Construction Project

New Single-Channel UHF Transmitter

This revised version of the 1987 single channel UHF transmitter uses a new high quality, low profile plastic case. It can be used with the 16 channel remote control project being described currently in EA, (single channel mode only) or with any other 304MHz UHF remote control that uses the Motorola 145026 trinary encoder IC. And all for $19.99!

by BRANCO JUSTIC and DOMENIC DECARIA

Readers may recall our January 1987 UHF single channel transmitter/receiver combination. We are currently also describing a 16 channel UHF remote control (see elsewhere in this issue), in a series of articles which commenced with the November issue.

The 1987 version of the single channel transmitter was housed in a small plastic case that was commercially available at that time. Since then, we have been able to source an even smaller and more elegant case. The new case is slimmer, much more rigid and has a pushbutton which is well recessed, to prevent accidental operation. Since the case is held together by a single screw, the case and its contents will not fall apart even when dropped!

The circuit of the revised transmitter is almost identical to our original and now well proven circuit design. It does however have one main circuit change – the LED is connected in series with the battery that powers the transmitter. This feature is desirable, since it reduces the power supply voltage available to the transmitter by approximately 2 volts as well as providing reverse polarity protection.

The main IC used in the transmitter is the SC41342 trinary encoder, which is now the replacement device for the original IC type MC145026. However, this new IC has a specified maximum supply voltage of 10V, unlike the MC145026 trinary encoder which could operate up to 15V. Thus, the revised circuit can operate with either of these ICs, as the circuit voltage is now set to around 10V, the LED providing a 2V drop from the 12V battery.

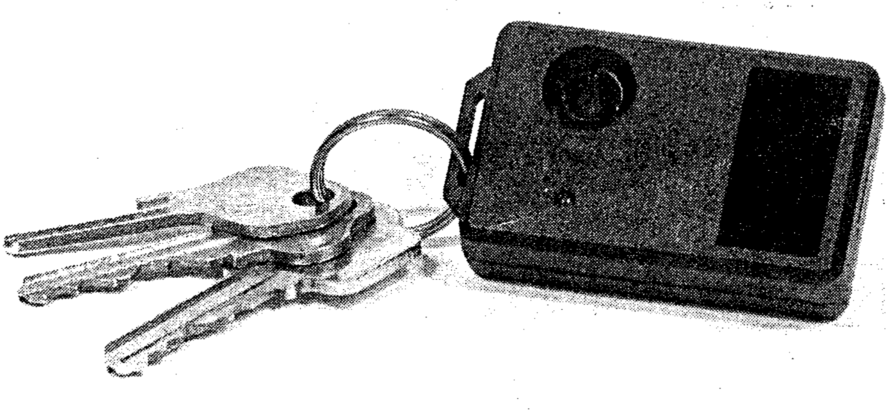
Since the LED is connected in series with the supply line it flashes in synchronism with the transmitted code, and therefore also provides a better indicator of correct transmitter operation.

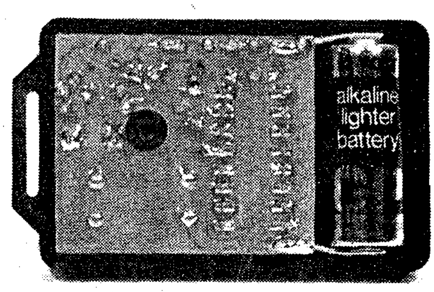
Construction

A kit of parts (less 12V battery) for this project is available from Oatley Electronics. The kit includes the case and all the necessary components needed to make the transmitter.

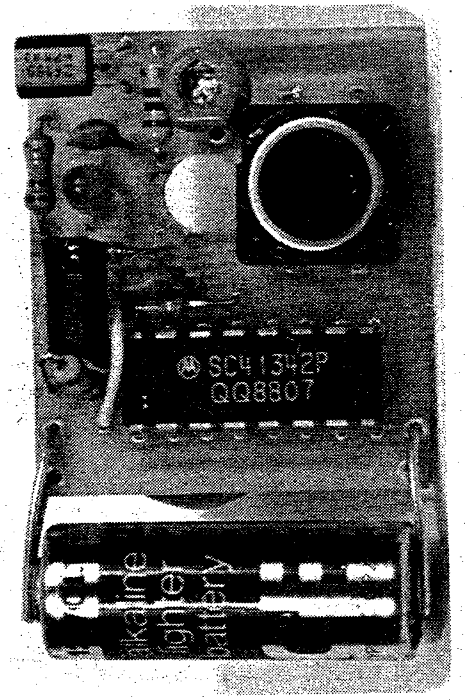
Assemble and solder all the components on the PCB provided. Note that the transistor is mounted horizontally, with the flat side facing up. Similarly, the 4.7nF capacitor is fitted horizontally, laying over the 100k resistor and the 1N4148 diode. There is also one insulated wire link used on the component side of the PCB.

The battery holder is made using

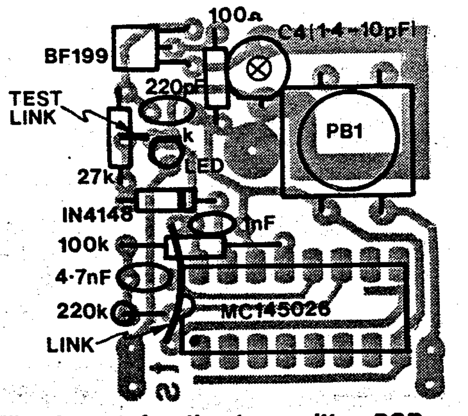




The new transmitter is smaller than the previous model and the case is held together with a single screw, giving a more robust arrangement. A recess around the pushbutton (see left picture) will minimise accidental operation.



