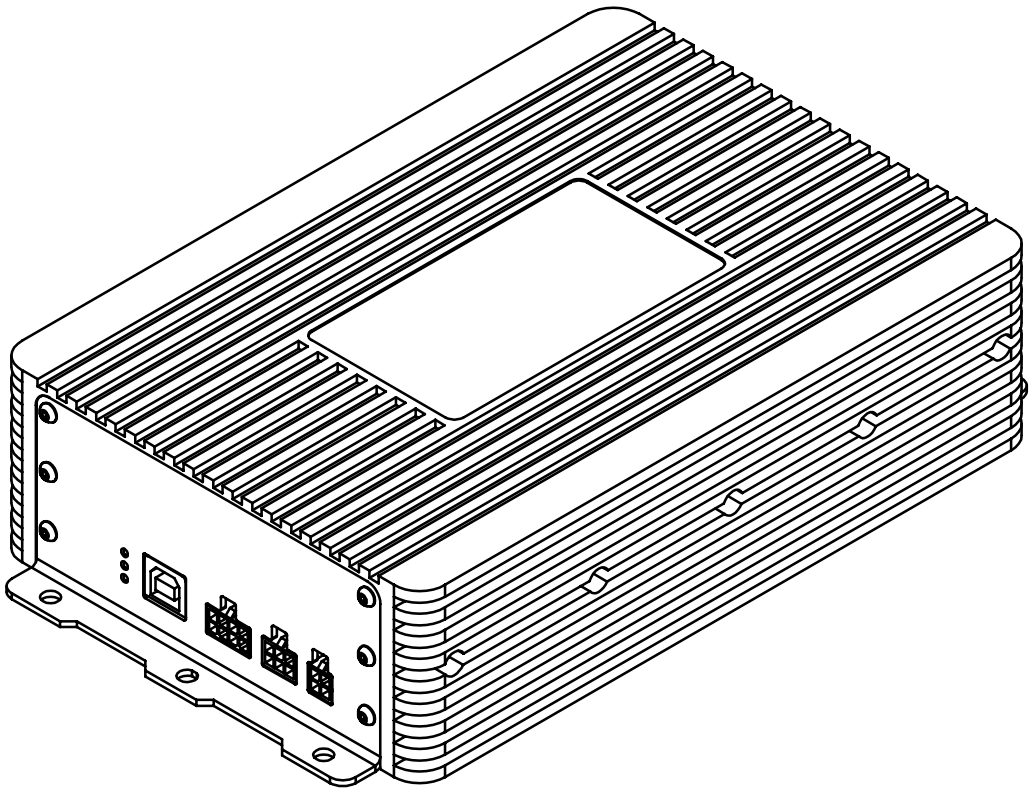
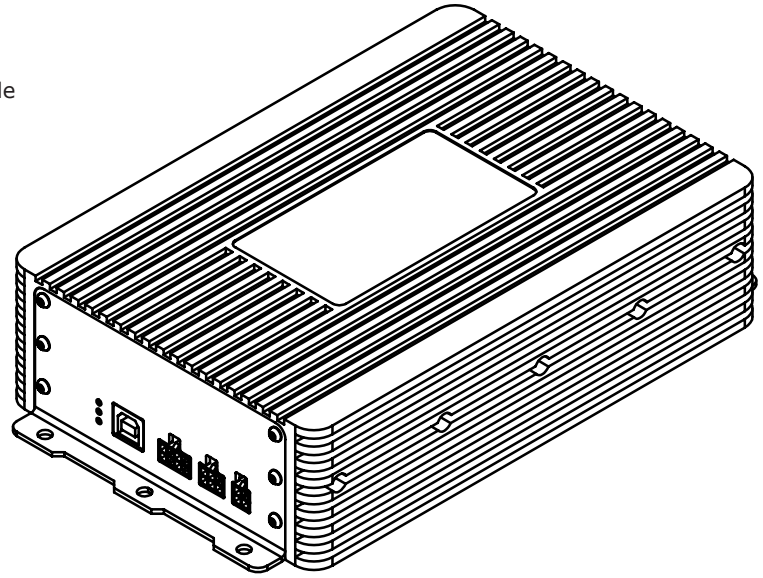
ION MOTION CONTROL



RoboClaw 2x160A, 34VDC Dual Channel
RoboClaw 2x120AHV, 60VDC Dual Channel
RoboClaw 2x160AHV, 60VDC Dual Channel
RoboClaw 2x200AHV, 60VDC Dual Channel
Brushed DC Motor Controllers

Data Sheet Version 2.1

Feature Overview:



- 120 / 160 / 200 Amps Per Channel
- 240 / 320 / 400 Amps in Bridged Channel Mode
- Dual Quadrature Decoding
- Multimode Interface
- TTL Serial
- USB Port
- Analog Interface
- R/C Input Control
- Limit, Home and E-Stops
- Up to 60VDC Operation
- Fully Enclosed
- Conduction and Air Based 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, 3A User Available Output
- Overvoltage and Under voltage Protection
- 2 General Purpose 40V, 3Amp User Controlled Outputs
- Easy Tuning, Monitor and Setup with PC utility

Device Overview

The RoboClaw is an intelligent, high performance, high power motor controller designed to control dual 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, two brushed DC motors 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 protect RoboClaw from damage in any operating condition. 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.

Multimode Interface

RoboClaw's inputs are voltage protected and can handle up to 5VDC. The inputs only output a high of 3.3V. This allows RoboClaw to be interfaced to 5V or 3V logic easily with no translation circuits required. RoboClaw can be connected directly to a Raspberry Pi or Arduino. All of RoboClaw's inputs are internally pulled-up to prevent false triggers. Inputs can also 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 3Amps. 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 depending on the model can be 34VDC, 60VDC or 80VDC. The models maximum input voltage can not be exceeded. Fully charged batteries maximum voltage must be taken into account when in used. RoboClaw is a regenerative motor controller. During regeneration, voltages can peak over the maximum rated voltage in which RoboClaw is designed to handle these over voltage spikes.

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 Ion Motion Control's software tools. The Windows based application enables users to quickly configure RoboClaw. The software can be used during run time to monitor and control several operational parameters. Ion studio is available from the Ionmc.com website. Its can be found in the downloads section of the site or listed under the production description.

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 so that sufficient airflow is provided. Which will dissipate the 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.

