UHF remote switch for burglar alarms

Fancy a remote-controlled burglar alarm? It can be done. This handy remote control lets you switch your car burglar alarm on and off by simply pressing the button on a handheld UHF transmitter unit. You can also use the device to eliminate the wiring between a house alarm and its sensors.

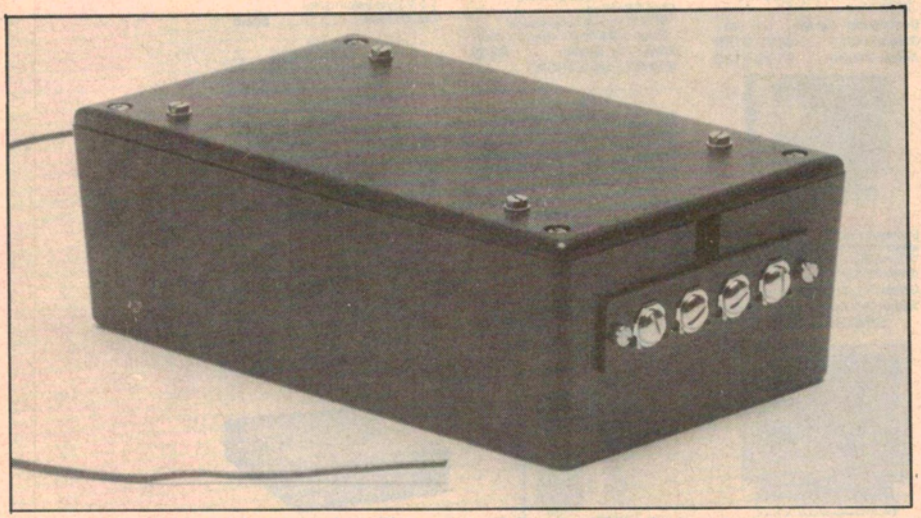
by BRANCO JUSTIC

This easy-to-build unit provides remote control of your car alarm, house alarm and other emergency electronic aids. It operates in the ultra high frequency (UHF) portion of the spectrum and you can select your own "key" combination from about 13,000 possible codes.

That's a lot more than from existing mechanical locks!

The unit is relatively simple to construct because there are no specialised RF coils to be wound. They are all included in the PCB pattern. Furthermore, the unit is easy to install since in its simplest form only three connections are necessary to wire it into an existing system.

Basically, this device lets you switch your car's burglar alarm on and off from outside the vehicle. No longer do you have to fumble about for the key, or worry about such things as hidden switches or exit and entry delays. Complete external control means that all sensors can now be wired to instant-trip inputs, a factor that will greatly improve security.



The receiver is housed in a plastic utility case and fitted with a short antenna.

The transmitter is virtually the same as those used with expensive commercial car alarm outfits. It fits into a small pocket-size plastic case. There is only one control — a pushbutton switch. Press the button once and the alarm switches on; press it again and the alarm switches off.

At the receiver end, the transmitted signal is decoded and used to drive a number of outputs. As well as switching the alarm on or off, these outputs also drive audible indicators and optional external relays.

Audible indicator

Many commercial units require extensive wiring in order to connect them to the vehicle's electrical system. The blinker, horn and hazard light circuits are usually wired to these units. This is often just too much of a hassle for the average hobbyist.

To simplify installation, this unit features an integral on/off audible indicator output. When connected to a loudspeaker or piezo transducer, this will give a short beep at switch on and a longer beep at switch off. This replaces the hazard flasher and horn function frequently used for on/off indication in commercial units.

However, you can wire up the horn or hazard flashers if you wish. This involves adding an external relay board to the circuit. More on this later.

House alarms

In addition to its obvious application in car burglar alarms, you can also use the UHF remote switch to control your house alarm. Another option is to use it to eliminate the extensive wiring normally required between the control box and the various sensors.

The result: a wireless alarm system just like those fancy commercial systems. All you have to do is build multiple transmitter units and connect them

Press the button once and the alarm turns on; press it again and the alarm turns off. You can buy the transmitter case from Dick Smith Electronics.

