

Remote control for the Playmaster tuner

For the final touch of luxury on your Playmaster Stereo AM/FM Tuner you need the Infrared Remote Control. With this you can sit back and select any of the 12 programmed stations at will or tune to any FM or AM station with the up and down tuning buttons.

Are you an impatient radio listener, dodging from one station to another trying to find the music to suit your mood? Are you a lazy listener, not wanting to shift from your chair when the station you have selected started putting out the wrong notes? If so, you

need this remote control accessory if you are to obtain full enjoyment from the Playmaster stereo AM/FM tuner.

You can be far more selective with the remote control. If a particular piece of music or advertisement is not to your liking, then you can zap onto another

station with a flick of your button-pushing digit. S'wonderful, S'marvellous!

Although the remote control does not mimic all the control functions available on the tuner, it does allow remote tuning to any station. There are two ways to do this.

Firstly, each of the six AM and six FM stations in memory can be selected. This is done using the six memory switches in conjunction with the AM/FM switch on the remote control. Secondly, to access unprogrammed AM or FM stations, use the Tune up or Tune down switches.

The functions not available on the remote control are Seek, Mono, ME (memory enable) and Power on/off.

The remote control transmitter unit consists of a small plastic case incorporating nine pushbutton switches. Two infrared (IR) transmitting diodes located behind a small red window at the front of the case emit coded infrared light. Power for the unit is supplied from a small nine volt battery.

The remote control receiver circuitry is part of the main printed circuit board for the tuner. For receiving the IR transmission an IR detector diode is located directly behind the neutral density plastic screen used for the tuner display.

The transmit and receive circuitry is based on the Plessey range of remote control ICs. There is one transmitter and one preamplifier IC in this range, and ten different receiver ICs. These are suitable for TV remote control, models, computers and other general applications.

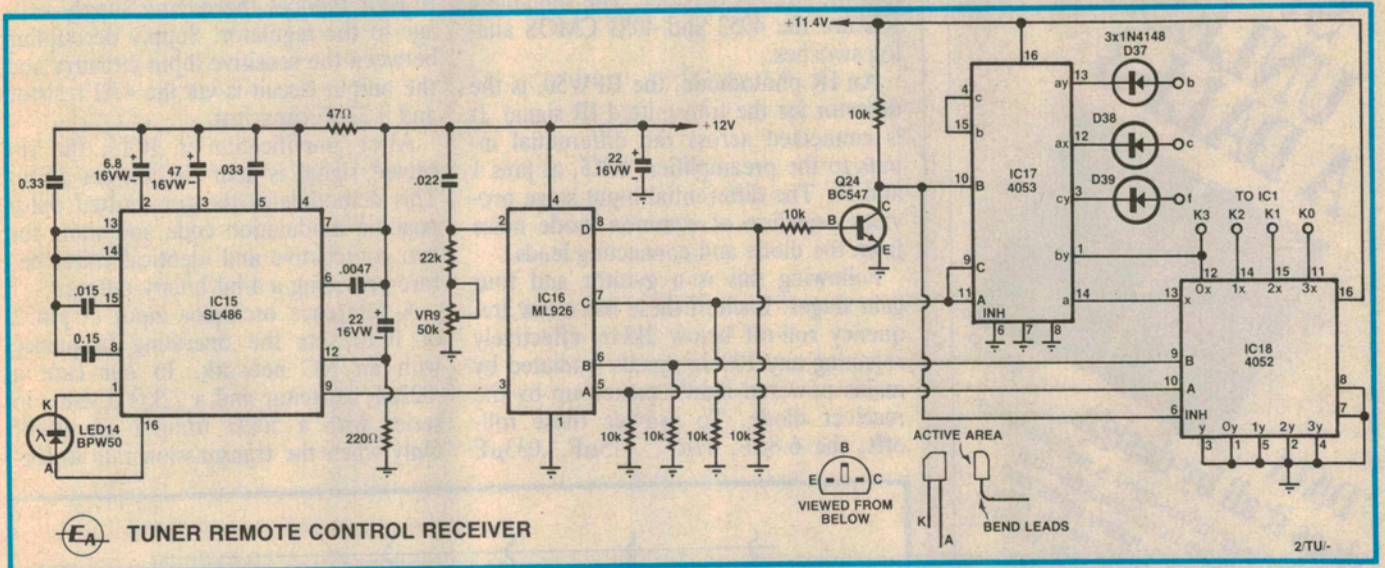
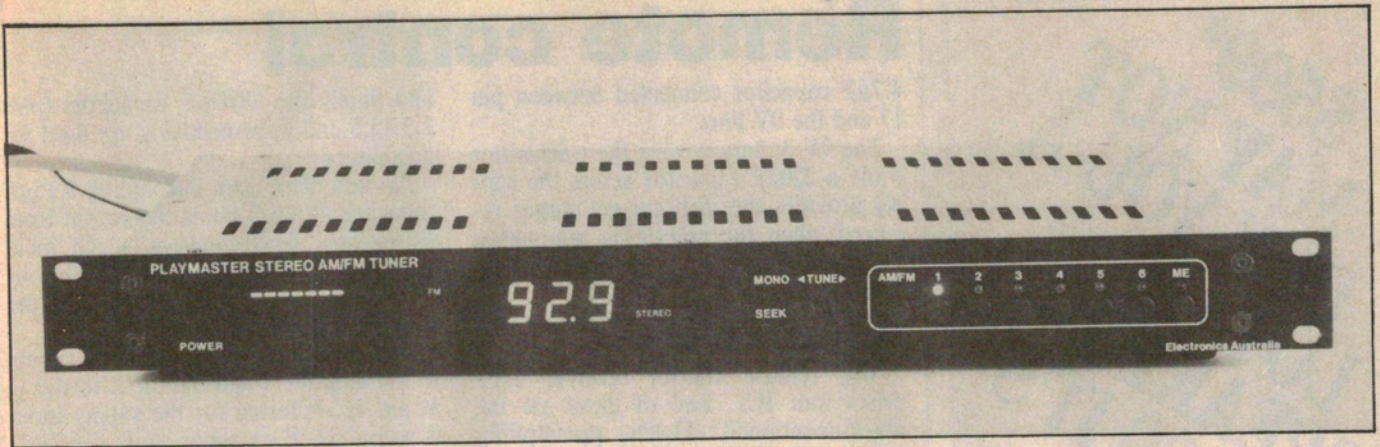
We used the SL490B transmitter, SL486 preamplifier and the ML926 receiver.

