2x80A Motor Controller

SKU: 3105-0202-0080

SUMMARY

This powerful motor controller is designed for high power brushed DC motors. It is controlled with a simple RC PWM interface, making it easy to control from any standard RC radio system. This motor controller offers a wide 7V to 30V operating voltage range and massive current delivery capabilities. It can supply continuous output currents of 80A per channel and bursts up to 160A per channel. A number of safety features ensure that this device will survive a variety of electrical conditions, making it ideal for beginners and experts alike.

Safety Features:

- Reverse Voltage Protection
- Current Limit Protection
- Short Circuit Protection
- Over Temp Protection
- BEC Reverse Voltage Protection
- BEC Current Limit Protection
- BEC Short Circuit Protection
- BEC Over Temp Protection

SUMMARY OF PRODUCT RATINGS			
Input Voltage	9V - 30V	Active Input Signal Range	1050μs - 1950μs
Input Signal Voltage	3.3V - 5V	Dead zone	±10μs (1490μs - 1510μs)
Input Power Connector	XT90	Signal Arming Range	±100μs (1400μs - 1600μs)
Motor Type	Brushed DC	BEC Output Voltage	6.2V
Motor Continuous Current (2)	80A	BEC Continuous Current	5A
Motor Burst Current (1) (2)	160A	BEC Burst Current (1) (2)	6A
Motor Output Direction	Bidirectional	Input Signal Connector	0.1” /TJC8
Motor Channels	2	Motor Output Connector	6mm Bullet

Notes:

(1) Burst Current Definition: The amount of current that can be sustained for 5 seconds.

(2) Ambient temperature is at or below 25°C

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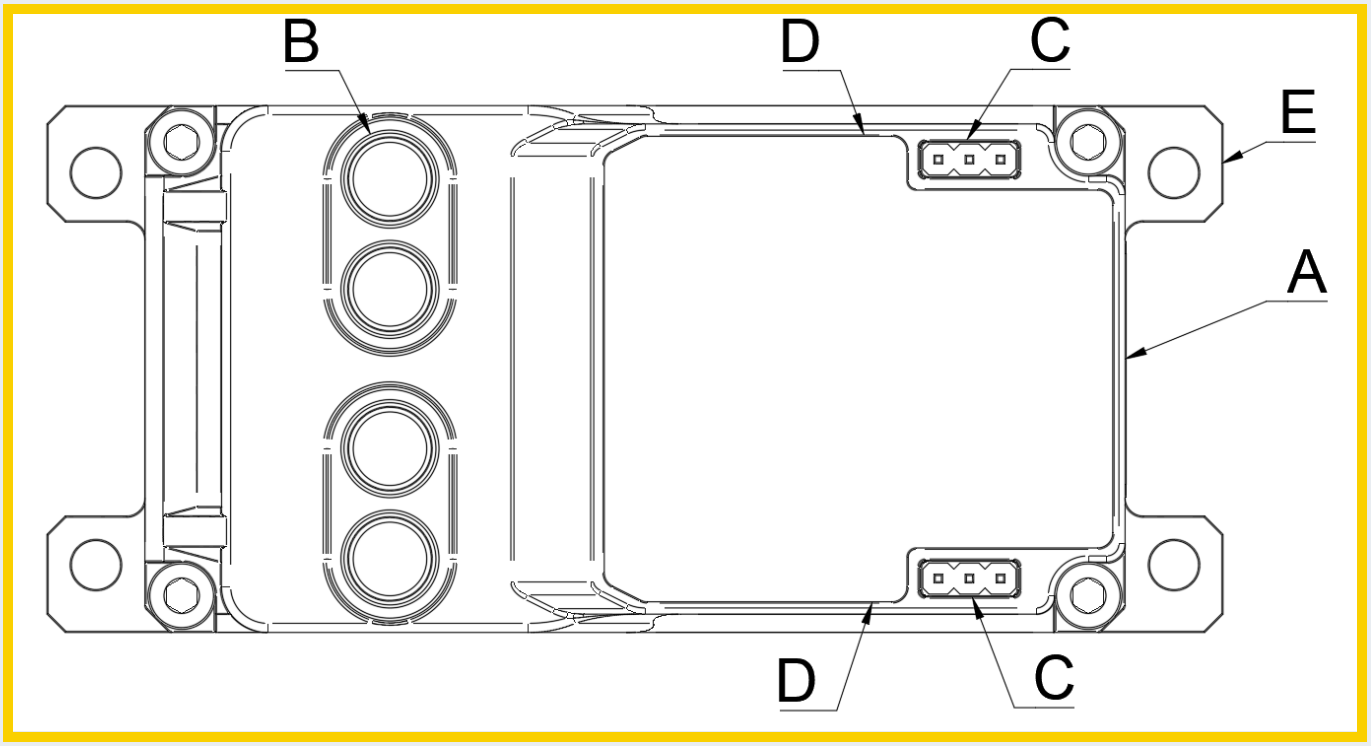
1 Hardware Overview