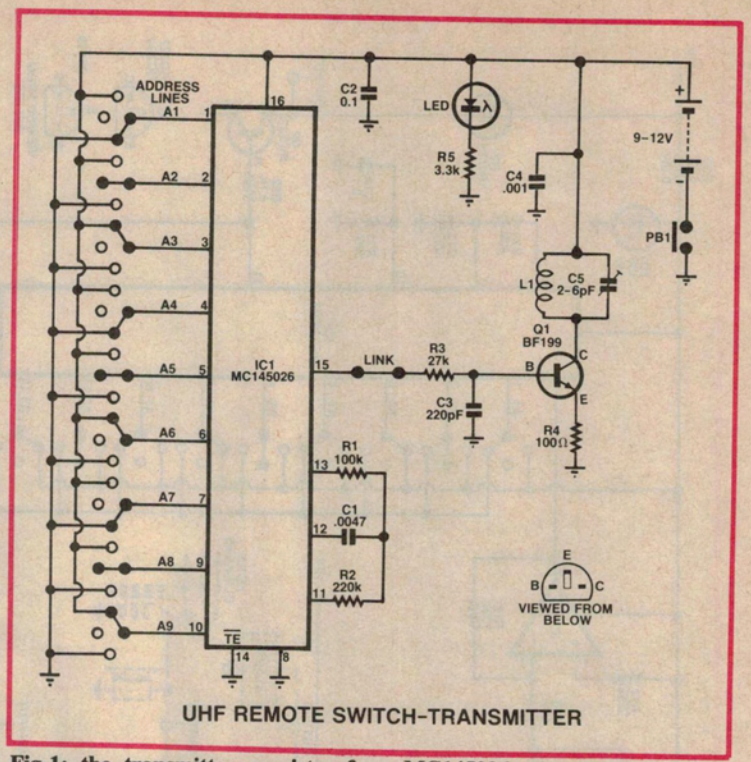
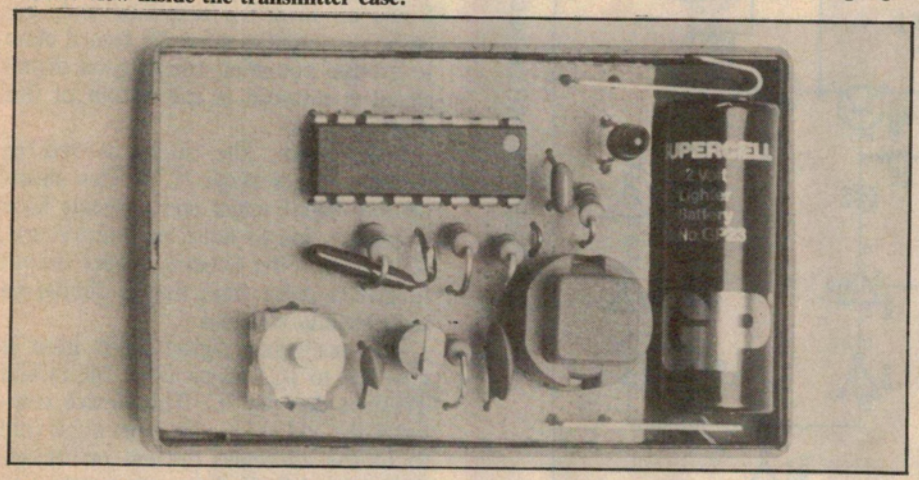


Fig.1: the transmitter consists of an MC145026 trinary encoder and UHF oscillator stage Q1.

Below: view inside the transmitter case.



so that they are switched by the sensor outputs instead of by the pushbutton switch.

The receiver circuit can be hidden away, close to the control box, and connected directly to an instant trip input.

Of course, we now have the problem of turning the alarm on and off. Answer: just build another receiver and matching hand-held transmitter unit and program them to a different code.

Why UHF?

UHF (ultra high frequency) transmission was chosen in preference to other possible systems for the following reasons:

(1). At UHF, better penetration is obtained into remote, partially shielded areas. This means that a good range can be obtained even with the receiver placed under the bonnet, under the dashboard, or in the boot.

Thus, the receiver and its associated short antenna can be completely hidden.

(2). Antennas required at UHF are very short. In fact, no external antenna is required for the transmitter — it's etched into the PC board. The effective radiated power is only a few microwatts.

(3). The circuitry can be kept simple while still conforming to Department of Communications standards for security radio alarm systems. The operating frequency is 304MHz while bandwidth is less than 100kHz.

Transmitter circuit

Fig.1 shows the transmitter circuit. It's really very simple and is based on IC1, an MC145026 trinary encoder. When pushbutton switch PB1 is pressed, this generates a code sequence (ie, a series of pulses) which drives UHF oscillator stage Q1.

