

Construction Project:

16-channel UHF Remote Control - 2

As promised, here is part 2 of our remote control system. If you have built the transmitter already, then combine it with the receiver described in this article, and you're up and running. Because the receiver also incorporates digital outputs, you can start using the system immediately. Next month we will complete the whole system with a relay driver board, and then it's up to your imagination what you do with it.

by BRANCO JUSTIC

Last month we published the transmitter section of a complete UHF remote control system that has been designed for a range of applications needing remote switching. As previously described, the system features 16 channel operation, allowing the transmitter to control one or more receivers, which in turn operate up to four 4-channel relay/indicator PCBs.

Now comes the receiver, the heart of the system. The receiver is actually two sections on the one board – the UHF receiver itself and the decoding logic. The outputs from the decoder are digital, direct from a CMOS demultiplexer in fact, and are intended to operate interface circuitry that can drive the necessary relays. A suitable relay driver

board will be described next month, completing the system.

Block diagram

The complete 'front end' of the receiver is based on a circuit almost identical to that used in the UHF switch published in *EA*, January 1987. As shown in the block diagram, it employs a self-detecting regenerative stage which is followed by two amplifier stages, a Schmitt trigger and an inverter stage.

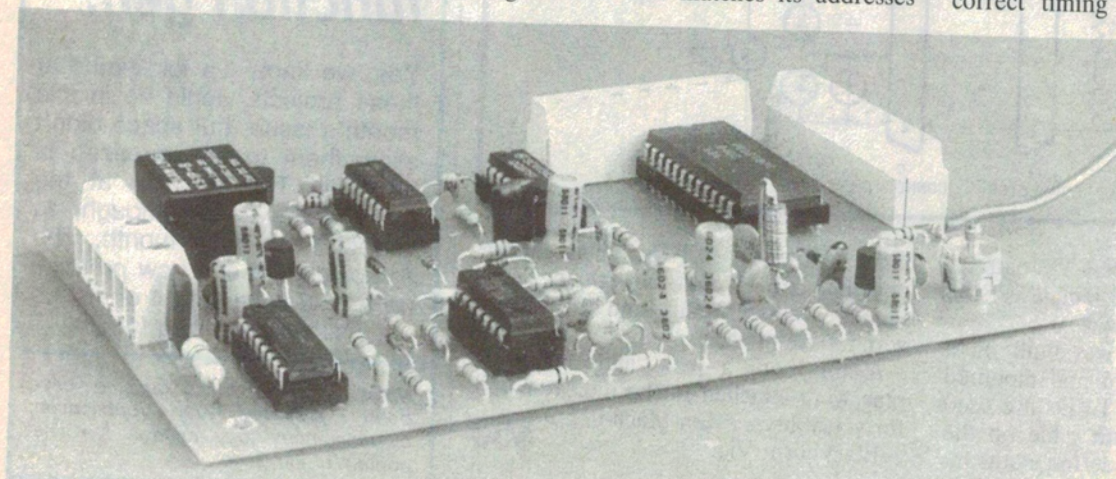
The digital output signal from the receiver itself is applied directly to the input of the first decoder (IC2) and via an AND gate to the input of the second decoder (IC4). If the first decoder receives two consecutive samples of a digital code that matches its addresses

and timing, its valid transmission output terminal (VT-1) will go high and activate a 10 second time extender. The output of the time extender will remain active for 10 seconds even if VT-1 goes low, as would be the case if no further transmission occurred or there was an invalid transmission.

The output from the 10 second time extender activates both an AND gate and a two second 'tamper detector'. Once the AND gate is activated, the digital information present at the receiver's output can now pass onto the second decoder (IC4). This second decoder will not receive any input unless the 10 second time extender has previously been activated by a logic 1 from VT-1 of the first decoder.