The PCB assembly. Lay C1 over D1 and R1 to allow the assembly to fit in the case.



The layout for the transmitter PCB. The link needs to be arranged as shown in the photo (left). Make the battery holder with two lengths (both ends) of thick tinned copper wire.

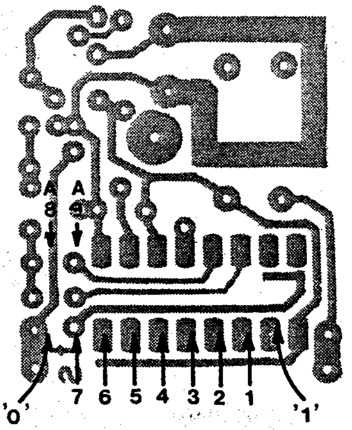


Fig.1 Coding the transmitter requires connecting address pins labelled A1 - A9 to either a logic 0, logic 1 or to be left open-circuit. Two PCB tracks are provided to allow each pin to be connected as required. There are 19,122 possible codes.

thick, tinned copper wire at either end of the PCB, formed to make good contact with the battery. Use two wires each end to give a stronger arrangement, although, when combined with the plastic case the holder will be quite strong and provide good support for the battery. A temporary test link using a short length of tinned copper wire is also required for initial testing.

The frequency of transmission of the finished transmitter should be set to the allocated frequency of 304MHz, although the printed circuit inductor will ensure the frequency is fairly close anyway. To enable the UHF oscillator to run continuously the test link as shown on the circuit diagram will be needed.

To measure the carrier frequency of the transmission a frequency counter should be loosely coupled to the output tank circuit and the trimmer capacitor, C4, adjusted with a non-metallic screwdriver so that the frequency, as read by the counter is 304MHz.

After this adjustment, remove the link to enable the transmitter to transmit the code sequence. Note that a functional transmitter should cause interference when placed close to the antenna terminals of a TV set or when it is placed near the ferrite antenna of an AM radio.

Coding the transmitter

This project provides a security code of 19,122 possible codes. The supplied

continued on page 159

PARTS LIST

1 PCB 30 x 34mm
1 Plastic case
1 Pushbutton switch
1 12V battery
Tinned copper wire and insulated copper wire.

Resistors

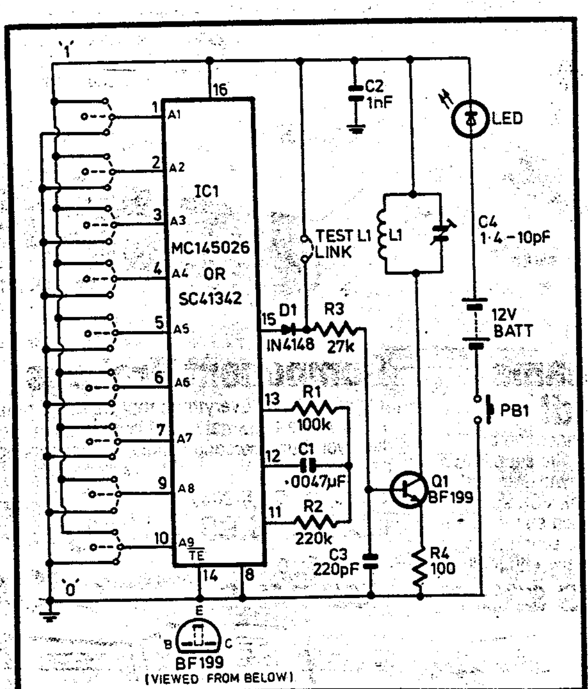
All 1/4W, 5%: 1 x 100 ohm, 1 x 27k, 1 x 100k, 1 x 220k.

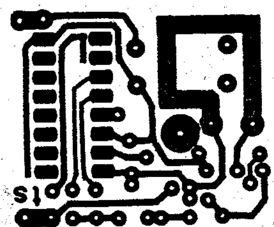
Capacitors

Disc ceramics: 1 x 220pF, 1 x 1nF
1 1.4 - 10pF trimmer capacitor
1 4.7nF metallised polyester

Semiconductors

1 1N4148 Si diode
1 Red LED (3mm)
1 BF199 Si NPN transistor
1 MC145026 Trinary encoder IC





The circuit diagram (left) and the PCB artwork (above). The transmitter circuit is in series with the indicator LED.

UHF Transmitter

continued from page 113

circuit board has all the address lines left open circuit, and the required code must be applied by adding links.

The final code you select is programmed into the transmitter by the chosen states of the address pins A1-A9 on IC1. These address pins can be left open circuit, connected to supply ('1') or to ground ('0'). The code is implemented by connecting each address pin to the selected logic level, using short lengths of tinned copper wire.

Obviously, the transmitter code needs to match the code used in the receiver. Fig.1 shows how to apply the code. For further information you might like to refer back to EA, January 1987. As well, because this transmitter can be used with the remote control system currently being described (low security channel only), reference to this set of articles may also be useful.

Frankly Frank

continued from page 42

that those who arrive here to check on what happened to us and where we went would have some inkling of what a neutrino was or is. (In their time that famous particle, the Higgs Boson might have returned.) Besides, the entrance to the abandoned salt mine would have been long buried – although our colleagues in the military electronic field have made it possible to readily find underground objects, wells, cisterns, etc.

In an attempt to locate those famous Viet Cong tunnels in Vietnam, the Americans built an underground microwave radar system. Sadly it didn't work too well in wet ground, but in the middle east where it isn't often too wet, the system is working wonderfully. At a place near the Gaza Strip, not a place of numerous streakers, but one hotly disputed by various people for these last four of five millenia, the microwave radar was used at Tell Halif.

