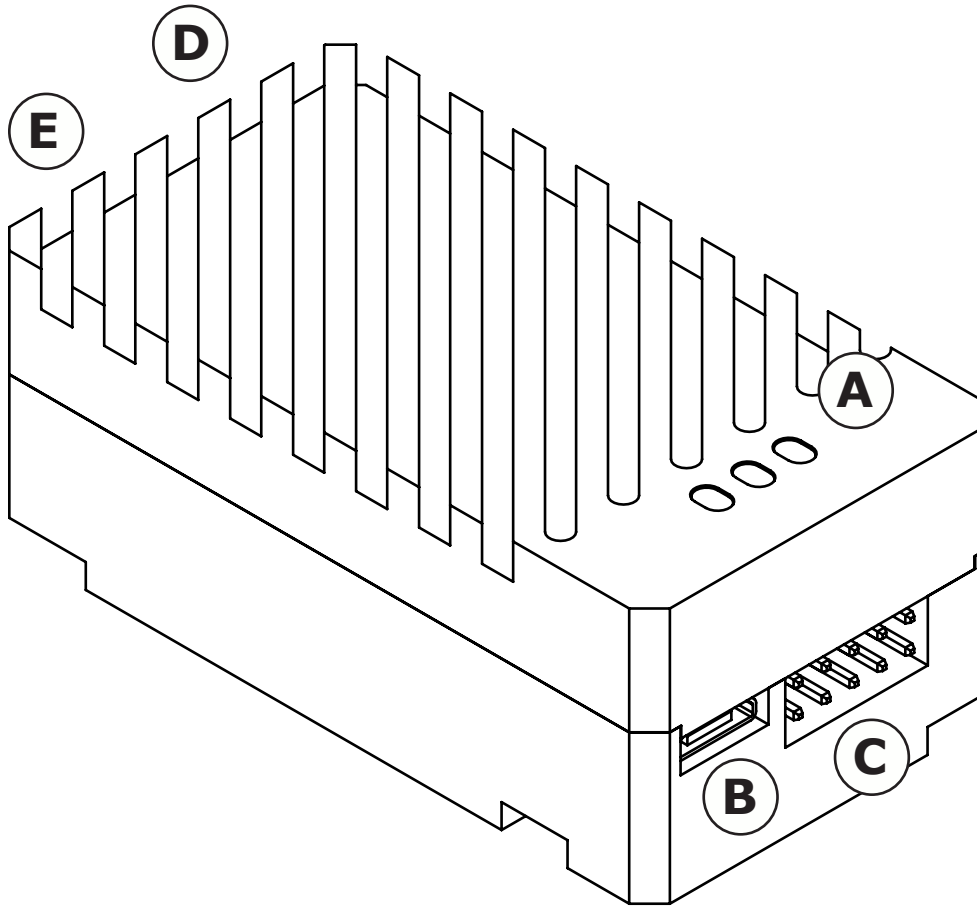
ID	Function	DESCRIPTION
A	Status LEDs	Provides RoboClaw status information.
B	USB Port	Communicate with RoboClaw via USB.
C	Control Inputs	S1,S2,S3,S4 and S5 control inputs.
D	Motor Channel 1	Motor driver output screw terminals for channel 1. Yellow and green wires.
E	Main Battery	Main battery screw terminal input. Red and black wires.

