

Part 2: receiver construction plus installation

Eight-channel IR remote control

Introduced last month, our Multifunction IR Remote control unit can control up to eight channels and has optional facilities for Power On/Off, Mute and Up/Dn volume. Following on from the description of the transmitter construction, we now continue with construction of the receivers.

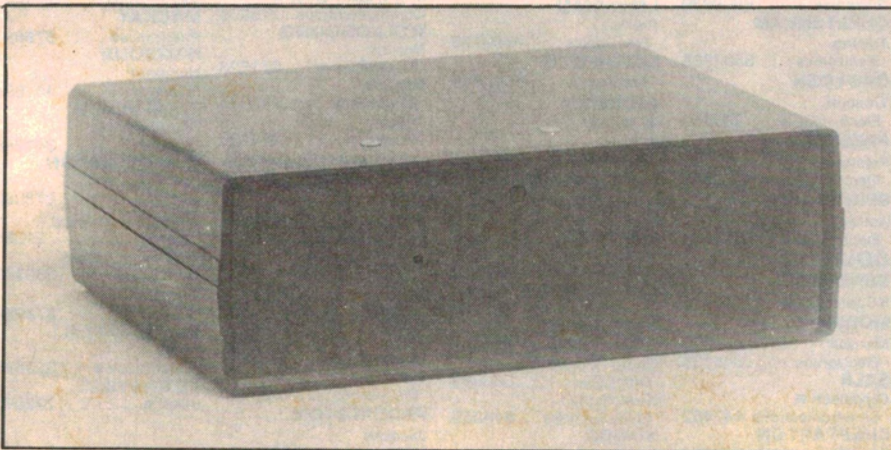
by JOHN CLARKE

There are two receivers which can be built for the infrared remote control. The first uses the full circuit and is suitable when power On/Off, Muting and Up/Dn volume control are required as well as the 8-channel selections. A simpler version of the receiver utilises only a portion of the circuit to provide for the 8-channel selections only with either momentary or latched relay contacts.

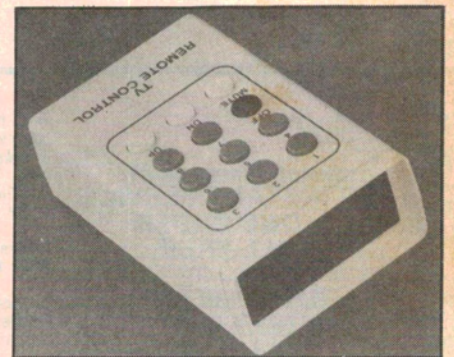
The choice of latched or momentary contacts is dependent upon the application. For adding remote control across switches of existing equipment, the choice of latched or momentary contacts

is determined by the type of switches within the equipment. For example, most CD, VCR and cassette players use momentary switches whereas most TV sets have latching switches for channel selection.

Most of the circuitry for the receiver is housed on a PCB coded 87rc5 and measuring 173 x 146mm. A separate PCB coded 87pa5 and measuring 46 x 46mm houses the amplifier for the IR receiver diode. This is contained within a tinplate shielded box to reduce the possibility of false triggering from outside interference.



A standard plastic instrument case accommodates the receiver circuitry.



The hand-held transmitter.

The 87rc5 PCB is designed to fit within a plastic instrument case measuring 200 x 160 x 70mm, with the IR amplifier 87pa5 PCB secured to the inside lid of the case. Alternatively, the entire receiver can be housed within the equipment to be controlled; eg, within a TV set.

Fully optioned version

Fig.1 shows the overlay for the fully optioned remote control receiver PCB. It provides for the full number of functions including power On/Off, Mute and Up/Down volume, as well as the eight channels.

Linking options on the PCB allow for either momentary or latched relay outputs for the eight channels. If only latched outputs are required, then IC5 and the associated 22k Ω resistor, 50k Ω trimpot and 0.027 μ F capacitor can be deleted from the PCB.

Further simplification can be made if the DC current output from IC3 can be used to directly control volume. Many TV sets utilise DC volume control and readers wishing to install the remote control in a TV should turn to the TV installation section of this article before proceeding with construction.

If there is any doubt about how the volume control operates, the LDR cir-

cuit should be used for control of the volume.

Using DC volume control removes the need for the LDR and associated parts. These include LED3, LED4, Q6, Q5, and the 39kΩ, 4.7kΩ, and 2 x 470Ω resistors. Also, the muting relay and D19 may not be necessary for many DC volume controls since the volume may be attenuated to a very low level using the DC volume control.

Of course, the full complement of relays does not have to be used. If you don't require eight channels, simply reduce the number of relays accordingly. For each relay not used, you can also delete the associated driver transistor and the diode across the coil.

Eight-channel version

Fig.2 shows the overlay diagram for the 8-channel version of the receiver. As with the more elaborate version, this has the option of either momentary or latched outputs. You should use the ML926 for IC5 when momentary contacts are required and the ML928 for IC5 when latched contacts are required.

