Capacitive Proximity Detector

With output contact

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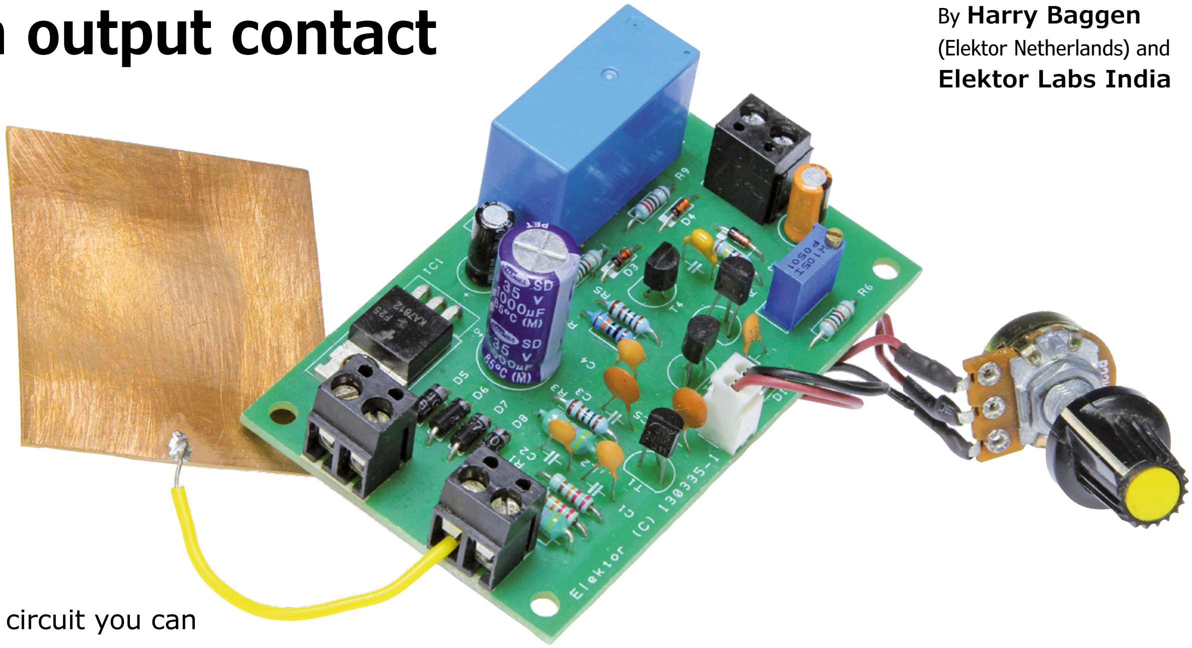

With this circuit you can detect the presence of an object from some distance away, depending on the sensitivity and the size of the object. Very handy for detecting whether someone is on the other side of a door without first having to open the door!

You can, for example, use this circuit to detect people, but you can also use it to detect the presence or absence of the car in the garage. It doesn't matter whether the detected objects moves or not, it only matters whether an object is within a certain distance of the sensor.

Circuit

The sensor consists of a metal plate (for example a piece of unetched circuit board) which forms part of a Clapp oscillator, which is built around transistor T1 (see **Figure 1**). This type of oscillator uses a tuned circuit comprising a coil and a capacitor (here L1 and the sensor plate) in series with another two capacitors (C1 and C2). Connected to the emitter of T1 is a series circuit of a resistor, a coil and a trimpot (decoupled with C3). By adjusting the position of P1, the DC-bias setting of the transistor can be altered, which sets the point of oscillation and with that the sensitivity of the circuit. The circuit is at its most sensitive when the trimpot is set to the position just before the circuit starts to oscillate. As soon as anything at all comes in the vicinity of the sensor plate, T1 will begin to oscillate. In the prototype we used a small plate of about 40 x 40 mm, which caused T1 to oscillate at about 2 MHz. A larger plate (more capacitance) will result in a slower frequency and the circuit will then react only to larger changes in the vicinity.

