In-flight voltage monitor

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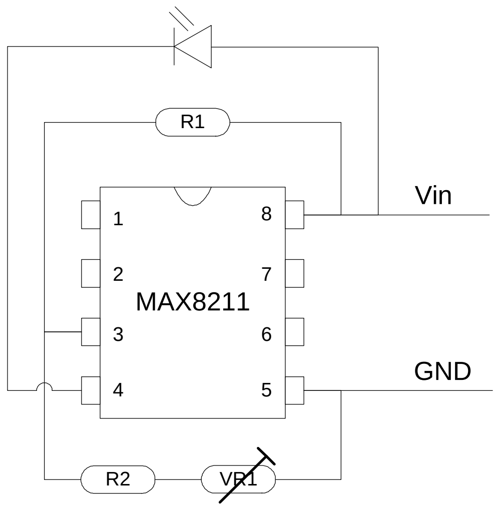
The Circuit

Here’s the circuit for the voltage monitor. It’s pretty basic really.



The IC is a Maxim 8211 voltage monitor designed for monitoring microprocessors. Pin 8 is the supply rail (anything from 2v to 16.5v). Pin 5 is ground.

The chip works by generating an internal 1.15v precision reference voltage which is compared to the voltage applied to pin 3 (the threshold pin). If the voltage at pin 3 is greater than 1.15v, the output pin 4 is off, if the voltage on pin 3 is less than 1.15v the output is on.

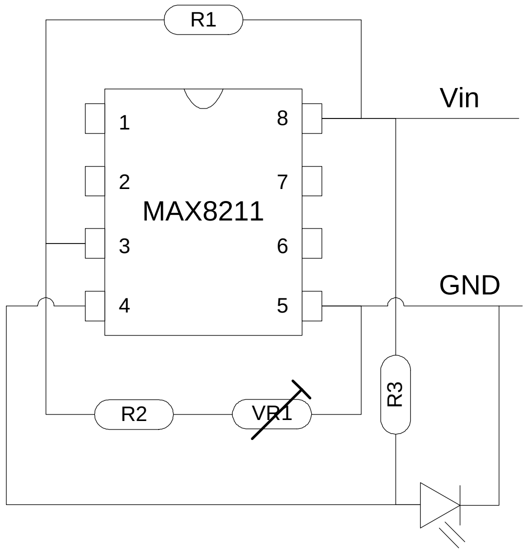
Resistors R1, R2 and VR1 form a voltage divider between Vin and GND, the output of which is applied to the threshold pin. The resistor values must be chosen such that for the required low-voltage point on Vin, a voltage of 1.15v is produced at pin 3. VR1 is a trimming pot that can be used to increase the resistance of the bottom half of the divider, thus increasing the voltage on the threshold pin and creating a lower trigger voltage. VR1 is optional, you can choose not to use it if desired. If used, the value of VR1 should be chosen to allow around 1 volt of adjustment to the trigger voltage.

The output circuit is also pretty straightforward. Pin 4 is open-drain. This means that when turned off, it is actually open-circuit (i.e. not connected to anything). When turned on, it is effectively tied to ground and can sink current up to 7mA. So, the positive lead of the LED must connect to Vin and the negative lead to pin 4.

The LED I used has an internal current limiting resistor, but I believe you could get away without it since pin 4 has an internal current limit set at 7mA.

Reversed Logic

If you want to LED to be normally on, and go off at the low voltage point, the following circuit should work (but is untested).



In this case the positive lead of the LED is pulled high by R3 when pin 4 is open-circuit, but when pin 4 is grounded (switched on) both sides of the LED are at the same potential and it should go off. R3 should be chosen to limit the LED current to a safe level (1K ohms perhaps).

Resistor Choices

Now, onto the values for R1 and R2. These need to be chosen to put 1.15v onto pin 3 at the desired Vin. The equation for this is

Vpin3 = (Vin * R2) / (R1 + R2)

The following table lists some common resistor values and the resultant threshold voltage. R1 goes down, R2 across.

