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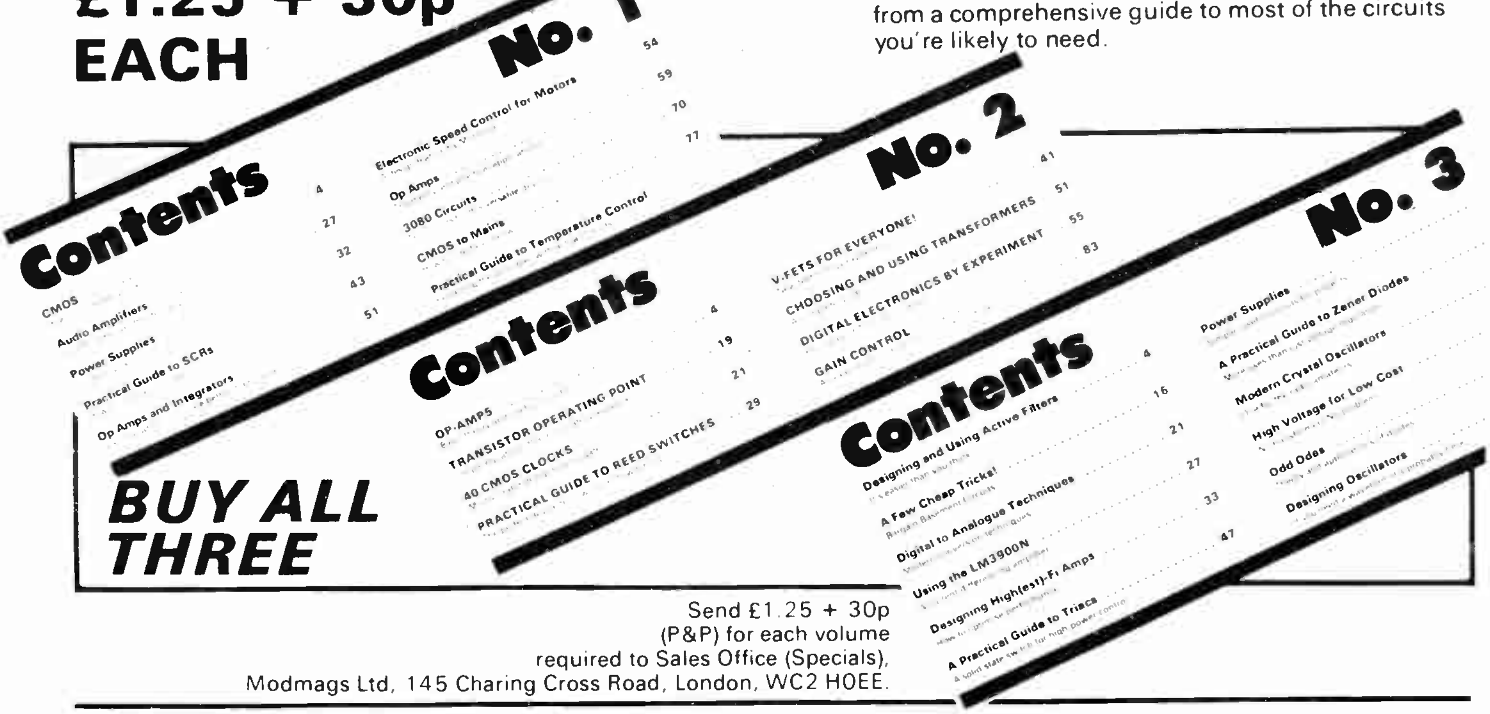

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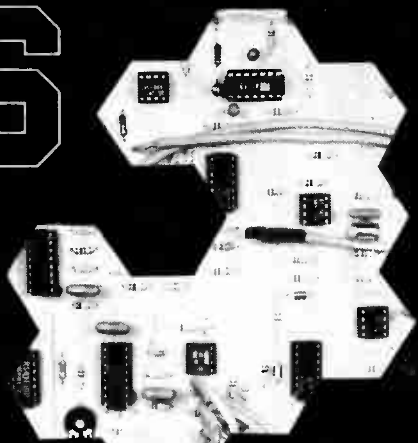

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CONTENTS

HAMMER THROW

An exciting game of skill and luck that will help pass those long and lonely winter evenings.

IF, LIKE MOST of the ETI staff, you have more brains than brawn, and would not boast about the quality of either, it is likely that the mere thought of swinging a massive weight around your cranium is enough to strain your bodily systems. This probably means — and we are sorry if this comes as a disappointment — that your chances of selection for the Olympic hammer throwing team are, shall we say, nil.

