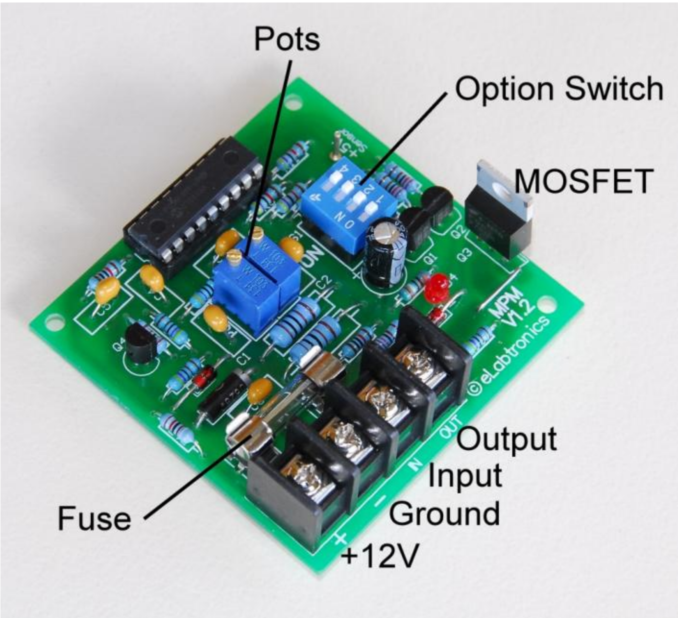
# eLabtronics Voltage Switch

***Want to trigger a device when a monitored voltage, temperature or light intensity reaches a certain value? The eLabtronics Voltage Switch is an incredibly easy way of doing it.***

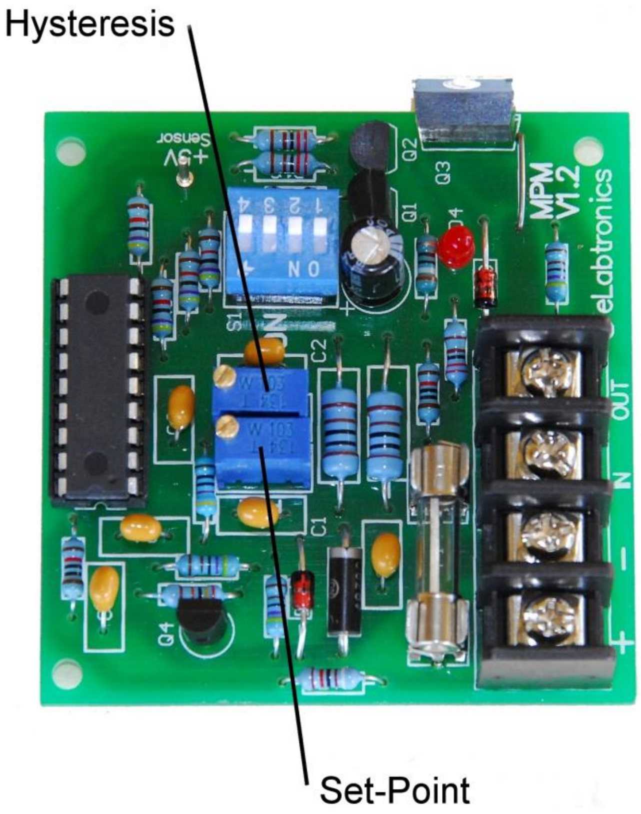
**Features:**

- Independent setting of set-point and hysteresis
- Monitors input voltage range of 0.1 – 50V
- Sensing direction: selectable for rising or falling
- Hysteresis adjustable from 1 – 100 per cent
- Output can be user-set to be fully on, pulse twice, or continuously pulse
- Operates from 10 – 40V DC
- Fuse and reverse polarity protected
- Can be configured to automatically switch at certain temperature or light level
- Output power: up to 10 amps continuous with appropriate heatsink, up to 15 amps short pulsed with appropriate heatsink, up to 100 amps with appropriately heatsinked external solid state relay



The eLabtronics Voltage Switch is a brilliant device. It can be used to monitor the voltage output of existing sensors (accelerometers, pressure sensors, airflow sensors, etc) or by adding a few components, it can monitor temperature or light levels.

You can automatically turn on cooling fans when it gets hot, operate a solar water heater pump, switch on lights when it gets dark, sound a low battery alarm, or even turn on a low fuel warning light in a car.




