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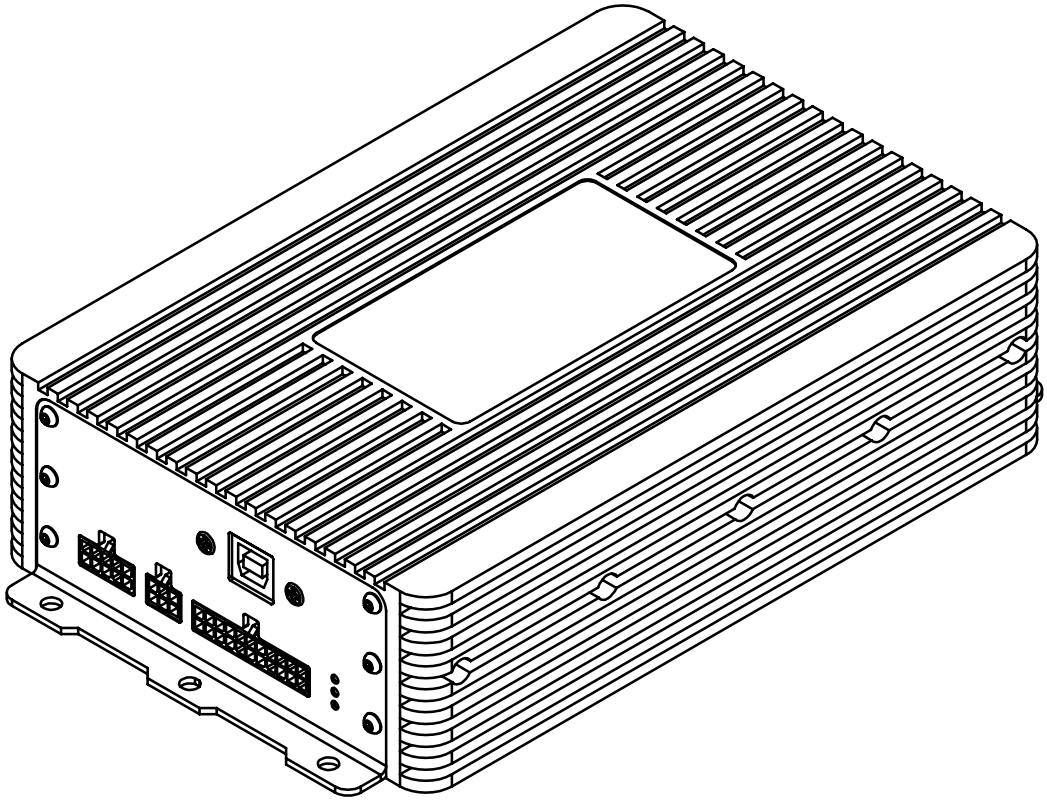

MCP2xx3, 34VDC Dual Channel
MCP2xx6, 60VDC Dual Channel
MCP2xx8, 80VDC Dual Channel

Programmable
Brushed DC Motor Controller

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Feature Overview:

- 120 / 160 / 200 Amps per channel for two brushed DC motors
- 240 / 320 / 400 Amps in bridged channel mode for one brushed DC motor
- Dual quadrature encoder inputs with hardware 32-Bit counters
- Programmable with built-in user scripting language
- Minimum of 100,000 instructions per second execution speed
- 128Kb Flash available for user scripting programs
- 16Kb Ram available for user scripting programs
- 1Kb Non-Volatile memory for storage by user scripting programs
- USB, RS232, TTL, R/C, PWM and Analog control modes
- Automatic control switching with user defined priority settings
- Input control mixing
- Data Logging
- Diagnostic LEDs for easy in field diagnostics
- Field Firmware Updates
- OpenCAN master or slave support
- I2C Interface for use with sensor such as gyros, accelerometers, temperature and displays
- Up to 11 Analog inputs for control, encoder feedback or as user script controlled inputs
- Up to 13 PWM inputs for control, encoder feedback or as user script controlled inputs
- Up to 20 Digital inputs for limit switches, emergency stops, homing or as user script controlled inputs
- 8 General purpose 40V, 1Amp user controlled outputs for driving relays, brakes or contactors
- User programmable input triggers with minimum and maximum range settings
- Regulated 5VDC, 3A output (BEC) for powering external devices such as sensors or controllers like Arduino, Rasberry Pi
- Up to 80VDC versions available
- Fully enclosed for protection
- Conduction plate and top side heat mangement for high performance cooling
- 3.3v Compliant outputs for safe interfacing with controllers such as Rasberry Pi
- 15v Tolerant inputs for interfacing to industrial devices such as PLCs
- Overvoltage and under voltage protection monitoring
- Programmable current limiting
- Auto tune PID for fast encoder and motor setup
- PC utility included for fast setup and tunning

Device Overview

The MCP motor controller is a high power, high performance rugged motor controller built to withstand the most demanding applications. It incorporates a built-in scripting language with advance motion control. At the heart is a 32Bit high performance Cortex M4 processor with DSP and FPU. The user programmable feature allows the MCP to be customized for any application. It can interface with several communication standards in addition to including several user configurable I/O. The MCP can be used as a standalone controller with out the need for an additional processor therefore reducing over all design cost and system complexity.

At the heart of the MCP motor controller is a high performance motion control intelligence which achieves high precision control and optimum motor performance in open or closed loop modes. Close loop mode supports dual quadrature encoders with up to 21 million PPS. Close loop mode creates absolute control over speed, velocity and direction regardless of loading changes. In addition, a wide range of sensor inputs including potentiometers and absolute encoders are supported.

Multimode Interface

The MCP supports several types of control input. USB, R/C Pulse, Analog, TTL, RS232 and CAN are supported. Control can be setup to auto switch from one interface to another. The MCP can be configured as a master or slave in a CAN network. In addition several user controllable I/O are available for setting up limit switches, sensors, E-stops and more. The MCP includes 2 user controllable general purpose 40V at 1Amp I/O for controlling brakes, contactors and other high load devices.

Protection

The MCP utilizes high precision temperature, current and voltage sensing to monitor conditions and ensure safe and reliable operations. The peak operational voltage depending on model can be up to 80VDC. MCP is a regenerative motor controller. During regeneration, voltages can peak over 80VDC. MCP is designed to handle well over 100VDC voltage spikes and is not rated to its absolutely maximum operating specifications which provides a safe and reliable operating margin.

Software

IonMotion is a free PC utility configuration tool used to setup, configure and monitor the MCP. The software can be used during run time to monitor and control several operational parameters. IonMotion is also the interface for customizing the built-in motion control language.