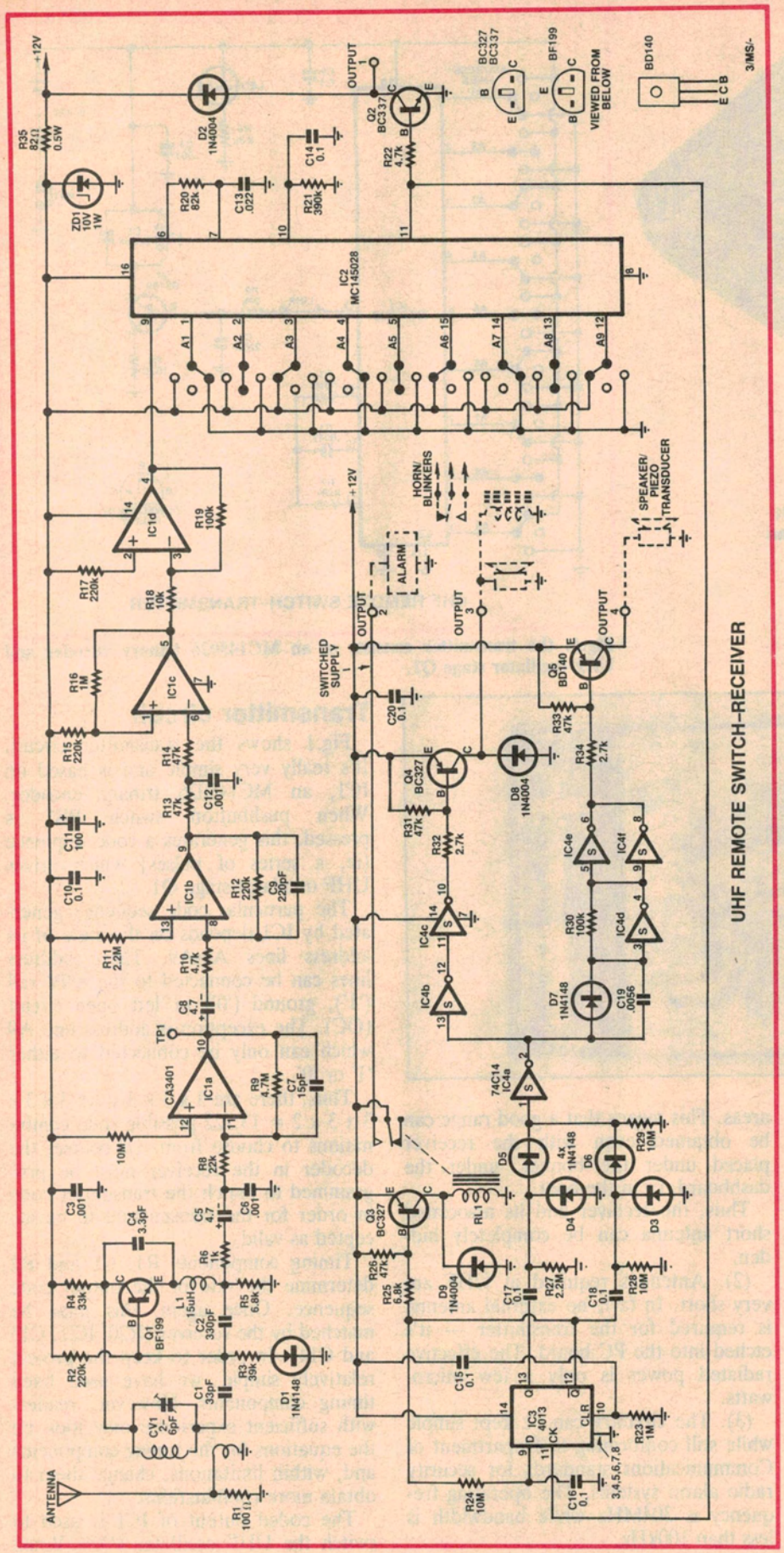
The particular code sequence generated by IC1 depends on the state of its address lines A1-A9. These address lines can be connected to the +9V rail ('1'), ground ('0') or left open circuit (OC). The exception is address line A9 which can only be connected to either '1' or '0'.

Thus, there are 3 x 3 x 3 x 3 x 3 x 3 x 3 x 3 x 2 = 13,122 possible code combinations to choose from. Of course, the decoder in the receiver must be programmed to match the transmitter code in order for the transmission to be accepted as valid.

Timing components R1, C1 and R2 determine the rate of the output code sequence. Once again, this must be matched by the receiver (R20, R21, C13 and C14). In order to keep the project relatively simple, we have used fixed timing components. However, readers with sufficient experience may look up the equations for the timing components and, within limitations, change them to obtain more combinations.

The coded output of IC1 is used to switch the UHF oscillator (Q1). When

UHF Remote



pin 15 of IC1 is high, the oscillator switches on. When pin 15 is low, the oscillator switches off (see Fig.2).

Q1 is connected in common-base configuration and forms an oscillator by virtue of its tuned collector load and the stray capacitance between its collector and emitter terminals. The operating frequency is set by paralleled tuned circuit L1 and C5 and must be accurately adjusted to 304MHz (see adjustment procedure).

Receiver circuit

The stage associated with Q1 forms a regenerative self-detecting UHF receiver. The resonant frequency of this stage is determined by the parallel tuned circuit L (printed inductor) and trimmer capacitor CV1.

The detected output is AC-coupled via R6, C5 and R8 to the inverting input of high gain amplifier stage IC1a. A test point is provided at the output of this stage for tuning purposes. IC1b also forms an inverting amplifier and, because its output is normally biased close to ground potential, the original digital signal is restored at the output of this stage.

From there, the signal is fed to Schmitt trigger stage IC3c. This cleans up the digital signal and prevents false triggering due to noise or interference. IC1d inverts the Schmitt trigger output to give a pulse train that is similar to the transmitted signal.

The recovered digital pulse train is now fed to IC2 which is an MC145028 Tri-state decoder IC. This device compares the code sequence at its input (pin 9) to the addresses present on its address pins 1-9. If these are matched to the encoder address pins, and the rate of code transmission is similar, the output of the decoder (pin 11) will go high for the duration of the transmission.

Thus, Q1 will be turned on and its output can be used to trigger the input of a house alarm, either directly or via an external relay.