We built this version using four relays with the latching ML928. Note that the relay order changes when the ML928 is used compared to the ML926. The ML926 relay numbering is as shown on

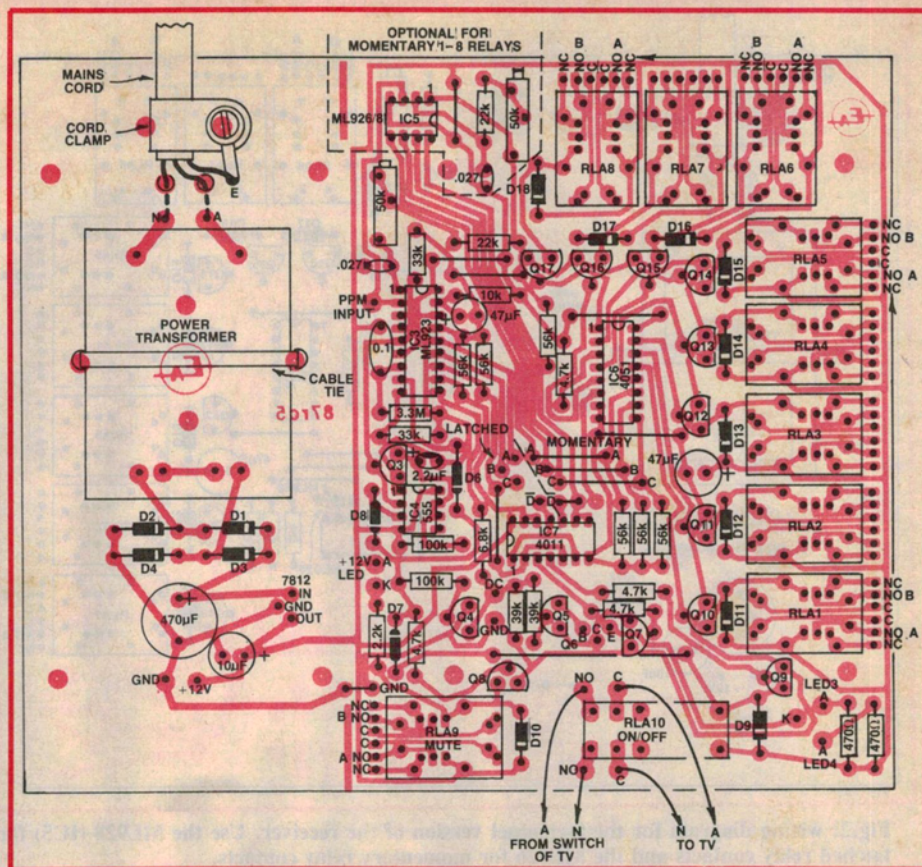
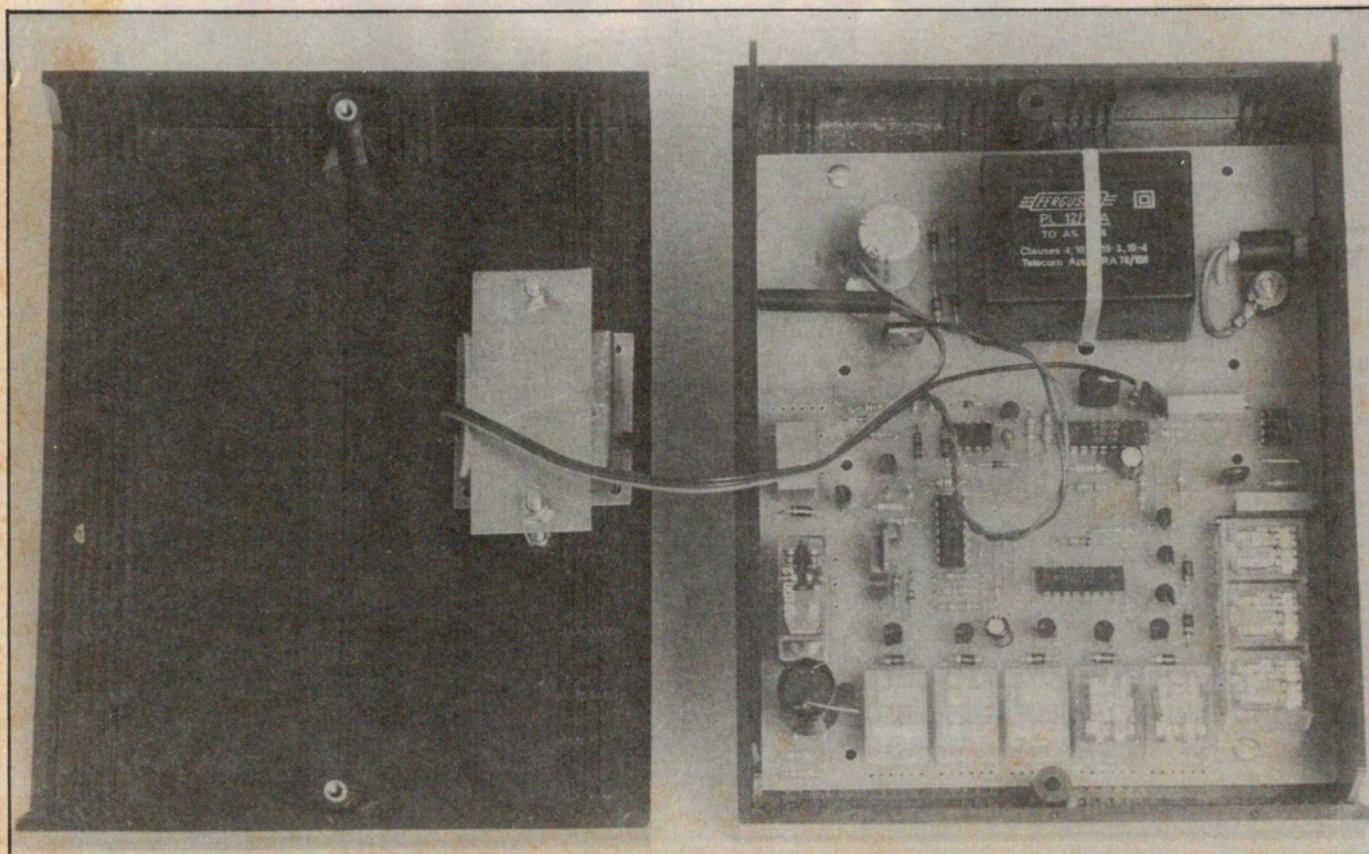


Fig.1: wiring diagram for the fully optioned version. Note the linking options for either momentary or latched relay contacts.



