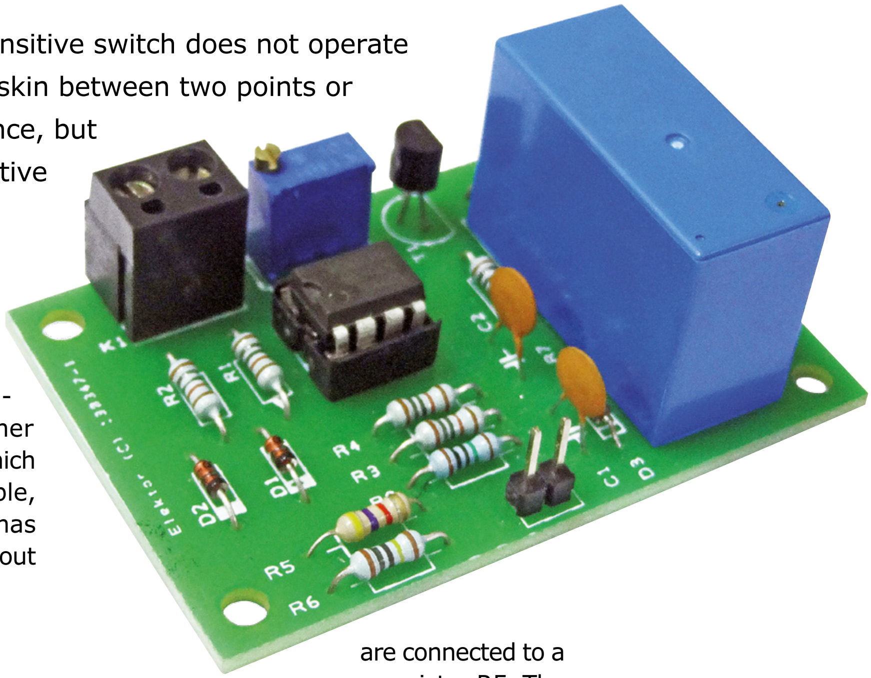
Alternative Touch Switch

Reacts to temperature changes

For a change, this simple touch-sensitive switch does not operate by detecting the resistance of the skin between two points or measuring the change in capacitance, but it reacts to heat instead. The negative temperature coefficient of a silicon diode is utilized for this purpose.



Diodes are normally used to rectify signals, but they are also suitable for other applications. Here we use a property which is normally considered to be undesirable, namely that an ordinary silicon diode has a negative temperature coefficient of about –2 mV/°C.

Two diodes and an opamp

In the schematic shown in **Figure 1**, you can see that we used two standard 1N4148 diodes (D1 and D2), each of which has a current of about 0.4 mA running through it via R1 and R2. The cathodes of the diodes are connected to a common resistor R5. The anodes are connected to the non-inverting and inverting inputs of the 741-opamp, which is configured as a comparator. The operation is as follows. We make the

