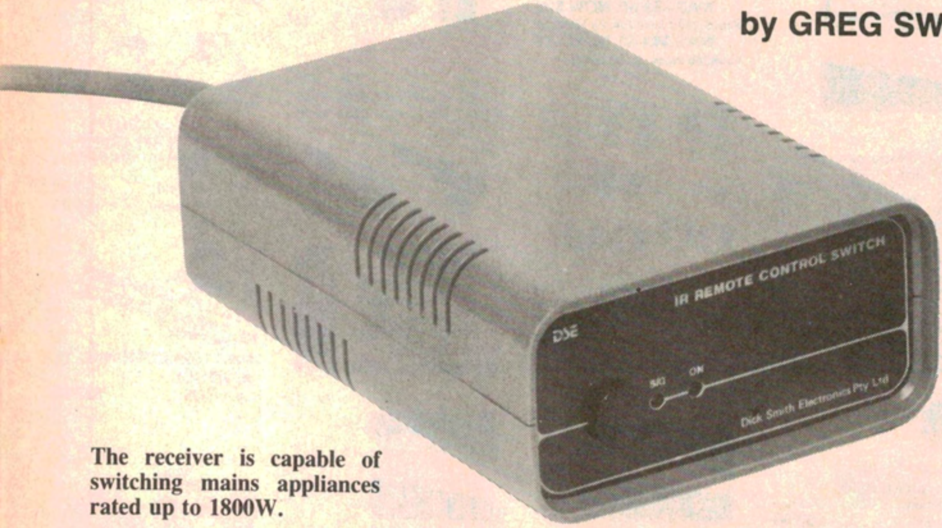
Don't get up. Press the button on this

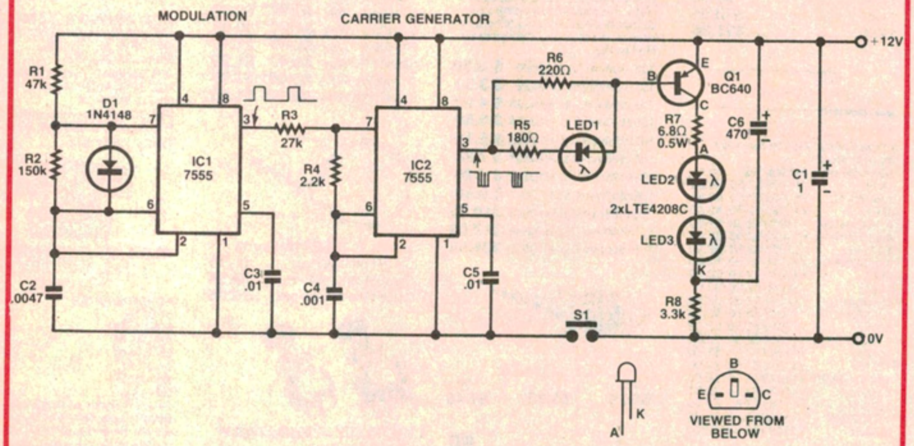
Infrared remote control switch

Want to switch your TV set on or off from the comfort of your lounge chair? This infrared remote control unit can switch any appliance at the touch of a button.

by GREG SWAIN



The receiver is capable of switching mains appliances rated up to 1800W.



INFRARED REMOTE CONTROL SWITCH — TRANSMITTER

2/LR/-

The transmitter circuit uses two TLC555 timers to generate a modulated carrier signal.

There are many situations where it would be convenient to switch a mains-appliance on or off without actually having to walk over to the mains outlet.

With this project, you can turn the TV set off after the late night movie without getting out of bed, control a table lamp from your lounge chair, or switch an outside light on when you arrive home late at night.

Other possible uses include switching a radio on or off, operating motorised curtains, or controlling an electric jug. Press the transmitter button once and the appliance turns on. Press it again and the appliance turns off. What could be neater?

The project can also be used as an ad-killer for TV. Normally, it uses a relay to switch power to a mains output socket. However, the wiring can easily be modified so that the relay contacts switch a loudspeaker in and out of circuit.

