REMOTE CONTROLLER FOR 25W STEREO MOS-FET AMPLIFIER

by Dave Goodman

- ★ **Remote control over Volume, Bass, Treble and Balance**
- ★ **Switched loudness (contour) compensation**
- ★ **Local or remote select**
- ★ **Flat response select**
- ★ **Can be incorporated into our MOSFET amplifier**

Over recent years infra-red control has greatly increased in popularity, as is evident by the plethora of televisions and video cassette recorders fitted with this facility. Some hi-fi systems do incorporate remote control, but not very many, which is regrettable because sound level and balance settings are dictated by listening position in relation to the loudspeakers.

This hi-fi controller project gives the user total control over adjustment of volume and speaker balance settings, also bass and treble cut and boost. All operations are performed by pressing an appropriate button on the hand-held control transmitter. The selected parameter can then be either stepped by single shot or automatically swept by holding the button down. Two further controls allow for return from remote to local (or vice versa), and an instant flat setting of speaker balance and tone response.

A Pulse Position Modulation (PPM) dedicated integrated circuit is used in this design, based on the SL490 IC (see figure 2).

IC 1 is an encoder-oscillator and pulse train generator, producing a series of five pulses of fixed amplitude. Each pulse can vary in width, either 6ms or 9ms, according to whether a digital '1' or '0' is required (see figure 1).

Each one of the six 'spaces' between every pulse is of a consistent 1.25ms duration, and the pulse train repeats for as long as an encoding key is held operating.

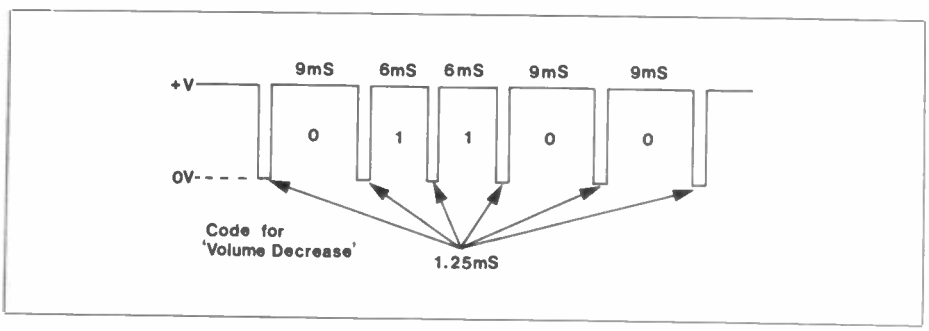


Figure 1. P.P.M. Pulse Train.

Switches S1 to S10 are PCB 'pads', and a ten-way bubble contact strip is used to join the appropriate pads together within the encoding matrix, pins 1, 4, 5, 8, and 10 to 13. Each bubble on the strip has an internal carbon contact of low electrical resistance, and applying pressure to the bubble flexes the contact down across the two pads. Table 1 lists each key, command, symbol, and pulse code used here and present on pin 2 of IC1.

TABLE 1

Key	Command	Symbol	Pulse Code
S1	Volume Down		01100
S2	Volume Up		00010
S3	Balance Left		11100
S4	Balance Right		10100
S5	Bass Cut		11110
S6	Bass Boost	+	10110
S7	Treble Cut	-	11111
S8	Treble Boost	+	10111
S9	Local-Remote	LOC/REM	11000
S10	Flat Response	Flat	11011

S9	Local-Remote	LOC/REM	11000
S10	Flat Response	Flat	11011

C2 and R3 produce a differentiated signal of narrow width, and this is applied to the base of TR2. D1 prevents TR2 from becoming reverse biased. TR1 is a MOSFET device capable of switching large current pulses for only a small loading on the drive stages. Pulses from TR2 turn TR1 on and off, effectively forward biasing D2, 3, and 4. These three diodes are infra-red devices, and transmit light in the infra-red band (940nM). When TR1 is turned on these diodes appear connected between the supply rails, C1 discharges, and the current drawn from the battery would be high damaging the diodes and battery. To prevent this happening TR1 is turned on then off very fast, so that the 'on' time is far smaller than the 'off' time, producing a duty cycle of only a few per cent. The mean current drawn from the battery is therefore low, being approximately 15mA, and well within the 100mA rating of the TIL38 diodes.

C3 and RV1 set the transmission rate/internal clock of IC1 at approxi-

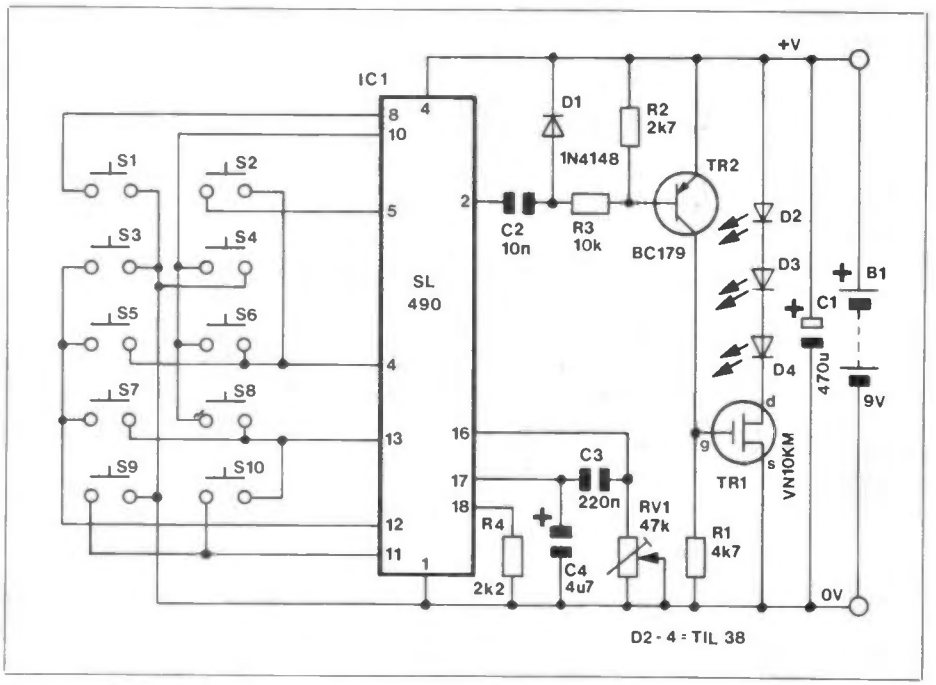


Figure 2. Circuit diagram of Transmitter.