View inside the fully optioned version. The input amplifier fits into a metal shield and is mounted on the lid of the case.

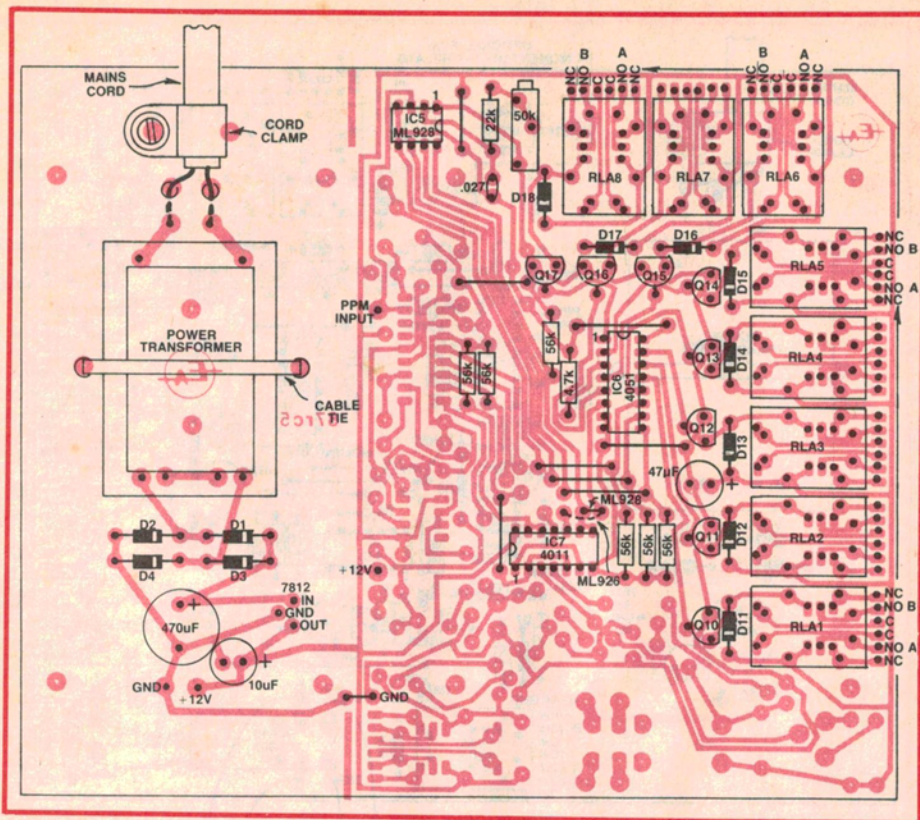


Fig.2: wiring diagram for the 8-channel version of the receiver. Use the ML928 (IC5) for latched relay contacts and the ML926 for momentary relay contacts.

the overlay diagram while numbering when using the ML928 is 6, 5, 7, 8, 2, 1, 3, 4.

Relays

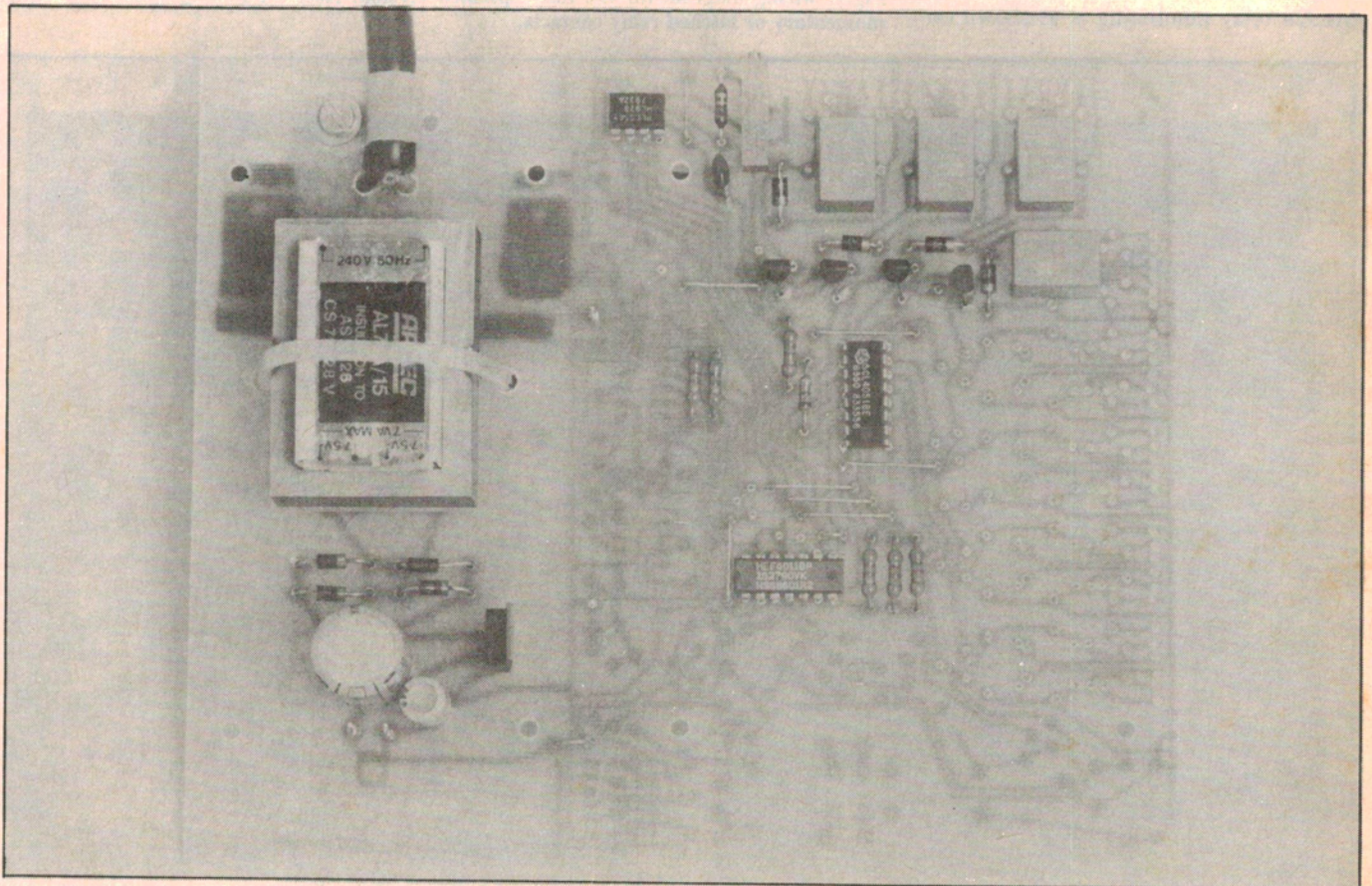
The PCB is designed to accept two different relay types for the 1 to 8 channel selections and for the Mute relay. These are the DPDT Original OUB12V (available from Hi-Com Unitronics, 7 President Lane, Caringbah, NSW 2229), and the Kamling KL2P DPDT relay (available from Altronics and Jaycar, Cat. S-4061).