Presentation

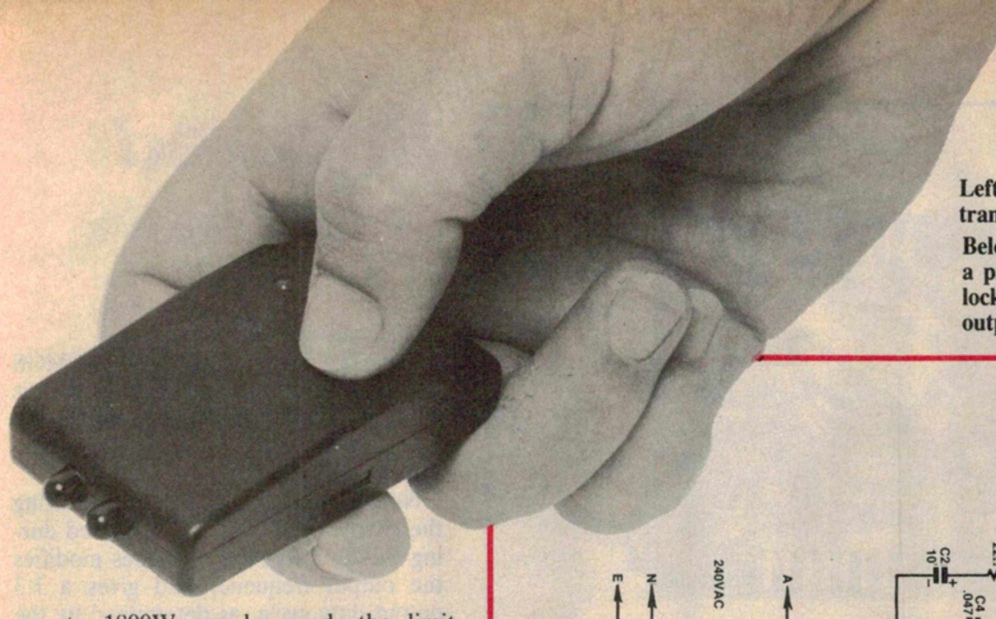
The Infrared Remote Control Switch comes in two parts: a small handheld infrared transmitter, and a companion receiver.

The transmitter is truly pocket size and is housed in a neat little plastic case with an integral clip on the back and a pushbutton on the top. It can be carried around in your pocket or clipped to your shirt. The receiver is also housed in a plastic case and is fitted with a 3-pin mains socket on the rear panel.

Overall dimensions are 36 x 60 x 20mm (W x D x H) for the transmitter, and 95 x 135 x 48mm (W x D x H) for the receiver.