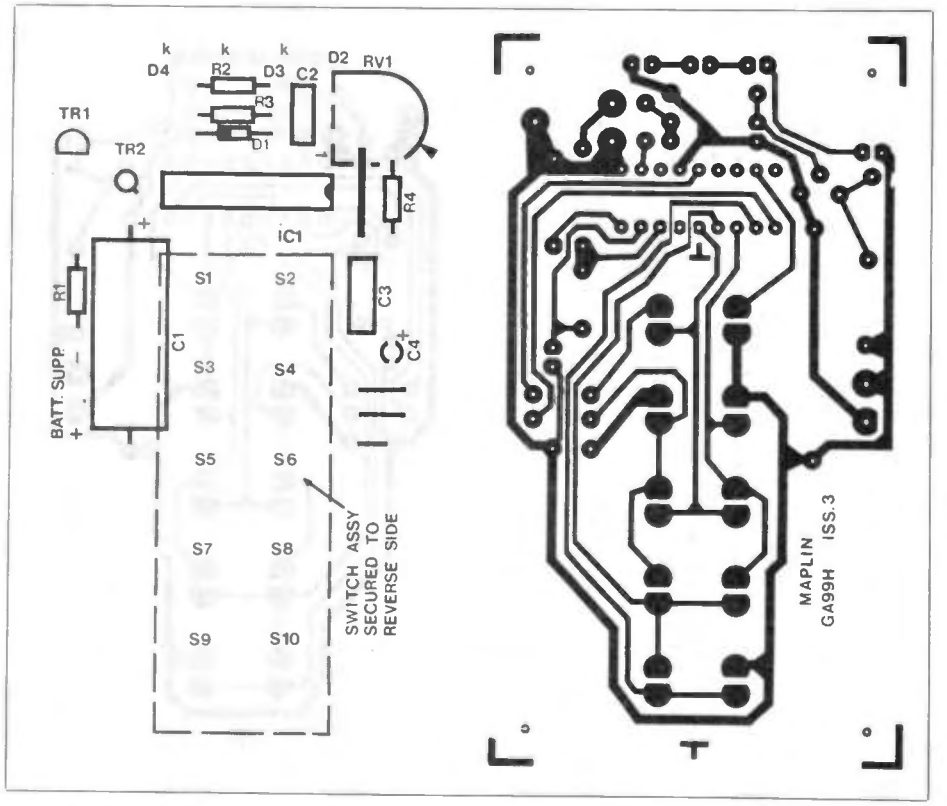
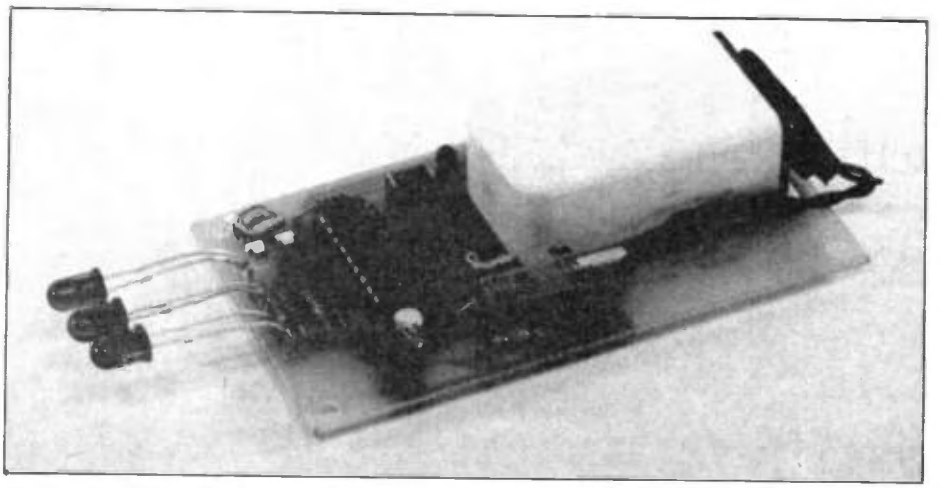


Figure 3. Component Overlay for Transmitter PCB.



mately 150Hz. Scope measurements can be made on pin 2 of IC1 with the 'treble cut' key S7 operated.

Transmitter Assembly And Construction

Cut four pieces of wire for links, bend to shape and insert. Fit diode D1, followed by R1 to R4 and RV1. Mount all four capacitors. Note that C1 and C4 are polarised, and must be fitted one way only. C1 is marked with a negative sign on the case, whilst C4 is marked with a positive. Insert TR2, and ensure the 'pip' on the metal case aligns with the symbol on the legend (figure 3). Next mount TR1, also noting correct positioning. Fit the DIL socket for IC1, and proceed with soldering and trimming all component leads. Do NOT fit infra-red diodes D2-4 at this stage. Clean the track with a suitable spirit and check for bad joints and short circuits.