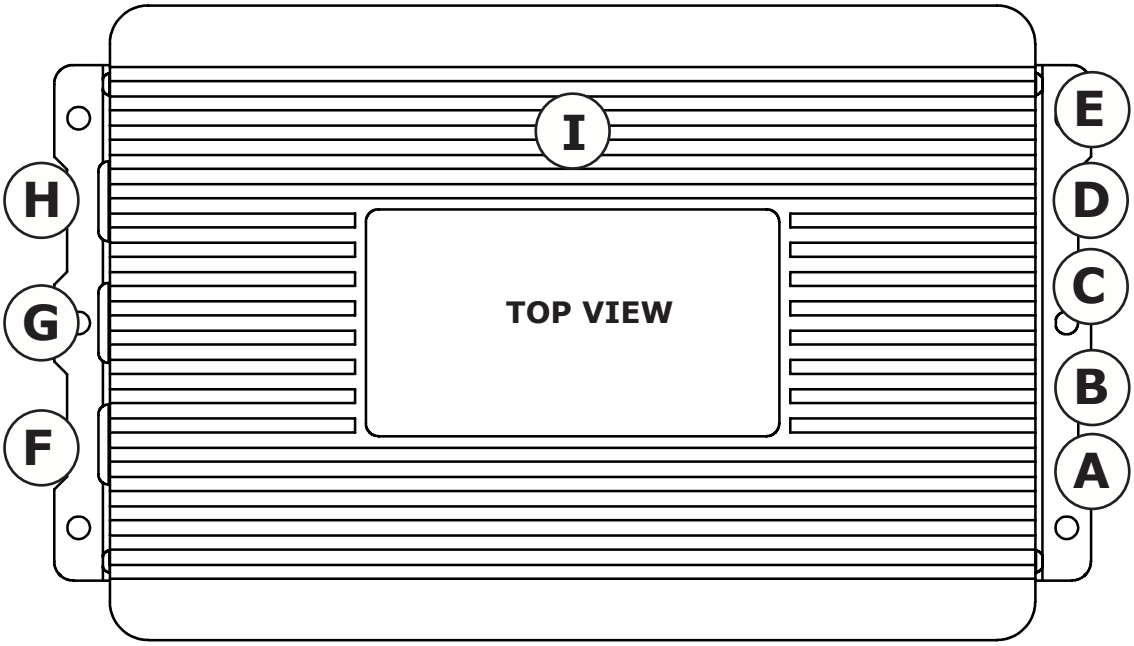
USB

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.

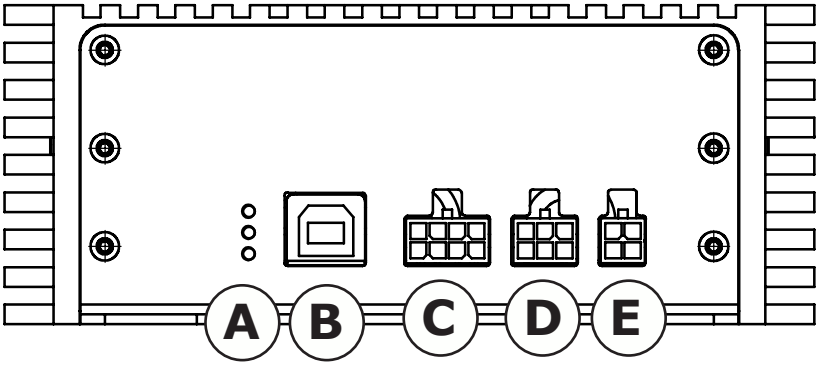
Firmware Updates

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:



