Battery Marvel Kits Assembly Manual

Version 1.20

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US Patent Pending
Battery Marvel, LLC.

Assembly instructions for Battery Marvel

Thank your for purchasing Battery Marvel! Please read these instructions carefully before assembling your kit.

Tools and materials required

These tools and materials are needed for assembly & calibration:

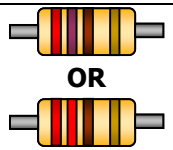
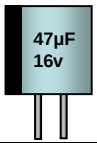
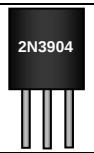
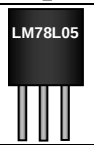
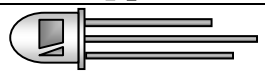
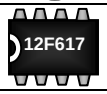
- Low-wattage "pencil" type soldering iron
- Rosin-core solder
- Small diagonal wire-cutting pliers
- An adhesive designed to bond ABS plastic parts (plastic model cement, Krazy Glue™, Super Glue™, etc.)
- An accurate DMM (digital multimeter) used for calibration
- Battery Marvel requires a 12.00v DC reference voltage for calibration. If you don't have an adjustable voltage source, we'll show you how to build one using parts included with your kit.

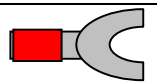
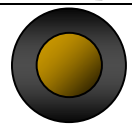
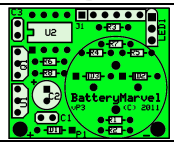
Tips on building your kit

- Carefully insert, then solder each component using a low-wattage soldering iron and rosin-core solder. Neatly trim component leads after soldering using small diagonal wire-cutting pliers. Leads should protrude no more than 1/16" from the back of the circuit board.
- Mark the appropriate checkbox in the diagram after soldering each component, like this: ☑ **R1 (47k)**.
- Components which MUST be inserted in a particular direction are marked with a '►' symbol, like this: ☐►**D1 (1N914)**. Verify the orientation of these components carefully before soldering!
- Components which may be inserted in either direction (such as resistors) are marked like this: ☐ **R1 (47k)**.
- Take your time. It takes more time to correct even one mistake than to double-check all components and prevent a problem.
- This manual is available on our website in PDF format. You can zoom in for a closer view and download or print additional copies. Please visit http://www.Battery_Marvel.com/support to learn more.

Step 0: Unpack and verify the contents of your kit

Verify that your parts bag contains the following components used to build your Battery Marvel:

Qty	Component	Description	Illustration
2	R1, R3	47kΩ resistor, 1/8w (yellow/violet/orange)	
2	R2, R7	10kΩ resistor, 1/8w (brown/black/orange)	
2	R4, R5	270Ω resistor, 1/8w (red/violet/brown) **OR** 220Ω resistor, 1/8w (red/red/brown)	
2	R6, R8	1kΩ resistor, 1/8w (brown/black/red)	
1	C2	47µF electrolytic capacitor *(appearance may vary)*	
2	C1, C3	0.1µF bypass capacitor	
3	D1-D3	1N914 fast switching diode	
1	Q1	2N3904 NPN transistor	
1	U1	LM78L05 linear voltage regulator, +5v	
1	LED1	Bi-color LED (red/green)	
1	SP1	LED spacer (black)	
1	U2	Pre-programmed PIC 12F617 (8 pin DIP)	

Qty	Component	Description	Illustration
1	CA1	12" long 2-conductor cable (red/black)	
2	SC1, SC2	Spade connectors	
1	P1	0.75" piezo element	
1	PCB	Battery Marvel printed circuit board (PCB)	
1	CASE	CNC-machined ABS plastic case	
1	LID	ABS case lid with tab	
1	MESH	Stainless steel mesh screen, ½" square	
1	LABEL	Battery Marvel self-adhesive label	
1	VELCRO	1" Velcro™ self-adhesive strip	

NOTE: You may discover a few "extra" parts not listed above. These are used to build an optional calibration voltage source – they are not part of your Battery Marvel. We will discuss how to build the optional calibration voltage source after we've finished building your kit before we test/calibrate it.

Step 1: Resistors, diodes and bypass caps

Begin construction by installing resistors R1 through R8 on the top surface of the PCB as shown in Fig. 1. **Note that resistors R4 and R5 included your kit may be 220Ω or 270Ω (either value works fine).** All resistors may be inserted in either direction. Fully insert and solder each component, one at a time. Mark off the appropriate checkbox on the figure below as you complete work on each component.

Next, insert and solder diodes D1 through D3. Note that D1-D3 are marked in the diagram with a "►" symbol, since they must be inserted in a particular direction. The end with the dark band (the cathode) must be toward the **right** for D1, and toward the **left** for D2 and D3.

Finally, insert and solder bypass capacitors C1 and C3. C1 and C3 may be inserted in either direction.