The oscillator signal generated by T1 is quite small, that is why it is amplified considerably by the amplifier stage around T2. This signal subsequently passes through C6 and is then rectified by D2 and finally drives an N-channel MOSFET (T3), which in turn switches on a

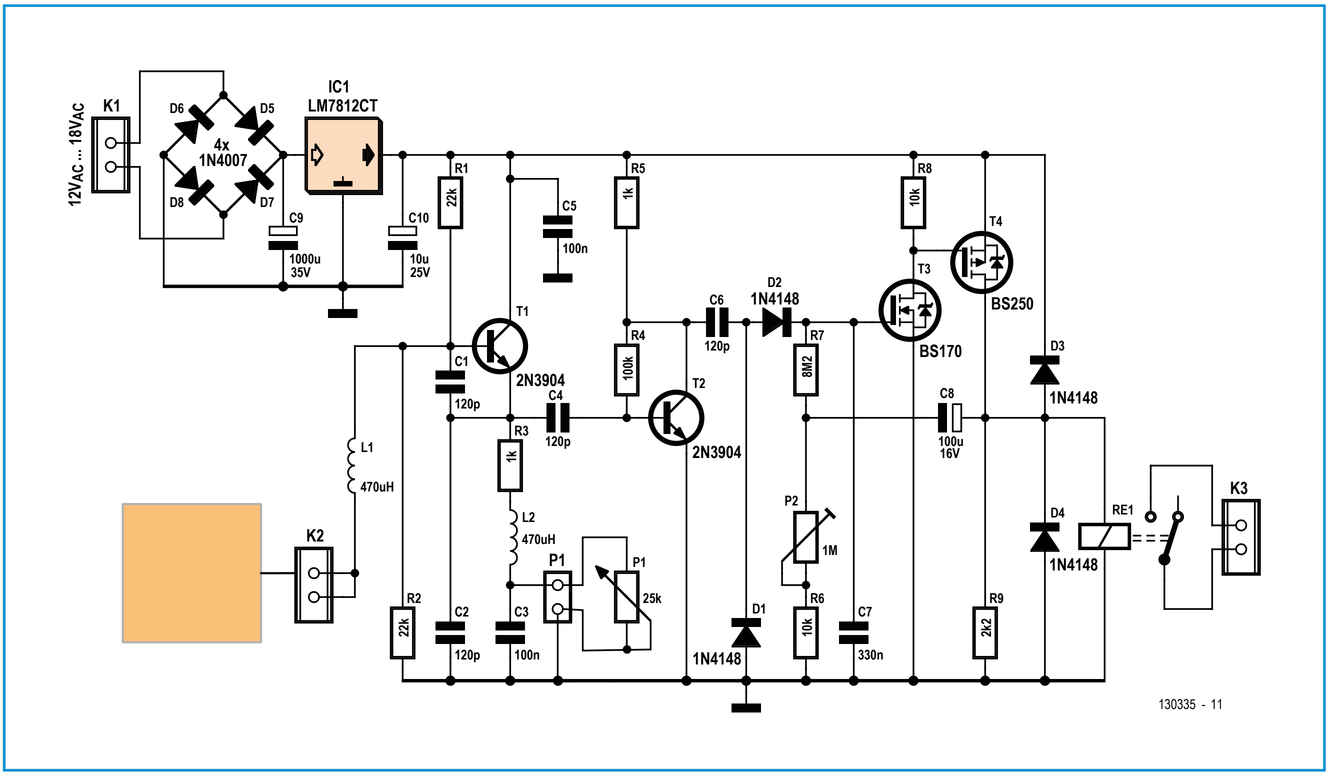

Figure 1.
The heart of the proximity detector comprises a Clapp-oscillator which is built around T1.