Some may say that this is a pity as the sheer thrill of an event such as the hammer throw is probably very stimulating to those chunky brutes that are lucky enough to be able to take part. This is where we come to the rescue with our armchair version of the game. We think it has a number of distinct advantages over the real thing. One of these is that anyone, from an anaemic sparrow upwards, can play the game. A second is that it is nowhere near as messy if, when playing in your lounge, you get things wrong.

The game, as can be seen from our photographs, has a front panel with a circle of sixteen LEDs together with a line of eight LEDs at a tangent to the circle.

To play, after pressing reset, firmly press the play button. The LEDs in the circle will light one at a time simulating a spot of light moving in a circle. At the same time a distinctive, not to say loud, sound will be generated.

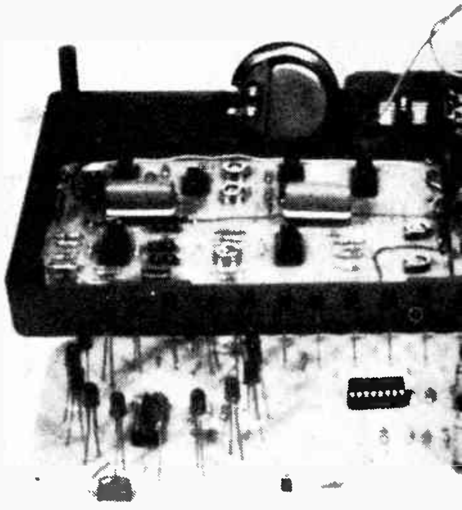
The spot will at first travel slowly round the circle, but will soon begin increasing in speed until it is travelling quite fast.

The object of the game is to release the play button at the instant that the 'top' LED of the circle is lit. If successful the line of LEDs will light to indicate your score, the faster the spot was moving when you scored the more will be your score. If you miss, the circle of LEDs will continue to rotate at the same speed as they were when you played.

Big Ones And Little Ones

A game will consist of, say, eight rounds — the score from each being added to the last. At the end of a game the person who scored the most is the winner. The skill comes in deciding whether to go for a number of low scores that are relatively easy to get, or for a few big ones.

As befits the design of a project of this nature we were in convivial mood and pleasant surroundings when we first discussed the game. We produced the first design sketch (well a few lines on a beer mat — yes in the pub again) which used digital devices. Upon seeing this some likely person said that he thought most games featuring LEDs designed over the past few years should



generically be called "spot the 4017".
Our initial reaction was to defend our design but a moment's thought showed that he had a point — the 4017 CMOS counter is over-used when it comes to games. At this stage we decided to rise to the occasion and produce the game using an all analogue approach.

The result can be seen in the circuit diagram. We are pleased with this circuit: it uses some unusual ICs and features a number of interesting circuit blocks — and of course there is not a 4017 in sight.

Construction

Construction of the game is greatly simplified if the PCBs are used. Three boards are required, one for the power supply, one for the display, and finally the main control board. Begin by building and testing the power supply. Take care to ensure that all components are mounted as shown in our overlay.

Next assemble the control and display boards. These carry a large number of components and mistakes made during assembly can be difficult to trace later — so take care at this stage. Do not insert the link between IC2/4 and IC9 at this stage.

It is best to test the boards before mounting them in the case, as it is difficult to get to some of the devices when the boards are in their final positions. We used a sloping front Vero box to house our game and the general layout adopted can be seen from our photographs.

Setting Up

There are five preset potentiometers on the board and all must be correctly set up before the game can be played.

The first adjustment to be made is to RV4. To calibrate this control first press the reset button and then the play button for a few seconds. At this stage a sound should be heard from the speaker and the game display LEDs should be seen flashing. Adjust RV4 until the LEDs produce a continuously rotating spot of light. The speed at which the circle of light rotates can be adjusted by RV1.