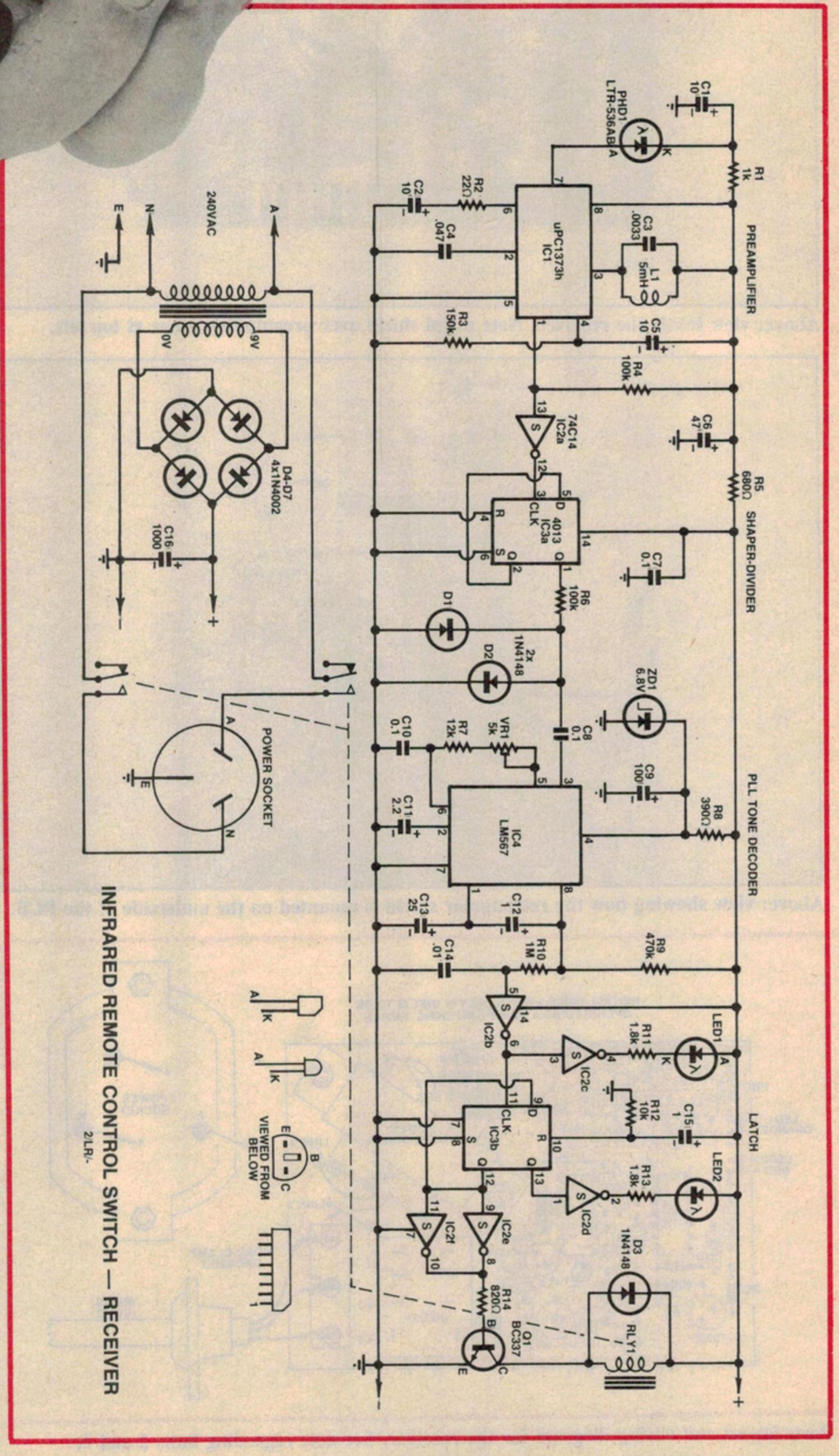
How it works

In use, the receiver is simply plugged into the mains and the appliance to be controlled plugged into the socket on the rear panel. Appliances with ratings



Left: the compact handheld transmitter unit.

Below: the receiver circuit consists of a preamplifier/detector (IC1), a phase lock loop tone decoder (IC4), and an output latch circuit (IC3b).



up to 1800W can be used, the limit being set by the ratings of the relay contacts and associated wiring.

When the transmitter button is pressed, the transmitter sends out a burst of modulated infrared light. At the same time, a small red LED adjacent to the button lights to indicate that a signal is being transmitted.

The receiver unit decodes the transmitted signal and switches the internal relay to control the mains outlet. Two front-panel LEDs indicate the receiver status. The first, labelled 'SIG' (short for signal), comes on whenever a signal is received from the transmitter. The second, labelled 'ON', turns on when the relay turns on.

Provided the line of sight between the transmitter and receiver is clear, a control distance of about 12 metres can be expected. This range is dependent on several factors. Electrical noise, strong light or strong RF signals may affect the sensitive high gain front-end of the receiver but, even under adverse conditions, the system will still operate over the full length of an average-size room.

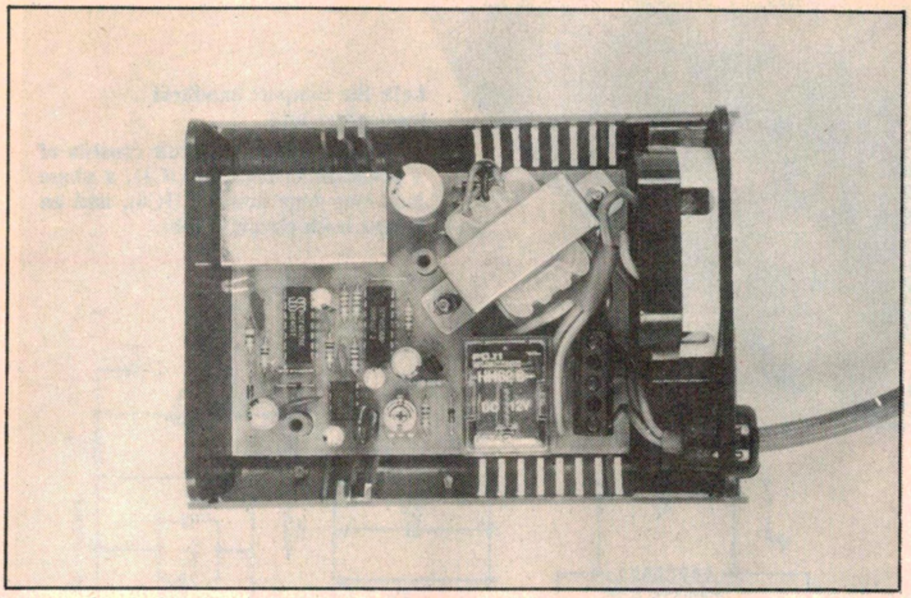
Note that the transmitter is designed to deliver maximum output when the button is first pressed. After that, the transmitter output drops to a much lower level. Once the button has been pressed, maximum output can only be regained by releasing the button for approximately 10 seconds.