The ten-way contact strip can now be fitted over the 'pads' on the track face of the PCB. Above and below these pads are two small 'T' symbols, which should be lined up with the two grooves situated along the centre line of this strip, one at each edge. These symbols do not connect electrically, and have been added solely as a guide for assembly. Use a contact type adhesive paringly around the edges of the strip, taking care not to spill over onto the carbon contacts. Remember that the glue will spread out once the strip is placed in position and pressed home, which might cover the PCB pads, so don't be too generous!

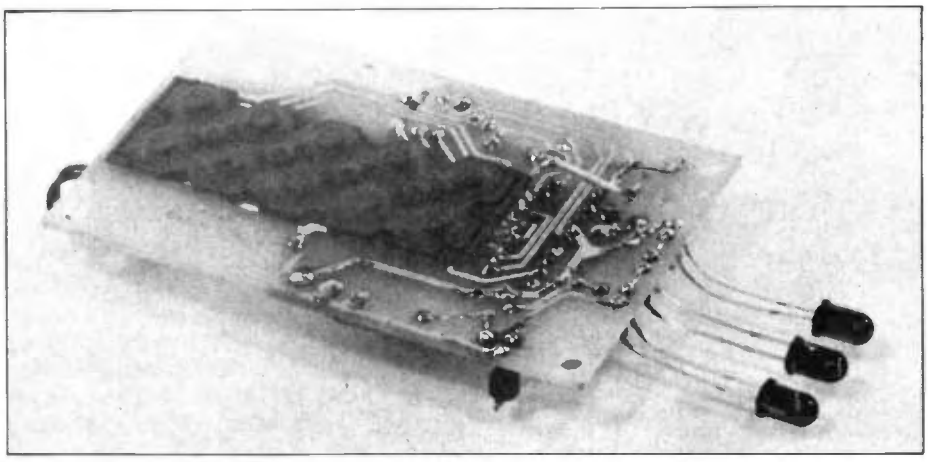
If you are satisfied with your efforts so far fit IC1 (SL490), and refer to the component lead configuration drawing for D2-4 description. All these LEDS may be fitted directly to the PCB, or connected with wires. Keep any wiring as short as possible. Finally, fit the battery clip. Check over all components and soldering once more before use.

Transmitter Use

Set RV1 wiper just past halfway, to line up with the arrow printed on the legend. Connect a 9v battery to the clip, but only on one stud contact. Place an ammeter between the other battery contact and clip, so that it is in series with the positive rail. Press each bubble contact in turn. The ammeter reading should be 15-20mA each time, and only a few uA otherwise.

If there is no reading at all, or a much higher reading, check TR1, 2 orientation, D1 and C1 polarity, and D2-4 orientation. Of course, the contact strip may also be misaligned, and should be rechecked.

Now place a voltmeter from the negative rail (C1 neg. lead) to D4 cathode. A reading of 6.9v should be



apparent. Press any one of S1 to S10 contacts, and the reading should drop 200mv to 6.7v. These readings can vary slightly, but serve to give an indication that all is well.

No particular box is recommended for this project, but a flip-lid box type 601 (LQ03D) was used for the prototype. The LEDS mount through the front, and a suitable cut-out for the switches was made in the lid. The PCB can then be screwed or taped inside the lid, with the battery suitably accommodated underneath. A screened switch panel (RK36P) is available to fit over the contacts S1-10.

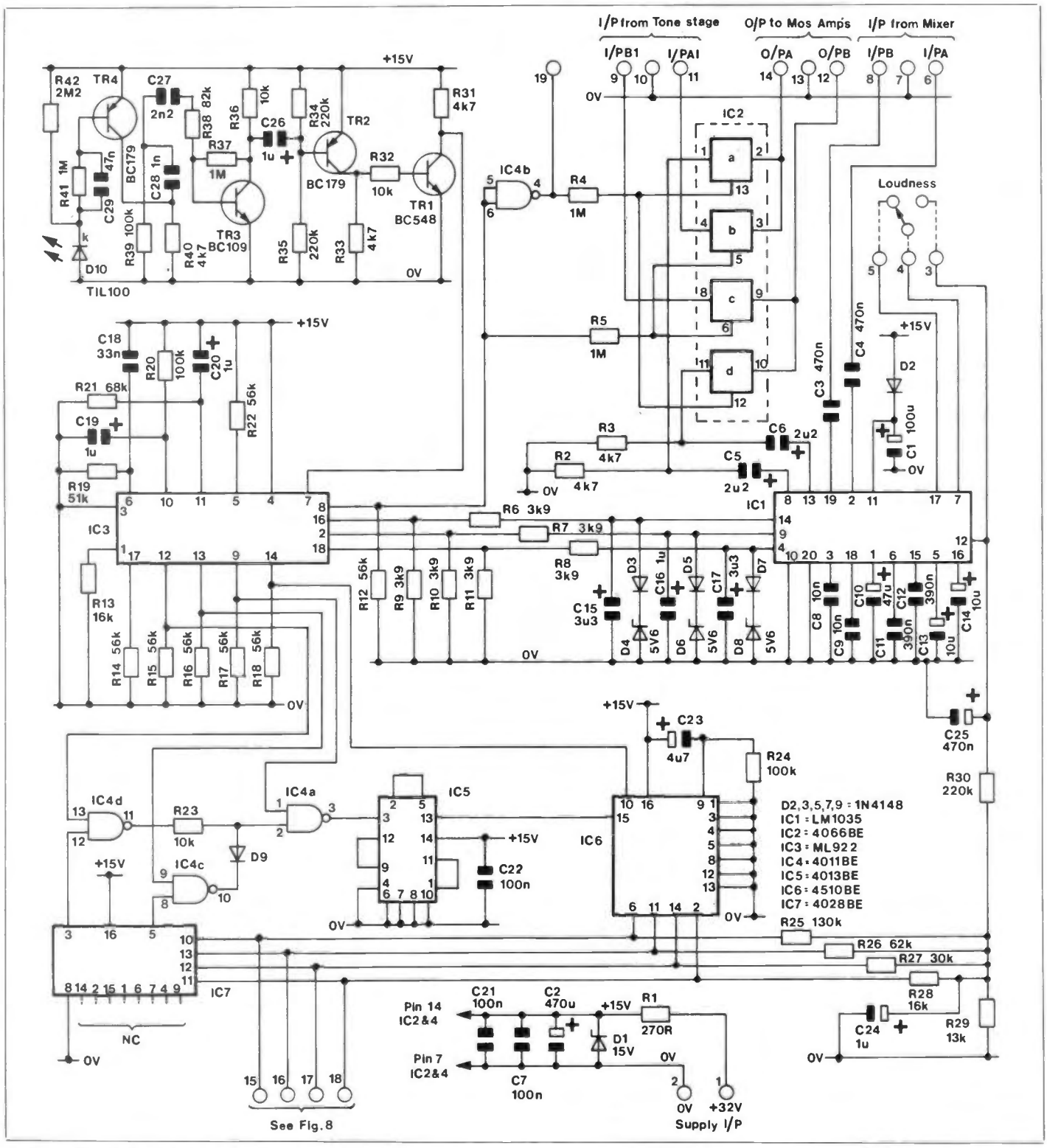
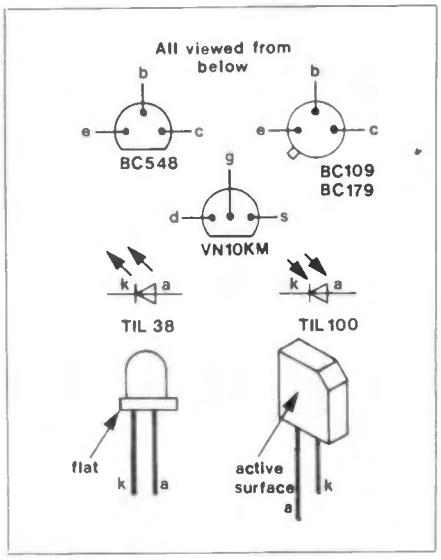