The set-point is adjustable by a multi-turn on-board pot, allowing very fine adjustment. Furthermore, the hysteresis (difference between turn on and turn off values) can be set from 1 – 100 per cent.

When the set-point is reached, the output can be configured to be fully on, to pulse twice, or to pulse continuously.

By just altering a switch position, the eLabtronics Voltage Switch can be set to trigger when the monitored signal level is falling, or when the level is rising.

Take the situation where you want an audible and visual warning that a greenhouse temperature is too low. You can configure the module so that when the temperature falls to the required level, a LED comes on and a buzzer sounds two warning beeps and then goes quiet. The buzzer alerts you and the LED keeps on reminding you...

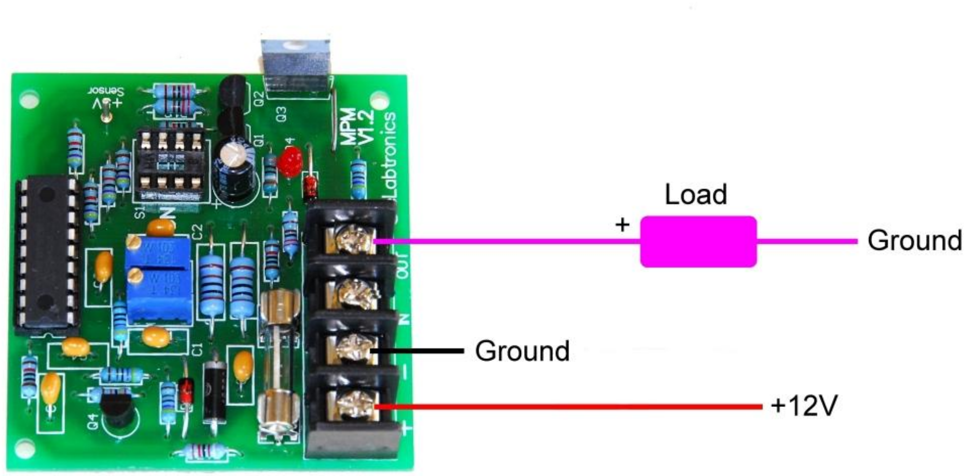
A heavy duty output transistor is fitted so that loads of up to 10 amps continuous can be directly driven. That means that with a suitable heatsink fitted to the transistor, horns, sirens, high power lights, pumps and other current-hungry devices can be directly driven without a relay.

For even bigger loads, just add a conventional or solid state relay (covered later).

**Using the eLabtronics Voltage Switch**

That might all sound pretty complicated, so let's take a look at an application, exploring the unit as we go.

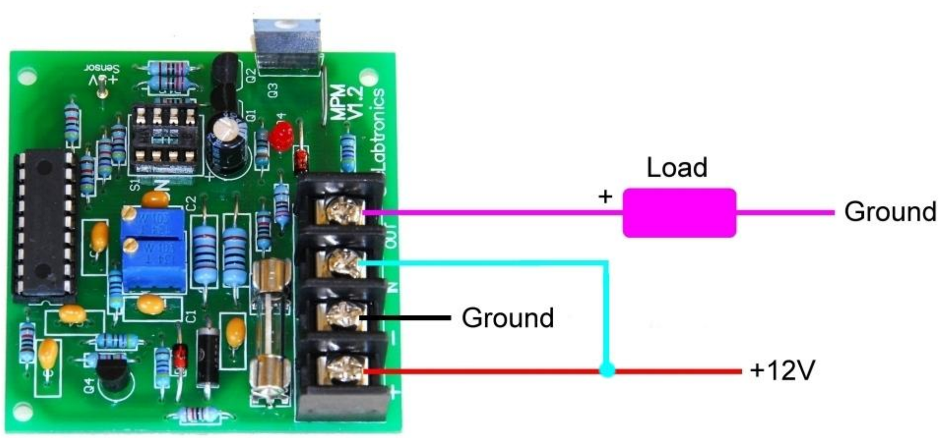
The eLabtronics Voltage Switch has just four connections. These are power (anything from 10 - 40V), ground, input and output. Let's take a look at the 'input' and 'output' terminals in more detail.




When the Voltage Switch's output MOSFET is turned on, battery power is available at the output terminal. So all you need to do is to wire your load (lights, buzzers, horns, solenoid, etc) between the output terminal and chassis ground.

