



Protective Circuit Board (PCB) Manual

LiPO PCB V3.X

LiPO PCB Lite V1.X

Sales@ProjectWolfDragon.com

This PCB is designed to prevent damage to battery packs due to discharge beyond safe voltage levels by stopping an airsoft gun (AEG) from firing, thus preventing the main power draining activity from occurring. While initially designed for use with LiPO and similar chemistry cells, software is being developed to enable the use of this PCB with battery packs of other, more conventional cell chemistries.

This PCB does NOT protect the pack from OVERCURRENT draw, ALWAYS USE A PROPERLY RATED FUSE TO AVOID THE RISK OF PACK DAMAGE AND/OR FIRE.

This PCB is designed to be used primarily with the SW-COMPUTER by Gandolf at www.Extreme-Fire.com. Typical applications also include the Trigger Master MOSFET Trigger as well as the entire line of Gandolf's Computerized MOSFETs. Since all three of these MOSFET Triggers are functionally identical, the term SW-COMPUTER as used throughout this document refers to all of these products.

Special Note: This product assumes the buyer is able to disassemble and reassemble the AEG and possibly the mechbox fairly easily. Rewiring, soldering, and heat shrinking are necessary skills for installation of this product.



Table of Contents

Supported Run Modes by Software Version	Page 3
Using your PCB	Page 4
Figure 0: Logic Diagrams for ALL PCBs in Production	Page 6
MOSFET Trigger and PCB Install Guide	Page 7
Step 1: Identify Your Hardware	Page 7
Figure 1-1: 5 Wire MOSFET Wiring Diagram	Page 8
Figure 1-2: 6 Wire MOSFET Wiring Diagram	Page 8
Figure 1-3: SW-COMPUTER Wiring Diagram (Special 6 Wire MOSFET)	Page 8
Step 2: Adding a LiPO PCB V3.X to the Installation	Page 9
RECONFIGURING YOUR PCB (LiPO PCB V3.X ONLY)	Page 9
Figure 2-1: SW-COMPUTER and 2 Cell LiPO PCB V3.X	Page 10
Figure 2-2: SW-COMPUTER and 3 Cell LiPO PCB V3.X	Page 10
Figure 2-3: SW-COMPUTER and 4 Cell LiPO PCB V3.X	Page 11
Figure 2-4: PCB Connection to SW-COMPUTER, other Computerized MOSFETs Vary	Page 12
Step 3: Adding a LiPO PCB V3.X + Trigger Mod to the Installation	Page 13
Figure 3-1: 5 Wire MOSFET and 2 Cell LiPO PCB V3.X + Trigger Mod	Page 14
Figure 3-2: 5 Wire MOSFET and 3 Cell LiPO PCB V3.X + Trigger Mod	Page 14
Figure 3-3: 5 Wire MOSFET and 4 Cell LiPO PCB V3.X + Trigger Mod	Page 15
Figure 3-5: 6 Wire MOSFET and 2 Cell LiPO PCB V3.X + Trigger Mod	Page 15
Figure 3-6: 6 Wire MOSFET and 3 Cell LiPO PCB V3.X + Trigger Mod	Page 16
Figure 3-7: 6 Wire MOSFET and 4 Cell LiPO PCB V3.X + Trigger Mod	Page 16
TRIGGER MOD ADDONS	Page 17
Step 4: Adding a LiPO PCB Lite V1.X to the Installation	Page 18
Figure 4-1: LiPO PCB Lite V1.X and 2 Cell LiPO Pack	Page 18
Figure 4-2: LiPO PCB Lite V1.X and 3 Cell LiPO Pack	Page 18
Figure 4-3: LiPO PCB Lite V1.X and 3 Cell LiPO Pack	Page 18
Troubleshooting and FAQ's	Page 20
Warranty Information	Page 21
Request for Information	Page 22



Supported Run Modes by Software Version

Board	Code	Status
LiPO PCB V3.X	L**	IN PRODUCTION
LiPO PCB V3.X + Trigger Mod	M**	IN PRODUCTION
LiPO PCB Lite V1.X	C**	IN PRODUCTION
NiCD/NiMH/SLA PCB		PLANNED
2 Wire LiPO PCB (No balance port)		PLANNED
ALL-IN-ONE PCB		PLANNED

This section is revised with each code revision, check this section before you decide to reconfigure your PCB as outlined in the **Installation Guide (PCB V3.X ONLY)**.

- L01 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)
- L02 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)
- M01 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)
- M02 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)
- C01 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)
- C02 2, 3, and 4 Cell LiPO Battery Packs (Li-ION supported as well, Cell Voltages 3.7V Nominal)

The higher the numbers after the letter in the code, the more recent revision of the code it is, if your PCB is not using the most recent revision of code, do not worry, they all do the same job, the *02 revisions just have a special backdoor built into the code that lets me test the PCB in a super easy way prior to shipping. (*01 revisions still get tested the old way that takes about 5 minutes.)

The PCB is designed to function as a “watch dog” and stop the AEG from firing when a single cell of your battery pack drops below a predefined level; this preserves the capacity and charging abilities of the pack. Attempting to use your PCB in a manner in which is not supported by the software of the CPU will cause malfunction and possibly result in a damaged battery pack.



Using your PCB

NOTES:

1. LiPO PCB V3.X + TRIGGER MOD CANNOT be used with SW-COMPUTER MOSFET Triggers via SW-LINK connections to the AUX PORT of the SW-COMPUTER, the SW-COMPUTER will be confused and the PCB will NOT stop the SW-COMPUTER from firing your AEG. Conversely, a non-TRIGGER MOD PCB, cannot be used in a TRIGGER MOD application.
2. LiPO PCB Lite V1.X's cannot be used SW-COMPUTER MOSFET Triggers nor can they be converted to a TRIGGER MOD.

The reason for this is software incompatibility with the logic levels produced by each type of code. Refer to the logic diagrams later in this section if you are curious.

First, read this **ENTIRE** section and make sure that you understand how you need to connect your PCB as outlined in the **Installation Guide**.

To connect your PCB to the Battery Pack, you will need to use the supplied JST XH Harness, attach the female side (short wires) of the harness to the wiring for your battery pack's balancing port. The male side is to be attached to the PCB.

The **MOSFET Trigger and PCB Install Guide** section shows you what voltages should be on which pad, do yourself a favor and mock up the whole thing and use a meter to check out the connection from one end to the other **BEFORE** you solder and especially before you connect the battery to the PCB and your AEG. The PCB is bit tolerant of being hooked up incorrectly (should not smoke) but it still will not work correctly unless properly connected. If you still need help, email me and send pictures as well as describe your problem (sales@projectwolfdragon.com).

After you have made all of your battery connections, run a test of the startup sequence (with a fully charged battery)

For LiPO PCB V3.X Boards - do not connect the SW-LINK Cable or Trigger Mod wire

Power Up Test Sequence OK
Red/Green LED Twiddle
Red On While Yellow Blinks the Number of Cells
Only Green LED ON

For LiPO PCB Lite V1.X Boards - the Alarm Buzzer or LED can and should be connected

Power Up Test Sequence OK
Buzzer or Red LED/Yellow LED Twiddle
While Yellow Blinks the Number of Cells
Buzzer or Red LED/Yellow LED OFF

If your PCB is working properly (and if you connected the battery correctly) you will get those startup codes. If not, email me and I can help you (sales@projectwolfdragon.com).



All that remains is connecting your PCB to your MOSFET Trigger as outlined in the **Installation Guide** section. You will need to use the SW-LINK Cable or the prewired Trigger Mod wire. Again, do yourself a favor and mock up the whole thing and use a meter to check out the connection from one end to the other **BEFORE** you solder and especially before you connect the battery to the PCB and your AEG.

After all wires are soldered to their proper places on the PCB (and of course trimmed to your desired lengths), use the clear heat shrink to protect the PCB from shorts and make everything look nice. (Optimal temperature for shrinkage is $\sim 250^{\circ}\text{F}$ ($\sim 120^{\circ}\text{C}$), I use a hot hairdryer).