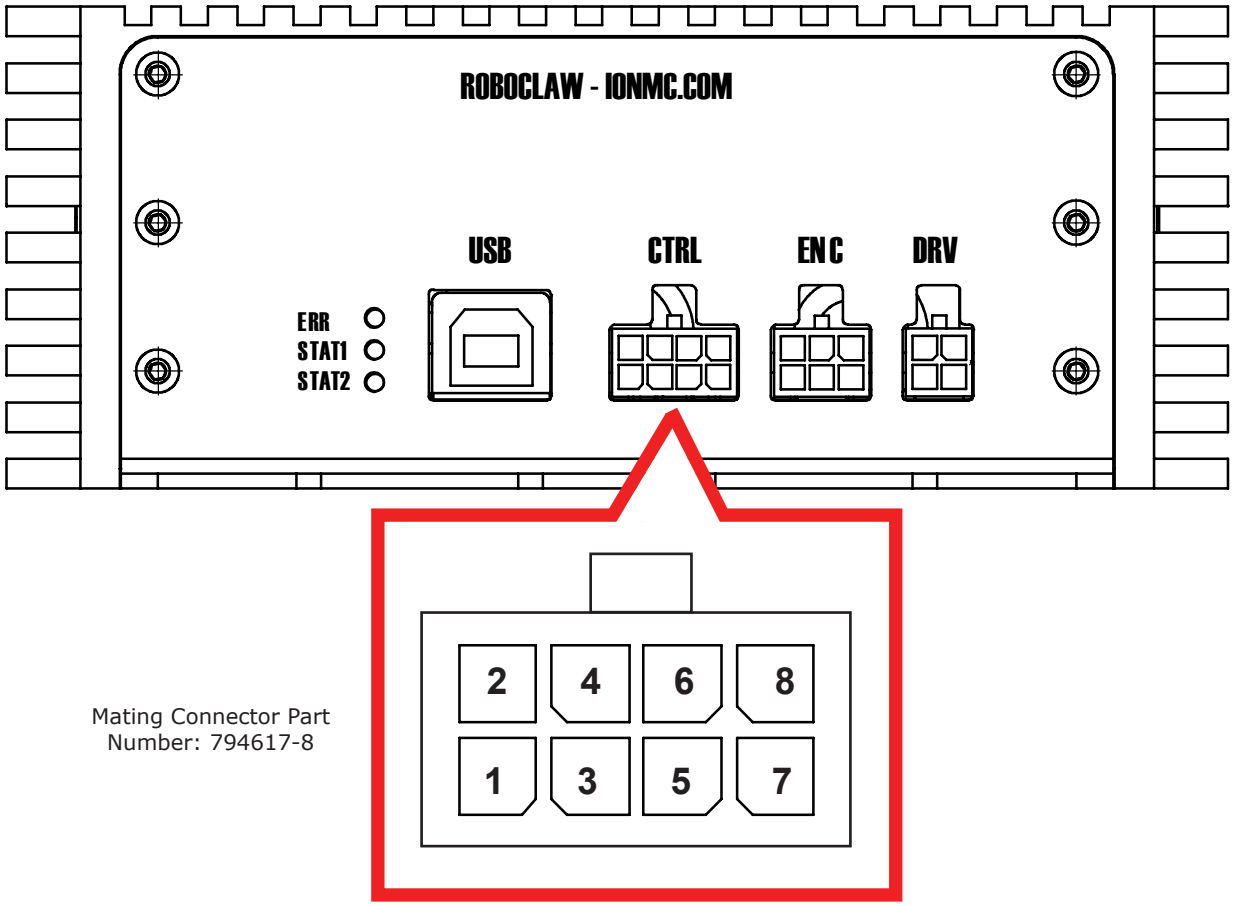
FRONT VIEW



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	Encoder Inputs	Dual encoder input and power pins.
E	Digital Ouput	High current output pins. Control contactors or relays.
F	Motor Channel 1	Motor driver output screw terminals for channel 1.
G	Main Battery	Main battery screw terminal input.
H	Motor Channel 2	Motor driver output screw terminals for channel 2.
I	Setup Buttons	Configure RoboClaw. Can bypass and use IonMotion PC setup utility.

Control Interface (CTRL)

RoboClaw 120A, 160A and 200A use Molex style female connectors. The following tables list the pins and their available functions. All pins are 5V tolerant and output 3.3V for compatibility with processor such as Rasberry Pi and Arduino. CTRL1 and CTRL2 pins are low side drivers at 40VDC, 3A per output. R/C pulse input, Analog and TTL can be generated from any microcontroller such as a Arduino or Rasberry Pi. The R/C Pulse in pins can also be driven by any standard R/C radio receiver. There are several user configurable options depending on the device used to control RoboClaw. To configure RoboClaw, install Ion Studio and connect it to an available USB port.



Mating Connector Part Number: 794617-8

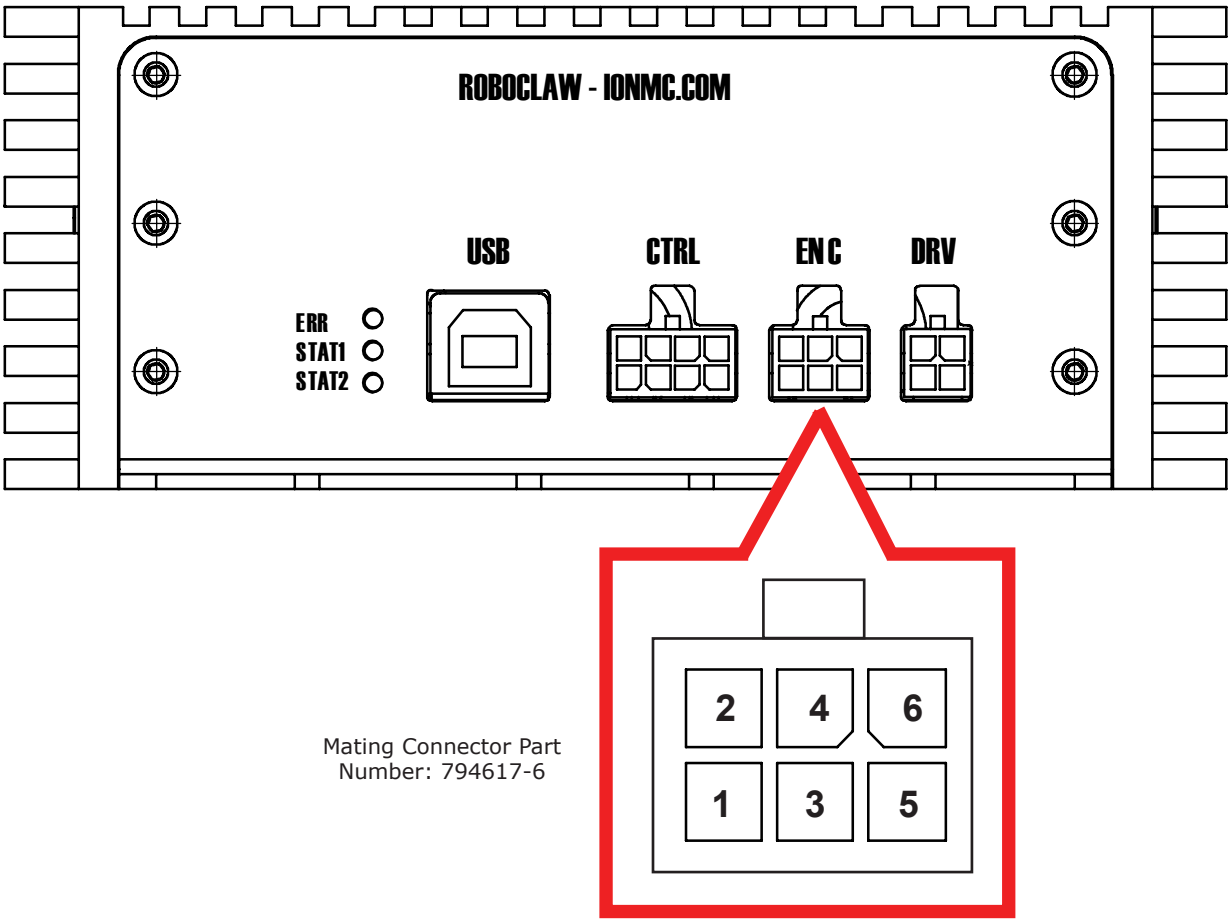
Pin	NAME	UART TTL	ANALOG	R/C PULSE	FLIP SWITCH	E-STOP	HOME	V-CLAMP
1	LB+							
2	S4					X(3)	Motor 1 (2)	X(1)
3	5V+							
4	S3				X(5)	X(3)		X(1)
5	GND							
6	S2	TX	X(4)	X(4)				
7	S5					X(3)	Motor 2 (2)	X(1)
8	S1	RX	X(4)	X(4)				

Notes:

1. Control external voltage clamp circuit. Redirect the regenerative function of RoboClaw.
2. Input can be used for home switch and automatic homing on power up.
3. Optional E-Stop input configuration. Pin state changes error will clear or board reset required.
4. Supports mixed control or individual control of motor channel.
5. Supports TTL or R/C signals

Encoders (ENC)

RoboClaw supports dual quadrature encoders with up to 19.6 million pulses per second. In addition, a wide range of sensor inputs including potentiometers and absolute encoders are supported. The encoder pins are not exclusive to supporting encoders and have several functions available. The encoder inputs were isolated on a separate connector for wiring convenience.