Now it is true that in a place that lies between the Gaza Strip and the Dead Sea, no person of reasonable sanity would seek to stay long. Archeologists are not people who fall into this category of sane people. Anyway, at Tell Halif a team of American archeologists have used microwave underground radar to locate a vast buried water supply cistern. Naturally it now has no water in it and the radar worked admirably.

So when our future archeologists, Zgglyl and his/her/its assistant, Ztxyll arrive from Barnard's star to find out all about us, it is safe to assume that they will have microwave ground search radar to help them locate the Cleveland neutrino detector's remains. If that object might confuse them a bit, imagine what they would make of the partially melted Opera House or the Giant Gippsland Earthworm museum!

This will all be a mite academic should the next supernova be located right in our near neighbourhood. Should Proxima Centauri decide to go supernova, or anything within about ten or twelve light years, then our friends from Bernard's star might just as well stay home. Not even that three kilometre wide feature on Mars, the one that looks like some upper house member's head, would survive. Perhaps Jupiter, the planet described as a 'failed' sun, might reverse its failure and the whole thing start again in four or five thousand million years...

Letters

continued from page 7

cancel each other.

Rigorous mathematical models describing the behaviour of a vented speaker have been around for almost thirty years, but apparently no-one has put the old explanation to the test.

An examination of the electrical equivalent circuit, or the mathematical expression derived from it reveals that, taking the high frequency acoustic output as reference, at resonance the cone output leads 90° and the vent output leads 180°. Thus for a traditional B4 alignment the driver and box resonance are coincident and there is a 90° difference between the phase of the cone and port outputs. Also the cone output is seen to be almost zero.

Readers having a mechanical bent may recognise the similarity to the harmonic balancer, where the primary and secondary masses are displaced 90° and the primary mass has almost zero motion.

That the output from cone and port are not in phase is of no consequence as the cone output is negligible compared to that of the port. What may be of interest is the phase reversal of the acoustic output as the program frequency is swept down towards the speaker resonance. Those concerned with phase linearity may care to examine this effect.

Peter H. Row, Manager
Technico Supplies & Services
Ashburton, VIC.

'Soft start' relay

Thank you for publishing the circuit of my soft start spotlight relay, in the October 1988 issue.

As mentioned in the text, there is about a 1/2-second delay before the filaments begin to glow. A 10uF/50V non-polarised capacitor across D1 (1N4004) solves this problem, without losing the soft-start characteristic. It forms a capacitive voltage divider network with C1, allowing for the effects of R2. When Hi Beam is switched on, C1 is immediately charged to Vthreshold, at which point the normal soft start feature of the circuit takes over.

When switching to Lo Beam, there is a slight negative voltage across the added capacitor, as allowed by D1. Thus it must be a non-polarised type.

I hope this further information will be of assistance to builders of the relay.

Ron McGregor,
Belconnen, ACT.

Vintage Valves

I noticed an article in your August 1988 edition by Mr Peter Lankshear – perhaps you could pass this enquiry on to him.

I would like to know if there is a market for vintage valves. I have a few but have never seen anyone who wants to buy.

I remember being given a box of 60 battery-set valves which I used for airgun target practice!

E.J. Spain
Hongkong

Comment: We thought it would be better to publish your letter, Mr Spain. If we get any enquiries, we'll forward the letters on to you.

Circuit symbols

Re your Forum of October 88, it seems to me that rectangular boxes could have been seen as a solution to neat, quick drawing for draftsmen. But I still prefer to see the traditional wriggly lines for resistors. Computer aided drafting makes those boxes obsolete, and we can now surely revert to symbols providing clarity of understanding.

Resist, by all means, introducing the bland and confusing boxes for logic symbols instead of the simple and more informative curved ones.

G Cutter
Bentleigh, Vic

Comment: Thanks for your support, Mr Cutter. We have no intention of changing our logic symbols, rest assured!

Construction Project:

New Single-Channel UHF Remote Control Receiver

Here's an all-new version of a single channel remote control receiver/decoder that will match the transmitter presented in January 1989. It's smaller, more versatile than previous models, is very easy to construct and tune. Best of all, it costs less than $35.

by BRANCO JUSTIC and DOMENIC DECARIA

A single channel remote control system is always a very popular project, as the applications for such a system are numerous. We presented our revised single channel transmitter in *EA* January 1989, and now present the all new receiver/decoder to go with it.

Regular readers will no doubt have noticed our 16-channel system as well, described in the November 1988 February 1989 issues. But for those who don't want any more than a single channel remote control system, we offer this project.

The new design is an update (and a considerable one at that) on the system previously presented in *EA* January 1987, and is therefore compatible with it. However, the new system has more features, and is much smaller.

The aim was to produce a versatile system that is easy to construct and align, but retaining a low cost. The main features we have been able to build into the new receiver/decoder are small size, low current consumption (2mA when no relays are energised), two modes of operation, and two on-board relays. The first relay is called the *switch* relay, and is used to drive the load – for example, to supply power to a car burglar alarm.

The second relay is called the *indicator* relay, and is used to operate an external indicator, such as the blinkers on your car. This feature therefore provides a visual short-duration indication of the new status of the system.

Connections are also provided for a buzzer that operates in parallel with the indicator relay. This way the relay can drive an external indicator, and the buzzer can be integral with the receiver/decoder. The choice is yours.