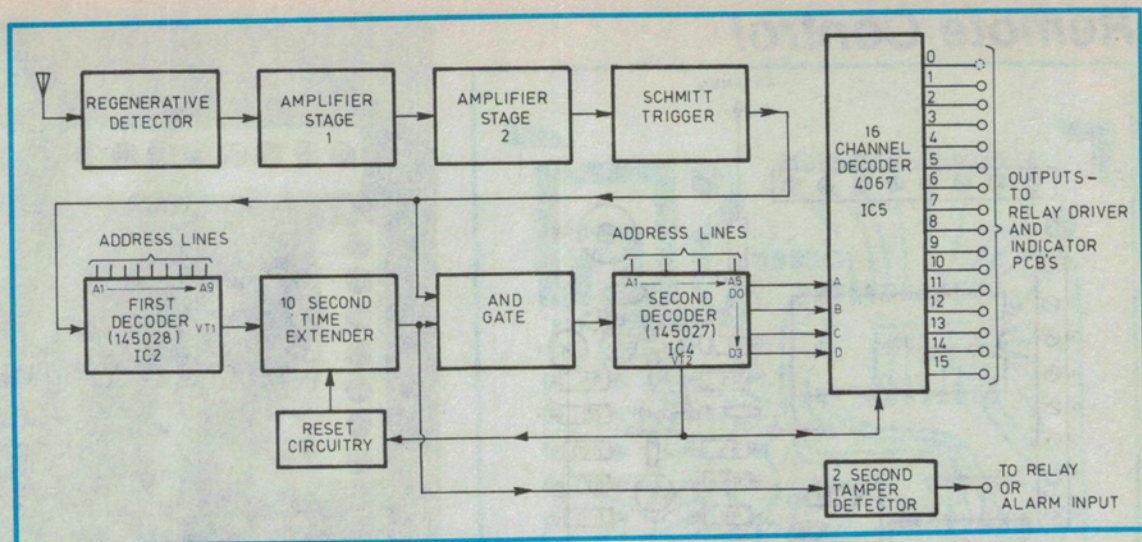
Therefore, if two consecutive samples of the digital signal at the second decoder input match its addresses and timing, the last four bits of data in the transmission will be transferred to data outputs (D0-D3), and VT-2 will go high. A high at VT-2 will reset, via the reset circuitry, both the 10 second time extender and the 2 second tamper detector.

If, however, a correct code with the correct timing is not received by the



The receiver/decoder unit itself. All connections to the board are made to the terminal blocks on the PCB.

The receiver block diagram. The receiver actually comprises two sections – the receiver and the decoder.



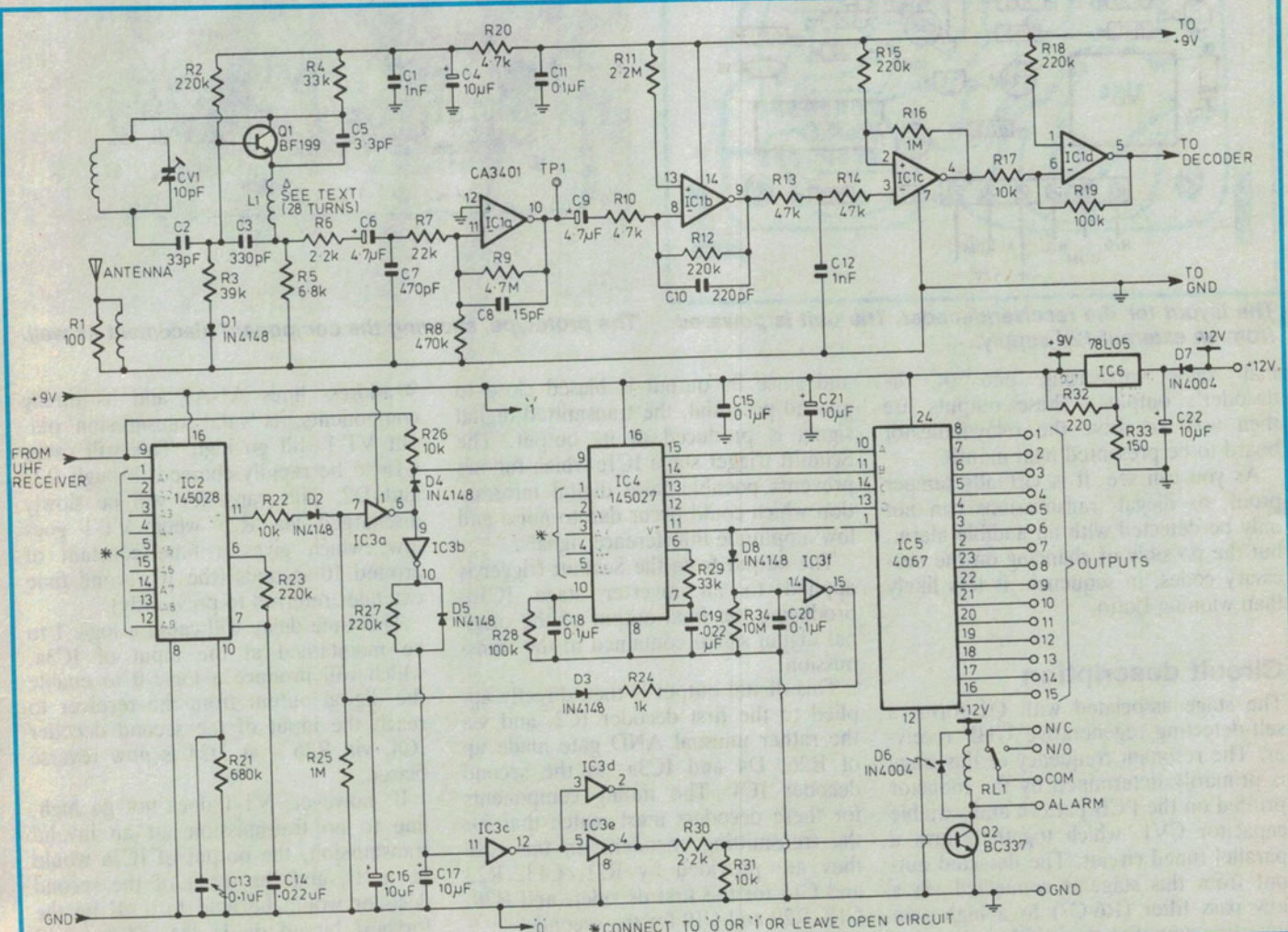
second decoder within the 2 second delay provided by the tamper detector, the alarm output will be activated. This output can be used to trigger an alarm to indicate illegal use of the system. However, because nearly 5 million codes are possible, it is unlikely anyone