	10000	**22000**	**34000**	**47000**	**51000**	**68000**	**82000**	**100000**	**220000**	**340000**	**470000**	**510000**	**680000**	**820000**	**1000000**	**3600000**
10000	2.30	1.67	1.49	1.39	1.38	1.32	1.29	1.27	1.20	1.18	1.17	1.17	1.17	1.16	1.16	1.15
22000	3.68	2.30	1.89	1.69	1.65	1.52	1.46	1.40	1.27	1.22	1.20	1.20	1.19	1.18	1.18	1.16
34000	5.06	2.93	2.30	1.98	1.92	1.73	1.63	1.54	1.33	1.27	1.23	1.23	1.21	1.20	1.19	1.16
47000	6.56	3.61	2.74	2.30	2.21	1.94	1.81	1.69	1.40	1.31	1.27	1.26	1.23	1.22	1.20	1.17
51000	7.02	3.82	2.88	2.40	2.30	2.01	1.87	1.74	1.42	1.32	1.27	1.27	1.24	1.22	1.21	1.17
68000	8.97	4.70	3.45	2.81	2.68	2.30	2.10	1.93	1.51	1.38	1.32	1.30	1.27	1.25	1.23	1.17
82000	10.58	5.44	3.92	3.16	3.00	2.54	2.30	2.09	1.58	1.43	1.35	1.33	1.29	1.27	1.24	1.18
100000	12.65	6.38	4.53	3.60	3.40	2.84	2.55	2.30	1.67	1.49	1.39	1.38	1.32	1.29	1.27	1.18
220000	26.45	12.65	8.59	6.53	6.11	4.87	4.24	3.68	2.30	1.89	1.69	1.65	1.52	1.46	1.40	1.22
340000	40.25	18.92	12.65	9.47	8.82	6.90	5.92	5.06	2.93	2.30	1.98	1.92	1.73	1.63	1.54	1.26
470000	55.20	25.72	17.05	12.65	11.75	9.10	7.74	6.56	3.61	2.74	2.30	2.21	1.94	1.81	1.69	1.30
510000	59.80	27.81	18.40	13.63	12.65	9.78	8.30	7.02	3.82	2.88	2.40	2.30	2.01	1.87	1.74	1.31
680000	79.35	36.70	24.15	17.79	16.48	12.65	10.69	8.97	4.70	3.45	2.81	2.68	2.30	2.10	1.93	1.37
820000	95.45	44.01	28.89	21.21	19.64	15.02	12.65	10.58	5.44	3.92	3.16	3.00	2.54	2.30	2.09	1.41
1000000	116.15	53.42	34.97	25.62	23.70	18.06	15.17	12.65	6.38	4.53	3.60	3.40	2.84	2.55	2.30	1.47

3600000	415.15	189.33	122.91	89.24	82.33	62.03	51.64	42.55	19.97	13.33	9.96	**9.27**	7.24	**6.20**	5.29	2.30

I chose the ones marked in bold.

For 9.27 volts (a 3 cell pack) R1 = 3.6Mohms, R2 = 510Kohms.
For 6.2 volts (a 2 cell pack) R1 = 3.6Mohms, R2 = 820Kohms.

For these value a 100K trim pot for VR1 allows the voltage for 9.27 to be adjusted down to 7.9V and the 6.2V down to 5.6V.

It is important to either measure your resistor values accurately, or use low tolerance (1%) resistors. Since the values are very large, a 5% tolerance can affect the detection voltage by quite a margin. Of course, if you use the trim pot, you can adjust for tolerance problems too. You will also be unable to measure the voltage on pin 3 using a multi-meter since they have an internal resistance of around 1Mohm which will seriously upset the circuit.

If you want to be sure and measure the voltage at pin 3 you should use resistors in the top-left side of the table above. The internal resistance of the meter won't then be a problem, but you will draw more current (though still a negligible amount).

The circuit as printed has a very, very high resistance and will draw only a few micro-amps of current with the LED off. When on, it will only draw about 7 milliamps.

Parts List

These are the parts I used (with Farnell code numbers in brackets): -

MAX8211 voltage detector	(205230, £1.34 + vat) x 1
Ultra Red LED (with internal resistor for 5V)	(621122, £0.40 + vat) x 5
Ultra Red LED (with internal resistor for 12V)	(621134, £0.36 + vat) x 5
3M6 1% resistor	(336798, £0.031 + vat) x 50
510K 1% resistor	(336592, £0.031 + vat) x 50

Make sure you choose a bright LED. The ones I chose are normally 500mcd with a 60-degree viewing angle and an internal current limiting resistor.

The LED's are only sold in multiples of 5, and the resistors in 50's.

Construction

Note: I haven't yet built mine with VR1 in place, so these details will need modifying to include it at some point.

Take a little care with static discharge. At least touch an earthed radiator or PC case before starting.

I snapped off the thin parts of the legs on the 8211 since I built everything on the chip, not on a PCB.

Cut the resistors to length to fit between the pins on the underside of the chip.

Bend and cut the LED legs to sit on the top of the chip and come down the side onto the right connecting pins. I put a little heat-shrink on one leg to avoid short-circuits.

Attach wire to Vin and GND (any wire will do, it's not carrying more than a few milliamps). Now you need to attach those wires across the battery connections on the helicopter (positive to positive, negative to negative). A y-connector would help. DON'T attach to the batteries since you won't then be able to stop the slow current draw used by the monitor.

Here are some pictures of my finished item. A little electrical tape or heat-shrink is probably sensible around the body before attaching to the chopper.