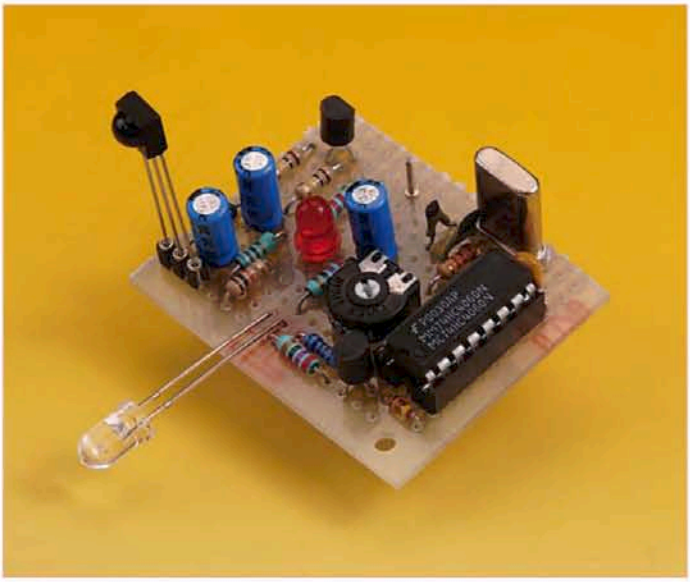
Touchless switch

By Ton Giesberts (Elektor Labs)

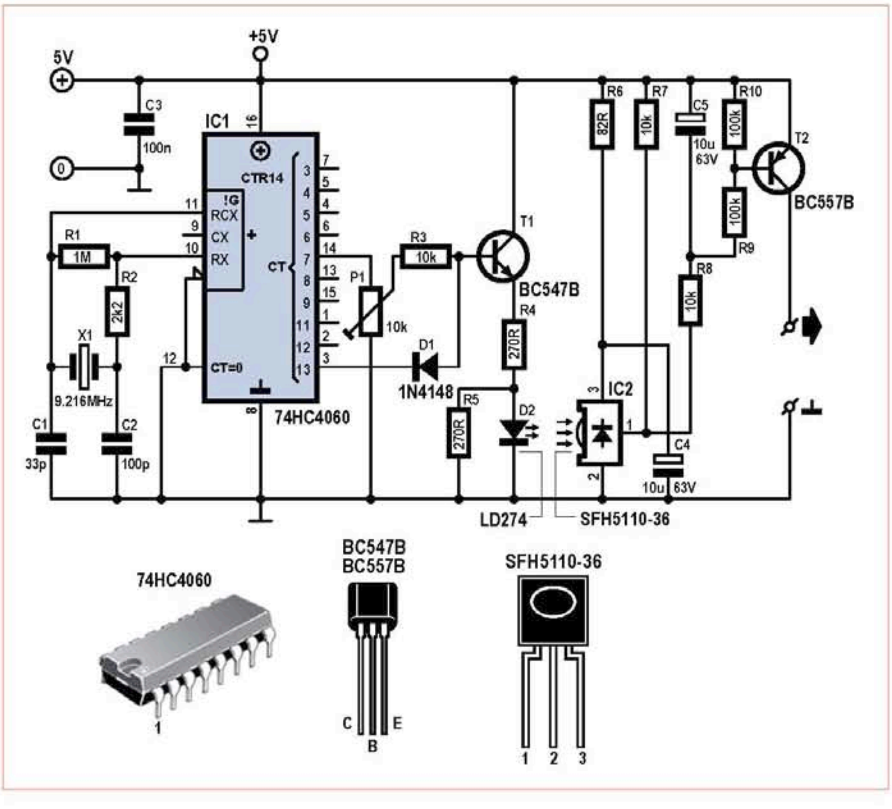
To the untrained eye, it may seem like magic: an engineer makes rapid Harry Potteresque gestures through the air and suddenly the light goes on or music starts to play... Luckily for you, the Elektor electronics lab isn't Hogwarts School of Witchcraft and Wizardry, even though it may seem so sometimes; everything conceived and built in our laboratory is firmly anchored in reality and can be understood and constructed by everyone!