could break into the system anyway.

Thus, the alarm output could be used as a separate channel, perhaps activated using the January 1987 transmitter. This transmitter provided a mere 13,122 combinations – much easier to break into – but if security is not a problem,

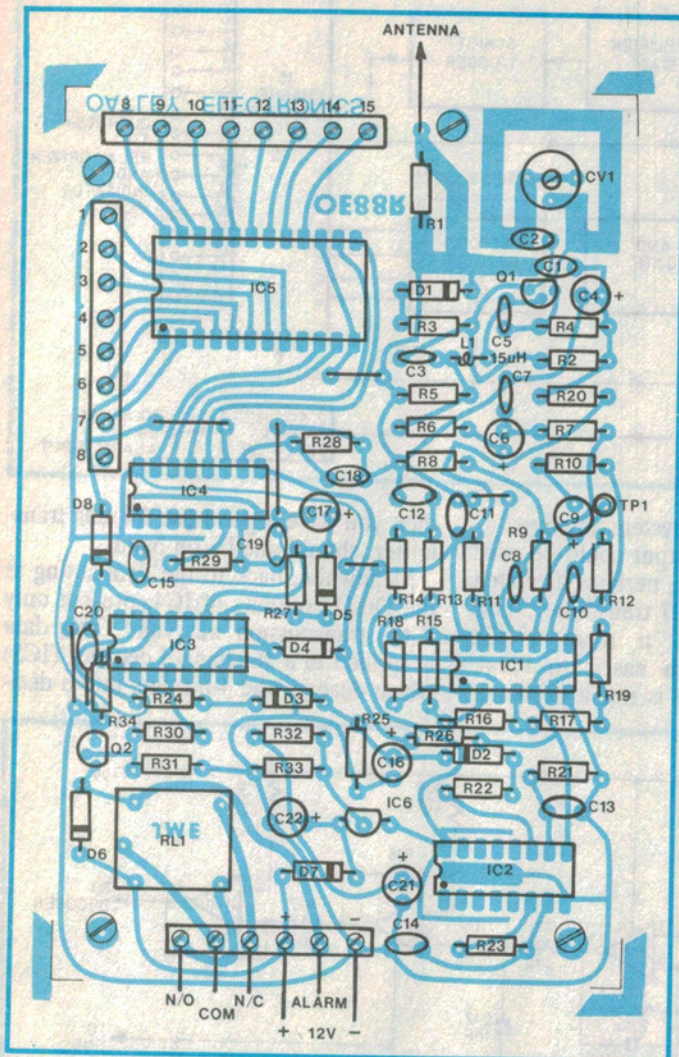
then you have a good use for this transmitter, should one be on hand.

