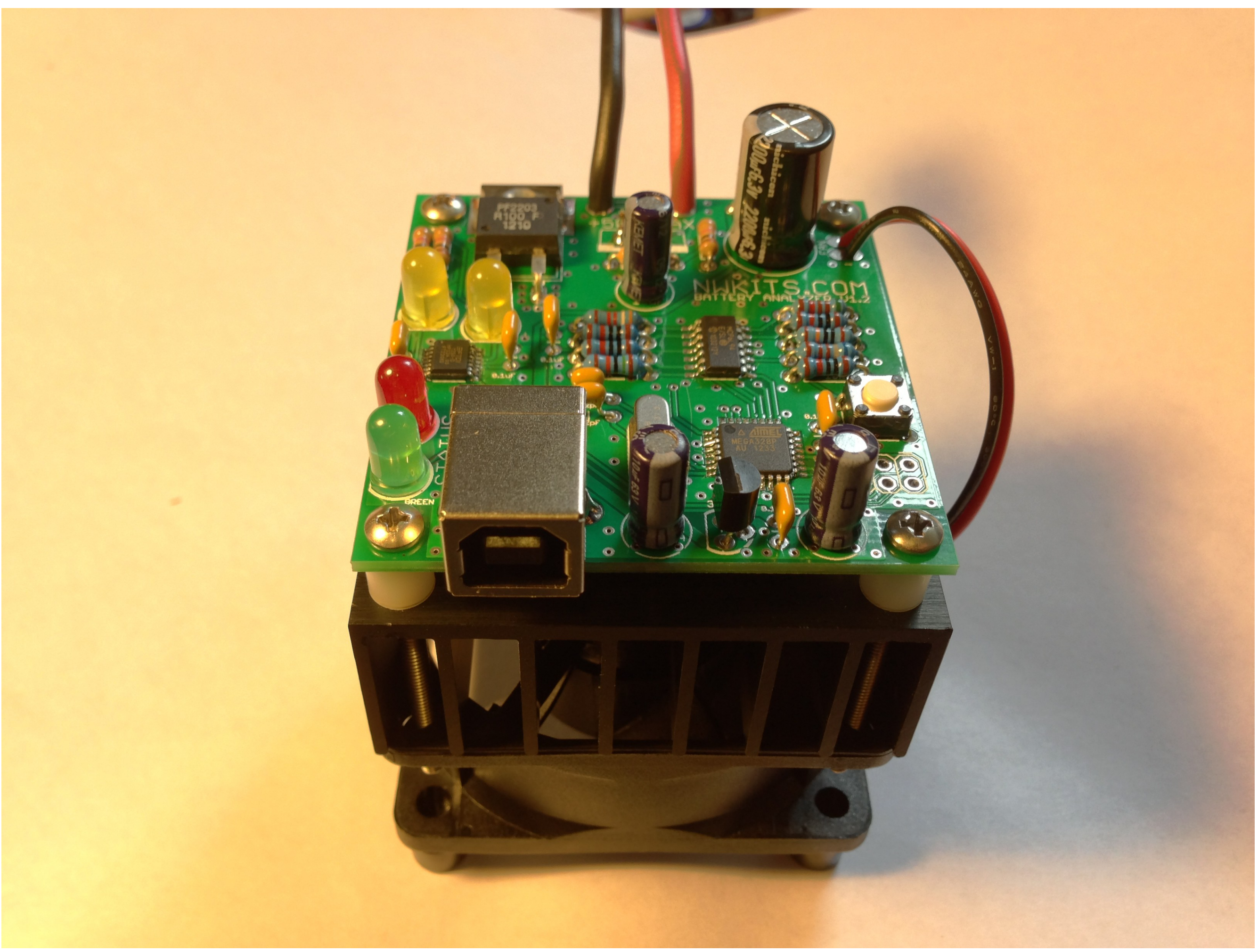
# Northwest Kits
# Battery Analyzer V1.2
# Assembly Instructions & User Manual

**NWKits.com, Updated April 2015**



# Introduction

Thank you for purchasing the Northwest Kits Battery Analyzer. We hope that it will exceed your expectations and provide a long life of useful service.

The Battery Analyzer relies on accurately controlling and measuring a current draw on the battery under test. This is accomplished by continuously controlling a MOSFET in linear conduction mode, while simultaneously monitoring the voltage of the battery under test.

This configuration allows the user to define an arbitrary current discharge rate, and an arbitrary discharge cutoff voltage. For example, if your application draws 250mA, and you intend to use a Lithium Polymer battery, the Battery Analyzer can be configured to discharge at the 250mA rate and discontinue the test at 2.8V, a safe limit for single Lithium Polymer cells.

The MOSFET, Heat Sink, and Fan can support discharge currents of 10A maximum, or 50W discharge, whichever is less. For example, in the case of a Lead-Acid battery at 12.8V nominal, the maximum discharge current would be 3.9A. This is given by the formula:

$$\text{Current\_Limit (Amps)} = 50 \text{ (Watts)} / \text{Battery\_Voltage (Volts)}$$

However, in an alternate example, if you had a 4V battery voltage, your maximum discharge is going to be limited to 10A. If you use the same formula, you end up with:

$$12.5\text{A} = 50\text{W} / 4\text{V}$$

You'll note that 12.5A is greater than our 10A limit, so we cannot discharge at a full 50W.

This flexibility to safely discharge a battery, at the rate likely to be experienced in your real world application gives fantastic insight into not only the capacity of your battery, but the suitability of your battery for a given application.

# Getting Started

Very little initial setup is needed for use of the Battery Analyzer. The USB interface is provided by an FTDI USB to UART converter. If you have used Arduino based boards before, it is likely that you have connected one of these to your computer.

Most current operating systems already include the drivers for this device. If however, your computer cannot automatically install the device, there are drivers available for Windows, Mac OSX and Linux operating systems at:

http://www.ftdichip.com/Drivers/VCP.htm

After confirming that the drivers are installed, the Battery Analyzer is ready to use.

You can choose to either use the GUI application provided on our website and nwkits.com, or you may use the Battery Analyzer directly via the Serial interface.