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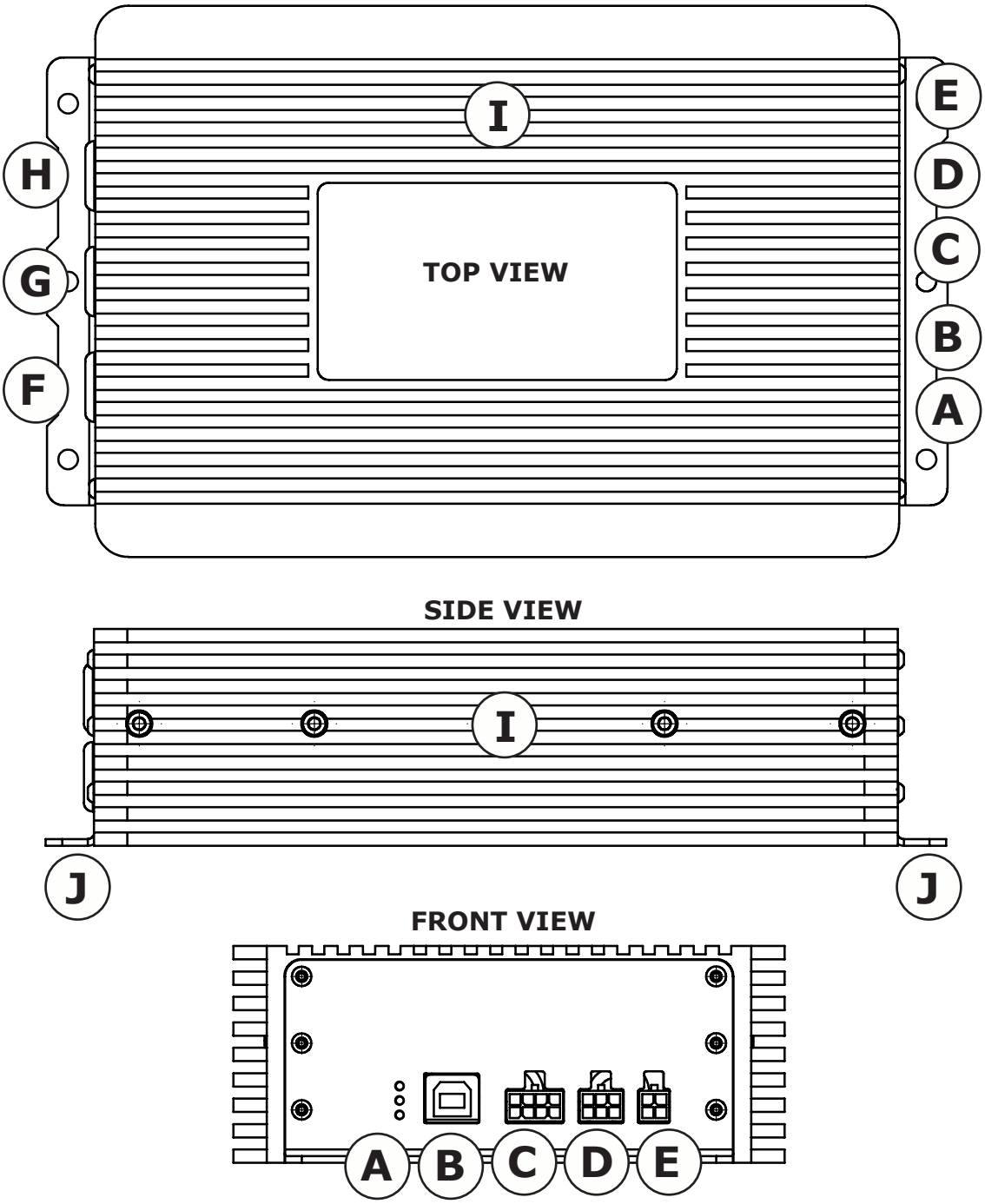
Hardware Overview:



A: Status LEDs.
B: USB Port.
C: Control Input.
D: Encoder Input.
E: Digital Ouput.
F: Motor Channel 1.
G: Main Battery Input.
H: Motor Channel 2.
I: Air Cooling.
J: Conduction Cooling.

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Important Notices
The following information is required for safe and reliable operation. It is up to the user to ensure the following criteria is met. Several external factors can influence how the MCP operates. Following basic safety procedures can prevent dangerous situations.

Warnings
The following guidelines should be followed when using the MCP or damage will occur. There are several factors that will affect the operation of the MCP.

1. Battery wire should be no longer than 20 inches in length.
2. Motor wire should be no longer than 20 inches in length.
3. DO NOT overload the BEC. Logic power is drawn from the same source and brownouts can occur.
4. DO NOT reverse the battery polarity. Damage will result.
5. ALWAYS Incorporate an emergency main battery cut off switch.
6. Cut off should always be on the positive (+) of power to prevent ground loops.
7. Power diode, fuse and pre charge resistor should be added to all power switch circuits.
8. DO NOT get the MCP wet and avoid high moisture environments without proper moisture control.

Mounting
The MCP will generate heat. The controller should be mounted to a metal surface that will conduct the heat away from the MCP during operation. The maximum amperage ratings can only be achieved and maintained with adequate heat dissipation.

Emergency Stop
MCP should be wired using an external contactor or relay to ultimately 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 level drops can occur from constant full load or full speed direction changes and can potential cause logic brown outs.

USB
The MCP USB port can be used for configuration and debugging. The USB protocol is not meant for electrically noisy environments. The USB port can potentially drop out during operation and may not recover without unplugging and plugging in the MCP. In high electrical noise environment RS232 should be used.

CAN Bus
The MCP can interface to a CAN bus using CANOpen protocol. The MCP supports the DS402 profile for motion control devices. The MCP can be a master or slave device on the bus. CAN is available when the MCP is plugged into the USB. The MCP can be used as a master interface to control other MCPs over the a CAN bus.

I2C
The I2C bus can be used to communicate to any compatible I2C device. The I2C devices can be controlled by a user program. The MCP can be easily interfaced to devices such as Gyro and Accelerometers for standalone applications.

Firmware Updates
From time to time new firmware updates will be available to add new features or resolve an issue. It is recommended to update to the latest firmware during development. Firmware updates are handled by the IonMotion PC utility. IonMotion is free to download from Ionmc.com. Once IonMotion is installed, connect the motor controller to your computer running Windows 7 or newer. Once IonMotion is launched it will detect the attached motor controller and attempt to first download the latest firmware from Ionmc.com before updating.