Startup Procedure:

1. Connect the PCB to the battery pack via LiPO Balancing Connector (Do **NOT** plug in AEG or pull the Trigger).
2. The PCB will boot up and go through its previously mentioned startup sequence.
3. Upon successful completion of the startup sequence, you can plug in the AEG (and wait for the SW-COMPUTER to finish its startup if it connected).
4. Plug in the battery pack to your AEG. If you are using a computerized MOSFET Trigger (and connected the PCB to the MOSET Trigger via the SW-LINK Cable) the normal ready to fire vibration will be much longer, this indicates that the PCB CPU and the MOSFET CPU are talking to each other properly.
5. Your AEG is now ready to fire.

NOTE:

The typical "ready to fire" vibration length of the SW-COMPUTER is significantly longer when the PCB is properly started and installed. Familiarize yourself with the normal "short" vibration length by powering up the SW-COMPUTER with the SW-LINK Cable disconnected from the AUX Port of the SW-COMPUTER prior to using your AEG with the PCB.

Always unplug the AEG before powering down the PCB. Do not leave the PCB connected to the pack when not in use, it draws a very small current and can drain the battery if you leave it on for an extended period of time.

LED Codes For LiPO PCB V3.X:

- Green ON, Yellow OFF, Red OFF – Normal State, Battery OK, GO Fire
- Green ON, Yellow ON, Red OFF – A cell has gone below 3.2 V, Caution Indication (Weak), GO Fire
- Green OFF, Yellow ON, Red ON – A cell has gone below 3.0V, Warning Indication (Dead), NO-GO Fire

LED/AUDIBLE Codes For LiPO PCB Lite V1.X:

- Yellow OFF, Buzzer / Red LED OFF – Normal State, Battery OK
- Yellow ON, Buzzer / Red LED OFF – A cell has gone below 3.2 V, Caution Indication (Weak)
- Yellow ON, Buzzer / Red LED Chirping or Blinking – A cell has gone below 3.0V, Warning Indication (Dead)

Special Note on Internal Operations:

The CPU on the PCB uses a rolling average method of determining cell voltage, meaning that the cell has to present low voltages for a few seconds before the error condition is indicated, this will help keep you firing when you need it and only stop you when there is a real problem. If you notice that your setup fires for a bit, stops and then keeps going, the rolling average needs to be looked at, your cells are nearing the end of their lifetimes, and/or your cells cannot safely keep up with the demands of your AEG. Contact me and we will come up with a solution (sales@projectwolfdragon.com).

Logic Diagrams:

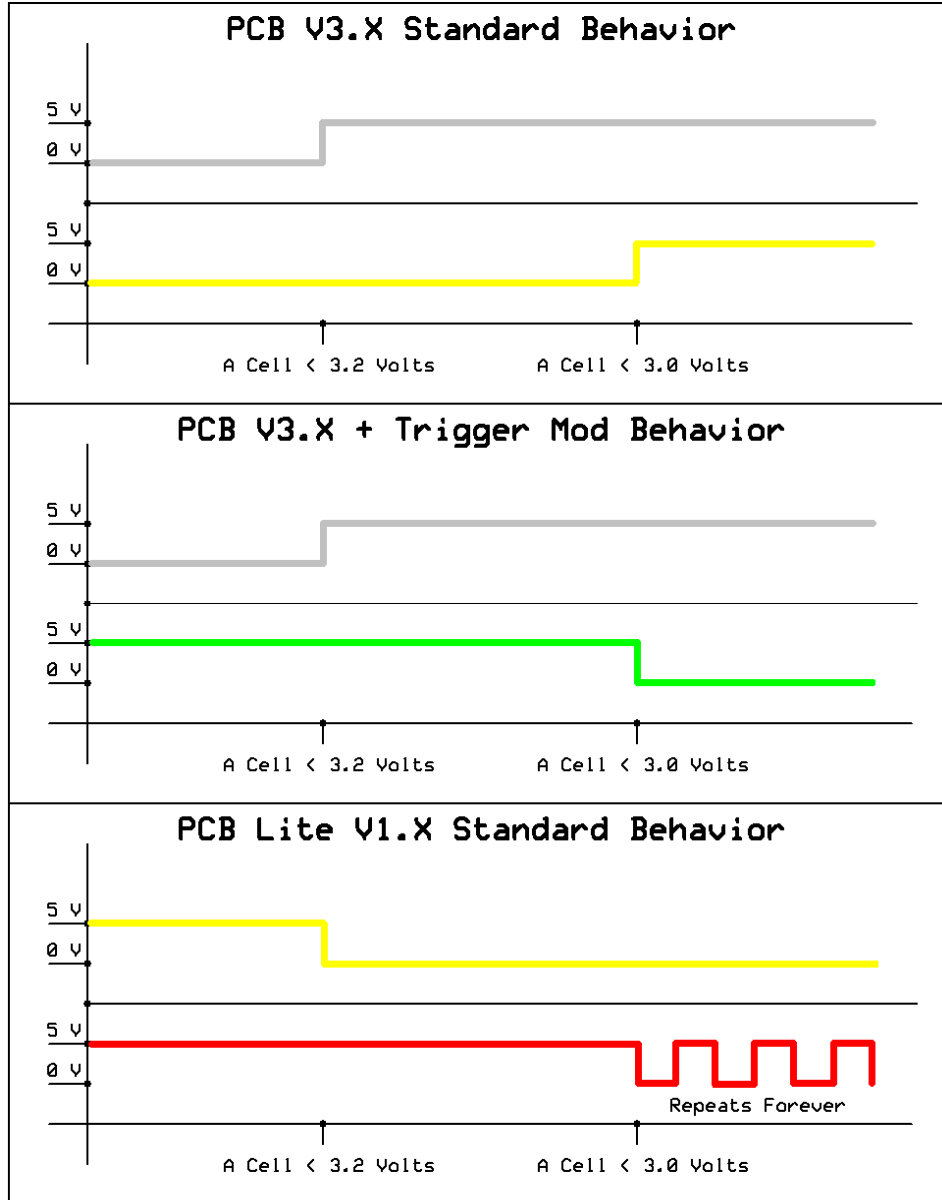


Figure 0: Logic Diagrams for ALL PCBs in Production



MOSFET Trigger and PCB Install Guide

The purpose of this document is to give a complete, but very simple overview on how to properly install a MOSFET Trigger as well as my PCB's into nearly any AEG. This guide assumes that the installer is capable of disassembling/reassembling his/her AEG as well as the ability to solder connections where no connector has been provided or wires have not been terminated. Additionally the knowledge of how to properly shrink heat shrink tubing is necessary.

Most all MOSFET Triggers fall into two categories: 5 wire and 6 wire configurations. Functionally these different types are identical; they are just wired slightly differently. Furthermore, the presence/absence of Active Braking has NO effect on the Figures shown below.

Step 1: Identify Your Hardware

Your MOSFET Trigger will have either 5 or 6 wires coming from it; think of the entire unit as a "Black Box" and just count. You will typically find the following: 2 Heavy Gauge Black Wires, 2 Heavy Gauge Red Wires, and either one or two smaller gauge wires. Provided the manufacturer of your MOSFET Trigger was nice enough, these wires should be labeled. The key here is to know which Red/Black pair is for the Battery and the Motor. The other important bit of information is to know what each of the smaller wires does. If your MOSFET Trigger is the 5 wire variety, the 5th wire is simply the Gate Control wire; I call this the Gate wire since it controls the Gate pin of the MOSFET(s) used in your MOSFET Trigger. If your MOSFET Trigger is the 6 wire variety, one of these smaller wires is just an extension of the Red Wire for the Battery; this is the Trigger Power (T Power or short) wire for the Trigger Contacts. Use a multimeter set to ohm mode and look for the meter to read 0.00 (a "dead short") to verify the connection between the Trigger Power wire and the Battery Red wire.

Refer to the three following figures if you plan to install only a MOSFET Trigger in your AEG. If you plan to install a PCB V3.X to use with your MOSFET Trigger, go to Step 2. If you plan to install a PCB V3.X + Trigger Mod to use with your MOSFET Trigger, go to Step 3. If you plan to install a PCB Lite V1.X, go to Step 4.