Meanwhile, back to the data sitting at the D0-D3 outputs of IC4, present only if the transmission was valid. This data is applied to a 16 channel decoder (IC5) which decodes the 4-bit data into a deci-

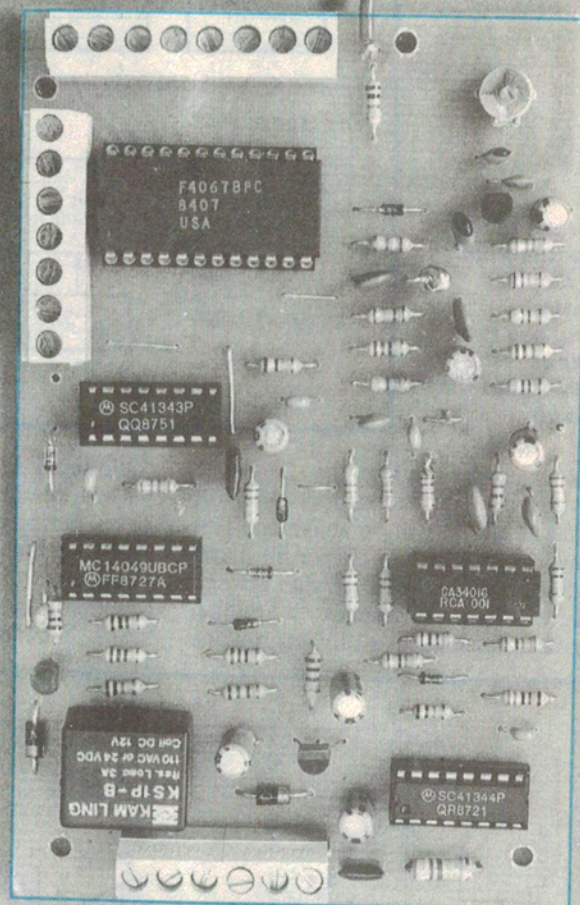


The receiver/decoder circuit diagram. The receiver section is shown as the top half, the decoder on the bottom.

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The layout for the receiver/decoder. The unit is powered from an external 12V supply.



The prototype, showing the component placement as well.

mal value, activating one of the decoder's outputs. These outputs are then used to drive the relay/indicator board to be presented next month.

As you can see, it is virtually tamper proof, as illegal transmissions can not only be detected with an audible alarm, but the possibly of chancing on the necessary codes, in sequence, is less likely than winning Lotto.

Circuit description

The stage associated with Q1 forms a self-detecting regenerative UHF receiver. The resonant frequency of this stage is primarily determined by the inductor printed on the PCB pattern and variable capacitor CV1, which together form a parallel tuned circuit. The detected output from this stage is connected via a low pass filter (R6-C7) to a high gain inverting amplifier stage IC1a.

IC1b is also an inverting amplifier,

and since its output is biased close to ground potential, the transmitted digital signal is produced at its output. The Schmitt trigger stage IC1c which follows prevents possible false digital information which could occur due to noise and low amplitude interference signals.

The output from the Schmitt trigger is applied to an inverter stage IC1d, producing the final output of the original digital signal contained in the transmission.

This digital output is then directly applied to the first decoder IC2, and via the rather unusual AND gate made up of R26, D4 and IC3a, to the second decoder IC4. The timing components for these decoders must match that for the transmitting encoders. In this case they are provided by R21, C13, R23, C18, R29 and C19 for the second.

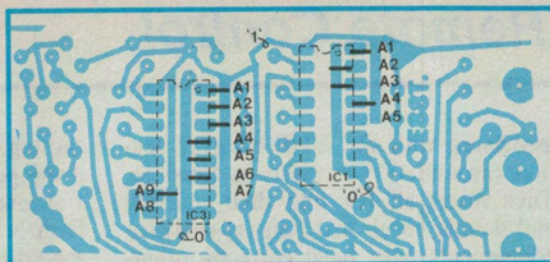
If the first decoder receives its correctly timed code, as determined by the

9 address lines A1-A9 and its timing components, its 'valid transmission' output VT-1 will go high. This will cause C16 to be rapidly charged through R22 and D2. This capacitor will be slowly discharged via R25 when VT-1 goes low, which gives a time constant of around 10 seconds (the 10 second time extender referred to previously).