This feature is designed to increase battery life.

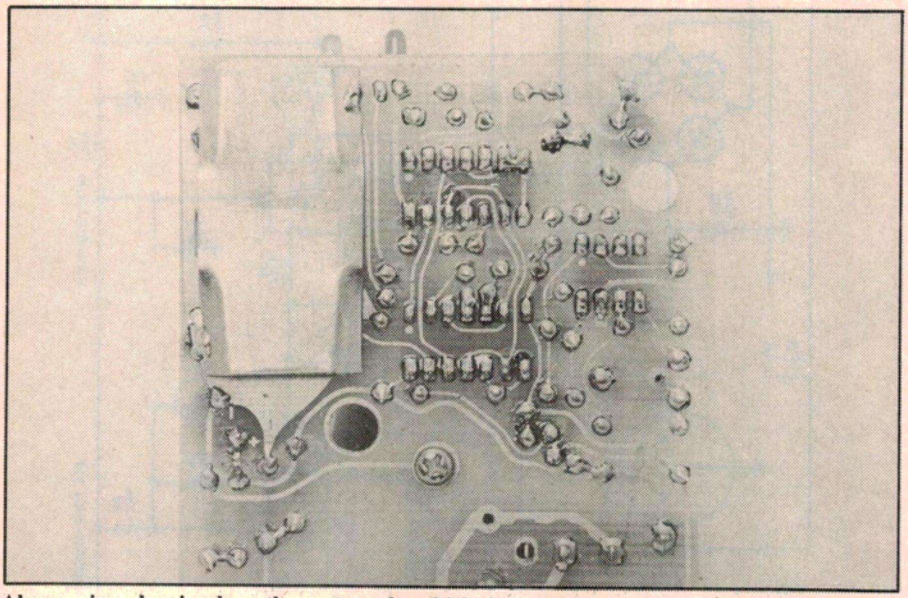
Circuit details

Let's now take a look at the circuit. We'll begin with the transmitter.

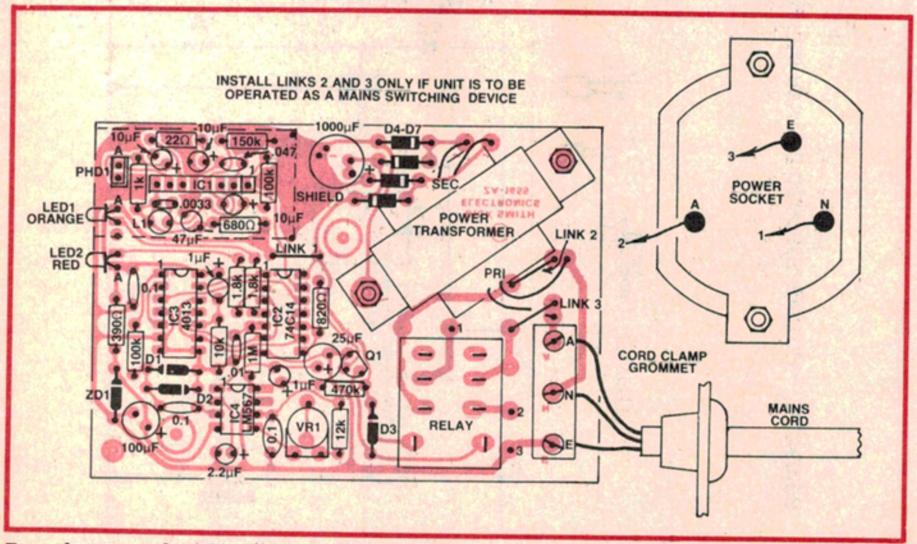
At the heart of the transmitter are two TLC555 timer ICs. These generate a 35kHz carrier signal which is pulse modulated at 1.5kHz. This is done so that the receiver can selectively decode the signal from the transmitter and re-



Above: view inside the receiver. Note metal shield over preamplifier stage at top left.



