Rejektor

Under this heading we will occasionally publish circuits, ideas and suggestions that did not make it to full publication in this magazine for various reasons (like lack of space).

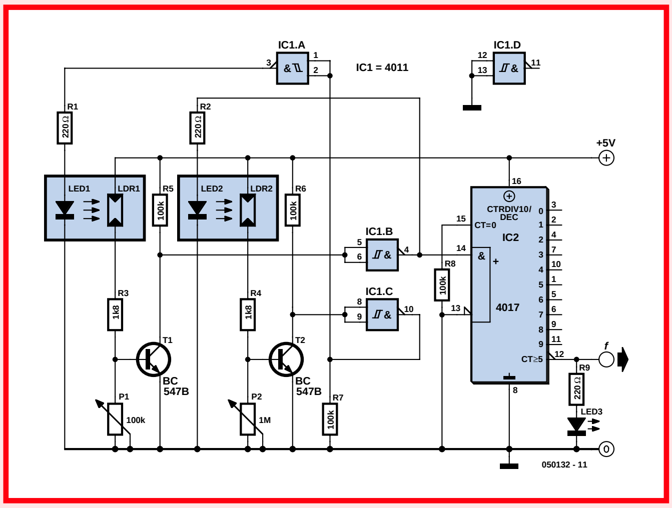
Photoelectrical Oscillator

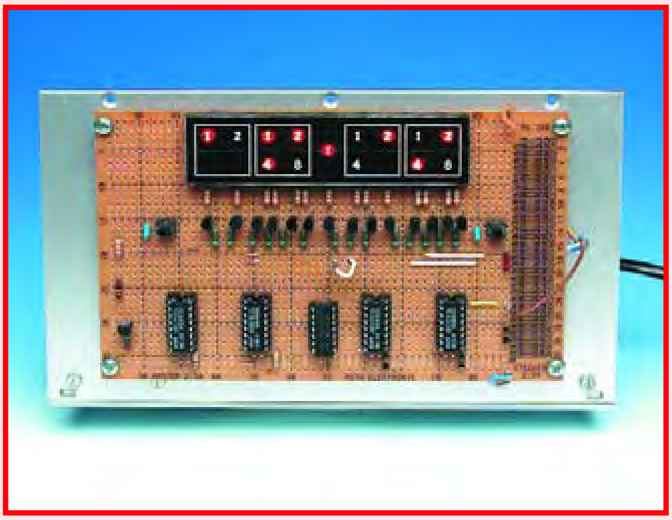
This circuit of a photoelectrical oscillator (PEO) sent to us by Marcus Bindhammer is an example of an original design approach. Although we're actually looking at a variant of the astable multivibrator, remarkably there are no capacitors in the circuit. The time constant is not determined by a resistor-capacitor combination as would be expected but by resistance alone. The resistance is formed by a light dependent resistor (LDR) rather than a normal resistor or potentiometer. Oscillation, then, is obtained from the time constant exhibited by an LDR. Marcus described the function as follows.

The PEO works without any kind of quartz crystal, R-C or L-C network. This oscillator is entirely resistance dependent, employing the slowness of light dependent resistors. Particularly with a fast reduction of the ambient light intensity, the ohmic resistance of an LDR will rise relatively slowly. Values for Dt of up to one second have been observed.

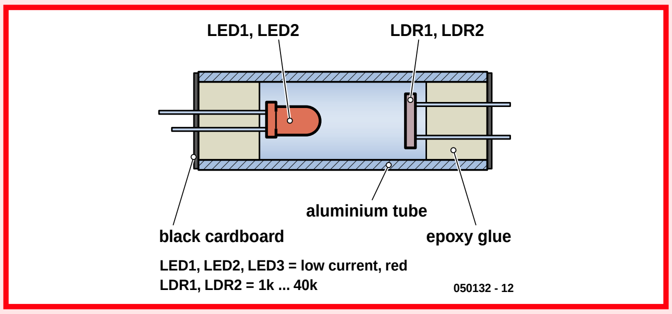
The LDR presents a non-linear semiconductor resistance. It is usually made from cadmium-sulphide applied as thin, meandering track on an isolating carrier and electrically connected between two copper electrodes. In response to incident light, electrons are released from molecules. As you will be able to imagine, photons will destroy crystal junctions, causing the number of free electrons and 'hole' to increase. The resultant increase in charge carriers causes the relative conductivity to increase.

If the supply voltage is applied to the circuit, the output of the first NAND gate, IC1.A (configured as an inverter) swings logic High (+5 V). This causes LED 1 to light and T1 to conduct. Next, the output of iC1.B goes High, LED2 lights and T2 starts to conduct. Next, the output of IC1.Cgoes High while that of IC1.A goes Low. However, T1 still conducts (due to the slow response of LDR1). When T1 switches off after Dt, or the High level for IC1.B is reached, its output switches to Low (–5 V) and LED2 goes out. T2, too, conducts for a period Dt. When the High level is reached at the input of the third inverter, its output drops





Low and the output of IC1.A, swings High. This means the circuit has returned to the initial state, and the cycle recommences. With the component values shown, an oscillation frequency between about 5 Hz and 50 Hz is obtained, which is adjustable with preset P2. Preset P1 enables fine adjustment, if necessary, and may be replaced by a 100-kΩ fixed resistor. The 4017 driven by the oscillator divides the frequency by 10. With some experimentation and patience the oscillator may be adjusted for the LED at the output to flash at a one-second rate, that is, 1 Hz.



Because LEDs produce heat and LDRs are temperature-dependent, the LDR-LED pairs are mounted in sealed aluminium tubes in order to aid their dissipation. A suggested construction of the LED/LDR optocoupler is illustrated in the second drawing. The author's photoelectrical oscillator is functional in a digital clock. As shown by the photograph of time readout, the clock is as unusual as the PEO, the time being indicated in binary format! For the sake of legibility however the display was designed to show hours and minutes as tens and units, just as on a regular clock. If you are interested in the design of the complete clock, the author's complete description of it including circuit diagrams and the display artwork is available as a free download from the Elektor Electronics website at www.elektor-electronics.co.uk, under Magazine, January 2006, Mailbox. The information is presented 'as is'.

Finally, we should mention that there is as yet no indication of the long-term stability of the PEO. It is however safe to assume that the accuracy of the PEO clock is about the same as that of a mechanical alarm clock. If you need better accuracy, go for a quartz crystal oscillator or divide the 50-Hz mains down to 1 Hz to drive the clock.