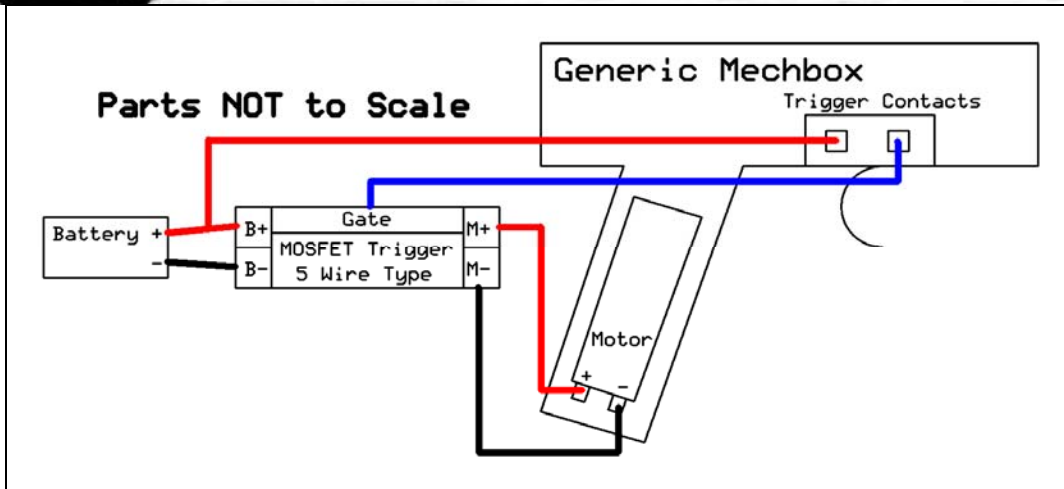


Figure 1-1: 5 Wire MOSFET Wiring Diagram

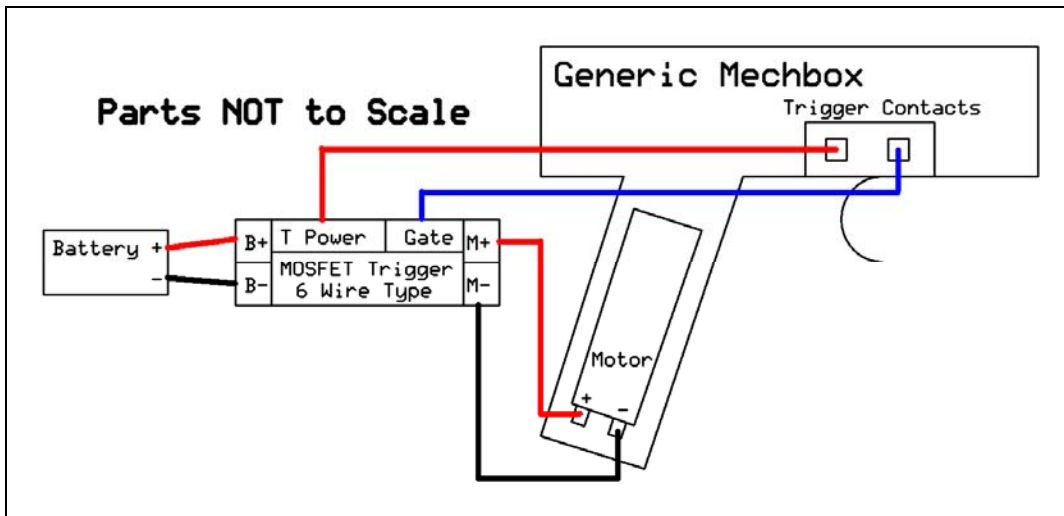


Figure 1-2: 6 Wire MOSFET Wiring Diagram

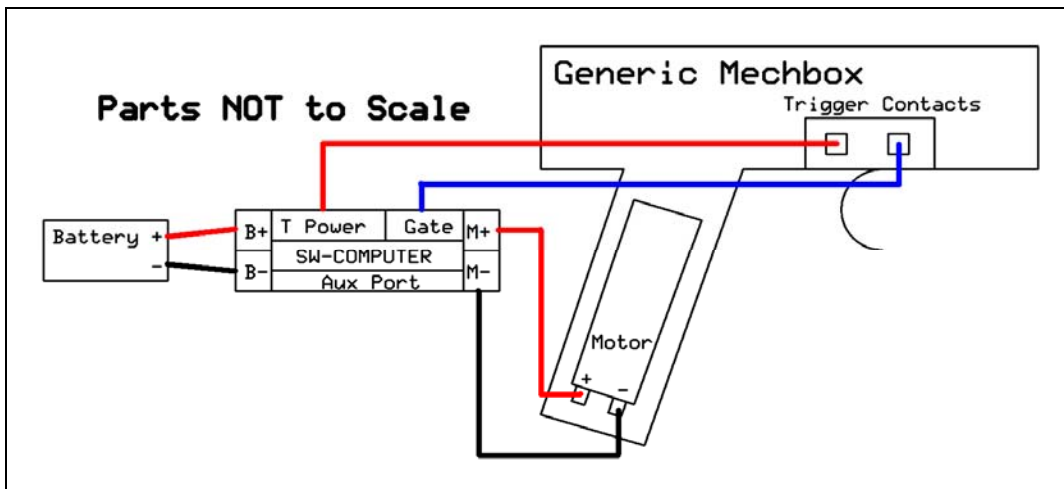


Figure 1-3: SW-COMPUTER Wiring Diagram (Special 6 Wire MOSFET)



Step 2: Adding a LiPO PCB V3.X to the Installation

If your hardware matches up to Figure 1-3: SW-COMPUTER Wiring Diagram (Special 6 Wire MOSFET), verify that the software is version 2.7 or higher. If it is not, contact Gandolf at salaes@Extreme-Fire.com for a replacement chip.

If your hardware does not match Figure 1-3 (MOSFET Trigger is not an SW-COMPUTER), go to Step 3.

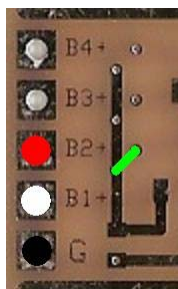
Your LiPO PCB V3.X will be configured as requested when ordered, if you cannot remember how you ordered your PCB, look at the back label, it is printed there along with other information about the PCB. With the configuration in hand, match your hardware and PCB to the following Figures. Specific connection information will follow the Figures.

RECONFIGURING YOUR PCB (LiPO PCB V3.X ONLY)

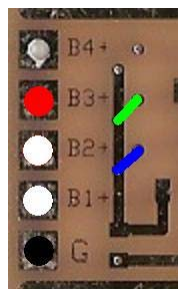
I do not recommend reconfiguring your PCB as such a modification (as with all) will void the warranty of your PCB. However, if you need to use a different battery pack, and the software revision supports your intended battery pack (refer to **Supported Run Modes By Software Version**).

The software inside of the PCB is smart enough to realize (when the pack is connected properly) what battery pack it is supposed to be protecting. Verification of this is found during the startup process when the YELLOW LED blinks the number of cells in the pack. However, the power supply for the PCB is NOT self configuring. The following figures outline where the power supply jumper should be installed to ensure proper operation. Ideal or multiple platform capable jumper positions are in BLUE, these are the LOW POWER positions, if your pack is sufficiently weak/old, you may encounter a supply problem (low voltage dropout) which will result in the PCB rebooting and causing the SW-COMPUTER and/or TRIGGER MOD to behave very strangely. The recommended jumper positions are in GREEN and indicate the HIGH POWER positions; these will not have low voltage dropout problems, but are pack type specific. From me, your PCB will have HIGH POWER jumpers installed. Included in the figures are colored dots to indicate where wires should be landed on the B1+ to B4+ pads. Refer to the later figures of this step for proper voltages of each landed wire.