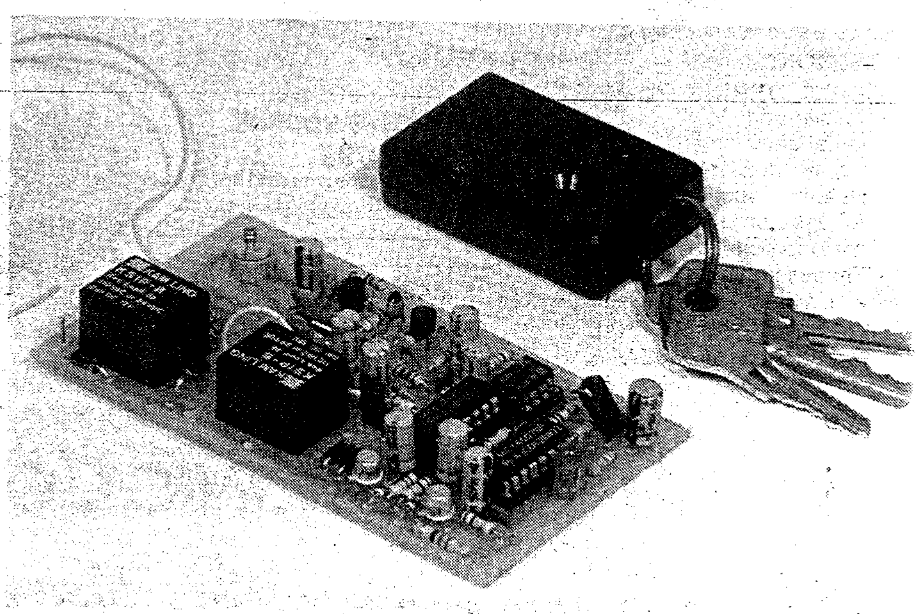
For example, in a remote controlled car burglar alarm, the blinkers could be operated by the indicator relay, and the alarm module by the switch relay. When you 'arm' the system, the blinkers would therefore come on for a certain interval to indicate the alarm is now set. When you 'disarm' the system, the blinkers will turn on for a shorter time. By changing the timing capacitors, you could arrange the times to give say, four flashes by the blinkers at 'arm' and one flash at 'disarm'. This might save you some embarrassment in the carpark!

The two modes of operation, selected with a wire link, are *pulse* and *toggle*. The pulse mode means the switch relay is energised only while the transmitter is activated, while toggle mode requires two transmitter pulses – one to turn the switch relay on, the other to turn it off.

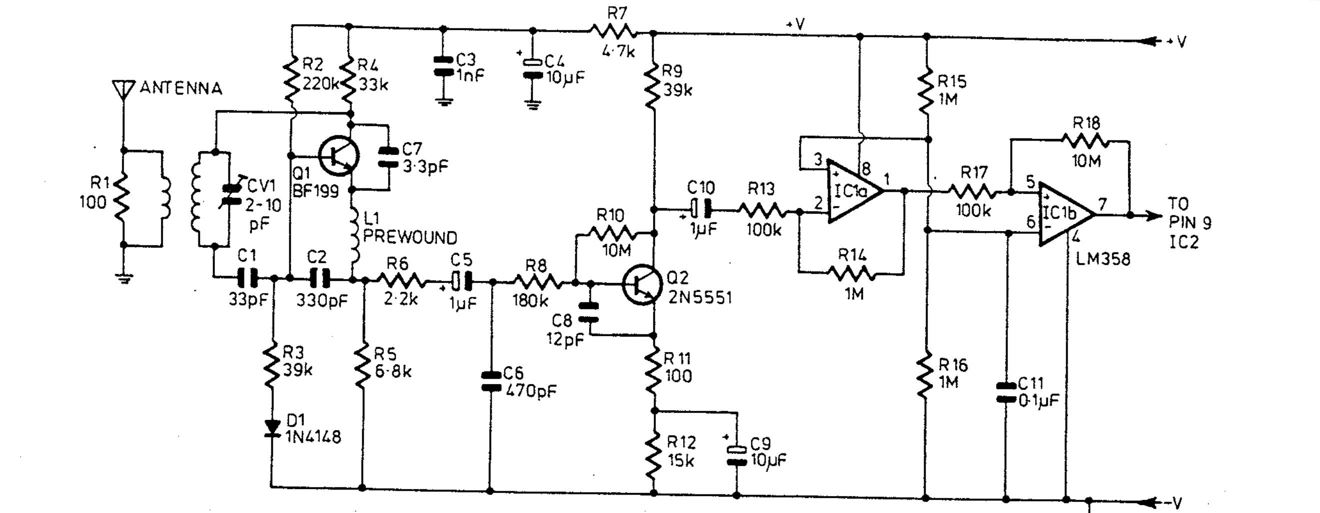
The indicator relay will work with both modes, although not quite as you might expect in pulse mode. In this mode, when you first activate the transmitter, the switch relay will operate for as long as the transmitter push-button is pressed, and the indicator relay will give the long duration indication.

When you release the push-button on the transmitter, the switch relay will turn off, but the indicator relay won't operate at all. The next time you press the transmitter push-button, the switch relay will, of course, come on again, but this time the indicator relay will pulse for the short duration time interval. This is handy if the switch relay is being used to toggle a load.