# Usage

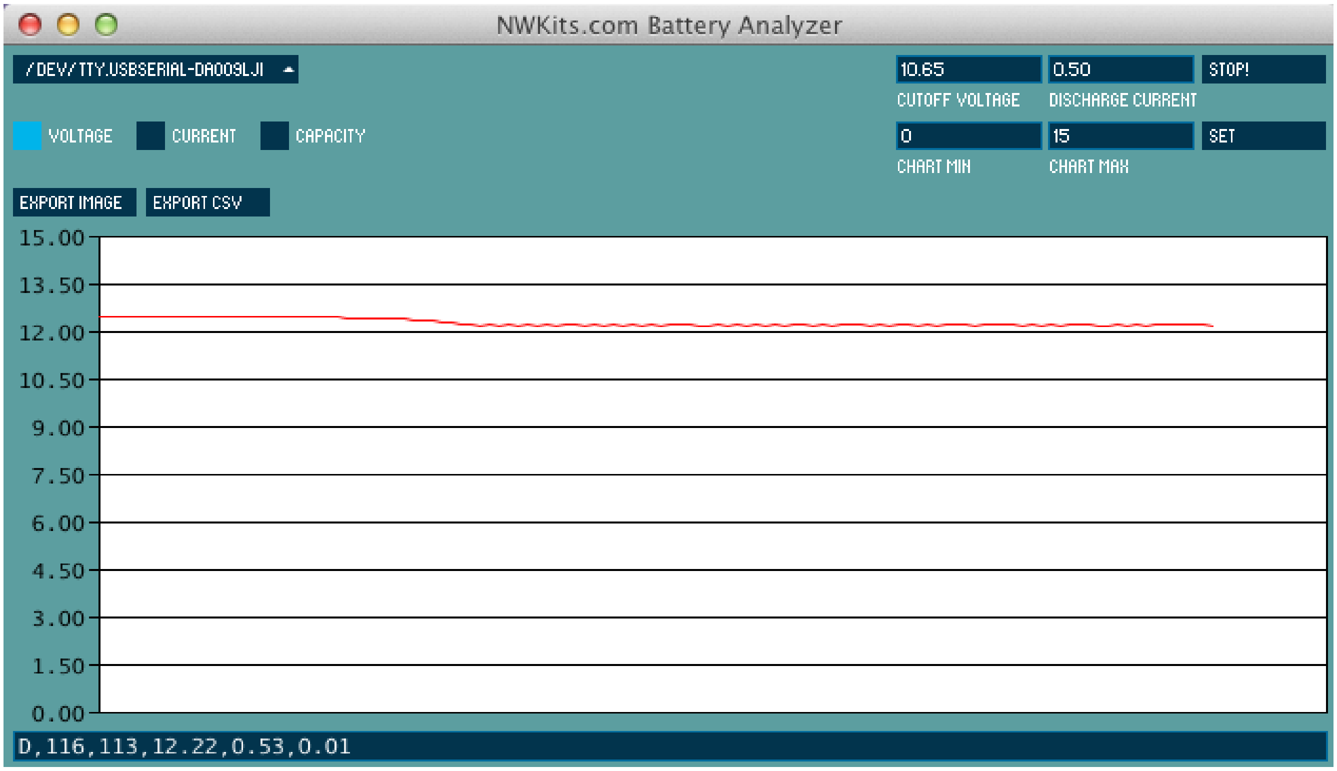
### NWKits Battery Analyzer GUI Application

A graphical application has been created to provide easier use of the Battery Analyzer, over the alternative of interfacing with the Battery Analyzer via a Serial console.

The application can be downloaded from the Battery Analyzer page on our web site. You can reach this by visiting:

https://github.com/nigelvh/NWKITS-Battery-Analyzer

Upon running the application, you'll be presented with a window like the one shown in the photo.



NWKits.com Battery Analyzer Application

In the application window, you'll find controls to select:

- The serial port your device is connected to. On Windows operating systems, this will be a list of COM ports, and on OS X and Linux operating systems this will show a list of TTY devices. In this case, the application is running on an OS X system, and the Battery Analyzer is connected as /dev/tty.usbserial-DA009LJI
- Text entry boxes to configure the discharge cutoff voltage, and the discharge current.
- A START/STOP button which initiates or discontinues a test.
- Tick boxes to select which data fields to plot. In this case we are only plotting battery voltage.
- Text entry boxes to configure the minimum and maximum values of the Y axis of the chart.

- A SET button to apply the changes to the chart.
- An EXPORT IMAGE button to save an image of the chart to a .png.
- An EXPORT CSV button to save a copy of the data received as a .csv file for processing in an external application.

Below these controls you will find:

- The chart area, which will automatically scale the X axis to accommodate the number of data points accrued in the test and the printed labels for the Y axis.
- A status bar which will indicate any errors or status. In the photo, a test is presently running, so the status bar is displaying the current data point.

Please note the following points when using the GUI application:

- The EXPORT IMAGE/CSV functions can only export data that has been received up until the point at which you select them. If you choose to export before a test is complete, your chart / data set will be incomplete.
- If you select an incorrect serial port, and select START, the application will attempt to communicate with the analyzer on that port and will not receive the proper response. The test will automatically be stopped, and you will need to reselect.
- Cutoff Voltage and Discharge Current parameters CANNOT be changed once a test is started. Any changes you make to these fields after a test is started will not be reflected by the analyzer.
- The START/STOP button may take a moment to display the updated status. The button will not switch from START to STOP or vice versa until the commands have been communicated to the Battery Analyzer and confirmation has been received.
- Please pay attention to messages presented in the Status bar. These messages will provide information on any errors encountered and recommendations on resolution.

## Serial Interface

The Battery Analyzer supports all configuration and test options via the USB based Serial interface.

Using your serial console of choice, connect to the Battery Analyzer at 19200 baud. You can test your connection with the Battery Analyzer by pressing the onboard Reset button. Momentarily, you should see the Battery Analyzer respond with its version information and default test parameters.

```
V,1.2,1.0,NWKits Battery Analyzer
P,0.00,0.00
```

Each of these responses from the Battery Analyzer has a command counterpart. Each of the commands and responses will be listed below.

### Version Request

```
$V
```

### Example Response

```
V,1.2,1.0,NWKits Battery Analyzer
```

### Field Information

- VersionResponse
- HardwareVersion – This will match the version printed on the circuit board.
- SoftwareVersion – This is the version loaded on the microcontroller.
- Description – This is a text description of the device

### Set Test Parameters

```
$P1065,1000
```

### Field Information

- 1065 is 10.65V * 100. This parameter sets the cutoff voltage.
- 1000 is the discharge current in milliamps. Both fields must be padded to four places. For example a 2.8V cutoff and 500mA would be sent as “$V0280,0500”

### Example Response

```
P,10.65,1.00
```

### Field Information

- Parameter Set Response
- Cutoff Voltage – Represented to two decimal points
- Discharge Current – Represented to two decimal places

## Test Begin Command

```
$B
```

## Example Response

```
T,B,10.65,1.00
```

## Field Information

- Test Status
- Test Begin
- Cutoff Voltage – Represented to two decimal places
- Discharge Current – Represented to two decimal places

## Test End Command

```
$E
```

## Example Response

```
T,E,822,10.64,1.01,0.24
```

## Field Information

- Test Status
- Test End
- Test Run Time (Seconds) – This test ran for 822 seconds
- Final Measured Voltage – Final battery voltage, represented to two decimal places, this test ended at 10.64V
- Final Measured Current – Final discharge current, represented to two decimal places, this test was running at very near the set level at 1.01A
- Total AmpHour Capacity – Measured AmpHour capacity, represented to two places, this battery has a total capacity of 0.24Ah at 1A discharge rate