Mating Connector Part Number: 794617-6

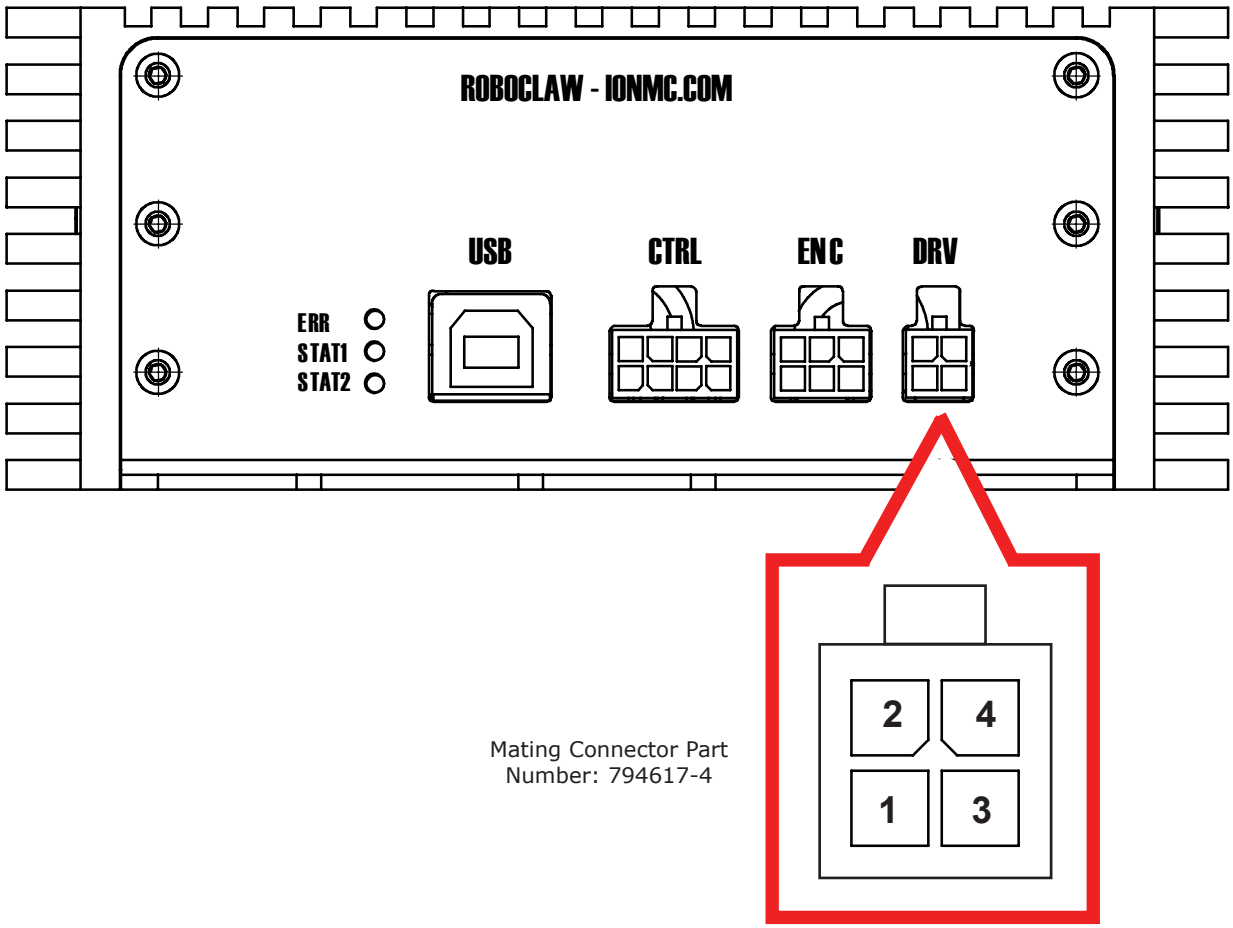
Pin	NAME	ENCODER	ABSOLUTE
1	+5V		
2	GND		
3	ENC1A	Channel 1A(1)	Channel 1(1,2)
4	ENC2A	Channel 2A(1)	Channel 2(1,2)
5	ENC1B	Channel 1B(1)	
6	ENC2B	Channel 2B(1)	

Notes:

1. Pins are 5V tolerant.
2. Absolute encoder pins are 0V to 2V analog reading range.

Digital Driver (DRV)

RoboClaw includes two general purpose 40V at 3Amp output for controlling brakes, contactors and other high load devices. The DRV pins in combination with a simple circuit can be used to regulate the regenerative function of RoboClaw allowing use of DC power supplies. The DRV pin functions can be defined using Ion Studio. They can also be setup using packet serial commands. See RoboClaw User Manual for examples.



Mating Connector Part Number: 794617-4

Pin	NAME	V-CLAMP	BRAKE	USER I/O
1	+5V			
2	CTRL1	X(1)	X(1)	X(1)
3	+5V			
4	CTRL2	X(1)	X(1)	X(1)

Notes:

1. CTRL pins can sink 3 Amps at up to 40V.

Logic Battery (LB+)

The logic circuit of RoboClaw can be powered from a secondary battery wired to LB+. A logic battery will prevent brownouts when the main battery is low or under heavy load. The positive (+) terminal is labeled LB+ and ground (-) is shared. The minimum input voltage is 6VDC and the maximum is 14VDC.

Failure to remove LB-MB jumper when a logic battery is in use, will result in damage.

Encoder Inputs (1A / 1B / 2A / 2B)

The encoders inputs are labeled ENC1 and ENC2. ENC1 is for encoder 1 and ENC2 is for encoder 2 which also correspond to motor channel 1 and motor channel 2. Quadrature encoder inputs are typically labeled 1A, 1B, 2A and 2B. Channel A of both ENC1 and ENC2 are located at the board edge on the pin header. Channel B pins are located near the heatsink on the pin header. Quadrature encoders are directional. When connecting encoders make sure the leading channel for the direction of rotation is connected to A. If one encoder is backwards to the other you will have one internal counter counting up and the other counting down. 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 / S4 /S5)

S1, S2, S3, S4 and S5 are configured for standard servo style headers I/O (except on ST models), +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, S4 and S5 can be used as emergency stops inputs or as voltage clamping control outputs. When configured as E-Stop inputs, they are active when pulled low. All I/O have internal pull-ups to prevent accidentally triggers when left floating. S4 and S5 can configured as home switch and limit switch inputs. The pins closest to the board edge are the I/0s, center pin is the +5V and the inside pins are ground. 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

The main power input can be from 6VDC to 34VDC on a standard RoboClaw and 10.5VDC to 60VDC or 80VDC on an HV (High Voltage) RoboClaw. The connections are marked **+** and **-** on the plate. The plus (**+**) symbol marks the positive wire and the negative (**-**) marks the negative wire. The main battery wires are color coded in addition to being labeled. The red wire is positive (+) and negative wire (-) is black. The main battery wires should be kept as short as possible.

