PROJECTS BOOK 18

Maplin Maplin Maplin

WEATHER SATELLITE RECEIVER
STEPPER MOTOR DRIVER
MIXING IT PART 2
AMSTRAD EXPANSION SYSTEM PT 1
LEAD ACID BATT. CHARGER
FANTASTIC FIVE

World Radio History

Electronics
THE MAPLIN MAGAZINE

PROJECT BOOK EIGHTEEN

This Project Book replaces issue 18 of 'Electronics' which is now out of print. Other issues of 'Electronics' will also be replaced by Project Books once they are out of print. For current prices of kits, please consult the latest Maplin price list, order as XF08J, available free of charge.

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World Radio History

World Radio History

by Robert Kirsch Part 1

The idea of looking down upon the world from space appeals to many people. With the aid of Weather Satellites and the receiving system described in this series, it is possible to receive and display pictures of cloud formations, weather systems and land masses from many of the orbiting weather satellites that transmit in the 137-138MHz band.

This article describes the receiver, aerial and storage system to be followed by the Decoder and Frame Store. Pictures from the decoder may be displayed either by using the Frame Store, which is connected to an ordinary television or monitor, or by using a suitable home computer such as the BBC B or Amstrad.

Opposite page: TIROS-N in orbit (Inset: The Straits of Gibraltar)

The prototype system, when used with a fixed aerial of the type described later in this article, has regularly received pictures from as far away as North Africa to the South, and Iceland and Norway to the North.

FREQUENCY	SATELLITE	APPROX TIME (ENGLAND)
137	MET 30	1015 – 1145
	METEOR & COSMOS	VARIOUS
137·5	NOAA 6	0530–0730 1800–2000
	NOAA 9	0000–0200 1230–1430
	METEOR	VARIOUS
138		

Receiving Times

There are several satellites regularly orbiting the Earth and sending picture information both in the visible and infra-red spectrum, most of which can be decoded by the MAPSAT system. Satellites that are easily received in this country include the American TIROS-N series (NOAA 6 and 9) see Figure 1, and the Russian Meteor and Cosmos satellites. These satellites orbit the Earth roughly every 100 minutes but, due to the rotation of the Earth, a satellite travelling in a roughly north/south orbit will cross the equator 25 degrees further west on each orbit, thus enabling the whole of the Earth's surface to be covered. Due to this effect, a satellite of this type will only pass within usable range two or three times every 12 hours, making it

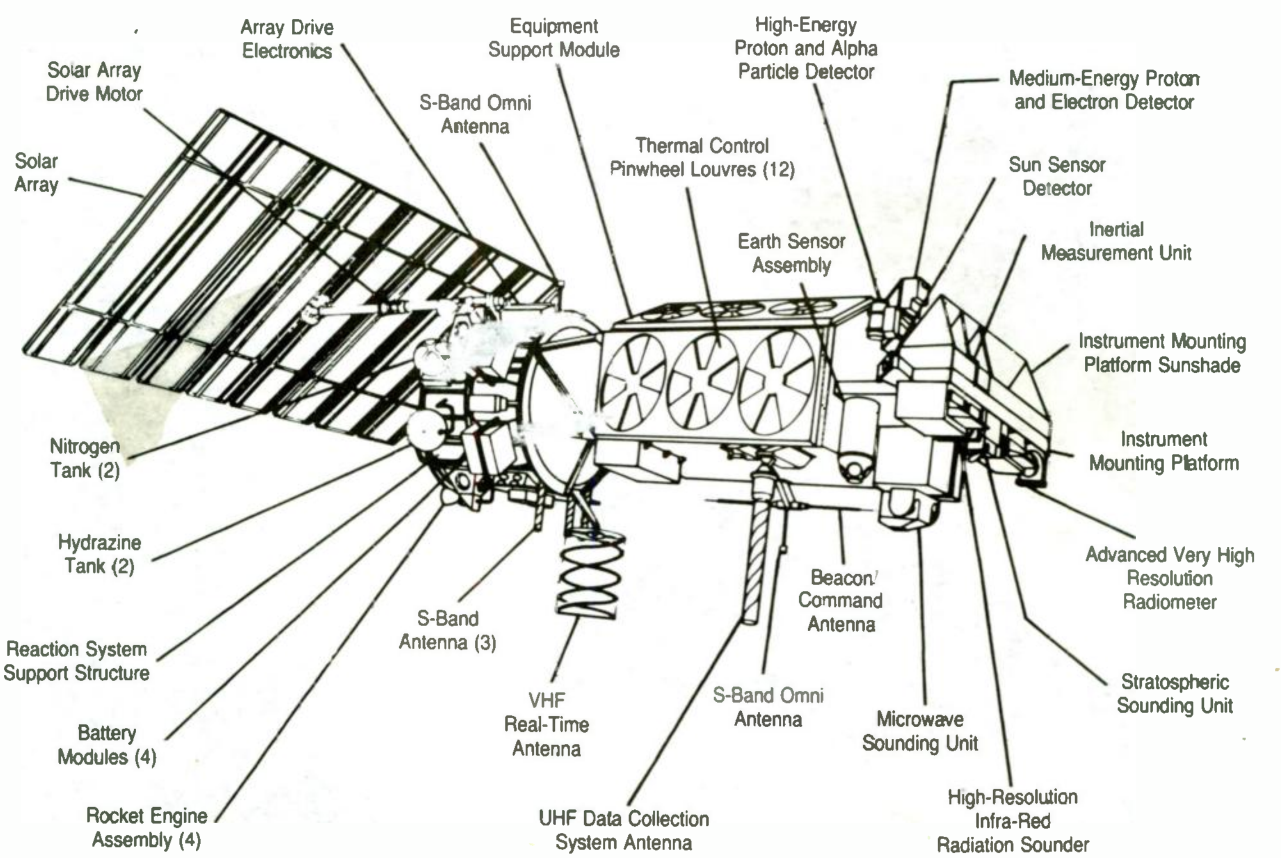

Figure 1. TIROS-N Satellite

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necessary to refer to a prediction chart to enable a particular satellite to be received. Prediction charts for NOAA 6 and 9 and any other satellites for which data is available will be published in future editions of Electronics. The receiving system can also be used to receive geostationary weather satellites such as METEOSAT, by using a down converter with a suitable aerial system.

The Complete System

Figure 2 shows a block diagram of the complete receiving, storage, decoding and display system. Incoming signals from the receiver are normally stored on tape before decoding, although it is possible to decode and display pictures as they are received immediately. Once stored on tape, a picture can be decoded at leisure and several runs can be made with various settings of the decoder to obtain the best results. The receiver, block schematic shown in Figure 3, includes interfacing for a standard mono or stereo cassette recorder via a DIN socket. A monitor amplifier is also provided that can be switched to the tape playback and decoder monitor points as well as receiver's output. The decoder is connected to the receiver by a DIN connector lead, and the decoder also provides 12 volts DC to supply the receiver. Connection to a computer or the Frame Store is made via a fifteen way D-range plug. The decoder also contains the mains power unit and a VU meter for setting the levels out of the tape system. The receiver may be run from any 12-14 volt supply such as a car battery or mains unregulated power supply (e.g. XX09K), in the absence of the decoder. Provision is also made to run the receiver from internal batteries for portable operation. This enables the receiver to be used outdoors in conjunction with a portable tape recorder and a directional aerial for tracking satellites, by using the SIGNAL meter to obtain maximum strength whilst aiming the aerial.

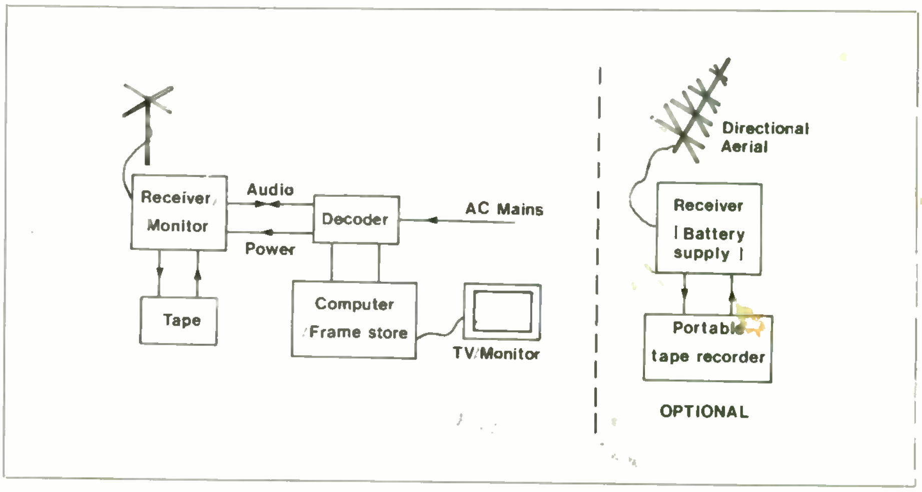

Figure 2. Complete System

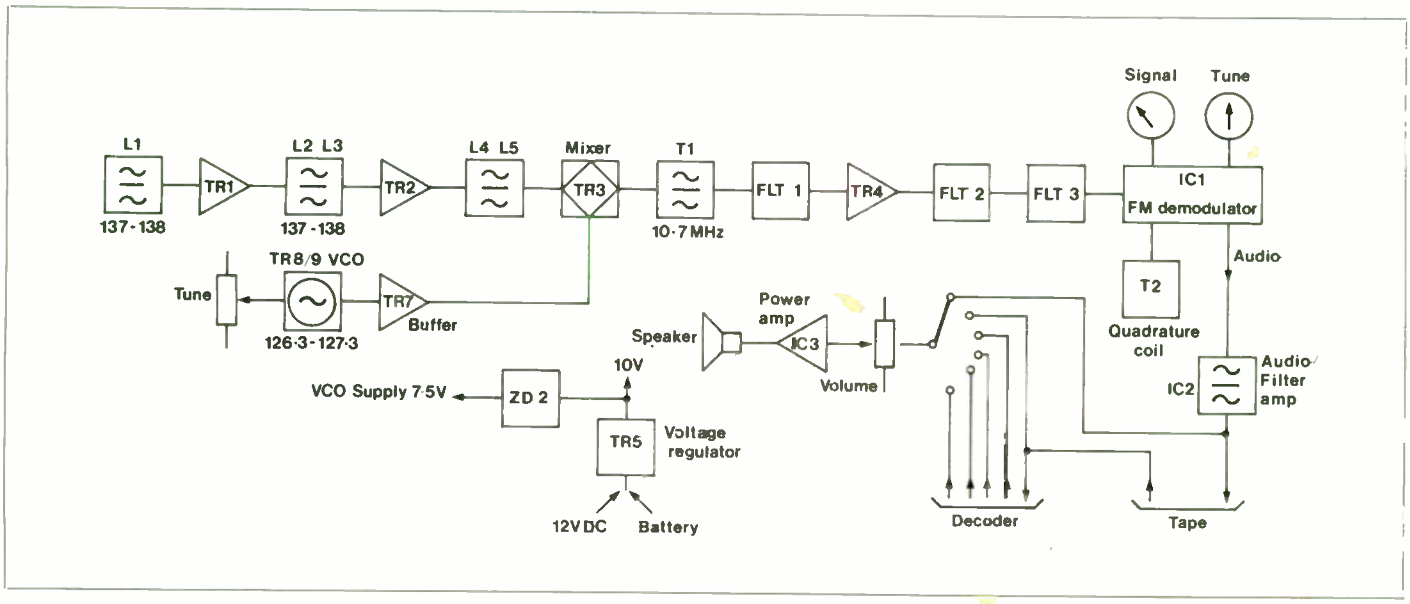

Figure 3. Receiver Block Schematic

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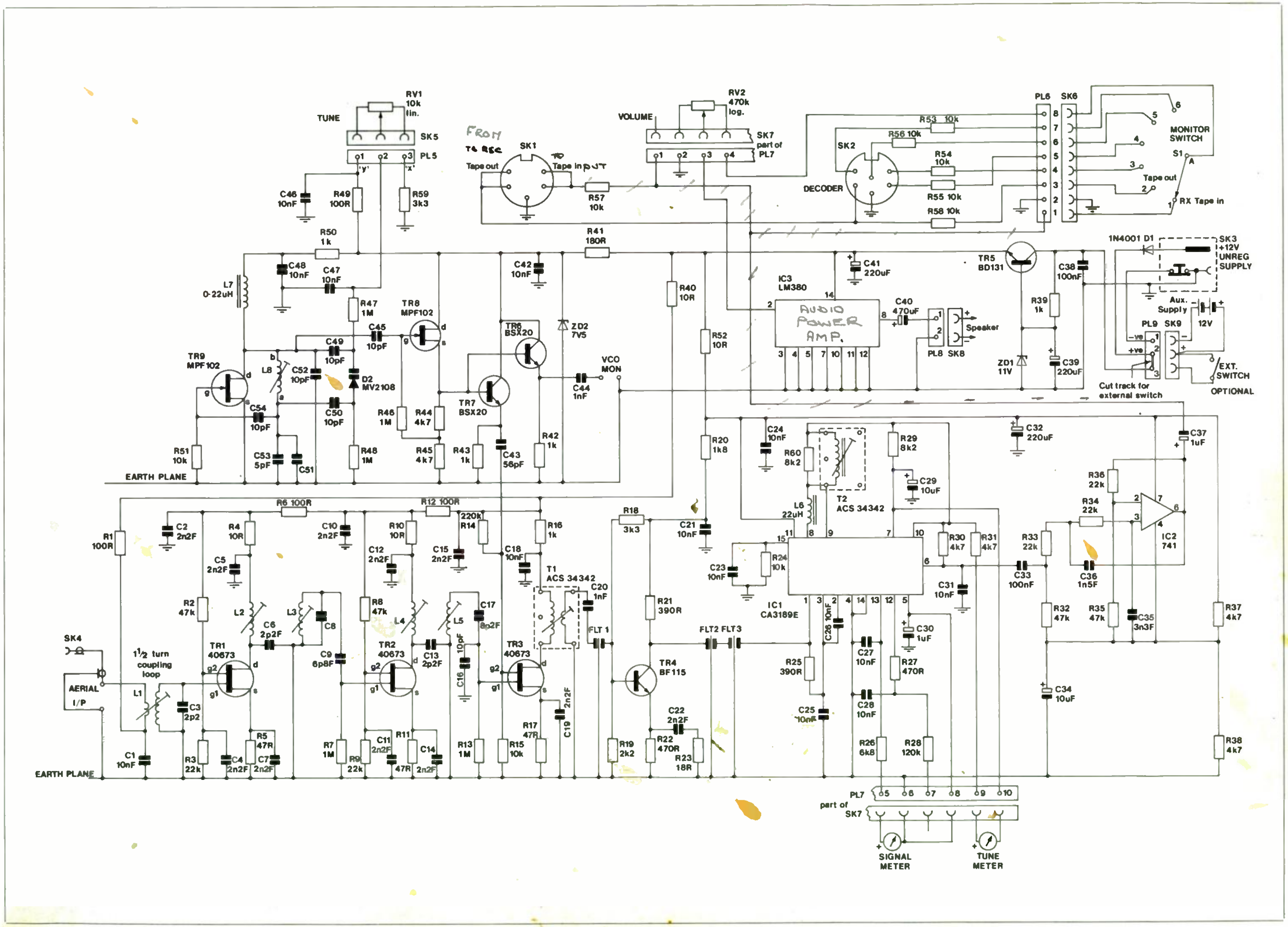

Figure 4. Receiver Circuit

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The Receiver - Circuit Description

Figure 4 shows the circuit of the receiver, monitor amp and switching. The 75 ohm aerial input is coupled to the first bandpass tuned circuit L1 by a 1½ turn coil, which, after being decoupled to ground by C1, is fed with 10 volts via R1. This supply, connected to the centre conductor of the aerial coax, is to power a masthead preamplifier (if used). The dual gate FET TR1 provides the first stage of amplification, with L2 and L3 in its output (drain) circuit to provide tuned coupling into TR2, the second RF amplifier. The output of TR2, via the third bandpass and coupling circuit, L4 and L5, is fed to gate 1 of the mixer FET TR3. Gate 2 of TR3 is fed from the VFO circuit, and the drain of this transistor is connected to the 10.7 MHz transformer T1.

The first of three ceramic filters is connected between the output of TR1 and the 10.7MHz amplifier, TR4. The output of TR4 is fed via the two remaining ceramic filters into IC1, the FM IF and demodulator sybsystem. This IC provides quadrature detection of the IF signal as well as providing outputs for the SIGNAL and TUNING meters and squelch (not used in this application). T2 is the quadrature inductor tuned to 10.7MHz. The output from pin 6 of IC1 is fed to the AF amplifier and filter formed by the op-amp IC2 and its surrounding circuitry. This filter limits the audio bandwidth to that required for satellite reception, attenuating all frequencies outside this band.

The audio signal is now fed to the DIN socket for connection to the tape recorder and to the switching for the monitor amplifier. The rotary MONITOR switch is connected via the VOLUME control RV2 to the input of the power amplifier IC3, which drives the loudspeaker.

The receiver is tuned by a voltage controlled oscillator, operating the range 126.3MHz to 127.3MHz, which is 10.7MHz below the input frequency of 137MHz to 138MHz (this provides an IF of 10.7MHz). The FET TR9 forms part of a Vacar type oscillator, whose tuned circuit L8 is tuned by the varicap diode D2. ZD2 stabilizes the power supply at 7.5 volts. This supply also feeds the tuning potentiometer RV1, whose wiper is connected via R47 to the cathode of the varicap diode. The anode of D2 is connected to 0 volts DC by R48.

The varicap diode is reverse biased and, as virtually no current flows through it, R47 and R48 can be of high resistance (i.e. 1MΩ), thus having little effect on the RF signal present across the diode. The output from the drain of the oscillator FET TR9 is taken to a source follower buffer FET TR8. The output from the buffer feeds two emitter follower transistors TR7 and TR6. TR7 feeds the mixer via C43, and TR6 connects to a monitor point that can also be used to feed a frequency

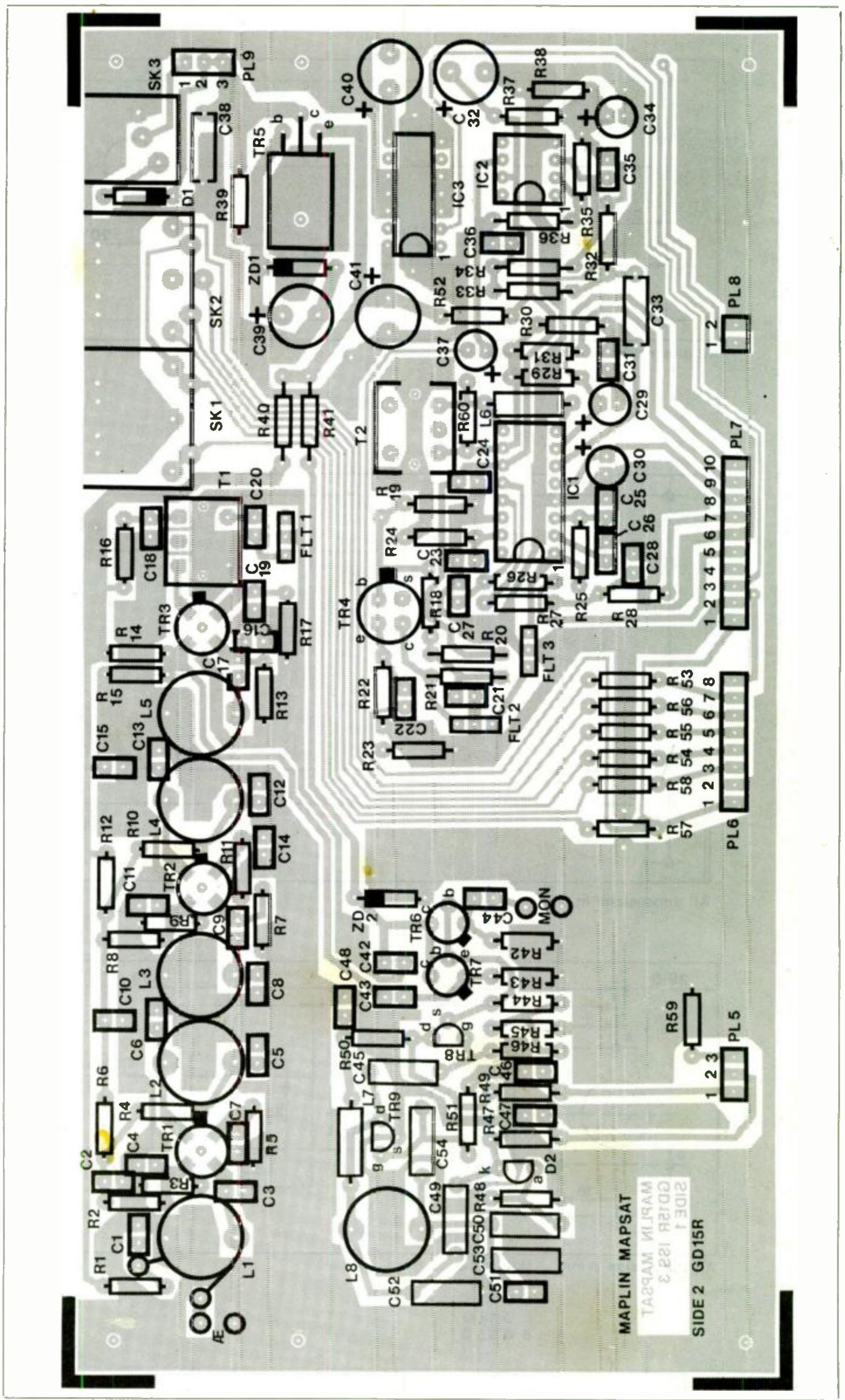
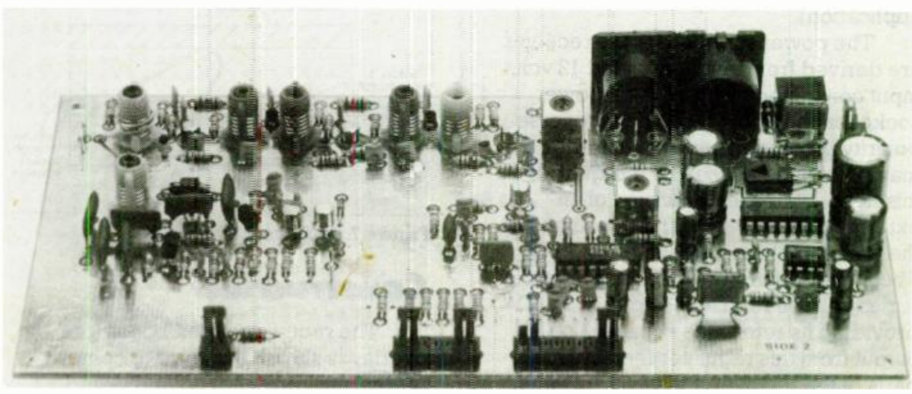