Control Interface

The RoboClaw use standard male pin headers with 0.100" (2.54mm) spacing. The pin headers are ideal for use with standard servo cables and other popular interface connectors. The table below list the pins and their respective functions. All pins are 5V tolerant and output 3.3V for compatibility with processor such as Raspberry Pi and Arduino. R/C pulse input, Analog and TTL can be generated from any microcontroller such as a Arduino or Raspberry Pi. The R/C Pulse input pins can also be driven by any standard R/C radio receiver. There are several user configurable options available. To configure RoboClaw, install Ion Studio and connect it to an available USB port.
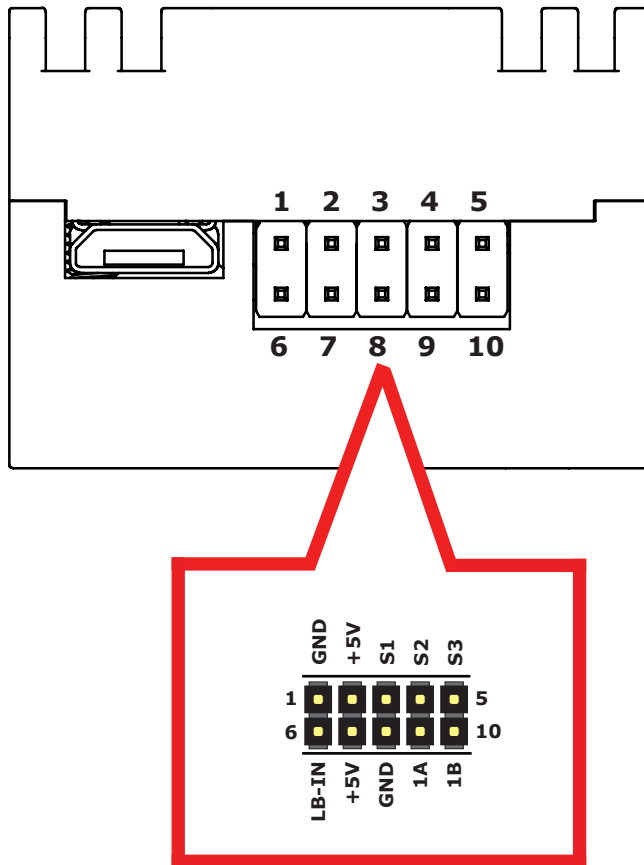
NAME	UART TTL	ANALOG	R/C PULSE	FLIP SWITCH	E-STOP	HOME	LIMIT	V-CLAMP	Encoder
S1	RX	Motor 1	Motor 1						
S2	TX	Motor 2	Motor 2	X	x				
S3				X	X	X	X	X	
1A									Motor 1
1B									Motor 1
+5V									
LB IN									

Logic Battery (LB IN)

The logic circuits of RoboClaw can be powered from a secondary battery wired to LB (Logic Battery). The logic battery will allow RoboClaw to function properly when the main battery is drained and protect against power brown outs when the main battery is under heavy load.

Encoder Inputs (1A / 1B)

The encoders input are labeled 1A and 1B. Quadrature encoder inputs are typically labeled 1A and 1B. Quadrature encoders are directional. The encoder register will count up or down depending on the direction of rotation. Use Ion Studio to determine the encoders direction to the motors rotation. Encoder channels A and B can be swapped in software using Ion Studio to avoid re-wiring the encoder or motor.

Control Inputs (S1 / S2 / S3)

S1, S2 and S3 are setup for standard servo style headers I/O, +5V and GND. S1 and S2 are the control inputs for serial, analog and RC modes. S3 can be used as a flip switch input when in RC or Analog modes. In serial mode S3 can be used as an emergency stop inputs or as voltage clamp control output. When S3 is set as an E-Stop it is active when pulled low. All I/O have internal pull-ups to prevent accidental triggers when left floating. Some RC receivers have their own supply and will conflict with the RoboClaw's 5v logic supply. It may be necessary to remove the +5V pin from the RC receivers cable in those situations.

Main Battery Wires

The main battery input rating is 6VDC to 34VDC. The RoboClaw Solo is pre-wired. The red wire is the positive (+) connection and the black is the ground (-) connections.

⚠️ ***Do not reverse main battery wires or damage will occur.***

Disconnect

The main battery should include a quick disconnect in case of a run away situation and power needs to be cut. The switch must be rated to handle the maximum current and voltage from the battery. Total current will vary depending on the type of motors used. A common solution would be an inexpensive contactor which can be source from sites like Ebay. A power diode rated for the maximum current the battery will deliver should be placed across the switch to provide a path back to the battery if disconnected while the motors are spinning. The diode will provide a path back to the battery for regenerative power even if the switch is opened.

