The Solarbotics Bicore Experimenter's PCB

The PM3 Power Module

PM3 SolarEngine

The PM3 Power Module is a "Type-3" (Voltage-Triggered/Reset) Solarengine circuit designed around the Maxim 8212 Voltage Monitor IC. Although more complex than the Miller Solarengine, it offers much wider voltage operation (1.15 to 16.5 volts), and it uses configurable hysteresis for power discharge.

Configurable hysteresis is the ability to tell the circuit how many volts it should drop to the load before turning off. Where the MSE1 uses a timer to determine this ("stay on for x seconds before shutting off"), the PM3 uses a set voltage gap("turn on 3V above this set voltage, and stay on until the voltage falls to this level").

Necessary Parts:
1 x Solarcell (SC)
1 x Storage Capacitor 1000µF - 1.0F+ (C1)
1 x Maxim 8212 Voltage Monitor
1 x 100k Baseline Resistor (Brn/Blk/Yel) (R1)
1 x Voltage Trip Resistor (to be determined) (R2)
1 x Voltage Hysteresis Resistor (to be determined) (R3)
1 x PNP Transistor / P-Channel FET

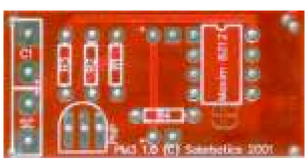
Other Parts:
1 x 1kW Transistor Base-Current Limiting Resistor (Brn/Blk/Red) (R4)

The Maxim 8212 IC uses three resistors to determine the off trip point (the "turn off" point) and the hysteresis voltage gap (or "delta V", meaning "change in voltage" before it turns the circuit on). Use the included graph and examples to find the values of these 2 resistors, as we use a 100k resistor baseline value.

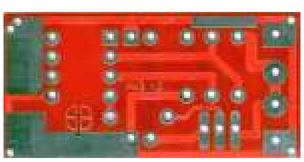
The 8212 can drive up to 35mA on the output, so although not absolutely required, we recommend a 1k transistor base resistor at R4. Otherwise, a wire jumper will need to be soldered in at position R4.

Since the 8212 has a "low" output, it drives PNP transistors (3906 / 2N2907 / ZTX550) or P-channel FETs (ZVP2106).

The PM3 is a "Vcc switching" solarengine that toggles the "+" side of the circuit, unlike the MSE1 that toggles the ground line.



Top

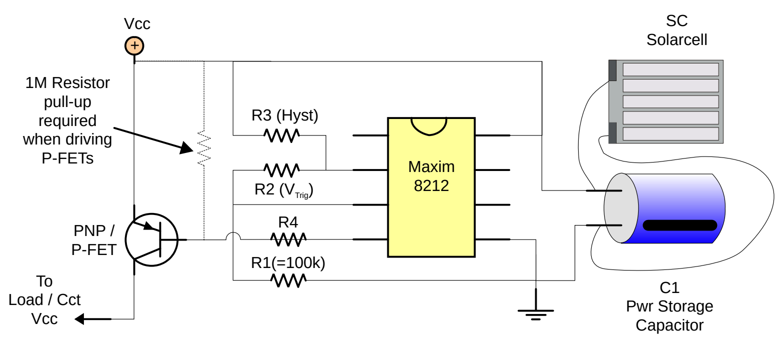


Bottom

- Edge Rail of PCB is Ground (-).
- Center Rail is Vcc Output (+).

- R1 requires transistor biasing resistor, or wire jumper to drive base/gate of PNP/P-Channel FET.

- Make SURE your solarcell/storage capacitor combination can reach the desired voltage before setting your resistor values (I.e: expecting 8V trigger out of a 5.5V solarcell won't work!)



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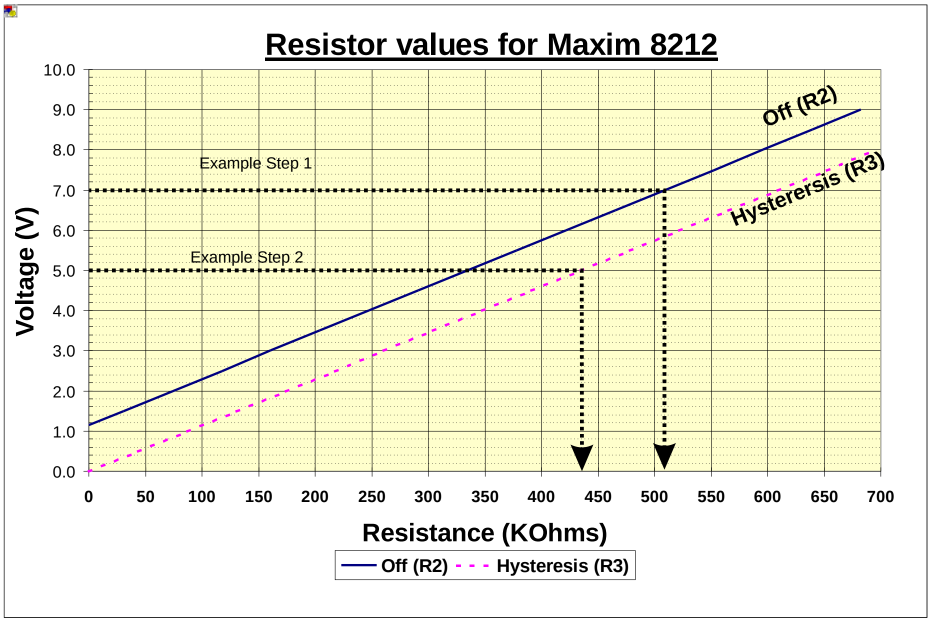