Figure 5. Receiver PCB Overlay



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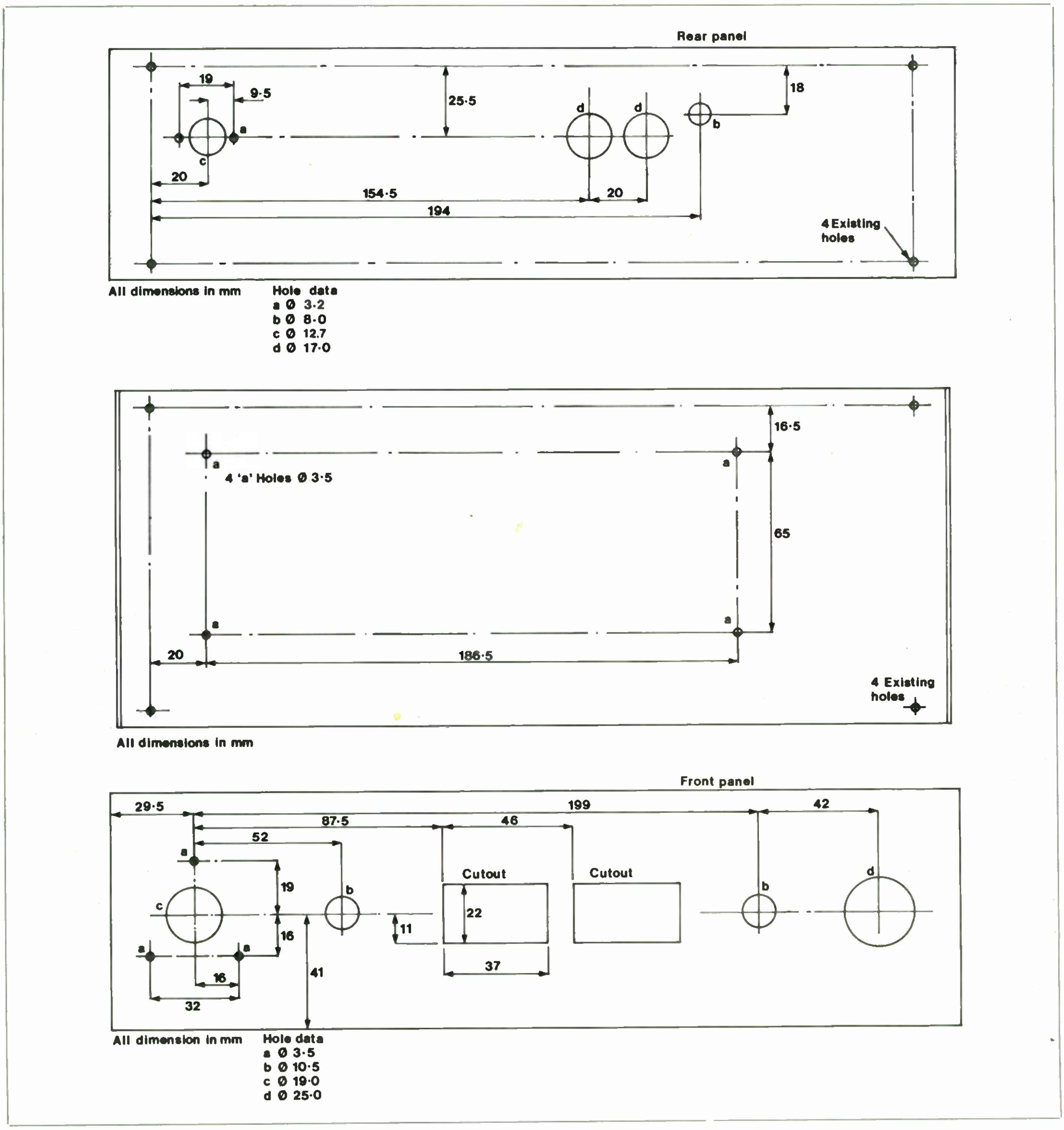

Figure 6. Box Drilling

synthesiser input (not used in this application).

The power supplies for the receiver are derived from an unregulated 12 volt input connected via the 2.5mm power socket on the pcb. D1 provides reverse polarity protection. Internal batteries may be connected via PL9 if required; this necessitates the provision of an external power switch, and the cutting of the track between pins 1 and 2 of PL9. The power transistor TR4 forms a simple series voltage regulator circuit, with ZD1 providing its reference voltage. The output from this regulator feeds various parts of the receiver, many via 10Ω and 100Ω decoupling resistors.

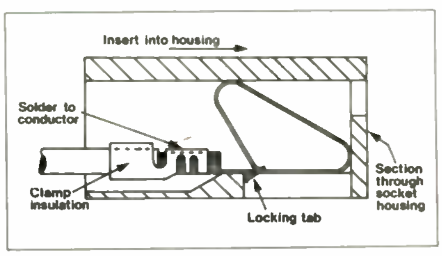

Figure 7. Minicon Connectors

Construction

The receiver circuit board (the overlay is shown in Figure 5) comes ready-built, pre-aligned and tested making construction very simple. The receiver should be housed in an all-metal case, such as the Instrument Case NM2H (YM51F, see also New Products), for which drilling details (see Figure 6) and a stick-on front panel are provided.

Excluding the aerial, all connections are made to the pcb by Minicon connectors, and care should be taken to ensure the correct wiring of these. Details of how to make up these connectors are shown in Figure 7. *Carefully* crimp and solder the required number of minicon terminals onto the wires, making sure they all line up with each other, and then ensure that each is firmly fastened to its conductor and that nothing will foul the minicon socket on

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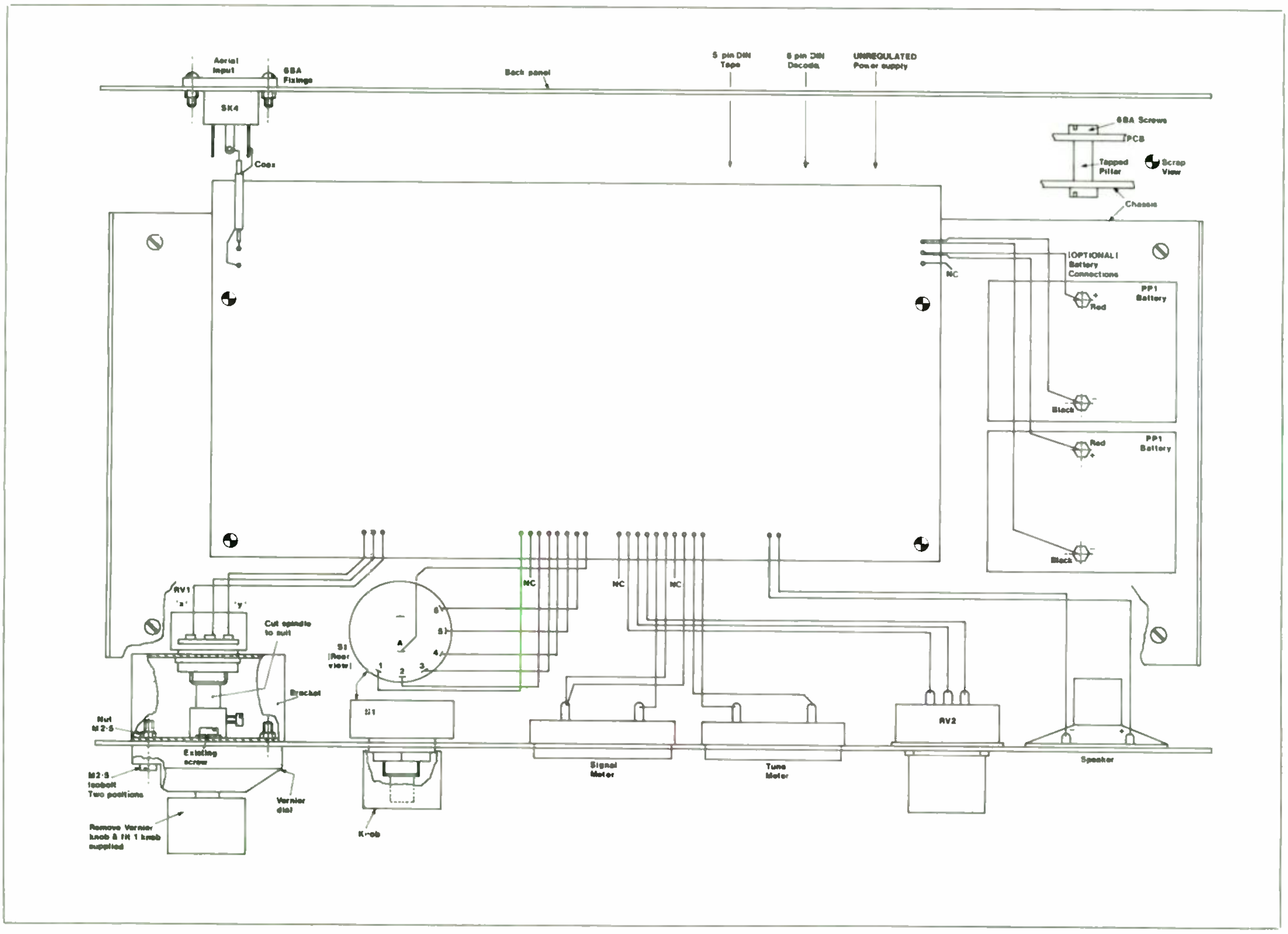
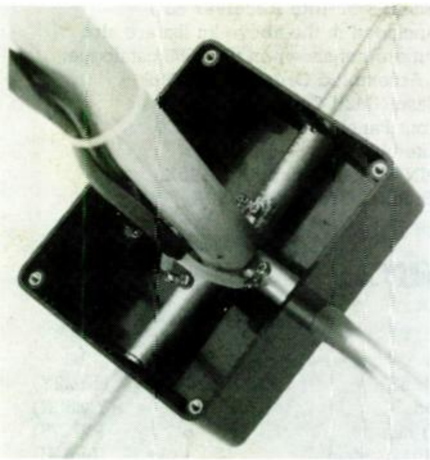


Figure 8. Receiver Wiring



Aerial Junction Box

Aerial in use

insertion. If all is well insert them into the socket the correct way round, and push them home until they click.
Refering to the wiring diagram, Figure 8, note that the short length of coax that connects from the board to the aerial socket has its screen connected to the ground pin on the pcb *and* the outer connection of the coax socket.

The meters and the loudspeaker may be held in position by using Araldite Rapid (FL44X), making sure that the metal surfaces are cleaned and roughened first to form a good bond. Note that if the recommended case and mounting method are not used, the pcb must be mounted 12mm above a metal plate to ensure correct operation.

When mounting the vernier dial, do not, at this stage, tighten the screw that locks the dial to the potentiometer spindle.

Connecting Up and Testing

Carefully check and recheck all wiring; then connect a suitable 12 volt power supply to the receiver. Connect the positive lead of a voltmeter of 20,000Ω/volt sensitivity and set to 10V f.s.d or an equivalent range, to the point marked 'x' on the tune potentiometer (RV1), and the negative lead to 0 volts (e.g. the aerial screen connection). A reading of 0.7±0.2 volts should be obtained.

Now transfer the positive lead to point 'y' on RV1. The reading at this point should be 7.25±0.3 volts. The positive lead should now be connected to the wiper of RV1, and the shaft of the potentiometer rotated to obtain a reading of 4.5 volts (the shaft may be rotated using a screwdriver in the slot at the rear of the potentiometer housing). Set the Vernier dial to '5', making sure the correct voltage is still present on the wiper, and tighten the locking screw. Rotate the dial in both directions and check that about 4.5 volts is still obtained when returned to 5 on the scale.

Turn the MONITOR switch to its fully anti-clockwise position (RECEIVE-TAPE IN). Rotating the volume control clockwise should produce a rushing noise from the speaker. The reading on the SIGNAL meter should rise a small amount when power is applied, and the TUNE meter should remain near the centre of its scale.

Connect the receiver to a tape recorder via the DIN connector (the Maplin DIN pack A - RW14Q is suitable for connection to cassette recorders having a suitable DIN connection wired to the DIN standard). For tape recorders with VU meters, it should be possible to

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obtain a reading of 0dB or 100% when switched to record and input level controls adjusted. A short recording should now be made from the system. Turn the MONITOR switch to TAPE OUT, rewind the tape and press play. The recorded signal should now be heard from the monitor speaker.

The system is now ready for use when connected to a suitable aerial. The receiver has an input of 75Ω, and ordinary UHF television low loss coax cable is suitable for connection between the receiver and the aerial. A suitable fixed aerial is available in kit form from Maplin (LM00A). The aerial should be sited as high as possible and away from sources of electrical interference.

Receiving Signals

Although pictures cannot be decoded at this stage, it is worth making recordings for future demodulation. Figure 9 shows a rough guide to the relationship between the received frequency and the dial reading. Signals from weather satellites can be easily identified by the 2.4kHz whistle that can be heard in the background of their transmissions, together with the characteristic synchronisation tones. The American NOAA satellites produce a 'clip-clop' type sound, and the Russian satellites a buzzing sound about once a second.

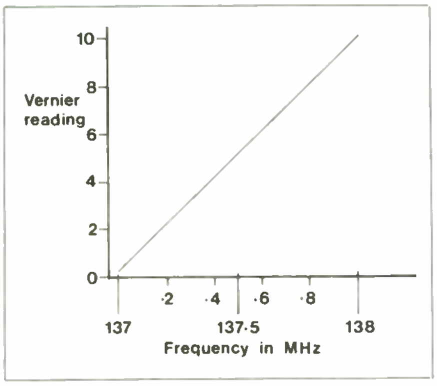

Figure 9. Vernier Dial and Received Frequency Relationship

The satellite signals can usually be heard some time before they are strong enough to produce a usable picture. The receiver should be tuned to obtain a maximum reading on the SIGNAL meter with the TUNE meter as near centre as possible. The receiver will probably need slight re-tuning during a satellite pass to compensate for Doppler shift of the signal as the spacecraft approaches and recedes. A good aerial system should give a reading of at least 4 on the SIGNAL meter for a close pass (within 10 degrees east or west).

Should it be found that the best reception does not coincide with the TUNE meter being in the centre position, a very careful adjustment to the core of T2 may be made.

Coming Soon . . .

The decoder and optional synchronisation unit will be described in future issues, together with interfacing details and software for the BBC B and Amstrad computers. The Frame Store, which has a definition of 418 x 312 pixels, with 16 luminance levels per pixel, giving approximately twice the resolution of that obtainable using the BBC, will also be described.

Several associated projects are planned for the future including an aerial preamp, frequency scanner unit, and a computer interfaceable frequency synthesiser.

Licence Requirements

There is no actual licence available for the reception of weather satellites, but it is necessary to obtain a 'Letter of Authority' from the Department of Trade and Industry for reception of NOAA and ESA satellites. There is no charge for this authorisation, and it can be obtained by writing to:-

Room 309, Radio Regularitory Division,
Waterloo Bridge House,
Waterloo Road,
LONDON SE1 8UA.

SATELLITE RECEIVER PARTS LIST

RESISTORS			
RV1	Pot. Lin. 10k	1	(FW02C)
RV2	Pot. Log. 470k	1	(FW27E)
MISCELLANEOUS			
S1	Switch 2-Pole 6-W Rotary	1	(FF74R)
SK4	Socket Flush Coax	1	(HH09K)
	Vernier Dial Small	1	(RX39N)
	Knobs K10B	3	(RK90X)
	Receiver PCB Assembled	1	(YM59P)
	Bracket MAPSAT	1	(FA92A)
SK5,9	Minicon Latch Housing 3-Way	2	(BX97F)
SK6	Minicon Latch Housing 8-Way	1	(YW23A)
SK7	Minicon Latch Housing 10-Way	1	(FY94C)
SK8	Minicon Latch Housing 2-Way	1	(HB59P)
	Minicon Terminal	26	(YW25C)
LS1	Loudspeaker 8Ω	1	(WB04E)
M1	Signal Strength Panel Meter	1	(LB80B)
M2	Tuning Panel Meter	1	(LB79L)
	Miniature Wire Coax	1 mtre	(XR88V)
	Ribbon Cable 10-Way	1 mtre	(XR06G)
	Bolt 6BA x 1in.	1 pkt	(BF07H)
	Threaded Spacer 6BA x ½in.	1 pkt	(LR72P)
	Nut 6BA	1 pkt	(BF18U)
	Isobolt M2.5 x 12mm	1 pkt	(BF55K)
	Isonut M2.5	1 pkt	(BF59P)
OPTIONAL			
	Instrument Case NM2H	1	(YM51F)
	Front Panel MAPSAT	1	(FA91Y)
	SPST Ultramin. Toggle	1	(FH97F)
	AC Adaptor Unregulated	1	(XX09K)
	Battery PP1 (6V)	2	(FM02C)
	Battery Clips PP9	2	(HF27E)
	Araldite Rapid	1	(FL44X)

A complete kit of all parts, excluding optional items, is available for this project:
Order As LK99H (Satellite Receiver Kit)
The following items included in the above kit list are also available separately, but are not shown in the 1986 catalogue:
Receiver PCB Assembled **Order As YM59P**
Instrument Case NM2H **Order As YM51F**
MAPSAT Front Panel **Order As FA91Y**
Ceramic Filter 10.7MHz/50kHz **UF71N**
PCB 6-Pin DIN Socket **Order As FA90X**
MAPSAT Bracket **Order As FA92A**

SATELLITE AERIAL PARTS LIST

MISCELLANEOUS			
	ABS Box MB3	1	(LH22Y)
	Aerial Rod	4	(YM58N)
	Hole Plug ⅜in.	8	(FW37S)
	Self Tap No.2 x 3/16in.	1 pkt	(BF64U)
	Tag 8BA	1 pkt	(LR02C)
	Low-Loss Coax Brown	5 mtrs	(XR29G)
	Low C Cable	1 mtre	(XR19V)
	Potting Compound 250g	1	(FT19V)
	Tie Wrap 186	5	(BF93B)
	PVC Tape Black 20mm	1	(FM84F)
PL4	Coax Plug Plastic	1	(YW08J)
OPTIONAL			
	Wooden Pole 1in. dia.		
	Wood Screw		

REFL 42"
DR. EL 40"
SPACE 24"

A complete kit of all parts, excluding optional items, is available for this project:
Order As LM00A (Satellite Aerial Kit)
The following item in the above kit list is also available separately, but is not shown in the 1986 catalogue:
Aerial Rod **Order As YM58N**

World Radio History

'MIXING IT'

by Dave Goodman

Part 2 — Using Maplin High Quality Mixer Modules

The Maplin range of HQ Mixer pre-amplifier modules serve as useful building blocks in audio circuits requiring high quality signal processing. General information and technical specifications are detailed here for a further four circuits, available in ready-built or kit form.

PU or Mic Input Module

This module is available in either mono (single channel) or stereo (dual channel) versions; Figure 17 shows the left channel circuit only of the stereo version, but the circuit is common to both mono and stereo. It is suitable for use

MODULE SPECIFICATIONS

	Mic	Mag' PU	Ceramic PU
Input Impedance	56kΩ	56kΩ	200kΩ
Input Signal Level	25mV	5.5mV	100mV
Max O/P before Clipping	7.75V rms (22V Pk)		
Total Harmonic Distortion	Better than 0.2%		
Frequency Response	Flat (−3dB @ 40kHz) to RIAA ±1dB		
Signal to Noise Ratio	Better than 90dB		
PSU	Max 30V DC @ 12mA (stereo) @ 6mA (mono)		

with the following:

a) *High impedance microphone:* Often called dynamic or electret, with 47kΩ to 100kΩ impedance. This module should not be used with 80 to 200Ω low impedance microphones.

b) *Magnetic pick-up cartridge:* Most commonly used on record player pick-ups with 47kΩ impedance and 5mV sensitivity.

c) *Ceramic pick-up cartridge:* Often used, but not so common as magnetic pick-ups. Usually high output, high impedance in nature.