Alternate presses of the transmitter key will also clock IC3. IC3 is a 'D' type flipflop connected to operate as a toggle ('T') type. The addition of R24 and C16 on pin 9 prevents IC3 from changing its output state at less than one second intervals. This prevents any unpredictable operation due to breaks in transmission.

C15 and R23 clear the flipflop (ie, Q = 0, Q-bar = 1) when power is first ap-

plied to the circuit. This is equivalent to the alarm off condition.

When pin 11 of IC2 subsequently switches high (ie, when a valid transmission is received), the flipflop is set and the Q output switches high and the Q-bar output low. Q3 is now forward biased and activates relay RL1 which switches the +12V rail to output 4.

Audible indicators

The Q and Q-bar outputs of IC3 also drive separate time constant networks. C17, R27 and R29 set the time constant on the Q output to approximately 0.2s, while C18, R28 and R29 set the time constant on the Q-bar output to around 0.5s. The outputs from these time constants are fed to pin 1 of Schmitt inverter IC4a via D5 and D6.

Thus, each time the flipflop toggles, pin 2 of IC4a briefly switches low for either 0.2s or 0.5s, depending upon which time constant is involved. When this happens, pin 10 of IC4c also switches low and Q4 switches the +12V rail to output 2 for the duration of the time constant. The output of IC4a also controls Schmitt trigger oscillator IC4d. Normally, the output of IC4a holds pin 3 of IC4d high via D7 and the oscillator is disabled. However, when pin 2 of IC4a switches low, the oscillator is enabled and drives Q5 and the loudspeaker via parallel inverter stages IC4e and IC4f. Note that the loudspeaker could be replaced by a piezo alarm transducer and parallel 1k resistor for lower current consumption and possibly louder sound output.

The result of all this jiggery-pokery is that the loudspeaker sounds for approximately 0.2 seconds when the alarm is switched on and for approximately 0.5 seconds when the alarm is switched off.

How to Use the Receiver Outputs

The receiver has four separate outputs and these should be used as follows:

Output 1 - this output is normally high and switches low during transmission. If you want to trip a house alarm, this is the output to use. It can either be used to trigger the alarm via an external relay (see Fig.5) or connected direct to one of the alarm inputs.

Output 2 - provides a switched +12V output via on-board relay contacts. This output can be used to switch a car burglar alarm on and off. It can also be used to drive an external relay to switch the EA Home Burglar Alarm on and off (see Fig. 6).

Output 3 - provides relay drive during on and off transitions. The relay can be used to activate the car's blinkers or the horn to provide on/off indication.

Output 4 - similar to output 3. This output is used to directly drive a loudspeaker via a 10 ohm 5W series resistor or drive a piezoelectric transducer with a parallel 1k resistor, for audible on/off indication.

Construction

Construction is quite easy and mainly involves the assembly of two printed circuit boards and then installing them in their respective cases. The transmitter board is very small and measures only 44 x 32mm. The receiver board is also fairly small and measures 115 x 77mm.

Before installing any of the parts or doing any soldering, you must first set

Coding the Transmitter & Receiver

With this project, you have 13,122 possible codes to choose from. The selected code is programmed into the transmitter and receiver by cutting the thin tracks joining the address pins (A1-A9) to the high ('1') and low ('0') logic lines.

Thus, each individual pin can either be connected to logic 1 or to logic 0, or left open circuit (OC). The exception is pin A9 which must either be connected to logic '1' or logic '0' (ie, it cannot be left open circuit). Table 1 shows an example code while Figs.3a and 3b show how this code is programmed.

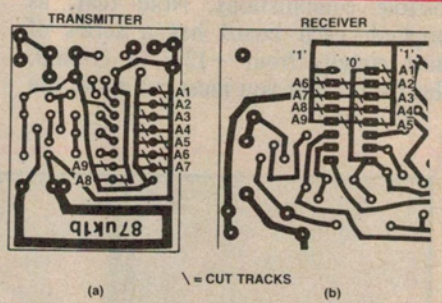


Fig.3: how to program the transmitter and receiver (example only).