Transmitter circuitry

The transmitter circuit comprises the SL490B, IC14, two transistors and two IR LEDs plus a few capacitors and resistors. The IR LEDs transmit a pulse position modulation (PPM) 5-bit code whenever one of the switches is pressed.

by JOHN CLARKE





The remote control receiver circuit is based on the Plessey SL486 and ML926 preamplifier and decoder ICs.

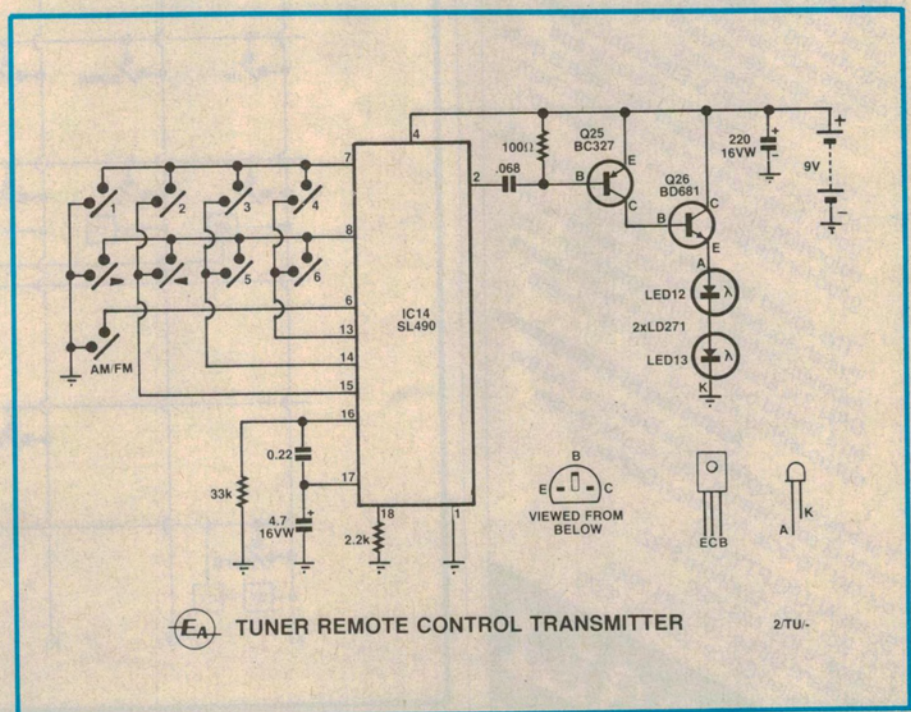
Up to 32 separate code commands are available with the SL490B. This is possible with 32 switches in an 8-row by 4-column switch matrix. Our remote control needs less than this and uses nine switches in a 4-column by 3-row matrix.

Switches for memories 1,2,3 and 4 have transmit codes from 01000 to 01011. The tune down, tune up and memories 5 and 6 have transmit codes from 01100 to 01111 and finally, the AM/FM switch sets transmission of 00100.

Transmit code output is at pin 2 of IC14. It is AC-coupled via the $.068\mu\text{F}$ capacitor to the base of transistor Q25 which produces a $15\mu\text{s}$ current pulse, each time pin 2 goes low. Thus Q26, which is driven by Q25, directly drives two IR LEDs with these very short current pulses.

The pulse position modulation frequency of transmission is set by the $33\text{k}\Omega$ resistor and $0.22\mu\text{F}$ capacitor.

Filtering for the internal 4.5V regulator of the SL490B is provided by the



The transmitter uses a Plessey SL490 IC to pulse code modulate two infrared LEDs.