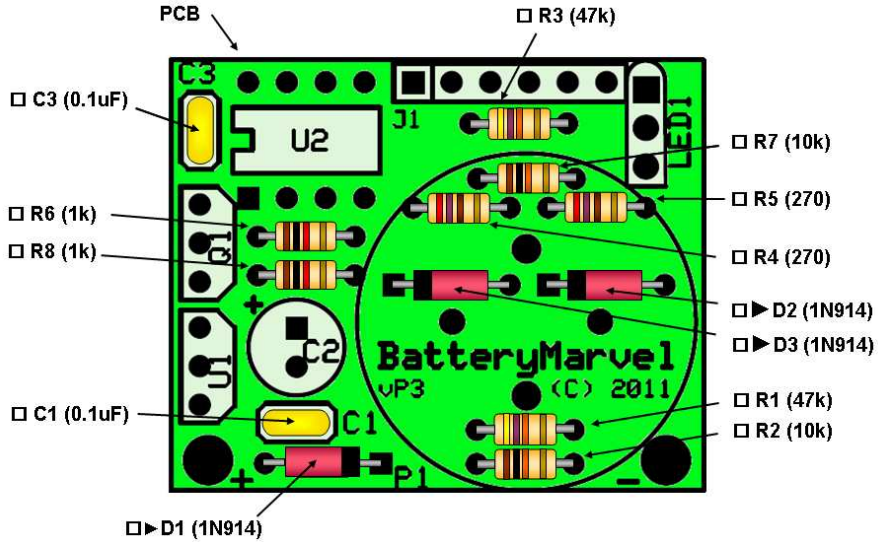


Fig. 1 –Resistors and diodes

Step 2: ICs, transistor and electrolytic cap

Insert and solder U2 as shown in Fig. 2. Note that the notch or "indent" on U2 must be toward the **left**. U2 is pre-programmed, so the factory programming connector J1 will be left unpopulated / unused.

Next, insert and solder Q1 and U1 – they look almost alike, so check the case markings carefully! The flat side of both Q1 and U1 must go toward the **left** as shown.

Finally, insert and solder C2, the electrolytic capacitor. The negative lead must be toward the **bottom** of the PCB.

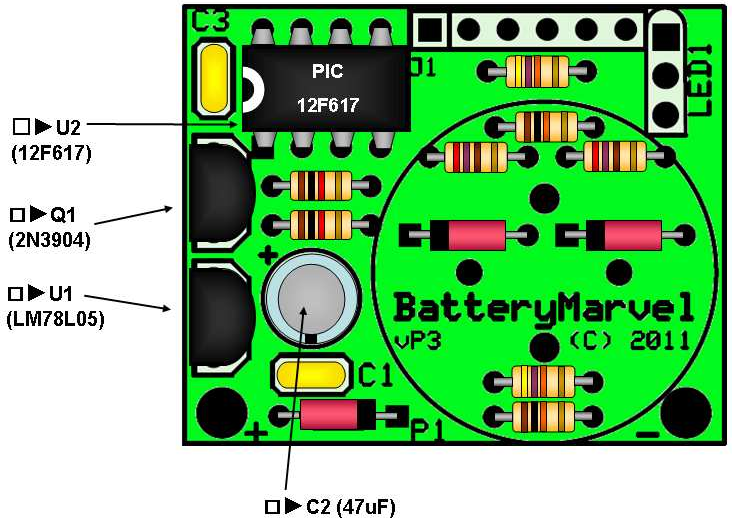


Fig. 2 – ICs, transistor and electrolytic cap

Step 3: LED and piezo

Install the piezo as shown in Fig. 3a. The piezo can be inserted in any direction. Make sure the piezo is fully inserted so it is soldered as close to the PCB as possible (this will ensure a proper fit in the case).

Next, thread LED1 through the 3 holes in SP1 as shown in Fig. 3a and 3b. Note the "flat" side of the LED case goes toward the **left**. Ensure the front face of the LED is even with the piezo when viewed from the side (see Fig. 3b). This will result in the best possible optical viewing angle when the PCB is installed in the case.