PCB construction

The 87rc5 PCB can be used as a single PCB incorporating the power supply or, alternatively, the PCB can be separated by cutting between the power supply and receiver/decoder sections. The separated PCBs can then be wired together by joining their +12V terminals and by joining their ground terminals.

Construction of the PCB can begin by installing the links. Note that the A, B, C and D or D-bar links near IC7 are dependent on the type of IC used for IC5 and whether the A, B and C outputs of IC5 or IC3 are decoded by IC6.

Fig.1 shows the required linking for latched or momentary connections on



This unit has relays installed on four outputs only and uses the ML928 for latched contacts. Note relay locations (see text).

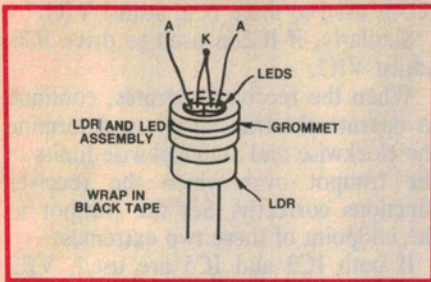


Fig.3: the LDR and LED assembly.

the full-featured version, while Fig.2 shows the link required when either the ML926 or ML928 is used.

We used PC stakes to terminate external connections on the PCB, the only exceptions being the relay outputs and mains wiring points.

The next step is to install the resistors, diodes and ICs. Be careful with the orientation of the ICs and diodes — these must be oriented as shown on the overlay. Note that diodes D6, D7 and D8 are 1N914 or 1N4148 small signal diodes whereas the remaining diodes are all 1N4002 types.

The transistors, 3-terminal regulator and capacitors can all now be installed. Make sure that the electrolytic capacitors and transistors are oriented as shown on the overlay diagram.

The relays can also be installed and soldered in position at this stage. Remember that the sequence of the 1 to 8 channel relays when the ML928 is used is 6, 5, 7, 8, 2, 1, 3, 4. This means that if fewer than 8 relays are used, you should follow this sequence for relay installation.

Construction of the LDR and LED assembly is shown in Fig.3. The two 3mm diameter LEDs are held within the rubber grommet and the assembly is wrapped in insulation tape to exclude any external light. The cathode (K) leads of the two LEDs are soldered together, while the anode leads are soldered to two PC stakes situated in the lower right hand corner of the PCB.

As shown in the photographs, the transformer should be secured using a cable tie. This passes around the transformer and through two holes in the