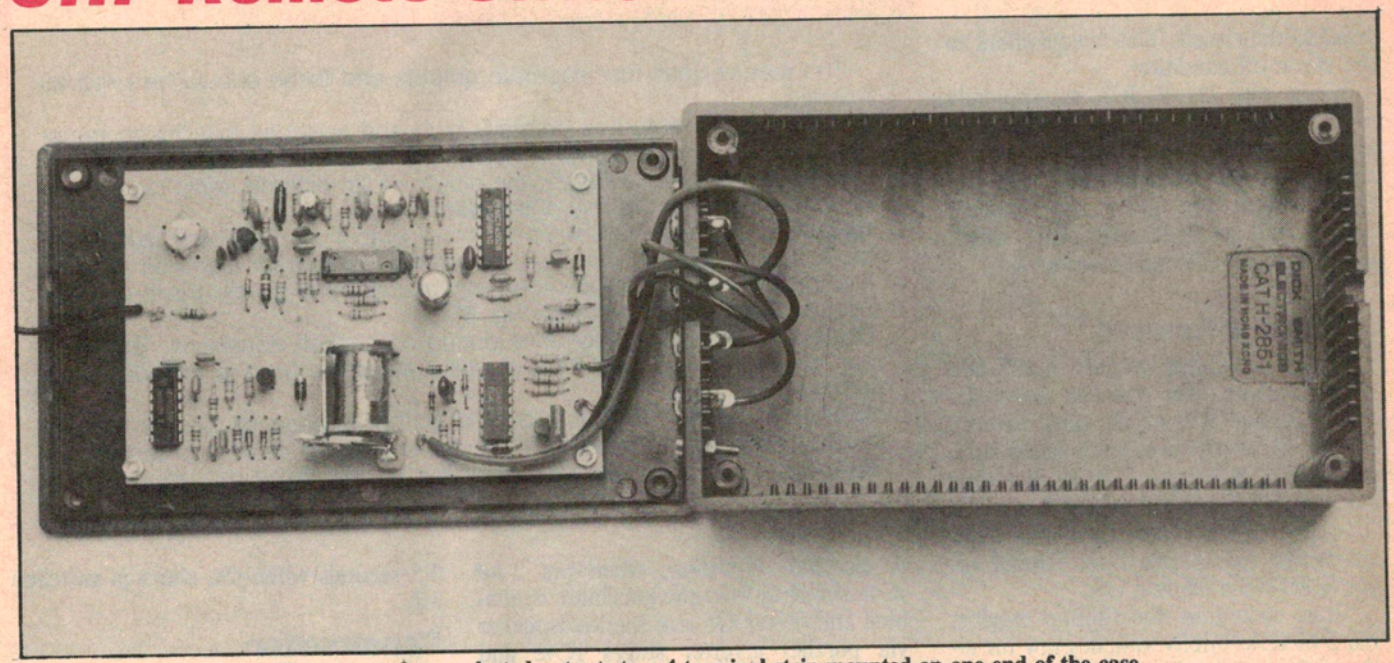
Address Line	A1	A2	A3	A4	A5	A6	A7	A8	A9
Choice of Address	0, OC, 1	0, OC, 1	0, OC, 1	0, OC, 1	0, OC, 1	0,OC,1	0,OC,1	0,OC,1	0,1
Our Example Code	0	0	1	1	OC	OC	0	0	1
Your Choice									

Table 1: the example code programmed in Figs.3a and 3b.

Thus, to program logic '0' on address lines A1, A2, A7 and A8, you must cut the thin track which joins these pins to the logic '1' line. Similarly, to program logic '1' on to pins A3, A4 and A9, you cut the thin track between these pins and logic '0'. Finally, to program OC on to pins A5 and A6, you cut the tracks leading to both logic '1' and logic '0' lines.

Follow the above example through and, when you understand the procedure, enter your own code into the space provided in Table 1. You can then program your own transmitter and receiver units by cutting the appropriate tracks with a sharp knife.

UHF Remote Switch



View inside the receiver. We connected our selected outputs to a 4-terminal strip mounted on one end of the case.

up the address lines for the encoder and decoder ICs (IC1 in the transmitter and IC2 in the receiver). This is done by making cuts in the thin copper tracks joining the address pins to the logic '1' (+12V) and logic '0' (ground) lines.

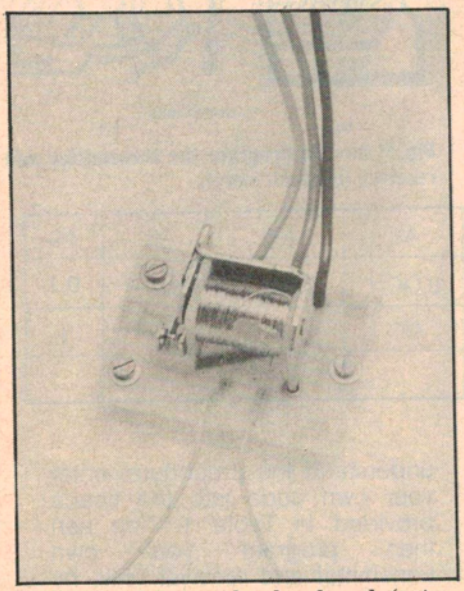
Figs.3(a) and 3(b) in the accompanying panel show just one of the 13,122 possible combinations. Note that, as supplied, each board has a series of short circuits from +12V to ground. This means that you must cut either the track to logic '1' or the track to logic '0' (or both) for each pin, otherwise the supply rails will be short circuit.

You should also take care to ensure that the transmitter addresses match those of the receiver, otherwise the unit will never work.

Once the address lines have been set up, the assembly work can begin.

The small transmitter PCB (coded 87uk1b) should only take a few minutes to assemble. Make sure that you install the switch, IC and transistor correctly but don't install the wire link (adjacent to pin 16 of IC1) at this stage. Note that some of the resistors are mounted 'end on' to save space.