If the load has a polarity, the positive terminal goes to the Voltage Switch.

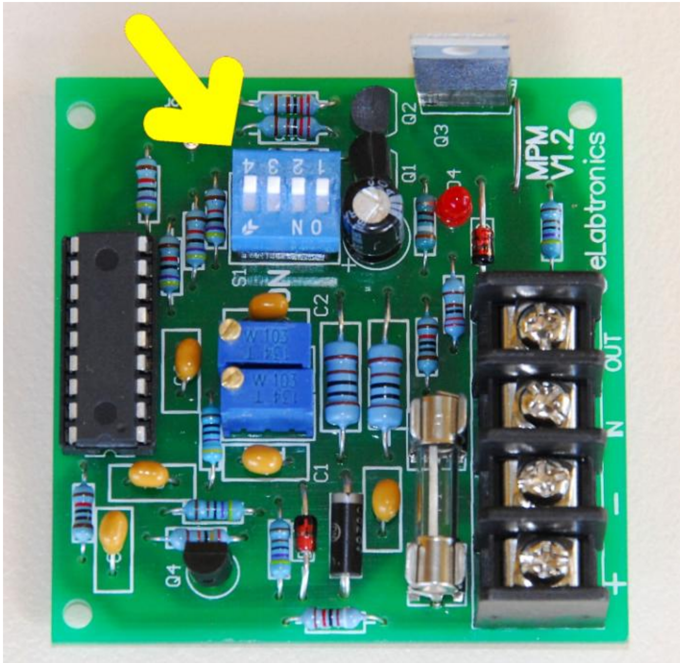
(Note that as with all MOSFETs, there is a slight voltage drop across it, so a little less than battery voltage will be available at the output.)




The voltage that is being monitored is connected to the Voltage Switch's Input terminal. For example, as shown here, the Voltage Switch can monitor the state of charge of a battery that's actually powering the module. The load could be a buzzer that will sound when battery voltage falls to a preset value.

So that's the wiring done! Next, we'll take a look at the switch options.

**Switch Options**




The eLabtronics Voltage Switch has a four-position DIP option switch (arrowed). Position the board **so that the terminal strip is on the right** and then the following switch positions give the listed behaviour. Note that the position of the last switch doesn't alter.

- **Output Switches on as Voltage RISES ABOVE Set-point**

| | | | |
|---|---|---|---|
| | | | X |
| X | X | X | |

Switches on as voltage rises above set-point, then on-board LED illuminates and output stays fully on. LED and output switch off when input voltage falls below set-point. This mode will be one of the most often used.

| | | | |
|---|---|---|---|
| X | | | X |
| | X | X | |

Switches on as voltage rises above set-point, then on-board LED illuminates and output constantly pulses. LED and output switch off when input voltage falls below set-point.

| | | | |
|---|---|---|---|
| | X | | X |
| X | | X | |

Switches on as voltage rises above set-point, then on-board LED illuminates and output gives two pulses. LED and output switch off when input voltage falls below set-point.

| | | | |
|---|---|---|---|
| X | X | | X |
| | | X | |

In addition, there is another that holds the output constantly on, irrespective of the input signal. This mode can be used in testing eg to check that the load has been wired correctly. Output constantly on (useful during set up only).

- **Output Switches on as Voltage FALLS BELOW Set-point**

| | | | |
|---|---|---|---|
| | | X | X |
| X | X | | |

Switches on as voltage falls below set-point, then on-board LED illuminates and output constantly on. LED and output switch off when input voltage rises above set-point.

| | | | |
|---|---|---|---|
| X | | X | X |
| | X | | |

Switches on as voltage falls below set-point, then on-board LED illuminates and output constantly pulsed. LED and output switch off when input voltage rises above set-point.

| | | | |
|---|---|---|---|
| | X | X | X |
| X | | | |

Switches on as voltage falls below set-point, then on-board LED illuminates and output gives two pulses. LED and output switch off when input voltage rises above set-point.

| | | | |
|---|---|---|---|
| X | X | X | X |
| | | | |

Again there is another test mode; this one holds the output constantly off. This is useful during set-up only.

**Note:** we've said that the output switches off when the voltage moves back past the set-point. In fact, the amount of hysteresis that's been set will determine exactly when the output turns off. More on this in a minute.