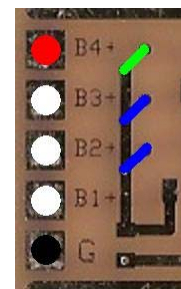
IMPORTANT: INSTALL ONLY ONE (1) POWER SUPPLY JUMPER, INSTALLING MORE WILL SHORT INDIVIDUAL CELLS AND DAMAGE YOUR BATTERY PACK



2 Cell LiPO



3 Cell LiPO



4 Cell LiPO

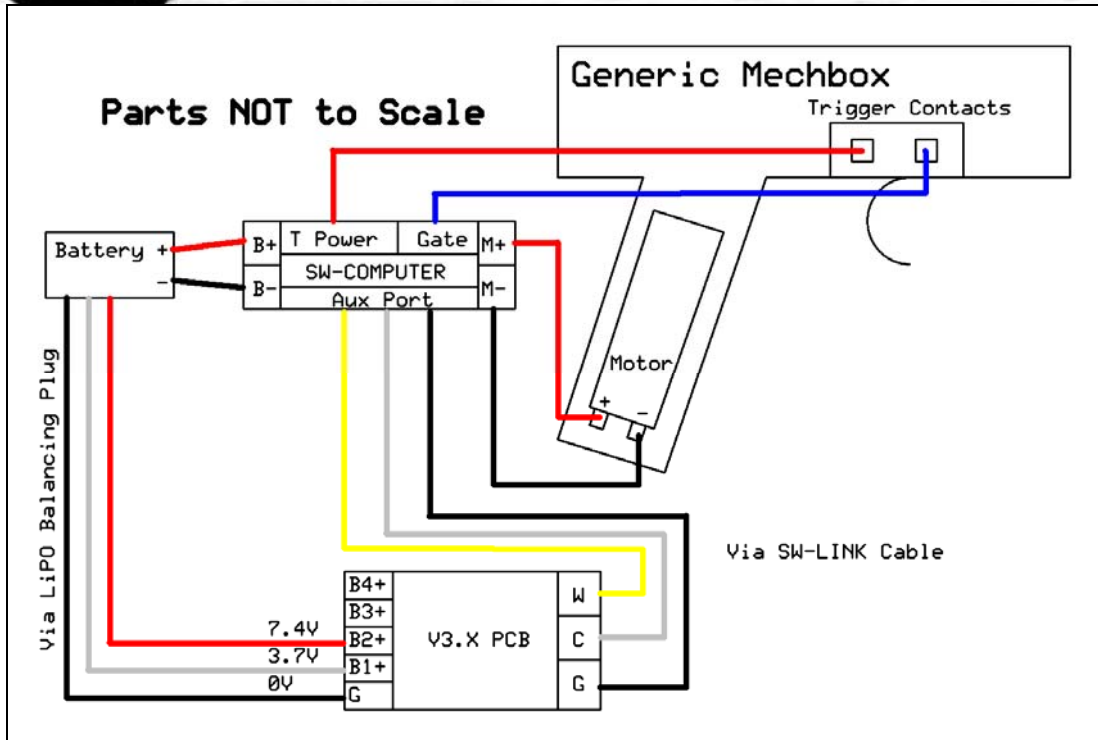


Figure 2-1: SW-COMPUTER and 2 Cell LiPO PCB V3.X

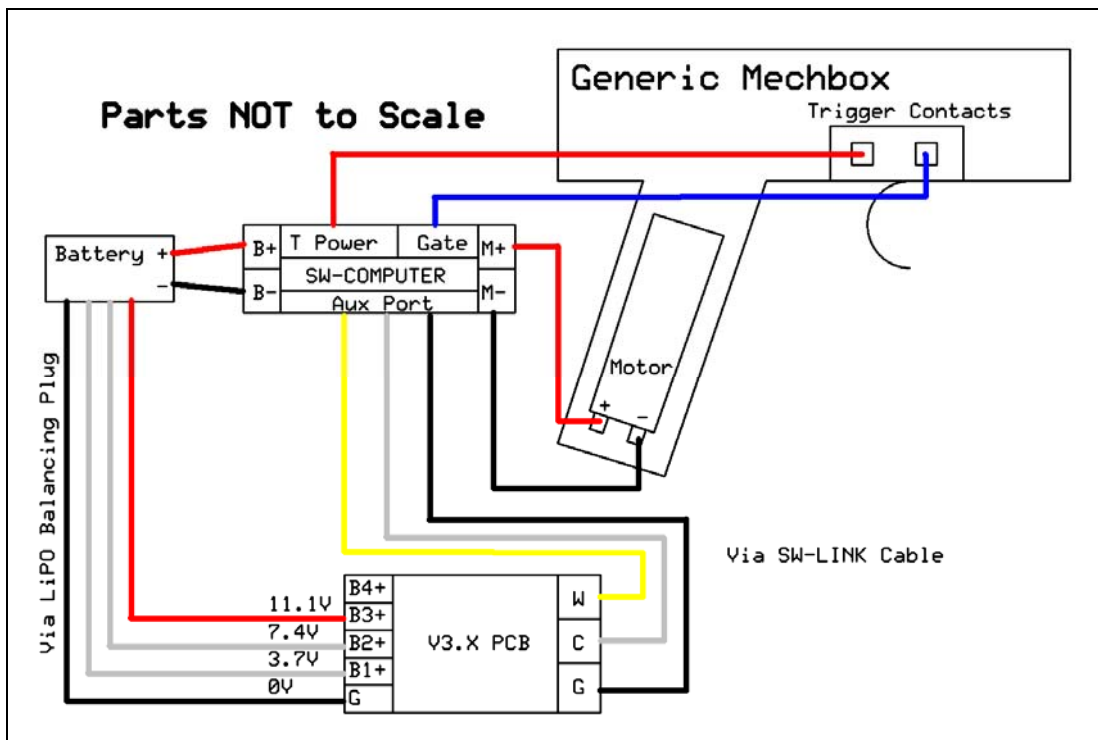


Figure 2-2: SW-COMPUTER and 3 Cell LiPO PCB V3.X

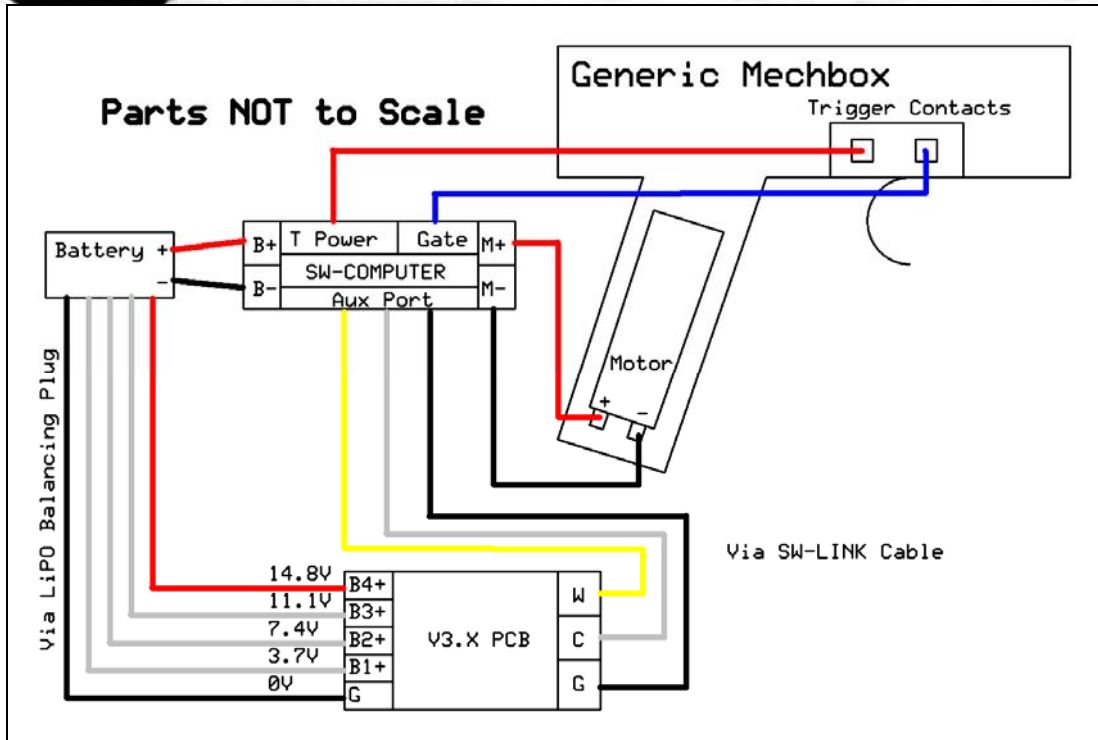


Figure 2-3: SW-COMPUTER and 4 Cell LiPO PCB V3.X

Due to the fact that these images have a white background, I had to cheat a little on the coloring of the wires. I will ALWAYS use WHITE wires for B1+, B2+, B3+, and C where indicated by GREY.