The next operation is to set up the score display. To accomplish this, press

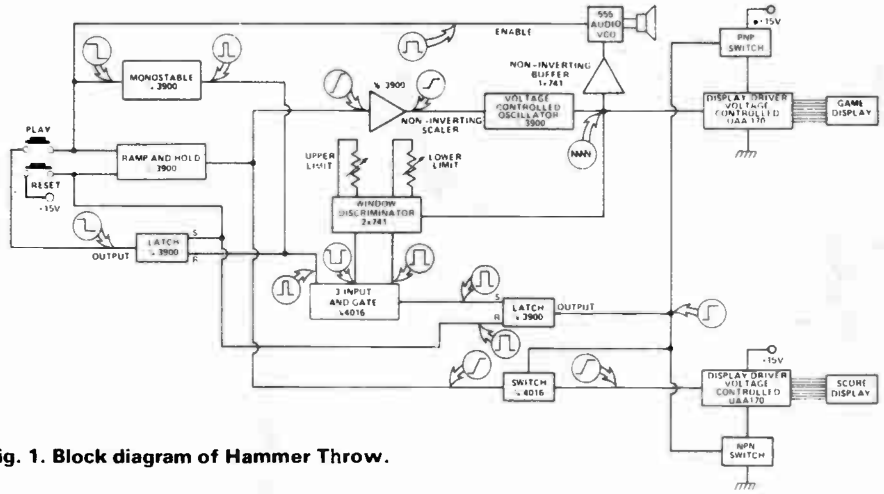
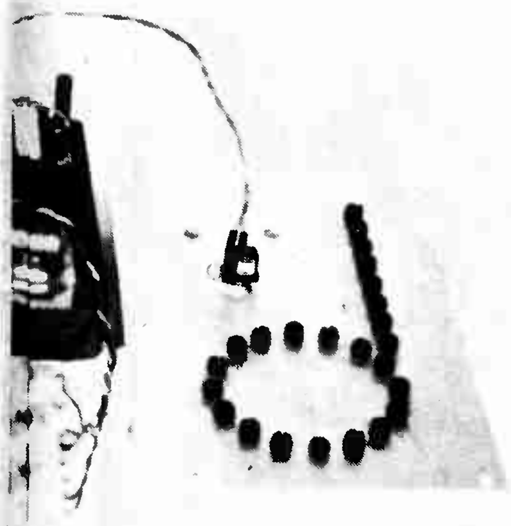


Fig. 1. Block diagram of Hammer Throw.



HOW IT WORKS

The circuit may be broken down into a number of major blocks — viz the display sections for both game and score, a voltage controlled oscillator, a ramp and hold circuit whose output controls the oscillator, a 'window' discriminator, a sound generating circuit and finally a power supply. As well as these major blocks there are also a number of latches, buffers and switches that are necessary for circuit operation.

The block diagram shown in Fig 1 shows most of the circuit blocks and, together with the circuit diagram, should be read in conjunction with this how it works.

SYSTEM OPERATION

The game display is based on a UAA 170 IC. This device is for driving LED displays and when connected to a line of sixteen LEDs will illuminate any one of these depending on the magnitude of the analogue voltage applied to its input. For the game display we need to produce the effect of a spot of light moving in a circle. To achieve this we arrange the sixteen LEDs in a circle and feed a sawtooth waveform into the UAA 170. A moment's thought will show that this will produce the desired effect.

In order to make the display rotate slowly at first, but speed up as play proceeds, we made the sawtooth generator voltage controlled. The control voltage is produced by a ramp and hold circuit which is reset to zero at the start of play, but begins to ramp up, thus increasing the sawtooth's frequency as play continues. When the play button is released, the voltage reached is held by the ramp and hold configuration until it is reset. This voltage is used for score purposes as described below.

The game requires that if, at the instant of releasing the play button, the 'Top' LED of the game display is lit, a score is indicated, the magnitude of the score being proportional to the speed at which the circle of LEDs was moving at the instant of release. From the description of the game display it will be seen that in order to light a specific LED the voltage input to the display driver must lie within a specific voltage range, thus in order to detect whether or not the 'top' LED is on we must look at the output of the sawtooth generator (this is input to UAA170) and decide whether it lies within the range that will light the specific LED at the instant the play button is released. The circuit that accomplishes this is the 'window' discriminator.

This is formed from two voltage comparators together with two analogue switches. Detailed action is described below, but briefly the circuit, when fed with the sawtooth output, will provide an indication whenever this waveform passes through an (adjustable) 'window' voltage range.

At the instant that the play button is released a short pulse is produced from a monostable. If this pulse is coincident with an indication from the window circuit that the top LED is on we must arrange to indicate a score.

The score must be proportional to the speed of the LED circle which is in turn proportional to the voltage level reached by the ramp and hold circuit. Thus, to produce a score, we feed the output from the ramp and hold, via an analogue switch, to a second UAA 170. This second display consists of eight LEDs in a line.

This completes a brief description of circuit action; we shall now deal with each block in more detail.

reset and then operate the play button until the spot of light is rotating at maximum speed. Release the play button and enable the score display by applying a positive pulse (from supply) to the junction of R29 and IC6. RV5 should now be adjusted so that the seventh score LED is just extinguished and the eighth lit.