User Regulated Power (BEC)
The MCP motor controllers provides a user power source typically referred to as a battery elimination circuit or BEC. This regulated supply provides power to user electronics and sensors. It eliminates the need for secondary battery sources due to high input voltages from the main power source. The BEC circuit is not monitored. The logic control circuits of the motor controller are supplied from the same switching regulator circuit. If maximum current is exceed the switching regulators built in thermal protection circuitry will activate causing a system wide brown out.

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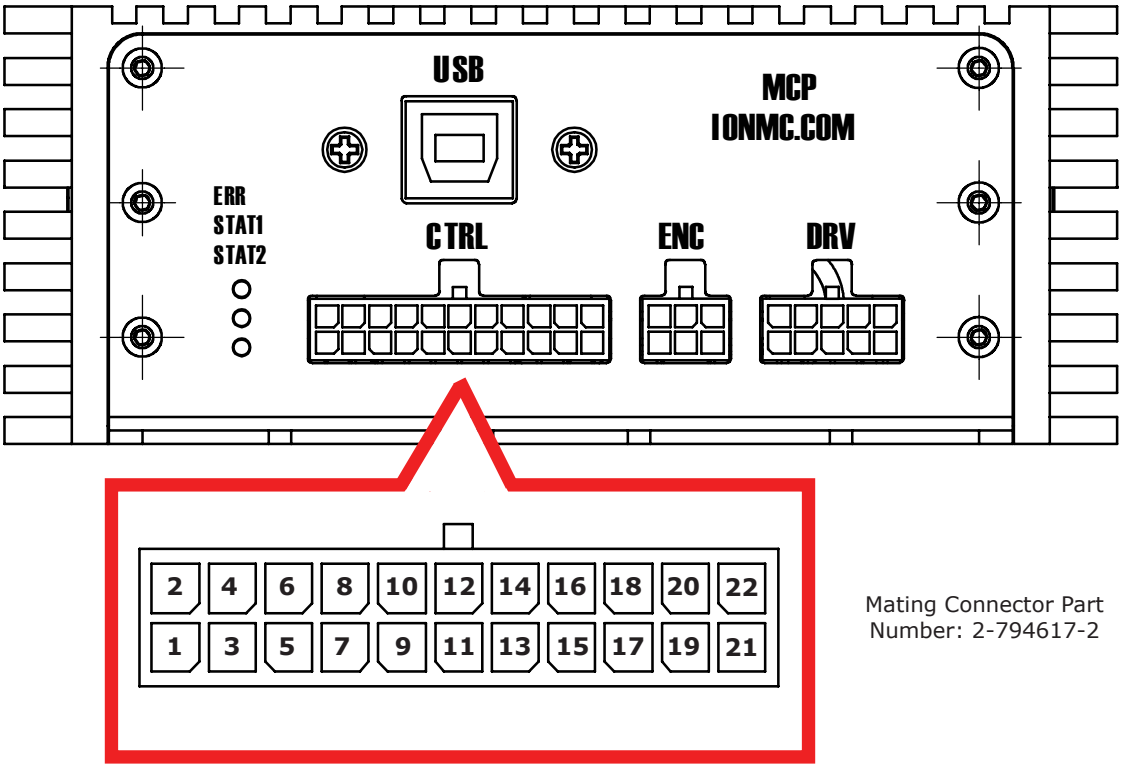
Control Interface (CTRL)

The MCP motor controllers use minature Molex connectors. The following tables list the pins and their functions. Most all pins are 15V tolerant and output 3.3V for compatibility with processor such as Rasberry Pi and Arduino. CTRL pins are low side drivers at 40VDC, 1A 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 the motor contoller. To configure the motor controller connect it to a free USB port. Then install the IonMotion PC utility.



Mating Connector Part Number: 2-794617-2

Pin	PWR	DIN	DOUT	ANALOG	PULSE	ENCODER	UART TTL	UART RS232	CAN	I2C
1							RX1			SDA
2	GND									
3							TX1			SCL
4	+5V									
5		DIN1		AN1	P1					
6		DIN2			P2	HALL1				
7		DIN3		AN2	P3					
8		DIN4			P4	HALL2				
9		DIN5		AN3						
10		DIN6			P5	HALL3				
11		DIN7		AN4	P6					
12		DIN8			P7					
13		DIN9		AN5						
14		DIN10					TX3			
15		DIN11		AN6						
16		DIN12					RX3			
17		DIN13		AN7	P8					
18								TX0	CANH	
19		DIN14			P9					
20								RX0	CANL	
21	GND									
22	LB+									

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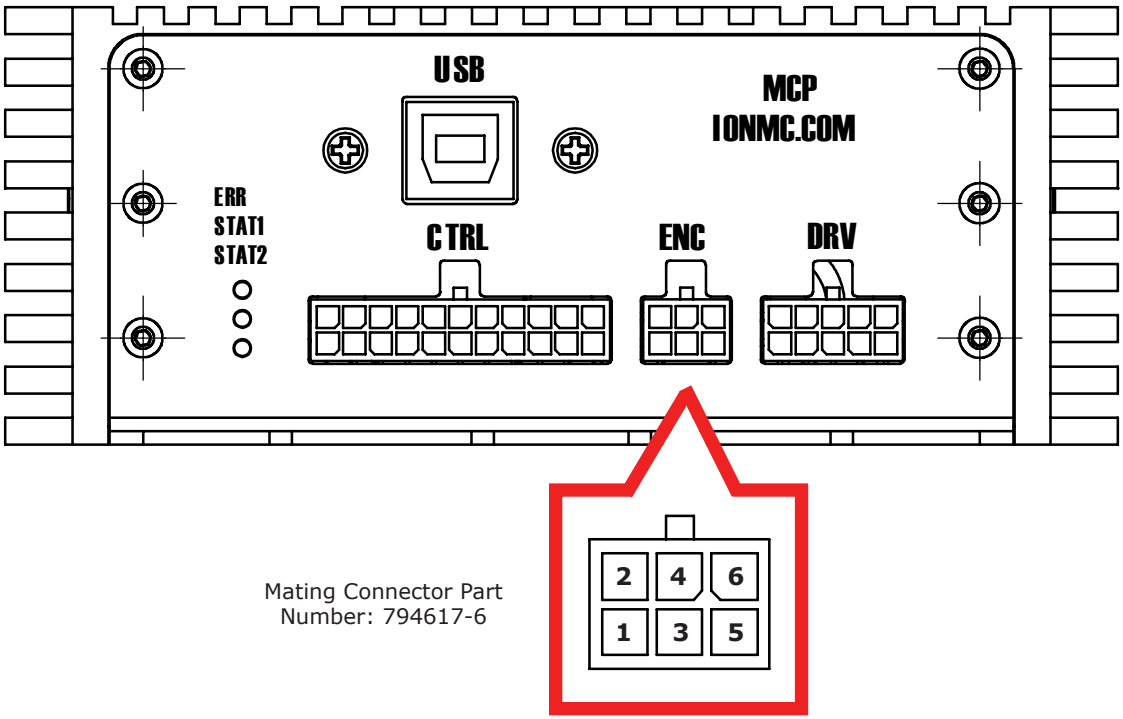
Encoders (ENC)