Hardware Overview		
ID	Name	Description
A	XT90 Input	Main Power Supply Connection
B	6mm Bullet Output	DC Motor Power Connection (Bidirectional)
C	IO	0.1” Header Pins / TJC8 Connector, Used as input for PWM control and output for 6.2V BEC
D	Status LEDs	LEDs for showing the status of each motor channel
E	Mounting Tabs	Aluminum Heat Sink mounting tabs (Thermally sink for best performance)

1.1 XT90 Input Connector

The Main Power connector is an XT90. This large power connector has the current capability of 90A continuously with minimal temperature rise. It is capable of passing significantly more current, but a temperature rise in the contacts will occur. The XT90 is a keyed connector, so its mating connector can only be inserted one way. When the included mating connector is wired correctly, the motor controller can’t be given reverse voltage. Note: Reverse voltage protection is embedded, making sure that even if power is applied in reverse, there will be no damage to the controller.

1.2 6mm Bullet Output Connector

The motor output terminals are 6mm female bullet connectors. This connector was selected for its high current capability, ease of use, and ruggedness. It is the connector of choice for all high power goBILDA® motors, making plug-and-play projects easy to assemble. The motor controller comes with (4) male bullets, allowing the user to solder male connectors to any two brushed DC motors.

1.3 Input/Output

The 0.1” Header Pins / TJC8 Connector, seen in Figure 1.1, serve two purposes. First, the pins labeled with an S are where the control PWM signal is input. Each pin labeled S controls the speed and direction of the corresponding motor channel. These signal pins are rated for 3.3 - 5V operation but have significant protection features. They are protected against ElectroStatic Discharge (ESD) events and over voltage events. Secondly, the pins labeled with +,- are used as an output for the 5A Battery Elimination Circuit (BEC). This is a switching buck converter that steps down the input voltage to 6.2V. This switching regulator can sustain 5A of continuous current and will burst up to 6A for 5 seconds. This supply is useful for many mobile robotics applications. Examples of devices that can be powered by the BEC include servos, low dropout linear regulators (LDOs), Arduinos, LED lights, etc.

Figure 1.1

1.4 Status LEDs

The motor controller has two status LEDs; one for each motor channel. When power is first applied, these status LEDs will briefly blink back and forth indicating the booting process. The table below shows the status LEDs blink-states.

State	STATUS LED (Blue)	FAULT LED (Red)	Beeping	Comments
Startup	Flashes quickly	Flashes quickly	Beeps 2 times	When ESC is first powered on
No signal or invalid signal (outside 500 to 2500µs)	OFF	ON	None	
Received signal within arm zone and output is now armed (1400 to 1600µs)	ON	OFF	Beeps 4 times	Within 4 seconds of power being applied to the ESC
Is armed and has a valid input signal (500 to 2500µs)	ON	OFF	None	
Is getting a valid signal (500 to 2500µs) but is not armed and not within Arm Zone	Blinks Slowly	OFF	Beeps slowly with status blink	
Temperature Protection	Continues to indicate status	Blinks 2 times while protection is active	None	Lowest blinking priority
Soft Current Protection	Continues to indicate status	Blinks 3 times while protection is active	None	2nd highest blinking priority
Hard Current Protection	OFF	Blinks 4 times continuously	None	Both outputs are unarmed. Highest blinking priority

1.5 Mounting Tabs

The aluminum bottom plate serves as a protective case and as a heat sink. It has four 4mm thru-holes that can be used for mounting. These dimensions can be seen in section 1.7.