Any one input device can be used per channel (or board) and appropriate equalisation can be selected by fitting

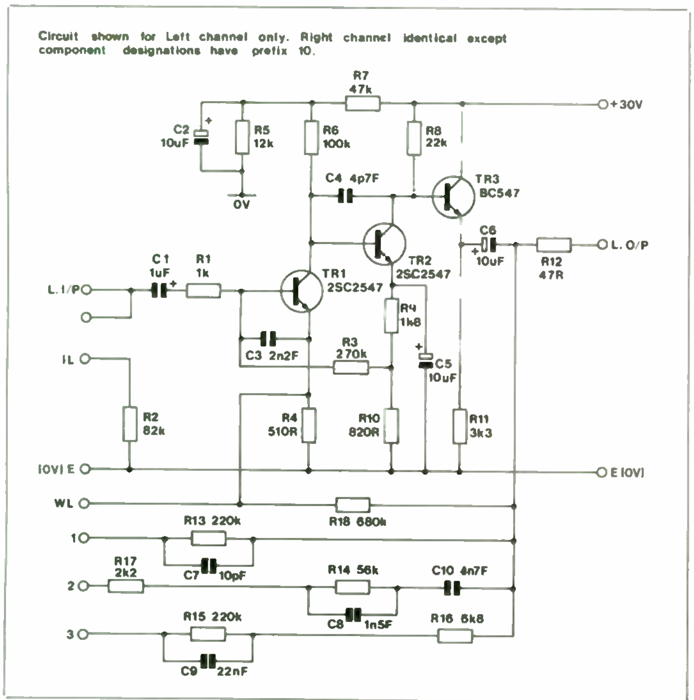

Figure 17. Mic Input Circuit

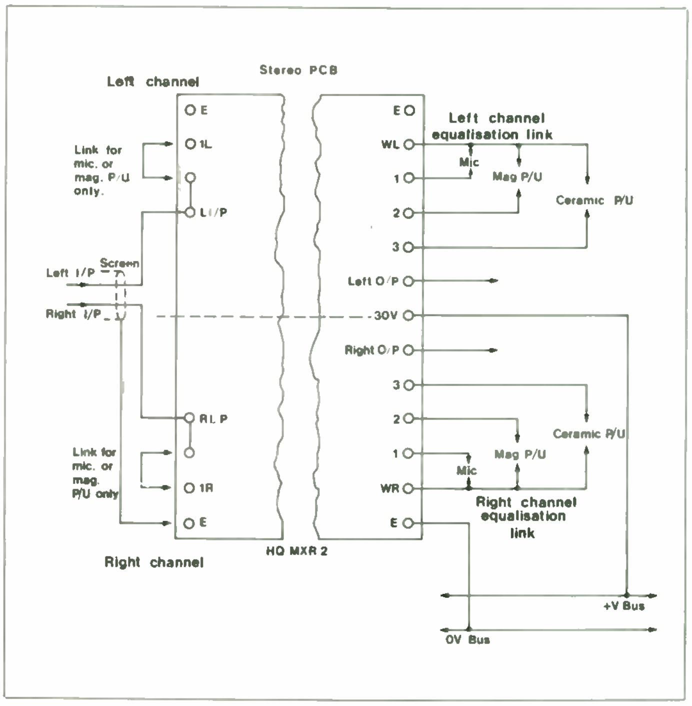

Figure 18. Equalisation link Selection

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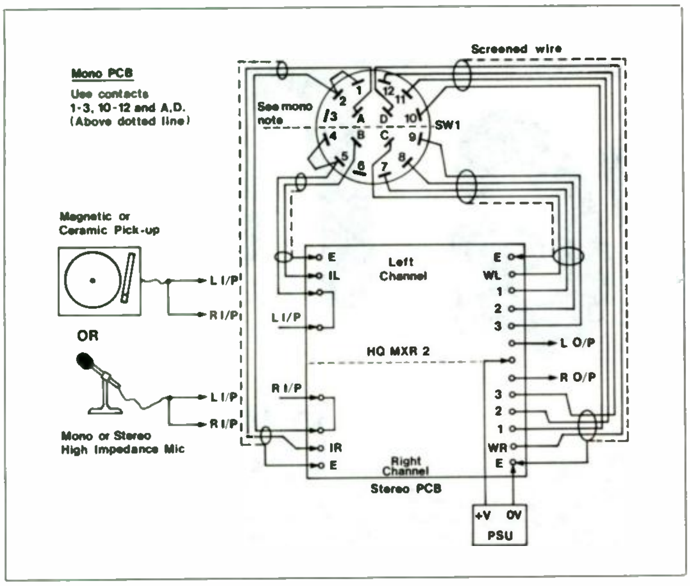

Figure 19. Using a switch for Selection

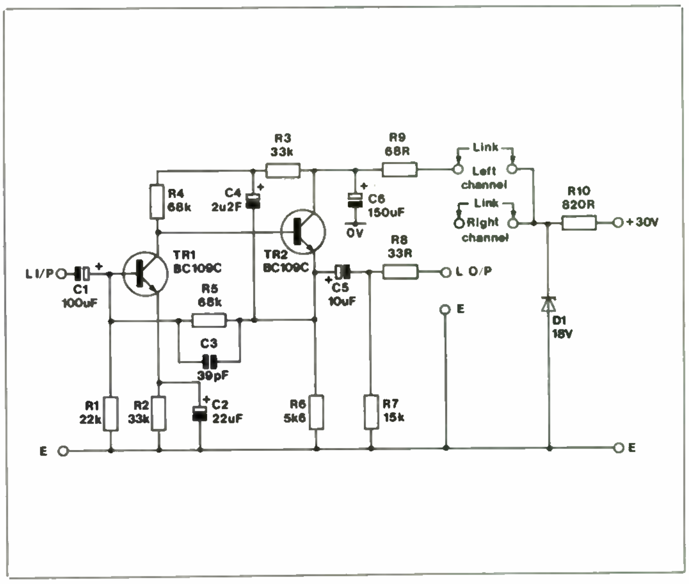

Figure 22. Mixer Circuit

links as shown in Figure 18. Alternatively, it may be found desirable to fit a switch selector instead of links and Figure 19 shows an example of this using screened wire for all signal connections and a 4-pole 3-way rotary switch on the stereo PCB version. Also, use screened wire for both input and output connections on the module, as hum pick-up and noise problems are greatly reduced this way.

The graph in Figure 20 shows the expected frequency response characteristic of the module when equalised for magnetic pick-up, and this closely follows the RIAA standard for replay. Records are manufactured with a boosted high frequency and attenuated low frequency signal content, effectively exhibiting a replay curve with an average rise of <6dB/octave with a small step in the mid-range, hence the replay characteristic for the pre-amp has to be the opposite to this. Ceramic pick-ups by nature exhibit increasing output levels at increasing frequencies; therefore with the ceramic pick-up equalisation selected, it can be seen (Figure 21) that low frequency signals are given a considerable amount of boost. In both instances, the object of equalising circuitry is for the final production of a flat frequency response from 20Hz to 20kHz. No plot is given for the module when used with a microphone, as the frequency response is flat throughout the useful audio range, dropping by 3dB at 40kHz.

The specifications given assume that a 30V DC power supply is used with the module. Lower voltage supplies will not unduly affect circuit performance, but will require lower input signal levels to avoid clipping the waveform.

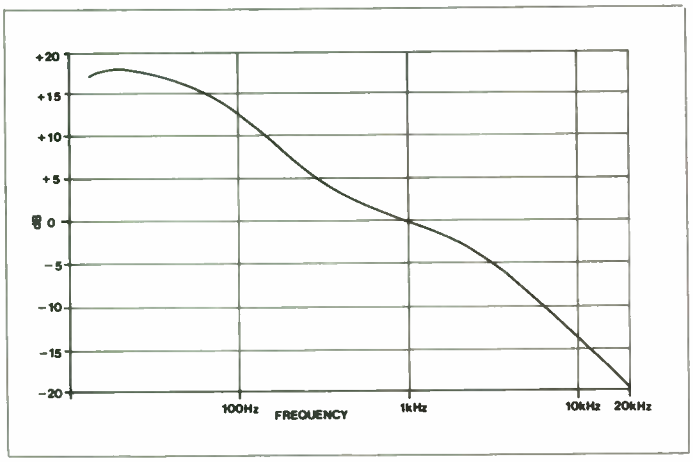

Figure 20. Magnetic PU Response Curve

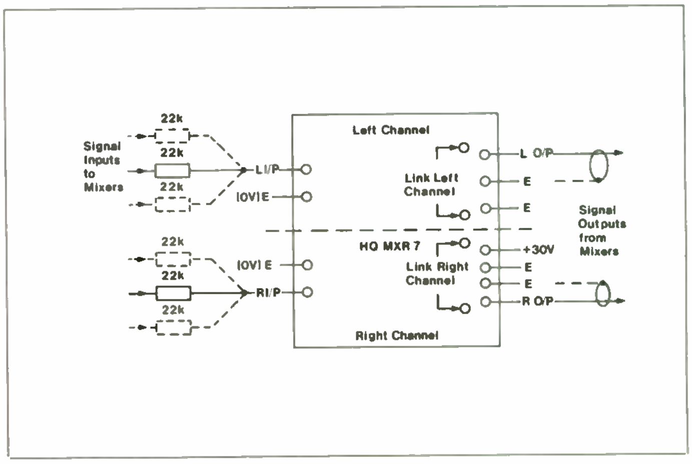

Figure 23. PCB wiring

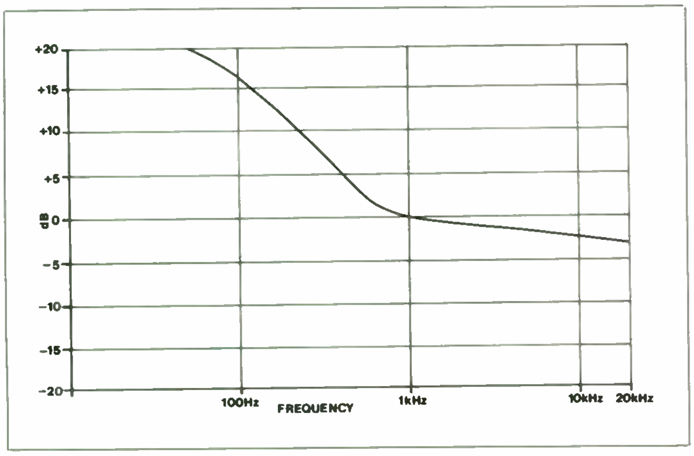

Figure 21. Ceramic PU Response Curve

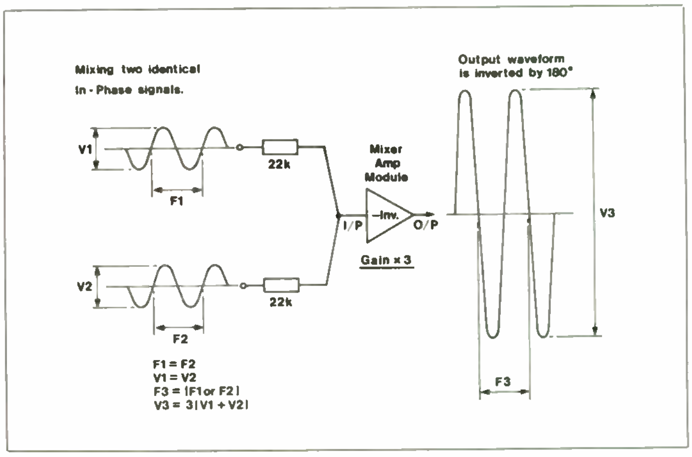

Figure 24. Mixing Identical in-phase Signals

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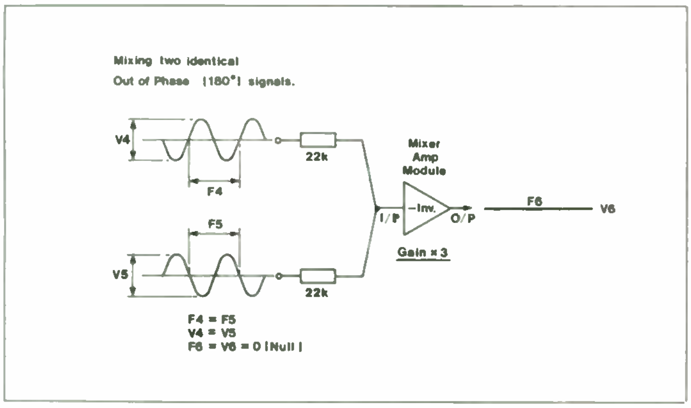

Figure 25. Mixing Identical out-of-phase (180°) Signals

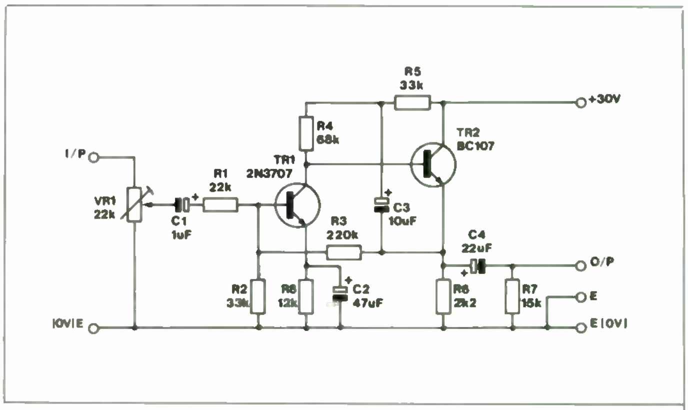

Figure 27. Line Amp Circuit

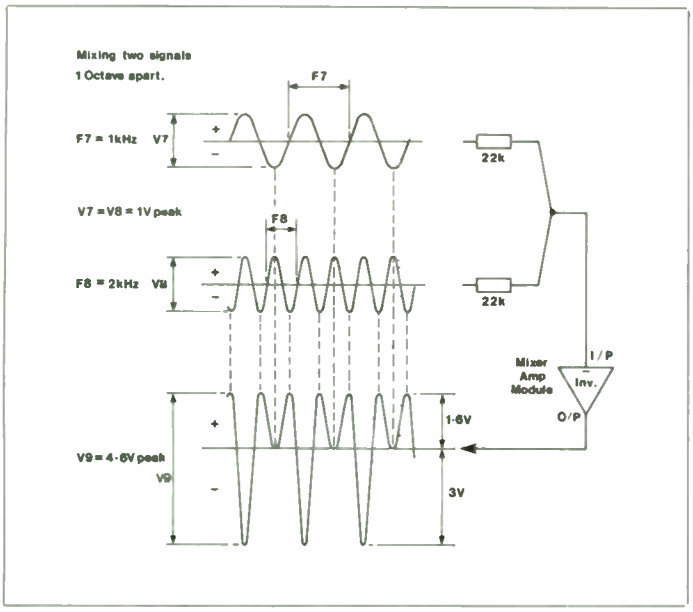

Figure 26. Mixing 2 signals 1 Octave apart

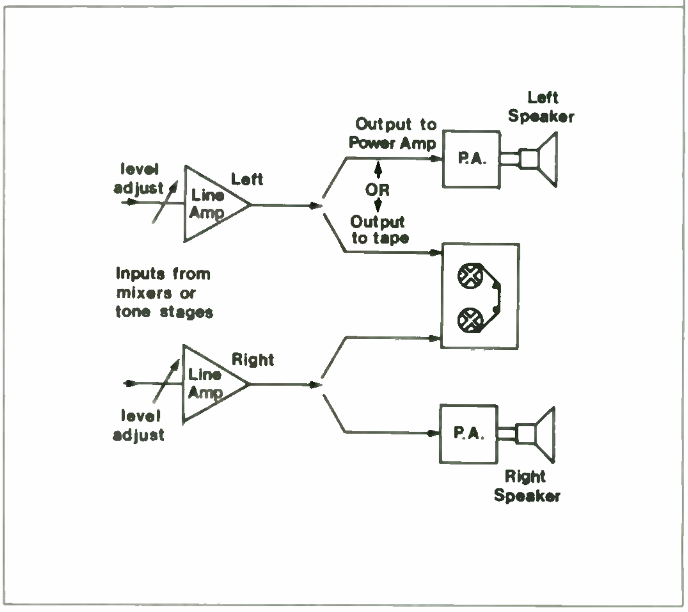

Figure 28. Driving Speakers or Tape Recorder

Mixer Amp Module

MODULE SPECIFICATIONS

Frequency Response	15Hz to 60kHz (−3dB)
Maximum Input Signal	5V Pk into 22k
Maximum Output Signal	15V Pk (Pre-Clipping)
Distortion (@ 1kHz)	0.02%
Noise Level	100μV
PSU 30V DC @ 14mA	

The mixer amplifier is only available as a stereo (dual channel) module. Both circuits are identical, except for prefix numbers on the right hand channel, as usual. From the circuit diagram, Figure 22, it can be seen that the supply regulation comes from R10 and zener diode D1. This part of the circuit is not repeated on both halves of the PCB and regulated 18V DC is extended to each mixer via links, see Figure 23. TR1 and TR2 form a DC coupled amplifier with an overall gain of approximately x3.

Virtual earth mixing is effected by coupling input signals via a 22k resistor (Figures 23 to 26), therefore, as an example, if a 1kHz sinewave signal with a peak-to-peak amplitude of 1V is connected to a 22k resistor and then to the module input at C1, the output signal from R8 will be a 1kHz, 3V peak sinewave (overall gain = x 3). If several different signal sources are to be connected to the module input, each source must be coupled by a separate 22k resistor. One point to note is that the pre-amp inverts all input signals, so the final output waveform does not follow the input waveform exactly in time! The mathematics of mixing signals can be quite complex to both explain easily and understand, and a very general idea is given in Figure 24, 25 and 26. Basically, mixing two identical waveforms together produces a similar waveform (in the case of a sinewave) but with an increased peak-to-peak (amplitude) level. The maximum peak signal output from the module, before clipping occurs, is 15V which corresponds to a 5V peak input signal. Obviously, attempting to connect two 5V in-phase signals at the same frequency would effectively produce a 30V signal which cannot occur due to supply limitations, and therefore, heavy clipping of the output waveform will be evident. In theory, an infinite number of input signals can be applied via an infinite number of resistors as long as the sum total voltages do not exceed 5V, including all in-phase and out-of-phase products. In practice, it is probably advisable to connect no more than six inputs per channel, especially if high (1V peak or more) signal levels are envisaged.

Line Amp Module

MODULE SPECIFICATIONS

Frequency Response	10Hz to 100kHz Flat
Maximum Output Level	26V peak (Pre-Clipping)
Minimum Input Signal for full Output	2.6V Peak
Maximum Input Signal	Continuously Variable
Pre-amp Gain	x10
THD	0.02% @ 1kHz
PSU	Max 30V DC @ 14mA

The line amp module circuit shown in Figure 27, is used as a high level buffer stage output drive to amplifiers or tape recorders, see Figure 28. Maximum gain of the circuit is ten times which makes it unsuitable for direct connection with microphones, and other low level input signal devices.

Wiring of the PCB is shown in Figure 29. In the typical application shown in Figure 30, line amp modules are shown in two output configurations, main output and unequalised output. The module is available in dual (stereo) version only and each input has its own level control which is infinitely variable from zero to maximum (see Specification).