## Data Sentence

During a test, the analyzer will print sentences every second providing the current test data

## Example Sentence

```
D,6,81,12.82,0.00,0.00
```

## Field Information

- Data Sentence
- Test Run Time (Seconds) – This test has been running for 6 seconds
- MOSFET PWM Setting (0-255) – The PWM control of the MOSFET is at 81
- Measured Battery Voltage – The currently measured battery voltage, represented to two decimal places.
- Measured Discharge Current – The currently measured discharge current, represented to two decimal places.
- Total AmpHour Capacity – The AmpHour capacity as integrated so far

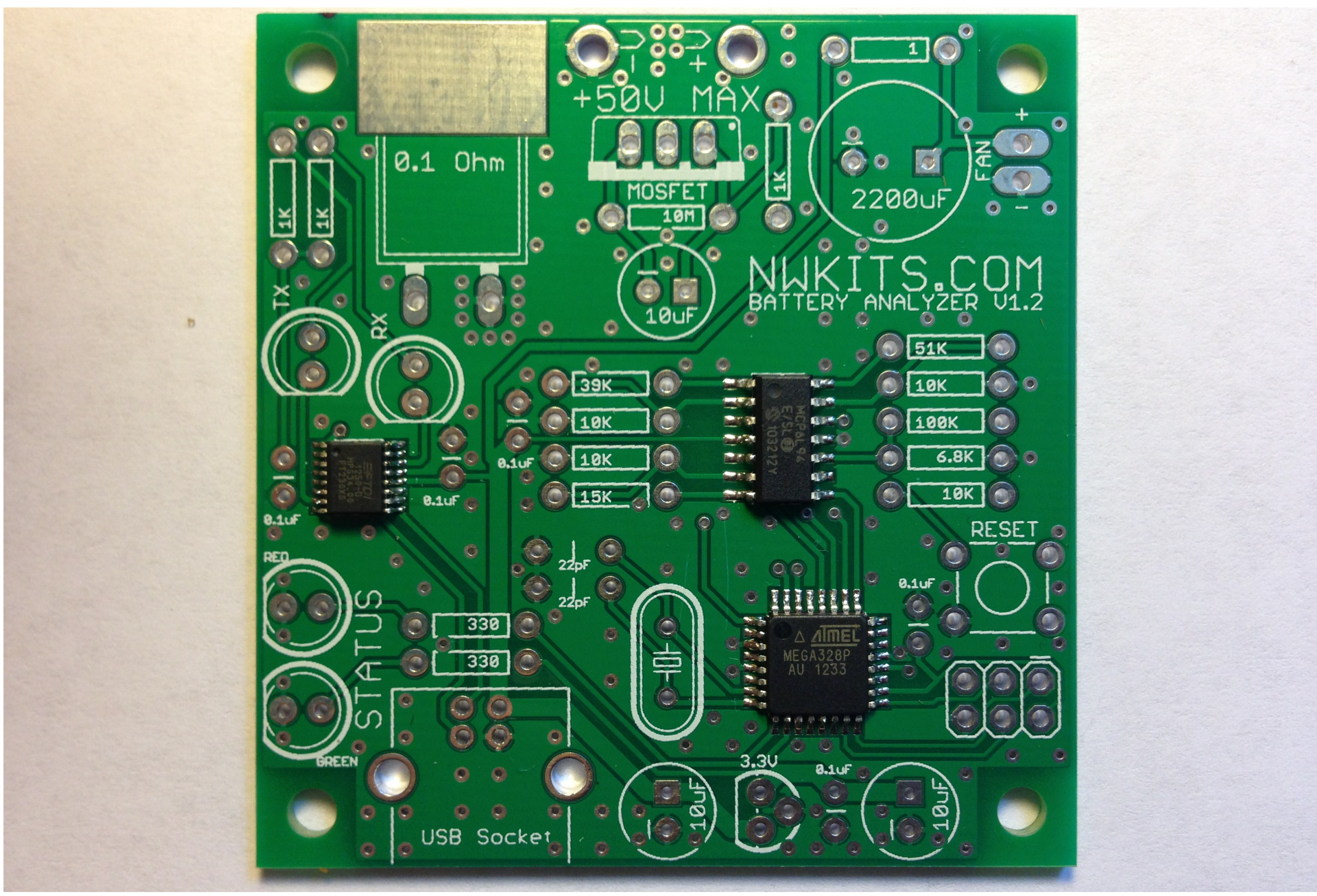
## Example Test Setup and Run

(Commands sent TO the Analyzer are in GREEN and responses FROM the Analyzer are in RED)

```
$V
V,1.2,1.0,NWKits Battery Analyzer
$P1065,1000
P,10.65,1.00
$B
T,B,10.65,1.00
D,0,75,12.81,0.00,0.00
D,1,76,12.81,0.00,0.00
D,2,77,12.81,0.00,0.00
$E
T,E,3,12.81,0.00,0.00
```

# Assembly

The Battery Analyzer is designed to be easy to assemble, and as such has all surface mount components preassembled and programmed.




Pre Assembly – This is how the board will arrive in your kit.

Installation of the remaining through hole components has been organized to ease installation and testing.

All component locations on the board have been marked with the component value, and likewise, the components supplied have been organized to line up with the steps provided in this manual.

**Step 1**
Install USB Socket
Install 16 MHz Crystal
Install 2x 22 pF Capacitors
Install 5x 0.1 uF Capacitors
Install Reset Switch
Install 4x 10 KOhm Resistors

Connect the Battery Analyzer to the USB port and if necessary and install USB drivers as noted above in Getting Started.

Open a serial connection to the board at 19200 baud (This can be done with the Arduino software, or Putty on Windows)

Press the Reset button on the Battery Analyzer. Within a few seconds, you should see the following come across the serial connection