The final adjustments concern the 'window' discriminator. To make this adjustment R38 (the end remote from IC9) should be connected to the slider of RV2. Adjustment of RV2 should illuminate successive LEDs of the game display. RV2 should be set to the point at which the top LED just extinguishes and the LED to the left just lights.

Now connect the input of IC9 to the slider of RV3. Adjust this pot so that the top LED just extinguishes and the LED to the right is just on.

This completes the adjustments and the link omitted during construction, should now be fitted.

Now is the time to get in training and, if you're good enough, you may yet make it to Los Angeles. ●

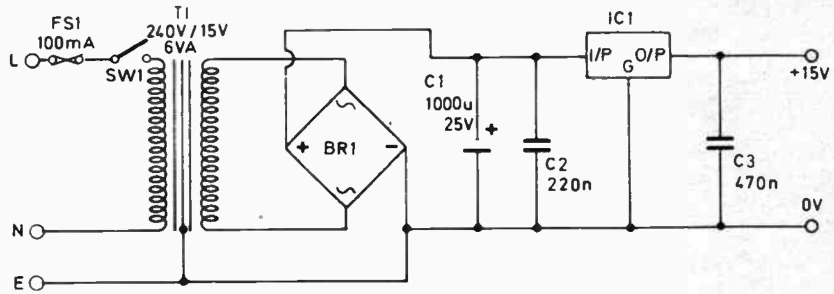


Fig. 2. Circuit diagram of the game's power supply.

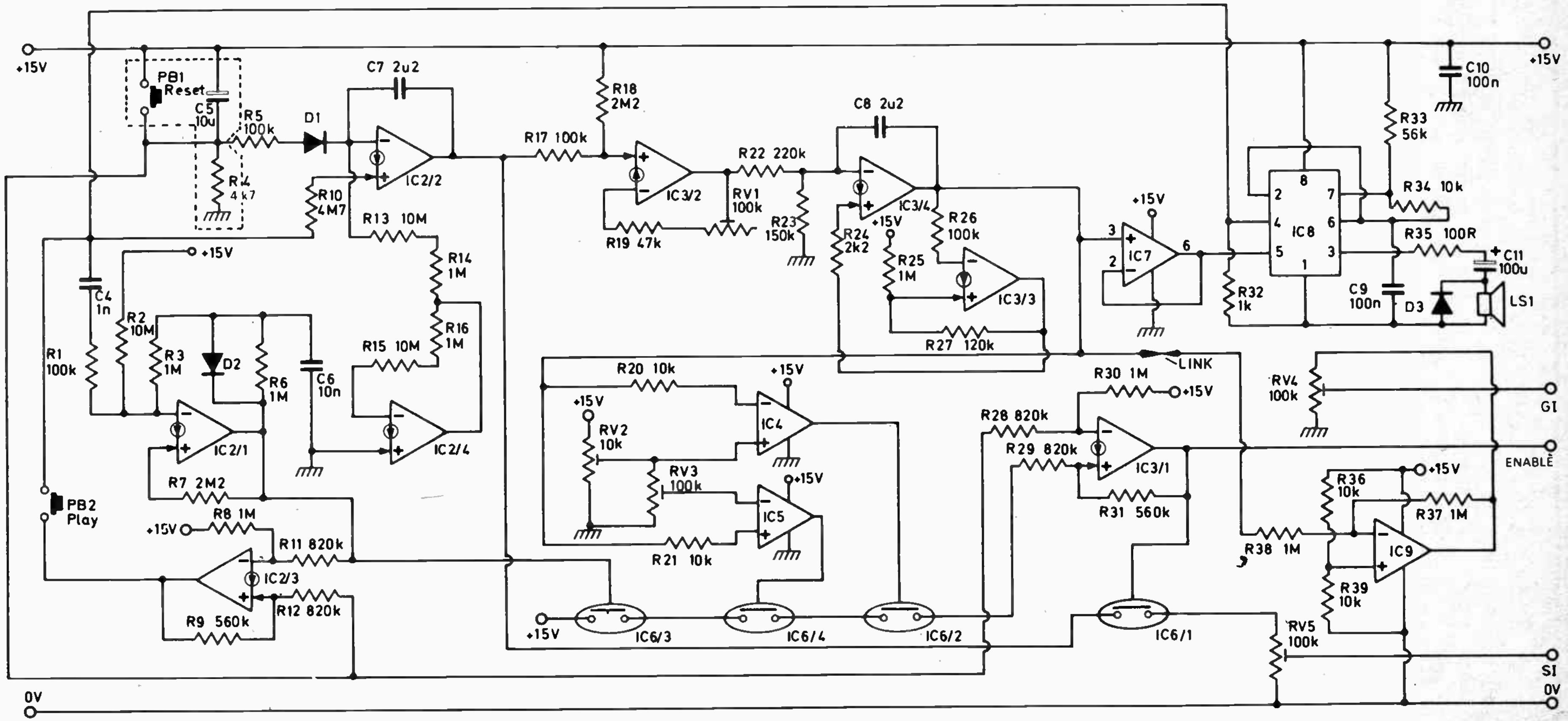


Fig. 3. Full circuit diagram of the hammer throw.