Above: view showing how the rectangular shield is mounted on the underside of the PCB.



Parts layout and wiring diagram for the receiver. See note regarding links 2 and 3.

Infrared switch

ject signals from other sources.

The TLC555 is essentially a CMOS version of the familiar 555 timer. IC1 is wired in astable mode and generates the 1.5kHz modulating frequency, as set by R1, R2, C2 and D1.

Note that D1 is forward biased during the charge cycle and reverse biased during the discharge cycle. It thus modifies the output frequency and gives a 1:3 output duty cycle, as determined by the ratio of the two timing resistors.

The output from IC1 appears at pin 3 and consists of a pulse train that is alternately high for 160μs and low for 500μs. This pulse train is used to control IC2 which is the carrier generator.

R3, R4 and C4 set the output frequency of IC2. When pin 3 of IC1 is high, IC2 is enabled and generates the 35kHz carrier signal. Conversely, when the output of IC1 is low, IC2 is disabled and its output remains high.

The resultant pulse modulated carrier signal appears at pin 3 and drives transistor output stage Q1 and two infrared LEDs (LED 2 and LED 3). At the same time, LED 1 is rapidly pulsed on and off by the carrier signal and thus appears to be continuously lit.

Resistor R7 limits the peak current through the two infrared LEDs to about 1A. While this level of current may seem excessive, the LEDs are in fact operated well within their ratings due to the low duty cycle of the carrier waveform (approx 1:15).

Power for the circuit is derived from a small 12V lighter battery and is switched to the circuit via S1 (which serves as the transmit switch). Because the battery is quite small, some form of energy management is necessary otherwise it would soon go flat. This is where C6 and R8 come in.

Initially, with S1 off, C6 charges via R8 to the full potential of the battery. Thus, when S1 is pressed, the full battery voltage is applied by C6 to Q1 and the infrared LED output stage. This scheme ensures maximum initial output from the infrared LEDs and increases the maximum range.

C6 subsequently quickly discharges via the forward-biased output stage. Resistor R8 then comes into play and limits the current through the output stage to about 2mA. The transmitter will now still operate, but over a much reduced range.

Maximum range can only be achieved again by releasing S1 for about 10s, as noted previously. This time is set by the time constant of R8 and C6, and the internal resistance of the battery.

If it were not for the above scheme, the range would either be severely limited or the battery would quickly go flat. As it stands, the battery should last for many months before requiring replacement.

Receiver

The receiver circuit can be broken up into three broad sections: an input preamplifier/detector, a PLL (phase lock loop) tone decoder, and an output latch/relay driver circuit.

The incoming infrared light is picked up by an LTR-536AB photodiode (PHD1) and applied to pin 7 of IC1. Made by NEC, this IC is a dedicated high-gain preamplifier/detector designed specifically for use in infrared remote control systems. It provides bias for the external photodiode and contains an amplifier stage, a limiter, a peak detector, and an output waveshaping buffer.

The internal amplifier stage is tuned by L1 and C3. These set the centre frequency to 35kHz to match the carrier frequency generated by the transmitter. The following detector stage extracts the 1.5kHz modulation signal from the carrier and passes it via the waveshaping buffer to the output (pin 1).

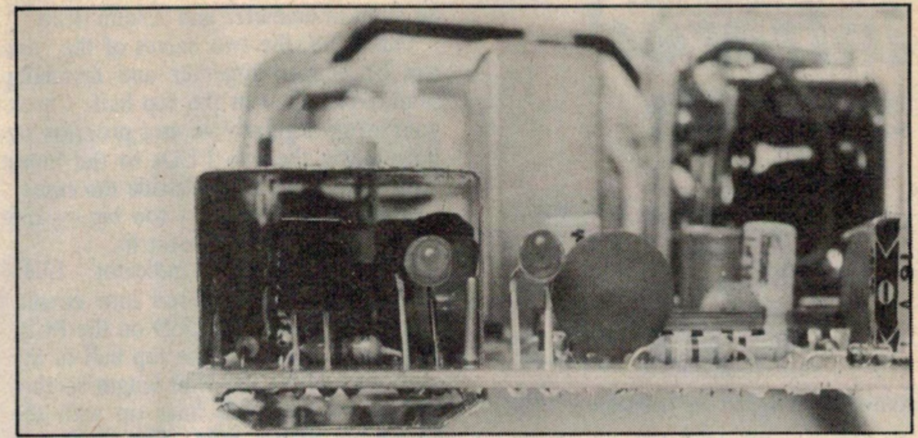
The resultant 1.5kHz signal is subsequently buffered by Schmitt trigger IC2a and applied to the clock input of IC3a, a 4013 D-type flipflop. IC3a divides by two and converts the input waveform to a 50% duty cycle.