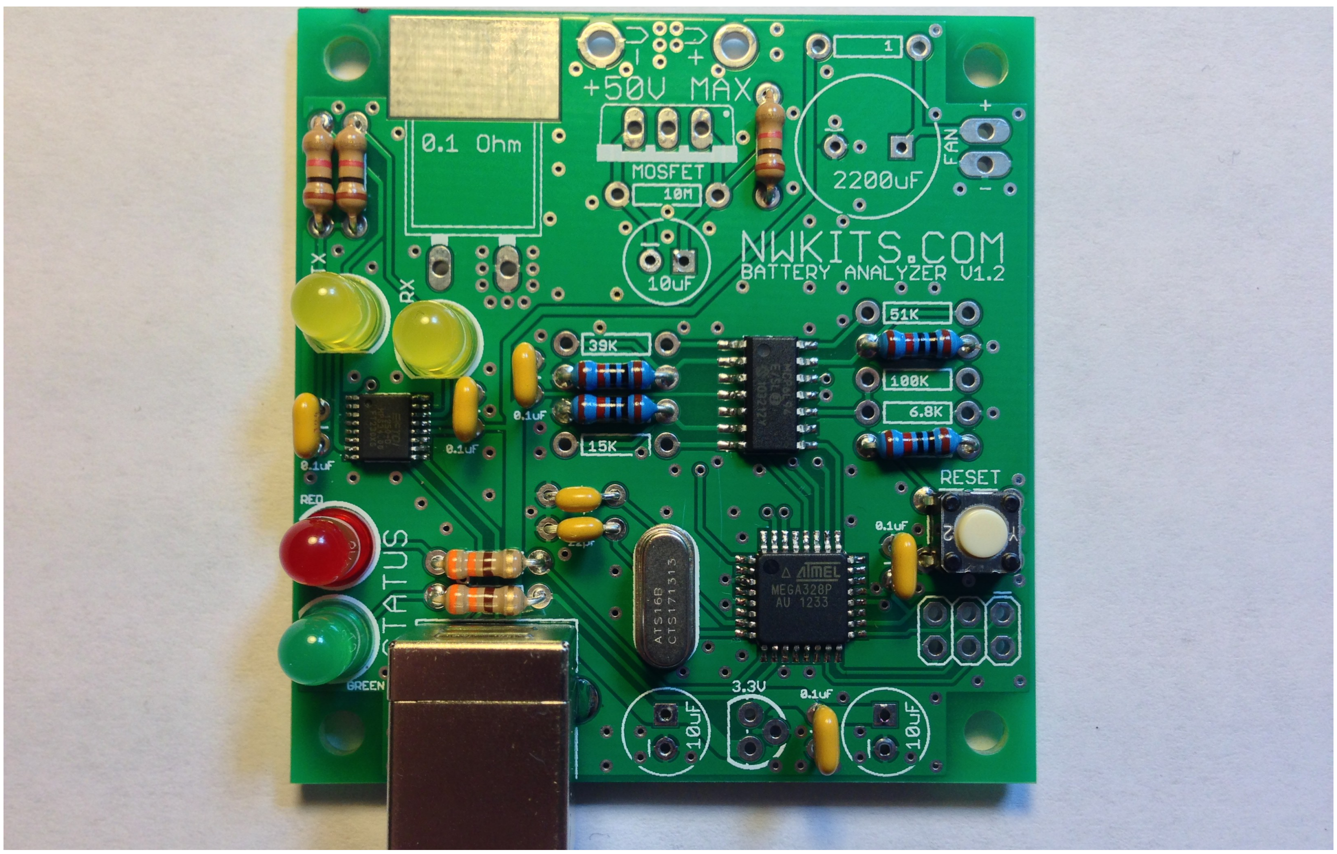
```
V,1.0,1.0,NWKits Battery Analyzer
P,0.00,0.00
```

Then using your serial connection, send "`$V`" ended with a newline char. In the Arduino software, select Newline from the menu at the bottom, If using Putty, simply press enter. You should again receive the following:

```
V,1.2,1.2,NWKits Battery Analyzer
```

These tests confirm that your connection to the Battery Analyzer is working properly and that it is responding to commands.

**Step 2**
Install 2x 330 Ohm Resistors
Install 3x 1 KOhm Resistors
Install 2x Yellow LEDs in the locations marked TX and RX
Install Red LED in the location marked RED
Install Green LED in the location marked GREEN



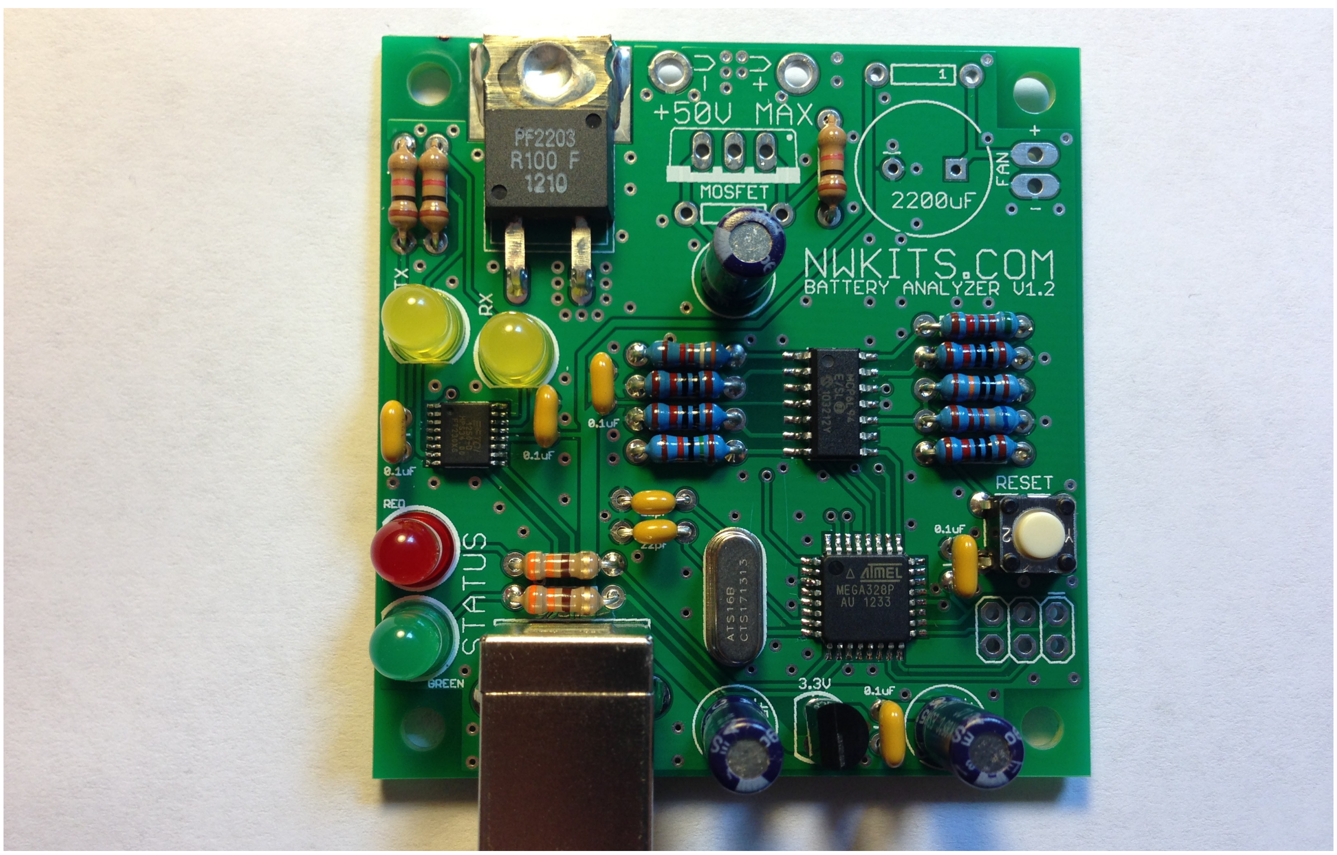
After Steps 1 & 2

Connect the Battery Analyzer to the USB port. In a moment, you should see both the Red and Green LED's turn on, a moment later the red will turn off and another moment later the green will turn off as well.