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Remote control

4.7 μ F capacitor connected between pin 17 and the 0V line.

The 9V battery powers the transmitter while a 220 μ F capacitor across the supply provides the high current surges required when the IR LEDs are pulsed on. Standby current of the circuit is less than 10 μ A.

Receiver circuitry

The remote control receiver comprises four ICs. Two of these are the above-mentioned SL486 preamplifier and the ML926 decoder. The remaining ICs are the 4052 and 4053 CMOS analog switches.

An IR photodiode, the BPW50, is the detector for the transmitted IR signal. It is connected across the differential inputs to the preamplifier, IC15, at pins 1 and 16. The differential input stage provides rejection of common mode noise from the diode and connecting leads.

Following this is a gyrator and four gain stages. Each of these has a low frequency roll-off below 2kHz, effectively rejecting any 100Hz signals (radiated by mains powered lights) picked up by the receiver diode. To provide these roll-offs, the 6.8 μ F, 47 μ F, .015 μ F, .033 μ F

and finally the .0047 μ F capacitors (pins 2,3,15,5 and 6) respectively are used for decoupling.

An automatic gain decoupling 0.15 μ F capacitor at pin 8 filters the output from an internal peak detector which measures the final output at pin 9. The resulting signal controls the gain of the first three amplifier stages.

An internal regulator stabilises supply to the amplifiers and the input to this is at pin 12. Filtering for the supply input is with a 22 μ F capacitor while the 220 Ω resistor reduces the overall supply voltage to the regulator. Supply decoupling between the sensitive input circuitry and the output circuit is via the 47 Ω resistor and 0.33 μ F capacitor.

After amplification in IC15, the received signal is sent to decoder IC16. This demodulates the transmitted pulse position modulation code and waits for two consecutive and identical codes before providing a 4-bit binary output.

A reference oscillator input at pin 2 of IC16 sets the operating frequency with an RC network. In our case a .022 μ F capacitor and a 22k Ω resistor in series with a 50k Ω trimpot are used. Only when the transmission rate is cor-