**Back to the Low Battery Alarm Example**

OK, so back to our example application, where we want an alarm to sound when battery level drops too low.

Since we want the buzzer to come on when battery voltage drops, we need configure the Voltage Switch to turn on when the voltage falls below the set-point. Next, it would be good if the buzzer pulsed on and off – that would better attract attention than just the buzzer being on continuously.

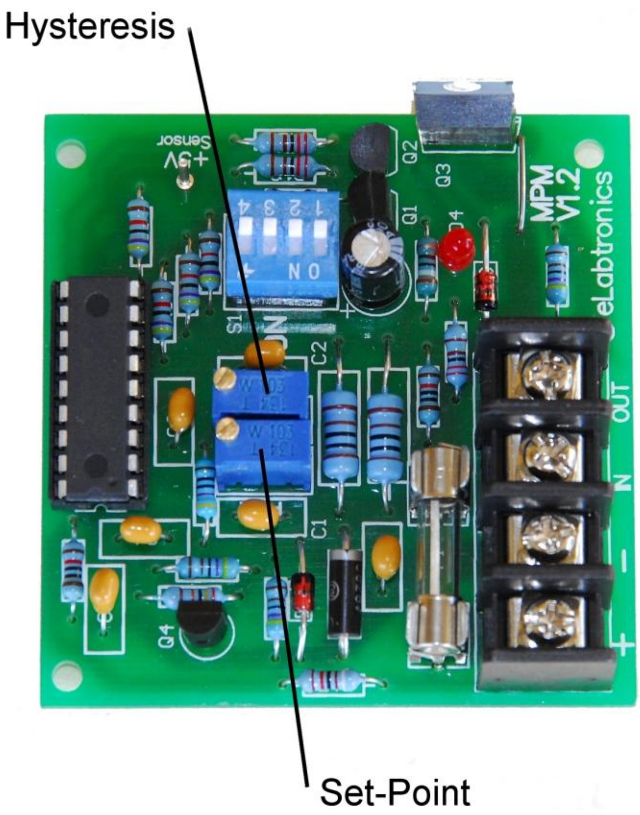
To achieve those outcomes, we set the switches like this:

| | | | |
|---|---|---|---|
| X | | X | X |
| | X | | |

Remember, the switches are viewed with the board orientated so that the **terminal strip is on the right**.

**Set-Up**

The next step is to set the voltage at which the Switch turns on the buzzer.




There are two adjustment pots on the board. These pots are multi-turn so don't expect to make only one rotation when setting them. Multi-turn pots also don't have clear end-stops (although they can sometimes be heard clicking when they've reached the end of their adjustment).

Rotating the set-point pot clockwise increases the input voltage level at which the switch activates its output.

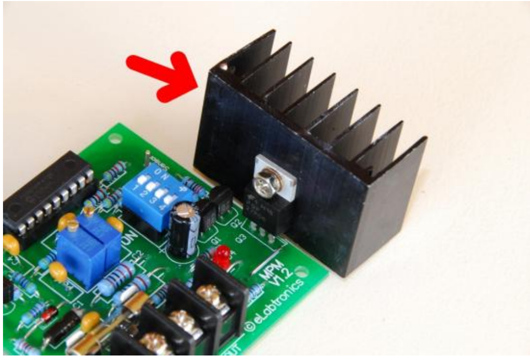
Assuming that you're monitoring a 12V battery, this pot will need to be rotated anti-clockwise a fair amount. The easiest way of setting this pot is to connect the circuit up to a battery that is already well down in voltage – in fact, at the voltage you want the alarm to trigger. Rotate the set-point pot anti-clockwise until the on-board LED lights and the wired-in buzzer pulses.

The other pot sets the difference between the switch-on and switch off values. (This is called hysteresis.) Rotating the hysteresis pot clockwise increases the hysteresis. In this case, you'd set the hysteresis pot a turn or two clockwise from its fully anti-clockwise position.

Of course, if you have access to a variable voltage power supply, the set-up procedure can be made more accurate and simpler.

**Output Power**

The output MOSFET (transistor) is rated to handle a continuous 10 amps – but that's when it is fitted with a big heatsink.



As a general rule of thumb, no heatsink will be needed if you're operating warning globes, LEDs or beepers. If you're pulsing a pump, a medium sized heatsink like the one pictured will be needed. If you're pulsing high powered lights or horns, a large heatsink will be needed.