The Yellow LEDs will blink dimly when data communications are occurring.

**Step 3**
Install 3x 10uF Capacitors
Install 3.3V Regulator
Install 6.8 KOhm Resistor
Install 15 KOhm Resistor
Install 39 KOhm Resistor
Install 51 KOhm Resistor
Install 100 KOhm Resistor

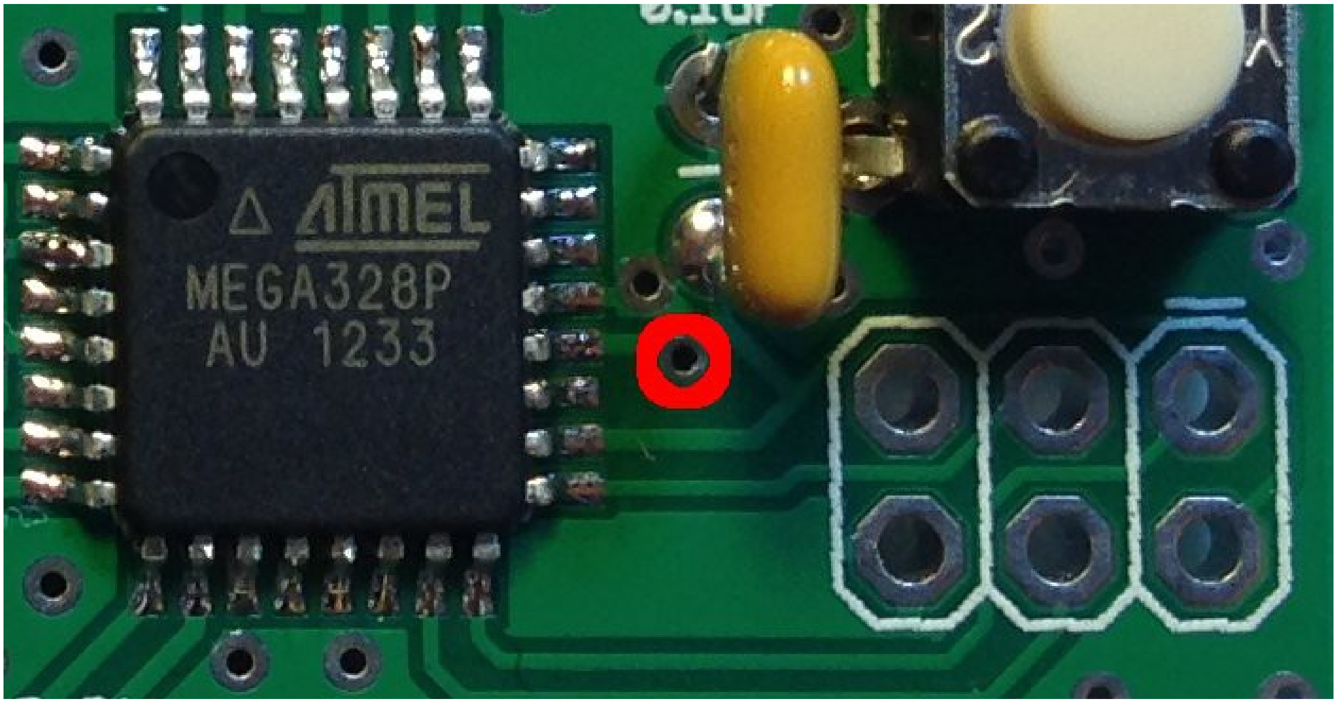
Please note that in the following photos, the large TO-220 0.1Ohm Resistor in the upper left is placed on the board. This is incorrect. It will be attached to the heatsink along with the MOSFET in a later step.



After Step 3

Connect the Battery Analyzer to the USB port.

Using a multimeter, check the voltage at the Via circled in the photo. You should see approximately 3.3V




You should see approximately 3.3V at this Via, referenced to Ground.

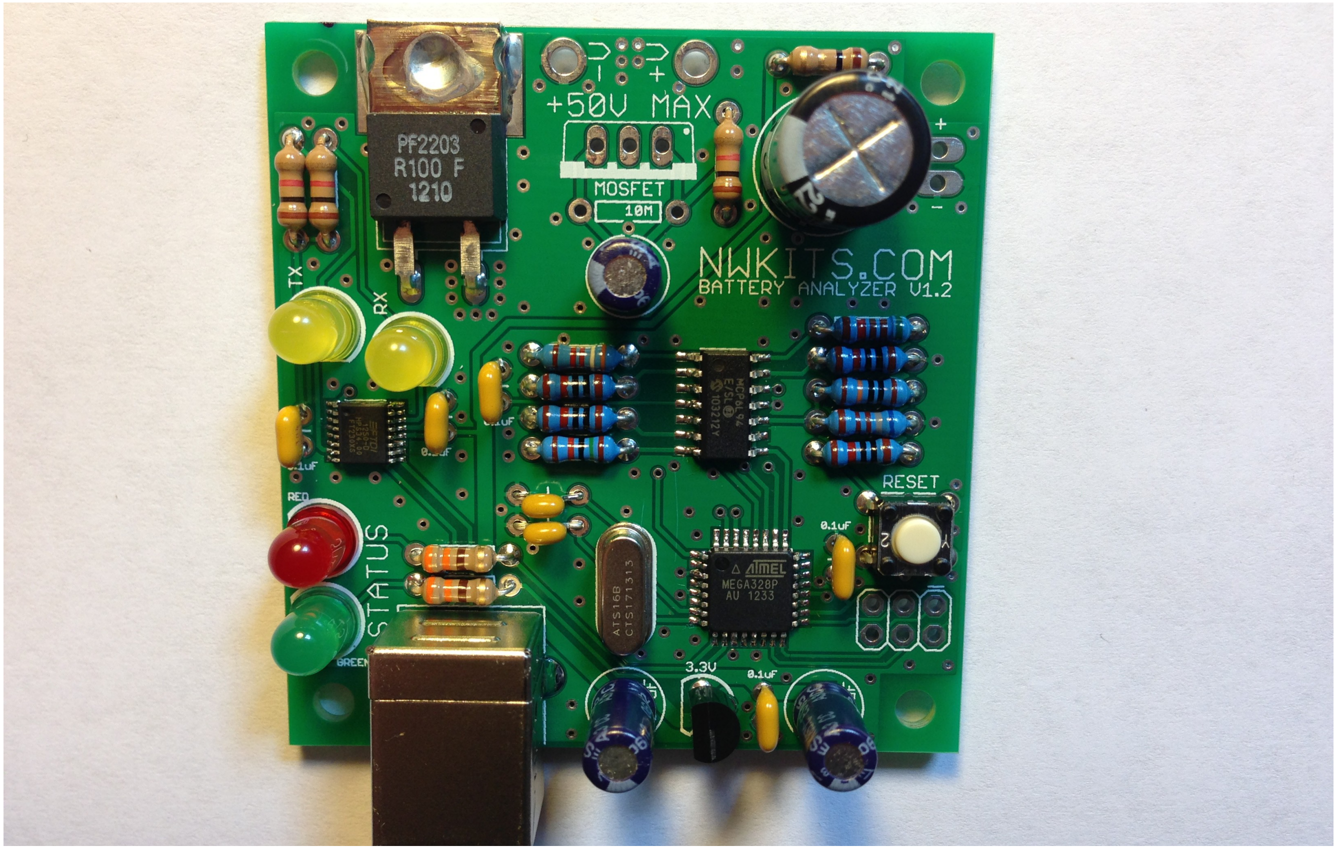
Then using your serial connection, send "$T" ended with a newline char. You should receive something near the following:

```
T,5.15,5.11,5.02,0.00
```