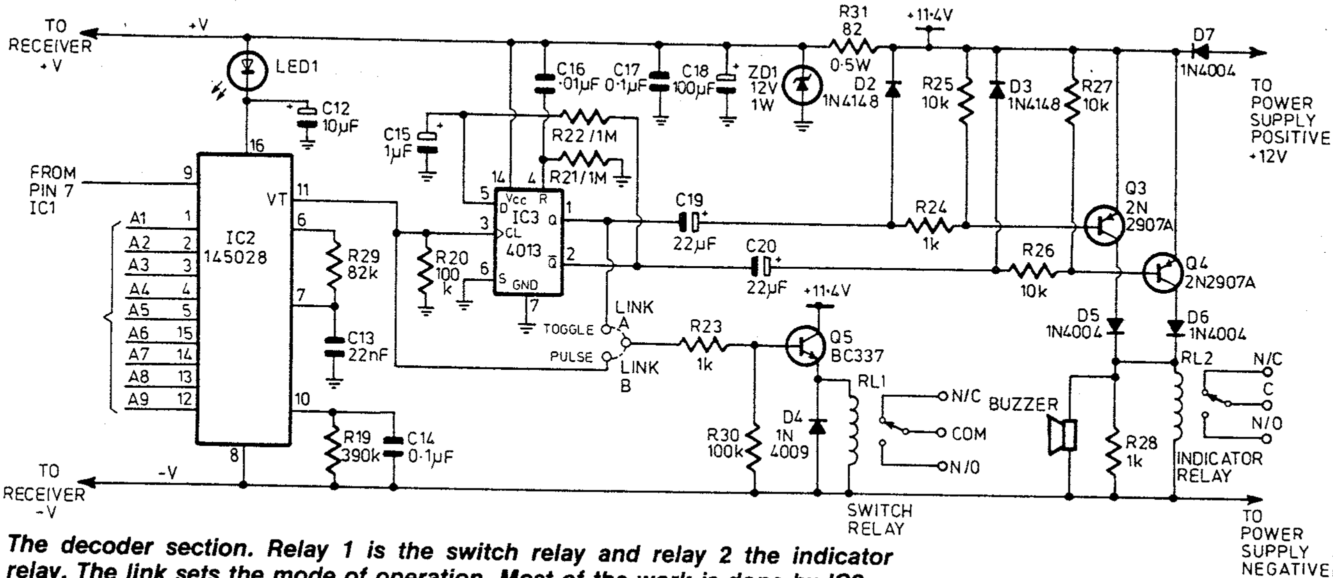
For toggle mode, the first press of the transmitter push-button will set the



The complete UHF single channel remote control system. It's considerably smaller and more versatile than the earlier version.



The circuit diagram of the receiver. The only tuning required is to adjust CV1 for best sensitivity. The output of this circuit connects to the decoder section.



The decoder section. Relay 1 is the switch relay and relay 2 the indicator relay. The link sets the mode of operation. Most of the work is done by IC2, a trinary decoder IC.

switch relay on, and cause the indicator relay to pulse for the long time interval. The next time the transmitter is activated, the switch relay will turn off, and the indicator relay will pulse for the short duration time interval.

The system has 19122 user selectable *key* codes, making it fairly secure against 'illegal' or unauthorised operation. The prototype was able to function reliably at distances exceeding 50 metres, giving excellent range. This will depend on the tuning of the transmitter and the receiver, as will be described.

How it works

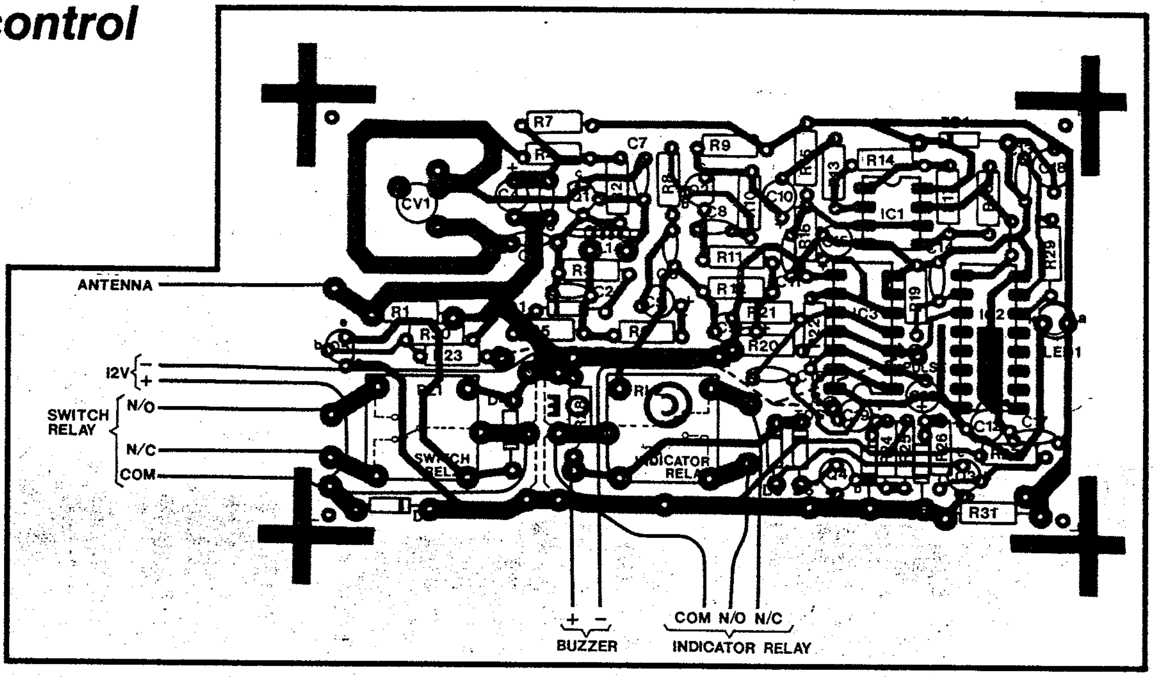
The single channel transmitter that goes with this project was described in *EA* January 1989. The receiver/decoder is a bit more complex, as it comprises two sections. We start with the receiver section.