World Radio History

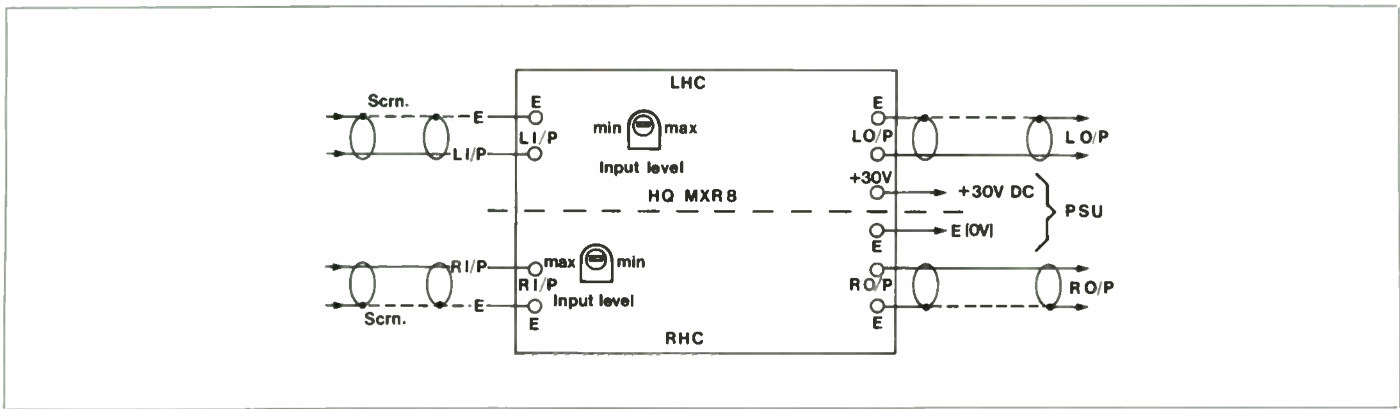

Figure 29. Line Amp wiring

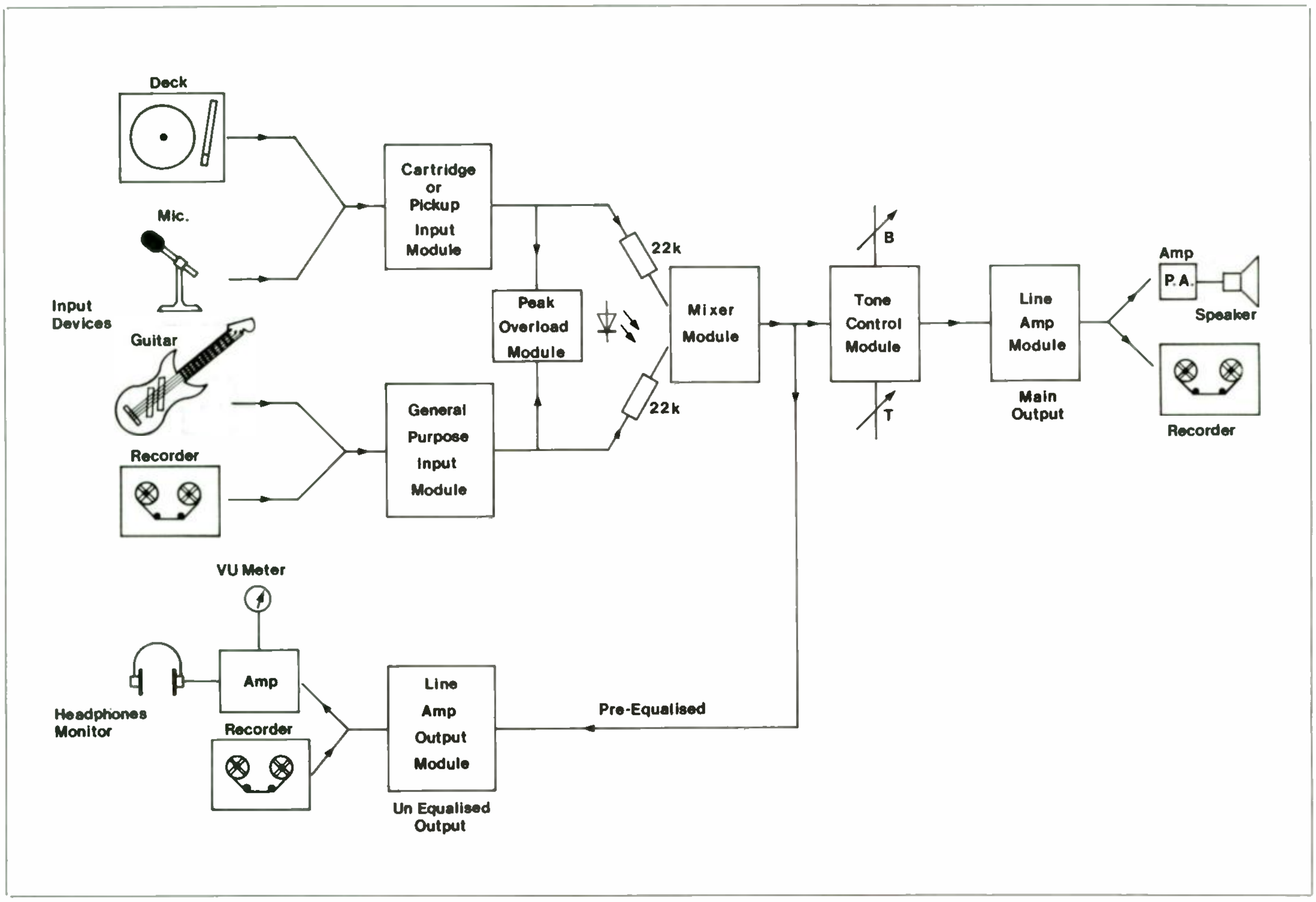

Figure 30. Typical Application

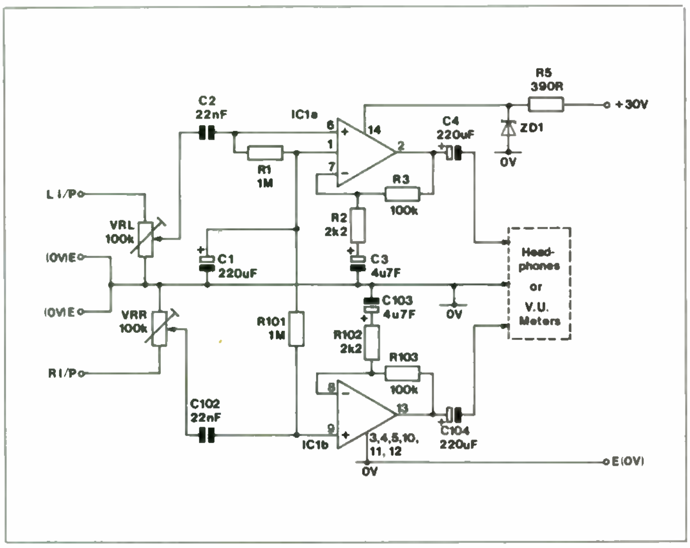

Figure 31. Basic Amplifier Circuit

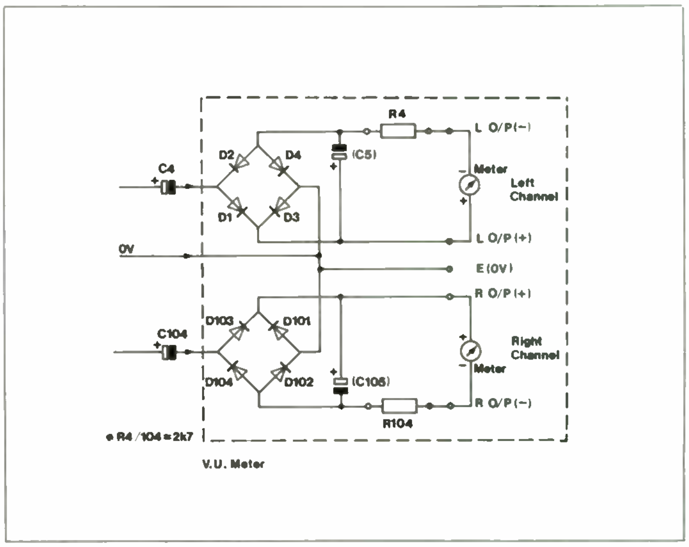

Figure 32. VU Meter Circuit

World Radio History

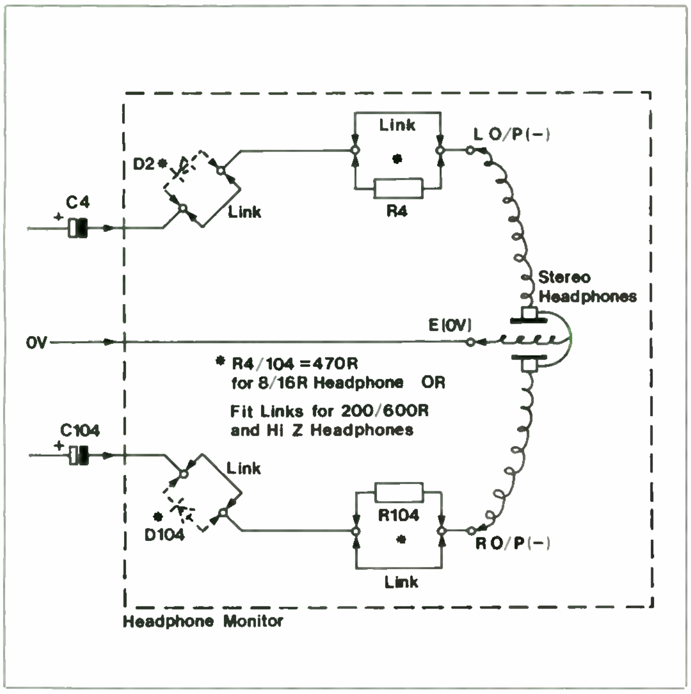

Figure 33. Headphone Monitor Circuit

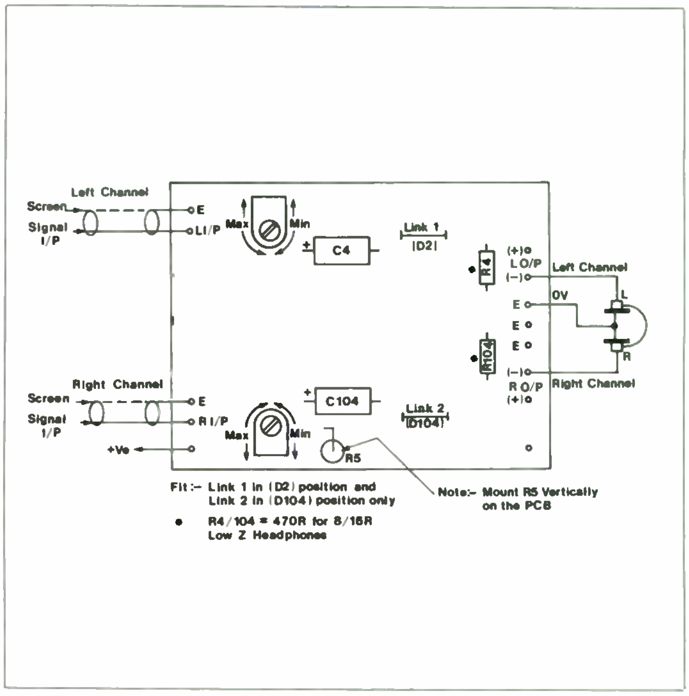

Figure 35. Headphone Monitor wiring

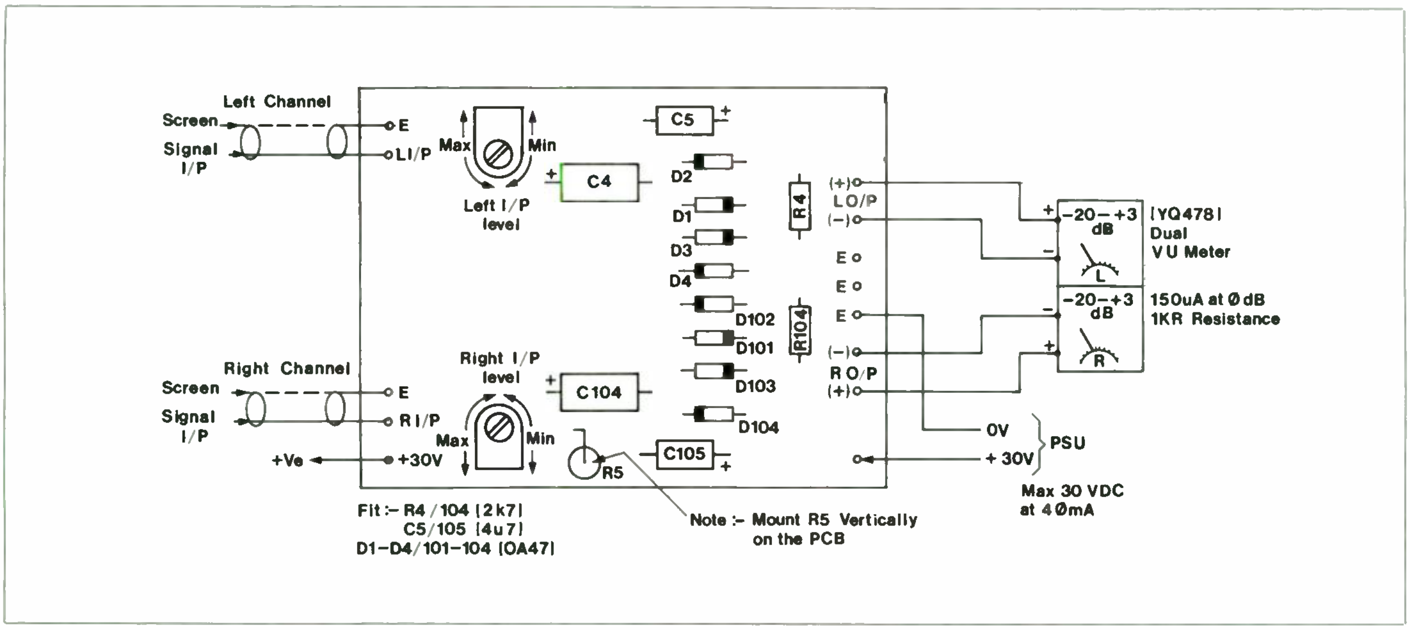

Figure 34. VU Meter wiring

VU/Monitor Amp Module

MODULE SPECIFICATIONS

Pre-Amp Frequency Response	50Hz-20kHz flat
Input Sensitivity	75mV r.m.s. maximum, Continuously variable
Max Output Level	10V pk (O/P open circuit) 150mV pk (into 8Ω 'phones)
VU Mode Input Level	18mV r.m.s. for 0dB scale
PSU Max	+30V DC @ 40mA

The VU/monitor module can be used in one of two ways: driving headphones or twin meter movements. Figure 31 shows the basic amplifier circuit, which is based around an LM377 power amp IC. Each channel input can be adjusted for the required output level via 'on board' presets, VR_R and VR_L.

VU Monitor

For VU meter mode, fit the additional components D1 to D4, D101 to D104, C5/105 and R4/104 (see Figures 32 and 34). With the specified components, a reading of 0dB on the meter scale is indicated with an 18mV r.m.s. input signal, and with the sensitivity presets (VR1, VR101) at maximum (both channels driven).

Headphone Monitor

To use the module in this mode, use wire links in place of D2 and D104, and insert 470Ω resistors in R4 and R104 positions only (see Figures 33 and 35). *Do not* insert any of the components required for the VU version!

When driving 8Ω low impedance headphones, the maximum (pre-clipping) signal developed will be approximately 150mV, which should be loud enough for most applications. It may be necessary to insert links in place of R4/104 if medium impedance (200 – 600Ω) headphones are being used, or to reduce the 470Ω rating accordingly. The power amp IC can only drive loads above 200Ω in this circuit configuration, before overheating of the package begins to cause problems. Power supply requirements are in the range of 15V to 30V DC at 40mA.

This module would normally be used for monitoring all signal lines in a mixer or disco, each line being selected by suitable switching. Alternatively, it could be used as a low power/low cost stereo headphone driver for most audio applications.

World Radio History

HI-Z MIC I/P (MONO) PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	1k	1	(M1K)
R2	82k	1	(M82k)
R3	270k	1	(M270K)
R4	510Ω	1	(M510R)
R5	12k	1	(M12K)
R6	100k	1	(M100K)
R7	47k	1	(M47K)
R8	22k	1	(M22K)
R9	1k8	1	(M1K8)
R10	820Ω	1	(M820R)
R11	3k3	1	(M3K3)
R12	47Ω	1	(M47R)
R13,15	220k	2	(M220K)
R14	56k	1	(M56K)
R16	6k8	1	(M6K8)
R17	2k2	1	(M2K2)
R18	680k	1	(M680K)
CAPACITORS			
C1	1μF 35V Tantalum	1	(WW60Q)
C2,5,6	10μF 63V Axial Electrolytic	3	(FB23A)
C3	2n2F Poly Layer	1	(WW24B)
C4	4p7F Ceramic	1	(WX40T)
C7	10pF Ceramic	1	(WX44X)
C8	1n5F 1% Polystyrene	1	(BX58N)
C9	22nF Poly Layer	1	(WW33L)
C10	4n7F 1% Polystyrene	1	(BX64U)
SEMICONDUCTORS			
TR1,2	2SC2547	2	(QY11M)
TR3	BC547	1	(QQ14Q)
MISCELLANEOUS			
	Hi-Z Mic I/P (Mono) PCB	1	(GD11M)
	Veropin 2145	1 Pkt	(FL24B)
OPTIONAL			
SW1	4 Pole 3-Way Rotary Switch	1	(FH45Y)

A complete kit of all parts and a ready built module, excluding optional item, are available for this project:
Order As LK92A (Hi-Z Mic Input Mono Kit)
Order As YM26D (Hi-Z Mic Input Mono Assembled)

HI-Z MIC I/P (STEREO) PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,101	1k	2	(M1K)
R2,102	82k	2	(M82k)
R3,103	270k	2	(M270K)
R4,104	510Ω	2	(M510R)
R5,105	12k	2	(M12K)
R6,106	100k	2	(M100K)
R7,107	47k	2	(M47K)
R8,108	22k	2	(M22K)
R9,109	1k8	2	(M1K8)
R10,1010	820Ω	2	(M820R)
R11,1011	3k3	2	(M3K3)
R12,1012	47Ω	2	(M47R)
R13,15,1013,1015	220k	4	(M220K)
R14,1014	56k	2	(M56K)
R16,1016	6k8	2	(M6K8)
R17,1017	2k2	2	(M2K2)
R18,1018	680k	2	(M680K)
CAPACITORS			
C1,101	1μF 35V Tantalum	2	(WW60Q)
C2,5,6,102, 105,106	10μF 63V Axial Electrolytic	6	(FB23A)
C3,103	2n2F Poly Layer	2	(WW24B)
C4,104	4p7F Ceramic	2	(WX40T)
C7,107	10pF Ceramic	2	(WX44X)
C8,108	1n5F 1% Polystyrene	2	(BX58N)
C9,109	22nF Poly Layer	2	(WW33L)
C10,1010	4n7F 1% Polystyrene	2	(BX64U)
SEMICONDUCTORS			
TR1,2,101,102	2SC2547	4	(QY11M)
TR3,103	BC547	2	(QQ14Q)
MISCELLANEOUS			
	HQ Mixer No.2 PCB	1	(LR13P)
	Veropin 2145	1 Pkt	(FL24B)
OPTIONAL			
SW1	4 Pole 3-Way Rotary Switch	1	(FH45Y)

A complete kit of all parts and a ready built module, excluding optional item, are available for this project:
Order As LK91Y (Hi-Z Mic Input Stereo Kit)
Order As YM25C (Hi-Z Mic Input Stereo Assembled)

LINE AMPLIFIER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,101	22k	2	(M22K)
R2,5,102,105	33k	4	(M33K)
R3,103	220k	2	(M220K)
R4,104	68k	2	(M68K)
R6,106	2k2	2	(M2K2)
R7,107	15k	2	(M15K)
R8,108	12k	2	(M12K)
VR1,101	Vert S-min Preset 22k	2	(WR72P)
CAPACITORS			
C1,101	1μF 100V Axial Electrolytic	2	(FB12N)
C2,102	47μF 16V Axial Electrolytic	2	(FB38R)
C3,103	10μF 63V Axial Electrolytic	2	(FB23A)
C4,104	22μF 25V Axial Electrolytic	2	(FB30H)
SEMICONDUCTORS			
TR1,101	2N3707	2	(QR31J)
TR2,102	BC107B	2	(QB31J)
MISCELLANEOUS			
	HQ Mixer No.8 PCB	1	(LR23A)
	Veropin 2145	1 Pkt	(FL24B)

A complete kit of all parts and a ready built module are available for this project:
Order As LK87U (Line Amp Kit)
Order As YM21X (Line Amp Assembled)

MIXER AMPLIFIER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,101	22k	2	(M22K)
R2,3,102,103	33k	4	(M33K)
R4,5,104,105	68k	4	(M68K)
R6.106	5k6	2	(M5K6)
R7,107	15k	2	(M15K)
R8,108	33Ω	2	(M33R)
R9,109	68Ω	2	(M68R)
R10	820Ω	1	(M820R)
CAPACITORS			
C1,101	100μF 10V P.C. Electrolytic	2	(FF10L)
C2,102	22μF 25V Axial Electrolytic	2	(FB30H)
C3,103	39pF Ceramic	2	(WX51F)
C4,104	2μ2F 100V Axial Electrolytic	2	(FB15R)
C5,105	10μF 25V Axial Electrolytic	2	(FB22Y)
C6,106	150μF 25V Axial Electrolytic	2	(FB56L)
SEMICONDUCTORS			
TR1,2,101,102	BC109C	4	(QB33L)
D1	BZY88C18V	1	(QH20W)
MISCELLANEOUS			
	Veropin 2145	1 Pkt	(FL24B)
	Mixer No.7 PCB	1	(LR22Y)
OPTIONAL			
	22k Input Resistor		(M22K)

A complete kit of all parts and a ready built module, excluding optional item, are available for this project:
Order As LK86T (Mixer Amp Kit)
Order As YM20W (Mixer Amp Assembled)

World Radio History

VU METER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film unless specified

R1,101	1M	2	(M1M)
R2,102	2k2	2	(M2K2)
R3,103	100k	2	(M100K)
R4,104	2k7	2	(M2K7)
R5	390Ω 1W Carbon Film	1	(C390R)
VRL,VRR	100k Hor Sub-min Preset	2	(WR61R)
CAPACITORS			
C1,4,104	220µF 35V Axial Electrolytic	3	(FB62S)
C2,102	22nF Ceramic	2	(WX78K)
C3,5,103,105	4µ7F 100V Axial Electrolytic	4	(FB18U)
SEMICONDUCTORS			
IC1	LM377N	1	(QH38R)
ZD1	BZX61C15V	1	(QF57M)
D1,2,3,4,101,102, 103,104	OA47	8	(QH70M)
MISCELLANEOUS			
	HQ Mixer PCB No.10	1	(LR25C)
	14 Pin DIL Skt	1	(BL18U)
	Veropin 2145	1 Pkt	(FL24B)
OPTIONAL			
	Dual VU Meter	1	(YQ47B)

A complete kit of parts and a ready built module, excluding Optional item, are available for this project.
Order As LK88V (VU Meter Kit)
Order As YM22Y (VU Meter Assembled)

HEADPHONE MONITOR PARTS LIST

RESISTORS: All 0.6W 1% Metal Film unless specified

R1,101	1M	2	(M1M)
R2,102	2k2	2	(M2K2)
R3,103	100k	2	(M100K)
R4,104	470Ω	2	(M470R)
R5	390Ω 1W Carbon Film	1	(C390R)
VRL,VRR	100k Hor Sub-min Preset	2	(WR61R)
CAPACITORS			
C1,4,104	220µF 35V Axial Electrolytic	3	(FB62S)
C2,102	22nF Ceramic	2	(WX78K)
C3,103	4µ7F 100V Axial Electrolytic	2	(FB18U)
SEMICONDUCTORS			
IC1	LM377N	1	(QH38R)
ZD1	BZX61C15V	1	(QF57M)
MISCELLANEOUS			
	HQ Mixer PCB No.10	1	(LR25C)
	14 Pin DIL Skt	1	(BL18U)
	Veropin 2145	1 Pkt	(FL24B)

A complete kit of parts and a ready built module are available for this project:
Order As LK89W (Headphone Monitor Kit)
Order As YM23A (Headphone Monitor Assembled)

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With most electronic projects, performance will depend on the conditions of use. Recommendations and suggestions made in the articles in this magazine are for guidance only, since conditions of use are beyond our control.

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Our 'Get-You-Working Service' is available for any of the projects published in this magazine, *provided* they are constructed on our ready-etched printed circuit boards, and that they use a majority of components supplied by us. We regret we *cannot* extend this service to the 'interest' circuits, for which we do not provide ready-made boards, or supply as projects or kits; nor for projects or kits that have been *customised or modified by the constructor.*

We cannot enter into correspondence with regards to fault-finding, and recommend you return the unit to us for servicing if you are unable to rectify the fault yourself.