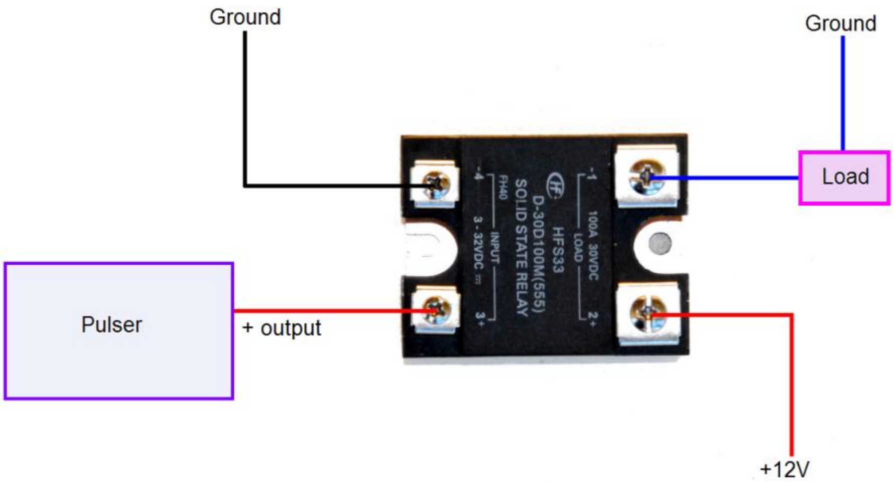
The heatsink needs to be isolated from ground and positive supplies, so either mount it so it fits inside a box (and can't touch anything metallic!) or mount the heatsink to the MOSFET using an insulating spacer and nylon nut and bolt.

**Ultra-High Currents**

But what if you want to operate really big loads – like multiple 12V halogen lights, high-powered sirens or the like? There's no problem – you'll just need to buy a solid state relay.

The Jaycar SY4086 is one example of a solid state relay suitable for switching DC current. It costs about AUD$40.

The relay is rated at 25 amps without any heatsink, and up to 100 amps with a large heatsink. This current handling means that, for example, you could pulse on and off twenty 50-watt halogen lamps – although you'd need a pretty big power supply to run that lot!




To wire the solid state relay to the Voltage Switch, the positive input lead of the relay connects to the output of the Voltage Switch. The negative input lead of the relay connects to the negative terminal of the Voltage Switch power supply.

The output connections of the relay are also straightforward. The positive output terminal of the relay connects to a power supply (it doesn't have to be the same one you're using to run the Voltage Switch) and the negative output terminal of the relay connects to the load, eg those halogen lights. The other side of the load connects to the negative lead of the load's power supply.

The solid state relay is limited in operating voltage to about 30V DC.

We suggest that whenever high currents need to be switched, a solid state relay is used - rather than a large heatsink on the Voltage Switch's MOSFET. Note that when the solid state relay is being used, the Voltage Switch MOSFET doesn't need a heatsink.

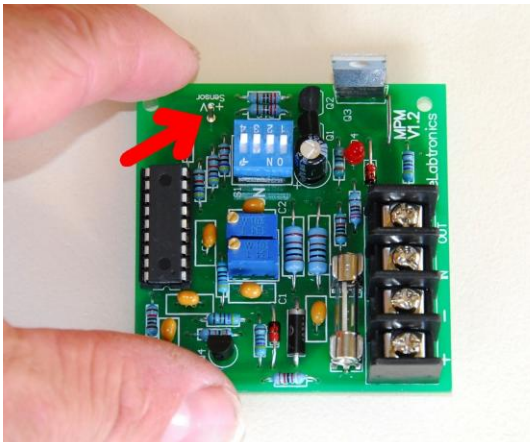
**Triggering From Light and Temperature Sensors**

As mentioned above, the Voltage Switch can monitor a voltage and then switch when a certain level is reached. However, by adding a few low cost components, the Voltage Switch can also monitor light or temperature levels.

Example uses include automatically switching on lights when it gets dark, turning on pumps or fans when the temperature rises, or monitoring two temps and switching when the difference is greater than a preset value.

Some soldering and component recognition skills are required when configuring the Voltage Switch for automatic switch-on, so the electronic skills needed are a little higher than when wiring-in the Voltage Switch for normal manual use. However, the wiring is still very straightforward.