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/contactor to provide a path back to the battery when 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 and labeled. M1A / M1B for channel 1 and M2A / M2B for channel 2. For a typical differential drive robot the wiring of one motor should be reversed from the other. The motor and battery 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 or the built-in buttons. 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

RoboClaw must be wired correctly to ensure safe and reliable operation. The wiring diagram below illustrates one of several possible wiring configurations. An external main power cut off solution should be incorporated for safety. Regeneration will occur if the motors are moved when the system is off causing possible erratic behavior. Use a high current diode (D1) to create a return path to the battery when the unit is switched off. Use a precharge resistor (R1) to avoid high inrush currents and arcing. A precharge resistor (R1) should be 1K, 1/2Watt for a 60VDC motor controller which will give a precharge time of about 15 seconds. A lower resistances can be used with lower voltages to decrease the precharge time.

Wiring Closed Loop Mode

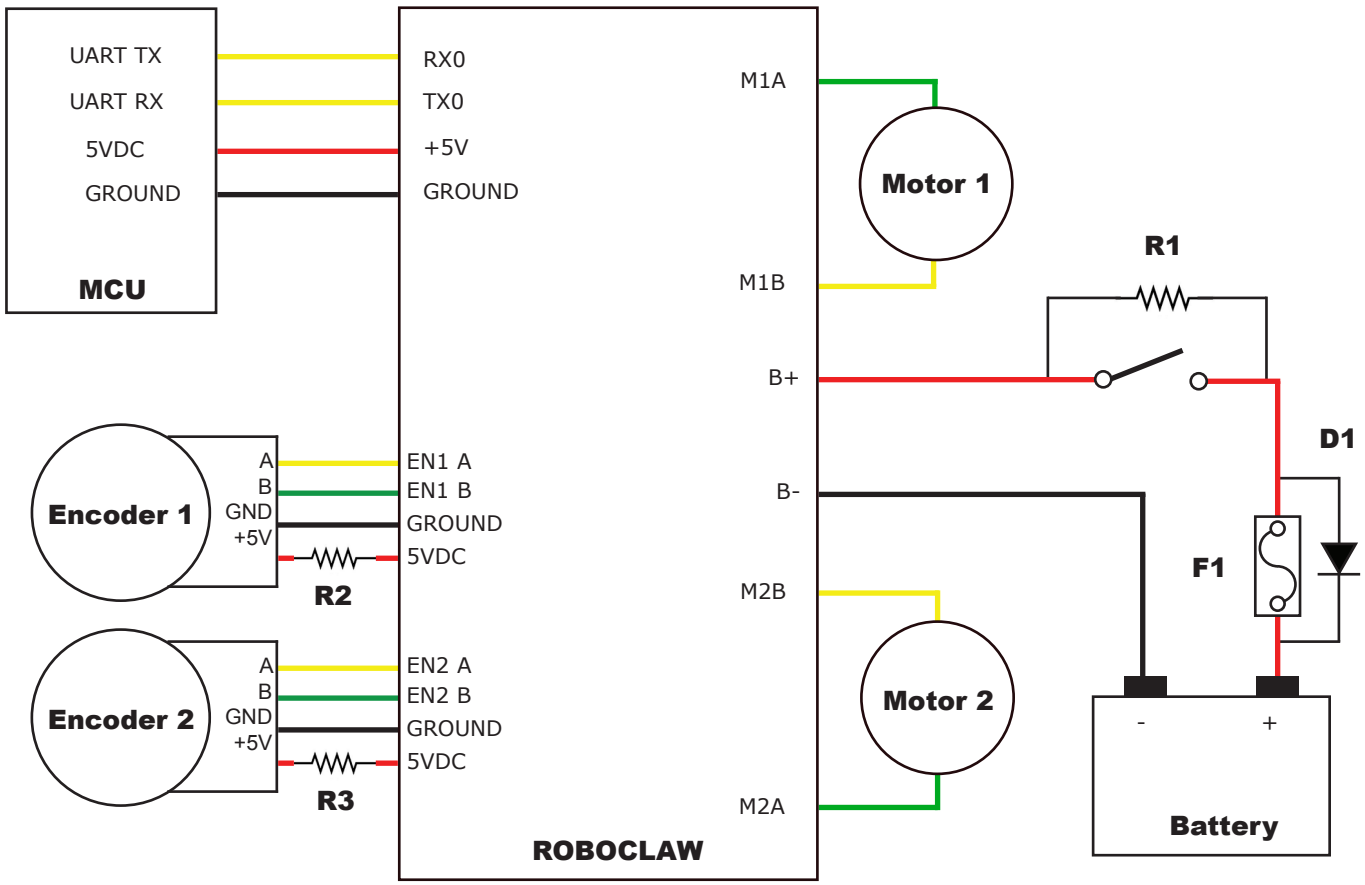
A wide range of sensors are supported for closed loop operation. Absolute and quadrature encoders are supported along with potentiometers and hall effect sensor. The illustration below is an example of the wiring required for closed loop mode using quadrature encoders. Quadrature encoders are directional. The internal RoboClaw counter to increment in one direction and decrement in the opposite direction. When wiring encoders 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.

Analog

RoboClaw has high speed 12 bit analog converters with a voltage range of 0V to 2V. The analog pins are 5V tolerant. If using a potentiometer its range will be limited if 5VDC is used as the reference voltage. A simple resistor divider circuit can be used to reduce the on board 5VDC to a 2VDC reference voltage. The below wiring diagram shows the placement of this resistor (R2 & R3) when using a potentiometer. The potentiometer will act as the other half of the divider circuit. If the potentiometer used is 5K, R2 & R3 = 7.5K. If the potentiometer is 10K, R2 & R3 = 15K and so on.