The connection from the Battery Pack to the PCB is typically made through the use of a JST XH Series plug, I will send you a Male/Female plug set to match your requested configuration with wires connected for you to wire up yourself.

IMPORTANT:

B1+, B2+, B3+, and B4+ are labeled with the appropriate voltages each wire is meant to see on a nominally charged pack (your numbers will be slightly higher on a fully charged pack). You are just looking for the steps in voltage between each wire. These wires MUST be properly connected to avoid damaging both the Battery Pack and the PCB. Additionally, do NOT leave the PCB connected to your pack when not in use, it pulls a small amount of current when "idle" and can over discharge your pack (which is what I made it to prevent by not letting the AEG fire).

The connection from the PCB is made through the use of the SW-LINK Cable which is a connection to "SW-COMPUTER" (I use the term exactly in this instance) AUX PORT is made simple by a pin header, connect as shown in Figure 2-5. This connection can be made permanent using either tape or glue if you intend to leave the PCB inside your AEG.

If you are using a Computerized MOSFET Trigger that is not an "SW-COMPUTER" the Black wire is Ground, Yellow goes to Pin 1 of the CPU, and White goes to Pin 2 of the CPU.

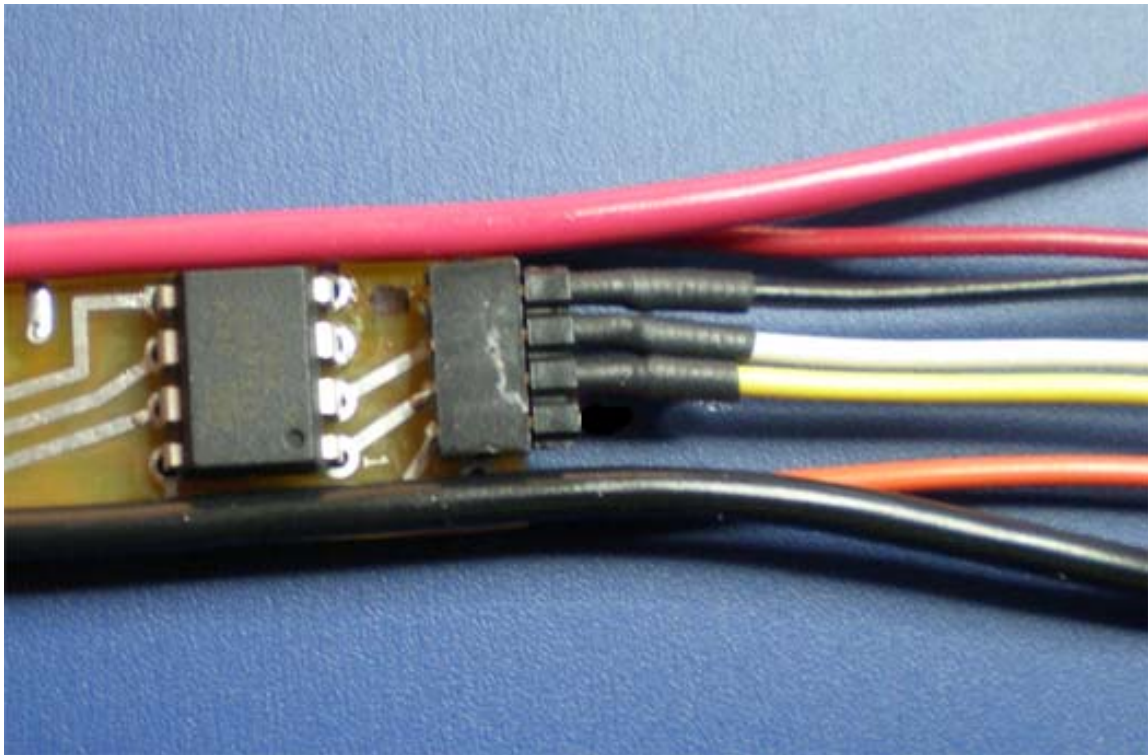


Figure 2-4: PCB Connection to SW-COMPUTER, other Computerized MOSFETs Vary



Step 3: Adding a LiPO PCB V3.X + Trigger Mod to the Installation

The Trigger Mod is an official mod to my PCB's that allows for practically any MOSFET Trigger to use my PCB's. This is made possible by making the PCB provide Trigger Power (T Power) for your setup, rather than using the one provided by your MOSFET Trigger, or by a jumper from the Battery Red Wire. Make sure that the T Power Wire provided by your MOSFET Trigger is wrapped in tape or just cut off to prevent it from shorting against the Mechbox or anything else in your AEG.

However, unlike the SW-COMPUTER application, the Trigger Mod does not generate a Low Voltage Caution; instead it just stops the AEG from firing when the Warning Voltage has been reached.

Your PCB will be configured as requested when ordered, if you cannot remember how you ordered your PCB, look at the back label. With the configuration in hand, match your hardware and PCB to the following Figures. Specific connection information will follow the Figures.

THE TRIGGER MOD USES SOFTWARE THAT IS INCOMPATIBLE WITH THE SW-COMPUTER, CONNECTING A TRIGGER MOD PCB TO THE AUX PORT OF THE SW-COMPUTER VIA SW-LINK CABLE WILL NOT DAMAGE THE SW-COMPUTER, BUT THE PCB WILL NOT CONTROL THE FIRING SEQUENCE OF THE SW-COMPUTER.

CONVERSELY, A NON TRIGGER MOD PCB WILL NOT FUNCTION AS A TRIGGER MOD PCB DUE TO THE SAME SOFTWARE INCOMPATIBILITY.

