

Battery Marvel Kits Assembly Manual

Version 1.00



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US Patent Pending
Battery Marvel, LLC.

Assembly instructions for Battery Marvel

Thank you 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:

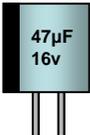
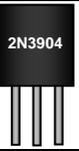
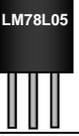
- Low-wattage "pencil" type soldering iron
- Rosin-core solder
- Small diagonal wire-cutting pliers
- An adhesive designed to bond ABS plastic parts (plastic model cement, Krazy Glue™, Super Glue™, etc.)
- An accurate DMM (digital multimeter) used for calibration
- Battery Marvel requires a 12.00v DC reference voltage for calibration. If you don't have an adjustable voltage source, we'll show you how to build one using 4 parts included with your kit.

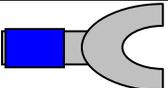
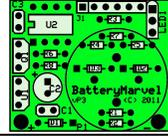
Tips on building your kit

- 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 (<i>appearance may vary</i>)	
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	U2	Pre-programmed PIC 12F617 (8 pin DIP)	
2	W1, W2	12" hookup wires	

Qty	Component	Description	Illustration
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, 1/2" 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.

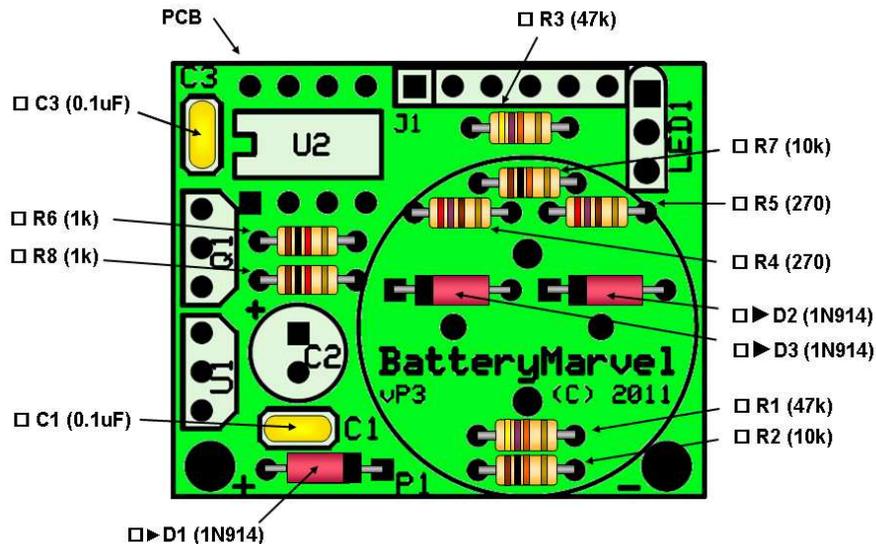


Fig. 1 –Resistors and diodes

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.

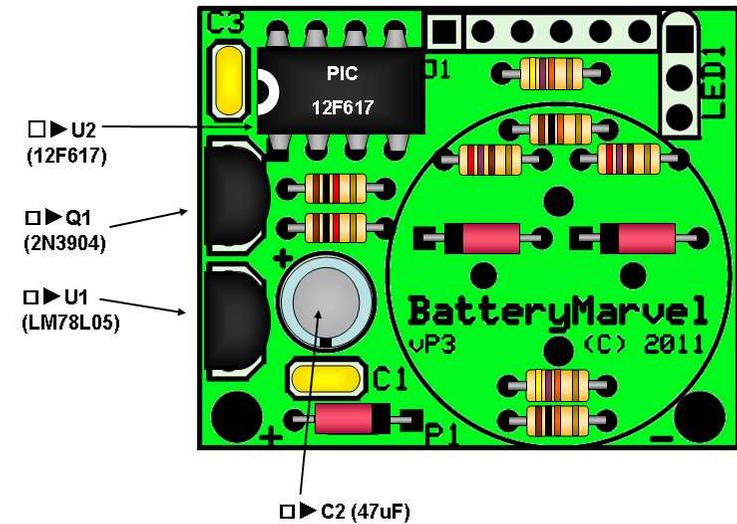


Fig. 2 – ICs, transistor and electrolytic cap

Step 3: LED and piezo

Insert and solder 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 insert the LED as shown in Fig. 3a. Note the "flat" side of the LED case should be 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 viewing angle when the PCB is inserted in the case.

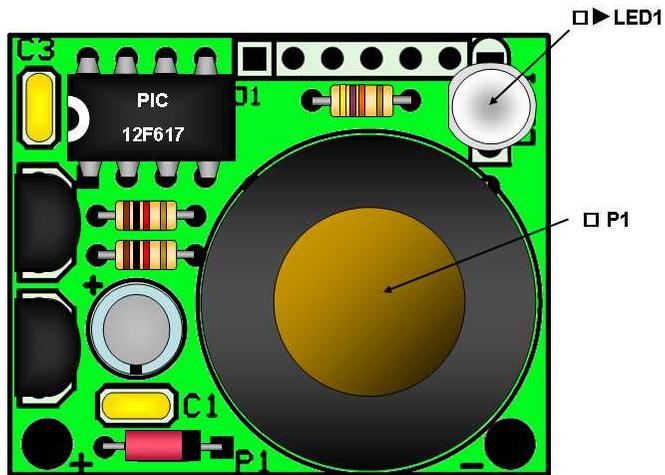


Fig. 3a – LED and piezo

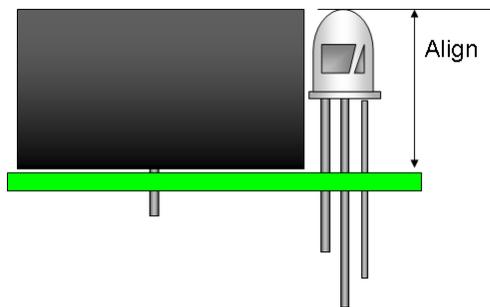


Fig. 3b – LED alignment

Step 4: Connecting wires

Carefully strip about 1/2" of insulation from one end of 12" connecting wires W1 and W2. Crimp (or solder) 1/4" terminals SC1 and SC2 onto W1 and W2 as shown in Fig. 4.