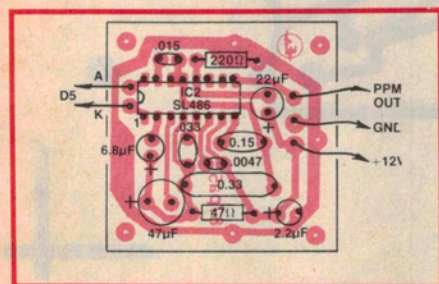
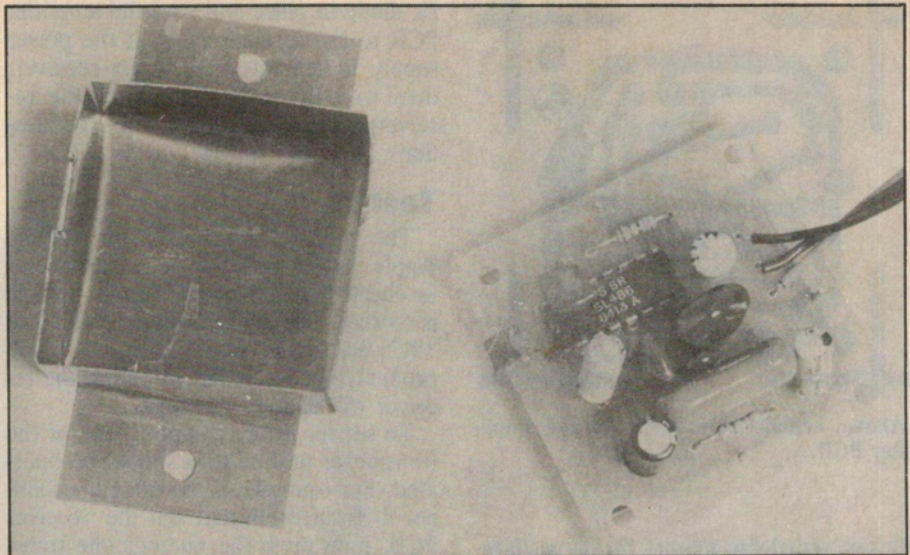


Fig.4: parts layout for the amplifier PCB.



Above: the metal shield is soldered to three PC stakes on the amplifier PCB (right).

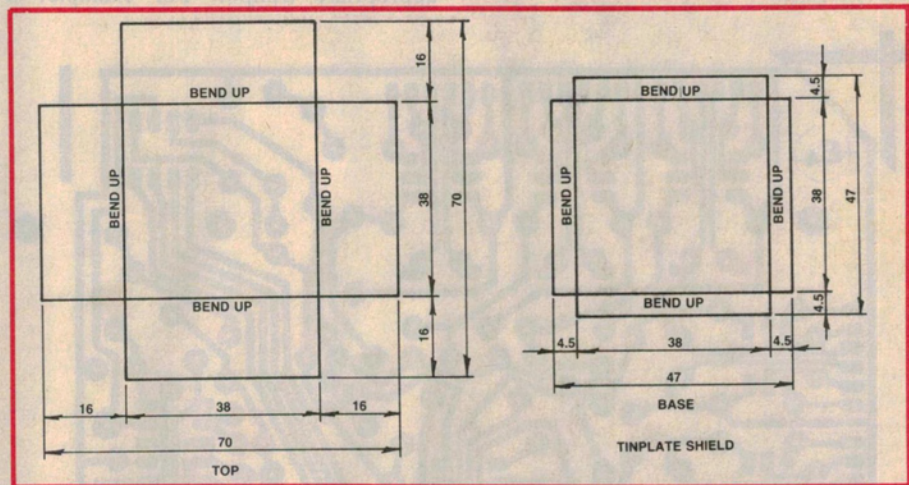


Fig.5: how to make the metal shield. The section at left goes over the top of the amplifier PCB while the section at right is fitted to the copper side.

PCB. This precaution provides additional safety as the transformer would otherwise only be supported by its mounting pins.

The mains cord is secured to the PCB using a cable clamp and the wires pass through holes in the PCB and solder to the mains input of the transformer on the underside of the PCB.

It is important to insulate the underside of the PCB where the mains wiring enters the transformer using a piece of stiff insulating material bolted to the underside of the PCB. This will prevent any accidental contact with the mains. Several mounting holes are provided for this purpose.

Amplifier board

Work can now begin on the 87pa5 amplifier PCB (Fig.4). Install IC2 and the two resistors first, making sure that IC2 is oriented correctly. The nine capacitors can then be installed, with the

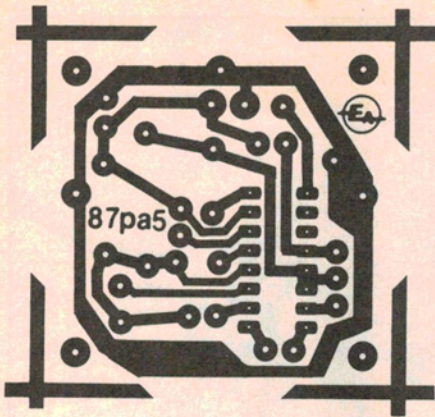
electrolytics oriented as shown on the diagram.

PC stakes can be used to terminate the +12V, ground, PPM and IR diode connections. They should also be installed at the three perimeter locations on the PCB earth track to facilitate soldering the tin plate shields into position. Do not solder the IR diode in position yet.

Fig.5 shows the dimensions of the tinplate shield for the amplifier 87pa5 PCB. Cut and fold this shield as shown and check that the base and top pieces fit correctly over the three PC stakes on the board. Adjust the sides as necessary but do not solder the shield to the PC stakes until after testing.

You will also have to mark and drill exit holes in the top shield side panels for the ground, +12V, PPM and IR diode connections.

Once construction of the shield has been completed, temporarily solder the



Above: actual size artwork for the amplifier PCB.

Below: actual size artwork for the main receiver PCB. The same artwork is used for both versions.

IR diode in place and wire the amplifier PCB to the receiver PCB. If the power supply is separated from the receiver, then wire the power supply to the receiver at the Ground and +12V connections.

Testing

The unit is now ready for testing. Apply power and use your multimeter to check that the power supply voltage is correct. The 50kΩ trim pots (VR1 and VR2) associated with IC3 and IC5 will probably need adjustment before the receiver will operate correctly.