The first three fields are voltage readings from the various voltage ranges. The final is a current reading, which since we are not running a test and have not populated the MOSFET this will be 0.

**Step 4**
Install 1 Ohm Resistor

Install 2200 uF Capacitor

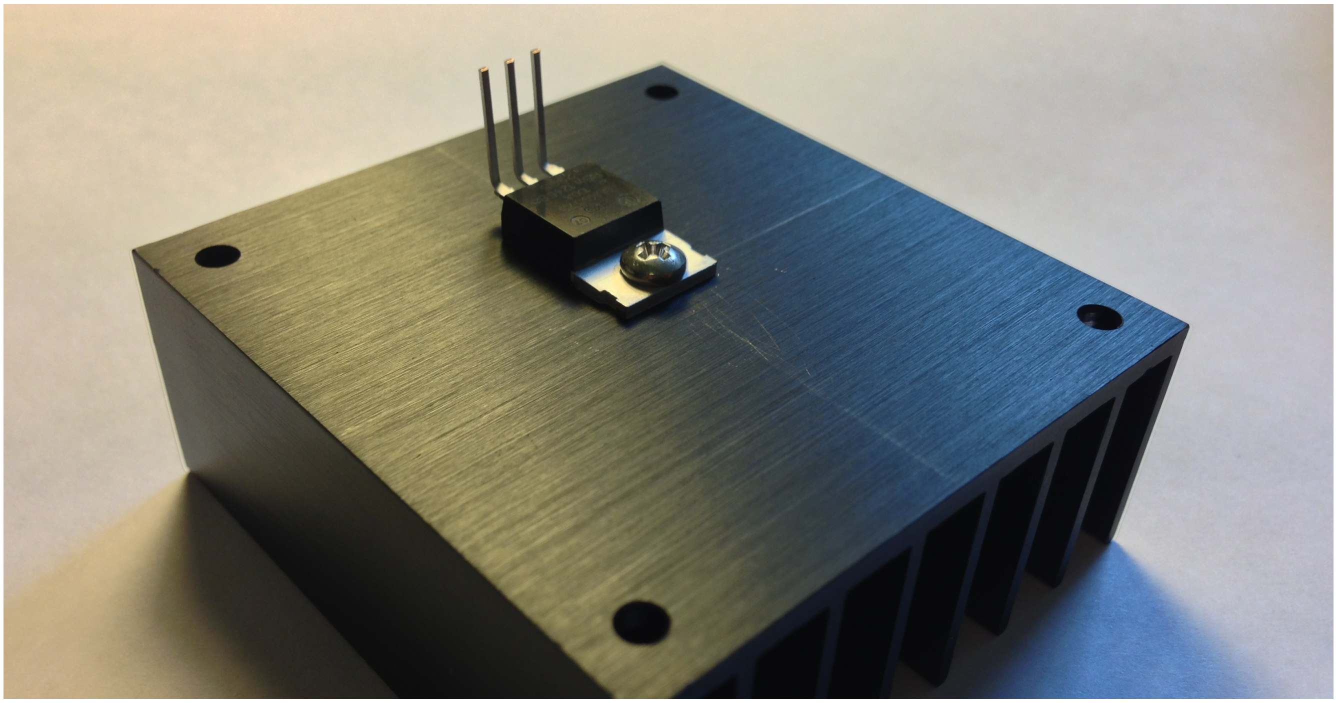


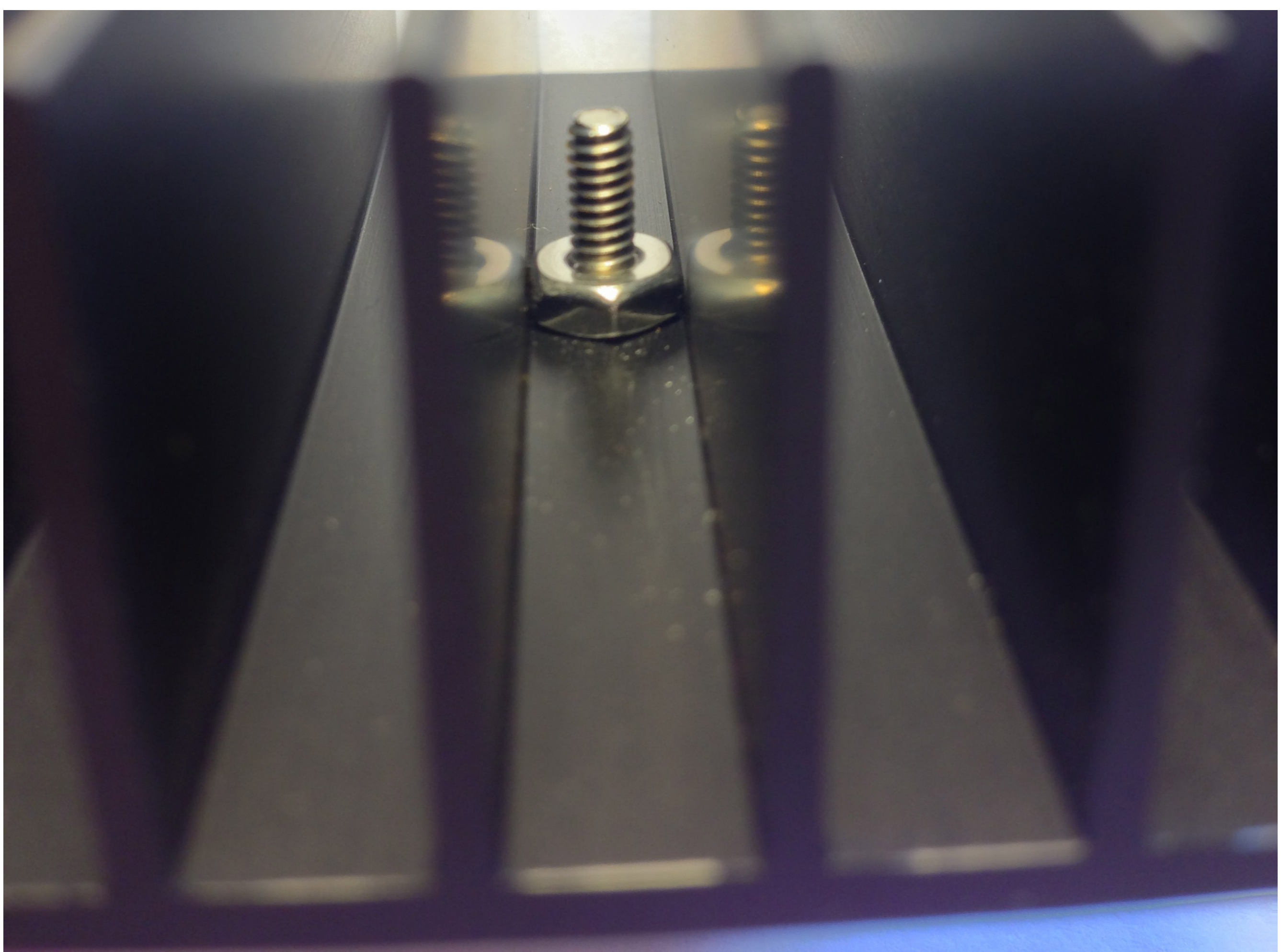

After Step 4

**Step 5**
Install 10 MOhm Resistor
Bend MOSFET legs up as shown in photo
Attach MOSFET to Heat Sink as shown using a small amount of thermal paste, using the center hole in the Heat Sink. Note that the MOSFET is aligned in the same direction as the fins of the Heat Sink.
Attach 0.1 Ohm Resistor to Heat Sink in the same way as the MOSFET, using a small amount of thermal pase, using the off-center hole. Note that the resistor is aligned in the same direction as the fins of the Heat Sink.