This time delay will cause a logic 1 to be maintained at the input of IC3a, which will produce a logic 0 to enable the digital output from the receiver to reach the input of the second decoder IC4, via R26 - as D24 is now reverse biased.

If, however, VT-1 does not go high, due to no transmission, or an invalid transmission, the output of IC3a would be a '1', and the input of the second decoder would be held to a '1' by the forward biased diode D4. This would prevent the receiver output from reaching the second decoder.

Fig.1(a) - the transmitter coding. Links are connected from the IC pin to the PC tracks as shown to give the desired '1' or '0' to that pin. An open-circuit (nc) is also a valid code.



(a) System coding for IC3 (transmitter) and IC2 (receiver)

Address line	A1	A2	A3	A4	A5	A6	A7	A8	A9
Example code	1	1	1	0	0	0	nc	nc	1
Your code									

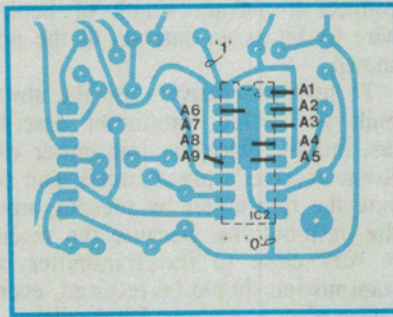
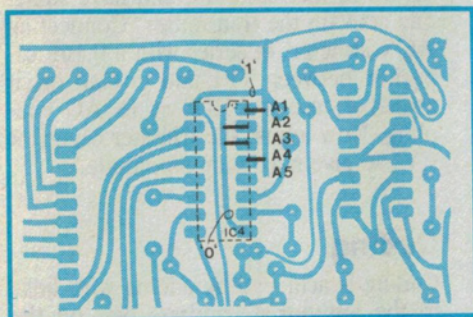


Fig.1(b) - the receiver coding. The decoder ICs must have the same code applied as that for the transmitter. Again, links are applied between the PC tracks and the IC pins.

(b) System coding for IC1 (transmitter) and IC4 (receiver)

Address line	A1	A2	A3	A4	A5
Example code	1	0	0	1	nc
Your code					

When the 10 second time extender is first activated, the output of inverter IC3b is set to a '1', and capacitor C17 starts charging towards the supply voltage through resistor R27. The time constant of R27/C17 is about 2 seconds (the 2 second tamper detector), and after this time C17 will have charged to a value that exceeds the threshold voltage of inverter IC3c. This causes the output of IC3c to become a '0' and the output of the paralleled gates IC3d/IC3e to be a '1', resulting in transistor Q2 being turned on via R31, activating the alarm relay RL1.

But if the second decoder receives its correct code before the 2 second delay, the charging of C17 is interrupted, and the alarm condition does not occur.

Assuming the second decoder has received its correctly timed code, the last four digits of data received are transferred and latched at its data outputs. Also, its valid transmission terminal,

VT2, will be set to a logic '1' which is applied to the input of inverter IC3f, via the time extender comprising D8, C20 and R34.

As a result, the output of IC3f is a '0', causing C16 to quickly discharge through the forward biased diode D3 and R24, effectively resetting the 10 second timer. Because of this, the output logic level at IC3b is set to a '0', allowing capacitor C17 to quickly discharge through forward biased diode D5, resetting the 2 second timer.

To activate the required channel from the transmitted binary information, a 16 channel demultiplexer (IC5) is used. This IC actually switches the logic level present at pin 1 to the selected output. Each output is selected by the input code; for example, if D = 0, C = 0, B = 0 and A = 1, output 1 will be sent to a logic 1, and all other outputs will remain in the high impedance state. The logic '1' level results from the output

PARTS LIST - RECEIVER

- 1 PCB 85 x 130mm, code OE88R
- 3 screw terminal strips, 1 each 6 way, 7 way, 8 way
- 1 12V relay
- 5 IC sockets, 1 x 14 pin, 3 x 16 pin, 1 x 24 pin
- Enamelled copper wire and ferrite former (for L1)

Resistors

All 1/4W, 5%: 1 x 100 ohm, 1 x 150 ohm, 1 x 220 ohm, 1 x 1k, 2 x 2.2k, 2 x 4.7k, 1 x 6.8k, 4 x 10k, 1 x 22k, 2 x 33k, 1 x 39k, 2 x 47k, 2 x 100k, 6 x 220k, 1 x 470k, 1 x 680k, 2 x 1M, 1 x 2.2M, 1 x 4.7M, 1 x 10M.