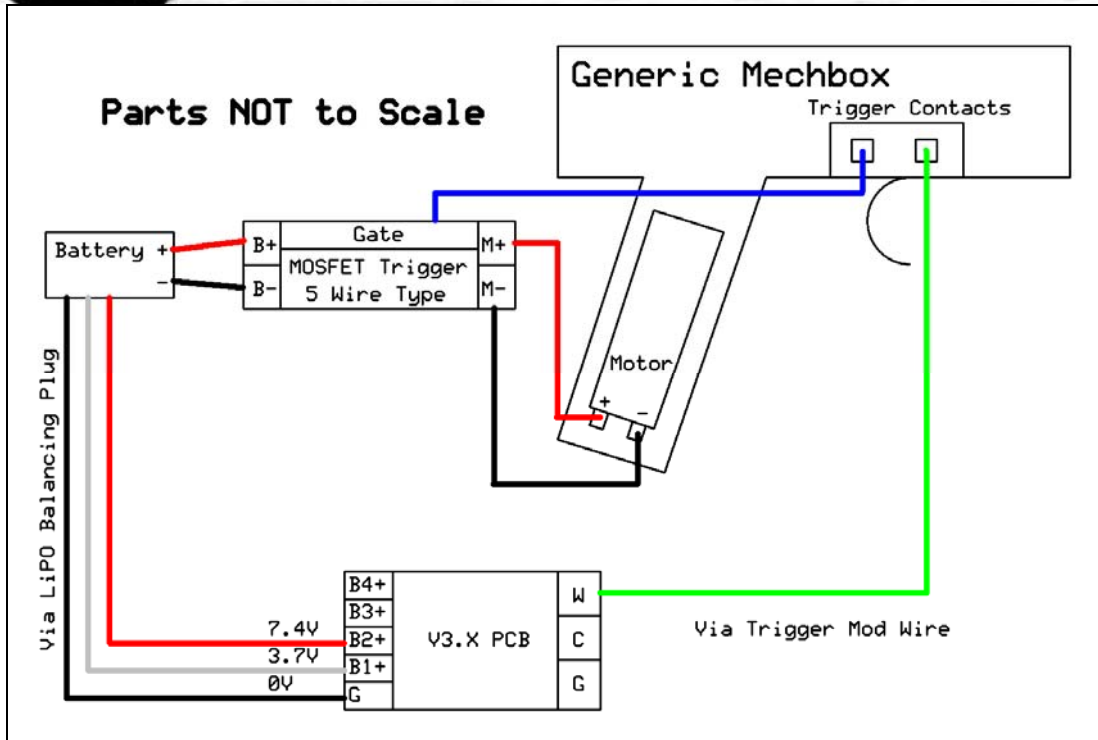


Figure 3-1: 5 Wire MOSFET and 2 Cell LiPO PCB V3.X + Trigger Mod

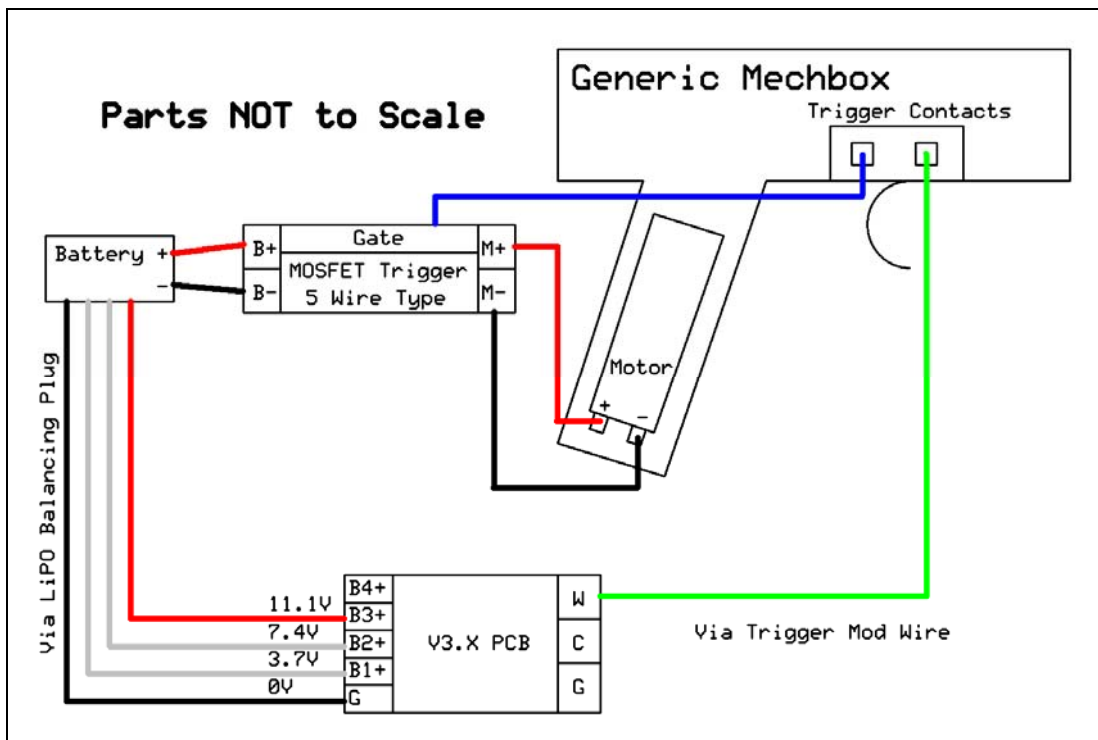


Figure 3-2: 5 Wire MOSFET and 3 Cell LiPO PCB V3.X + Trigger Mod

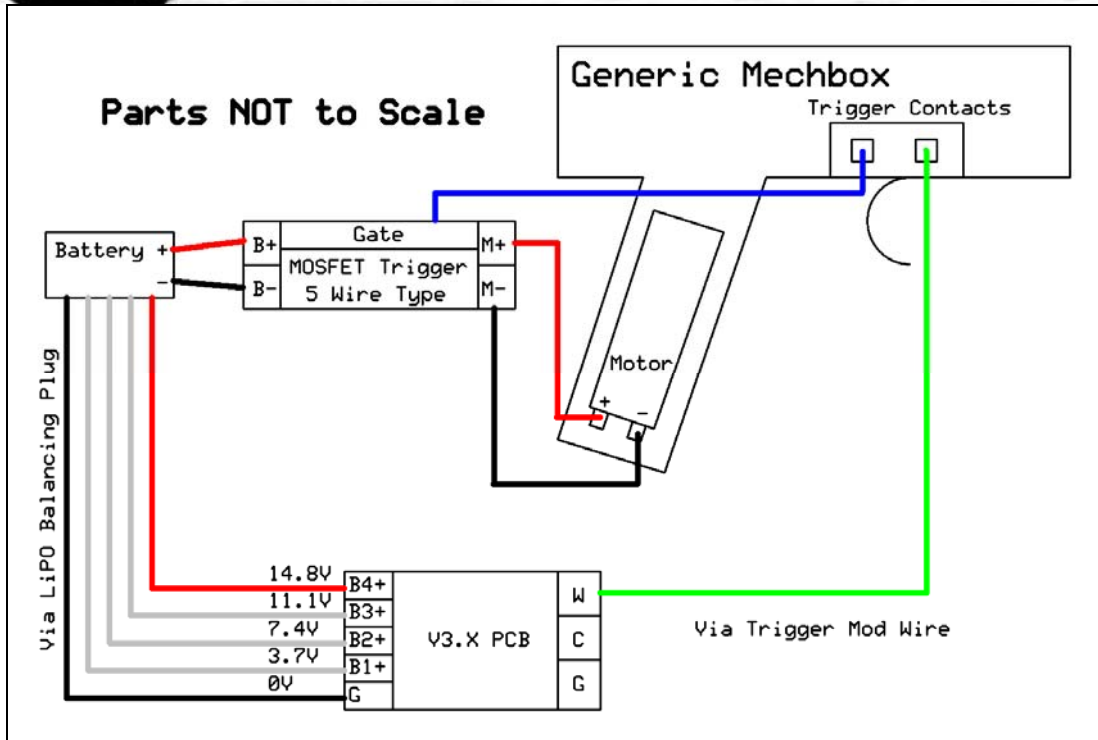


Figure 3-3: 5 Wire MOSFET and 4 Cell LiPO PCB V3.X + Trigger Mod

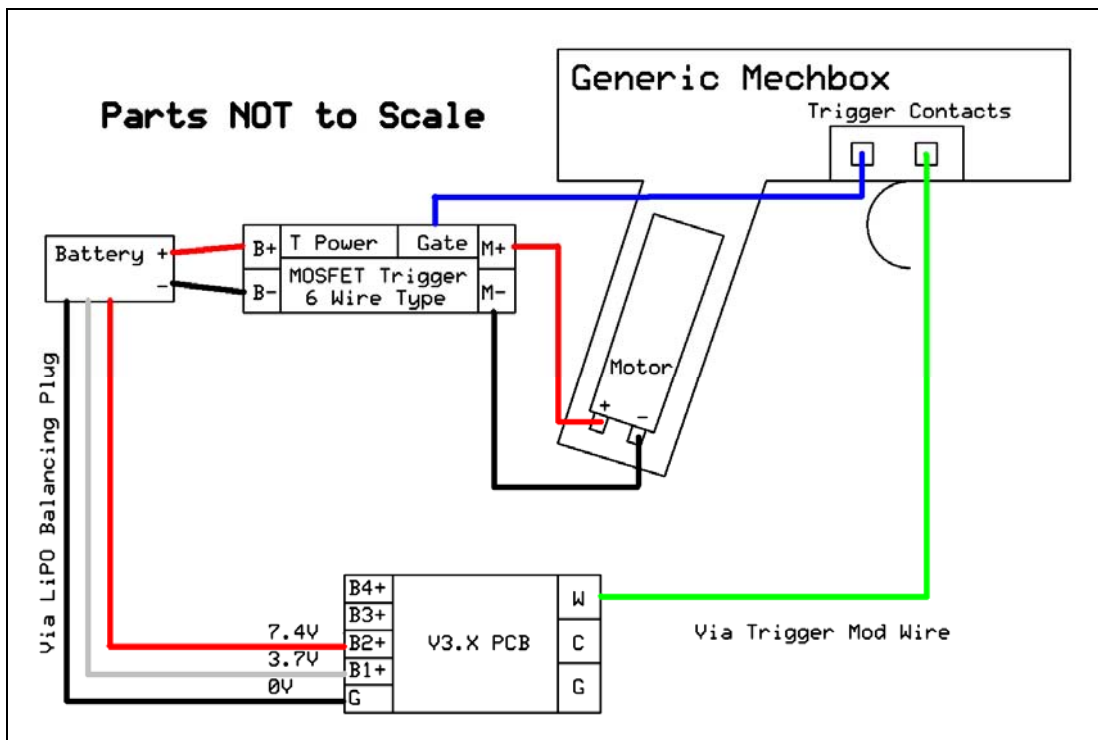


Figure 3-5: 6 Wire MOSFET and 2 Cell LiPO PCB V3.X + Trigger Mod

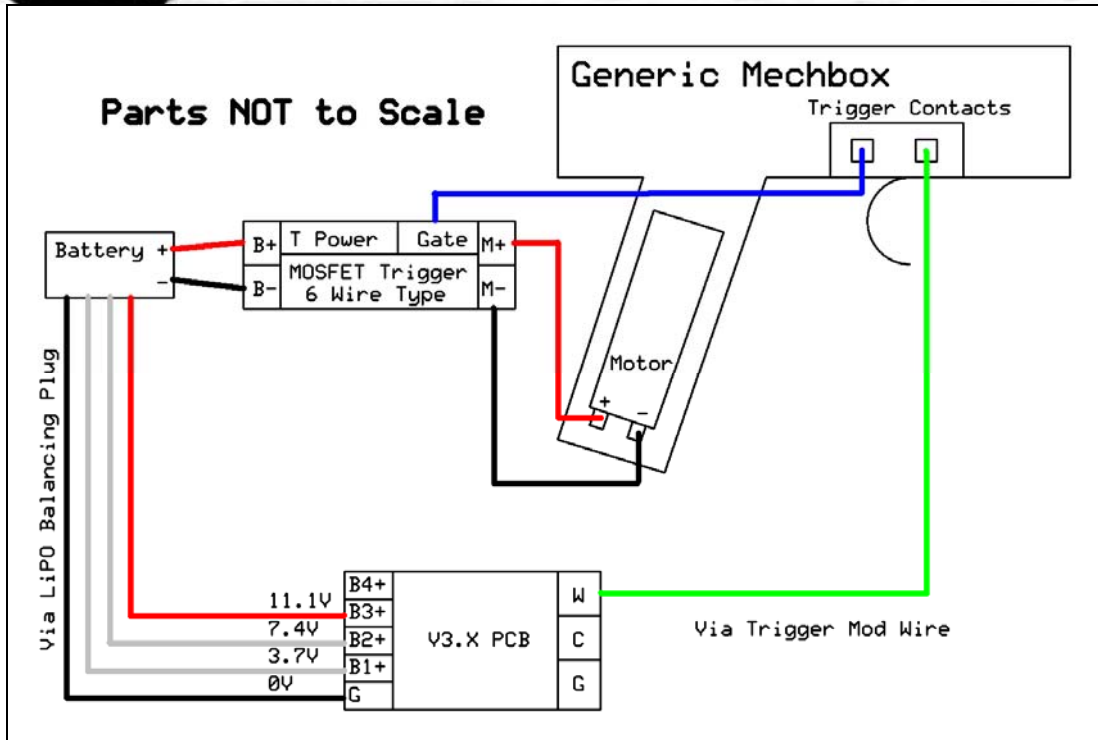


Figure 3-6: 6 Wire MOSFET and 3 Cell LiPO PCB V3.X + Trigger Mod

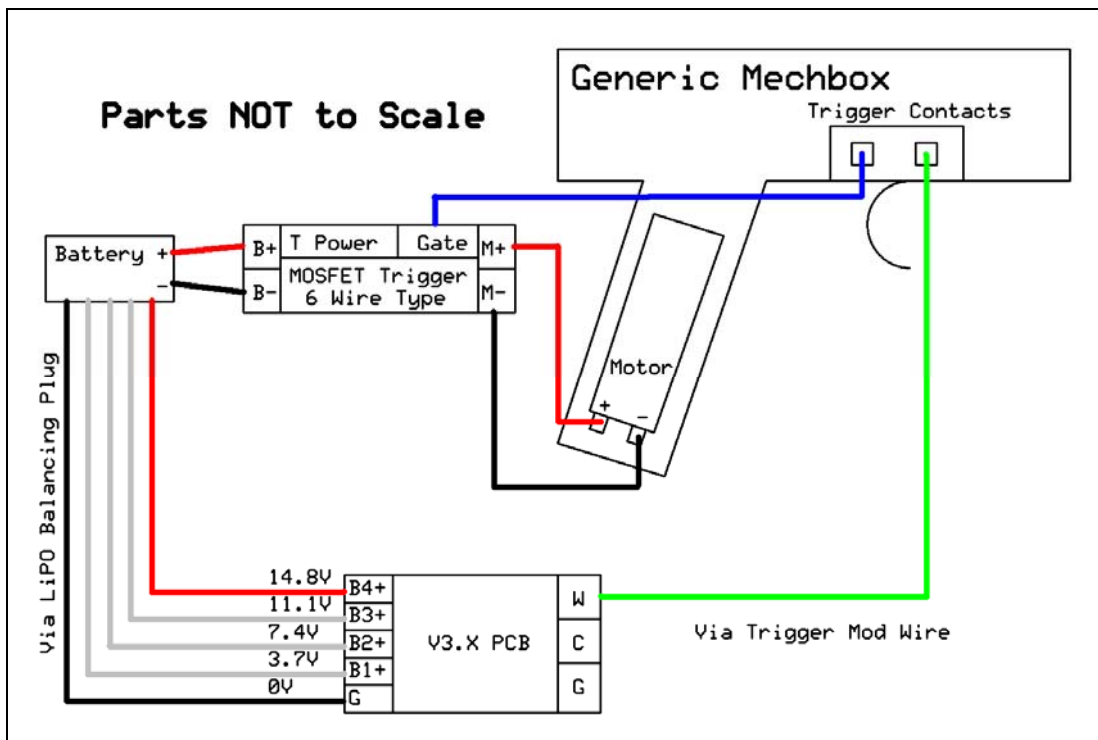