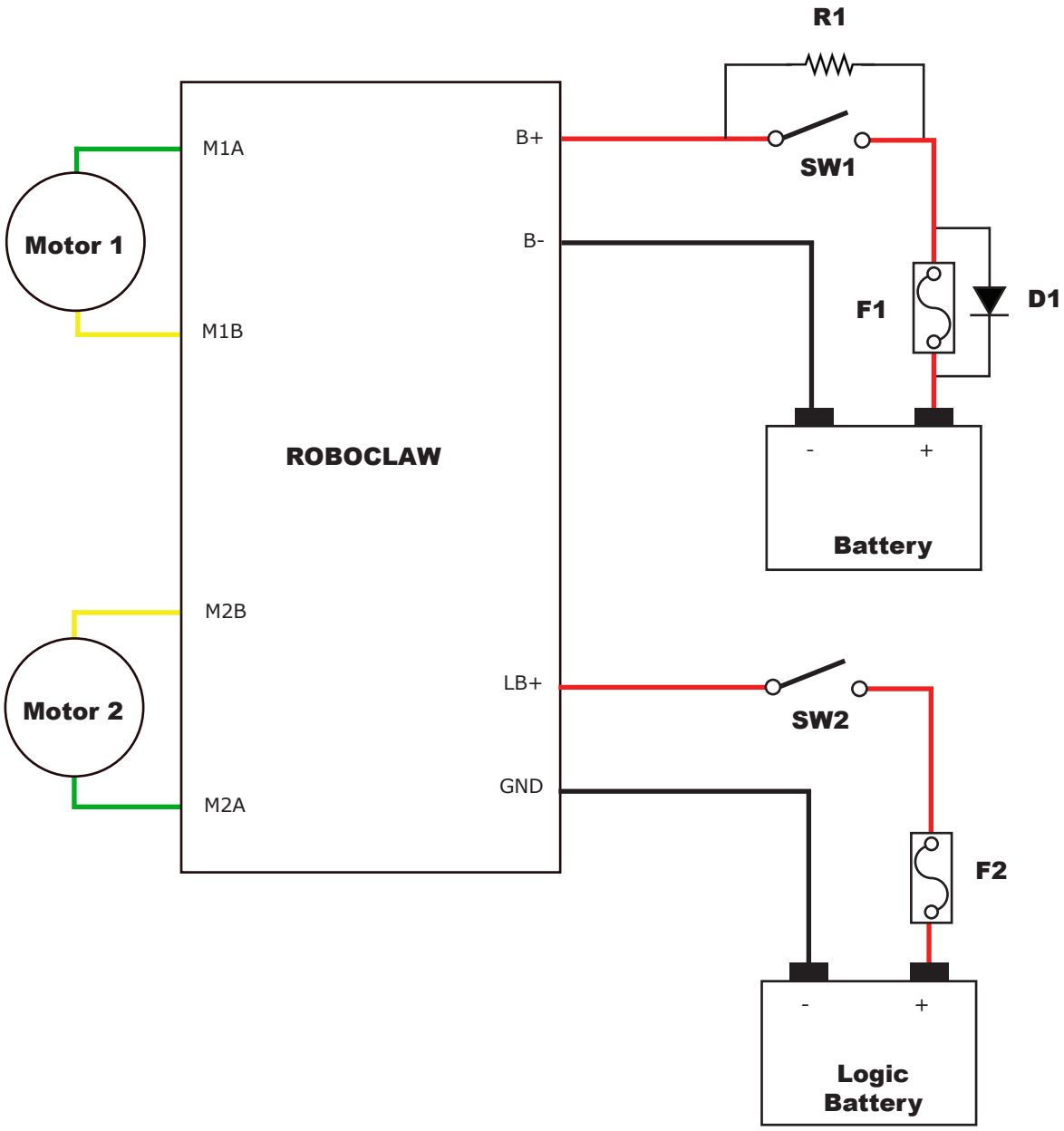
Wiring Diagram

RoboClaw has several wiring configurations, depending on the type of input or output being used. See the User Manual for additional examples.