2 Main Power Supply

The 2x80A Motor Controller is designed for mobile RC projects and thus should be used with a battery as its main power source. We recommended battery chemistries of Lithium Polymer (LiPo) or Lithium Ion (Li-ion). Other chemistries of batteries are acceptable so long as the battery you choose is capable of handling the current draw of your project.

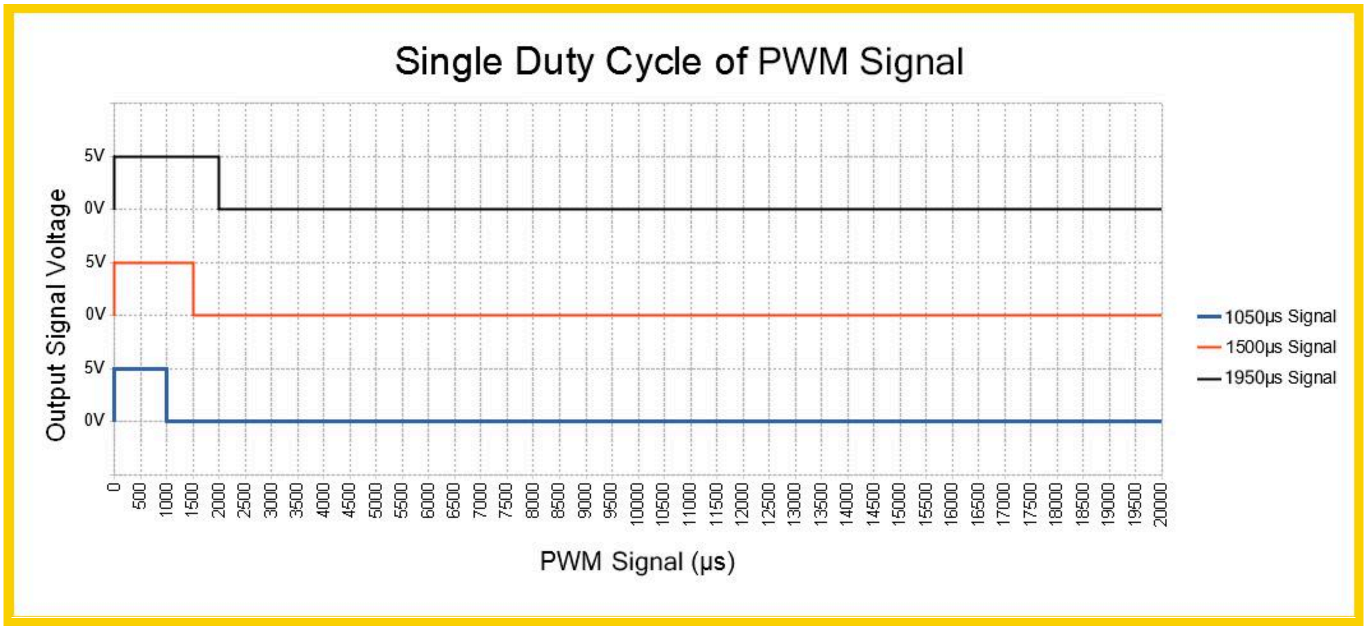
Given that the primary objective is RC and mobile robotics, the best configuration of this controller is to be in a brake mode when no signal is applied, or when a signal of 1500 is supplied. This means that a motor will not freely spin when it is not intended to be. This scheme is very advantageous in any mobile platform. This type of control scheme can feed voltage back to the supply. This normally is not an issue with batteries, but it may prove to be detrimental in a switching power supply (AC to DC converter). Often the over-voltage protection of a power supply will shut down the supply if a voltage spike is detected.