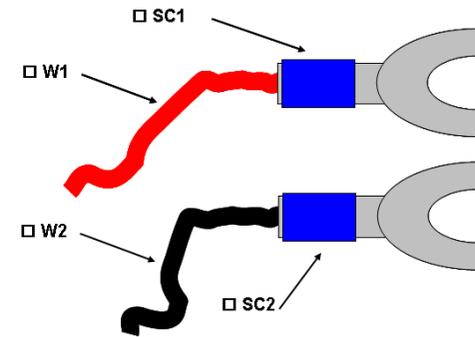


Fig. 4 – Connecting wire preparation

Step 5: Attach connecting wires

Place the CASE and assembled PCB **face down** as shown in Fig. 5. Strip about 1/8" of insulation from the end of wires W1 and W2. Pass wires W1 and W2 through the holes in the case. Insert from the front side of the PCB and solder on the back side, like 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.

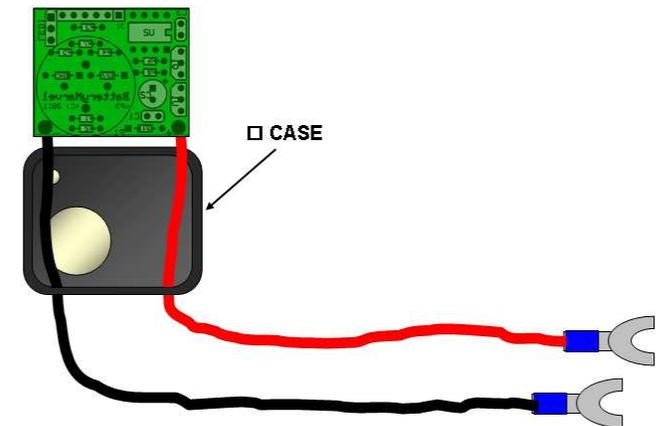


Fig. 5 – Attach connecting wires

Step 6: Attach mesh screen and label

Flip CASE over and cut MESH screen to fit into the small recessed pocket as shown in Fig. 6. Place the MESH screen into the pocket, then peel the backing off of LABEL and attach to CASE, trapping MESH in between.

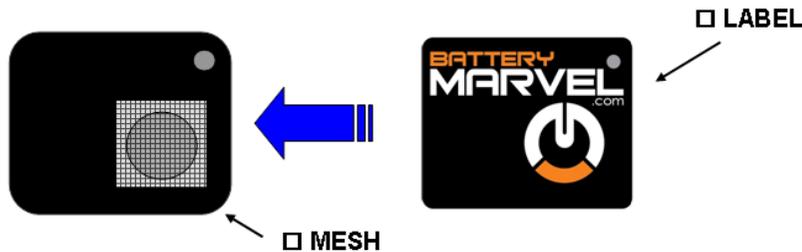


Fig. 6 – Attaching Mesh and Label

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.

Step 7: 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 8: 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 9 and use your own source to calibrate your kit.
- You may also skip step 9 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 9 to build the calibration voltage source from the extra parts included with your kit.

Step 9: Building a 12.00v calibration voltage source



This step is optional

Verify that your kit includes the following parts which are used to build the 12.00v calibration voltage source:

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

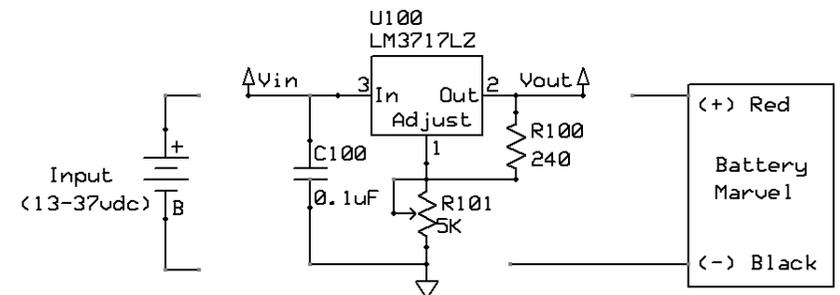


Fig. 9a – Calibration voltage reference schematic

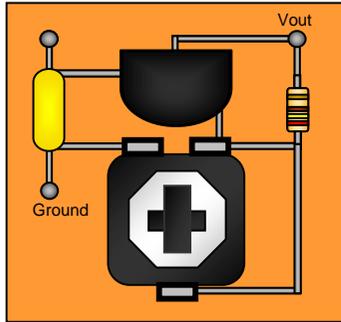


Fig. 9 – Calibration voltage reference sample layout

Step 10: Test / Checkout

The first time you power up your Battery Marvel, it will attempt to calibrate itself if the voltage is between (approximately) 10-14vdc. If the voltage is outside this range, Battery Marvel will not attempt to calibrate. Instead, it will beep, then alternately blink red / green (forever). We will use fact to test your Battery Marvel before we calibrate it.

Connect your Battery Marvel to a 9v transistor battery (or another available 6-9vdc regulated power source). Make sure the source is no more than 9v. You should hear a short beep, then Battery Marvel will start blinking red/green.

If this test works, you are ready to calibrate! If not, check your work and try again.

Step 11: 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 at 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 is a bit 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 calibration. Check R1, R2, R3, R7, D2 and D3 carefully.

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

Step 12: 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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