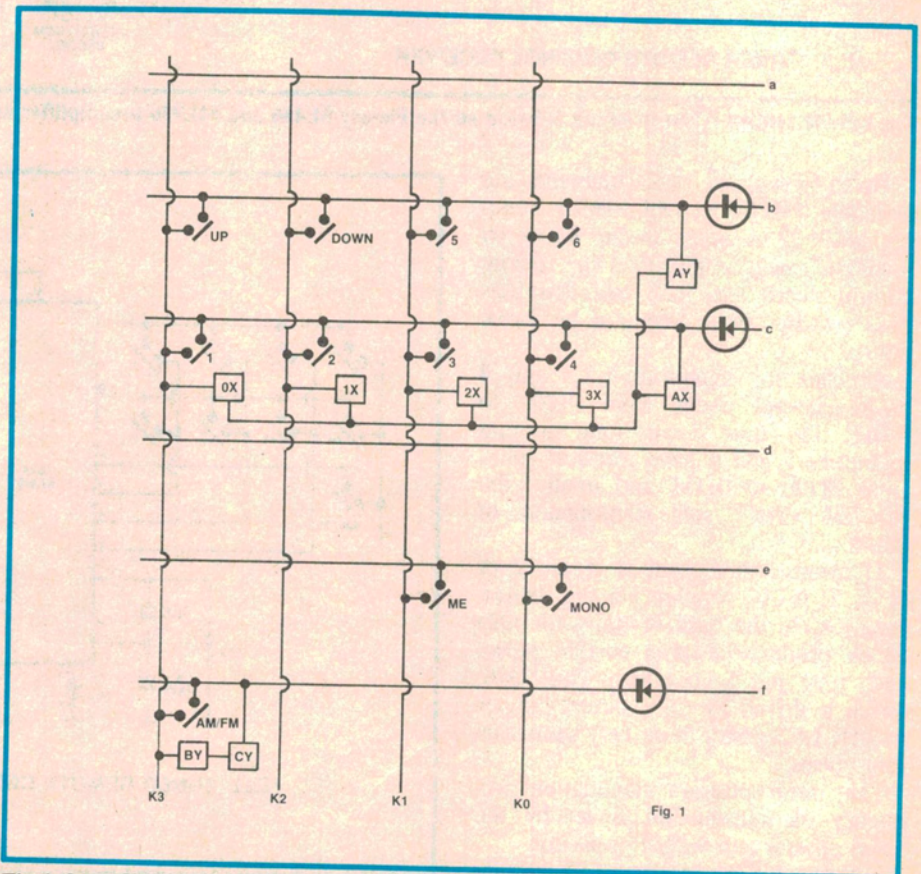
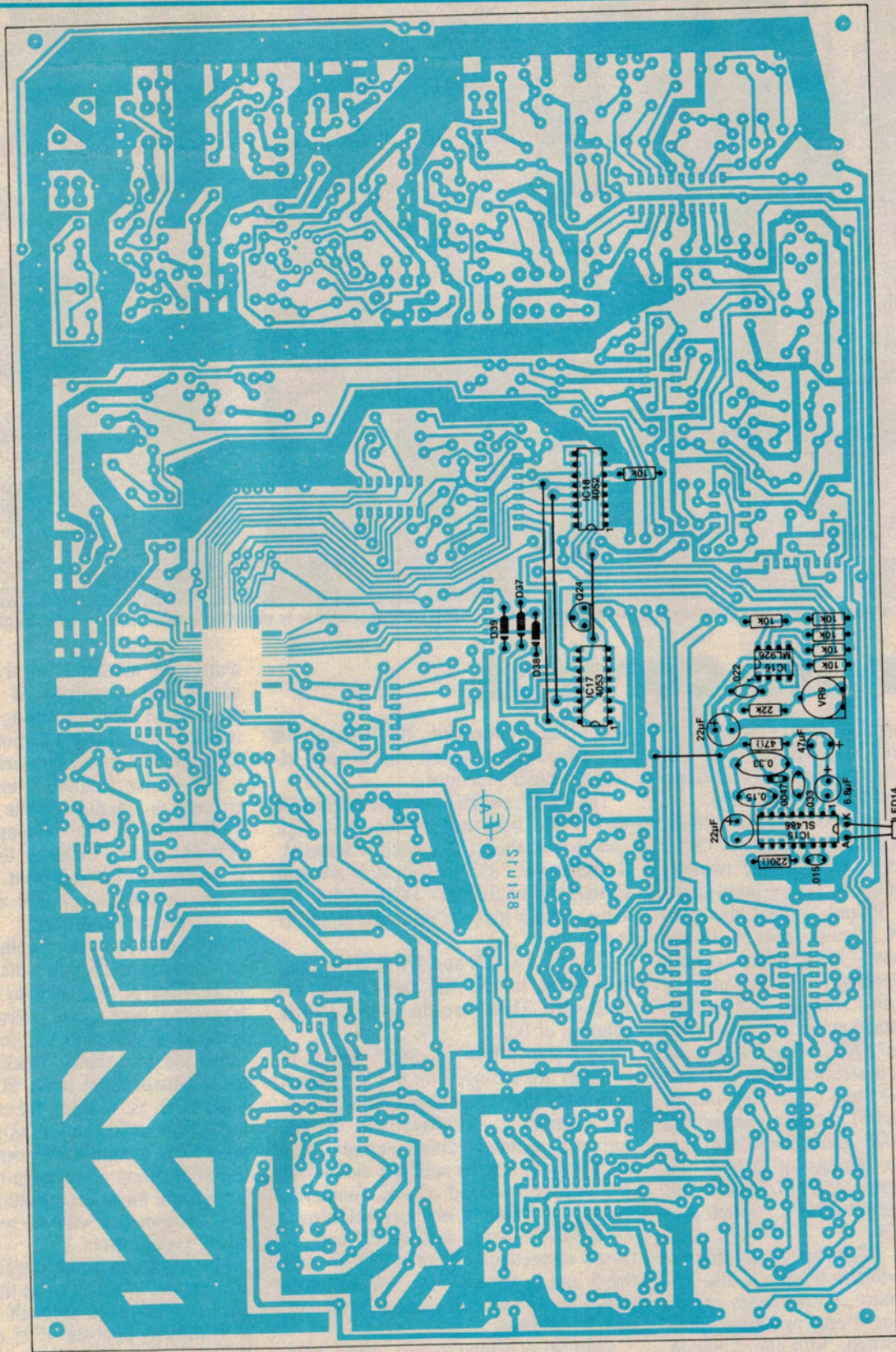


Fig.1: how the IC17 and IC18 CMOS switches are arranged on the IC1 switch matrix.