Take care when installing the LED — the anode is the longer of the two leads and is installed next to the positive battery terminal. Note that the top of the LED should be about 11mm proud of the PCB so that it will fit into the hole in the lid of the case.



The optional external relay board (note: does not include diodes for blinker circuit).

Adding an External Relay Board

Some readers will want to use their receiver to drive external relays. No problem — just add this handy relay board. The assembly includes a PCB, a low-cost SPDT 12V relay, three mounting screws and has provision for diode isolation for blinker flashing (on/off indication).

Fig.7 shows the circuit of the external relay board, while Fig.8 shows the parts layout. Note that the two diodes are only necessary if you're hooking up the car's blinkers. For most other applications, they can be left out of circuit.

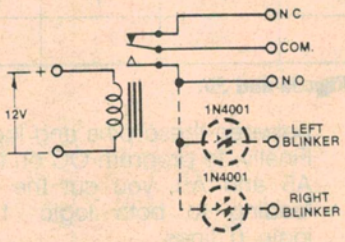


Fig.7: the external relay circuit.

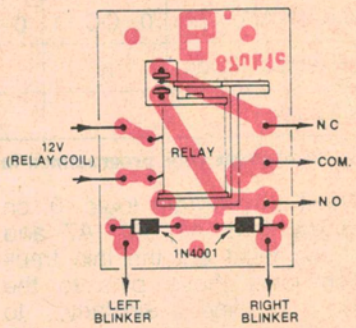


Fig.8: parts layout for relay PCB.

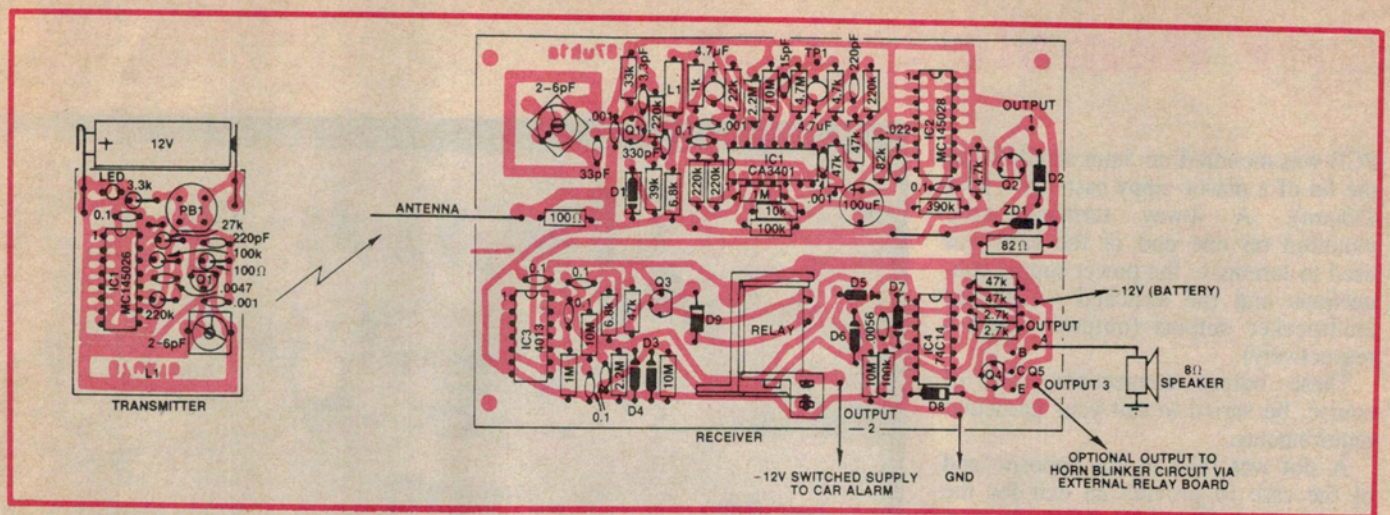


Fig.4: how to use the UHF Remote Switch to switch your car alarm on and off. L1 in the transmitter and the inductors in the parallel tuned input circuit of the receiver are etched into the PCB patterns.