The circuitry associated with Q1 forms a self-detecting regenerative UHF receiver that operates at 304MHz. The detected output from this stage, representing the original binary information, is amplified by the common emitter amplifier comprising Q2 and its associated circuitry. Further amplification is provided by the inverting amplifier IC1a. This stage has a gain of 10 and its output is coupled to the Schmitt trigger IC1b.

Resistors R15 and R16 provide half-rail bias for both IC1a and IC1b. The original transmitted digital signal is produced at the output of IC1b and is then passed onto the decoder section. The decoder section receives the binary information from the output of IC1b, which is applied to the input (pin 9) of the trinary decoder IC2. If the code sequence at the input of IC2 matches its address lines and the rate of the code sequence matches its timing (set by R29, C13, R30 and C14), the valid transmission output terminal (VT-pin 11) will go high.

The indicator LED (LED1) is connected in series with the decoder's positive supply pin and serves as a visual indicator for correctly received data (lights up briefly during a valid transmission) and also drops the available supply voltage to the decoder by approximately 2 volts. This is necessary as the maximum recommended supply voltage for one of the two available decoders (SC1344) is 10 volts.

Remote control receiver



The PCB layout. The board is fairly crowded, requiring care that all components are correctly placed. All external connections should be taken from the points shown.

The valid transmission pulse output from the decoder IC2 is applied to the input of flipflop IC3, and also to a PCB terminal labelled 'pulse'. If this terminal is connected by link B to R23, a high at the valid transmission output will turn on transistor Q5 via resistor R23 and the switch relay will operate. Thus link B establishes the mode of operation in which the relay will only remain on only while the transmitter push-button is pressed, that is, *pulsed* operation.

The D-type flipflop IC3 has its Q-bar output connected to its D input, via R22, establishing toggle operation of the flipflop. This means that each time the VT output terminal of the decoder sends a pulse to the clock terminal of IC3, the outputs (pins 1 and 2) will toggle. This allows alternate presses of the transmitter push-button to toggle IC3. The addition of R22 and C15 stops IC3 from changing its output states at less than 1 second intervals, and prevents possible double toggling when the transmitter is operated for a longer than usual period.

C16 and R21 reset the flipflop when power is first applied to the relay board, setting the Q output to a low, and the Q-bar output to a high. If link A was connected (instead of link B), the low at pin 1 (Q output) will hold Q5 off, preventing the relay from operating. A pulse from the transmitter will now cause the flipflop to toggle, and turn on Q5 by the logic 1 now present at the Q output. A subsequent press will turn it off again. Thus if *toggle* operation is required, link A is connected to couple R23 to the Q output of the flipflop.

Links A and B therefore establish the mode of operation of the decoder, and are connected as required during construction. Note that both flipflops of the dual CMOS D flipflop (IC3) are connected in parallel, to give more output. This is not shown on the circuit, but has been implemented on the PCB.

The indicator relay is driven by Q3 and Q4, which are in turn driven by the flipflop through timing capacitors C19 and C20. The indicator relay is independent of the mode of operation – it always operates as though the system is in toggle mode. The switch relay can be driven either by the flipflop (toggle mode) or by the VT terminal (pulse mode). For this reason, you will probably only use the indicator relay when the system is in toggle mode.

The operation of the indicator relay driver circuitry is as follows. When the system is first powered up, pin 1 (Q output) of IC3 is set low, and pin 2 (Q-bar output) is set high. Because the Q output is low, timing capacitor C19 will charge through R24 and the parallel combination of R24 and the base-emitter junction of Q3. This will cause Q3 to conduct and operate the indicator relay until C19 has charged. This time interval is only short: around 100ms or so. Thus, the indicator relay will operate once at power on.

When a valid transmission is received, the flipflop will toggle, setting Q to a high (thereby turning on the switch relay) and the Q-bar output will go low. This causes C20 to charge through R26 and the parallel combination of R27 and the base-emitter of Q4, again operating the indicator relay. Because the value of R26 is larger than that of R24, the time the relay will operate is therefore longer (approximately 1 second), giving a longer pulse to indicate that the switch relay is now on.

If another valid transmission pulse is received, the Q output will go low, (turning off the switch relay) and allow C19 to charge as already described. This will give the short duration pulse to indicate that the switch relay is now turned off.

Diodes D2 and D3 provide a discharge path for the capacitors when the outputs of the flipflop return to their high state. Diodes D5 and D6 isolate the emitters of Q3 and Q4 from each other and allow these transistors to both operate the indicator relay.