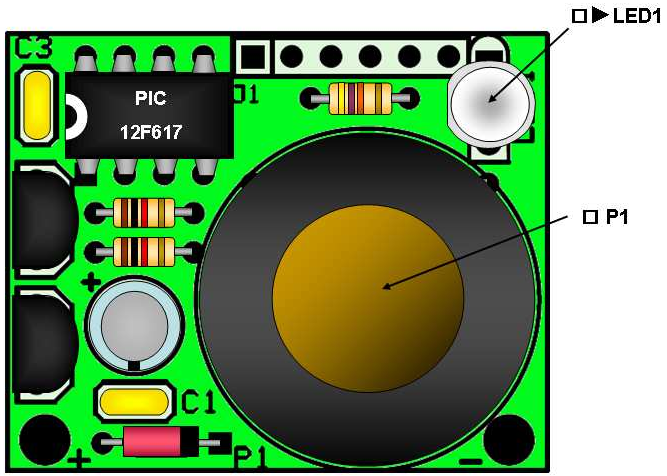


Fig. 3a – LED and piezo

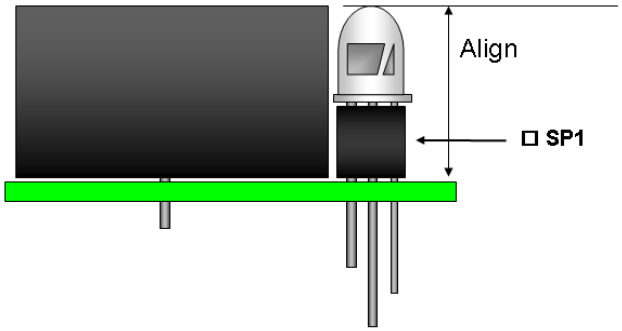


Fig. 3b – LED standoff and alignment

Step 4: Connecting cable

Carefully strip about ½" of insulation from the red and black conductors on one end of the cable CA1. Crimp (or solder) the ¼" terminals SC1 and SC2 onto the red and black wires as shown in Fig. 4.

Place the assembled PCB **face down** as shown. Strip about 1/8" of insulation from the other end of CA1. Insert from the back side of the PCB and solder on the front side, i.e. the opposite way you soldered all the other components. Observe the polarity: the red wire goes to "+" and the black wire goes to "-". Don't press the PCB into the case yet.

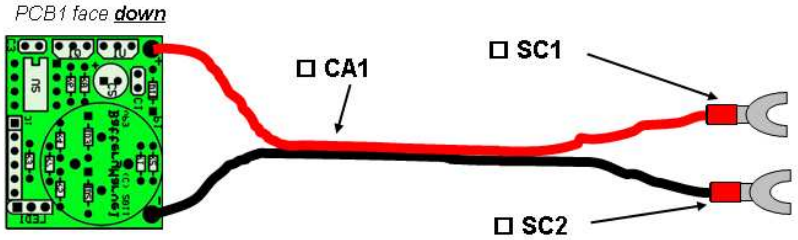


Fig. 4 – Connecting cable preparation

Step 5: Attach mesh screen and label

Cut MESH screen to fit into the small recessed pocket of CASE as shown in Fig. 5. Place the MESH screen into the pocket, then peel the backing off of LABEL and attach to CASE, trapping MESH in between.

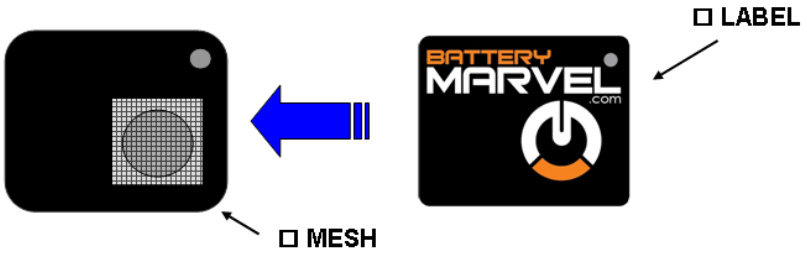


Fig. 5 – Attaching Mesh and Label

Attach the VELCRO strip to the back of LID (the smooth side without the tab). Carefully cut the tab off using a sharp knife or diagonal cutter. Insert PCB into case and place LID temporarily to check for clearance. Trim any leads on back of PCB as necessary to ensure a good fit.

Step 6: Inspection

Inspect your work carefully to verify:

- ICs are inserted in the proper location and in the correct direction
- Components are placed in the right locations and oriented correctly
- There are no solder bridges, soldering flaws or stray wire clippings
- Leads are neatly trimmed on the back of the PCB

Step 7: Decide how you will calibrate your kit

For proper operation, Battery Marvel **must** be calibrated before use

A calibration voltage source of exactly 12.00v DC is required. For proper operation, it is critical that this voltage is as close as possible to 12.00v.

- If a precision 12.00v DC source is available, you may skip step 8 and use your own voltage source to calibrate your kit.
- You may also skip step 8 if you have an adjustable DC voltage source and a quality DMM to verify the output voltage is 12.00v.
- If there is no suitable voltage source available, continue with step 8 to build the calibration voltage source from parts included with your kit.