Capacitors

Disc ceramics: 1 x 3.3pF, 1 x 15pF, 1 x 33pF, 1 x 220pF, 1 x 330pF, 1 x 470 pF, 2 x 1nF.
Trimmer capacitor: 1 x 2-10pF.
Metallised polyester: 2 x 22nF
Monolithic capacitors: 5 x 0.1uF
Low leakage electrolytics (RBLL): 2 x 4.7uF, 5 x 10uF.

Semiconductors

- 6 1N4148 signal diodes
- 2 IN4004 diodes
- 1 BC337 transistor
- 1 BF199 transistor
- 1 78L05 regulator
- 1 4049 hex inverter
- 1 3401 quad op amp
- 1 145027 or 41343 decoder
- 1 145028 or 41344 decoder
- 1 4067 multiplexer

level of VT-2 which is connected to the input of the demultiplexer.

Construction

A complete kit of parts for this project is available from Oatley Electronics. The kit is complete (as per prototype photograph) and also includes IC sockets and all terminal strips.

The only component that has to be made prior to assembly is the inductor L1. Wind 28 turns of the supplied enamelled copper wire onto the special grade ferrite core also supplied in the kit. Note that the wire can be soldered without removal of the insulation, although we suggest that both ends of the completed inductor should be tinned before it is mounted on the PCB.

Next, mount and solder all of the passive components on the PCB, keeping all lead lengths for those components

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associated with the UHF receiver section (around Q1) as short as possible. Then insert all ICs into their sockets, and double check that polarity sensitive components have been correctly orientated. Also, do a final check on the track side to verify that no inadvertent short-circuits have crept in unnoticed.

Testing & adjustment

Once convinced that the construction is correct, apply 12V DC to the circuit as shown on the layout diagram. Also, connect a 400mm length of hook-up wire to act as an antenna to the point shown.

To test the receiver, use the already built and tested transmitter described last month. Place the transmitter close to the receiver's tuned circuit, and activate the transmitter by pressing any of the push-buttons. Because the receiver is very close to the transmitter, the transmission should be received, even if the receiver is not tuned correctly.

A very short press of a push-button should activate the tamper function,

causing the relay to operate. However, if the push-button is pressed for around 1 second or more, causing the LED to flash a few times, the tamper function should not operate. In this instance, the output corresponding to the key code being transmitted should give a brief positive pulse, which can be detected with either a voltmeter or a CRO connected between the output and ground.

Assuming all is well, it remains to tune the receiver to the transmitter. Separate the receiver and the transmitter by 10 metres or so, and have someone activate the transmitter. Connect an AC voltmeter, in series with a 0.1uF capacitor between TP1 and ground or, if available, use a CRO set to AC coupling. Now adjust the trimmer capacitor CV1 to give maximum amplitude.

Coding

Coding is achieved by adding wire links to the appropriate address pins on the encoder and decoder ICs. A pin can either be connected to the supply voltage or to ground, or left open circuit. However, the receiver and the transmitter codes must match!

Fig.1 shows an example of how a code can be applied. Fig.1(a) shows how the example code has been implemented for the transmitter, and Fig.1(b) how the same code has been applied to the receiver. Note that links are connected to the appropriate logic level PCB track from the selected address pin.

Next month

Although the system is now operative, it remains to connect it to the outside world. This is the task of the relay driver board that will be presented next month.

You may be able to invent your own drivers, which would allow you to start using the transmitter-receiver combination. However why bother, when we have done all the work anyway.

We also plan to present a 4-channel mains appliance switching unit as well. This particular board will also include a power supply suitable for powering the receiver. We did promise a versatile unit, didn't we?

In closing, my thanks to Mr Jeff Monegal for his help in the design of this project.

Kits of parts for this project are available from:

OATLEY ELECTRONICS

5 Lansdowne Pde,

Oatley West, NSW 2223

Phone (02) 579 4985

Postal Address (Mail orders):

PO Box 89, Oatley, NSW 2223

The prices for the kits associated with this project are:

Complete transmitter kit (battery included).....	\$34.95
Receiver/decoder PCB and components kit.....	\$59.95
Four relay driver/indicator PCB and components kit.....	TBA
Four channel mains supply switching unit kit.....	TBA
Post & packing charge.....	\$3.00

NOTE: Each kit only available after publication in Electronics Australia.

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