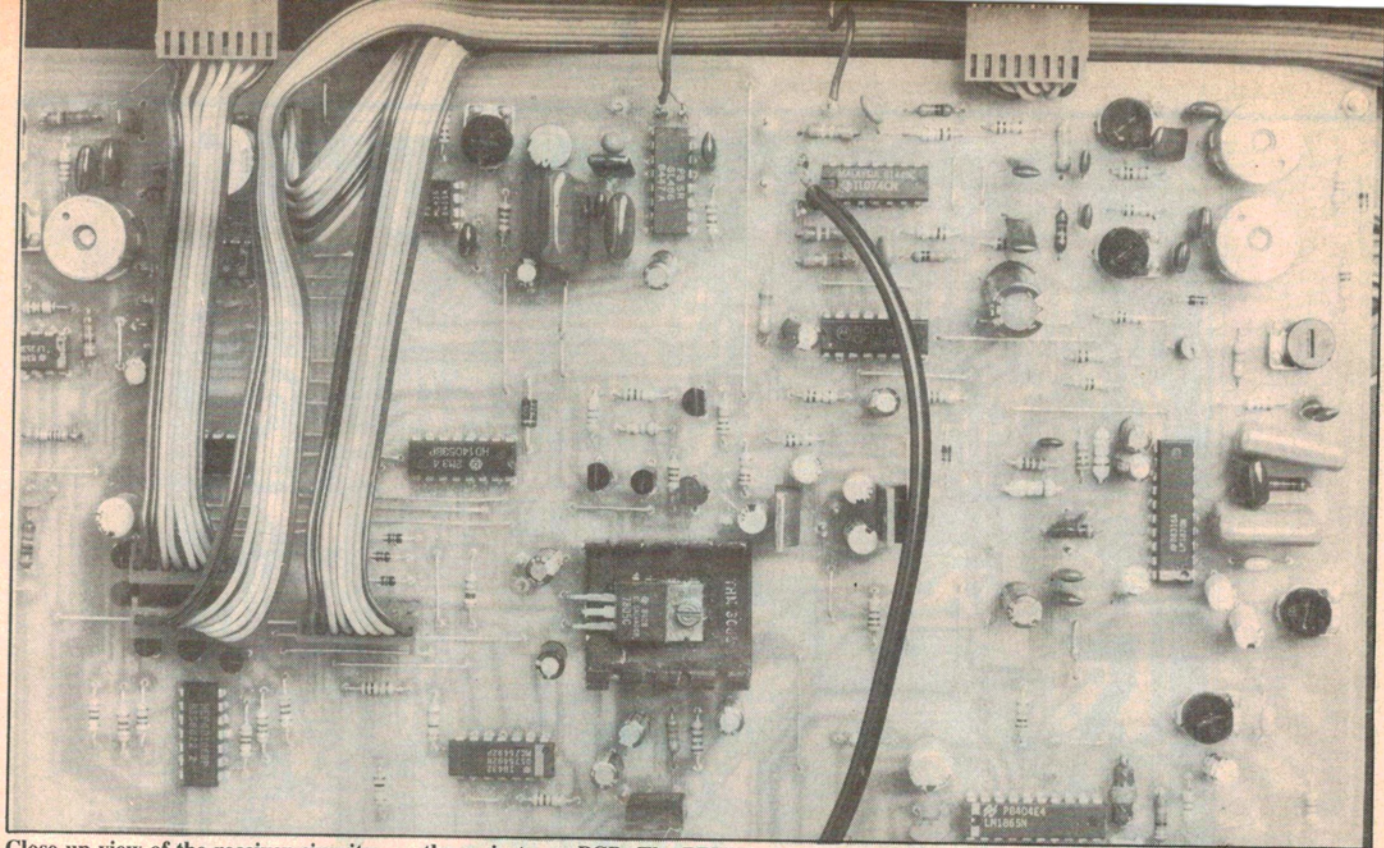
The receiver circuitry is accommodated on the main tuner PCB.

rect will IC16 provide a decoded output from the received signal.

Outputs at A,B,C and D are normally pulled low with 10kΩ resistors. When a

correct code is received, outputs will go high. Note that the ML926 is designed only to receive 5-bit transmitter codes that have the most significant bit low,

ie. it really only decodes 4-bit signals. (Another version of this IC is the Plessey ML927. This type responds to codes with the most significant bit high.)



Close-up view of the receiver circuitry on the main tuner PCB. The BPW50 photodiode is mounted behind the perspex front panel.

Remote control

The most significant (D) output from IC16 is inverted by transistor Q24. This D-complement plus the A, B and C signals are applied to IC17 and IC18.

These two ICs are CMOS binary decoders with analog switches. IC17 can be considered as a three-pole two-way switch responding to binary input codes fed to pins 9, 10 and 11. The binary inputs are the A, B and C pins (9, 10 and 11) which have independent control over their respective "a", "b" and "c" switch poles. For example, when A is high, the Y position of the "a" switch pole is selected (AY). When A is low, the X position is selected (AX).

The AX, AY and CY switch output (pins 12, 13 and 3) positions connect via diodes D37, D38 and D39 to the b, c and f segment outputs of IC1 in the Playmaster stereo AM/FM tuner. The BY pole connects to the K3 switch matrix input of IC1.

For its part, IC18 can be considered as a two-pole four-way switch also responding to binary control codes except that we are using it only as a single-pole four-position switch, with the common (wiper) being pin 13.

Note that the INhibit input at pin 6 is normally held high by virtue of the inversion of the D output from IC16. When pin 6 is low, IC18 is selected. This means that when no signal codes

are being transmitted, IC17 and IC18 are effectively disabled and do not affect the tuner functions.

The "0X" switch is selected when A and B are both low. When A is high and B low, the "1X" switch is selected. To select the "2X" switch, A is low and B high and finally the "3X" switch is selected with a high on both the A and B inputs.

The 0X, 1X, 2X and 3X switches connect to the K3, K2, K1 and K0 lines respectively. These are the switch matrix columns of IC1.

Fig.1 shows how the IC17 and IC18 switches are arranged on the IC1 switch matrix on the main tuner board. To select memory 1, we close both the 0X and AX switches simultaneously. For the UP selection we need 0X closed but AY is closed instead of AX. Similarly, for the 2, 3 and 4 memory selections, we need AX closed and 1X, 2X and 3X closed respectively. For the DOWN and the 5 and 6 memory, the AY switch is closed along with the respective 1X, 2X and 3X switches.