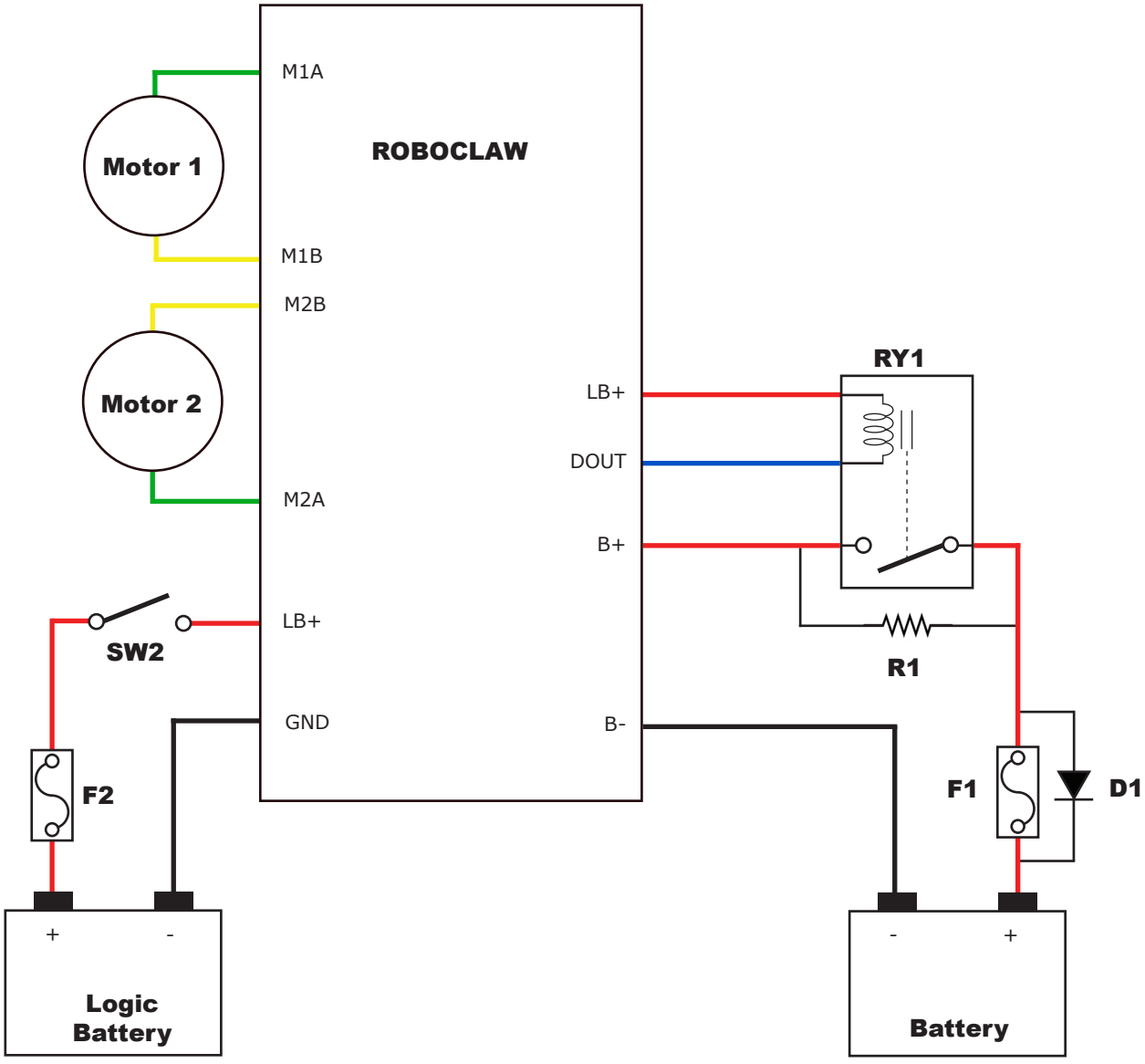
Logic Battery

An optional logic battery supply 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 12VDC 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.



Contactors, Relays and Solenoids

As a safety precaution an external power disconnect device should be used. A disconnect such as a contactor, relay or solenoid with the proper ratings for the planned load. The disconnect devices contacts should be rated for the total current output of both motor channels combined. The disconnect device can be controlled by the DOUT pins or a simple manual switch. The DOUT pins are designed to control inductive loads. They can be toggled by users commands. The wiring diagram below illustrates a basic wire scheme using a relay as a disconnect for the main power. The DOUT controls the ground to the relay coil. The positive terminal of the relay coil can be connected several ways depending on its rated voltage. The diagram below shows a 12VDC logic battery and a 12VDC Relay. If the relay coil is 5VDC the regulated user output (BEC) could be used instead. The main battery can also be the power source provided a logic battery is present.

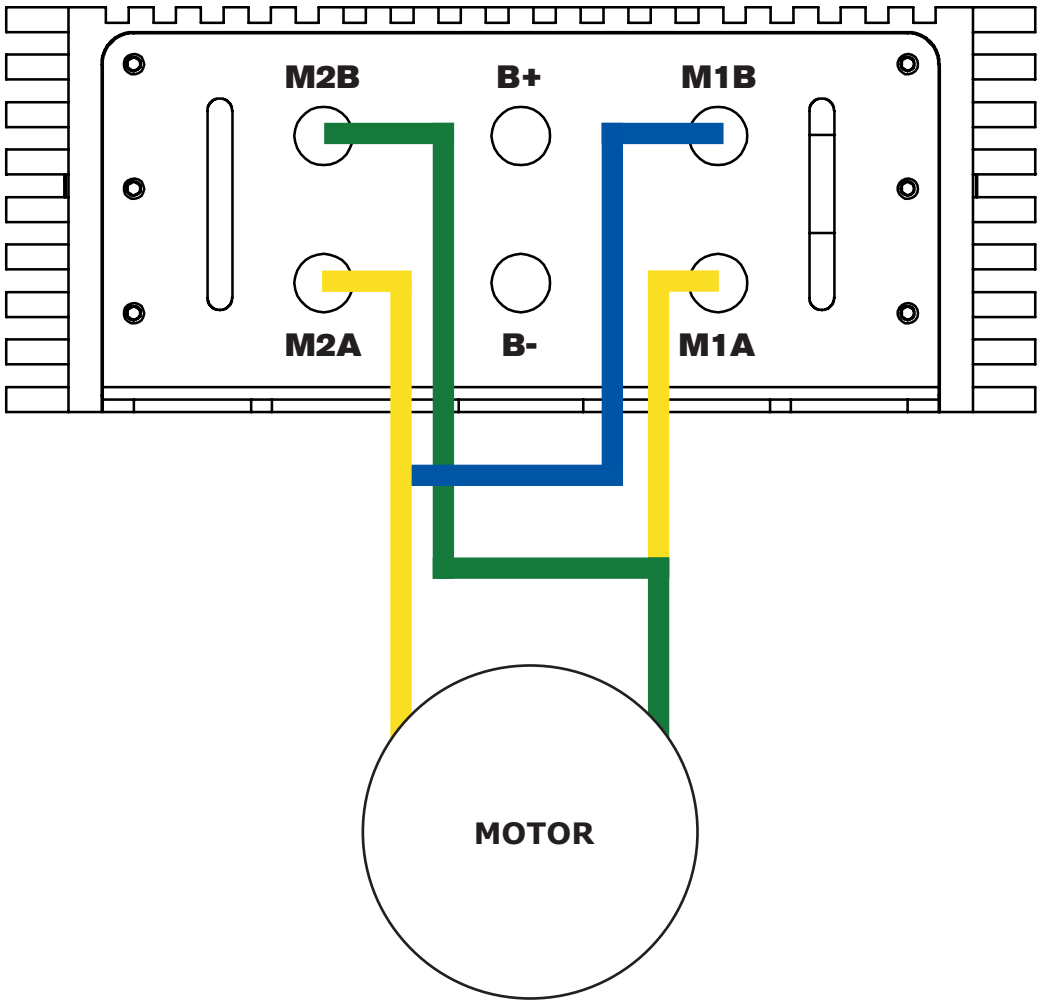


Bridging Channels

RoboClaws dual channels can be bridge to run as one channel, effectively doubling its current capability for one motor. Damage will result if RoboClaw is not set to bridged channel mode before wiring. Download and install Ion Studio. Connect the motor controller to the computer using an available USB port. Run Ion Studio and in general settings check the option to combine channels. Then click "Save Settings" in the device menu. When operating in bridged channel mode the total peak current output is combined from both channels. The peak current run time is dependant on heat build up. Adequate cooling must be maintained. For more information see the RoboClaw user manual.