Motor Wires

The motor wires are color coded. The green wire is M1A and the yellow wire is M2B. The motor wires should be as short as possible. Long wires can increase the inductance and therefore increase potentially harmful voltage spikes.

Control Modes

RoboClaw has 4 main functional control modes explained below. Each mode has several configuration options. The modes can be configured using Ion Studio. Refer to the RoboClaw User Manual for installation and setup instructions.

RC

Using RC mode RoboClaw can be controlled from any hobby RC radio system. RC input mode also allows low powered microcontrollers such as a Basic Stamp to control RoboClaw. Servo pulse inputs are used to control the direction and speed. Very similar to how a regular servo is controlled. RC mode can be used with encoders. Refer to the RoboClaw user manual for setup instructions.

Analog

Analog mode uses an analog signal from 0V to 2V to control the speed and direction of each motor. RoboClaw can be controlled using a potentiometer or filtered PWM from a microcontroller. Analog mode is ideal for interfacing RoboClaw with joystick positioning systems or other non microcontroller interfacing hardware. Analog mode can use encoders if properly setup(See Encoder section).

Simple Serial

In simple serial mode RoboClaw expects TTL level RS-232 serial data to control direction and speed of each motor. Simple serial is typically used to control RoboClaw from a microcontroller or PC. If using a PC, a MAX232 or an equivalent level converter circuit must be used since RoboClaw only works with TTL level inputs. Simple serial includes a slave select mode which allows multiple RoboClaws to be controlled from a signal RS-232 port (PC or microcontroller). Simple serial is a one way format, RoboClaw can only receive data. Encoders are not supported in Simple Serial mode.

Packet Serial

In packet serial mode RoboClaw expects TTL level RS-232 serial data to control direction and speed of each motor. Packet serial is typically used to control RoboClaw from a microcontroller or PC. If using a PC a MAX232 or an equivalent level converter circuit must be used since RoboClaw only works with TTL level input. In packet serial mode each RoboClaw is assigned a unique address. There are 8 addresses available. This means up to 8 RoboClaws can be on the same serial port. Encoders are support in Packet Serial mode(See Encoder section).

USB Control

USB can be used in any mode. When RoboClaw is in packet serial mode and another device, such as an Arduino, is connected commands from the USB and Arduino will be executed and can potential over ride one another. However if RoboClaw is not in packet serial mode, motor movement commands will not function. USB packet serial commands can then only be used to read status information and set configuration settings.

Wiring Basics

There are several wiring configurations for RoboClaw. Each configuration will have unique wiring requirements to ensure safe and reliable operation. The diagram below illustrates a very basic wiring configuration used in a small motor system where safety concerns are minimal. This is the most basic wiring configuration possible. All uses of RoboClaw should include some kind of main battery shut off switch, even when safety concerns are minimal. Never underestimate a system with movement when an uncontrolled situation arises.

In addition, RoboClaw is a regenerative motor controller. If the motors are moved when the system is off, it could cause potential erratic behavior due to the regenerative voltages powering the system. The regenerative voltages can will cause problems if a power supply is used to power RoboClaw. A voltage clamping circuit is required to dump the excessive voltages. See the RoboClaw user manual for voltage clamping setup and wiring diagrams.