To set the 50kΩ trim pots, one of the transmitter pushbuttons should be operated. For example, if the relay for channel 1 is incorporated on the receiver PCB, then press the number one transmitter pushbutton while adjusting the appropriate trimpot. For example, if

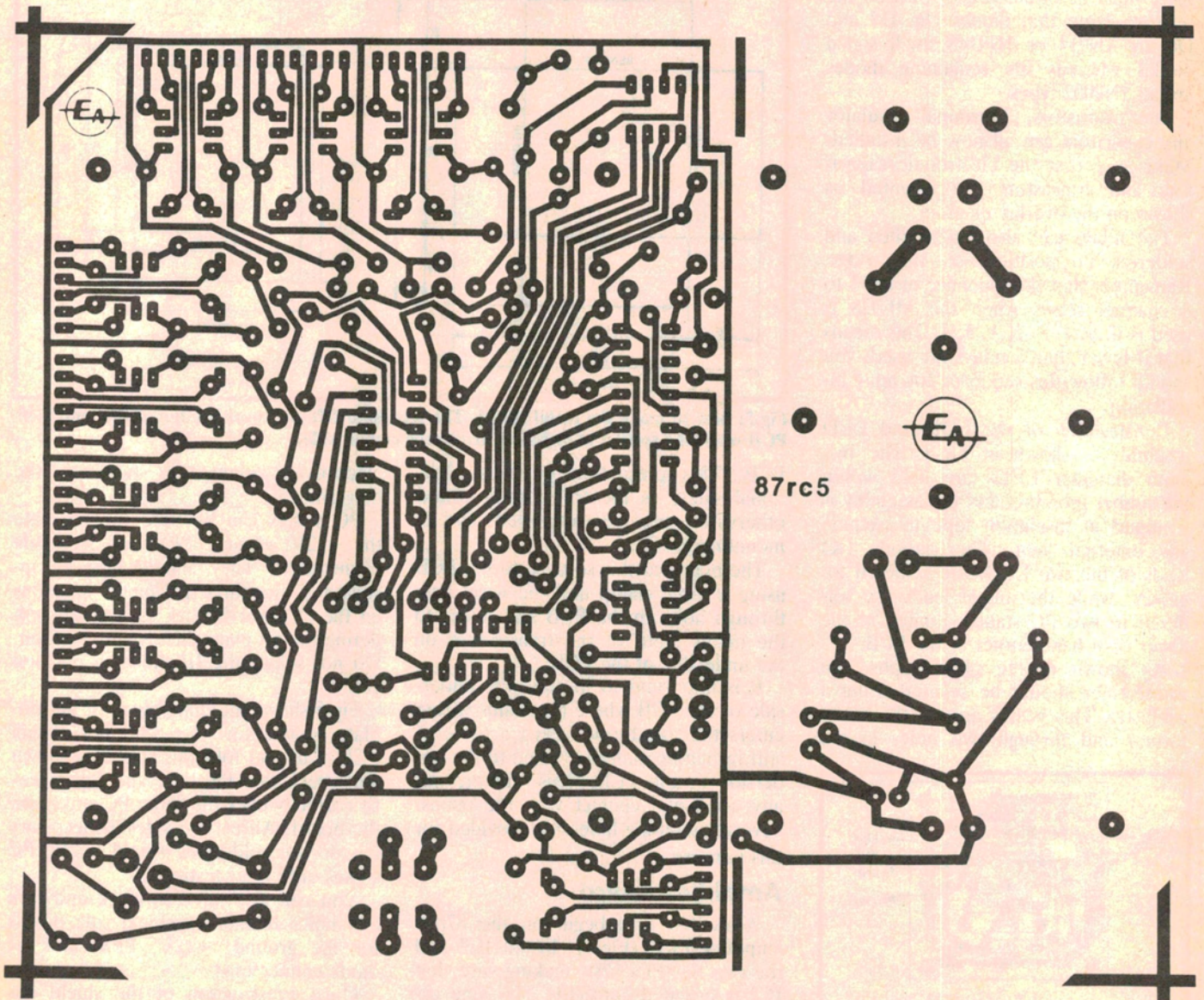
IC5 is used to drive IC6, adjust VR1.

Similarly, if IC3 is used to drive IC6, adjust VR2.

When the receiver operates, continue to operate the transmitter to determine the clockwise and anticlockwise limits of the trimpot over which the receiver functions correctly. Set the trimpot to the midpoint of these two extremes.

If both IC3 and IC5 are used, VR2 should be set using the Mute output for testing. You can either monitor the pin 8 output using a meter or, if the mute relay is installed, listen for its operation. The Mute operates in a flipflop fashion so that, on the first pressing of the transmitter switch, the relay switches on and pin 8 goes high. On the second pressing, the relay turns off and pin 8 goes low.

As before, find the limits of the trimpot over which the receiver operates



correctly and set the trimpot to mid setting.

The remaining functions can now be tested. The 1-8 channel relays should switch on when they are selected by the transmitter and be off otherwise.

To check operation of the volume control, connect a multimeter set to measure ohms across the LDR. Now press the up and down volume buttons and observe the change in resistance of the LDR. It should change from about 470Ω on Mute to over 1MΩ at the maximum volume setting.

If the LDR section of the circuit is not used, the current output from IC3 can be checked by measuring the voltage across the 39kΩ resistor at the collector of Q4. The voltage here should range from 0V when muted to about 9.5V at maximum volume setting. At initial power up, this voltage should be about 8.6V.

The Mute relay should switch on and off alternately with each pressing of the Mute control. It should also switch on briefly each time a channel selection is

made and be on while the Dn volume is at its minimum setting. Muting should also occur on power off (ie, when the power relay switches off).

Power relay RLA9 should switch on again after selection of one of the eight channels.