**5V supply**



To automatically trigger the Voltage Switch on the basis of temperature or light intensity, use is made of a regulated 5V supply sourced from the module. This is available on the pin shown here.

Note that while a regulated 5V is available on this pin, the amount of current that can be drawn is strictly limited. There is sufficient current available to operate the temperature and light sensor circuits described here, but there is **not** enough current available to run other sensors (eg automotive MAP sensors). In fact, the output current rating of this source is only 2 milliamps.

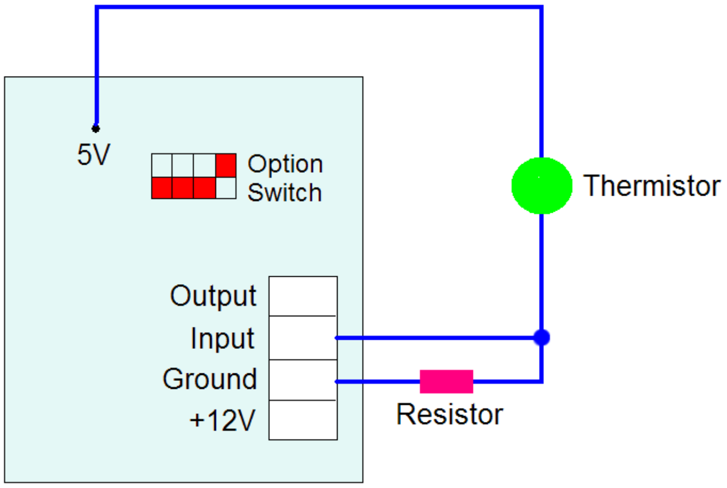
Effectively, the 5V pin supplies a fixed voltage that is them modified by the action of the specific sensor (temp or light) and adjustment pot before being fed to the Input.

So how is the Voltage Switch wired for temp and light sensing? Let's look at temperature first.

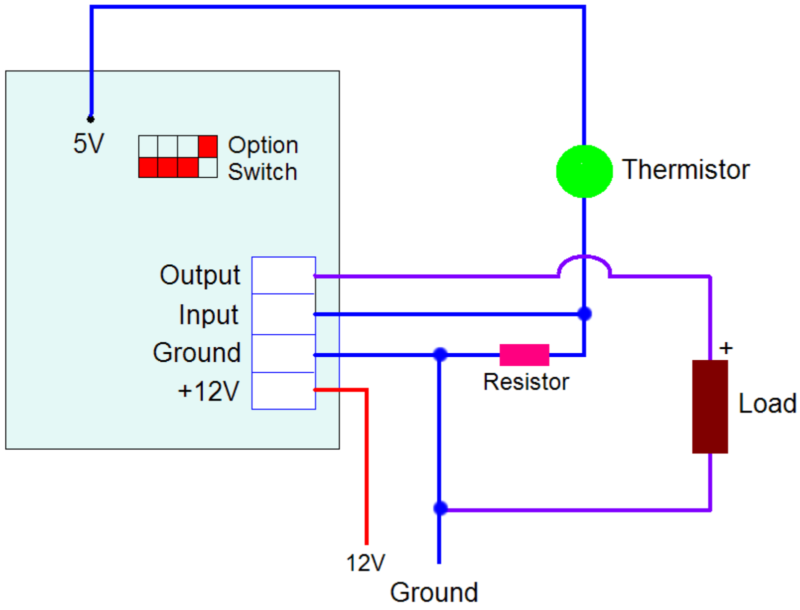
**Temperature**

- **Turns on when it gets hot**

This is the approach to go for when things need to be switched once the temperature **rises above** a certain point.




Here is the wiring diagram. Note that for the sake of simplicity, the power and load connections for the Voltage Switch are not shown here (or in most of the wiring diagrams in this story).




However, as a special once-off, here is a full working system, complete with ground, +12V and the load connections.