Bridged Channel Wiring

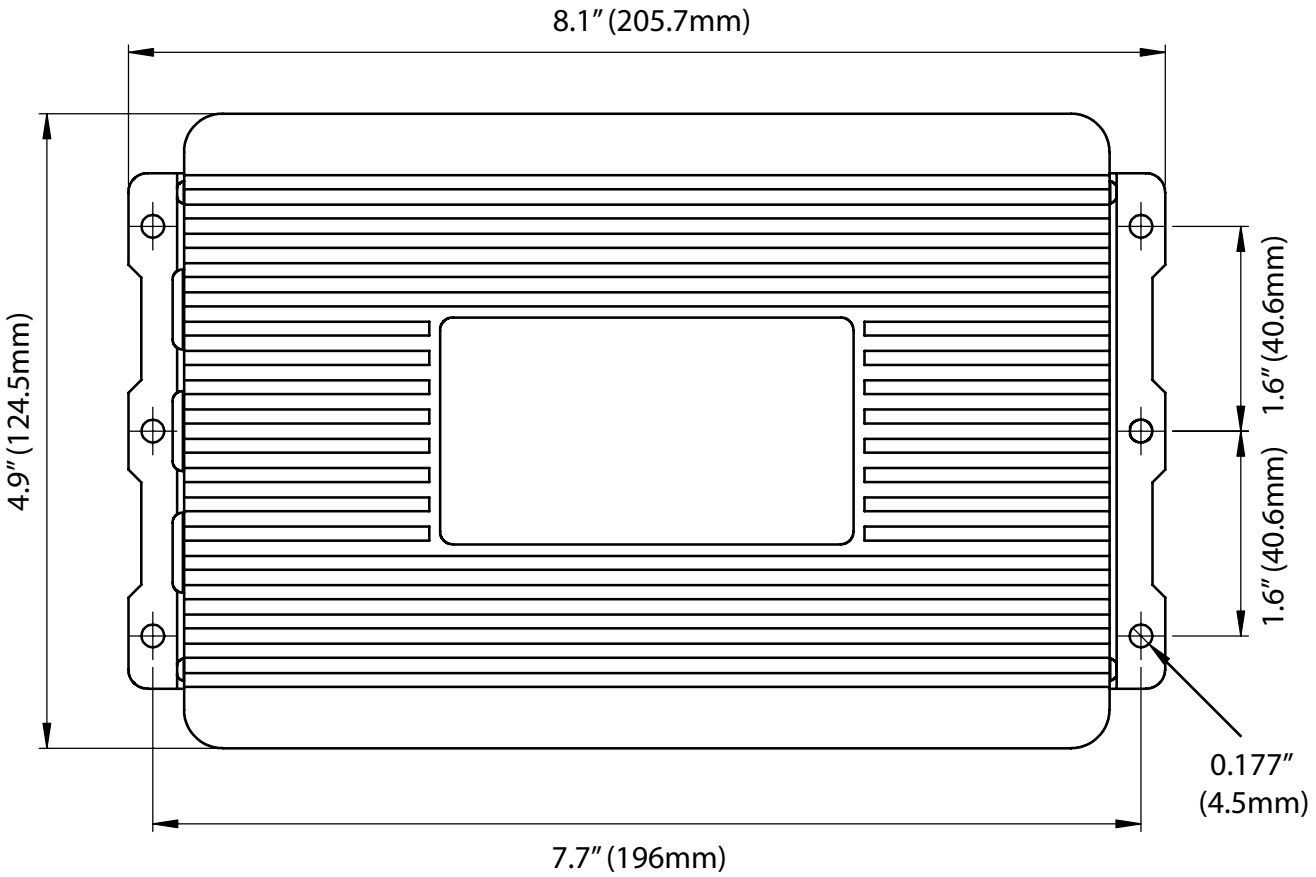
The RoboClaw 120A, 160A and 400A models are wired the same for bridge channel mode. When bridged channel mode is active the internal driver scheme for the output stage is modified. The output leads must be wiring correctly or damage will result. The motor output wire M1B is connected to M2A to form one side. Then M2B is connected to M1A to form the other side.

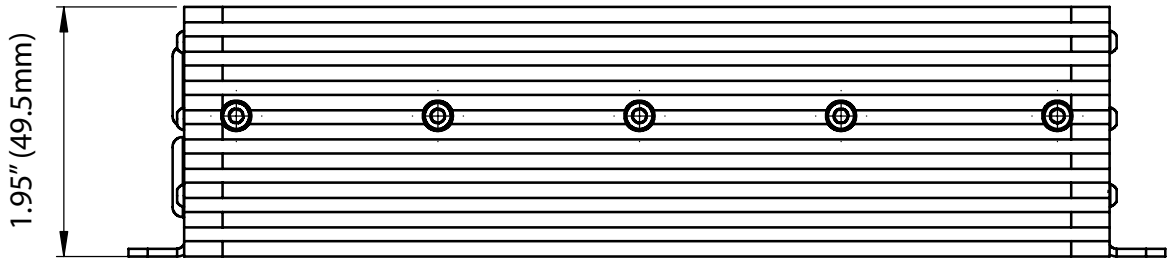


Mechanical Specifications

Characteristic	Model	Min	Typ	Max	Rating
Weight	2X120A		68 (1927)		Oz (g)
Motor / Battery Wire Shipping Length			17" (432)		in (mm)
Motor / Battery Wire Shipping Diameter			0.340" (8.6)		in (mm)

Dimensions





Electrical Specifications

Characteristic	Model	Min	Typ	Max	Rating
Main Battery	2X160A	10		34	VDC
	2X120AHV	10		60	VDC
	2X160AHV	10		60	VDC
	2X200AHV	10		60	VDC
Logic Battery	All	6	12	14	VDC
Maximum External Current Draw (BEC)	All			3	A
Motor Current Per Channel	2X160A		120(2)	160(1,2)	A
	2X120AHV		90(2)	120(1,2)	A
	2X160AHV		120(2)	160(1,2)	A
	2X200AHV		160(2)	200(1,2)	
On Resistance	2X160A		1		mOhm
	2X120AHV		1.85		mOhm
	2X160AHV		1		mOhm
	2X200AHV		1		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
CTRL1 / CTRL2	All			40	VDC
CTRL1 / CTRL2	All			3	A
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		1.44		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	90	°C
Temperature Protection Range	All	75		90	°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 75°C, the current limit is reduced on a slope with a maximum temperature of 90°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. Non 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.

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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.