Installation

Installation of the 1-8 channel only remote control into an item of equipment is straightforward. Simply connect the relay contacts for each channel across existing switches in the equipment.

A circuit diagram for the equipment will enable you to check the connections required for the switch contacts. In some cases, the switches may be double pole types or even use the changeover facility of the switch. This can be duplicated with the DPDT relay contacts.

Note that the relays are not mains rated and cannot be used to directly control mains voltages. You can, however, use them to drive separate mains rated relays.

Where possible, you can install the receiver PCB in the equipment to be controlled. Alternatively, the PCB can be installed in a plastic instrument case measuring 200 x 160 x 70mm (W x H x D).

The accompanying photographs show the full complement circuit board secured to the base of the case using self tapping screws. The IR amplifier PCB is enclosed in the metal shield and mounted towards the front of the lid using suitable brackets.

A hole in the front panel exposes the IR diode which is connected to the amplifier PCB using short leads. Drill a hole in the rear panel for the mains cord and grommet and for the relay contact wires. We opted to include the muting LED on the front panel for the full function version.

TV installation

Connection to a TV set is a little more complex. As well as making connections to the channel pushbutton switches, you also have to wire in the

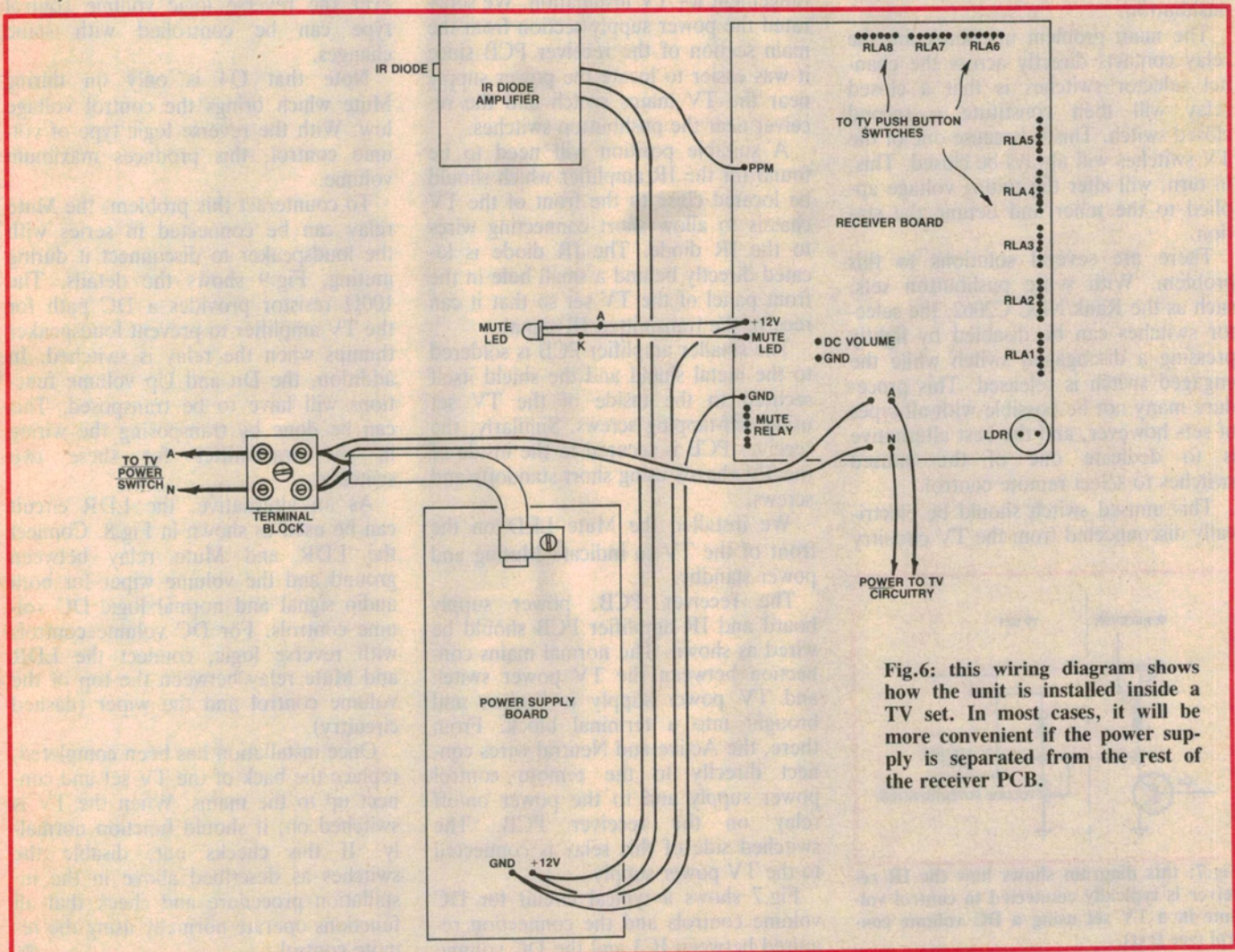


Fig.6: this wiring diagram shows how the unit is installed inside a TV set. In most cases, it will be more convenient if the power supply is separated from the rest of the receiver PCB.

muting, volume and power on/off connections.

Note that the unit can only be connected to pushbutton TV sets. Those with a rotary turret are unsuitable for remote control modification since the switch constitutes part of the tuner.

Adding remote control does not affect normal operation of the TV set. When the set is first switched on via the TV power switch, the power relay is energised, the volume is set to 66% of the normal volume and the 8-channel relays are off. This allows the TV pushbuttons to operate as normal.