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	UART TTL	DIN	ANALOG	PULSE
1	+5V						
2	GND						
3	ENC1A	Channel 1A (1)	Channel 1 (1)(2)	TX2	DIN15	AN8	P10
4	ENC2A	Channel 2A (1)	Channel 2 (1)(2)		DIN16	AN9	P11
5	ENC1B	Channel 1B (1)		RX2	DIN17	AN10	P12
6	ENC2B	Channel 2B (1)			DIN18	AN11	P13

Notes:

1. Digital input pins are 15V tolerant.
2. Digital output pins can drive up to 3Amp at 40V. DOUT are low side driving pins.
3. Analog pins are 0V to 5.9V range.
4. I2C pins are 5V tolerant inputs with 3.3V compliant output.
5. Pulse inputs have a resolution of 12ns.

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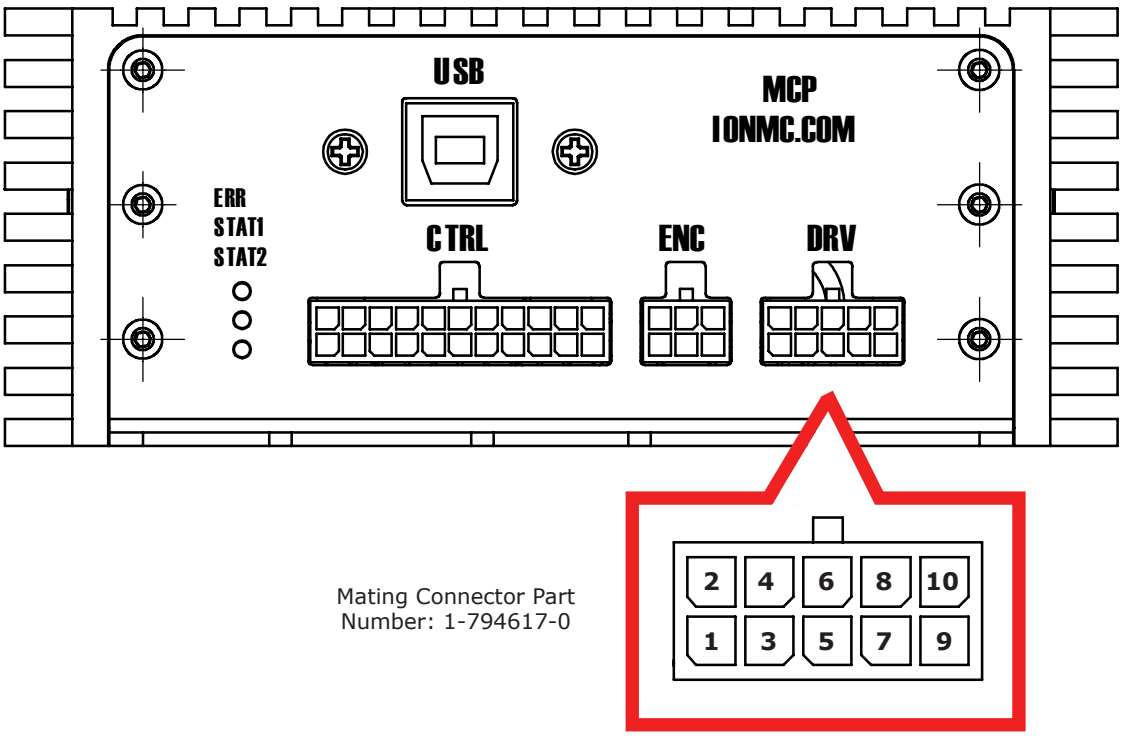
Digital Driver (DRV)

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 IonMotion PC utility. They can also be setup using packet serial commands. See RoboClaw User Manual for examples.



Mating Connector Part Number: 1-794617-0

Pin	PWR	DIN	DOUT	ANALOG	PULSE	ENCODER	UART TTL	UART RS232	CAN	I2C
1			DOUT1							
2			DOUT2							
3			DOUT3							
4			DOUT4							
5			DOUT5							
6			DOUT6							
7			DOUT7							
8			DOUT8							
9	+5V									
10	GND									

Notes:

1. Digital input pins are 15V tolerant.
2. Digital output pins can drive up to 3Amp at 40V. DOUT are low side driving pins.
3. Analog pins are 0V to 5.9V range.
4. I2C pins are 5V tolerant inputs with 3.3V compliant output.
5. Pulse inputs have a resolution of 12ns.