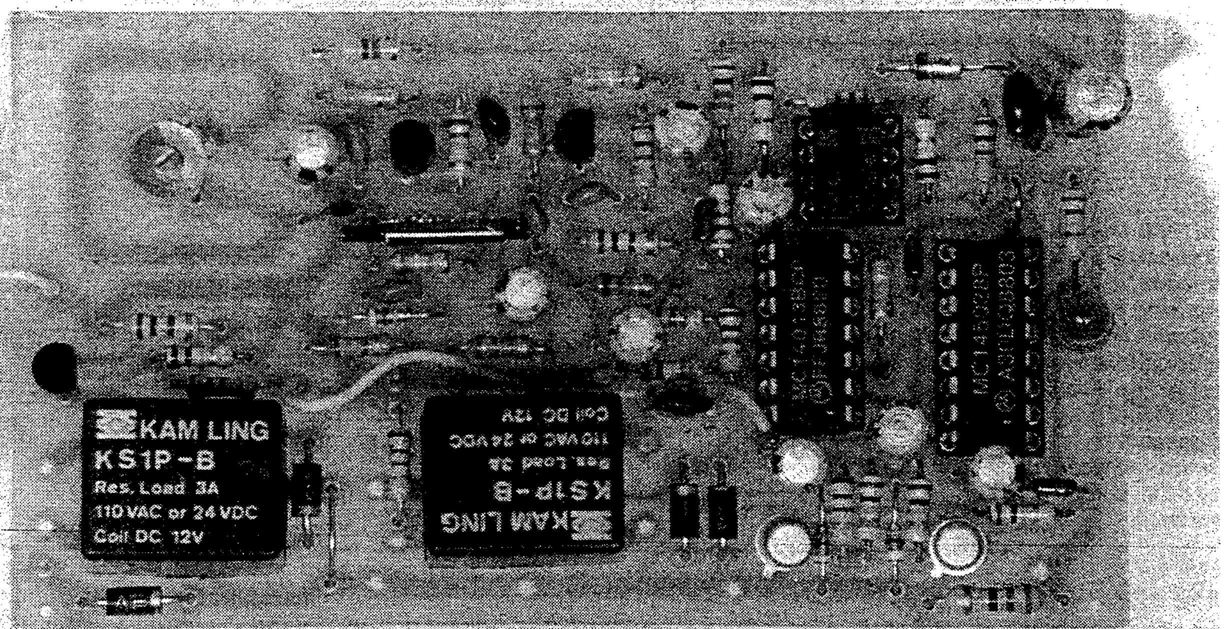
Resistor R31 and the 12V zener diode ZD1 are included to prevent the supply voltage to the ICs exceeding 12V, in the event of transients or if the applied supply voltage is greater than 12V. Diode D7 protects the circuit in the event of a reverse supply connection.

Construction

A complete kit of parts is available for this project from its designers, Oatley Electronics, who can also provide the necessary technical support to constructors. For this reason, the PCB artwork is not included in this article. Note that the matching UHF transmitter kit is also available from this supplier.

Before starting construction, carefully check the PCB for any faults. Then insert and solder the low profile compo-

Remote control receiver



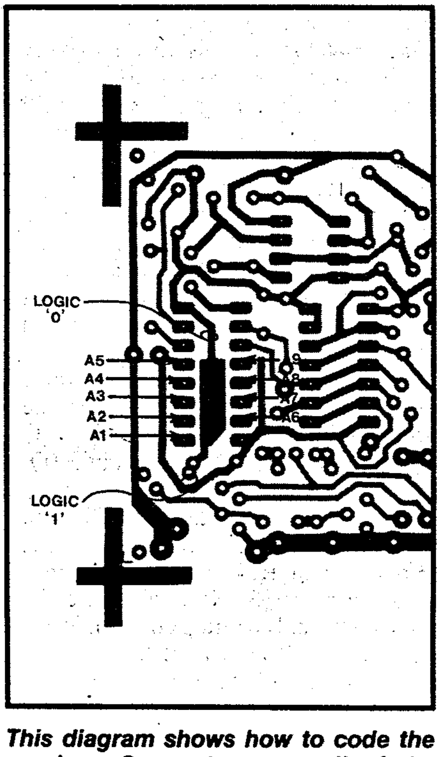
This picture shows the receiver/decoder PCB. The unit is set to 'toggle' mode by the long wire link. Note also that IC1 (the LM358) faces the opposite way to the other two ICs.

nents into the PCB, paying close attention to the orientation of the diodes and the electrolytic capacitors. Make sure that the 1N4148 signal diodes and the 1N4004 power diodes are not interchanged, as the signal diodes will fail if used in lieu of a power diode. There is one wire link required, next to IC2. Some components are placed fairly closely to each other on the PCB, and care should be taken to ensure they are placed in the correct position. All components mount horizontally.

Next install the transistors, again being careful that they are placed the correct way round, and that the type numbers are not interchanged. The 2N2907 types are PNP, and the BF199 type is for RF use. Now solder in the IC sockets and the relays. Note that IC1 (LM358) faces the opposite way to the other ICs.

Before proceeding, decide on the mode of operation you want. If toggle mode is selected, connect the link marked 'B' on the layout diagram. If pulse mode is required, connect the link shown as 'A'. Use a length of insulated single strand wire for this purpose (telephone-type wire is fine) and leave it long enough so you can change it later if needed.

Connect the leads for the antenna, power supply and any leads from the relays you might require. It is important that the power supply earth be connected to the point shown on the layout diagram. The track extending from the antenna connection point to the main earth track actually behaves as an inductor at 304MHz, and should not be used as an earth point.



This diagram shows how to code the receiver. Connect any or all of the nine address pins to either a logic 1, a logic 0 or leave open-circuit. The diagram shows the PCB tracks that can be used to supply either logic level. The code you choose must match the code in your transmitter.

The antenna used on the prototype was a 250mm length of insulated multistrand hookup wire.

Finally insert the ICs into their sockets, and check over your soldering and construction in general. The ICs should be handled carefully, as (apart from IC1) they are CMOS devices.

It is recommended that you code the transmitter and receiver only after you test the operation of the system. No coding need be applied for the following testing procedure, as the PCBs are supplied with all coded inputs left open circuit. This should match the transmitter, unless you are using a transmitter that has already been coded. In this case, either remove the code from the transmitter, or match the receiver to the transmitter code.

Testing

You will need a working transmitter to check the receiver/decoder. Remember that you can confirm if the transmitter is functioning by holding it next to

Remote control receiver

the ferrite rod of an AM radio, and listening for interference when the transmitter button is pressed.