Project Servicing

If the problem has been caused by a faulty component supplied by us, then there will be no charge for the work performed or the components used. If the fault has been caused by error(s) in construction, then there will be a charge for the work performed at a rate of £10 per hour, or part of an hour plus the cost of any damaged components which need to be replaced. If *no fault* is found on the unit, then there will still be a charge of £10 per hour or part of an hour *for the time involved in establishing this fact.*

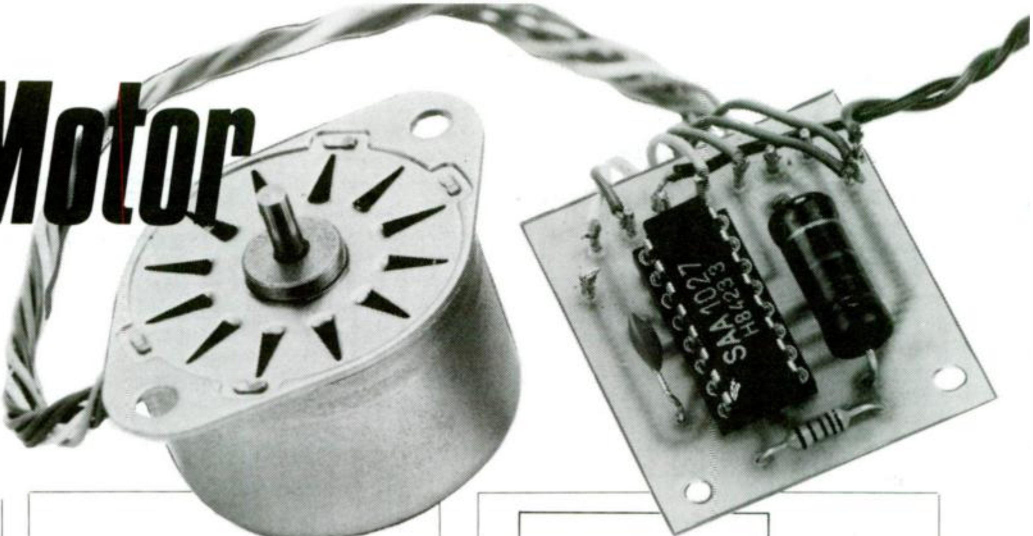
Projects returned for repair should be addressed to:–

Service Department
Maplin Electronic Supplies Ltd
P.O. Box 3
Rayleigh
Essex
SS6 8LR

World Radio History

Stepper Motor Driver

by Mark Brighton



The Stepper Motor is an increasingly popular means by which positional and/or speed control may be achieved in motor driven systems, especially those controlled by digital logic or microprocessor circuits. It is, however, rather awkward to control using simple digital electronics as it requires several sequential combinations of logic states on its control lines to cause it to rotate.

- ★ ***Simple to Use***
- ★ ***Based on the SAA1027 IC***
- ★ ***Easy to Construct***

In Figure 1, the SAA1027 is a Mullard IC designed to simplify the driving of 4-phase unipolar Stepping Motors, such as that shown on page 437 of the 1986 Maplin Catalogue. It requires only a 12V pulse for each step of the motor, and a 12V/0V logic state to control the direction of rotation. A reset pin is also available to internally re-initialise the stepping sequence within the chip. This chip, together with the necessary external parts and a pcb, is offered as a kit and is small enough to be mounted on or nearby the motor, where available space is limited.

Construction

Referring to Figure 2, insert fully and solder all veropins, R1, RB, C1, and the IC socket onto the pcb, noting alignment mark on the legend. Fit the IC into its socket with the same orientation. Check for short circuits and wash off excess flux with thinners.

Testing

Wire the pcb to the motor as shown in Figure 3. Connect the 'M' pin to 0V, and apply 12V pulses to the 'C' pin. 'R' should be connected to +12V if reset is *not* required. The motor should rotate clockwise. On connecting 'M' to +12V, it should run anticlockwise.

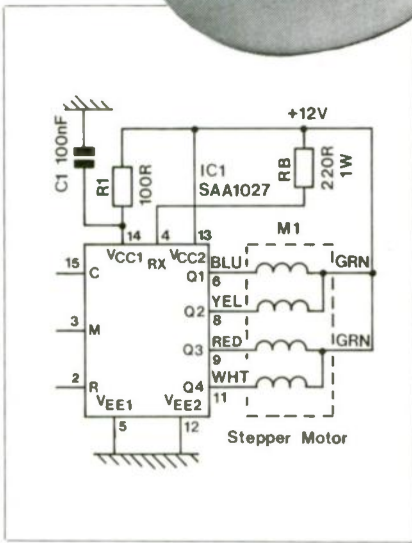


Figure 1. Circuit

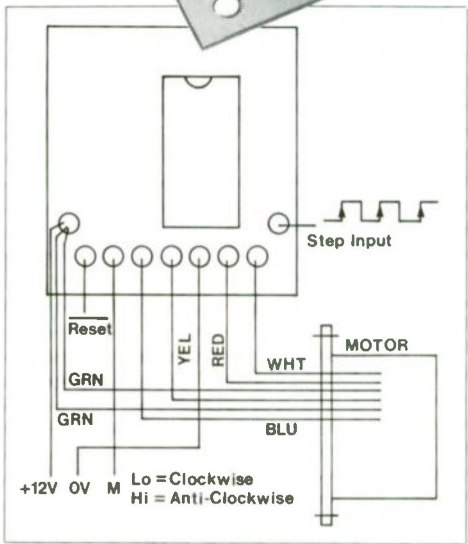


Figure 3. Wiring

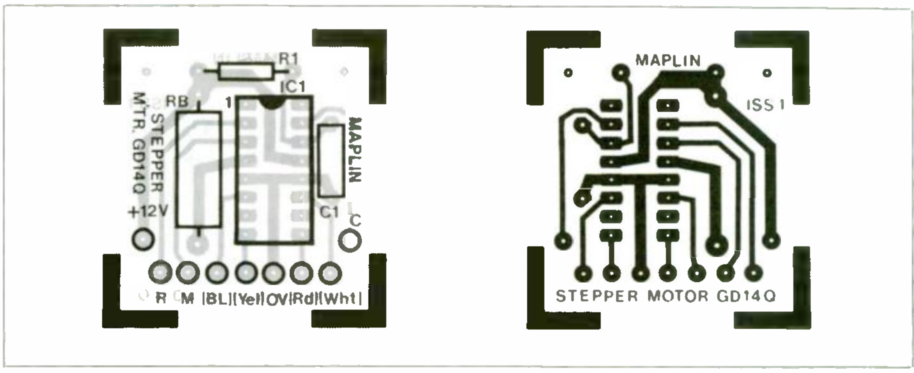


Figure 2. PCB Layout

STEPPER MOTOR DRIVER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film unless specified			
R1	100R	1	(M100R)
RB	220R 1W Carbon Film	1	(C220R)
CAPACITORS			
C1	100nF Disc Ceramic	1	(BX03D)
SEMICONDUCTORS			
IC1	SAA1027	1	(QY76H)
MISCELLANEOUS			
M1	Stepper Motor	1	(FT73Q)
	SAA1027 Data Sheet	1	(DS00A)
	Veropin 2145	1 Pkt	(FL24B)
	Stepper Motor PCB	1	(GD14Q)

A complete kit of all parts is available:
Order As LK76H (Stepper Motor Driver Kit)
The following item in the above list is also available separately but is not shown in our 1986 catalogue:
Stepper Motor PCB **Order As GD14Q**

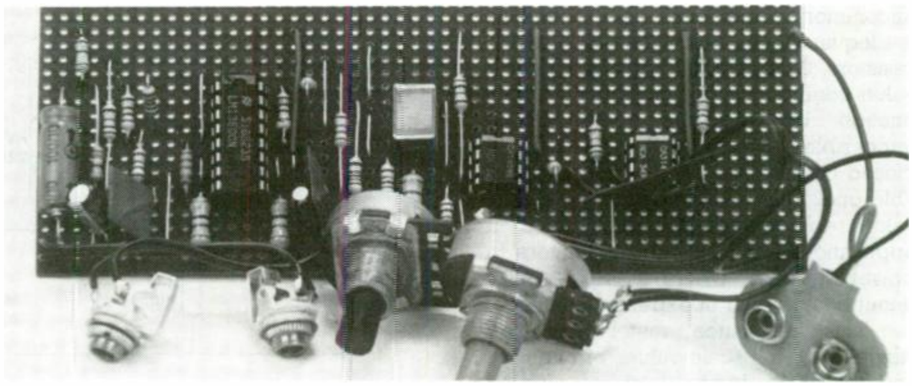
World Radio History

FANTASTIC FIVE

by Robert Penfold

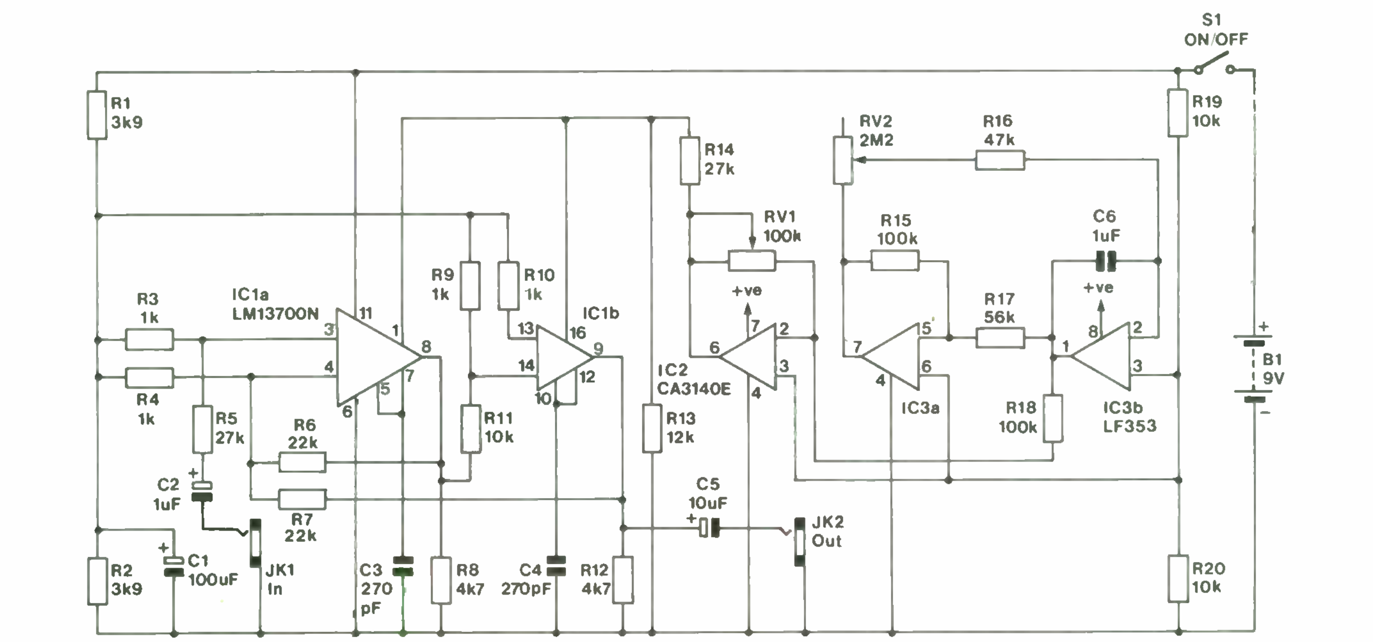
Lowpass Filter Effects Unit

There are a great many forms of musical effects unit, and most rely on some form of frequency selective filtering for their operation. The unit featured here is in this category, and it is basically just a 12dB per octabe lowpass filter which is swept by a low frequency oscillator. This gives a sort of tremolo effect on the high frequency content of the processed signal, producing a relatively mild but useful effect. It is an effect that is available on many synthesisers, but which seems to be something of a rarity as far as stand-alone effects units are concerned.



The circuit breaks down into two sections; the filter which is built around IC1, and the oscillator which is based on IC2 and IC3. Starting with the filter, this uses two transconductance operational amplifiers which are contained in a single LM13700N device. A darlington pair emitter follower output stage is also included for each amplifier, and these have discrete load resistors R8 and R12. The two amplifiers are connected in series, and in this application function more as voltage controlled resistors than amplifiers. They act as simple 6dB per octave lowpass filters in conjunction with C3 and C4, giving a combined attenuation rate of 12dB per octave. Feedback through R6 and R7 gives what is actually a bandpass response at pin 8 of IC1, and by taking the output signal from here a form of waa-waa effect can be obtained. IC1 is current rather than voltage operated, but the inclusion of R14 in series with the control inputs gives a current flow that is roughly proportional to the applied voltage, and effectively converts the filter to voltage controlled operation. R13 reduces the input voltage range from the oscillator slightly, bringing it into a more suitable range to drive the filter.

The oscillator uses IC3 in a well known configuration which is based on a Millier Integrator (IC3a) and a Schmitt



Low Pass Filter

World Radio History

Trigger (IC3b). This type of circuit gives both squarewave and triangular outputs. In this application a triangular waveform gives good results with a smooth sweeping of the filter frequency, and it is this output that is utilized. The operating frequency can be varied by means of RV2, and the nominal frequency range is from 10Hz at minimum resistance to 0.2Hz (one cycle every five seconds) at maximum resistance.

It is more than a little useful to have some control over the sweep range, and this is provided by RV1. This controls the feedback applied to IC2, and hence the voltage gain of this device. When set at a low value IC2 has only a low voltage gain, resulting in the cut-off frequency of the filter being varied over a narrow range of frequencies in the lower treble range. Higher resistance gives greater sweep width, with the cut-off frequency being swept over most of the audio frequency range with RV1 set at maximum value.

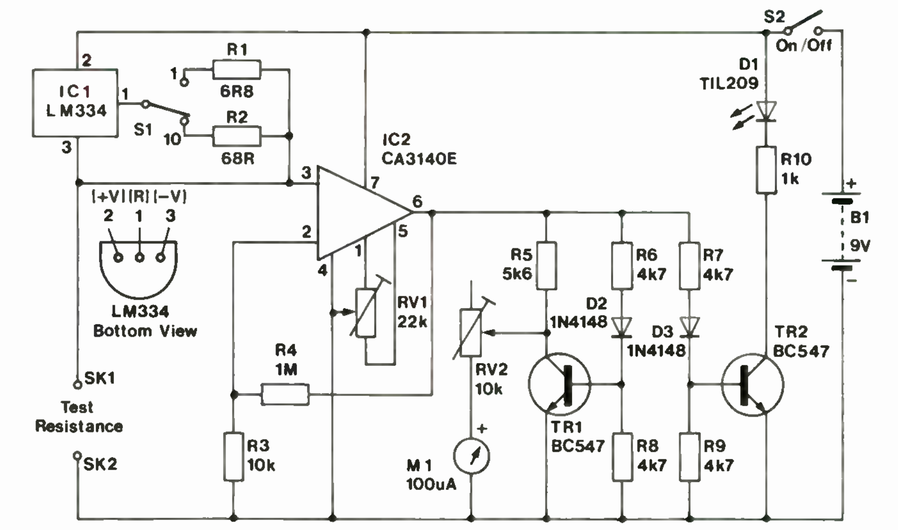
As with any effects unit, it is advisable to build the unit into a strong metal case such as a diecast aluminium type. If a bypass switch is needed a standard DPDT bypass configuration can be used, and the switch should be a heavy duty push button type mounted on the top of the case so that it can be operated by foot.

Low Resistance Meter

Normal multimeters, including some quite expensive digital types, do not give very good results at low resistances. This is something that obviously varies from one instrument to another, but a resolution of one ohm or more is not uncommon, and this is obviously inadequate when testing very low value resistors. Open circuit or seriously overvalue components can be detected well enough, but it could prove to be impossible to distinguish between a closed circuit component and a serviceable one. This is often important as low value resistors are commonly used in applications such as current limiters in power supplies, where a faulty component could result in expensive damage.

This resistance meter has two ranges with full scale values of one ohm and ten ohms. It can therefore give an accurate assessment of resistances as low as a fraction of an ohm. It is an analogue instrument, but unlike conventional analogue resistance meters it has a forward reading linear scale. With an in-range resistance across the test prods, it uses a test voltage of no more than about 10 millivolts, and it will consequently not respond to semiconductor junctions. This can be useful when making continuity checks on circuit boards, where forward biased semiconductor junctions can often give misleading results by suggesting the presence of a short circuit where none exists.

The system used in this meter is to feed a constant current to the test resistance, and to measure the voltage developed across it. As this voltage is proportional to the resistance present, the meter can be calibrated dirctly in ohms using a forward reading linear scale, rather than the awkward reverse reading logarithmic type which is normally associated with analogue resistance meters. Here the constant current is provided by IC1 which is an integrated circuit designed specifically for current regulator applications. The current is controlled by a discrete resistor, and in this circuit two switched resistors (R1 and R2) give current options of 1 and 10 milliamps. M1, RV2, and R5 form the voltmeter circuit, and the nominal full scale value is 1 volt. However, IC2 boosts the sensitivity by a factor of about one hundred, giving a full scale value of 10 millivolts to the voltmeter circuit as a whole. Using Ohm's Law this gives full



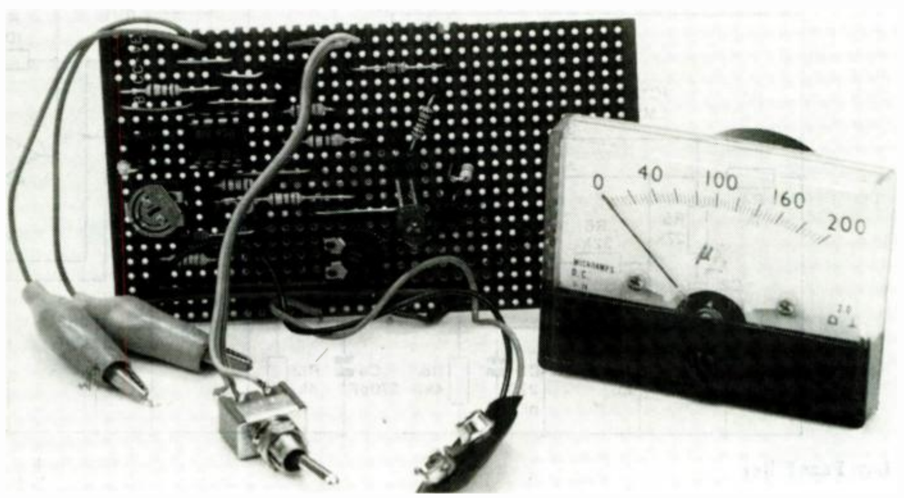
Low Resistance Meter

scale values of 1 ohm with a 10 milliamp test current, and 10 ohms with a 1 milliamp test current. RV2 is adjusted to give good accuracy, and RV1 compensates for offset voltages in IC2.

One problem with the basic circuit is that the meter would be driven hard against its end stop with no in-range resistance across the test prods. This is overcome by using TR1 as an electronic switch, which bypasses the meter circuit if the output of IC2 goes to more than about +1.2 volts. This prevents serious overloads of the meter, but makes it impossible to determine whether a valid reading or an overload is present. This is overcome by using TR2 to switch on LED indicator D1 if an overload is present. D1 switching off therefore indicates that a valid meter reading is present.

The unit is calibrated on the 10 ohm range using 1 and 10 ohm 1% resistors. First RV2 is adjusted for fsd with the 10 ohm resistor in circuit, after which the 1 ohm resistor is connected across the test prods and RV1 is adjusted for the correct reading of one tenth fsd. This procedure is repeated until no further adjustment is necessary.

In the interest of good accuracy it is important to keep resistances at the input of the circuit as low as possible. In particular, use short test leads of heavy gauge wire, and test prods that provide a low resistance (some spring types seem to be unsuitable).



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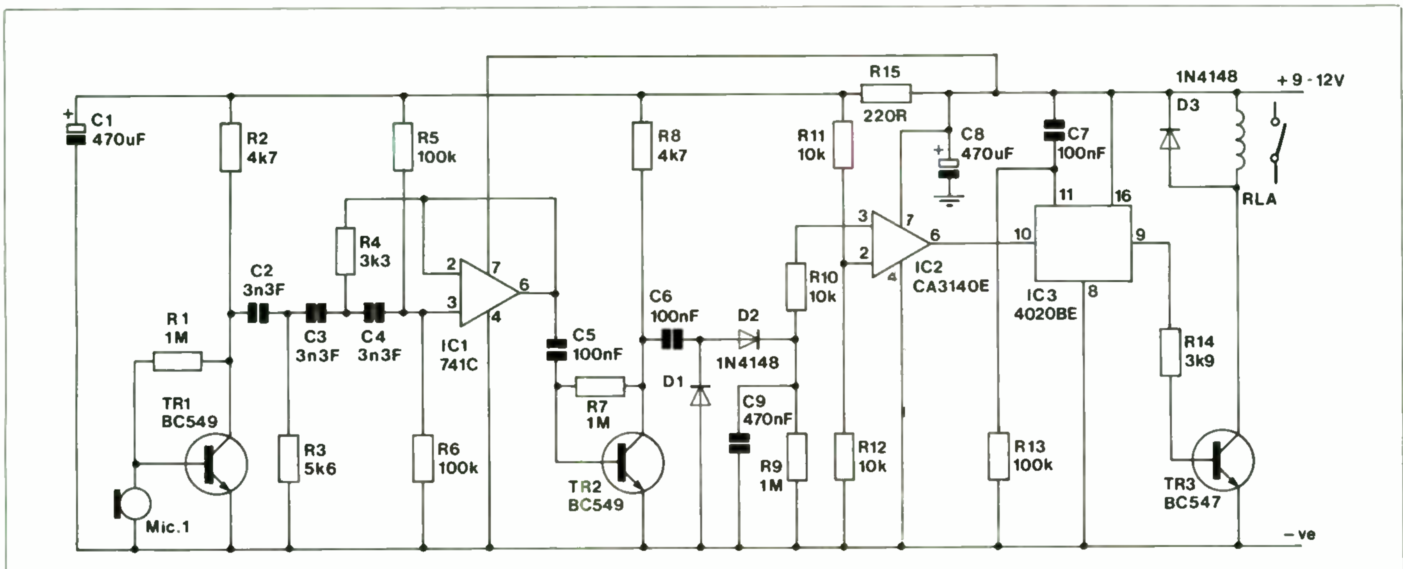


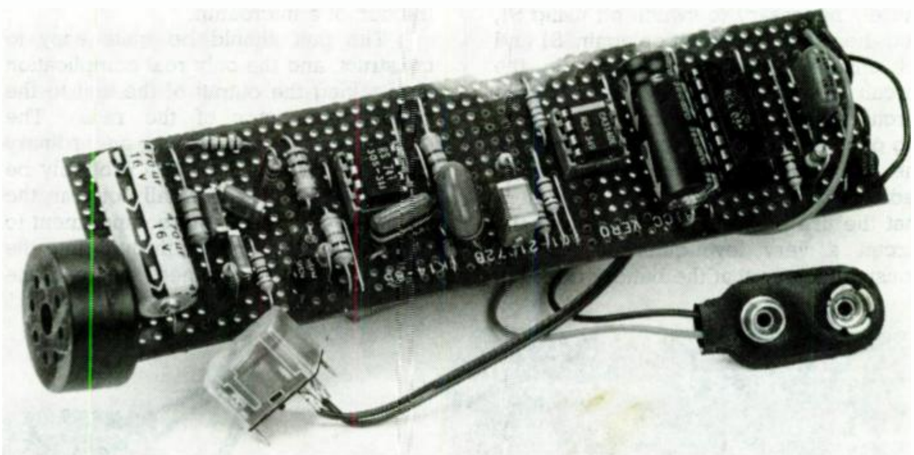
Clap Switch

Clap Switch

This circuit was designed mainly as a novelty project, but although intended to be in the 'impress your friends' category, it could in fact be used as a practical alternative to simple ultrasonic and infra-red remote control systems. It is merely necessary to clap once in order to switch on the piece of controlled equipment, and to clap once more in order to switch it off again. Being a sound activated switch it is not totally immune to sounds other than handclaps, but a combination of moderate sensitivity and built-in filtering minimise the risk of spurious triggering.