If a switching power supply (AC to DC converter) is used in your application, a shunt voltage suppressor is required for consistent and reliable operation with this type of supply. A shunt voltage suppressor will sense and suppress any voltage spikes that are created and keep the voltage within spec of the supply. These voltage spikes typically scale with the size of the motor.

Summary: Batteries are the best power source for this motor controller; if a switching supply is used, a voltage suppressing circuit must also be used.

3 Control Interface

Speed control is achieved by an RC PWM control interface used in basic RC transmitters and receivers. This RC PWM sends information in the duty cycle to dictate the direction and power output of each motor channel. RC PWM is a 50Hz signal with a period of 2ms, or 20,000μs. The duty cycle of this signal should be between 5% and 10%. Typically when referring to this signal we talk about the time that the square wave is high. This 5-10% duty cycle typically refers to the range of 1050μs to 1950μs when the signal is high, leaving the rest of the time the signal is low.



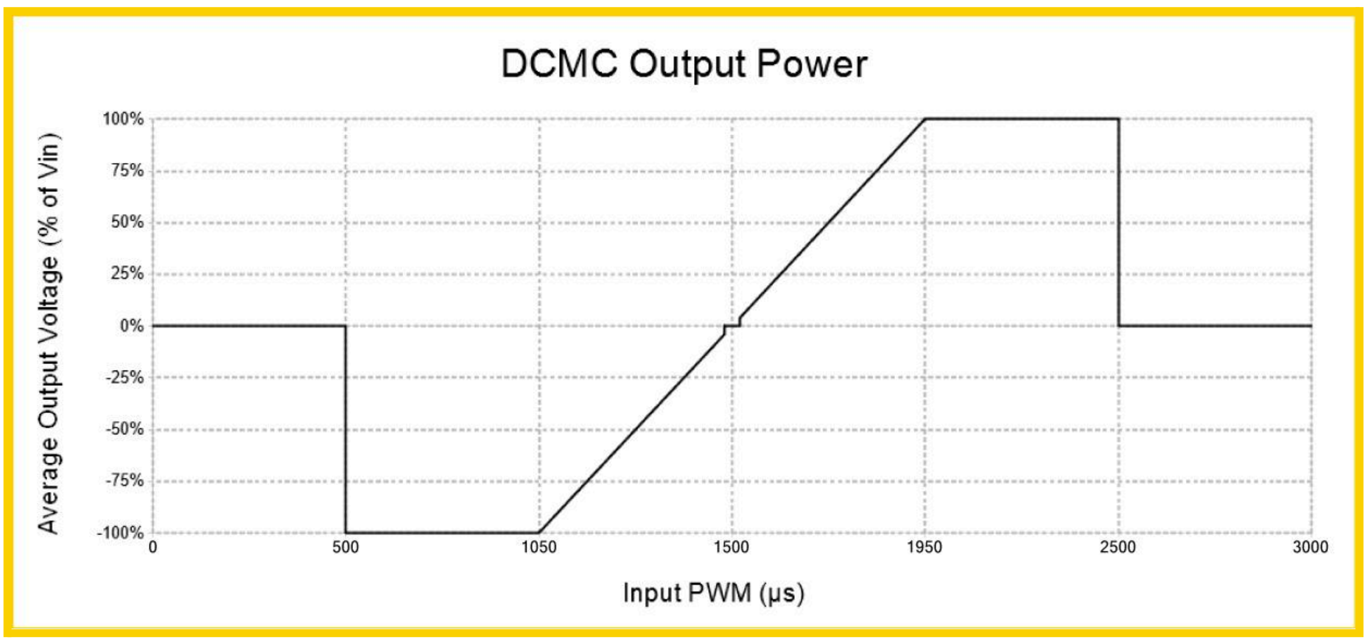
Key Signal Terms	
Valid Signal	500μs - 2500μs
Proportional Output Range	1050μs - 1950μs
Deadzone	±10μs (1490μs - 1510μs)
Armzone	±100μs (1400μs - 1600μs)
Armed	The motor output is enabled and will respond proportionally to the input signal

With this basic understanding of an RC PWM signal, we can discuss how to control each channel of the motor controller. The first step is to ***Arm*** each channel. This is a safety feature to ensure the motors will be at or close to zero speed when a PWM signal is first applied. When a ***Valid*** **Signal** (500µs to 2500µs) is applied to the motor input, the status LED will blink slowly indicating it is receiving this signal and that it is formatted correctly. To ***Arm*** each channel, simply provide a signal inside the ***Arm zone*** (1400µs - 1600µs) for two seconds. When armed the LED will switch from a slow blink to a fast blink.