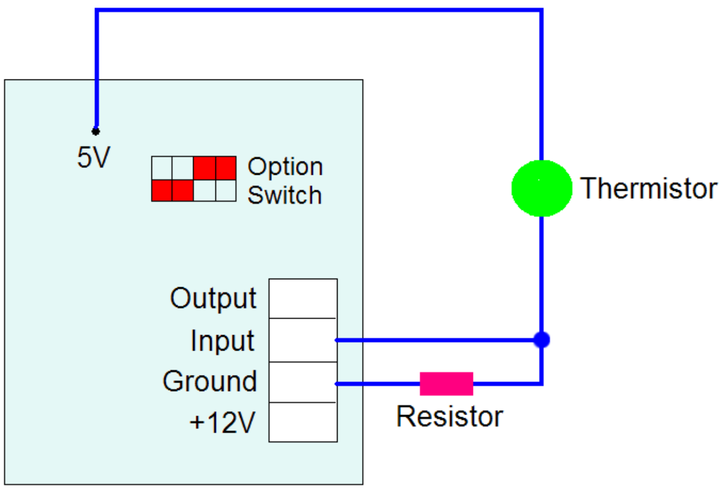
To trigger the Voltage Switch on the basis of temperature, the required additional components are:

- 200 kilo-ohm resistor
- 100 kilo-ohm thermistor

The circuit is wired as shown here. The thermistor and resistor have no polarity so they can go into the circuit either way around.

Adjustment of the on-board trip-point pot sets the temp at which the switch triggers. The hysteresis (difference between on and off temps) is adjustable with the hysteresis pot. With the depicted components, the selectable temp range is from about 0 degrees C to about 100 degrees C.

- **Turns on when it gets cold**



This is the approach to go for when things need to be pulsed once the temperature **falls below** a certain point.

Another way of looking at this is to say that the output will be on when it is cold, and off when it is hot. An example use is a warning light that flashes when a solar water heater has not yet heated the water sufficiently. Place the sensor so that it can detect water temp and if the water is too cold, a warning light will flash.

Again adjustment of the on-board trip-point pot sets the temp at which the switch triggers. The hysteresis (difference between on and off temps) is adjustable with the hysteresis pot. With the depicted components, the selectable temp range is from about 0 degrees C to about 100 degrees C.

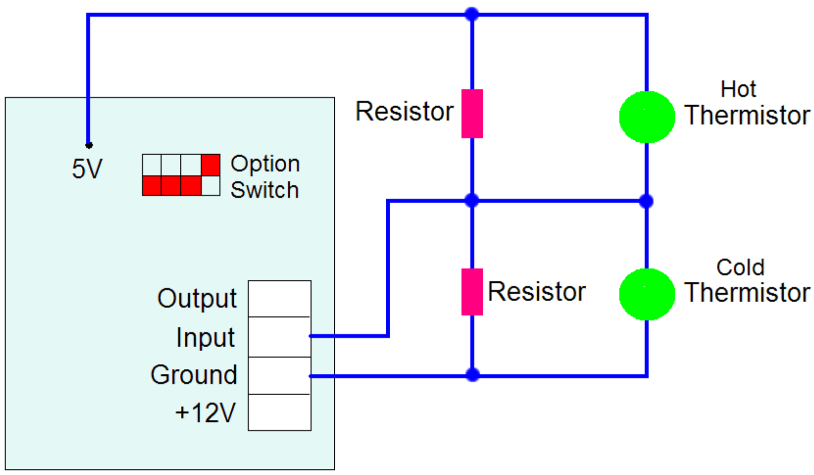
- **Turns on when temperature difference is high**

This is the approach to go for when things need to be pulsed once the **temperature difference** between two sensors **increases above** a certain point.

The benefit of using two sensors is that it takes into account different ambient temp levels that might exist. An example makes it clearer.

Suppose you want to turn on a turbocharged car's intercooler water spray when the core temp exceeds 50 degrees C. Trouble is, if the intercooler is under the bonnet, that will happen most times you're stopped in traffic and the day is hot! The result is an empty water tank.

Now change that set-up to using two sensors – one positioned in the general area of the intercooler core and the other actually buried in the fins of the intercooler core. If the spray is set to trip when the intercooler core sensor is (say) 15 degrees C hotter than the other sensor, the spray will come on only when the core is not working sufficiently well – in fact, when it is working as a pre-heater! Tricky, eh?




The wiring is carried out as shown here. The 'hot' sensor is placed so that it will be the hotter of the two sensors. When the 'hot' sensor is (say) 15 degrees C higher in temp than the 'cold' sensor, the Voltage Switch will be switched on.