Before commencing installation, make sure that you unplug the TV set from the power point. This is to prevent accidental contact with the mains.

Refer to your TV set's schematic diagram for the connections necessary to the pushbutton switches. Many TV sets have eight or more pushbuttons, although it is not necessary to provide remote control for all of these. Some TV sets may also require connection to an indicating LED located beside each pushbutton.

The main problem in connecting the relay contacts directly across the channel selector switches is that a closed relay will then constitute a second closed switch. This is because one of the TV switches will always be closed. This, in turn, will alter the tuning voltage applied to the tuner and detune the station.

There are several solutions to this problem. With some pushbutton sets, such as the Rank/NEC C2062, the selector switches can be disabled by lightly pressing a disengaged switch while the engaged switch is released. This procedure may not be possible with all types of sets however, and the best alternative is to dedicate one of the unused switches to select remote control.

This unused switch should be electrically disconnected from the TV circuitry

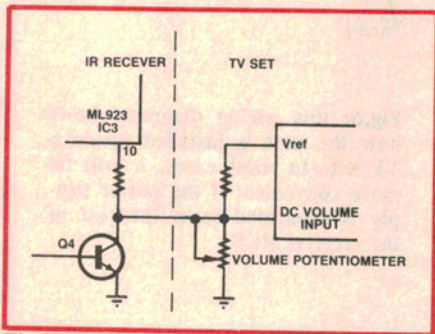


Fig. 7: this diagram shows how the IR receiver is typically connected to control volume in a TV set using a DC volume control (see text).

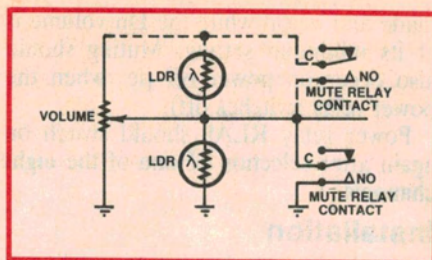


Fig. 8: alternative circuit for controlling volume. The dotted circuitry is for reverse logic DC controls.

by cutting the PCB tracks to it, or by disconnecting any wire leads. After that, it's simply a matter of pressing this switch (to disable the others) whenever you wish to use the remote control.

The remaining switches can then still be used for normal operation but note that it will necessary to reset the remote control circuit by turning the TV set off and on again.

Once the switching arrangement has been sorted out, the remote control receiver is ready to be installed within the TV set. Fig. 6 shows the general arrangement for TV installation. We separated the power supply section from the main section of the receiver PCB since it was easier to locate the power supply near the TV mains switch and the receiver near the pushbutton switches.

A suitable position will need to be found for the IR amplifier which should be located close to the front of the TV chassis to allow short connecting wires to the IR diode. The IR diode is located directly behind a small hole in the front panel of the TV set so that it can receive the transmitted IR signal.

The smaller amplifier PCB is soldered to the metal shield and the shield itself secured to the inside of the TV set using self-tapping screws. Similarly, the receiver PCB is secured to the inside of the TV chassis using short standoffs and screws.

We installed the Mute LED on the front of the TV to indicate Muting and power standby.

The receiver PCB, power supply board and IR amplifier PCB should be wired as shown. The normal mains connection between the TV power switch and TV power supply is broken and brought into a terminal block. From there, the Active and Neutral wires connect directly to the remote control power supply and to the power on/off relay on the receiver PCB. The switched side of this relay is connected to the TV power supply.

Fig. 7 shows a typical circuit for DC volume controls and the connection required between IC3 and the DC volume

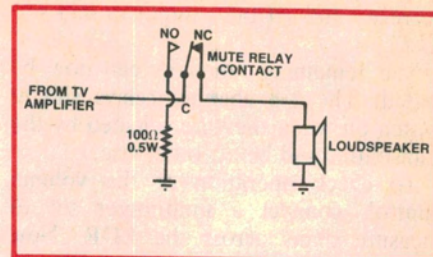


Fig. 9: this alternative muting circuit should be used when Fig. 7 is used with reverse logic DC controls.

control within the TV set. The Vref input is usually about 6V and the DC input is varied using the volume potentiometer. The current source from pin 10 of IC3 forces current through the volume potentiometer so that the voltage at the DC input can be varied remotely.

Some DC controls operate such that low voltage gives high volume and high voltage, low volume (reverse logic). Others operate with low volume on low voltage and high volume on high voltage (normal logic). The output circuit of IC3 is intended for the later case, however the reverse logic volume control type can be controlled with some changes.

Note that Q4 is only on during Mute which brings the control voltage low. With the reverse logic type of volume control, this produces maximum volume.

To counteract this problem, the Mute relay can be connected in series with the loudspeaker to disconnect it during muting. Fig. 9 shows the details. The 100Ω resistor provides a DC path for the TV amplifier to prevent loudspeaker thumps when the relay is switched. In addition, the Dn and Up volume functions will have to be transposed. This can be done by transposing the wiring in the transmitter for these two switches.

As an alternative, the LDR circuit can be used as shown in Fig. 8. Connect the LDR and Mute relay between ground and the volume wiper for both audio signal and normal logic DC volume controls. For DC volume controls with reverse logic, connect the LDR and Mute relay between the top of the volume control and the wiper (dashed circuitry).

Once installation has been completed, replace the back of the TV set and connect up to the mains. When the TV is switched on, it should function normally. If this checks out, disable the switches as described above in the installation procedure and check that all functions operate normally using the remote control.