Figure 4. Circuit diagram of Infra-red Decoder.

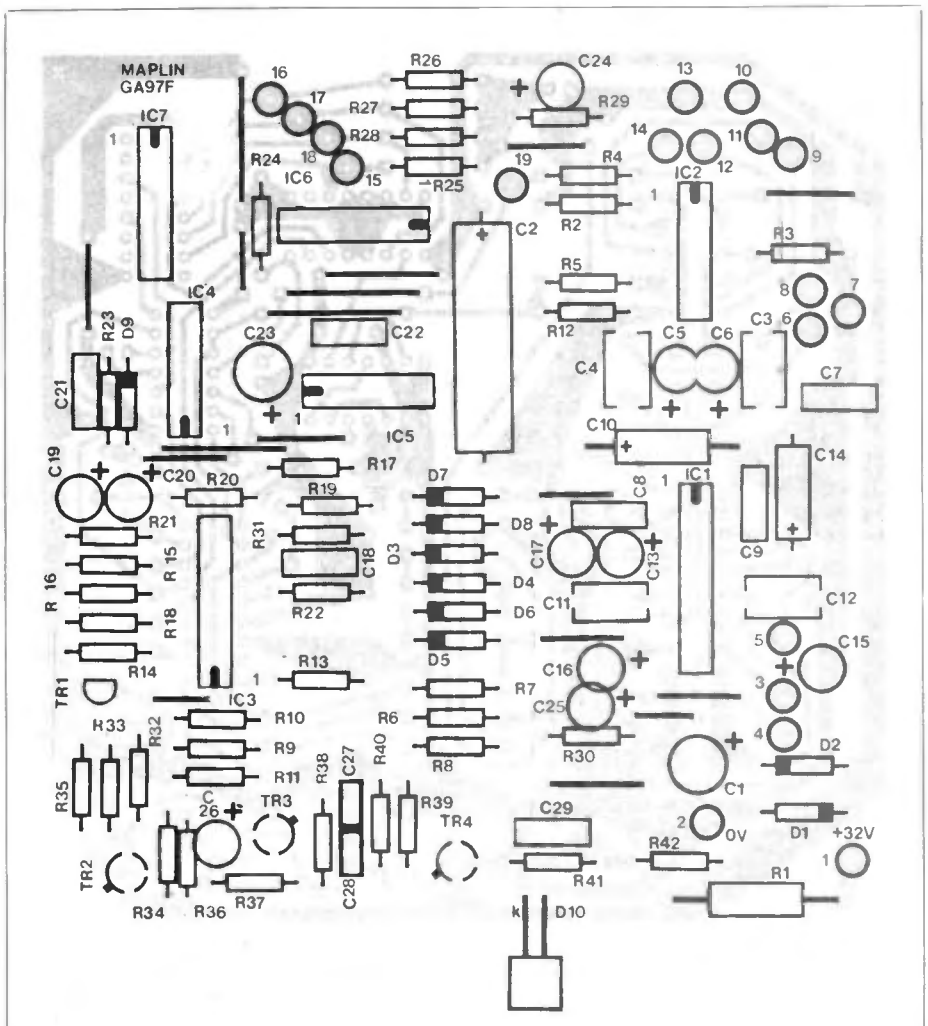
Decoder Circuit Description

P.P.M. data transmitted by the hand controller are received by D10 (figure 4), which is an infra-fred photodiode designed to react with signals of 940nM wavelength.

It is used in reverse bias mode and R42, 41, and C29 help prevent signals generated by incandescent or fluorescent light from becoming amplified. Quite considerable gain is required, to bring the incoming signals to a level suitable for correct operation, and circuit stability can become a problem.