AM/FM switching occurs when both the BY and CY switches are closed.

Construction

The Tuner Remote Control transmitter is housed in a small plastic case measuring 112 x 62 x 31mm. All compo-

nents are mounted on a PCB coded 85rc12 and measuring 56 x 74mm. A front panel label measuring 114 x 64mm indicates the switch functions as well as providing the finishing touch.

The Tuner Remote Control receiver circuitry is mounted on the main 85tu12 PCB used in the Playmaster stereo AM/FM tuner. Receiver diode BPW50 is secured to the sub-front panel of the tuner behind the neutral density filter screen on the front panel.

Construction of the remote receiver is straightforward. Firstly, the main tuner PCB (85tu12) will need to be removed from the tuner case. Disconnect the audio and AM antenna leads and remove the rear panel. Unclip the 8-way leads between the main PCB and display PCB as well as the short stereo lead. Now undo the screws securing the main PCB. It should be possible to have the PCB sitting up on edge to give sufficient room for inserting the remote control components without removing the power supply wires.

The front panel and display PCB will also require removal to fit the IR diode. Drill a 4mm hole through the display PCB directly opposite IC15 on the main PCB. This position is clearly marked with a copper pad just next to the "t" in the word "top" on the display side of the PCB.

Directly in front of this hole on the sub-front panel, drill another hole to expose the IR detector diode. The leads

are bent back on the IR diode as shown on the circuit diagram. Note that the infrared active area is the flat face side of the diode.

Use epoxy resin to secure the IR diode to the sub-front panel. Note that it is important not to allow the leads to make contact with the metal panel and avoid placing glue on the active area of the diode.

Solder short leads to the diode and feed them through the hole in the display PCB. The front panel, sub-front panel and display PCB can now be reassembled.

When assembling components onto the main tuner PCB, follow the overlay diagram and do not forget the links. Note that the ICs, electrolytic capacitors and diodes must be oriented as shown.

After this PCB is completely assembled, it can be bolted back into the case. Replace the rear panel and resolder the audio plus AM antenna wiring. Reconnect the 8-way cables.

With the receiver complete, work can begin on the transmitter.

Insert the resistors, BC327 (Q25), and IC14 in position first. The capacitors and the BD681 (Q26) unconventionally lie sideways on the PCB. This is to leave sufficient room for the switches to protrude through the front panel.

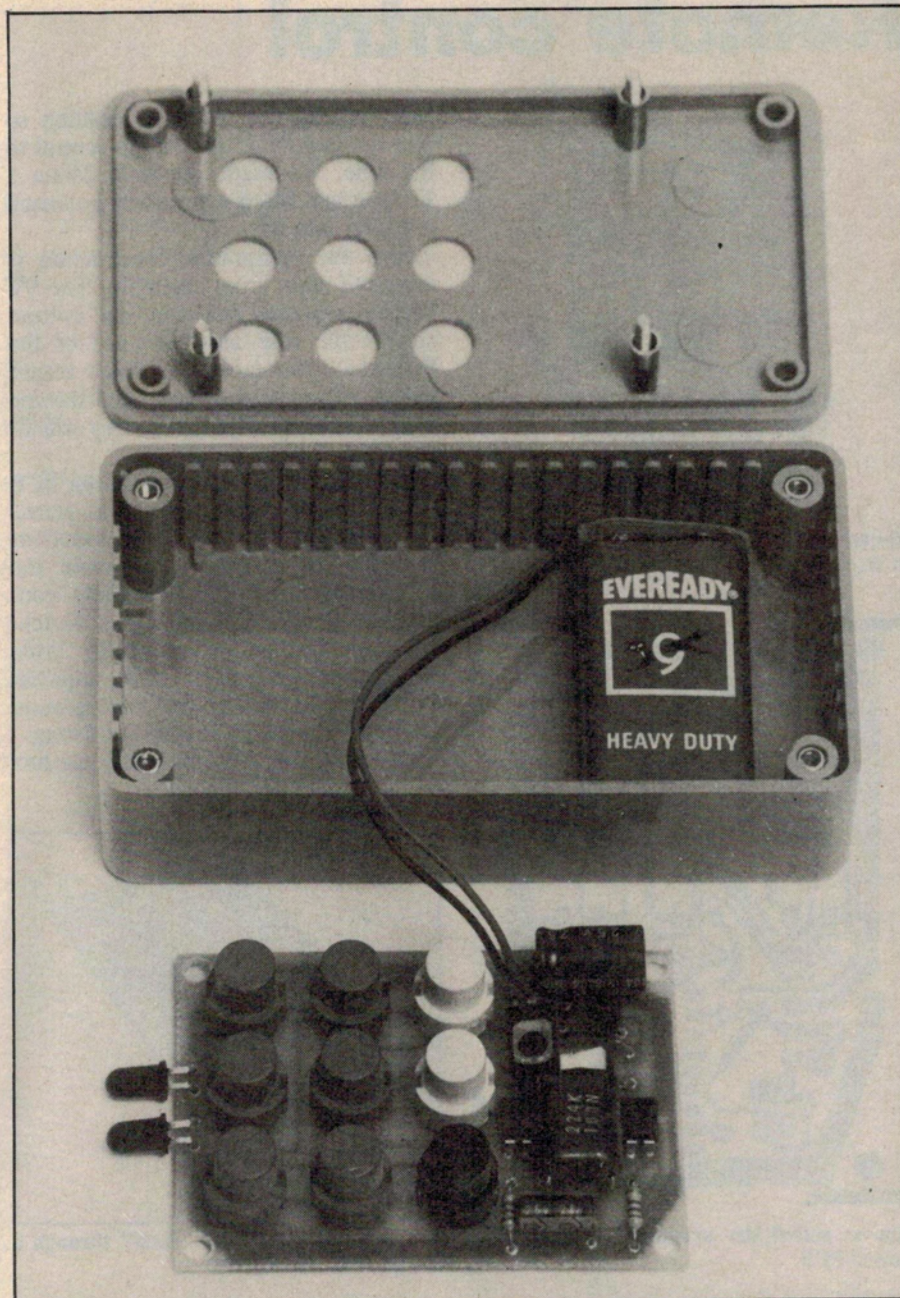
Lying flat on the PCB are the $4.7\mu\text{F}$ and $220\mu\text{F}$ capacitors. The $0.22\mu\text{F}$ capacitor lies across the IC, while the $.068\mu\text{F}$ sits on top of the 100Ω resistor. Transistor Q26 straddles the $.068\mu\text{F}$ capacitor.