Once ***Armed,*** a 1050µs to 1950µs input signal will have a proportional output on each channel. Above and below this range(1050µs - 1950µs) the motor outputs will be fully on in each direction until the signal reaches the limit of what is considered a ***Valid*** **Signal (**500µs - 2500µs). Outside this valid range, the motor controller considers the signal to be invalid and will disarm the channel and turn the output off.

Another important behavior is the ***Deadzone****.* The motor controller's output will be off inside this range. Some receivers or signal generators such as Arduinos may not be able to generate a perfect 1500µs signal reliably to turn the output off under normal operating conditions. Thus a ***Deadzone*** of ±10µs is applied to the center (1500µs) of the input range to account for potential signal variance. The deadzone ensures your motors won't become energized unintentionally, and assists in preserving battery power. This is advantageous for preserving battery power in applications where power is limited.

Below is a complete graph illustrating the Motor Output Average Voltage vs. Input PWM

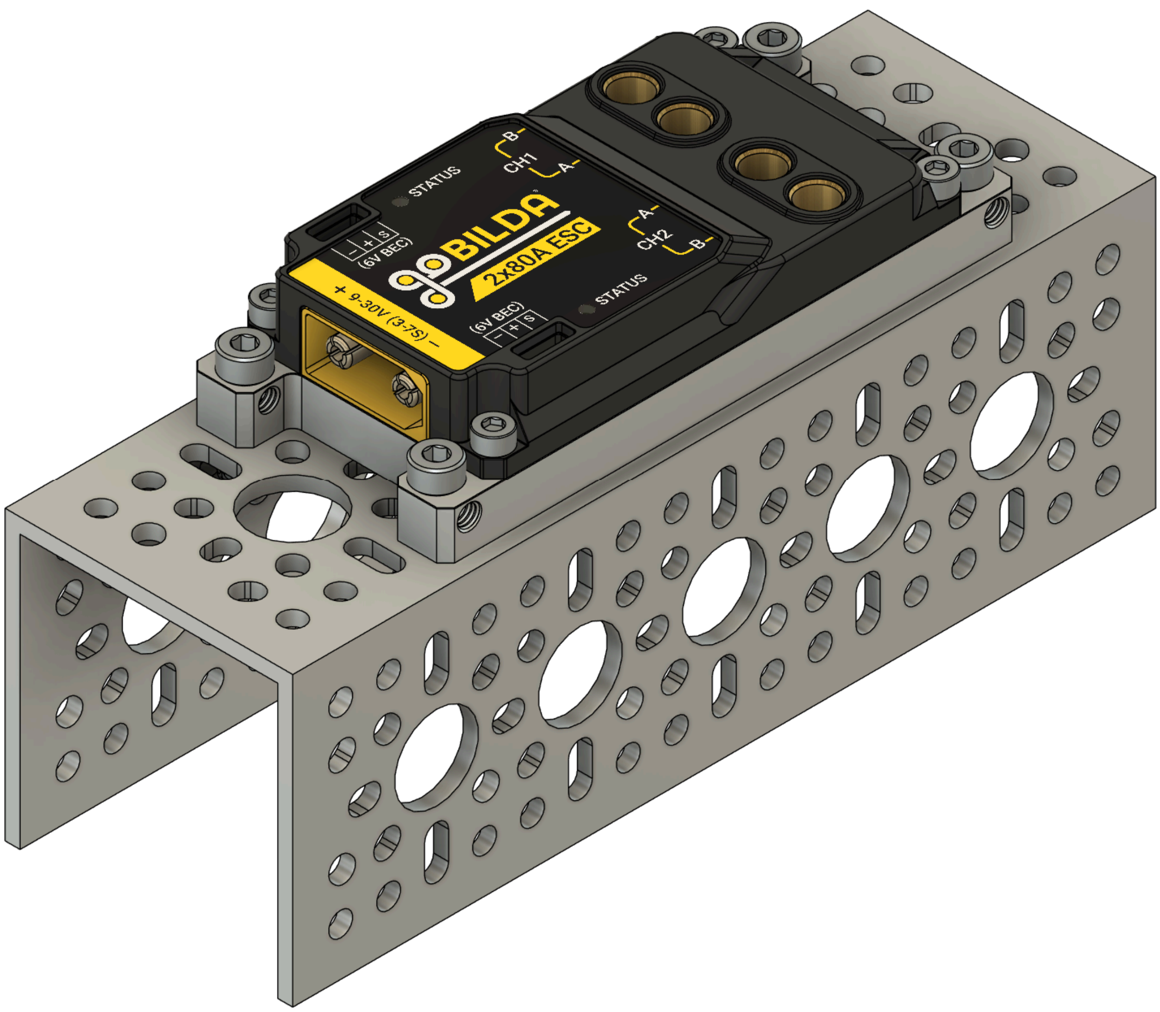


Note: The *Deadzone* seen in the center of this graph is exaggerated to make it easier to see. In practice this range is negligible.

4 Cooling

Keeping the Motor Controller cool is a key aspect of ensuring long life and optimal performance. All components that generate significant heat are thermally connected to the aluminum bottom plate, allowing for high current capabilities. Under large loads, the motor controller will generate enough heat to saturate the bottom aluminum plate. Temperature sensors are used in key areas to monitor the temperature and reduce the output power delivered if the Motor Controller gets too hot. The temperature in