R/C Mode

The below wiring diagram is very basic and for use with R/C mode. R/C mode can be used when pairing RoboClaw with a standard R/C receiver. R/C mode can also be used with a microcontroller and using servo pulses to control RoboClaw. The RoboClaw supplies power to the R/C system. If the R/C receiver used, has its own power the 5V pin on the 3 pin header must be remove otherwise it will interfere with RoboClaw's BEC.
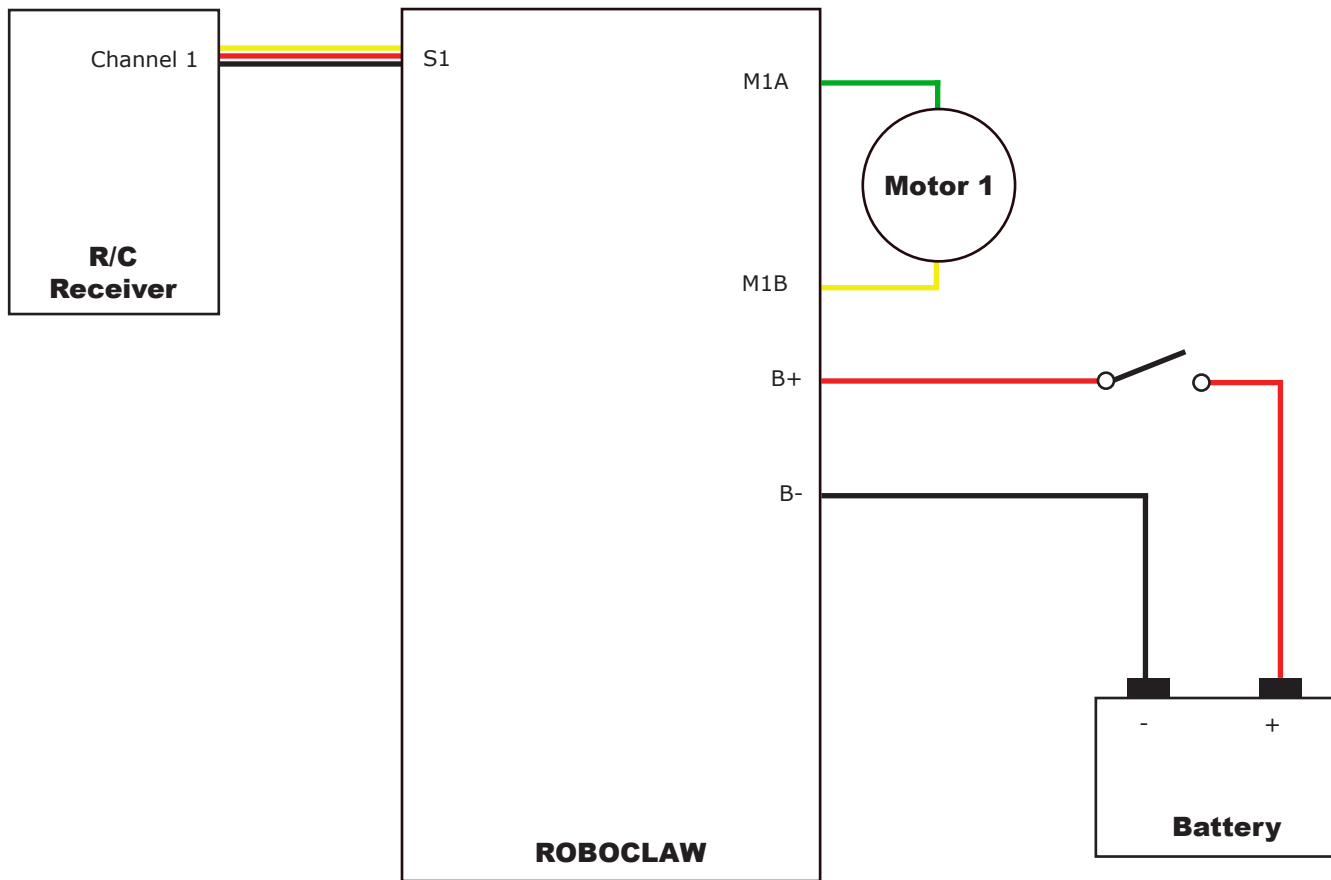
Wiring Safety

In all system with movement, safety is a concern. The wiring diagram below illustrates a properly wired system for safety. An external main power cut off is required for safety. When the RoboClaw is switched off or the fuse is blown, a high current diode (D1) is required to create a return path to the battery for any regenerative voltages. The use of a pre-charge resistor (R1) is required to avoid high inrush currents and arcing. A pre-charge resistor (R1) should be 1K, 1/2Watt for a 60VDC motor controller which will give a pre-charge time of about 15 seconds. A lower resistances can be used with lower voltages to decrease the pre-charge time.