All switches are mounted with the same orientation, ie, with the flat side to the right side of the PCB. Both IR LEDs are mounted close to the edge of the PCB and are bent over so that they point along the plane of the PCB. Wires for the 9V battery clip can also be soldered in place.

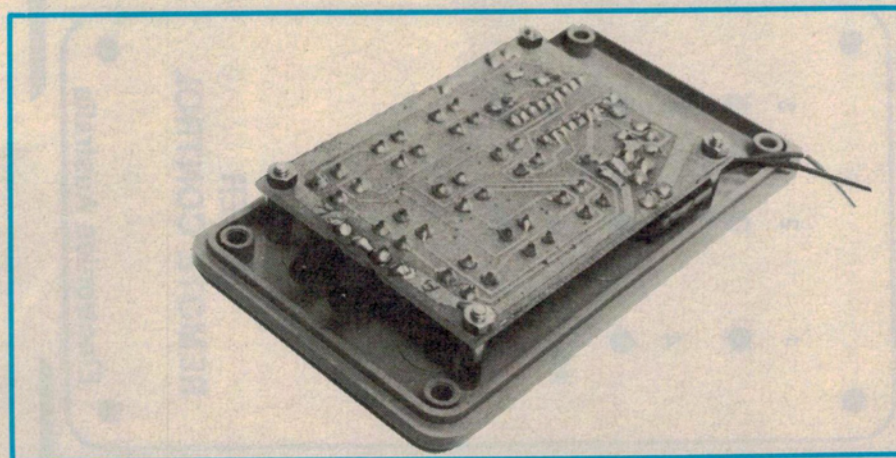
The PCB can be held within the box using one of two methods. We used screws, 12mm spacers and nuts to support the PCB at the four corners from the front panel. If you prefer not to see securing screws on the front panel, then the plastic clips that are supplied with the box can be used. These are designed to clip into the corrugations in the side of the box and hold the PCB at the correct height. Cut the clips to length so that the switch tops will just protrude through the front panel.

Place the Scotchcal label on the lid of the box making sure it is lined up correctly before sticking it down. Drill holes for each switch and the PCB corner mountings if used.

Make a rectangular cut-out at the

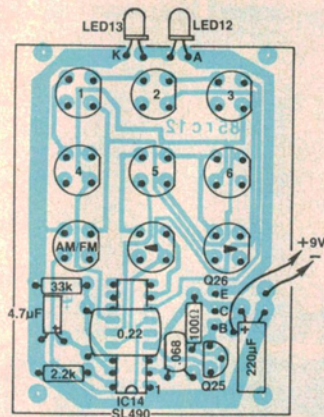


View showing the completed transmitter PCB, ready for assembly into the case.

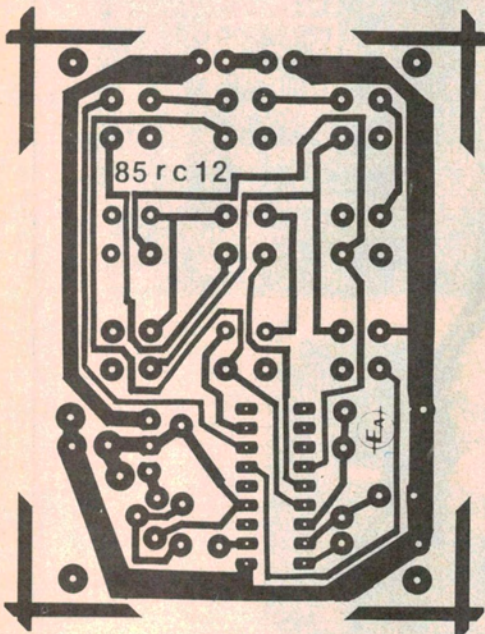


The transmitter PCB is mounted on the lid of the case using four 6mm standoffs.