TR1 operates as a high gain common emitter preamplifier, and its input is fed direct from a crystal microphone. This can be an inexpensive microphone insert, although many of these seem to give poor sensitivity, and a ceramic resonator was found to provide better results. A crystal microphone needs to feed into a very high load impedance in order to give a flat frequency response, and a fairly low input impedance (such as that of TR1) gives poor bass and middle frequency response. In this case though, we are only interested in the pre-dominantly high frequency content of a handclap, and the lack of bass and middle frequency response is an advantage as it reduces the risk of spurious triggering. In fact, the input stage is followed by an active highpass filter based on IC1 which gives an 18dB per octave roll-off below about 7kHz. The output of the filter feeds the input of a second high gain common emitter amplifier, this time based on TR2.

The output from TR2 is rectified and smoothed by D1, D2, and C6, but under stand-by conditions there will be no significant output signal. However, a handclap will produce a strong positive DC bias across C6 that will decay over a period of a few hundred milliseconds. IC2 operates as a comparator which converts this signal into a pulse that will reliably drive the next stage, which is a CMOS divide by two circuit. In fact the



4020BE used for IC3 is a 14 stage type, but only one stage is used here. This drives the relay via switching transistor TR3, and the purpose of the divider circuit is to give the required successive type of operation, with alternate input pulses switching the relay on and off. C7 and R13 provide a reset pulse to IC3 at switch on, starting the relay in the off state. D3 is the usual protection diode.

The specified relay has a change-over contact with a rating of 5A at 240 volts AC. However, the unit should work properly using any relay having adequate contact ratings for your intended application, and a 6 volt coil with a resistance of about 200 ohms or more. Of course, a relay having a nominal 12 volt operating voltage is suitable if the unit is used with a 12 volt supply. If a mains load is controlled by the unit it is essential to observe all the normal safety precautions, and beginners would be well advised not to attempt control of mains powered equipment. The microphone must be reasonably well acoustically isolated from the relay if oscillation due to acoustic feedback is to be avoided. The current consumption is about 5 milliamps with the relay switched off, and around 40 milliamps when it is activated. In most cases battery operation will only be viable if some form of rechargeable type is used.

Snooze Timer

Virtually all clock radios include a 'snooze' or 'sleep' facility which simply switches off the set after a preset time has elapsed. The general idea is to activate the timer when going to bed, and the radio then switches itself off when the user has become drowsy and is just dropping off to sleep. A somewhat simpler version of this feature (with non-adjustable delay) is sometimes found in other types of radio, ranging from cheap portable radios to expensive communications receivers, and it is quite easy to add a simple 'sleep' function to small battery operated radios. A suitable circuit is shown here, and this gives a switch-off delay of about 10 minutes. However, by changing the value of one component it is possible to obtain virtually any required delay time.

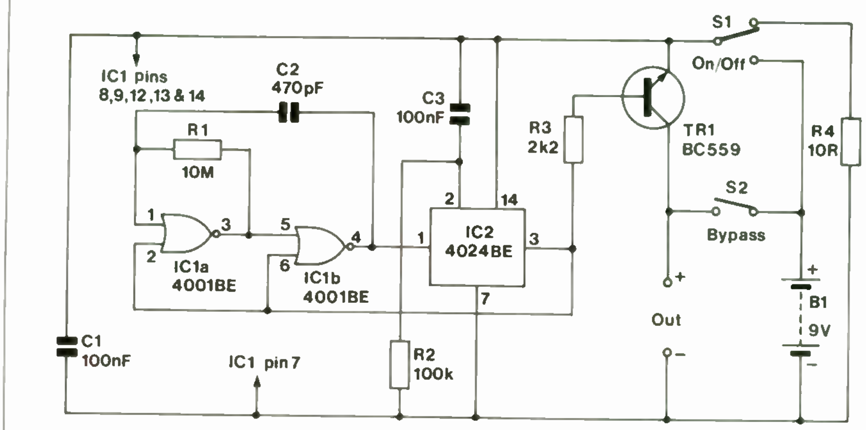
Simple C – R timing circuits work quite well when only short pulse lengths are required, but for periods of about a minute or more, the required values become impractically high. The standard solution to the problem, and the one adopted here, is to use an oscillator and divider chain arrangement. In this circuit two CMOS NOR gates (IC1a and IC1b) are used as inverters and connected in a standard CMOS astable configuration. IC2 is the divider, and is a CMOS 7 stage binary type, giving a total division rate

World Radio History

of 128 with all seven stages used (as they are here). TR1 operates as a common emitter switch which is driven from the output of stage seven of IC2. TR2 is cut off when this output is high, and turned on when it is low. C3 and R2 provide a reset pulse to IC2 at switch-on, and this takes all seven outputs low, causing TR1 to turn on and supply power to the radio set.

After 64 clock pulses from IC1, the output of the final binary divider goes high, switching off both TR1 and the radio set. After a further 64 clock pulses the circuit would revert back to its original state, and it would continue to cycle indefinitely in this way. This problem is overcome by using a gated astable clock oscillator, with the gate input being fed from pin 3 of IC2. The clock is therefore muted when pin 3 of IC2 goes high at the end of the switch-off delay.

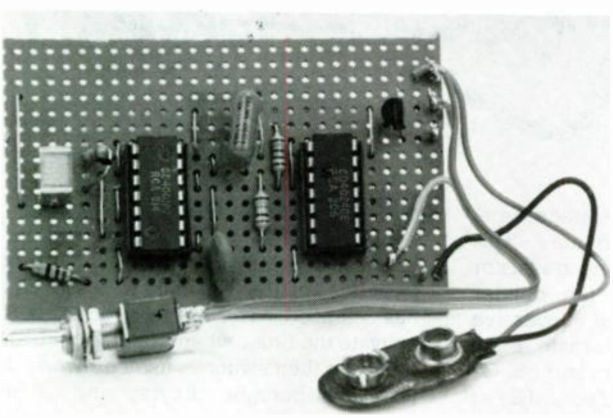
In order to reactivate the circuit it is merely necessary to switch off using S1, and then switch the unit on again. S1 and R4 ensure that the capacitors in the circuit discharge rapidly, leaving the circuit ready to operate from the beginning once again. S2 can be used to bypass the unit when normal operation of the radio is required. An important point is that the use of CMOS devices gives the circuit a very low quiescent current consumption so that the battery does not run down significantly when the radio is switched off. In fact, the quiescent current consumption is typically only a fraction of a microamp.

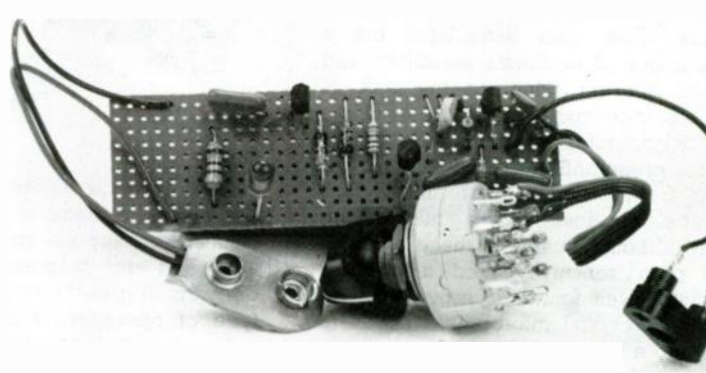


Snooze Timer

The unit should be quite easy to construct, and the only real complication is in taking the output of the unit to the battery connector of the radio. The output can be carried via an ordinary battery clip lead, but it will probably be necessary to make a small notch in the lid of the radio's battery compartment to enable the lead to pass through into the set. Be careful to connect the lead the right way round. The circuit can handle currents of up to 100 milliamps, and it will also work with a 6 volt battery. It will therefore function properly with the majority of transistor radios.

The switch-off delay is proportional to the value of C2, and also to that of R1. Different times can therefore be obtained by altering the value of one or both of these. For instance, a value of 220nF for C2 would give a delay of just under 5 minute, or using two 10M components in series for R1 would increase the delay to around 20 minutes.

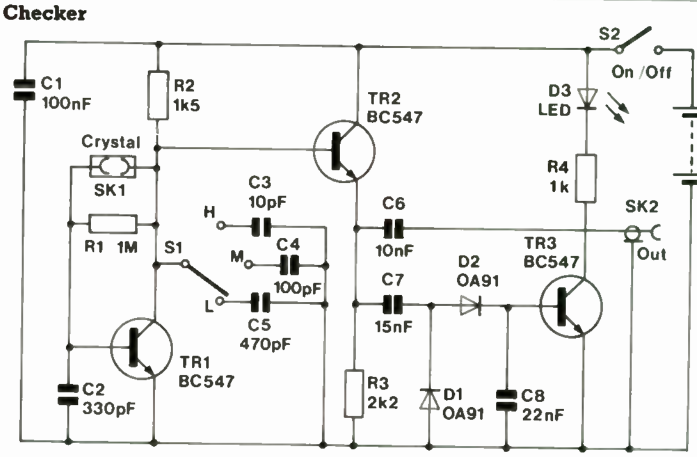




Crystal Checker

Although at one time crystals seemed to be vanishing from the amateur electronics scene, with the revival in the popularity of radio and the increasing use of crystal oscillators in digital and micro circuits, these components are probably more widely used now than at any time in the past. Crystals are not components that can be checked properly using an ordinary multimeter, and a more elaborate system of testing is required. In its most simple form a crystal checker can consist of an oscillator circuit into which the suspect component is connected, and some form of detector circuit to indicate whether or not oscillation is present. An oscillator output socket is useful as it enables a check on the output frequency to be made with the aid of a suitable frequency meter or radio receiver.

This checker is of the basic type outlined above, and it has a LED indicator which switches on if the test component is producing oscillation. The circuit will work with crystals having fundamental frequencies from around 100kHz to about 20MHz or so. Most crystals are in this category since those having marked frequencies of more than 20MHz are usually overtone types which have fundamental frequencies at typically only a third or a fifth of the marked frequency. This checker will not work with very low frequency crystals having operating

Crystal Checker


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HIGH FREQUENCY TREMOLO PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,2	3k9	2	(M3K9)
R3,4,9,10	1k	4	(M1K)
R5,14	27k	2	(M27K)
R6,7	22k	2	(M22K)
R8,12	4k7	2	(M4K7)
R11,19,20	10k	3	(M10K)
R13	12k	1	(M12K)
R15,18	100k	2	(M100K)
R16	47k	1	(M47K)
R17	56k	1	(M56K)
RV1	100k Lin. Pot	1	(FW05F)
RV2	2M2 Lin. Pot	1	(FW09K)

CAPACITORS

C1	100µF Axial Electrolytic 10V	1	(FB48C)
C2	1µF Axial Electrolytic 100V	1	(FB12N)
C3,4	270pF Ceramic	2	(WX61R)
C5	10µF Axial Electrolytic 25V	1	(FB22Y)
C6	1µF Poly Layer	1	(WW53H)

SEMICONDUCTORS

IC1	LM13700N	1	(YH64U)
IC2	CA3140E	1	(QH29G)
IC3	LF353	1	(WQ31J)

MISCELLANEOUS

SK1,2	Jack Socket	2	(HF90X)
S1	SPST Ultra-Min Toggle	1	(FH97F)
B1	PP7 9V Battery	1	(FM04E)
	Battery Clips	1	(HF27E)
	DIL Socket 16-pin	1	(BL19V)
	DIL Socket 8-pin	2	(BL17T)

LOW RESISTANCE METER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	6R8	1	(M6R8)
R2	68R	1	(M68R)
R3	10k	1	(M10K)
R4	1M	1	(M1M)
R5	5k6	1	(M5K6)
R6,7,8,9	4k7	4	(M4K7)
R10	1k	1	(M1K)
RV1	22k Sub-min Hor Preset	1	(WR59P)
RV2	10k Sub-min Hor Preset	1	(WR58N)

SEMICONDUCTORS

IC1	LM334	1	(WQ32K)
IC2	CA3140E	1	(QH29G)
TR1,2	BC547	2	(QQ14Q)
D1	Red LED	1	(WL27E)
D2,3	1N4148	2	(QL80B)

MISCELLANEOUS

SK1,2	1mm Socket	2	(WL59P)
S1	SPDT Ultra-Min Toggle	1	(FH98G)
S2	SPST Ultra-Min Toggle	1	(FH97F)
M1	100µA Panel Meter	1	(RW92A)
B1	PP7 9V Battery	1	(FM04E)
	Battery Clip	1	(HF27E)
	DIL Socket 8-pin	1	(BL17T)

CLAP SWITCH PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,7,9	1M	3	(M1M)
R2,8	4k7	2	(M4K7)
R3	5k6	1	(M5K6)
R4	3k3	1	(M3K3)
R5,6,13	100k	3	(M100K)
R10,11,12	10k	3	(M10K)
R14	3k9	1	(M3K9)
R15	220R	1	(M220R)

CAPACITORS

C1,8	470µF Axial Electrolytic 10V	2	(FB71N)
C2,3,4	3n3F Poly Layer	3	(WW25C)
C5,6,7	100nF Polyester	3	(BX76H)
C9	470nF Poly Layer	1	(WW49D)

SEMICONDUCTORS

D1,2,3	1N4148	3	(QL80B)
TR1,2	BC549	2	(QQ15R)
TR3	BC547	1	(QQ14Q)
IC1	µA741C	1	(QL22Y)
IC2	CA3140E	1	(QH29G)
IC3	4020BE	1	(QX11M)

MISCELLANEOUS

Mic 1	Min-Piezo Sounder	1	(FM59P)
RLA	Open Relay 6V	1	(FX23A)
	DIL Socket 8-pin	2	(BL17T)
	DIL Socket 16-pin	1	(BL19V)

SNOOZE TIMER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	10M	1	(M10M)
R2	100k	1	(M100K)
R3	2k2	1	(M2K2)
R4	10R	1	(M10R)

CAPACITORS

C1,3	100nF Disc Ceramic	2	(BX03D)
C2	470pF Ceramic	1	(WX64U)

SEMICONDUCTORS

IC1	4001BE	1	(QX01B)
IC2	4024BE	1	(QX13P)
TR1	BC559	1	(QQ18U)

MISCELLANEOUS

S1	SPDT Ultra-Min Toggle	1	(FH98G)
S2	SPST Ultra-Min Toggle	1	(FH97F)
B1	PP9 9V Battery	1	(FM05F)
	Battery Clips	1	(HF27E)
	DIL Socket 14-pin	2	(BL18U)

CRYSTAL CHECKER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	1M	1	(M1M)
R2	1k5	1	(M1K5)
R3	2k2	1	(M2K2)
R4	1k	1	(M1K)

CAPACITORS

C1	100nF Disc Ceramic	1	(BX03D)
C2	330pF Ceramic	1	(WX62S)
C3	10pF Ceramic	1	(WX44X)
C4	100pF Ceramic	1	(WX56L)
C5	470pF Ceramic	1	(WX64U)
C6	10nF Polyester	1	(BX70M)
C7	15nF Polyester	1	(BX71N)
C8	22nF Polyester	1	(BX72P)

SEMICONDUCTORS

TR1,2,3	BC547	3	(QQ14Q)
D1,2	OA91	2	(QH72P)
D3	Red LED	1	(WL27E)

MISCELLANEOUS

SK1	Crystal Socket	1	(HX61R)
SK2	Coaxial Socket Flush	1	(HH09K)
S1	3-way 4 pole Rotary	1	(FF76H)
S2	SPST Ultra-min Toggle	1	(FH97F)
B1	PP3 Battery	1	(FK58N)
	Battery Clips	1	(HF28F)

Continued on page 26.

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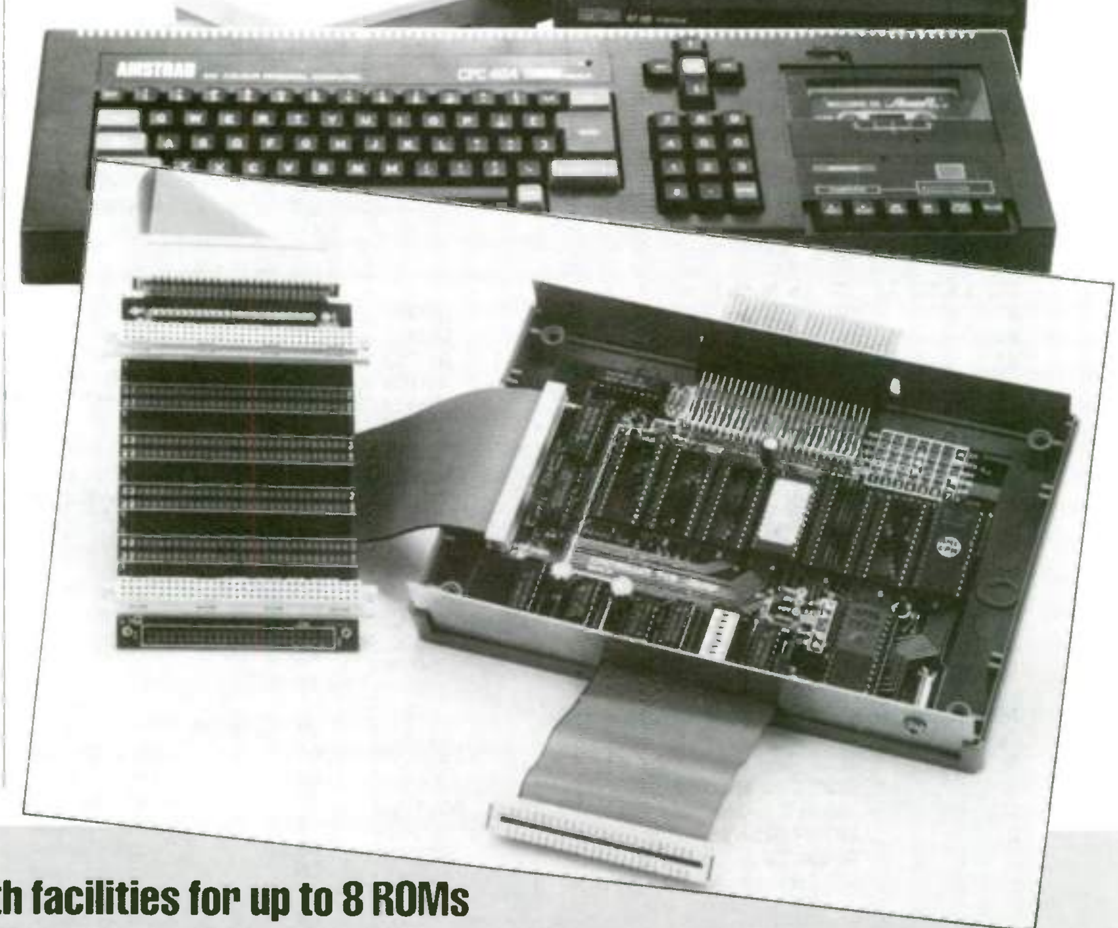
AMSTRAD EXPANSION SYSTEM

by Dave Goodman and John Attfield
Part 1



External ROM Card and I/O

The Amstrad computers have proved to be very popular over the past few years, possibly due to the excellent value and facilities provided as standard. One very important feature is the Amstrad's RSX (Resident System Extension) and External or 'sideways' ROM supporting firmware, which allows BASIC command extensions, machine code routines and utilities to be added quite simply. The potential provided by this facility is well recognised by many manufacturers, and has led to a steadily increasing number of preprogrammed ROMs becoming commercially available, usually of the 8K and 16K variety.

However, before these ROMs can be used, it is necessary to fit a decoding system, designed for this purpose and the Maplin External ROM Card has been produced to this end.