The 750Hz output from IC3a is extracted from pin 1, clipped by diodes D1 and D2 and coupled via C8 to pin 3 of IC4, and the LM567 tone decoder IC. Inside the tone decoder is a phase lock loop. VR1, R7 and C10 set the centre frequency of the PLL to 750Hz, while C11 sets the detection bandwidth.

Whenever it receives a 750Hz signal, IC4 switches its pin 8 output low. C12, in conjunction with C13, stretches the output pulse to around 1.5 seconds, while R9, R10 and C14 provide further output filtering. IC2b and IC2c buffer the low output from IC4 and drive LED 1 (the signal received LED).

Latch circuit

IC3b forms the output latch circuit. Each time pin 6 of IC2b switches high, IC3b toggles, its Q and Q-bar outputs going alternatively high and low. The Q-bar output drives output transistor Q1 via parallel Schmitt inverter stages IC2e and IC2f.



This view shows how the metal shields, photodiode and LEDs are mounted on the receiver PCB.

When Q-bar is low, Q1 turns on and activates the output relay. At the same time, the Q output drives LED 2 via IC2d to indicate the "ON" condition. When the next pulse is received from IC2b, Q-bar goes high, Q goes low, and Q1, the relay and LED 2 switch off.

C15 and R12 provide power-on reset for IC3b. This sets Q low and Q-bar high and ensures that the relay remains off when the receiver is first powered up.

Power for the circuit is derived from a mains transformer with a 9V secondary. This drives a bridge rectifier (D4-D7) and a 1000µF filter capacitor (C16) to provide a nominal 12V rail (depending on the load). R1/C1 and R5/C6 decouple the supply rail to the photodiode and IC1, while ZD1 provides a regulated 6.8V supply for the LM567 tone decoder.

RECEIVER PARTS LIST

- 1 plastic case assembly with pre-punched panels and screened lettering
- 1 printed circuit board, code ZA-1655, 100 x 70mm
- 1 3-pin 10A mains socket (HPM55)
- 1 9V 150mA mains transformer
- 1 3-core mains cord with moulded plug
- 1 1 PC-mounting mains terminal block
- 1 12V DPDT relay, 240V 10A contacts
- 1 5mH RF choke
- 2 pre-made tinplate shields
- 4 PC stakes
- 3 75mm lengths of 24/0.2mm hookup wire (brown, blue and green)
- 2 3 x 9mm Philips-head screws
- 2 3 x 19mm Philips-head screws
- 4 3mm hex nuts
- 4 3mm washers

Semiconductors

- 1 uPC1373H preamplifier
- 1 74C14 hex Schmitt inverter
- 1 4013 dual D-type flipflop
- 1 LM567 PLL tone decoder
- 1 BC337 NPN transistor
- 4 1N4002 diodes
- 3 1N4148 diodes
- 1 6.8V 400mW zener diode
- 1 LTR-536AB (BPW50) photodiode
- 1 3mm red LED
- 1 3mm orange LED

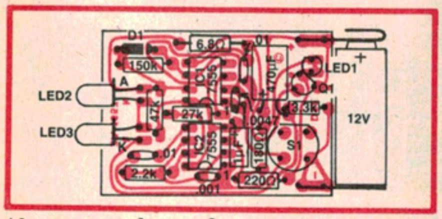
Capacitors

- 1 1000µF 16VW PC-mounting electrolytic
- 1 100µF 25VW PC-mounting electrolytic
- 1 47µF 35VW PC-mounting electrolytic
- 1 25µF 25VW PC-mounting electrolytic
- 3 10µF 25VW PC-mounting electrolytics
- 1 2.2µF 25VW PC-mounting electrolytic
- 2 1µF 50VW PC-mounting electrolytics
- 3 0.1µF ceramics
- 1 .047µF ceramic
- 1 .01µF ceramic
- 1 .003µF ceramic

Resistors (0.25W, 5%)

1 x 1MΩ, 1 x 470kΩ, 1 x 150kΩ, 2 x 100kΩ, 1 x 12kΩ, 1 x 10kΩ, 2 x 1.8kΩ, 1 x 1kΩ, 1 x 820Ω, 1 x 680Ω, 1 x 390Ω, 1 x 22Ω, 1 x 5kΩ miniature horizontal trimpot.