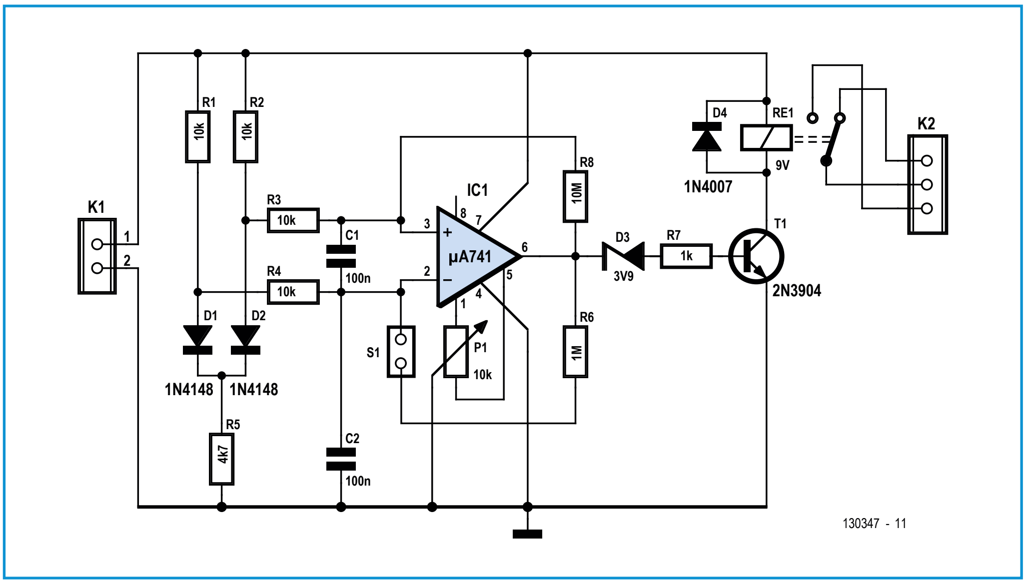


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Figure 1.
The touch switch uses two diodes as sensors.

assumption that the initial voltage drops across the two diodes are exactly equal. When the power supply voltage is turned on, the voltage at the inverting input will be a little lower than the voltage at the non-inverting input because of the presence of C2. The output of the opamp is then ‘high’. Because of the presence of the positive-feedback resistor R8 this situation will persist. Relay RE1 will be switched on via transistor T1.

When diode D2 is heated by touching the diode with a finger, the voltage drop across the diode will reduce somewhat, with the consequence that the voltage at the non-inverting input will become lower than the voltage at the inverting input. The output of the 741 will flip state and the relay will be switched off via T1 (zener diode D3 ensures that the transistor will be fully off even when the output voltage of IC1 does not quite go all the way down to zero). By touching D1 the voltage at the inverting input will become lower than the voltage at the non-inverting input, with the result that the output of the 741 will become high again and the relay will be switched back on again.

The above description is of course only valid if the voltage drop across each of the diodes is exactly the same. In practice, however, this will not be the case. These small differences in diode voltages and also the input-offset voltage of the opamp can be compensated for with the aid of P1. To do this, the pins labeled S1 are temporarily linked with a jumper. This temporarily disables the positive feedback around the opamp. Now adjust P1 so that the output of the opamp is half (4.5 V) of the power supply voltage. It may be necessary to experiment further with this setting afterwards.

Handy circuit board

Figure 2 shows the small circuit board that we have designed for this circuit. The assembly is very straightforward, only standard through-hole components have been used. Although the prescribed relay can switch considerable currents (provided you reinforce the copper traces to the relay contacts with solder), the layout is not suitable for connecting to line voltages.

The photo of the prototype shows that the diodes are mounted directly on the circuit board, but that is not very convenient for a practical application. You would be better to mount them some distance above the circuit board and in such a way that it is possible to easily touch each diode individually.

The circuit can be powered from a small wall adapter which supplies a regulated output voltage of 9 V and has a rating of at least 100 mA.

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Figure 2.
Using this small circuit board the whole thing is quickly assembled.

Component List

Resistors
R1–R4 = 10kΩ
R5 = 4.7kΩ
R6 = 1MΩ
R7 = 1kΩ
R8 = 10MΩ
P1 = 10kΩ multiturn trimpot, vertical mounting

Capacitors
C1,C2 = 100nF

Semiconductors
D1,D2 = 1N4148
D3 = 3.9V 500mW zener diode, e.g. BZX55C3V9
D4 = 1N4007
T1 = 2N3904
IC1 = µA741CP

Miscellaneous
RE1 = 9V, 1 x c/o/, e.g. TE Connectivity OMI-SH-109LM,095)
K1 = 2-way PCB screw terminal block, 0.2” pitch
K2 = 3-pin pinheader, 0.1” pitch
S1 = 2-pin pinheader, 0.1” pitch
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