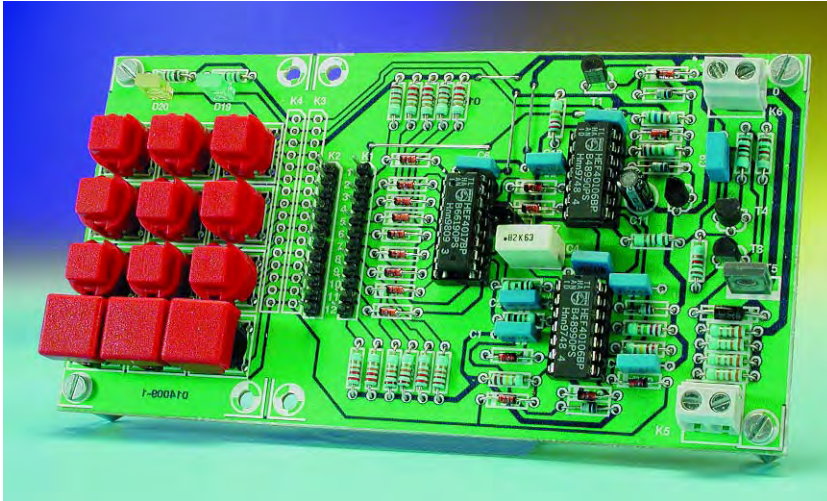


Electronic Code Lock

005



R. Heimann

Nowadays, electronic code locks are usually based on microcontrollers. However, if you like your electronics discrete, you will enjoy the battery-operated circuit shown here. Since the circuit automatically switches off after the door has been opened and draws no current in the idle state, three alkaline batteries (mignon, AA or R6 cells) are good for around 5,000 door openings. The main advantage is that the door opener can also be powered from the battery, so it's not necessary to run any extra cables.

Figure 1 shows the schematic diagram of the circuit, which is split into two parts. The first part is the control panel, which consists of a 12-position keypad and two LEDs. The second part is the programming and evaluation logic, which contains only standard logic ICs. The control panel is connected to the logic board by a 16-way flat cable. The keypad circuit is laid out with separate connections to the individual switches, instead of a matrix. The code is programmed using the two pin connector strips K1 and K2.

The circuit allows any desired combination of numbers to be used for the code, up to a maximum of 9 positions. Pressing a particular button, which in principle is random but which naturally must be specified in advance, awakens the circuit from the zero-current idle state. This Start button cannot be used in the subsequent code sequence. The Start button is programmed by connecting a wire bridge from the associated pin of K2 to pin 1 of K1.

The code sequence is programmed in a similar manner. The first numeral of the code is programmed by connecting the associated pin of K2 to pin 2 of K1, the connection for the second numeral is made to pin 3 of K1, the third to pin 4 and so on. Numerals that are not used in the code do not actually have to be connected. However, if the unused buttons are connected to V_{DD} , the code lock will assume that an error has occurred if any of these buttons is pressed

and will reset the circuit.

Pressing the Start button switches on transistor T1, which connects the supply voltage source to the code lock. This is indicated by the yellow LED (D20). Since the logic ICs are now enabled, the output of IC3f will be High, so T2 also conducts and pulls the base of T1 to ground. This means that the Start button can be released without affecting the circuit. However, C11 can now slowly charge via the high resistance of R12 until the voltage at the inverter input is high enough to cause its output to go Low, which interrupts the supply voltage to the circuit and puts it back into the idle state. The valid code must therefore be entered during the time interval determined by this R-C time

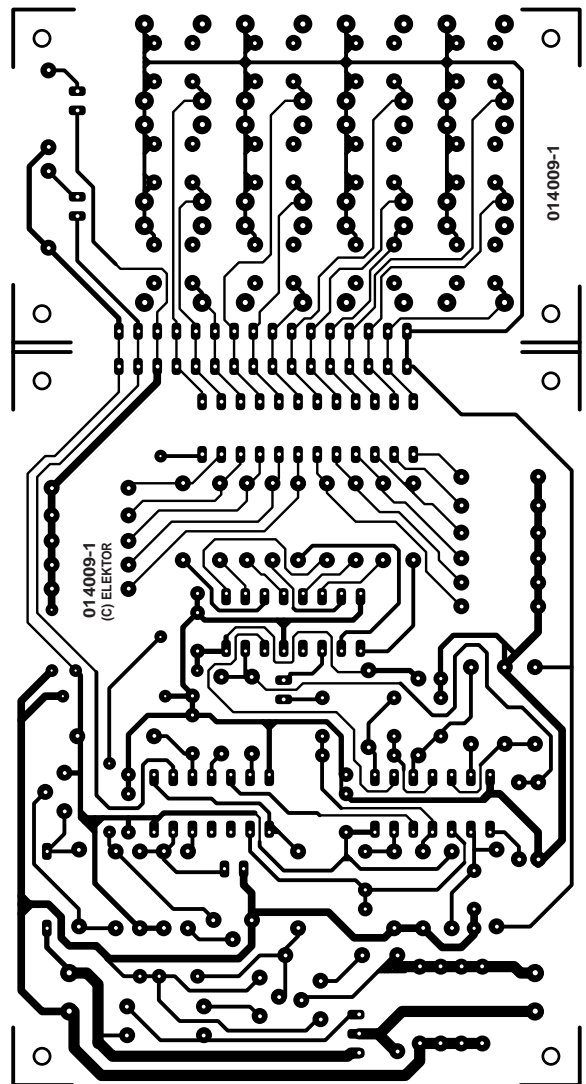
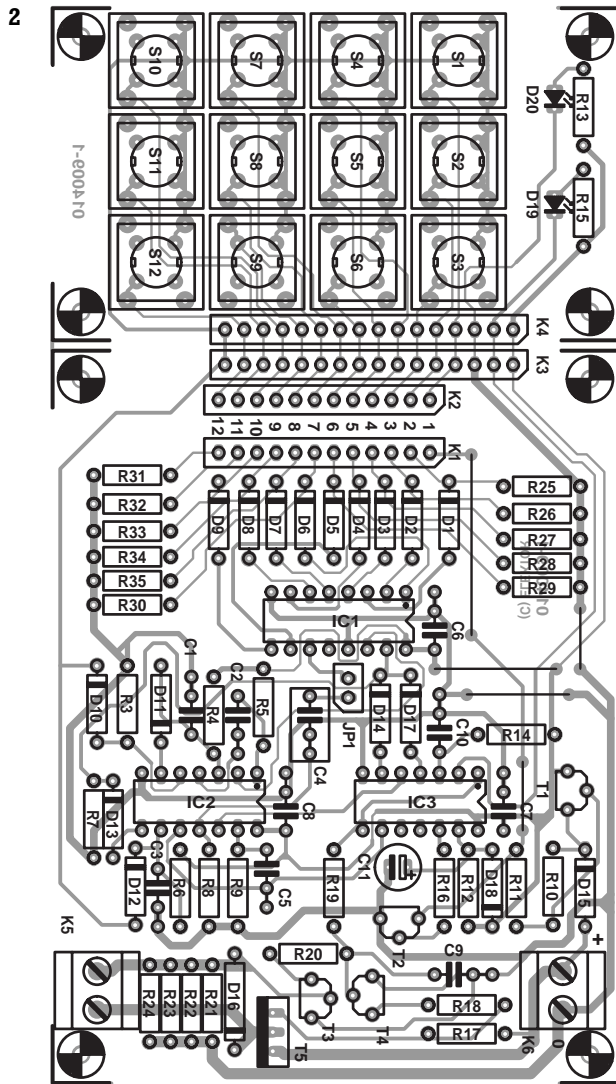
constant. Once the supply voltage is disconnected, C11 discharges rapidly via D18. This is important, since otherwise C11 could retain its charge for a long time. This would make the time allowed for entering the code significantly shorter the next time the lock is used.