Infrared switch



Above: parts layout for transmitter PCB.

Construction

Construction is straightforward, with the parts accommodated on two small printed circuit boards (PCBs). The transmitter board is coded ZA-1657 and measures 32 x 45mm, while the receiver board is coded ZA-1655 and measures 100 x 70mm.

Begin construction by installing the parts on the transmitter PCB. No special procedure need be followed, but note carefully the orientation of the ICs, transistor, LEDs and electrolytic capacitors when they are being installed.

Capacitors C1 and C6 should be installed so that they lie flat against the PCB, as shown in the layout diagram. Bend their leads as appropriate before soldering them in position. Note that the flat side of the switch body faces towards R8.

The two infrared LEDs (grey) are mounted with their leads bent at right angles, 4mm from the LED bodies. The cathode (K) lead is adjacent to the flat edge on the side of each LED. The indicator LED (LED 1) should be left off the board for the time being.

The case must now be modified to accept the two infrared LEDs. To do this, position the PCB in the bottom half of the case and mark the two LED centre points. A rat-tail file can then be used to file two semi-circles in the front lip of the case. These semi-circles should each be 5mm in diameter and 2.5mm deep.

This done, the two halves of the case can be clipped together and matching semi-circles filed in the top half. Check your work regularly as you progress by introducing the two LEDs to the holes (you can do this from outside the case).

Don't make the holes too big — the LEDs should just be a neat fit.

Finally, the red indicator LED (LED 1) can be soldered into circuit. To do this, install the LED on the PCB, position the board in the top half of the case, and adjust the lead length so that the top of the LED lines up with the top of its access hole. The leads can then be soldered and trimmed.

Note that the holes for the pushbutton switch and the indicator LED are part of the original case moulding.

Construction of the transmitter can now be completed by fitting the battery (watch the polarity) and clipping the two halves of the case together.

Receiver assembly

Because IC1 (uPC1373H) in the transmitter is a high-gain stage, it must be shielded from adjacent circuit components. This takes the form of a simple U-shaped shield mounted on top of the PCB, and a rectangular shield plate mounted on the underside of the PCB.

The shield components are cut from 0.3mm-thick tinplate and are supplied ready-made with the kit. They are supported on the board by means of four PC stakes.

Begin assembly of the receiver PCB by fitting the PC stakes to the shield corner positions. After that, the various components can be installed, but leave C16 and the transformer off the board for the time being.

As before, take care with the orientation of the semiconductors and electrolytic capacitors. Pin 1 of IC1 is indicated by a bevelled edge at one end of the IC. The IC should be installed with this adjacent to R4 (100kΩ).

Note that there are three wire links on the PCB. Link 2 and Link 3 should be installed only if the unit is to be operated as a mains switching device. These links should be sleeved with spaghetti insulation.

The LTR-536AB photodiode must be stood off the PCB by 4mm. Make sure that it is correctly oriented — the cathode lead is indicated by the bevelled edge on the top of the case.

The two indicator LEDs are installed with their leads bent at right angles about 4mm from their bodies. These should be installed at full lead length. Later on, they will have to be manipulated to fit through matching holes in the front panel.

Take care when installing the two LEDs. LED 1 should be installed with its anode adjacent to PHD1, while LED 2 has its anode adjacent to C7 (0.1µF).

Once all the components have been fitted, the metal shields can be installed. These are simply solder tacked to the four PC stakes previously fitted to the board. After that, C16, the mains transformer, and the relay can all be installed.

Trim the leads of the transformer to a suitable length before soldering them to the PCB. The centre tap of the secondary is not used — it can be cut short and covered with heatshrink tubing or insulation tape.

The transformer is secured to the PCB using machine screws and nuts.