Figure 3-7: 6 Wire MOSFET and 4 Cell LiPO PCB V3.X + Trigger Mod



Due to the fact that these images have a white background, I had to cheat a little on the coloring of the wires. I will ALWAYS use WHITE wires for B1+, B2+, B3+, and C where indicated by GREY.

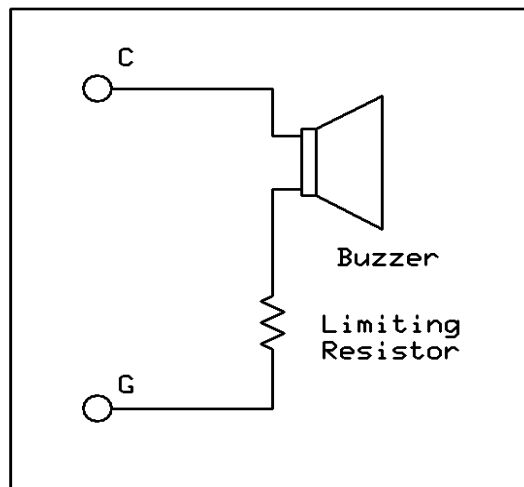
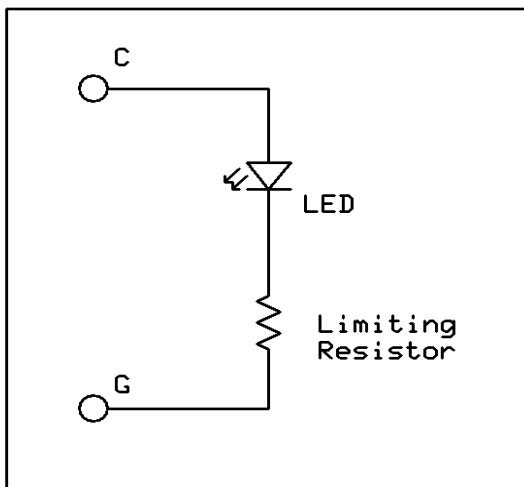
The connection from the Battery Pack to the PCB is typically made through the use of a JST XH Series plug, I will send you a Male/Female plug set to match your requested configuration with wires connected for you to wire up yourself.