Therefore two gain stages, comprising TR2 and TR3, have been incorporated. TR1 inverts the recovered pulse train so that it is in the correct sense and amplitude for use by IC3. PPM principles have been explained in the text previously, and reference can be made as necessary. IC3 (ML922), is a PPM decoder with one pulse, four digital, and three analogue outputs. An internal oscillator, with a clock frequency determined by C18 and R19, enables decoding of incoming pulse trains. R20 and C19 reset the decode circuits at switch-on, and C20 and R21 set the rate at which digital output codes step on. P16 controls bass, P18 controls treble, and P2 controls speaker balance. Only these three outputs step up and down about a 2.7v centre or 'flat' point, and are analogue channels. D3-8, C15-17, and R6-8 compress positive going voltage changes, thus producing a linear control of these functions within IC1. Pin 8 has a normally high output (+15v), holding the bilateral switches IC2b and c closed. IC4b, an inverter, holds IC2a and d open. Input signals from the MOSFET amplifier tone processing stages on pins 9 and 11 are thus connected via IC2 to pins 12 and 14 and, hence, to the power amp. stages (figure 6). Pre-processed signals are connected to input pins 6-8, and direct to IC1, which is a voltage controlled stereo, volume, and tone control IC. IC3, on receipt of a VOLUME UP or DOWN incoming pulse code, places a



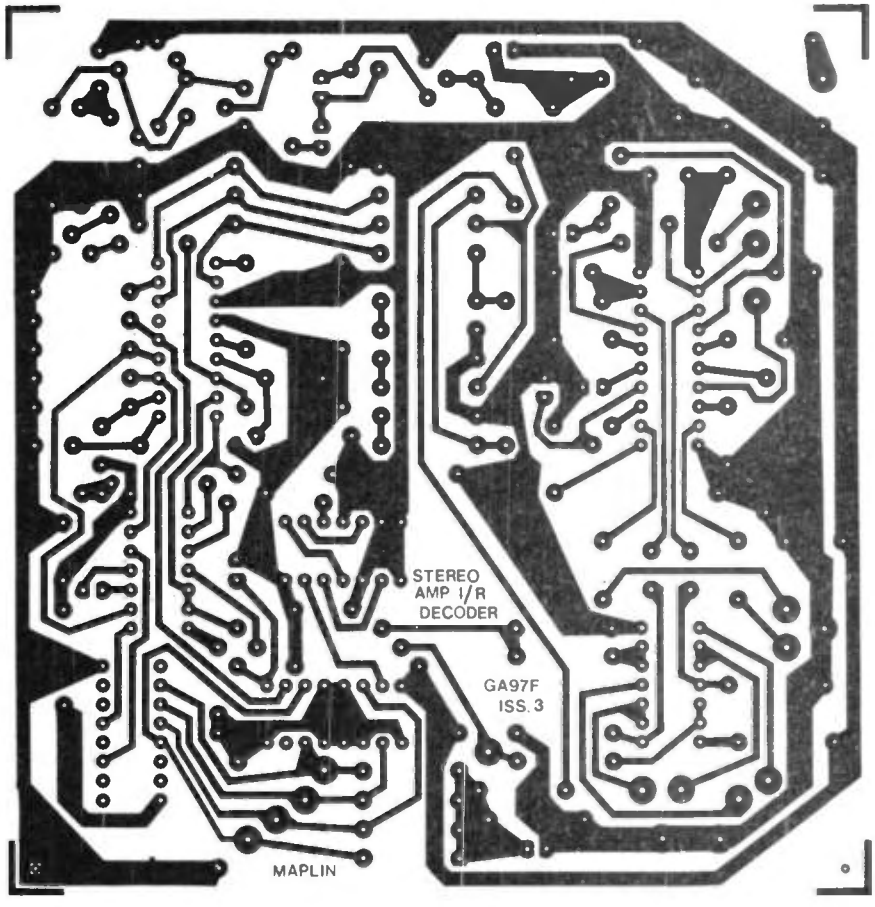


Figure 5. Component Overlay for Infra-red Decoder PCB.

low (0v) on pin 8. IC4b switches IC2a, d closed and IC2b, c open. Processed audio signals from IC1 are then transferred via C5,6, and IC2 to pins 12 and 14 and to the power amp stages.

Control of loudness (or contour) at low volume levels is achieved by connecting a change-over switch between pins 3, 4, and 5 as shown in figure 4. The action is local, and remote control of this facility has not been included. If loudness control is not required, then strap pins 4 and 5 together. C8 and 9 allow 15dB boost or cut at treble frequencies of 16kHz, whilst C12 and C13 allow 15dB boost or cut at bass frequencies of 40Hz.

ICs 4 to 7 are used to decode volume level commands. At power on, IC3 pins 12 to 14 are high (logic 1). Pin 14 determines volume 'direction', and is high for an increase or low for a decrease. Pin 9 is normally high with a negative going pulse output. Pin 13 is normally high and remains so for an up count switching low for a down count; whilst pin 12 is high for a down count and low for an up count. Table 2 should explain this more clearly.

IC3	PIN 12	PIN 13	PIN 14	PIN 9
Switch on	1	1	1	1
Volume increase	0	1	1	
Volume decrease	1	0	0	

TABLE 2

IC6, a BCD up-down counter, generates a four bit binary output which is converted to an analogue voltage by R25 to 29, and fed via R30 to volume control input pin 12 of IC1. The stepped voltage ranges from 0v to +5.4v.

When a voltage step command is received IC3 pin 9 output pulses continuously at 15Hz, via IC4a, to IC5. The signal is then divided by four and steps IC6 through the up/down sequence. IC7, BCD to decimal decoder, examines all output codes from IC6, and gates IC4a output when one of two codes corresponding to either minimum or maximum volume are present. Otherwise, the volume sequence would keep running through max. to min. without control.