Closed Loop Mode

A wide range of sensors are supported for closed loop operation. RoboClaw supports dual quadrature encoders (up to 19.6 million QPPS), absolute encoders, potentiometers and hall effect sensors. The wiring diagram below is an example of closed loop mode using quadrature encoders. Quadrature encoders are directional. RoboClaw's internal counters will increment for clockwise rotation (CW) and decrement for counter clockwise rotation (CCW). When wiring encoders A and B channels it is important they are wired to match the direction of the motor. If the encoder is wired in reverse it can cause a run away condition. All motor and encoder combinations will need to be tuned (see the RoboClaw user manual).
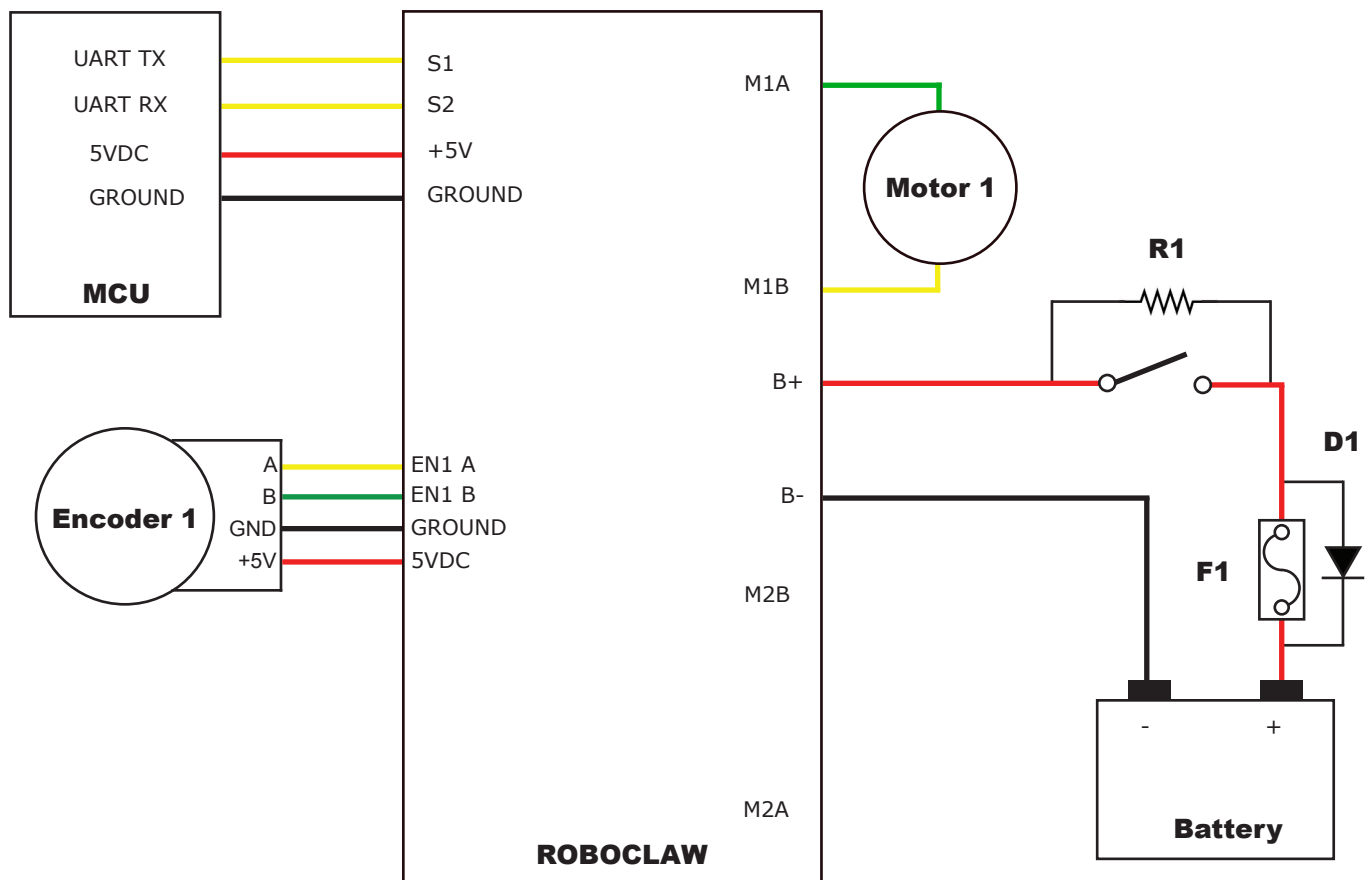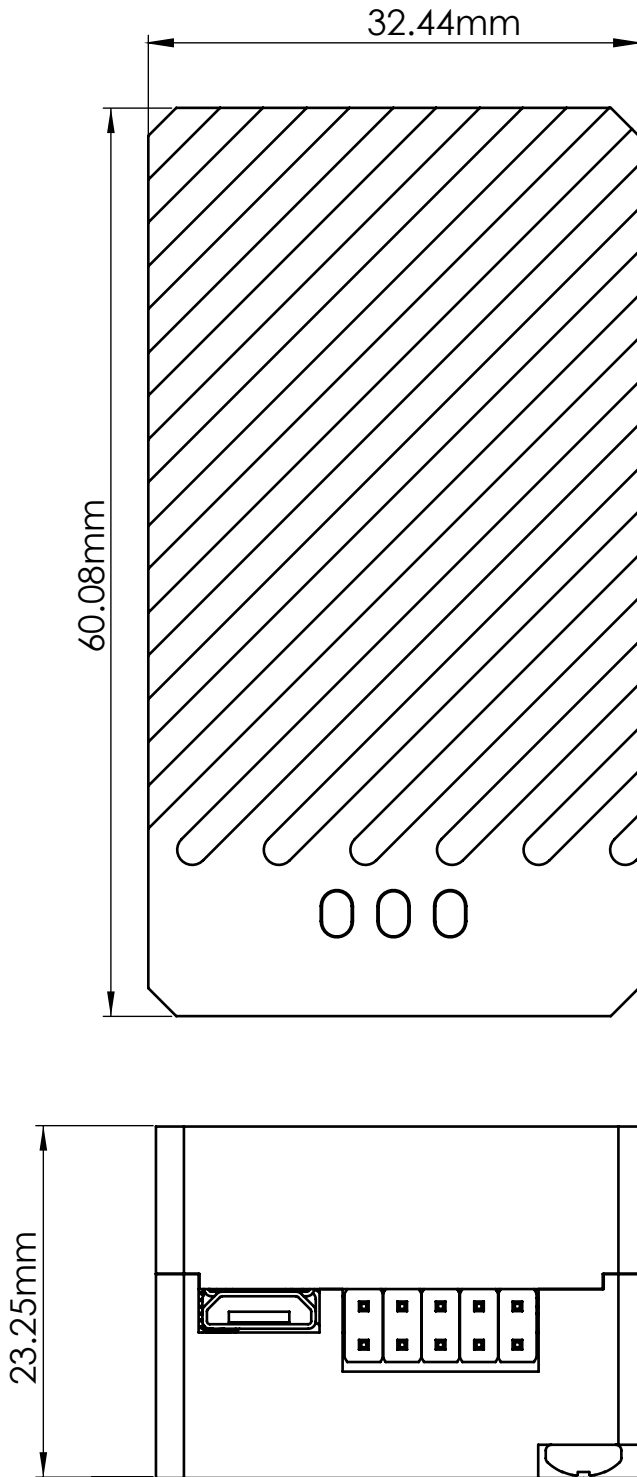
Logic Battery