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Wiring Basics

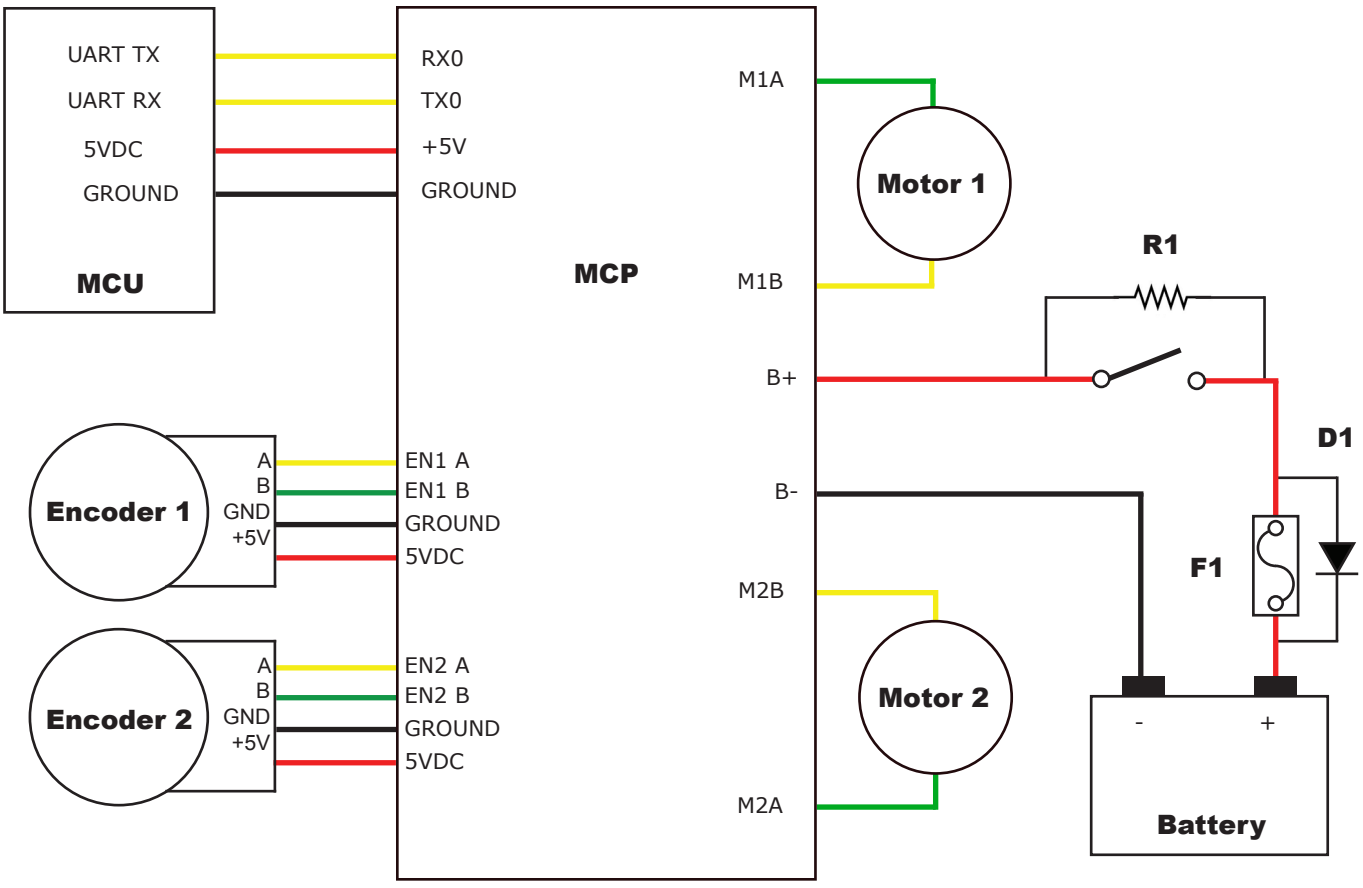
MCP must be wired correctly to ensure safe and reliable operation. The wiring diagram below illustrates one of several possible wiring configurations. An external main power cut off solution should be incorporated for safety. Regeneration will occur if the motors are moved when the system is off causing possible erratic behavior. Use a high current diode (D1) to create a return path to ground 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, 2Watt for a 80VDC 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 for closed loop modes are supported including absolute, quadrature, 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 hardware counter will increment and decrement based on the direction of spin. 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.

Wiring Diagram

Several wiring configurations are possible depending on the type of input or output being used. See the User Manual for additional examples.



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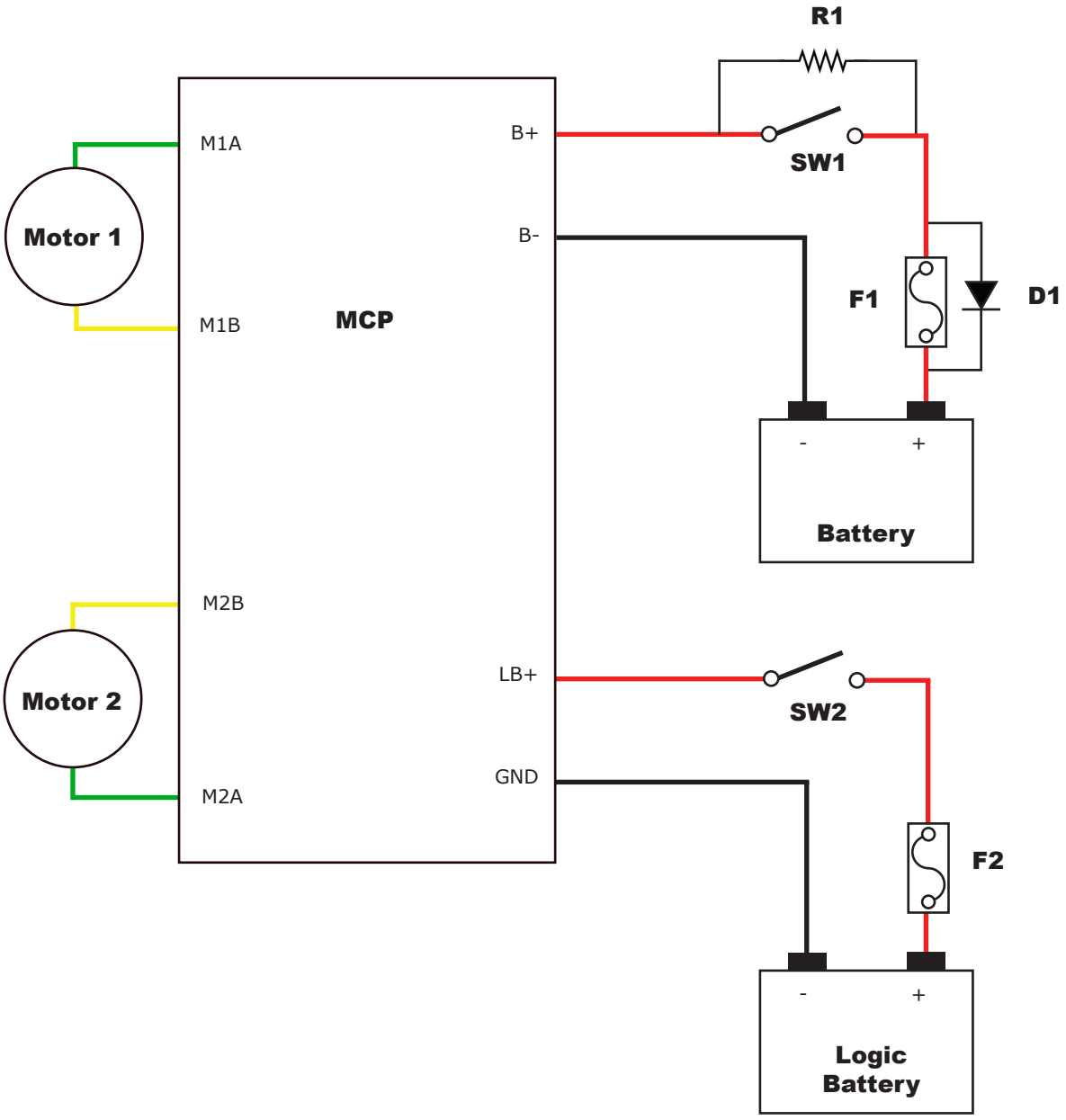
Logic Battery

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 secondairy 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.