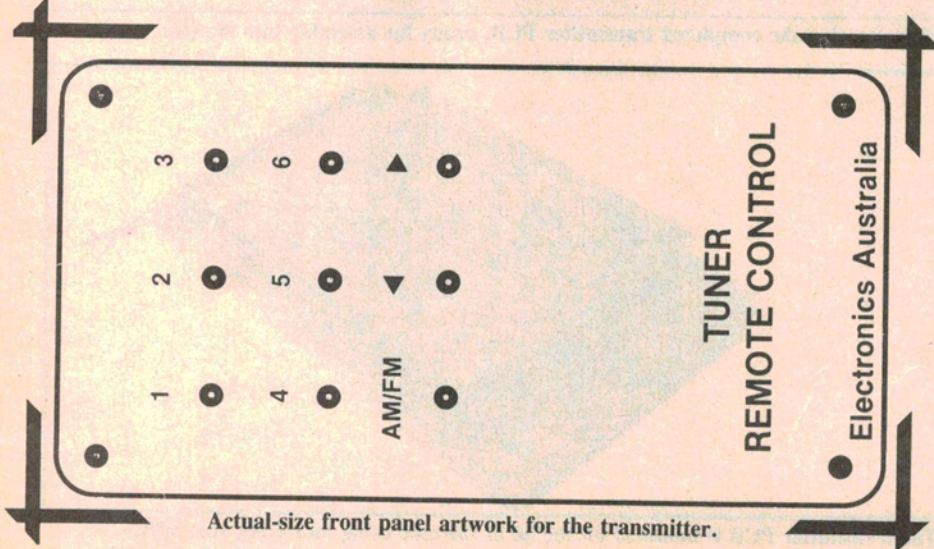
Remote control



Above: parts layout for the transmitter PCB.



Above: actual size artwork for the transmitter PCB.



Actual-size front panel artwork for the transmitter.

front end of the box in a position so that the two IR LEDs will be central to the hole. We made our hole 24mm x 12.5mm and fitted a circularly polarised red filter into this.

Now the transmitter construction is complete apart from assembly. The 9V battery squeezes between the bottom end of the case and the edge of the PCB. In some cases, the lower corner pillars within the case may need shaving with a knife so that the battery will fit correctly.

If screws are used to secure the PCB to the front panel, place a plastic washer under the nut at the top right mounting hole. This will insulate the PCB track from the electrically connected screws on the aluminium Scotchcal front panel. The remaining three corner mounting holes have adjacent PC tracks that are of the same ground potential and do not require insulating.

Assemble the transmitter into the box and it is ready for testing.



The two infrared diodes "look" through a red perspex window.

Testing

Switch on the Playmaster stereo AM/FM tuner and aim the transmitter at the tuner. Push either the tune down or tune up remote control switches and adjust the VR9 trimpot in the receiver until the tuner responds correctly to the transmitter commands. Now check the remaining remote control functions and you are finally in business. EA

PARTS LIST

- 1 PC board, 56 x 74mm, code 85rc12
- 1 Scotchcal front panel, 114 x 64mm
- 1 plastic case, 112 x 62 x 31mm
- 1 red perspex sheet approx 24 x 12.5mm x 1-2mm
- 9 snap action keyboard switches, 6 green, 2 white, 1 black
- 1 216 9V battery
- 1 9V battery clip
- 4 6mm standoffs and screws and nuts

Semiconductors

- 1 SL490 remote control transmitter (Plessey)
- 1 SL486 IR remote control preamplifier (Plessey)
- 1 ML926 remote control receiver (Plessey)
- 1 4052 CMOS switch
- 1 4053 CMOS switch
- 1 BD681 NPN Darlington transistor
- 1 BC327 PNP transistor
- 1 BC547 NPN transistor
- 2 LD271 IR LEDs
- 1 BPW50 IR detector diode
- 3 1N4148, 1N914 small signal diodes

Capacitors

- 1 220µF 16VW PC electrolytic
- 1 47µF 16VW PC electrolytic
- 2 22µF 16VW PC electrolytics
- 1 6.8µF 16VW PC electrolytic
- 1 4.7µF 16VW PC electrolytic
- 1 0.33µF metallised polyester
- 1 0.22µF metallised polyester
- 1 .068µF metallised polyester
- 1 .033µF metallised polyester
- 1 .022µF metallised polyester
- 2 .015µF metallised polyester
- 1 .0047µF metallised polyester

Resistors

- (0.25W, 5% unless stated)
- 1 x 33kΩ, 1 x 22kΩ, 6 x 10kΩ,
 - 1 x 2.2kΩ, 1 x 220Ω 1/2W, 1 x 100Ω, 1 x 47Ω, 1 x 50kΩ horizontal cermet trimpot.