An optional logic battery is supported. Under heavy loads the main power can suffer voltage drops, causing potential logic brown outs which may result in uncontrolled behavior. A separate power source for the motor controllers logic circuits, can remedy potential problems from main power voltage drops. The logic battery maximum input voltage is 34VDC with a minimum input voltage of 6VDC. The 5V regulated user output is supplied by the secondary logic battery, if supplied. The mAh of the logic battery should be determined based on the load of attached devices powered by the regulated 5V user output.
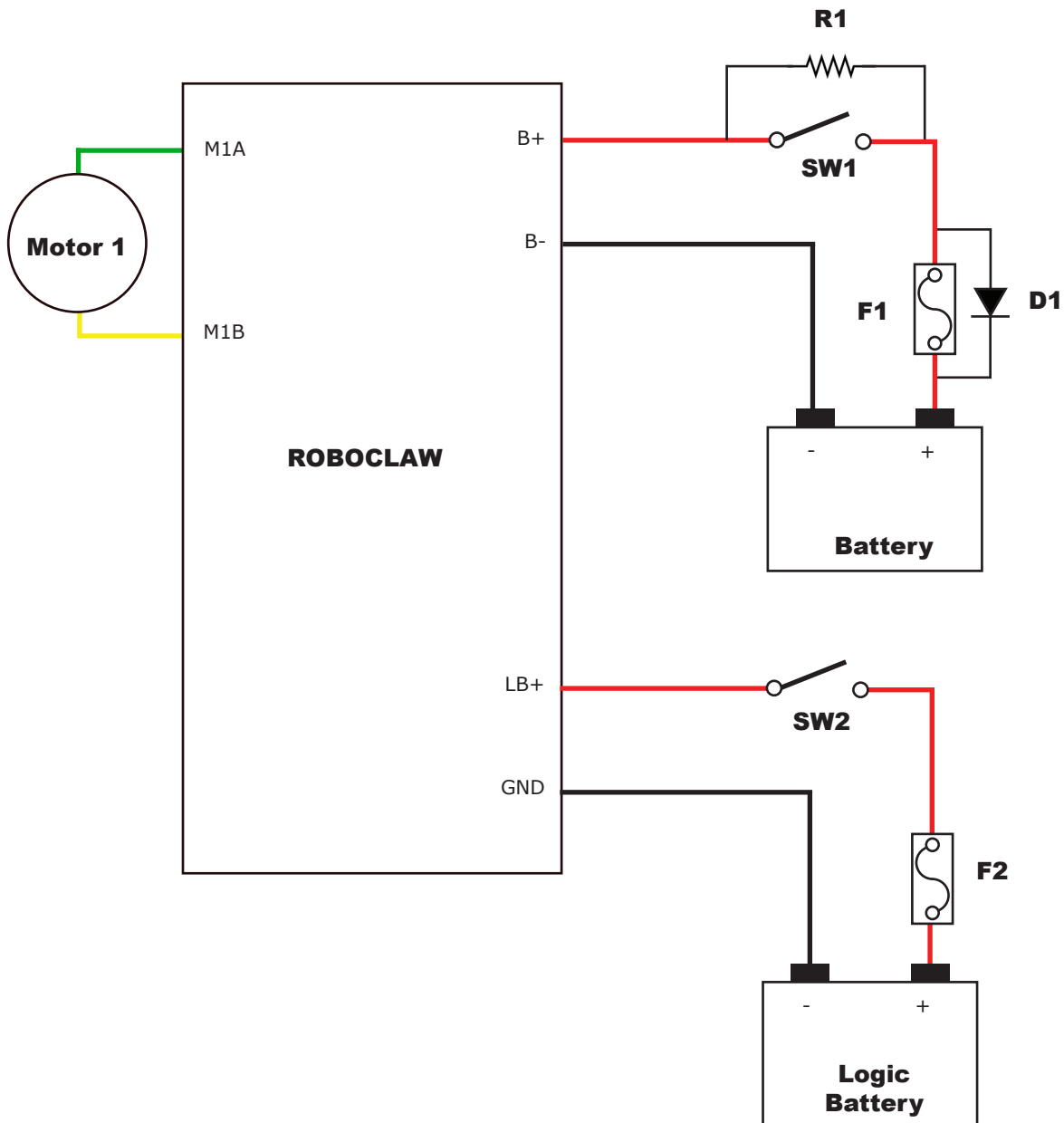
Mechanical Specifications