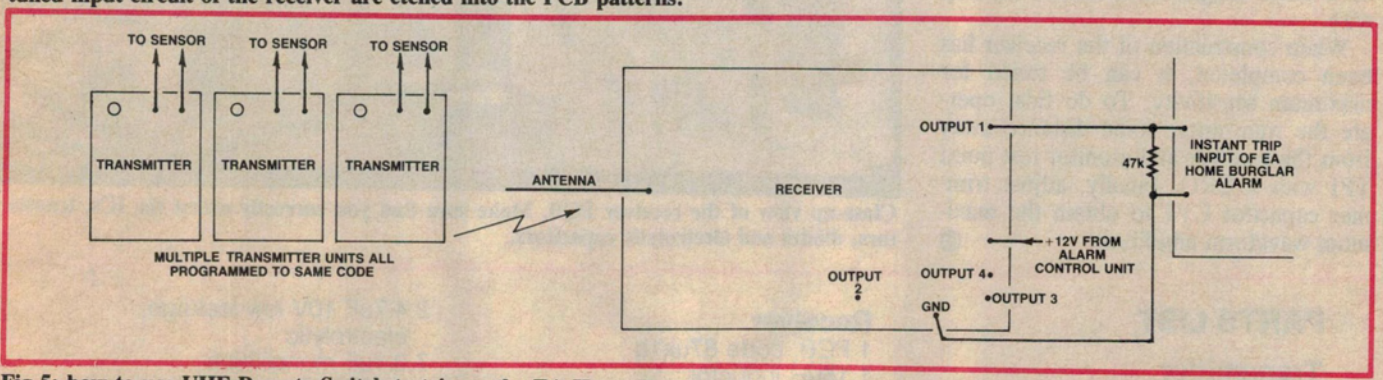


Fig.5: how to use UHF Remote Switch to trigger the EA Home Burglar Alarm. Some alarm systems may require triggering via the external relay board.

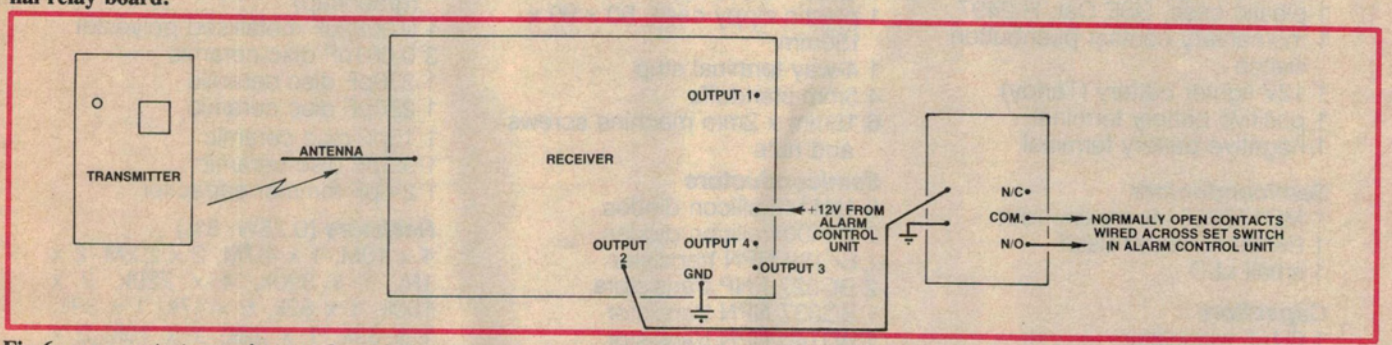


Fig.6: a separate transmitter and receiver are required to switch the EA Home Burglar Alarm on and off. They must be programmed to a different code than those in Fig.5

At this stage, all the parts should be installed except for the wire link. You are now ready to adjust the transmitter to its correct operating frequency.

To do this, temporarily connect the link side of R3 (27k) to the positive supply rail and install the battery. The oscillator will now run continuously when the button is pressed and its output frequency must accurately set to 304MHz using a frequency counter. The counter input should be loosely coupled to the printed inductor on the transmitter.

In most cases, it will be sufficient to simply hold the transmitter adjacent to the counter input and press the button. If this doesn't do the trick try winding a few turns of insulated wire around the transmitter to act as a pick-up probe.

The output can now be set to 304MHz by adjusting C5 (use a plastic alignment tool). Don't touch any of the parts or the PCB tracks during this procedure otherwise you'll get a wrong reading. In fact, it's best to sit the transmitter in the bottom half of the case while adjustments are carried out.

Once the adjustments have been completed, disconnect the link to the positive supply and install the link on the PCB between R3 and pin 15 of IC1. Assembly of the transmitter can now be completed by installing the PCB in the lower half of the case and clipping the two halves of the case together.

Building the receiver

Fig.4 shows the assembly details for the receiver PCB (87uk1a). Use PC stakes for all external connections and for TP1, and take care to ensure that all polarised components are correctly installed. These include the ICs, transistors, diodes and electrolytic capacitors.

Inductor L1 (15uH) can be installed either way round. The inductors in the parallel tuned input circuit form part of the PCB pattern, so you don't have to worry about these.