Resistor Selection:

This chart is calculated based on using a R1 value of 100k. If you want to use a different R1 value, use the formula instead.

1) Find your "Off" point: First we have to decide what voltage we want the 8212 to turn off at (the point where the circuits stops sending power to the load). Decide what voltage you want to use as your "Off" point from the left side of the graph, and follow the line over to where it intersects the solid "Off (R2)" line. Follow that line to where it crosses the solid "Trigger" line, then read the resistor value below it.

2) Set Hysteresis / "On" point: So we know when we want it off, so next we figure out when we want it on. This is calculated by adding the "hysteresis" voltage to the "off" voltage. Hysteresis is the term given to the space between the on/off voltages, and maintains whatever state the circuit is until the other value is met. That is, a 1 volt hysteresis on a 5 volt "Off" point means the circuit turns off at 5 volts, and will not turn on again until the voltage climbs over the 1 volt hysteresis (at 6 volts), at which point it will turn on and stay on until the voltage goes down to 5 volt "Off" point again.

Decide your desired hysteresis voltage by subtracting your desired trigger voltage from the "Off" voltage. Then read this calculated hysteresis voltage from the left side of the graph, and follow it over to where it intersects the dashed "Hysteresis (R3)" line. Then like before, follow it down from the intersecting line to the resistor value on the bottom.

Example: You have a high-power solarcell/capacitor combination you want to trigger at 12 volts, and reset at 7 volts. Your "Off" point is 7 volts, and your hysteresis value is 5 volts (12V "On" point - 5V hysteresis = 7V "Off" point). Well, you already know the value of R1; it's 100k (an easy-to-use value we selected to base the other resistor values from).

Step 1 - Calculate the Resistor Value for the "Off" point: Follow the 7V line across until it hits the "Off" line, and follow it down to the bottom, where we read a R2 value of near 510k.

Step 2 - Calculate the Resistor Value for the Hysteresis: We want a 5 volt gap to get to a 12 volt trigger point, so find the 5 volts on the left side, follow it across until it hits the "Hysteresis" line, and follow it down to the bottom, where we read a R3 value of near 430k.

<u>R1 = 100k, R2 = 510k, R3 = 430k</u>

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Hint: If you don't have these resistor values, use the same graph and divide all the values by 10 - it'll still work perfectly! Ie: R1 = 10k, R2 = 51k, R3 = 43k

Calculation Method:

1) Choose a value of R1, typically between 10k to 10Mohms.
2) Calculate R2:

$$R2 = R1 \times \left(\frac{(V_{Off} - 1.15V)}{1.15V} \right) \qquad R2 = 100k \times \left(\frac{(7V - 1.15V)}{1.15V} \right) \qquad R2 = 100k \times \left(\frac{5.85V}{1.15V} \right) = 509k$$

3) Calculate R3:

$$R3 = R1 \times \left(\frac{(V_{On} - V_{Off})}{1.15V} \right) \qquad R3 = 100k \times \left(\frac{(12V - 7V)}{1.15V} \right) \qquad R3 = 100k \times \left(\frac{(12V - 7V)}{1.15V} \right) = 435k$$

Note: Want to streamline your circuit? Only need to set a voltage "On" point, and let it run out as long as possible? Well, were a tricky bunch at Solarbotics, and we've got just the solution.

Get rid of the R2 (Off) resistor and swap in a wire (or shorting lead), and simply select a R3 (Hysteresis) resistor that gives you your trigger point minus 1.15 volts. Since the chip has a built-in lower cut-off of 1.15V (you can't make it detect any lower than that), you take advantage of this lower-value, and simply select the increase in voltage required.

Example:

Want a 5 volt "On" (and the default 1.15 volt "off)? You need a hysteresis of 3.85 volts (5V - 1.15V = 3.85V). Read 3.85V off the side of the graph, follow it over to the R3 line, and down to the resistance needed (about 340k). Don't forget to replace the R2 resistor with a shorting lead!