Characteristic	Model	Min	Typ	Max	Rating
Weight	SOLO		4.6 (130)		Oz (g)

Dimensions

Electrical Specifications

Characteristic	Model	Min	Typ	Max	Rating
Main Battery	All	6		34	VDC
Logic Battery	All	6	12	34	VDC
Maximum External Current Draw (BEC)	All			1.2	A
Motor Current Per Channel	Solo 30A		30[2]	45[1,2]	A
	Solo 60A		60[2]	100[1,2]	A
On Resistance	Solo 30A		4.3		mOhm
	Solo 60A		1.9		mOhm
Logic Circuit Current Draw	All		90mA		mA
Input Impedance	All		100		Ω
Input	All	0		5	VDC
Input Low	All	-0.3		0.8	VDC
Input High	All	2		5	VDC
I/O Output Voltage	All	0		3.3	VDC
Digital and Analog Input Voltage	All			5	VDC
Analog Useful Range	All	0		2	VDC
Analog Resolution	All		1		mV
Pulse Width	All	1		2	mS
Encoder Counters	All		32		Bits
Encoder Frequency	All			19.66	Mhz
RS232 Baud Rate (Note 3)	All			460,800	Bits/s
RS232 Time Out (Note 3)	All	10			ms
Temperature Range	All	-40	40	100	°C
Temperature Protection Range	All	85		100	°C
Humidity Range	All			100 (4)	%

Notes:
1. Peak current is automatically reduced to the typical current limit as temperature approaches 85°C.
2. Current is limited by maximum temperature. Starting at 85°C, the current limit is reduced on a slope with a maximum temperature of 100°C, which will reduce the current to 0 amps. Current ratings are based on ambient temperature of 25°C.
3. RS232 format is 8Bit, No Parity and 1 Stop bit.
4. Condensing humidity will damage the motor controller.

Warranty

Ion Motion Control warranties its products against defects in material and workmanship for a period of 1 year. If a defect is discovered, Ion Motion Control will, at our discretion, repair, replace, or refund the purchase price of the product in question. Contact us at sales@ionmc.com. No returns will be accepted without the proper authorization.

Copyrights and Trademarks

Copyright© 2017 by Ion Motion Control, Inc. All rights reserved. All referenced trademarks mentioned are registered trademarks of their respective holders.

Disclaimer

Ion Motion Control cannot be held responsible for any incidental or consequential damages resulting from use of products manufactured or sold by Ion Motion Control or its distributors. No products from Ion Motion Control should be used in any medical devices and/or medical situations. No product should be used in a life support situation.

Contacts

Email: sales@ionmc.com
Tech support: support@ionmc.com
Web: http://www.ionmc.com

Discussion List

A web based discussion board is maintained at http://www.ionmc.com

Technical Support

Technical support is available by sending an email to support@ionmc.com, by opening a support ticket on the Ion Motion Control website or by calling 800-535-9161 during normal operating hours. All email will be answered within 48 hours.