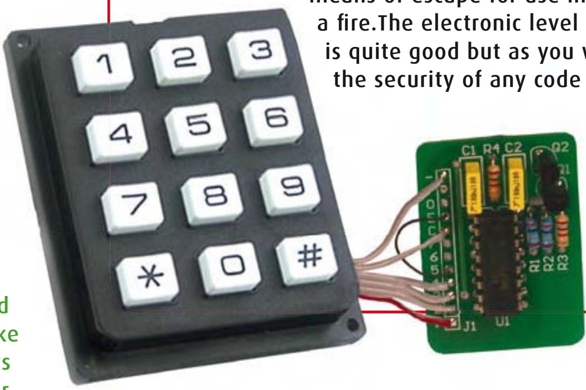
Code lock

Design: Rob Reilink (The Netherlands)

There always seemed to be a point in old thriller movies when the camera zoomed in on beads of sweat forming on the safe cracker's face as he strains to hear through a stethoscope the sound of tumblers falling while twiddling the dial on a safe. Nowadays it's a bit more sophisticated; the scoundrel reaches into his tool bag takes out what could be a prototype breadboard that you may find lying on a bench in the Elektor labs. He attaches it to the lock mechanism, presses a few buttons, lights flash accompanied by some bleeps that you would expect such a device to make and *bingo*, the door to the bullion vault swings open. Others fictional characters use a 'sonic screwdriver' to gain entry or escape from marauding aliens.

From a safety point of view if the code lock is used for entry/exit control it is essential to provide an alternative means of escape for use in the event of a fire.The electronic level of protection is quite good but as you will appreciate the security of any code lock system is also a function of the robustness of the key pad and how firmly it is mounted.

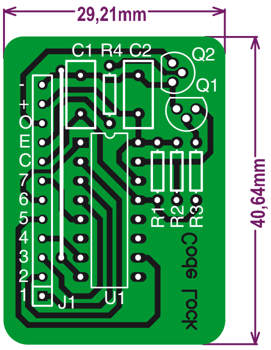


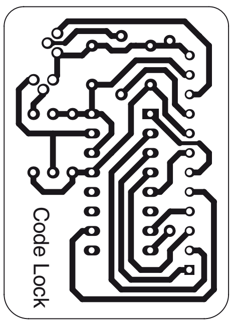
Sturdy mechanical locks are still widely in use for security purposes but ever more electronics-based systems are appearing on the market. The most familiar electronic security system is the door entry device where a code sequence is entered using a numeric keypad. Rob Reilink's circuit suggestion shown here performs this job admirably while using very few components.

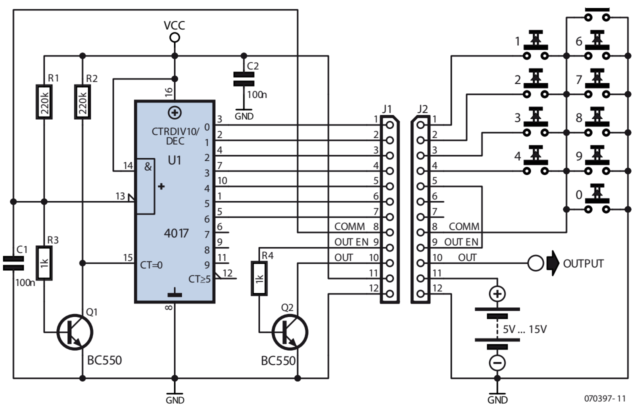
The circuit is built around the CMOS 10-stage Johnson counter type 4017. With this device only one of the ten outputs (0 to 9) is ever high. In this application it is configured to count on the falling clock edges. At reset only output 1 is high and with each falling clock edge the high is transferred to the next o/p. When it reaches 9 the next active clock edge transfers it back to 0 and the process repeats.

It is important to make sure that you have the right type of keypad for this circuit; do not use the type that are commonly used for calculators or telephones where the keys are wired as a matrix, instead you need one where all the keys have one common connection. A keypad can be made up using discrete pushbuttons wired according to the circuit diagram or it may be possible to modify the wiring of a matrix type keypad. There is practically no limit to the number of keys allowed on the keypad, in fact the more keys you have the longer it would take to find the correct code by entering every possible combination. The code sequence can be up to six numbers long or if you are not too bothered about security it can be just a single number.

The unlock code is determined by the keypad wiring. The common connection to all the keys is wired to COMM. The unlock sequence shown in the circuit diagram is 1234.The first number key in the code is wired to output 0 (pin 3) of U1. The second code number key is wired to output 1 (pin 2) of U1 etc. When all the code keys have been wired up the next output pin of U1 provides the 'OUT EN' signal. In the circuit the fifth output from U1 is used to provide the 'OUT EN' signal. All other keys are wired to ground.







Operation of the circuit begins after a reset (pressing any non-code key) output 0 of U1 will go high. Transistor Q1 will be conducting because of the forward bias at its base provided by R3 and R1. The reset input of U1 (pin 15) is held low (inactive). The voltage level at the clock input of U1 (pin 13) is around 0.6 V which is interpreted as a digital '0'. When the first key in the sequence is pressed the COMM signal will go high providing a rising clock edge on pin 13, when the key is released the falling clock edge causes the counter to advance so that now only output 1 (pin2) is high. This process is repeated for the entire code sequence. When the last key is released the 'OUT EN' will go high indicating a correct code sequence and switches transistor Q2 into conduction which pulls the OUT signal low. A relay or similar electrical device can be connected between OUT and V_{CC} the maximum current supplied here is approximately 100 mA.

Any incorrect key pressed will put a low on the COMM line and turn off Q1, generating a reset of the whole chip. The code sequence must now be entered from the beginning again.
It is possible to make your own PCB using the layout shown here (see the Elektor website for more information on this design) when the images have been transferred to transparent film check that the overall dimensions of the track side measure 40.6 x 29.2 mm.
The circuit can be powered with a voltage in the range of 3 to 15 V. The circuit takes a quiescent current of around 30 µA at 3 V. Two standard AA batteries should be capable of powering the circuit for over a year. When the batteries go flat or the mains power fails (when powered by a mains adapter) the code lock will remain locked.