which it begins to limit the output power is approximately 80°C; this temperature is taken on the PCB and thus the temperature of the heat sink will likely be lower when limiting occurs. When an overtemp condition occurs, the amount of current allowed to pass through the overheated channel is dropped from 160A down to 80A until the temperature returns to a safe operating temperature.

It is advised to thermally connect the controller's aluminum bottom plate to a metal object to increase the thermal mass of the controller. goBILDA U-Channel works well for this but any metal connected to it will help.



Important Note: This aluminum base plate is electrically connected to the protected ground of the controller.

5 Safety Features

5.1 Reverse Voltage Protection

The 2x80A Motor Controller has reverse voltage protection that is implemented in two forms. First, the XT90 main power connector is keyed so that the mating XT90 connector that is delivering power must be plugged-in with the proper orientation. Reverse voltage protection circuitry has been implemented that protects the entire board. This circuit will stop current flow through the Motor Controller and will work at a maximum of -30V on the main power connectors.

5.2 Current Limit Protection

Current Limit is defined as limiting the output current to a specified amperage, regardless of the load or how that power is applied. Current is limited on both motor channels as well as the BEC switching regulator on this motor controller. Each motor channel is independently limited to 160A of current and will not exceed this limit. If a load that will draw greater than 160A is applied, the motor controller will “chop” and regulate the output to sustain 160A. This limit is adjusted by the controller when over temp conditions are met, dropping it to 80A.