Specification

Sockets are provided for a maximum of eight ROMs which can be 2K, 4K, 8K or 16K in size giving a total of 128K memory

- ★ **ROM Card with facilities for up to 8 ROMs**
- ★ **Accepts 2K(2716), 4K(2732), 8K(2764), and 16K(27128) EPROM types**
- ★ **Extension board and socket for DD1 Disk Drive (CPC464)**
- ★ **Buffering and mapped decoding for up to 128, 8-bit I/O addresses**
- ★ **Motherboard extension for plug in (Eurocard) modules**
- ★ **Mechanically and electrically compatible with CPC464, 664 and 6128 computers**

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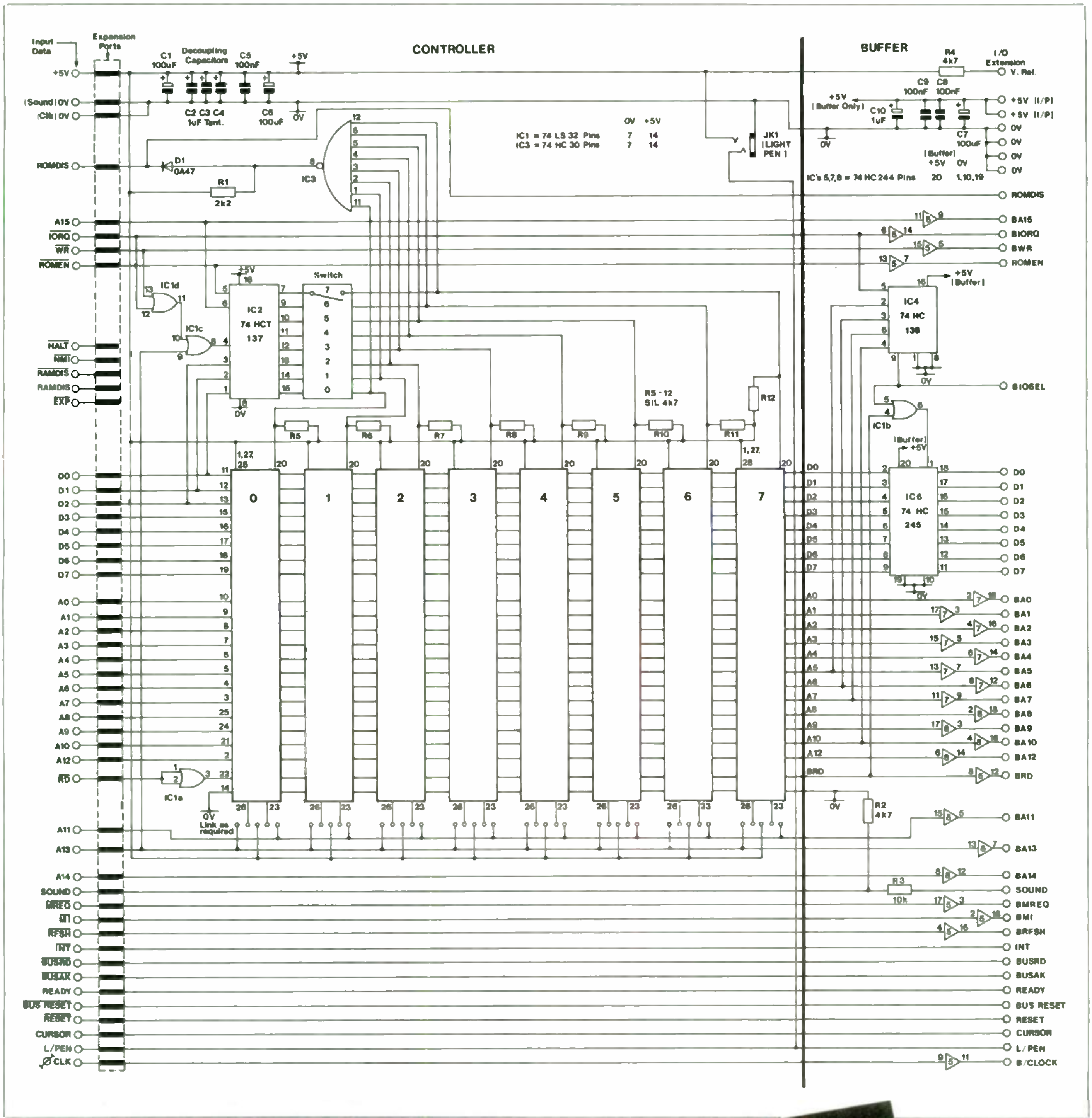
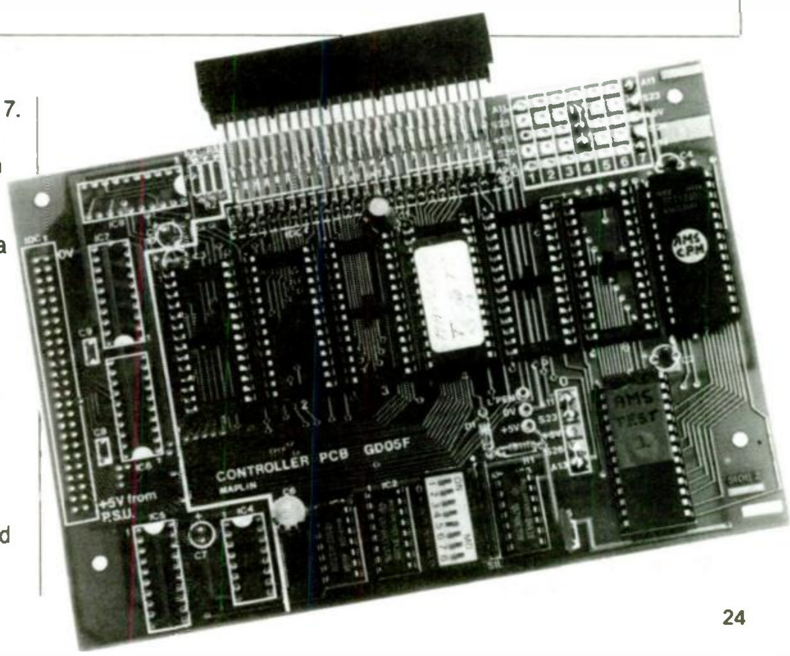


Figure 1. Circuit Diagram

expansion. Amstrad recommend fast access types of 200ns although the 250ns EPROMs available from the Maplin range have been found adequate on the prototype system. ROMs are decoded and given a positional (0 to 7) address during cold start or system reset, and any ROM found will be 'logged in' automatically. An eight position switch bank allows any ROM to be switched in or out of service as required. ROM position 7 should not be used if Amstrad's DD1 disk interface module is fitted to the 464, and this also applies to the CPC664 and 6128 versions! Therefore, only 464 machines, with no disk fitted, can use ROM 7.

A socket is provided for the connection of a Light Pen, which is wired to the Amstrad L'PEN input and 0V, +5V supply. Any Light Pen used here must have a positive pulse output at TTL levels to be compatible. A separate buffer and decoding section extends address, data and control lines out via an IDC cable to a Motherboard. IN/OUT address blocks are decoded HEX, F8, F9, FA and FB for the upper byte (A8 to A15). Lower byte decoding (A0 to A7) will be performed on individual Eurocard projects which plug into the Motherboard.



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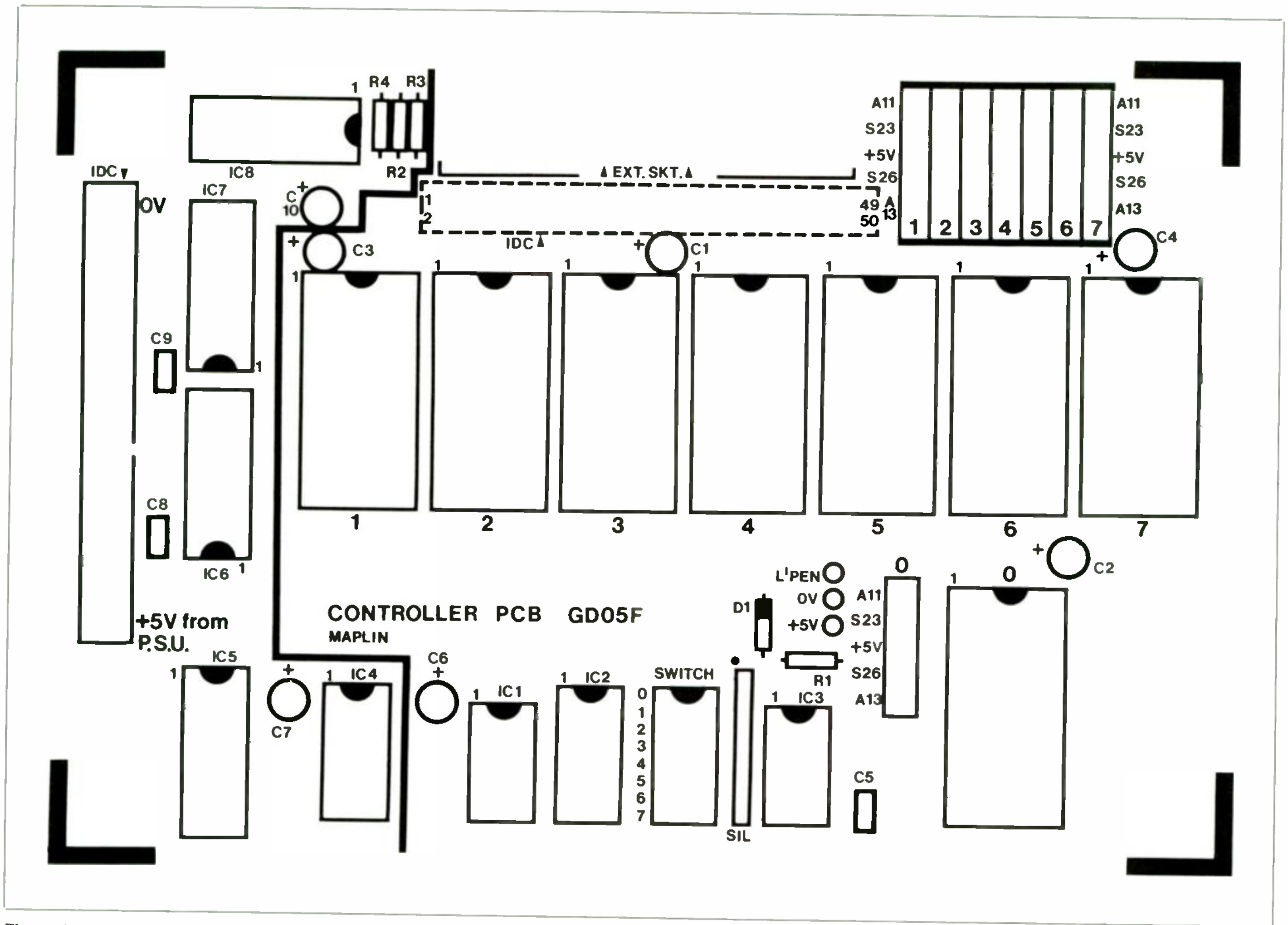


Figure 2. PCB Layout

The Amstrad expansion bus is extended out from the back of the ROM Card using a 2 x 25-way edge socket and a small plug-in extension board, thus providing facilities for disk drives, etc.

Motherboard and Modules

This card will accept up to 6 plug-in Eurocard modules. Each position uses a DIN 41612 2 x 32-way receptacle, and the board can be extended with a 50-way IDC transition cable, if required. A separate PSU is required to power modules on the Motherboard and also to supply the buffering components used on the ROM Card. Eurocard size modules to be available in future issues are:

a) *6 x 8 I/O Port.* Decodes lower address byte for Port 1 in four blocks: E0, E8, F0 and F8 and Port 2 in four blocks: E4, EC, F4 and FC. Each lower block address is selectable as are the upper decoded address blocks, thus allowing maximum flexibility and compatibility with any other devices used on the Amstrad. Port 1 and Port 2 each have three 8-bit busses for a total of 6 x 8-bit (48-bit) input/output lines.

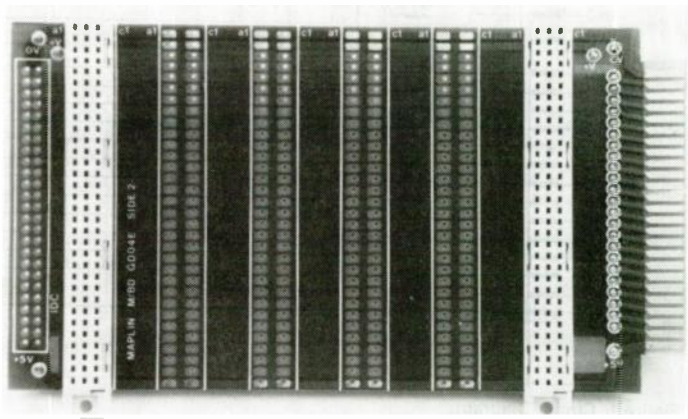
b) *EPROM Programmer.* An extension to the 6 x 8 I/O Port module will be an EPROM Programmer. This project is a must for constructors who wish to design their own external ROMs for use on the ROM card. A background ROM will be available for driving this project (via the I/O Port) which allows copying of different sized ROMs, standard and fast burn algorithms, modifying program bytes and copying from assembler buffers.

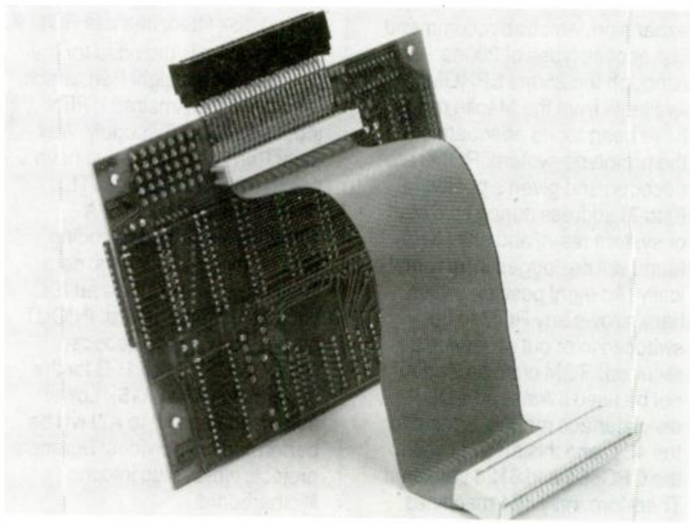
c) *Power Supply Card.* Produces a regulated +5V and unregulated supply for powering modules and buffer section.

d) *Serial I/O Port.* Will have full protocol availability and selectable Baud speeds, compatible with most networks including RTTY and printers. The module will be both TTL and RS232 compatible and the system controlled by a background ROM.

External ROM Card Details

Full construction, operational details, descriptions and





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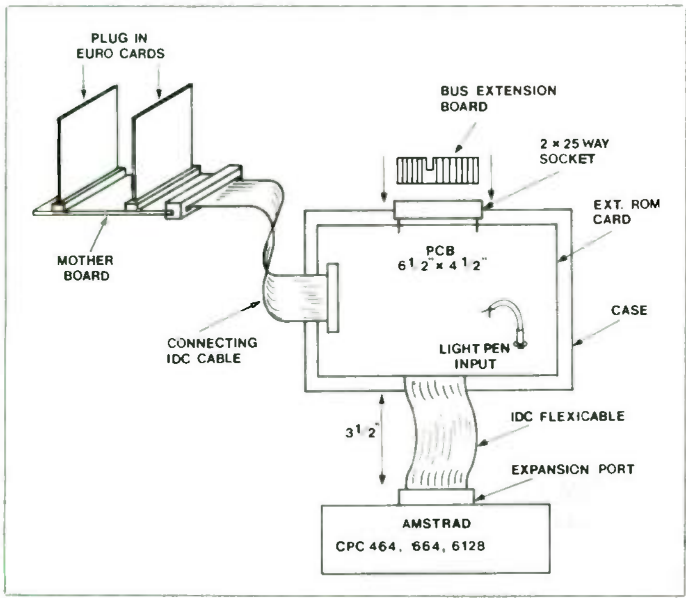

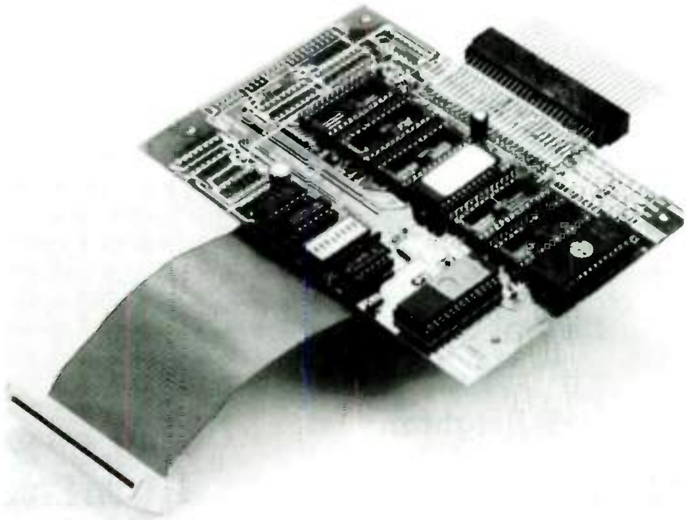

Figure 3. Overall System

ROM programming techniques are available in a separate pamphlet which is supplied with the kit version of this project. Pamphlets may also be purchased individually.

Figure 1 shows the complete ROM Card circuitry and buffer section. Figure 2 shows the ROM Card layout and Figure 3 gives an overall impression of the complete system.

The kit for the ROM Card contains the main PCB, sockets for mounting the ROMs, a cable harness for connection to the Amstrad computer, an extension connector with expansion card PCB, the case with front and rear panels, the pamphlet and ancillary components. The Motherboard Kit contains the motherboard PCB, a cableform for connection to the ROM Card, buffer components to be fitted to ROM Card and ancillary components. Note that the ROM Card kit does not contain any ROMs so that the types the constructor wishes to use can be selected by him. Also, the Motherboard Kit does not include the 64-way expansion sockets; these are rather expensive and can be purchased as required for each add-on card fitted to the unit.

EXTERNAL ROM CARD PARTS

A kit of parts for the ROM Card is available:
Order As LK97F (External ROM Card Kit)

The following parts are also available separately but are not shown in our 1986 catalogue:
Controller PCB **Order As GD05F**
Amstrad Pamphlet **Order As XH65V**
50-way Amstrad Cable **Order As FA86T**
2 x 25-way Edge Connector **Order As FA87U**
Front Panel **Order As FA88V**
Rear Panel **Order As FA89W**
Expansion PCB **Order As GB99H**
Test ROM 2716/M11 **Order As UF73Q**

MOTHERBOARD PARTS

A kit of parts for the motherboard extension is available:
Order As LK98G (Motherboard Kit)
The following item is also available separately, but is not shown in our 1986 catalogue:
Motherboard PCB **Order As GD04E**

READY-BUILT CONTROLLER

The ROM card is also available ready-built into its case, together with front and rear panels, Expansion pcb and cable for connection to the Amstrad. The buffer components are also mounted onto the pcb together with the cable to connect to the motherboard. No ROMs are included however.
Order As YM57M (Amstrad Controller Assembled)

FANTASTIC FIVE *Continued from page 22.*

frequencies of around 10 to 40kHz as these require special oscillator circuits.

TR1 acts as the basis of the oscillator, and this is a standard configuration which uses two capacitors to form a tapping on the crystal which operates as a parallel resonant tuned circuit. The crystal and capacitive tapping effectively form a single-wound resonant transformer, connected so that it provides a signal inversion. Thus, although the base and collector of common emitter transistor TR1 are out-of-phase, the inversion through the tuned circuit gives positive feedback over the circuit, and oscillation results provided the losses through the tuned circuit are not too high. Any reasonably active crystal will produce oscillation, but the values of the capacitors in the tapping circuit must have suitable values for the frequency of the test component. In this case one capacitor (C2) has a fixed value, while the other capacitor is one of three switched components (C3 to C5). Use C5 for low frequency (about 100kHz to 500kHz) types, C4 for medium frequency (500kHz to 6MHz) components, and C3 for high frequency (above 6MHz) types.

TR2 is an emitter follower output stage which can be used to drive a receiver or a frequency meter connected to SK2. TR2 is also used to drive a simple rectifier and smoothing circuit comprising D1, D2, and C8. If oscillation is produced, the strong positive bias generated across C8 is sufficient to turn on TR3 which in turn switches on LED indicator D3.

The circuit is quite easy to construct, and the only slight complication is in making the connections to the test crystals. One approach is to use several front panel mounted crystal holders wired in parallel in the SK1 position. These should be of different types so that any normal type of crystal will connect to the unit via one or other of the holders (even wire ended types can normally be connected to one of the holders well enough to facilitate testing). Of course, if you only use crystals with one type of base, a single holder will suffice. Another approach is to use two short leads terminated with small crocodile clips which fit onto the pins or leadout wires of test components.

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Lead-Acid Battery Charger

by Mark Brighton

- ★ 4V, 6V & 12V Settings
- ★ Two Step Charging
- ★ Simple Construction

Properly charging sealed lead-acid batteries is very important for long trouble free battery service. The circuit shown in Figure 1 is capable of quickly and safely charging lead-acid batteries, and features temperature compensation in addition to two charging levels (with automatic switchover).

Circuit Description

Temperature compensation in a charger is important to prevent over-charging, especially if the battery is subjected to wide temperature variations. A temperature coefficient of −5mV/°C/cell at the output of the charger is provided by IC1, a current mode temperature sensor which is either located near the battery, or if high charging currents are involved, it could be attached directly to the battery.