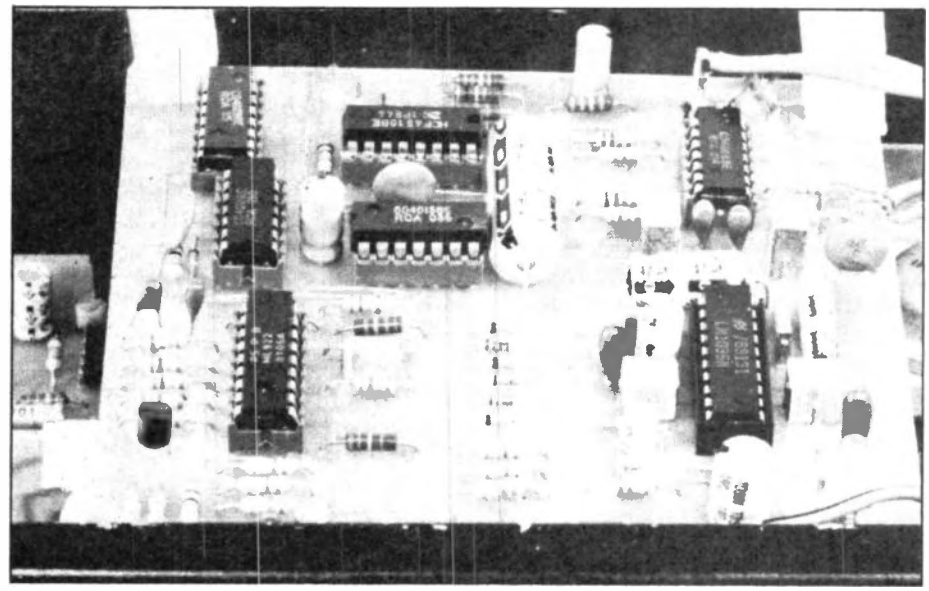
Figure 8 shows a BCD decoder to LED driver circuit, and has been included purely as an addition, not as part of the system. Connection can be made to pins 15-18 and +15v, 0v. Volume level settings are then displayed as numbers 0 to 9.

Finally, receipt of a 'flat' pulse code sets IC3 pins 2,16, and 18 to 2.7v internally. IC1 will interpret this as a flat response of bass and treble and even speaker balance.

Construction

Refer to parts list and figure 5.

Start by making and inserting all sixteen links, diodes D1 to 9 (noting that D1,4,6, and 8 are zeners), and resistors



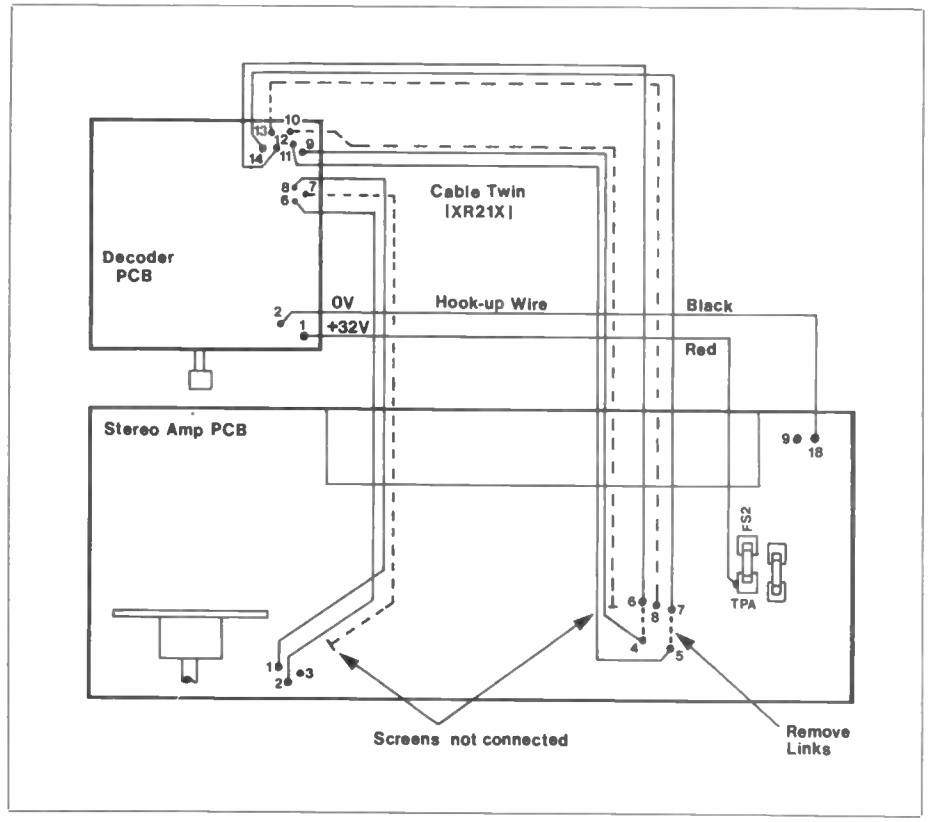


Figure 6. Connecting to 25W Mosfet Amplifier.