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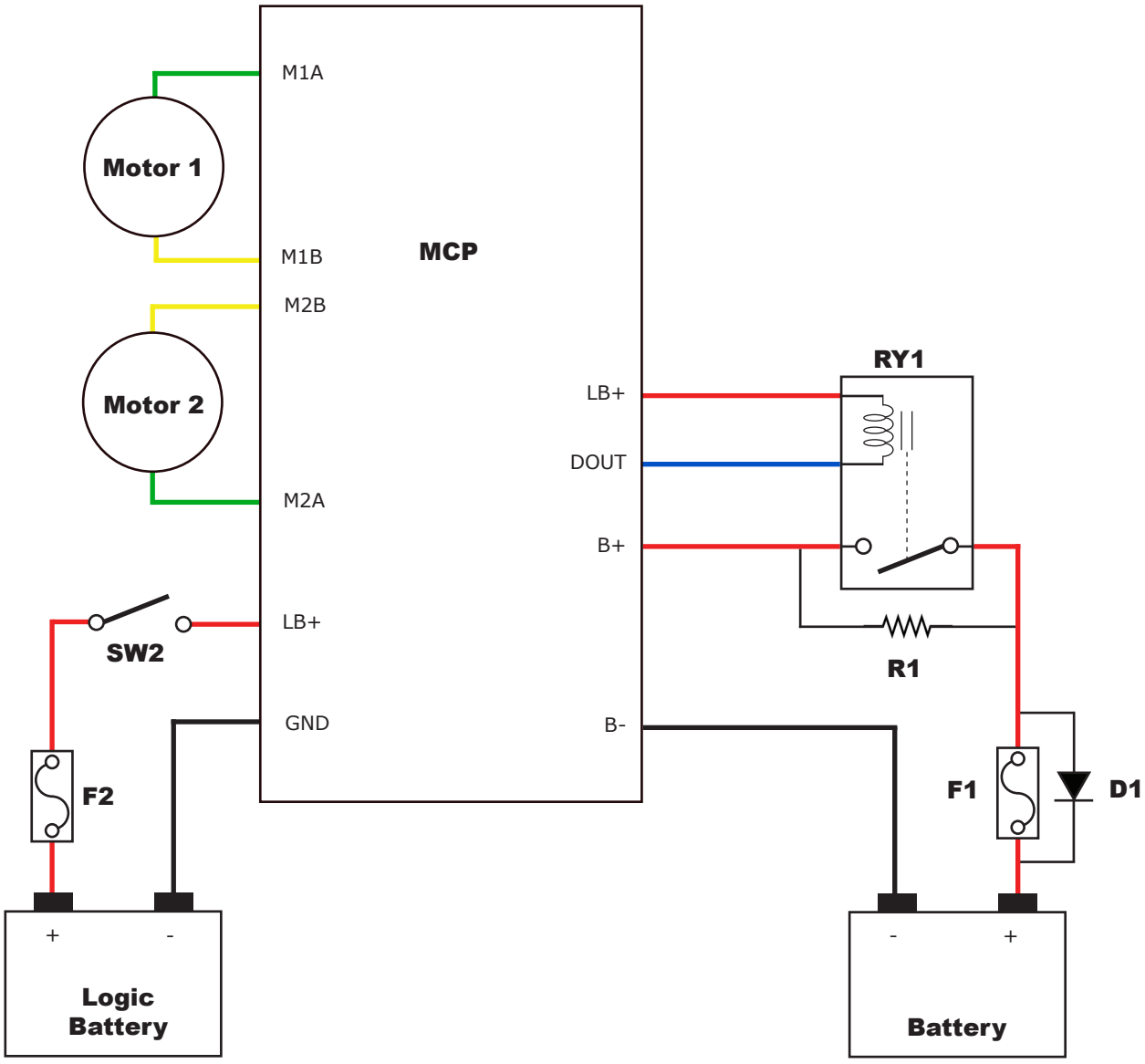
Contactors, Relays and Solenoids

As a safety precaution an external power disconnect device should be used. A discconect 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 programs. 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 Rleay. 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.



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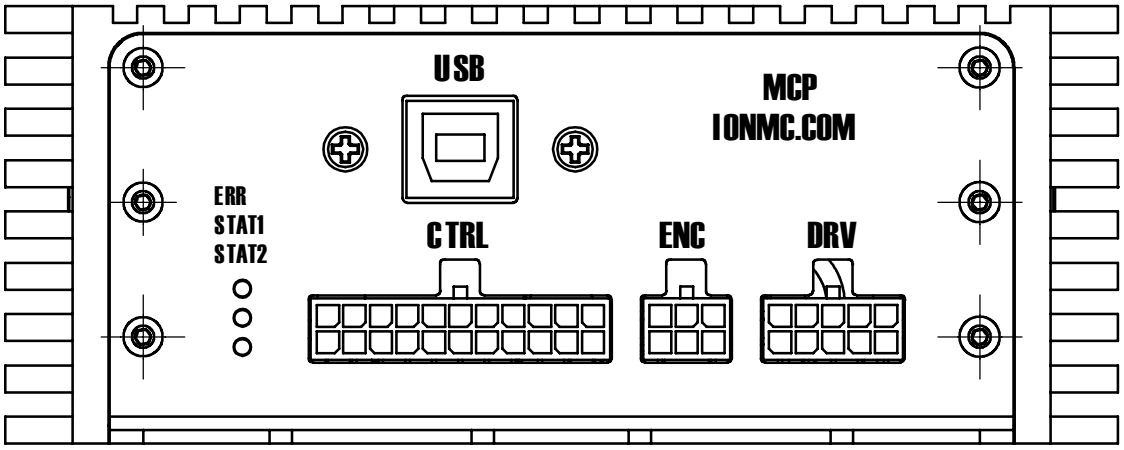
Status and Error LEDs

The MCP motor controller has three LEDs for in field diagnostic. Two status LEDs labeled STAT1 and STAT2 and an error LED labeled ERR. When the motor controller is first powered on all 3 LEDs should flash briefly to indicate all LEDs are functional. The LEDs will behave differently depending on the mode. During normal operation the status 1 LED will remain on continuously or blink when data is received in RC Mode or Serial Modes. The status 2 LED will light when either drive stage is active.



Error and Warning States

When an error occurs both motor channel outputs will be disabled and RoboClaw will stop any further actions until the unit is reset, or in the case of non-latching E-Stops, the error state is cleared. When warnings occur both motor channel outputs will be controlled automatically depending on the warning condition(s).