Pressing the Start button also has other consequences. Via the Start switch, ground potential arrives at IC2d, where it causes a pulse to be generated that places counter IC1 in a defined state ($Q_0 = 1$) prior to the entry of the first code numeral.

The first code numeral can now be entered. If the correct button is pressed, the High potential from Q_0 passes through the closed switch to reach IC2d-IC2a. This network generates a positive pulse at the instant that the button is released. This pulse clocks the counter, so that the High level from Q_0 moves by one position to Q_1 . This process repeats itself until all code numerals have been entered.

After the ninth numeral has been entered, the positive voltage jumps to Q_9 , where it charges C4 (if jumper JP1 is installed). While C4 is charging, the output of IC2e goes Low for approximately two seconds, and the output of IC3d goes high for the same interval. Power transistor T5 is switched on via R19 and T4 to supply current to the door opener. At the same time, IC3a switches on the green LED (D19) to indicate that the door can be opened. T3 limits the current through the door opener to around 700 mA.

Once C4 is sufficiently charged, the output of IC2e changes to High. Not only does this switch off the door opener, but the positive edge also generates a pulse in the network IC2f/IC3c that passes through D14 to reach IC1 as a reset pulse (D14, D17 D13 and R7 together form a 'wired-or' gate). Inverter IC3b also provides the power-up reset to the counter. The reset signal places the circuit back into its initial state.



COMPONENTS LIST

Resistors:

R1, R2 = not fitted
 R3 = 220kΩ
 R4, R5 = 1MΩ
 R6 = 220kΩ
 R7, R9, R10, R17 = 100kΩ
 R8, R12, R14 = 2MΩ
 R11 = 560Ω
 R13, R15, R20 = 1kΩ
 R16 = 100kΩ

R18 = 120Ω
 R19 = 10k
 R21-R24 = 3Ω
 R25-R35 = 22kΩ

Capacitors:

C1, C6, C7, C8, C10 = 100nF
 C2, C3, C5 = 10nF
 C4 = 1μF
 C9 = 330nF
 C11 = 47μF 16V radial

Semiconductors:

D1-D9, D11, D13, D14, D15, D17,
 D18 = 1N4148
 D10, D12 = zener diode 1V2
 0.4W*
 D16 = 1N4001
 D19 = LED, green
 D20 = LED, yellow
 T1 = BC327
 T2, T3, T4 = BC337
 T5 = BD140
 IC1 = 4017

IC2, IC3 = 4069 or 40106

Miscellaneous:

JP1 = jumper
 K1, K2 = 12-way pinheader or
 wire links
 K3, K4 = not required (ribbon
 cable)
 K5, K6 = 2-way PCB terminal
 block, lead pitch 5mm
 S1-S12 = pushbutton with
 make contact

circuit board with a length of cable. Otherwise, a screwdriver or a bit of wire connected between the emitter and collector of T5 is all that is needed to outfox the code lock and open the door.

Fitting the components to the circuit board should not be difficult. The ICs can be mounted in sockets. The author used 4049 inverter ICs, but in the *Elektor Electronics* lab prototype we used 4069's, which are functionally compatible but not pin-compatible, and we also tried a 40106, which has Schmitt-trigger inputs. With a 4069, normal

1N4148 diodes can be used for D10 and D12. The best solution is to use the relatively noise-immune 40106. However, it is then necessary to use Zener diodes for D10 and D12, due to the higher threshold voltage. A 3.3-V type is ideal with an operating voltage of 15 V. There is one thing you should not overlook: with low-voltage zener diodes, the band on the package marks the anode instead of the cathode, as you would normally expect. At least, this is true in most cases, but not always...

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