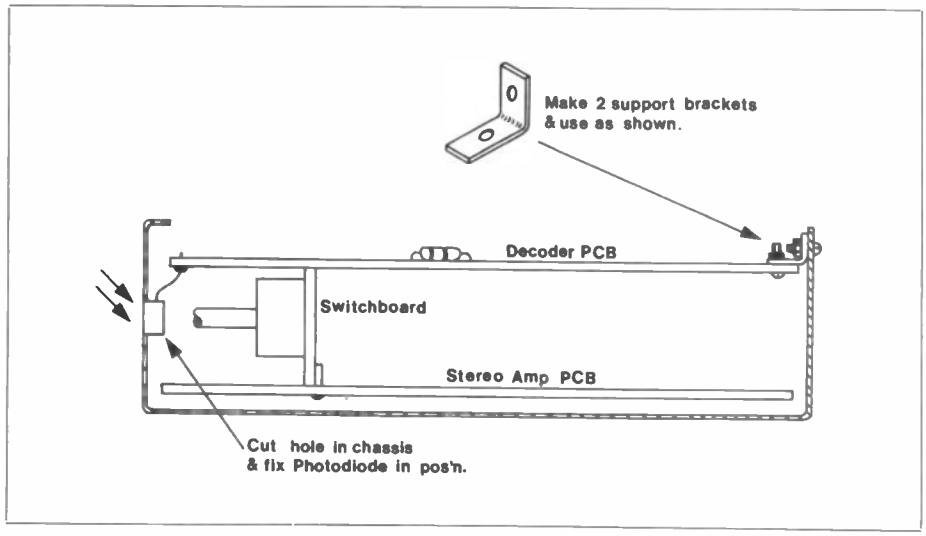


Figure 7. Mounting Decoder in 25W Mosfet Amplifier.

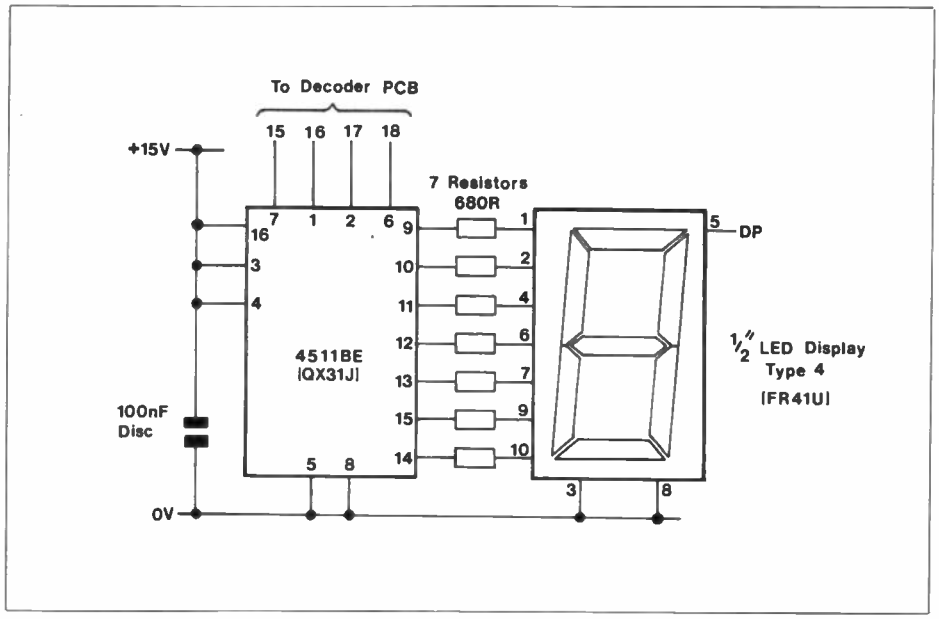


Figure 8. LED Volume Indicator.

R1 to 42. Some resistors are 1% tolerance, and should not be replaced by 5% min. types. R1 may get hot in use, and it would be advisable to mount this component a few mms above the PCB.

Axial, polycarbonate elactrolytic, and tantalum capacitors can be fitted next. Note that these components are polarised, and that tantalums have a positive sign, whilst all others have a negative sign. Fit all remaining capacitors, taking care not to bend the polycarbonate leads, as they are easily broken. Insert remaining transistors and IC holders.

Solder all parts carefully, and clean track surface to remove flux and possible short circuits. Faults are easier to find this way. Insert Vero-pins, if used, and fit all integrated circuits. A final check over is always well-advised before applying power.

Assembly And Testing

Photodiode, D10, has one active and one insensitive side. Refer to the pin configuration drawing for correct use of this component, before fitting. On the prototype, D10 was fitted to the track side of the PCB, and inserted with the active area to the front.

When applying power, note that D1 and R1 are fitted for use with the +32v power supply from the MOSFET amp P.S.U. If available, a +15v power supply would be better for test purposes, and R1 will need to be bridged with a wire or clip, to avoide a large voltage drop across it.

Current consumption of the decoder should be approximately 55-60 mA, and a check with an ammeter in series with the positive supply will indicate this.

Use a voltmeter and check the following:

IC3	
pins 2,16,18	+2.7v
pins 8,9,12,13,14	+15v
pin 1	+7v
pin 7	0v
IC1	
pin 11	+14.3v
pin 7	+5.9v
TR2 collector	+15v
TR3 collector	+2.75v
TR4 collector	+1.5v

all with respect to 0v

These voltage readings may vary by up to 4%, depending on the +15v rail regulation, so allow accordingly.

Connect the voltmeter to IC3 pin 7 (R31 is the most convenient place to clip on to), and the infra-red transmitter can now be used. Hold the transmitter two to three feet in front of the photo-diode (no closer!), and press S2, volume increase. A reading of between three and five volts can be expected, varying with alterations in range. Transfer the voltmeter to the common junction of R25 and 30, above pin 19. Switch the decoder off, then on again to reset. Repeat the transmitter operation, and check the meter reading steps as follows:

0.5v, 1.2v, 1.8v, 2.5v, 3.1v, 3.7v, 4.3v, 4.7v, and 5.2v. Connect the meter to IC3 pin 8. A reading of 0v will be indicated. Press S10 on the transmitter, and +15v should appear. Press S1 or S2 and the reading will change to 0v.

Connect the meter to IC3 pin 2. Switch off the decoder and re-apply power to reset. The reading will be 2.7v. Press S4 and the reading should swing up to +5.4v. Press S3 and reading will swing down to 0v. Repeat on IC3 pin 16, using S5 and S6, and IC3 pin 18, using S7/S8 on the transmitter.