5.3 Short Circuit Protection

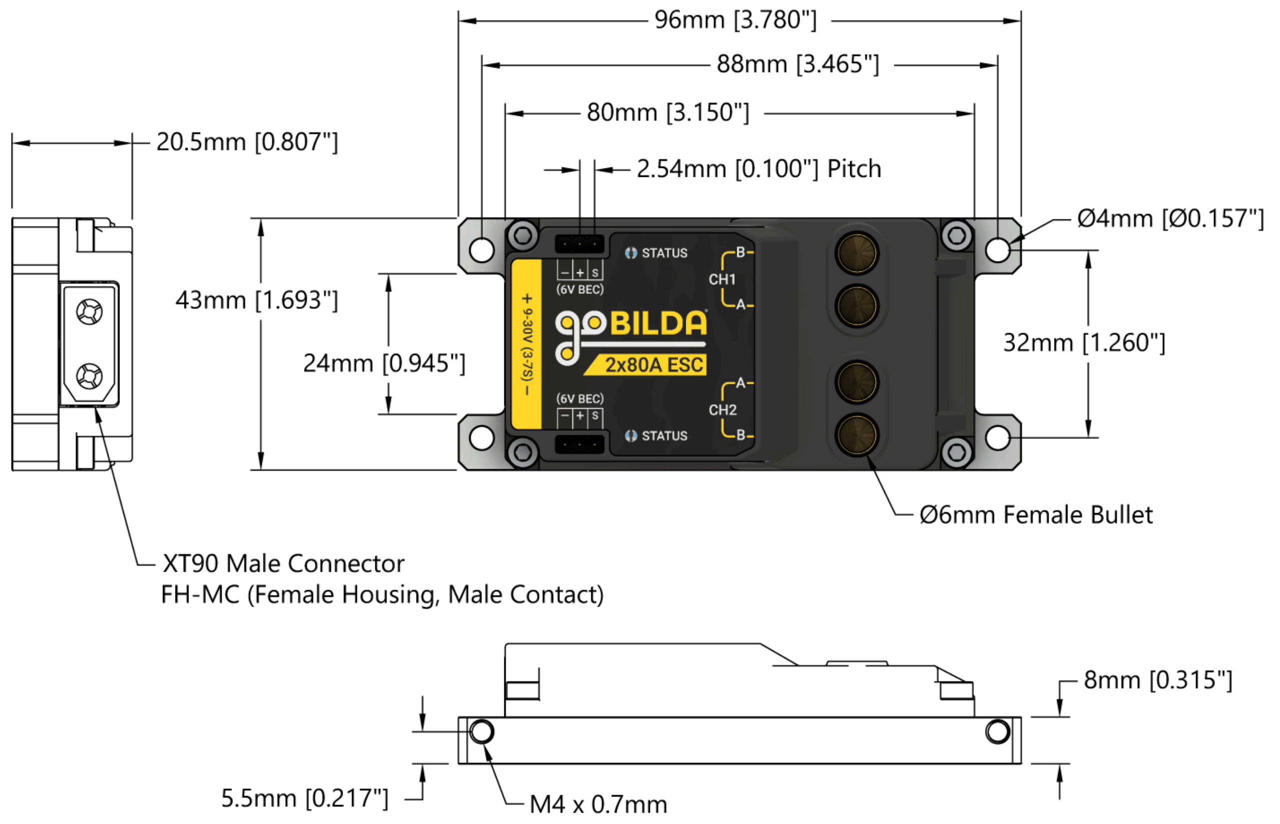
The motor outputs and the BEC switching regulator both have short circuit protection. This protection prevents component damage in the following conditions. Direct connection across motor output terminals, or from the 6.2V (BEC) and ground. For each of these systems, when a short circuit is detected, these circuits will turn off their outputs to prevent damage. The affected circuit(s) will attempt to “restart” their outputs at a given interval until the short is cleared.

5.4 Over Temperature Protection

Over Temperature Protection has been implemented to prevent thermal damage to any of the components or PCB. Each of the motor outputs are monitored by temperature sensors. When an overtemp condition occurs, the amount of current allowed to pass through the overheated channel is dropped from 160A down to 80A until the temperature returns to a safe operating range. The temperature in which it begins to limit the output power is approximately 80°C. This temperature is taken on the PCB and thus the temperature of the heat sink will likely be lower when current limiting occurs.

Alternatively, the BEC also contains this protection feature. If a burst level of current is sustained for too long this circuit will enter an over temp shutdown and let itself cool down. When an over temp condition occurs, the circuitry will be protected; however the entire motor controller will shutdown until the temperature is reduced to safe operating temp. Typically this only takes a few seconds.

6 Schematic/Drill Guide



7 Datasheet / Revision History