Step 8: Building a 12.00v calibration voltage source

This step is optional

Verify that your kit includes the following parts:

Qty	Component	Description	Illustration
1	R100	240Ω resistor, 1/4w (red/yellow/brown)	
1	R101	5kΩ potentiometer	
1	C100	0.1uF bypass capacitor	
1	U100	LM317LZ adjustable voltage regulator, 1.2-37v in, 100mA out	

Assemble the parts listed above according to the schematic in Fig. 8a and illustration in Fig. 8b below. Note the pinout for U100 – the output is on the **center** pin (pin 2). Vin can be any low-noise voltage source of 13 to 37vdc. Two 9v transistor batteries wired in series (18v) works well if a DC power supply is not available. After constructing this circuit, adjust R101 carefully while monitoring Vout with a digital voltmeter (DMM) until the output is exactly 12.00v DC.

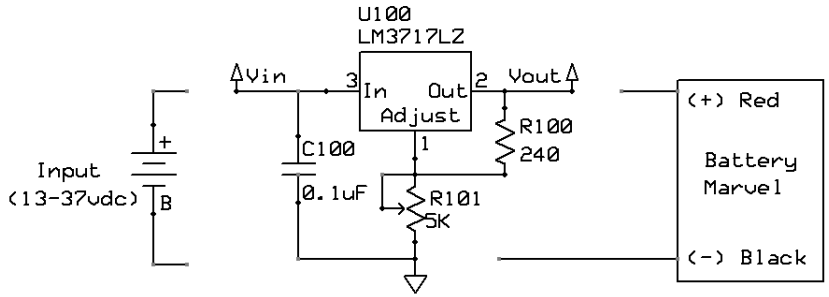


Fig. 8a – Calibration voltage reference schematic

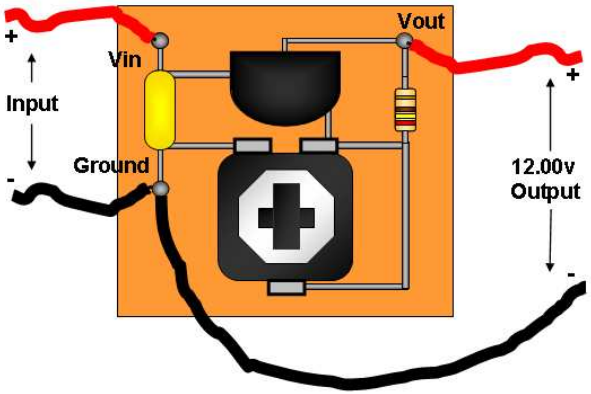


Fig. 8b – Calibration voltage reference sample layout

Step 9: Test / Checkout

The first time you power up Battery Marvel, it will attempt to calibrate itself if the voltage is between (approximately) 9.5-14vdc. If the voltage is outside this range, Battery Marvel will not calibrate. Instead, it will alternately blink red / green (forever). We will take advantage of this feature to test your Battery Marvel before we calibrate it.

Connect your Battery Marvel to a 9v transistor battery (or another available 6-9v DC regulated power source). Make sure the source is no more than 9v DC. Battery Marvel should alternately blink red/green. If this test works, you are ready to calibrate! If not, check your work and try again.

Step 10: Calibration

For best results, you should ensure that the Battery Marvel is at "normal" room temperature during calibration (around 70 deg. F) as the temperature sensor will also be calibrated at the same time. Battery Marvel assumes that the ambient temperature during calibration is 70 deg. F. However, the temperature calibration is much less critical than the voltage calibration, so don't worry if it's a few degrees off in your environment.

To calibrate, simply connect your device to the calibration voltage source. If the calibration is successful, you will hear a "tick-tock" countdown sound for 30 seconds, followed by a very brief (and LOUD!) "sample" alert. This is what Battery Marvel sounds like when it alerts you to a problem (though the real alert lasts longer). Your Battery Marvel is now calibrated and ready to use!

If your Battery Marvel simply blinks red/green (without making any sound) then the calibration did not complete successfully. A red/green blinking pattern with no sound indicates that the measured voltage or temperature are too far off to complete the calibration. Check R1, R2, R3, R7, D2 and D3 carefully to troubleshoot. Also check your 12.00v reference voltage to ensure it is accurate.

If you ever want to recalibrate, boot your Battery Marvel with pins 3 and 4 (the two center pins) of J1 temporarily connected (shorted) together. This will erase the calibration data and return your Battery Marvel to the uncalibrated state.

Step 11: Final assembly

After everything checks out, gently press the PCB into place inside of the CASE. Make sure the LED lines up with the translucent LED window in the LABEL. Press the LID onto the back of the CASE. We recommend that you try Battery Marvel in your vehicle before gluing the LID onto the case (you may hold it temporarily with some tape). When you are confident everything is OK, you may glue the LID permanently in place.

Congratulations, this completes your Battery Marvel kit!

Please refer to the Battery Marvel User Manual for instructions on how to install and use your Battery Marvel!

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