The required components are:

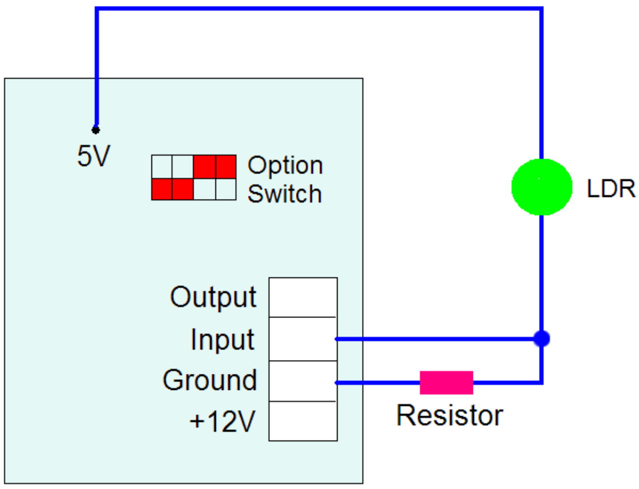
- 2 x 100 kilo-ohm resistors

- 2 x 100 kilo-ohm thermistors

Again adjustment of the on-board trip-point pot sets the temp at which the switch triggers. The hysteresis (difference between on and off temps) is adjustable with the hysteresis pot. With the depicted components, the selectable temp range is from about 0 degrees C to about 100 degrees C.

**Light Intensity**

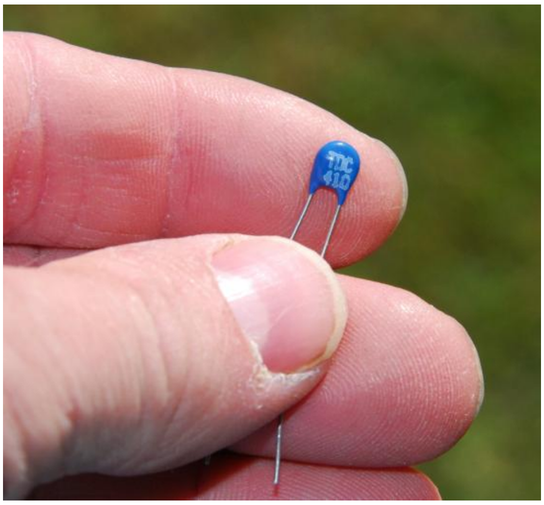
- **Turns on when it gets dark**



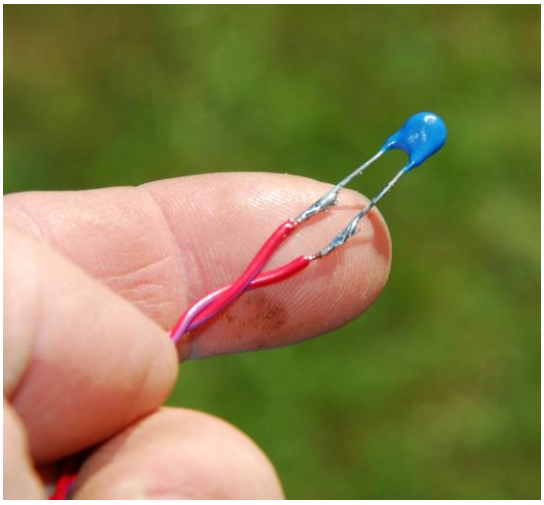

Wired in this form, the Voltage Switch switches itself **on when it gets dark.** An example use is to automatically turn on lights whenever it's dark. The wiring requires a Light Dependent Resistor (LDR) with a nominal 48 – 140 kilo-ohm response and a 200 kilo-ohm resistor.

**Mounting the Sensors**

Both the thermistors and LDR come as bare electronic components. To wire them into place, you'll need to do two things: solder them to extension wiring and mount them.



Here’s a bare thermistor



Shorten the leads and then solder two insulted wires to the leads.

Use insulation tape (when working with relatively low temps) or good quality heatshrink (high temp sensing) to insulate the connections.

The Light Dependent Resistor (LDR) can be handled in the same way.

If the sensor is detecting just ambient conditions (eg ambient temperature or light intensity), the sensor can simply be positioned appropriately and held in place with a cable tie. However, if the sensor is working in a much tougher environment, use high-temp epoxy to mount the sensor in a threaded brass fitting so that it can be securely mounted.

**Conclusion**

The Voltage Switch is extraordinarily versatile. It allows you to monitor existing sensors, or by means of a few extra components, switch on the basis of changing temperature or light levels. The beauty of the design is in its compactness, power handling ability and the ease with which a wide range of different output behaviours can be attained.