Tip: Orient the off-center hole to the left, and place the resistor and MOSFET pins away from you as you are attaching the devices to ensure they line up with the circuit board.

First Photo: How the MOSFET pins should be bent, and the MOSFET aligned with the Heat Sink.
Second Photo: How the screw and nut will be attached.





**Step 6**
Attach battery connector of choice. In this example we have used Anderson PowerPole connectors with 14 Gauge stranded copper wire.

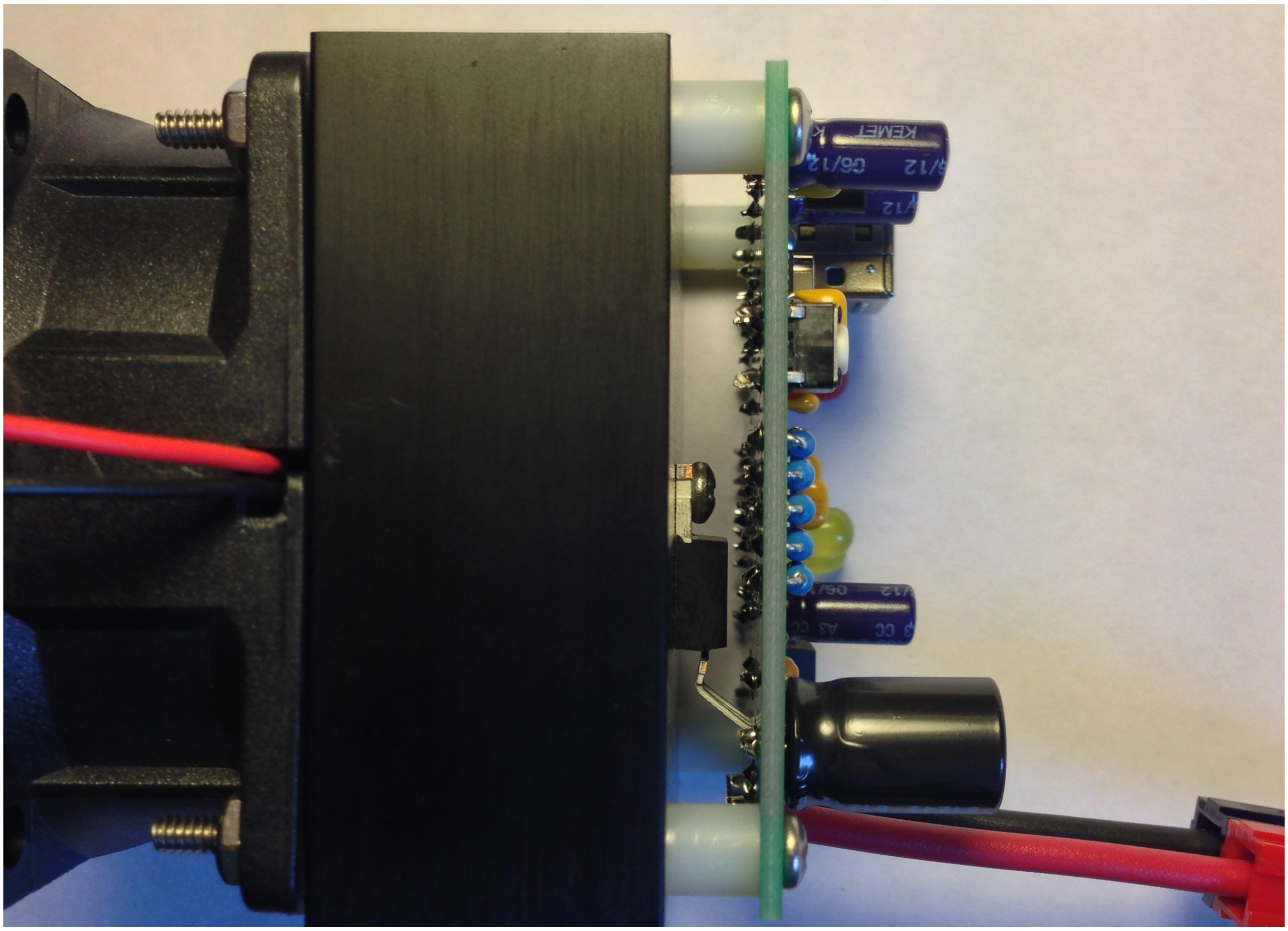
**Step 7**
Thread the four screws through the circuit board with nylon spacers below the board, and thread through the mounting holes in the heatsink.