TRANSMITTER PARTS LIST

- 1 plastic case assembly
- 1 printed circuit board, code ZA-1657, 32 x 45mm
- 1 pushbutton switch (S-1200 type)
- 1 positive battery contact
- 1 negative battery contact
- 1 mini 12V battery

Semiconductors

- 2 TLC555 or 7555 CMOS timers
- 1 BC640 PNP transistor
- 1 1N4148 diode
- 1 3mm red LED
- 2 LTE-4208C (LD271) infrared LEDs

Capacitors

- 1 470µF 16W electrolytic
- 1 1µF 50W electrolytic
- 2 .01µF ceramics
- 1 .0047µF ceramic
- 1 .001µF ceramic

Resistors (0.25W, 5%)

1 x 150kΩ, 1 x 47kΩ, 1 x 27kΩ, 1 x 3.3kΩ, 1 x 2.2kΩ, 1 x 220Ω, 1 x 170Ω, 1 x 6.8Ω 1/2W

Where to buy the kit

This project was developed at the Research and Development Department at Dick Smith Electronics Pty Ltd. It can be purchased as a kit of parts, either by mail order or from your nearest Dick Smith Electronics Store.

The kit comes complete and includes fibreglass PCBs, plastic cases, pre-punched panels with screened lettering, and a construction manual. The cost is $69 plus postage and packing charges where applicable.

Mail orders should be sent to: Dick Smith Electronics Pty Ltd, PO Box 321, North Ryde, NSW 2113. Phone (02) 888 2105.

Final assembly

With the PCB assembly now completed, attention can be turned to the plastic case. This is supplied with prepunched front and rear panels.

Fit the mains socket to the rear panel and wire it to the PCB using short lengths of mains-rated hookup wire. Take care with the mains wiring — the three socket terminals are clearly labelled A, N and E (active, neutral and earth).

The mains cord enters through a cord-grip grommet on the rear panel and its leads terminate in the 3-way terminal block installed on the PCB.

Next, the red bezel can be fitted to the front panel. Cut off the rear tips of the shoulders and position them so that they meet the vertical edges of the photodiode. The two indicator LEDs can then be pushed through the front panel holes and the completed assembly installed in the case.

The PCB is designed to fit over the integral mounting bosses in one of the case halves. Note that the front half of the board will be obstructed by one of two 3mm posts. This post should be removed using a pair of sidecutters.

The top half of the case should be left off until after the adjustment procedure.

Above: the transmitter PCB fits neatly into the small plastic case.

Adjustment

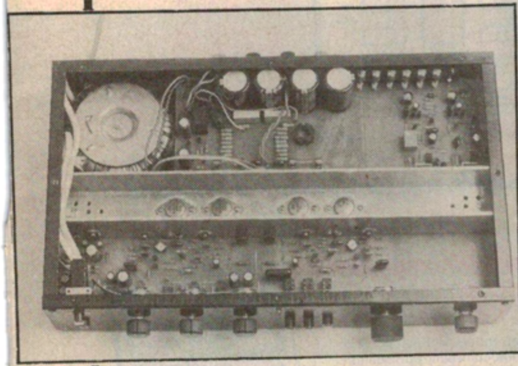
This procedure simply involves adjusting VR1 to set the centre frequency of the LM567 tone decoder.

To do this, set VR1 to mid-position, plug the receiver into the mains, and press the transmitter button. Check that the relay operates and that LED 1 lights for a brief period. If not, adjust VR1 until a response is obtained (keep the transmitter button pressed during this procedure).

VR1 can now be adjusted for maximum range. Progressively increase the distance between the transmitter and receiver (you'll need another person to help you) and adjust VR1 each time until the relay operates. Continue this process until the maximum range is obtained.

Finally, remove the centre-most boss of the top half of the case and clip the two halves of the case together. You can now plug a mains appliance into the receiver and switch it on and off to your heart's content.

Playmaster Sixty Sixty Stereo Amplifier



This is our exciting replacement for the highly successful Playmaster Twin 25 and Forty Forty stereo amplifiers. It features greatly upgraded performance, even simpler construction than the Twin 25, and 60W per channel power output.

Next month in Electronics Australia

Stereo Compressor for CD Players

Want to record CD discs for use in your car cassette player but stymied by excessive dynamic range? This easy-to-build stereo compressor is the answer. It reduces the dynamic range by about 23dB.

UHF Antenna for Channel 28

If you intend building the UHF to VHF Converter described on page 24, you'll need an antenna to go with it. This antenna has been specially designed for Channel 28 and can be built for less than $25.

Note: Although these articles have been prepared for publication, circumstances may change the final content.