For the prototype, the completed

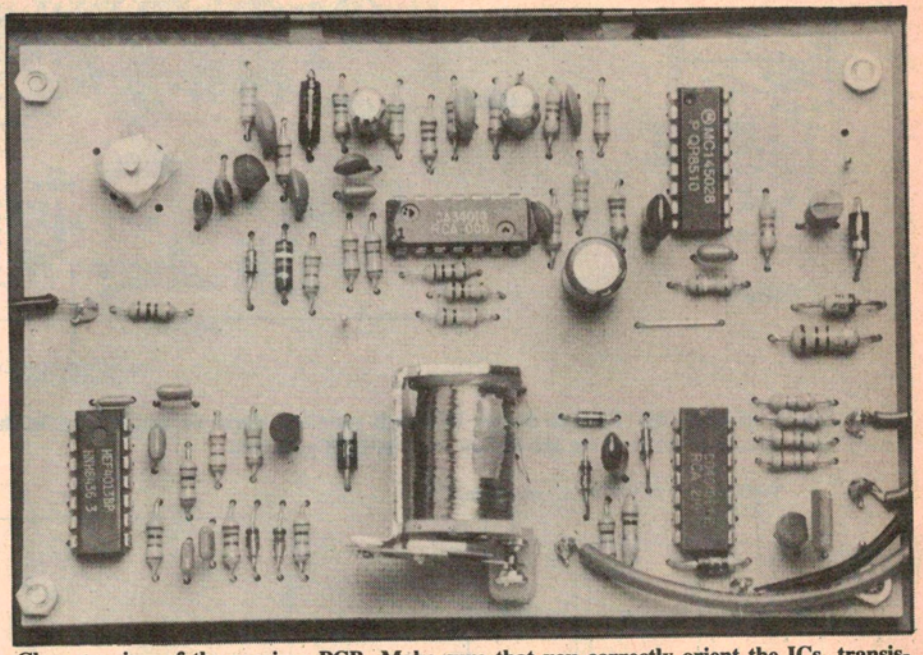
UHF Remote Switch

PCB was mounted on 5mm standoffs on the lid of a plastic zippy case (50 x 90 x 150mm). A 4-way terminal strip mounted on one end of the case was used to terminate the power supply connections and the switched +12V and loudspeaker outputs (outputs 4 and 3 respectively).

These output connections can, of course, be varied to suit your particular requirements.

A slot was filed in the opposite end of the case to provide an exit for the antenna lead. This lead simply consists of a 25cm length of insulated hookup wire.

When construction of the receiver has been completed, it can be tuned for maximum sensitivity. To do this, operate the transmitter some distance away from the receiver and monitor test point TP1 with a CRO. Finally, adjust trimmer capacitor CV1 to obtain the maximum waveform amplitude.



Close-up view of the receiver PCB. Make sure that you correctly orient the ICs, transistors, diodes and electrolytic capacitors.

PARTS LIST

Transmitter

1 PCB, code 87uk1b
1 plastic case, DSE Cat. H-2497
1 momentary contact pushbutton switch
1 12V lighter battery (Tandy)
1 positive battery terminal
1 negative battery terminal

Semiconductors

1 MC145026 trinary encoder
1 BF199 NPN transistor
1 small LED

Capacitors

1 0.1uF monolithic
1 0.0047uF polyester
1 0.001uF disc ceramic
1 220pF disc ceramic
1 2-6pF trimmer

Resistors (0.25W, 5%)

1 x 220k, 1 x 100k, 1 x 27k, 1 x 3.3k, 1 x 100 ohms

Receiver

1 PCB, code 87uk1a
1 15uH inductor
1 SPDT 12V relay
1 plastic zippy case, 50 x 90 x 150mm
1 4-way terminal strip
4 5mm standoffs
6 15mm x 2mm machine screws and nuts

Semiconductors

6 1N4148 silicon diodes
2 1N4004 silicon diodes
1 BF199 NPN transistor
2 BC327 PNP transistors
1 BC337 NPN transistor
1 BD140 NPN transistor
1 RCA3401 op amp
1 MC145028 trinary decoder
1 4013 D-type flipflop
1 74C14, 40106 Schmitt trigger
1 10V 1W zener diode

Capacitors

1 100uF 16V electrolytic
2 4.7uF 10V low leakage electrolytic
7 0.1uF monolithics
1 0.0056uF metallised polyester (greencap)
1 0.0022uF metallised polyester
3 0.001uF disc ceramic
1 330pF disc ceramic
1 220pF disc ceramic
1 15pF disc ceramic
1 3.3pF disc ceramic
1 2-6pF trimmer capacitor

Resistors (0.25W, 5%)

4 x 10M, 1 x 4.7M, 2 x 2.2M, 2 x 1M, 1 x 390k, 4 x 220k, 2 x 100k, 1 x 82k, 5 x 47k, 1 x 39k, 1 x 33k, 1 x 22k, 1 x 10k, 2 x 6.8k, 2 x 4.7k, 2 x 2.7k, 1 x 1k, 1 x 100 ohms, 1 x 82 ohms 0.5W

Relay assembly

1 relay PCB
1 SPDT 12V relay
3 mounting screws
2 1N4004 diodes (optional)

Where to buy the parts: parts for this project are available from Oatley Electronics, 5 Lansdowne Pde (PO Box 89), Oatley, NSW 2223. Telephone 579 4985 (Thursday & Friday only). Prices are as follows:
Transmitter kit (minus battery, case and pushbutton switch) .... $11.90.
Receiver PCB kit .... $29.90.
Receiver plastic case, terminal strip, screws and wire kit .... $5.90.
Relay kit (does not include diodes) $3.20
All prices include packaging and postage (minimum purchase $10 only).
The transmitter case (Cat. H-2497), pushbutton switch (Cat. S-1200), and 12V lighter battery (Cat. S-3335) are available from Dick Smith Electronics. The 12V lighter battery (No. GP23) is also available from Tandy.