Apply 12V DC to the receiver/decoder, and if all is well the LED next to IC2 will pulse on, then extinguish and

PARTS LIST

1 PCB coded OE89R
1 prewound inductor
2 12V relays

Resistors

All 1/4W, 5%: 2 x 100ohm, 3 x 1k, 1 x 2.2k, 1 x 4.7k, 1 x 6.8k, 3 x 10k, 1 x 15k, 1 x 33k, 2 x 39k, 1 x 82k, 4 x 100k, 1 x 180k, 1 x 220k, 1 x 390k, 5 x 1M, 2 x 10M.

1 82 ohm 1/2W.

Capacitors

Disc ceramics: 1 x 3.3pF, 1 x 12pF, 1 x 33pF, 1 x 330pF, 1 x 470pF, 1 x 1nF, 3 x 0.1uF.

1 2 – 10pF trimmer capacitor

Polyester: 1 x 10nF, 1 x 22nF

Electrolytics: 3 x 1uF, 3 x 10uF, 2 x 22uF, 1 x 100uF.

Semiconductors

3 1N4148 Si diodes
4 1N4004 1 amp diodes
1 12V 1W zener diode
1 Green LED (5mm)
1 BF199 Si NPN VHF transistor
1 2N5551 Si NPN transistor
2 2N2907A Si PNP transistors
1 BC337 Si transistor
1 LM358 dual op amp IC
1 MC145028 Trinary decoder IC
1 4013 CMOS dual D flipflop

Miscellaneous

Hook up wire, optional IC sockets, solder etc.

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985

Postal Address (mail orders):

PO Box 89, Oatley West NSW 2223.

Transmitter kit, new version (battery excluded) $19.99
Transmitter kit, old version (battery excluded) $15.00
12V Alkaline battery $2.00
Receiver (complete kit) $34.90
Post & Packing charge............. $2.50

the indicator relay will operate for a brief time. If the LED stays on, check around IC2. If the LED stays on even with IC2 removed, either replace C12, or look for track shorts.

Assuming all is well so far, hold the transmitter next to the receiver's antenna, and operate the transmitter pushbutton. The LED (next to IC2) should come on briefly, and the indicator and switch relays should both operate. If not, try adjusting the trimmer capacitor CV1 on the receiver PCB, and repeat the experiment. The adjusting tool (preferably a proper insulated aligning tool) should be removed from the capacitor during testing, as it will detune the receiver when in contact with the capacitor. At this close range the receiver should receive the transmitted signal even if it is incorrectly tuned.

Having established correct operation at close range, it remains to tune the receiver for best sensitivity. This can be done by connecting a CRO to the collector of Q2 and adjusting CV1 for the highest amplitude signal when the transmitter is activated.

If you don't have a CRO, you can try connecting an AC voltmeter (analog or DMM) in series with a 0.1uF capacitor to this point. However, you will need a sensitive meter to get a useful indication. Another alternative is to connect an audio amplifier to this point, again in series with a 0.1uF capacitor.

The correct signal is a series of pulses, approximately 5ms wide, spaced by 5ms – in effect, a square wave of 100Hz – but interrupted every few pulses by a gap of 8ms. This will be quite audible through a conventional amplifier, although the volume should be kept down low, to hear any increase as adjustment is made. You could connect an AC voltmeter across the speaker to give a more reliable indication of any change in level.

Now adjust the trimmer capacitor to get the highest peak to peak value. A peak to peak value of around 0.2V was obtained on the prototype when the transmitter was held approximately 1 metre from the antenna.

If you cannot get good sensitivity, it may be that the transmitter is not operating at the correct frequency of 304MHz. Try adjusting the trimmer capacitor in the transmitter (just slightly) and repeat the procedure. You should be able to get reliable operation for at least 10 metres, and even more given ideal transmission conditions and correct tuning.

Coding

This project gives you a security code combination of 19122 codes to choose from. The supplied circuit boards for both the transmitter and the receiver have all the address lines left open circuit and it is up to you to add your own code, but only after correct operation has been confirmed.

The method of coding the transmitter was explained in the text for that project, although a layout error resulted in the PCB artwork diagram being printed upside down. See the March edition, in the errata section, for the correct diagram.

The receiver code must match the code applied to the transmitter, and is applied in the same way. That is, the nine address pins of IC2 must be connected either to a logic 1, logic 0 or be left open-circuit.

These connections are made by soldering short lengths of tinned copper wire to the chosen logic levels and the corresponding address pins on the PCBs. The method of doing this is shown in the coding diagram, which shows the PCB tracks you can connect to for a logic 1 or a logic 0 for coding purposes.

If you are a little unsure about the coding procedure, remember that the system will work to start with since all the codes are identical in that all pins are open-circuit. You can then try changing one code at a time, in both the transmitter and the receiver, and then test to see if the system still works.

If you want to have longer time delays for the indicator relay, change the value of C19 to modify the pulse length indicating switch relay OFF, and C20 for the relay ON indication. Larger capacitors will be a tight squeeze on the PCB, and if this becomes a problem, you could try increasing the values of R24 and R26. However, there is a limit to the amount this can be done, as the transistor base currents flow through these resistors, and too high a value might prevent the transistors conducting.

Connection points are provided on the PCB to connect the common terminal of the relays to either ground or the positive supply rail. However don't use the positive supply rail as a source of power for loads greater than 20mA or so, as the voltage transient caused will give false triggering and multiple pulsing of the relay.

Then all that remains is putting the system to work. And that's up to you...