The decoder PCB is now ready for use. If using in conjunction with our 25w MOSFET Amp project, refer to figure 6 for wiring details. A connection is made to TPA (+32v) using hook-up wire, for the positive supply. Do not forget to remove the short across R1 before connecting to TPA, otherwise the ICs will incur damage. All audio connections are made using screened wire, and should be kept as short as possible. Figure 7 shows the decoder mounted into the amplifier chassis above the switchboard. Brackets or sticky pads can be used for securing in position, and D10 can be mounted on the front panel as shown. Obviously, you do not have to do this, and an external box, with PSU, could be used instead; connections being made with DIN or PHONO plug leads and sockets.

Alternatively, the decoder may be used with any other audio system that has access sockets, either for tape in/out or pre-amp to power amp in/out. In this case wire pin 8 to pin 9, and pin 6 to pin 11. Signal inputs will then be on pin 6/8, and outputs on pins 12/14.

Switching between remote control and local control can then be effected, although in some circumstances a 'pop' may be heard in the speakers whilst doing so. *Continued on page 21*

STEREO AMP I/R CONTROLLER PARTS LIST

Resistors — all ¼W 5% carbon unless specified.

R1	4k7	(M4K7)
R2	2k7	(M2K7)
R3	10k	(M10K)
R4	2k2	(M2K2)
RV1	47k hor-sub min preset	(WR60Q)
Capacitors		
C1	470uF 10V axial electrolytic	(FB71N)
C2	10nF disc ceramic	(BX00A)
C3	220nF polycarbonate	(WW45Y)
C4	4u7F 16V tantalum	(WW64U)

Semiconductors			
D1	1N4148		(QL80B)
D2,3,4	TIL 38	3 off	(YH70M)
TR1	VN10KM		(QQ27E)
TR2	BC179		(QB54J)
IC1	SL490		(YH66W)
Miscellaneous			
S1-10inc.	Switch contacts (10 way)		(YR71N)
B1	NICAD PP3		(HW31J)
	Battery clip		(HF28F)
	Veropin 2141		(FL21X)
	Flip-top Box 601		(LQ03D)
	P.C.B.		(GA99H)
	Switch panel		(RK36P)

For kit details see Decoder Parts List on page 21.

IR REMOTE CONTROLLER

Continued from page 19

Maximum range is quite good, and may be improved by careful adjustment of RV1 on the transmitter PCB. Most average sized rooms should be adequately covered, but close range use (i.e. three feet or less) may not work reliably, and local control is preferable here. When first switching everything on, the decoder will be in local control mode; remote control is effected by pressing the volume buttons. Set bass, treble, and balance to suit, or press LOC/REM button for return to local control. When changing control from local to remote all other settings switch 'flat' and will need re-adjustment as necessary with the appropriate button.

PARTS LIST — STEREO AMP I/R DECODER

Resistors — all ⅓W 5% carbon unless specified.

R1	270R (3W) wirewound		(W270R)
R2,3,31,33,40	4k7	5 off	(M4K7)
R4,5,37,41	1M0	4 off	(M1M)
R6-11	3k9	6 off	(M3K9)
R12,14-18inc.,22	56k	7 off	(M56K)
R13	16k (½W 1%)		(T16K)
R19	51k (½W 1%)		(T51K)
R20,24,39	100k	3 off	(M100K)
R21	68k		(M68K)
R23,32,36	10k	3 off	(M10K)
R25	130k (½W 1%)		(T130K)
R26	62k (½W 1%)		(T62K)
R27	30k (½W 1%)		(T30K)
R28	16k (½W 1%)		(T16K)
R29	13k (½W 1%)		(T13K)
R30,34,35	220k	3 off	(M220K)
R38	82k		(M82K)
R42	2M2 (10%)		(M2M2)
Capacitors			
C1	100uF 25V P.C. electrolytic		(FF11M)
C2	470uF 16V axial electrolytic		(FB72P)
C3,4	470nF polycarbonate	2 off	(WW49D)
C5,6	2u2F 35V tantalum	2 off	(WW62S)
C7,21,22	100nF disc ceramic	3 off	(BX03D)
C8,9	10nF polycarbonate	2 off	(WW29G)
C10	47uF 25V axial electrolytic		(FB39N)
C11,12	390nF polycarbonate	2 off	(WW48C)
C13	10uF 35V P.C. electrolytic		(FF04E)
C14	10uF 25V axial electrolytic		(FB22Y)
C15,17	3u3F 35V tantalum	2 off	(WW63T)
C16,19,20,26	1uF 35V tantalum	4 off	(WW60Q)
C18	33nf polycarbonate		(WW35Q)
C23	4u7F 63V P.C. electrolytic		(FF03D)
C24	1uF 100V P.C. electrolytic		(FF01B)
C25	470nF 100V P.C. electrolytic		(FF00A)
C27	2n2F ceramic		(WX72P)
C28	1nF ceramic		(WX68Y)
C29	47nF polycarbonate		(WW37S)
Semiconductors			
D1	BZX61C15V		(QF57M)
D2,3,5,7,9	1N4148	5 off	(QL80B)
D4,6,8	BZY88C5V6	3 off	(QH08J)
D10	TIL 100		(YH71N)
TR1	BC548		(QB73Q)
TR2,4	BC179	2 off	(QB54J)
TR3	BC109c		(QB33L)
IC1	LM1035		(QY19V)
IC2	4066 BE		(QX23A)
IC3	ML922		(YH67X)
IC4	4011 BE		(QX05F)
IC5	4013 BE		(QX07H)
IC6	4510 BE		(QW83E)
IC7	4028 BE		(QX17T)
Miscellaneous			
	Veropin 2141	19 off	(FL21X)
	P.C.B.		(GA97F)

A complete kit of all the parts needed to build the Encoder and Decoder are available.
Order As LW77J (Amp Remote Control Kit). Price £26.95