P-channel MOSFET (T4). The latter then energizes the relay, which can be used to operate a lamp or buzzer. Because of feedback via C8 between the output and input, the switching stage around T3/T4 operates as a monostable, where the monostable time (the time after which the relay remains energized after the object has been removed from the sensor) can be set with P2 over a wide range (a few seconds to about one minute).

A 12-V voltage regulator (IC1) provides the regulated power supply voltage for the circuit. Because of the bridge rectifier at the input you can connect either an AC voltage or a DC voltage to the power supply input connector (K1). The current consumption is around 50 mA (when the relay is energized).

Construction

The printed circuit board which has been design for the proximity detector is shown in **Figure 2** (download via [2]). Only normal through-hole components have been used so that the mounting and soldering of the parts will be easy. Make sure that you have the pinout connections for the BS250 MOSFET correct, since there are several variants of this part in circulation and they are not all the same (just to make sure, consult the manufacturer's datasheet for the specific part). On the circuit board there are 3 sets of screw terminals for the power supply voltage (K1: 12 to 18 V AC, or 15 to 20 V DC), the sensor (K2) and the relay output (K3) respectively. It is possible to connect trimpot P1 to the circuit board with reasonably long wires (up to 3 feet), so that it becomes possible to adjust the sensitivity of the circuit some distance away from the circuit board. The connection between the sensor plate and K2 must not be to far, preferably less than 4 inches.

Once the circuit has been built and a power supply has been connected it can be tested whether everything works. Slowly approach the sensor with your hand and then adjust P1 such that the relay energizes. The switching time of the relay is set with P2. After you wait until the relay has de-energized, you can experiment somewhat with the position of P1

Web Links

[1] http://nl.wikipedia.org/wiki/Clapp-oscillator

[2] www.elektor-magazine.com/nl/extra/post.html

to find the setting at which the sensor is as sensitive as possible. You can also change the size of the sensor—in this respect the circuit has plenty of scope for experimenting.

(130335-I)

Component List

Resistors
R1,R2 = 22kΩ
R3,R5 = 1kΩ
R4 = 100kΩ
R6,R8 = 10kΩ
R7 = 8.2MΩ
R9 = 2.2kΩ
P1 = 25kΩ linear potentiometer
P2 = 1MΩ multiturn preset, vertical mounting (e.g. Bourns 3299W-1-105LF)

Capacitors
C10 = 10µF 25V radial
C8 = 100µF 16V radial
C9 = 1000µF 35V radial
C1,C2,C4,C6 = 120pF
C3,C5 = 100nF
C7 = 330nF

Inductors
L1,L2 = 470µH

Semiconductors
D1–D4 = 1N4148
D5–D8 = 1N4007RLG
T1,T2 = 2N3904
T3 = BS170
T4 = BS250
IC1 = 7812

Miscellaneous
RE1 = PCB mount relay, 12V/0.25A, with changeover contact (e.g. Omron G5SB112DC)
K1,K2,K3 = 2-way PCB terminal block, 5mm pitch
P1 = 2-pin pinheader
Piece of unetched circuit board for sensor (e.g. 5x5 cm)
PCB # 130335-1 [2]

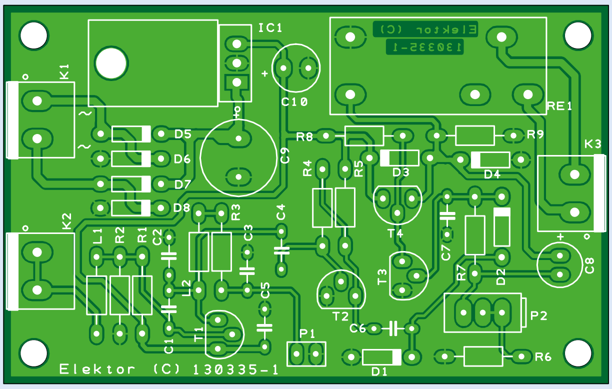

Figure 2. The circuit board is readily assembled; it only contains through-hole components.