The two-step charging feature provides a higher initial charging voltage

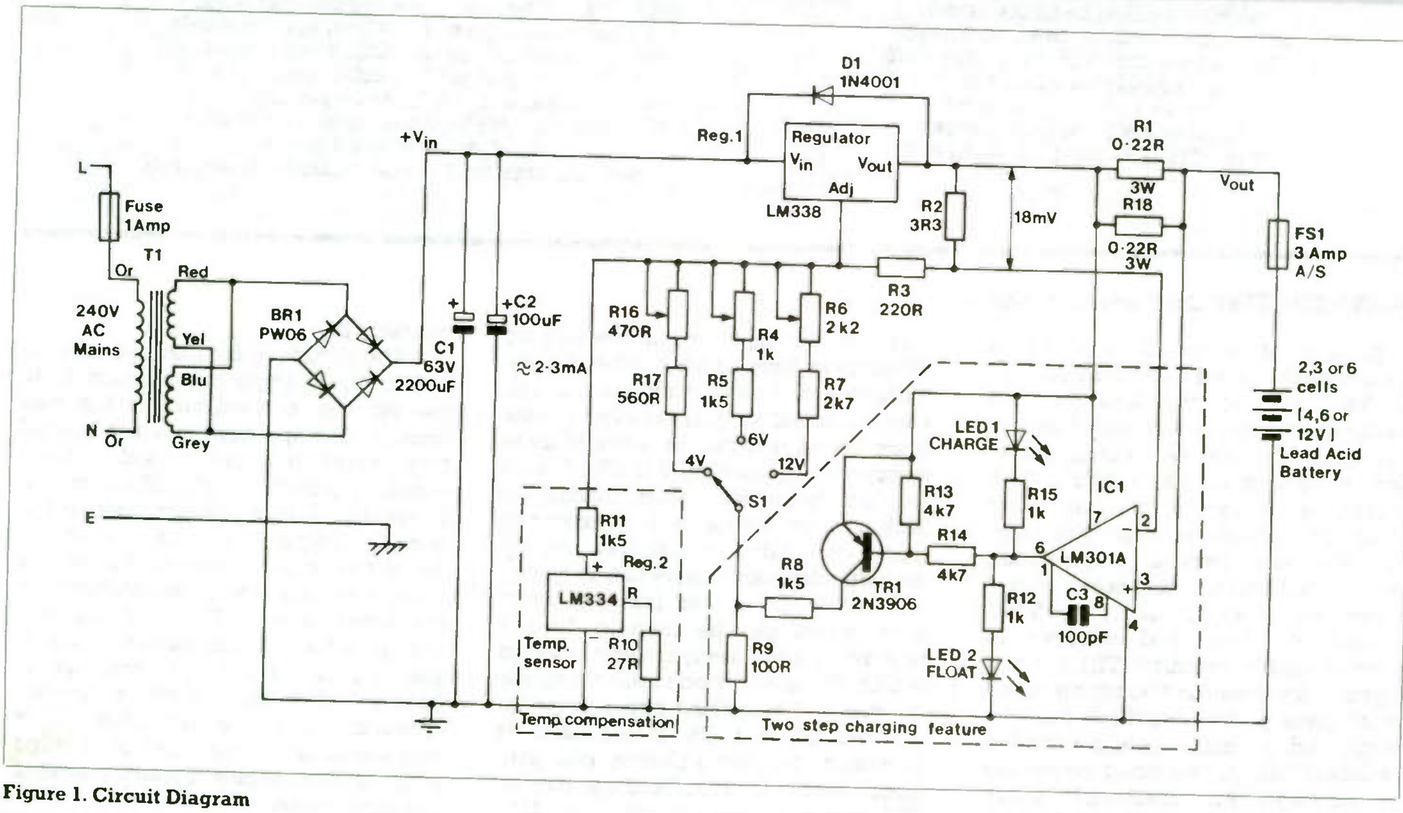

Figure 1. Circuit Diagram

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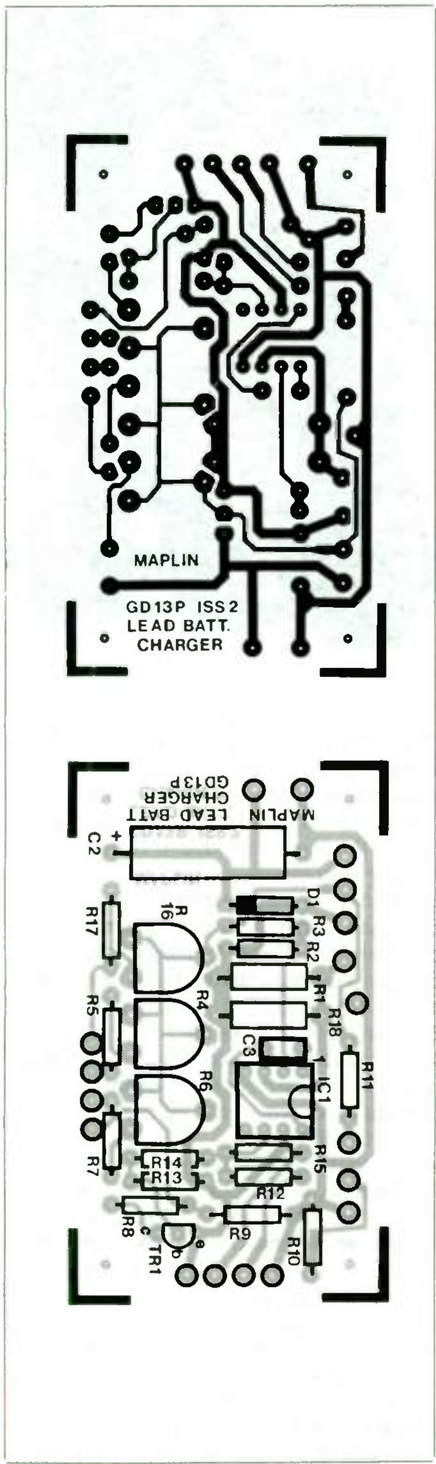


Figure 2. PCB Layout and Legend

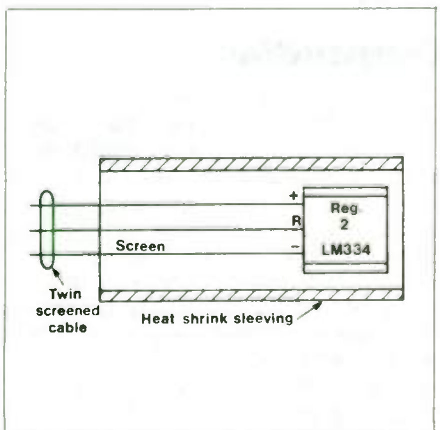


Figure 3b. Fitting REG 2

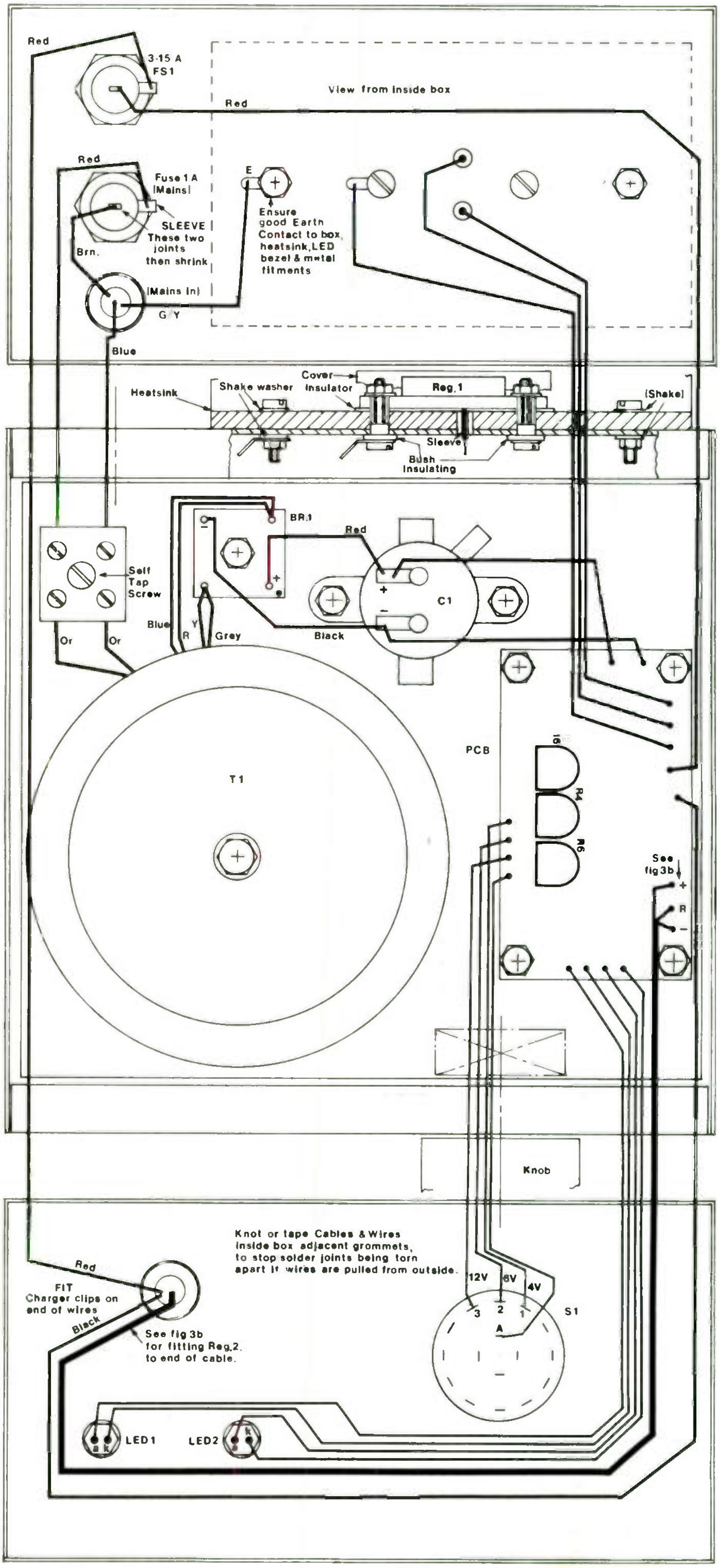


Figure 3a. Wiring Diagram

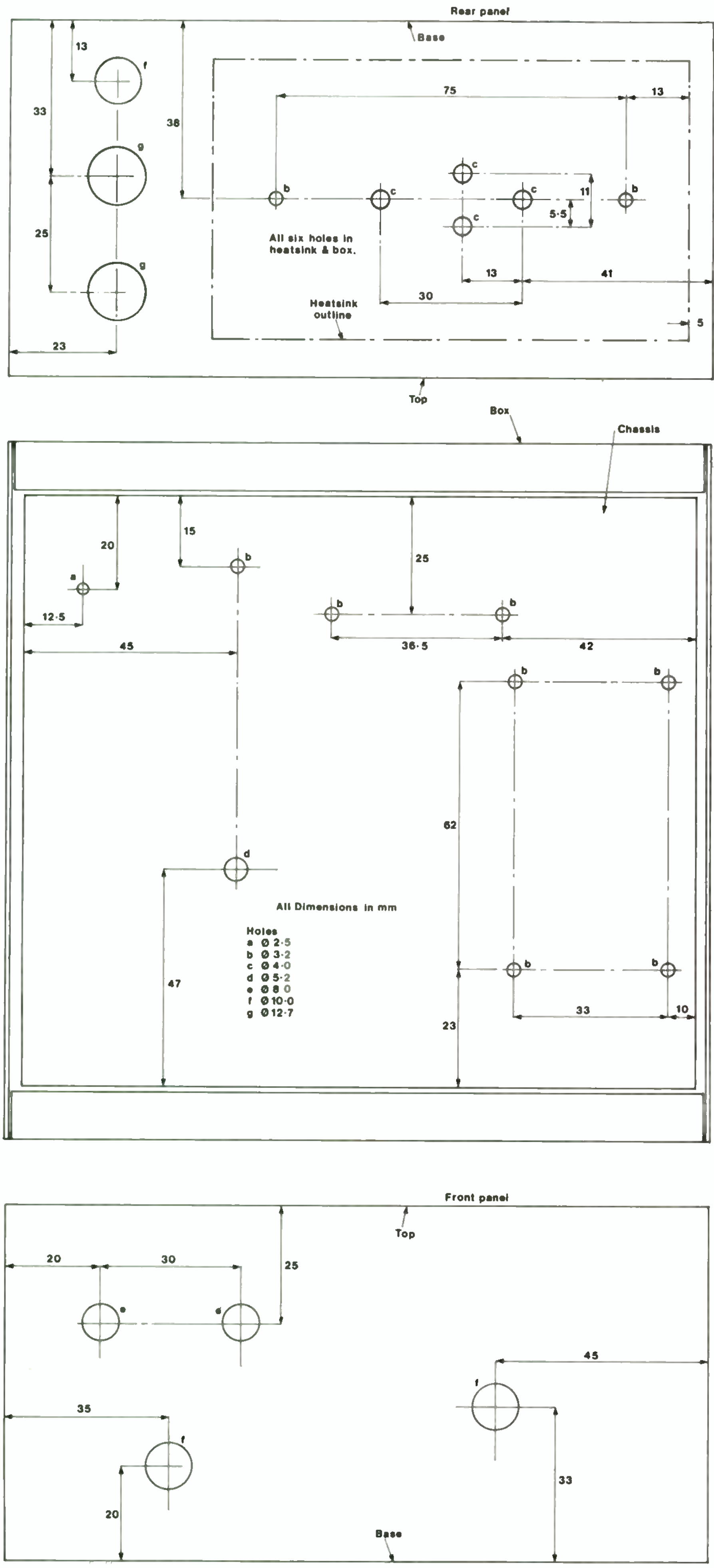
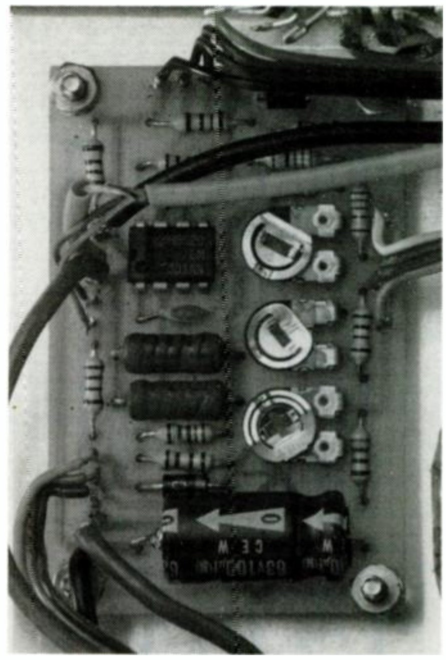


Figure 4. Box Drilling Details



(2.5 Volts/cell @ 25°C) to rapidly bring a discharged battery up to near full charge. The amount of charging current is determined by the amount of charge remaining in the battery and the current limit of the regulator, REG 1. As the battery approaches a fully charged condition, the current begins to decrease. When it drops below a predetermined level (≃180mA) the charger's output voltage drops to a float condition voltage of 2.35 Volts/cell @ 25°C, which maintains the battery in a fully charged condition. This float voltage prevents the battery from becoming overcharged, which can seriously shorten its life.

R1/R18 and R2 determine the current level when the charger switches from a charge mode to a float mode, while R8 and R9 set the amount of voltage change. The LED's indicate which mode the charger is in (charge or float). The amount of temperature compensation is controlled by the value of resistor R10.

A unique feature of this charger is that it provides the correct temperature coefficient and the correct amount of charge-mode voltage boost for each cell, regardless of the number of cells being charged.

Construction

Insert all veropins from the track side of the board (shown in Figure 2), and push them home firmly with a soldering iron. Solder the pins into place. Now insert all resistors and capacitors, noting the polarity of C1, and solder the component leads in place. Insert and solder the IC socket, ensuring that the end notch is at the same end as the white bar on the legend; then TR1, referring to the legend for correct orientation. Plug IC2 into the DIL socket with the notch on the IC aligned with the cutout on the socket, and/or pin 1 (marked with a dot) adjacent to the '1' on the legend. Bolt REG

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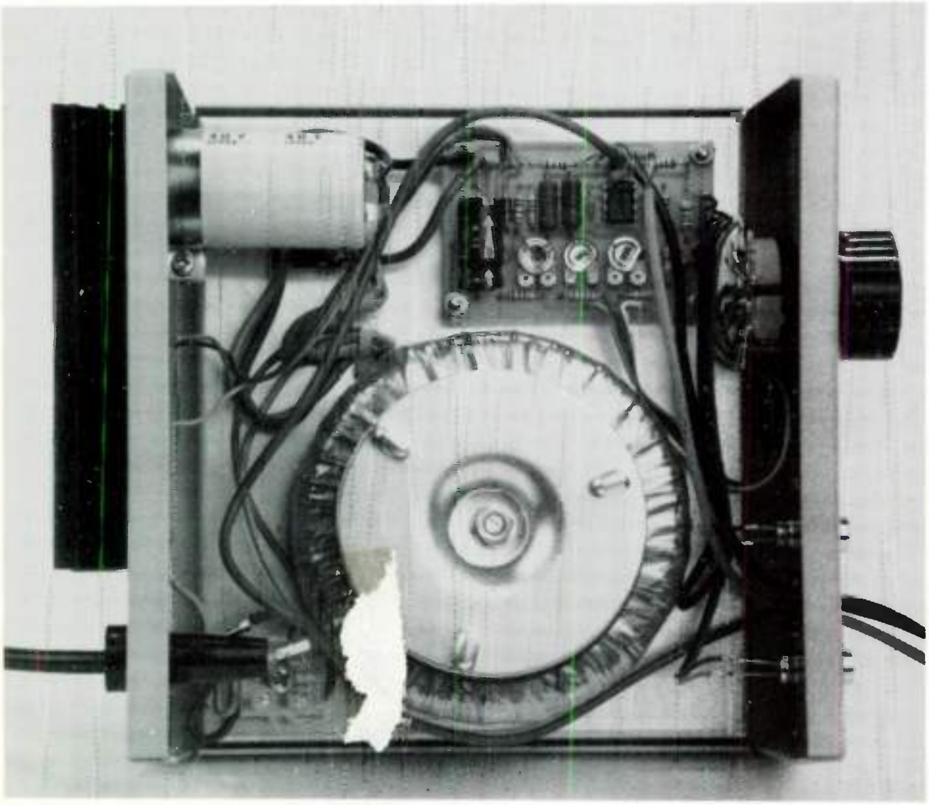
1 onto the heatsink, using the mounting kit provided. Referring to Figure 3, wire-up the pcb to S1, LED 1 and 2, IC1, and REG 1 respectively, and also the transformer/ rectifier etc. Figure 4 shows drilling details of a suggested case.



Testing and Use

The accuracy of a digital voltmeter is really required here in order to carry out the following procedure. Apply power to the circuit and connect the digital voltmeter across the output leads. Set S1 to 4V, and adjust R16 for a 4.5V output. Set S1 to 6V, and adjust R4 for a 7.05V output. Set S1 to 12V, and adjust R6 for a 14.1V output. Now connect the output leads to a partially discharged lead-acid battery, first selecting the appropriate voltage setting at S1, and via a multimeter set to read current up to a minimum f.s.d. of 5A. Check the direction of current flow, (if the battery is discharging, you have a problem: re-check your wiring, etc). *Under NO circumstances should the current exceed 5A.*

The red 'charge' LED should be on and should remain on until the charge current falls below ≃180mA, at which point the green 'float' LED should light, indicating that the charge cycle has finished and the charger is in trickle charge mode.

Lastly, if the temperature sensor is held between finger and thumb, the charge current should start to drop, indicating that the temperature compensation is functioning correctly.

NOTE: When using the charger, you should ensure that correct polarity of the battery connections is always observed and that prolonged short circuit of the output leads is avoided. It is also worth bearing in mind that if the mains supply is removed from the charger whilst it is connected to a battery, the battery will commence to slowly discharge through the charger, so always disconnect the battery before switching off at the mains.

LEAD ACID BATTERY CHARGER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film unless stated			
R1,18	0.22Ω 3W 5% Wirewound	2	(W0.22)
R2	3Ω3	1	(M3R3)
R3	220Ω	1	(M220R)
R4	1k Hor. S. Min. Preset	1	(WR55K)
R6	2k2 Hor. S. Min. Preset	1	WR56L)
R7	2k7	1	(M2K7)
R8,5,11	1k5	3	(M1K5)
R9	100Ω	1	(M100R)
R10	27Ω	1	(M27R)
R13,14	4k7	2	(M4K7)
R12,15	1k	2	(M1K)
R16	470Ω Hor. S. Min. Preset	1	(WR54J)
R17	560Ω	1	(M560R)
CAPACITORS			
C1	2200µF 63V Can Electrolytic	1	(FF22Y)
C2	100µF 63V Axial Electrolytic	1	(FB51F)
C3	100pF Ceramic	1	(WX56L)
SEMICONDUCTORS			
TR1	2N3906	1	(QR42V)
IC1	LM301A	1	(QH36P)
REG1	LM338K	1	(RA88V)
REG2	LM334	1	(WQ32K)
LED1	Chrome LED Large Red	1	(YY60Q)
LED2	Chrome LED Large Green	1	(QY47B)
BR1	PW06 Bridge Rectifier	1	(WQ58N)
D1	1N4001	1	(QL73Q)
MISCELLANEOUS			
T1	Transformer Toroidal 80VA 18V	1	(YK17T)
	Safuseholder 20	2	(RX96E)
FS1	Fuse 3.15A 20mm Anti-Surge	1	(RA11M)
FS2	Fuse 1A 20mm	1	(WR03D)
	Heatsink 4Y	1	(FL41U)
	Insulator Kit T03	1	(WR24B)
	Transistor Cover	1	(FL56L)
	Grommet Small	2	(RW59P)
	Terminal Block 5A	1	(HF01B)
S1	Switch Rotary SW3B	1	(FF76H)
	Blue Case 231	1	(XY44X)
	Knob K7C	1	(YX03D)
	P.C. Board	1	(GD13P)
	Spacer 6BA x ⅛in.	1 pkt	(FW33L)
	Bolt 6BA x ½in.	2 pkt	(BF06G)
	Nut 6BA	2 pkt	(BF18U)
	Washer 6BA	1 pkt	(BF22Y)
	Tag 6BA	1 pkt	(BF29G)
	Washer Shake 6BA	1 pkt	(BF26D)
	Self Tap No. 6 x ½in.	1 pkt	(BF67X)
	Extra Flex Black	2 mtrs	(XR40T)
	Extra Flex Red	2 mtrs	(XR44X)
	Heat Shrink Sleeving CP48	1 mtre	(BF89W)
	Ribbon Cable 10-Way	1 mtre	(XR06G)
	Lapped Twin Screened Cable	2 mtrs	(XR20W)
	3 Core Mains Black	2 mtrs	(XR01B)
	Charger Clip	2	(HF26D)

A complete kit of all parts is available for this project:
Order As LM01B (Lead Acid Battery Charger)
The following item in the above kit list is also available separately, but is not shown in the 1986 catalogue:
Lead Acid Battery Charger PCB **Order As GD13P**
A ready built version of this project will be available soon – check future issues for details.

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