There are a few different approaches you can take when building a switch that's operated without any physical contact. For example, you could brush up on Maxwell's equations and go for a capacitive or inductive approach. Although switches have been made using those principles, such a solution would require more electronics than what you're used to of i-TRIXX or Summer Circuits. That's why the engineers at the Elektor lab chose to take a radically different direction. Their solution is, for the largest part, comprised of components which you'll probably still have lying around. The principle is simple: An infrared LED transmits an invisible signal, which does not reach the infrared receiver in normal circumstances. As soon as you place your hand in the vicinity of the switch though, the signal gets reflected enough to activate the receiver, which in turn controls a relay used to switch something on or off.

The circuit is comprised of two parts: the transmitter and the receiver. To keep the construction simple, a standard infrared receiver-module (IC2) is used, which is normally used in conjunction with infrared remote controls. This 'three-pin device type SFH5110-36 contains just about everything you need to detect the presence of the signal, although there are a few peculiarities you'll need to pay attention to. This IC is probably one of the two components



you won't have lying around on your workbench in the junkbox, or in a drawer.
The core of the transmitter is formed by the fast HC version of the trusty old 4060 (IC1). This chip combines an oscillator circuit and a 14-stage binary counter (of which the highest ten are bonded out to pins) in a 16-pin package. To prevent calibration problems, we designed a crystal oscillator circuit using the oscillator section of IC1 and crystal X1. Because of the high frequency produced by X1 (9.216 MHz), you really have to use the HC version of the 4060.
On IC1s output Q8 (pin 14), you'll find the oscillator frequency divided by 28 (256), which amounts to a signal of exactly 36 kHz. IC2, the receiver, is tuned to receive exactly that frequency. Bear in mind that the SFH5110 is also available for use with other frequencies, so make sure you really get a hold of the SFH5110-36. This frequency is used to make a normal infrared LED (D2) flash. Potentiometer P1 is added to control the sensitivity of the circuit as a whole. This is done at the transmitter because SFH5110 doesn't contain any calibration options.
Now the only unanswered question remaining is just what diode D1 is doing in the circuit. It connects the base of T1 to the output Q14 (pin 3) of the 4060. Well, this is where the peculiarity of IC2 comes in. Because the module was built to receive information from remote controls, it ignores continuous, unmodulated carrier waves. An unmodulated signal, which can not contain any information, is therefore interpreted as 'no signal' and gets dealt with accordingly. Thanks to D1, T1 is switched on and off at the signal frequency at pin 3 of IC1 (which is 9.216 MHz divided by 214, or 562.5 Hz). This results in a perfect 50% modulated signal, which doesn't get ignored, therefore allowing us to detect the presence of an infrared signal.
As soon as the receiver module sees the reflected signal from D2, a square wave appears on its output with a frequency of approximately 563 Hz. Components R8 and C5 act as a filter and create a neat switching signal which drives the transistor T2 through the voltage divider R9/R10. The voltage divider prevents the circuit from reacting too enthusiastically on signals from regular remote controls.
A PNP transistor was chosen for T2, because the output of the infrared module IC2 is high in quiescent state (when no infrared signal is received). When a signal is received, the transistor will conduct and switch on anything connected to its output.



For testing purposes, you can wire up a low-current LED from the output of the circuit to ground through a 1 kΩ resistor. If you want to control TTL or CMOS logic, you could connect T2's collector to the ground through a 10 kΩ resistor and use the potential across the resistor to drive your circuit. A relay generally draws more current (20 to 30 mA) than T2 is able to supply, so you'll need a buffer to get things working.

Assembling the circuit won't be a problem we reckon. It's recommended to use a socket for IC1 and for X1 if necessary. Make sure you mount all oscillator components as close together as possible. The infrared LED D2 and the receiver module IC2 should not be allowed to be in visual range of each other, so place a screen between the two.

P1 controls the range of the circuit. When using the indicated component values, it's about 20 cm. If desired, the range can be increased by lowering the value of R4.

Now all that's left is to wish you a happy build!

(i-00870)