As you thread the screws through, align the holes in the circuit board with the pins of the MOSFET

Once the screws are fully through, the pins of the MOSFET and 0.1 Ohm Resistor are properly aligned and through the holes, align the fan on the bottom.

The fan has arrows to indicate spin direction and air flow near the wires. Make sure to align the fan so that the wires and arrows are on the right hand side near the FAN- and FAN+ connector, and that air flows into the Heat Sink.

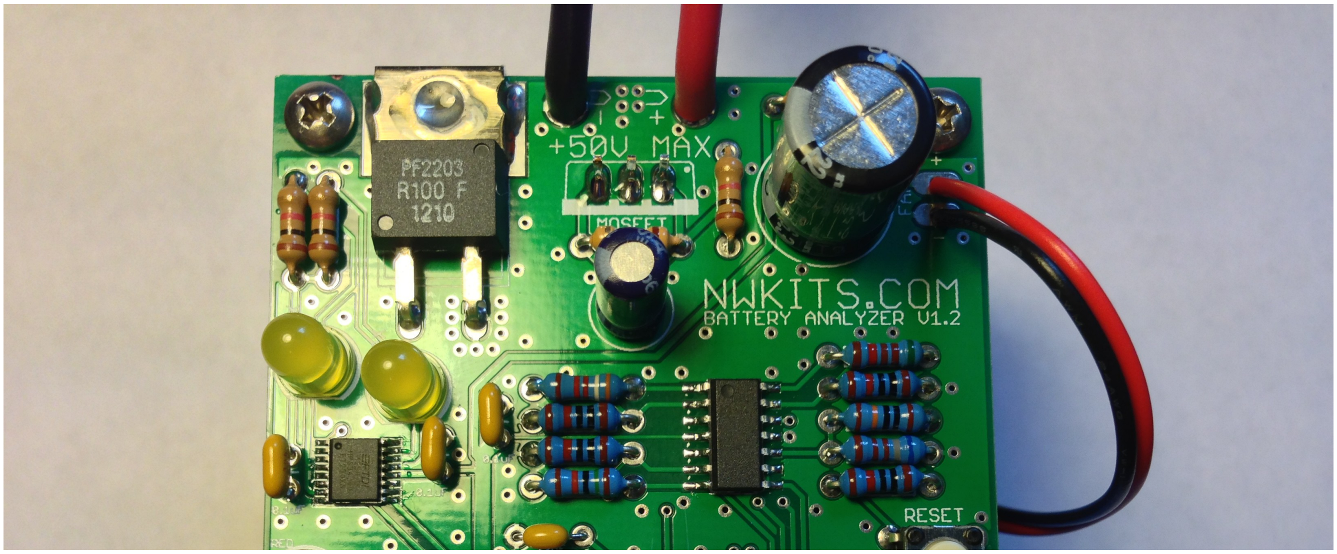
Thread the nuts onto the screws and hand tighten.



How the circuit board mounts to the Heat Sink and Fan and aligns with the legs of the MOSFET.

From the top side of the board, solder the MOSFET pins to the board.

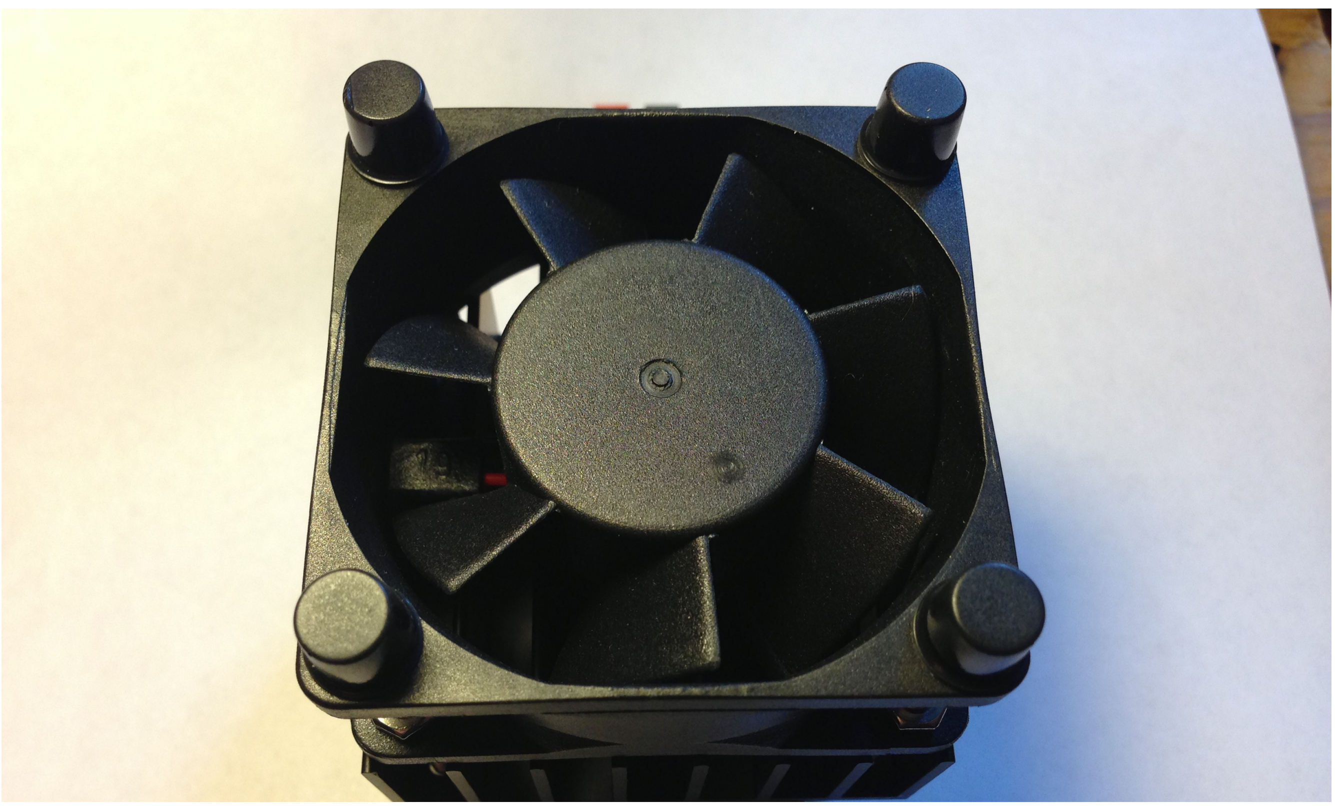
Trim the fan leads to length and solder to the fan connector.



After soldering the Fan wires and the MOSFET pins

**Step 8**

Lightly snug the screws down.
Attach the adhesive feet as shown in the photo.



# Congratulations!
## Assembly of your Northwest Kits Battery Analyzer is complete!