IMPORTANT:

I labeled B1+, B2+, B3+, and B4+ with the appropriate voltages each wire is meant to see on a nominally charged pack (your numbers will be slightly higher on a fully charged pack). You are just looking for the steps in voltage between each wire. These wires MUST be properly connected to for the PCB to function properly. Additionally, do NOT leave the PCB connected to your pack when not in use, it pulls a small amount of current when "idle" and can over discharge your pack (which is what I made it to prevent by not letting the AEG fire in the first place).

TRIGGER MOD ADDONS:

These two schematics outline how to add a low battery Caution to the Trigger Mod of the PCB. The limit for power consumption from pad C is 30mA. This is plenty of power for running a LED or a buzzer. Switches can be added to turn off the LED or buzzer after you have been alerted to the low battery state and not blow your cover. Be sure to match the limiting resistor to your LED or buzzer. Voltage at C is either 0 or 5 volts, battery good and low battery respectively. If you do not know how to choose these components, email me at sales@projectwolfdragon.com and I can help you.



Step 4: Adding a LiPO PCB Lite V1.X to the Installation

The software inside of the PCB is smart enough to realize (when the pack is connected properly) what battery pack it is supposed to be protecting. Verification of this is found during the startup process when the YELLOW LED blinks the number of cells in the pack. For the PCB Lite V1.X, the power supply for the PCB is self configuring. So unlike the V3.X PCB, there are no jumpers to fiddle with, you just simply connect whatever pack you like, and it just works. Connect your battery pack to the LiPO PCB Lite V1.X per the following figures.

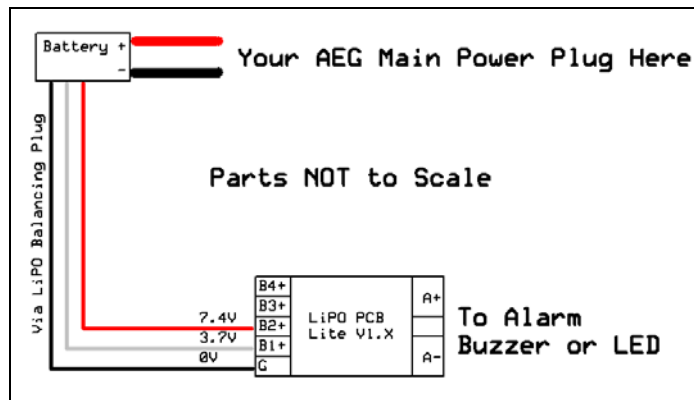


Figure 4-1: LiPO PCB Lite V1.X and 2 Cell LiPO Pack

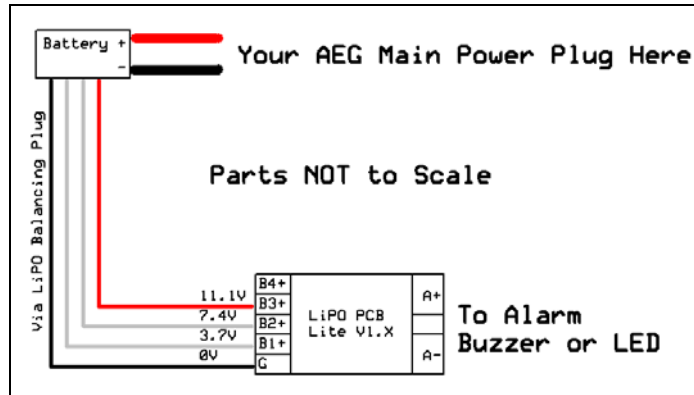


Figure 4-2: LiPO PCB Lite V1.X and 3 Cell LiPO Pack

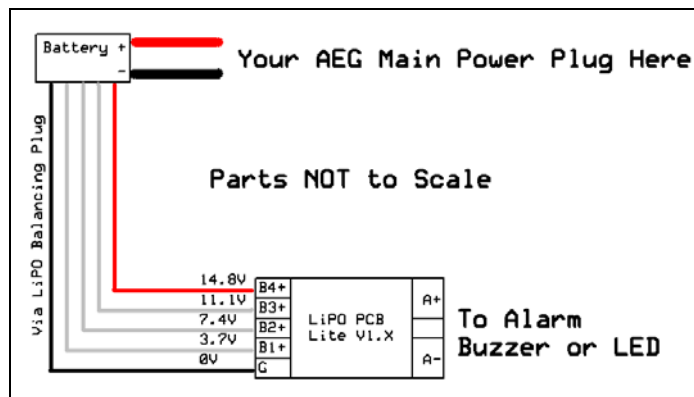


Figure 4-3: LiPO PCB Lite V1.X and 3 Cell LiPO Pack



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The connection from the Battery Pack to the PCB is typically made through the use of a JST XH Series plug, I will send you a Male/Female plug set to match your requested configuration with wires connected for you to wire up yourself.

IMPORTANT:

I labeled B1+, B2+, B3+, and B4+ with the appropriate voltages each wire is meant to see on a nominally charged pack (your numbers will be slightly higher on a fully charged pack). You are just looking for the steps in voltage between each wire. These wires MUST be properly connected to for the PCB to function properly. Additionally, do NOT leave the PCB connected to your pack when not in use, it pulls a small amount of current when "idle" and can over discharge your pack (which is what I made it to prevent).



Troubleshooting and FAQ's

To date the only issue that has occurred with all of the PCB's is related to the AUX Port of the SW-COMPUTER being dirty. The problem is that the SW-COMPUTER will throw pack weak and pack dead errors when the PCB is showing only a GREEN LED (Pack Good). Mechanically scrubbing the connector by plugging and unplugging the SW-LINK Cable several times seems to resolve this issue.

That's it for the FAQ, but feel free to help me add to it.

Contact me (sales@projectwolfdragon.com) if you are having ANY questions/problems about/with your PCB.



Warranty Information

90 Day Limited Warranty

ProjectWolfDragon.com warrants its items to be free from manufacturing defects in workmanship and materials for a period of 90 days from the shipping date.

This warranty does not cover damage caused by improper installation, abuse, modification, or physical damage.

This product requires that the buyer is able to disassemble and reassemble the AEG and/or mechbox fairly easily.

Rewiring and soldering are necessary skills for installation of this product.

Note that disassembly of Airsoft guns and/or the addition/subtraction of stock/aftermarket components generally voids the AEG manufacturer's warranties.

New, unused items in their original condition and packaging may be returned within 45 days of shipment and a refund will be issued by paypal or other method as necessary. All returns are subject to a \$5 restocking fee. Used items will be evaluated on a case-by-case basis.

Under no circumstances, shall ProjectWolfDragon and/or its employees be liable for any incidental, special, or consequential damages that result from the use of these items. Basically, by buying this product you agree that you can't hold me liable or responsible for damages and/or injuries you do to yourself and/or others. Use your head; it's the only thing that makes you unique.

Refer all questions/comments to: sales@ProjectWolfDragon.com



Request for Information

I have done the best I can to offer you a high quality product for your AEG. I use my boards in ALL of my AEGs and am arguably their most demanding critic. I request your help to continue to supply a high quality product. If you have any ideas for improving the PCBs, features you would like to see, and/or general comments about my work, please let me know (sales@projectwolfdragon.com).

I also ask for one bit of information in particular, I would like to know what AEG and MOSFET Trigger you are using my PCBs with as well as how much wire you actually needed to install the PCB. Additionally your estimate of lengths necessary for a generic install would be greatly appreciated. Currently I am supplying ~8 inches (~20 cm) of wire for both the SW-LINK and Battery Pack Connectors and ~12 inches (30 cm) of wire for the Trigger Mod Wire and Alarms for the PCB Lites. I hope that this more than enough for your application, personally I find it highly annoying when I order something and the included wiring harnesses are too short.

Thank you for your purchase,

Kevin Stewart (WolfDragon)