LED Status	Condition	Type	Description
All three LEDs lit.	E-Stop	Error	Motors are stopped by braking.
Error LED lit while condition is active.	Over 85°C Temperature	Warning	Motor current limit is recalculated based on temperature.
Error LED blinks once with short delay. Other LEDs off.	Over 100°C Temperature	Error	Motors freewheel while condition exist.
Error LED lit while condition is active.	Over Current	Warning	Motor power is automatically limited.
Error LED blinking twice. STAT1 or STAT2 indicates channel.	Driver Fault	Error	Motors freewheel. MCP has detected damage.
Error LED blinking three times.	Logic Battery High	Error	Motors freewheel until MCP is reset.
Error LED blinking four times.	Logic Battery Low	Error	Motors freewheel until MCP is reset.
Error LED blinking five times.	Main Battery High	Error	Motors are stopped by braking until MCP is reset.
Error LED lit while condition is active.	Main Battery High	Warning	Motors are stopped by braking while condition exist.
Error LED lit while condition is active.	Main Battery Low	Warning	Motors freewheel while condition exist.
Error LED lit while condition is active.	M1 or M2 Home	Warning	Motor is stopped and encoder is reset to 0

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Firmware Update LED State

If all three LEDs begin to cycle on and off after powering on, the MCP has successfully been set to receive new firmware. Use IonMotion on a Windows PC to install the new firmware to clear this state.

Automatic Battery Detection on Startup

If the automatic battery detection mode is enabled the Stat2 LED will blink to indicate the detected battery type. Each blink indicates the number of LIPO cells detected. If automatic detection is used the number of cells detected should be confirmed on power up before running the unit.

Undercharged or overcharged batteries can cause invalid auto detection.

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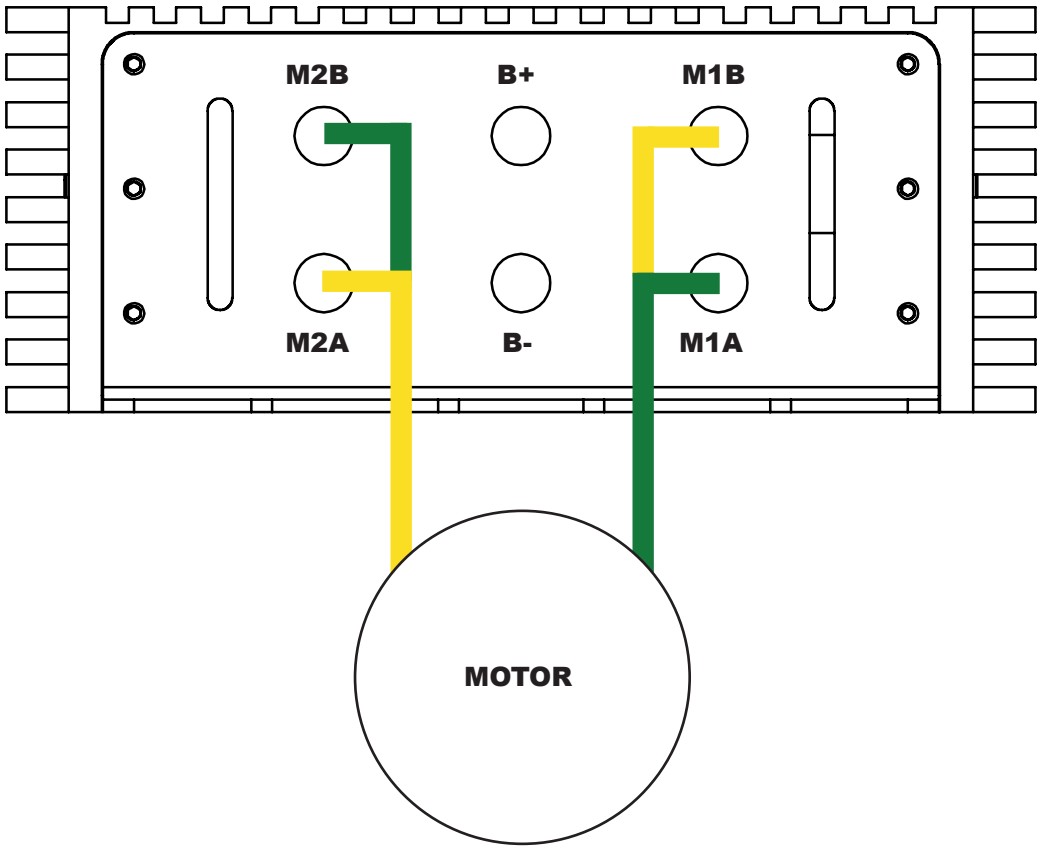
Bridging Channels

The MCPs dual channels can be bridge to run as one channel, effectively doubling its current capability for one motor. Damage will result if the MCP is not set to bridged channel mode before wiring. Download and install IonMotion PC utility. Connect the motor controller to the computer using an available USB port. Run IonMotion and in general settings check the option to combine channels. When operating in bridged channel mode the total peak current output can be 240 / 320 / 400 amps depending on the model. The peak current run time is dependant on internal heat build up. Adequate cooling must be maintained.

Bridged Channel Wiring

When bridged channel mode is active the internal driver scheme for the output stage is modified. The output leads must be wired correctly or damage will result. Motor wire M1B is connected to M1A to create one side of the bridged driver. Motor wire M2A is connected to M2B to create the other side of the bridged driver.



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Motion Control Language

The MCP motor controller can be customized using a built in programming language. The programming language is modeled after BASIC. The MCP motor controller can operate in standalone mode without additional external control. Several user I/O and operational parameters are directly accessible from user programs. The MCP includes IonMotion which is a free PC utility to create and download user programs to the motor controller.

Programming Specifications

Characteristic	Model	Min	Typ	Max	Rating
User Program Memory	All		128		KBytes
User Variable Memory	All		16		KBytes
User Program Execution Speed	All		100,000		Lines/s
Analog to Digital Resolution	All			12	Bits
System Clock Resolution	All			32	Bits
Microsecond Clock Resolution	All			32	Bits
Millisecond Clock Resolution	All			32	Bits
Uart Buffer	All			256	Bytes
Subroutine Nesting				256	Levels

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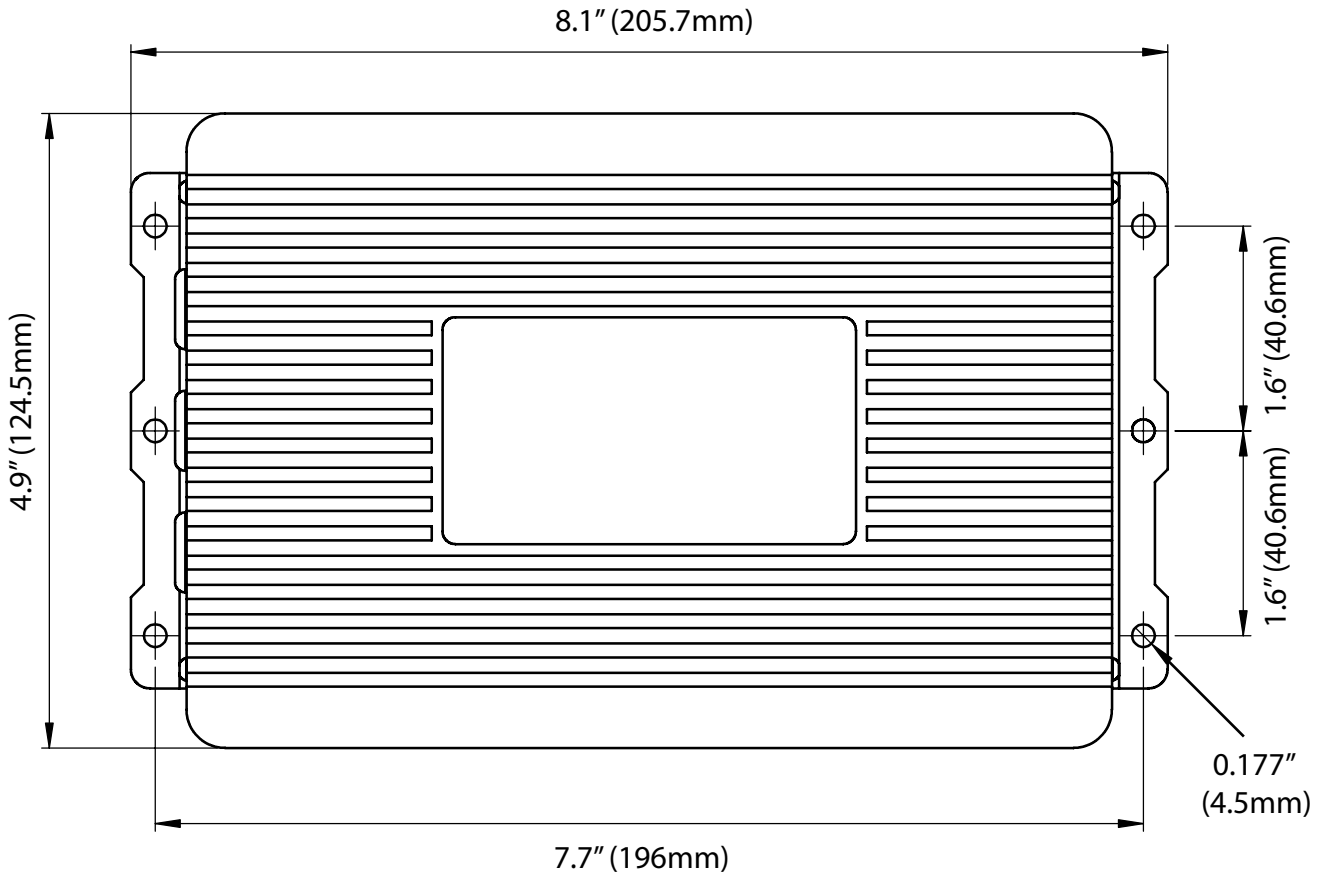
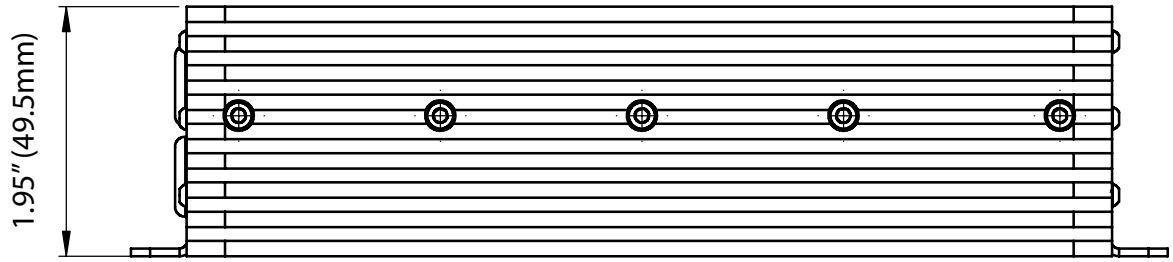
Mechanical Specifications

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

Dimensions





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Electrical Specifications

Characteristic	Model	Min	Typ	Max	Rating
Main Battery at 25°C	MCP2xx3	10		34	VDC
	MCP2xx6	10		60	VDC
	MCP2xx8	10		80	VDC
Regeneration Voltages	All			100	VDC
Reverse Voltage	All			-1	VDC
Logic Battery	All	6	12	14	VDC
Current Per Channel	MCP212x		90(3)	120(1,2,3)	A
	MCP216x		120(3)	160(1,2,3)	A
	MCP220x		160(3)	200(1,2,3)	A
Current Bridged Channel	MCP212x		180(3)	240(1,2,3)	A
	MCP216x		240(3)	320(1,2,3)	A
	MCP220x		320(3)	400(1,2,3)	A
On Resistance	MCP212x		1.85		mOhm
	MCP216x		1		mOhm
	MCP220x		1		mOhm
User Current (BEC)	All			3	A
Logic Circuit Idle Current Draw	All		90mA		mA
DIN Input Impedance	All		1.2		K Ω
I2C Input Impedance	All		100		Ω
I2C Input	All	0		5	VDC
DIN Input	All	0		15	VDC
DIN Input Low	All	-0.3		0.5	VDC
DIN Input High	All	1.5		15	VDC
DOUT Maximum Current	All			1	A
DOUT Maximum Voltage	All			40	VDC
DOUT Short Circuit Threshold	All	3.5			A
I/O Output Voltage	All	0		3.3	VDC
Analog Input Voltage	All			15	VDC
Analog Useful Range	All	0		5.9	VDC
Analog Resolution	All		1.25		mV
Pulse In Resolution	All		12		ns
Encoder Counters	All		32		Bits
Encoder Frequency	All			21	Mhz
RS232 Baud Rate	All			921,600	Bits/s
RS232 Time Out	All	10			ms
RS232 Max Voltage	All	-13		13	VDC
Temperature Operating Range	All	-40	40	90	°C
Thermal Protection Range	All		75	90	°C

Notes:

1. Peak current is automatically reduced to the typical current limit as temperature approaches 85°C.
2. Motor Controller mounting and ventilation will affect maximum current.
3. 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.
4. RS232 format is 8Bit, No Parity and 1 Stop bit.
5. Condensing humidity will damage the motor controller.

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Warranty

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

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Contacts

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

Discussion List

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

Technical Support

Technical support is available by sending an email to support@basicmicro.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.

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