HOW IT WORKS

RESET CIRCUITRY

The game is initiated by operation of the reset button (PB1). This zeros the ramp and hold circuit described below, as well as setting latch 1 IC2/3 and resetting latch 2 IC3/1. Latch 1 enables the play button when its output is high (set) — latch 2 enables the score display when low (reset), the game display when high (set)

Each latch is based on one of the amplifiers of an LM 3900 Quad Norton amplifier package. This device is unusual in that instead of amplifying the difference in voltage applied to its input terminals, it amplifies the difference in input current.

The + and — inputs of these Norton amplifiers are both clamped to one Diode-Drop above ground and thus all input voltages must be converted to currents (by resistors) before being applied to the inputs. This is the basis for the current-mode (Norton) type of operation.

In operation the current flowing into the + input must equal that flowing into the — input, the difference between the current demanded and the current provided by an external source must flow in the feedback circuitry.

Operation of both latches is the same and we shall only describe the action of latch 1.

Assuming that the latch output is low (the latch is reset) the current injected into the — input of IC2/3 will ensure that the output remains low. If now sufficient current is injected into the + input the output voltage will rise as the device attempts to reduce the input current differential to zero. Positive feedback via R9 will enhance this action and cause the amplifier to latch high. This is because the current injected into the + input via R9 in this case is greater than that into the — input due to R8. A positive pulse via R11 to the — input will however once again bring the output low.

C5 and R4 ensure that when power is first applied the game is reset.

RAMP AND HOLD

The ramp and hold action is provided by IC2/2 and IC2/4. A positive voltage via R5 and D1 causes the output to ramp down while a similar voltage via R10 causes the output to ramp up. The reset button causes the downward ramp while play causes an upward ramp.

In any sample and hold application a very low input bias current is required if the hold period is to be stable. The existence of matched amplifiers within the LM3900 allows one amplifier to bias another.

In operation the LM 3900 requires a bias current to be applied to its — terminal. IC2/4 has its + terminal grounded and feedback applied via R15 and R16. The output voltage of this device will attain a level such that the current fed back via these resistors is equal to the bias current demanded by the input. This same current will flow via R13 and R14 into the — input of IC2/2 reducing the effective bias current of this amplifier to almost zero. D1 isolates this bias current from the rest of the input circuitry.

If now a positive current is injected into the — terminal, the output voltage will fall as it attempts to feedback a current of this value in order to reduce the input current differential. This constant current across C7 results in a linear voltage ramp appearing across C7. Input to the + terminal causes a positive going ramp, to the — terminal a negative going ramp.

The rate at which the voltage across C7 changes is proportional to the value of the constant current supplied which is in turn proportional to R5 and R10. As R5 is some 40 times larger than R10, the ramp down (reset) is far quicker than the ramp up.

The output from the ramp and hold circuit is fed, via IC6/1 to the score display and via IC3/2, a non-inverting scaler, to the sawtooth VCO.

NON-INVERTING SCALER

The scaler is required because the output from the ramp and hold configuration can vary over nearly the whole supply voltage wheres the VCO requires only small voltage swing to provide the required frequency change.

The scaler is based on another Norton amplifier arranged as a non-inverting amplifier. Feedback is applied via RV1 and R19 and output is fed to a potential divider formed by R22 and R23 and thence to the VCO.

VOLTAGE CONTROLLED SAWTOOTH OSCILLATOR

The VCO is formed by IC3/3 and IC3/4. Action of IC3/4 is much the same as that of IC2/2 described above. The special input bias circuitry is not required as there is no hold requirement.

IC3/3 acts as a comparator and circuit action is as follows: while the output of IC3/4 is high and ramping down (input to — terminal) the current into the — input of IC3/3 due to R26 is greater than that to its + terminal due to R25 — its output is thus low.

As the output of IC3/4 ramps low however, there comes a point where this situation is reversed. The output of IC3/3 goes high. This state is maintained by positive feedback via R27 and a large current is injected into the + input of IC3/3 as R27 is much smaller than R25.

The output of IC3/4 thus goes high, restoring current flow via R26 and starting the cycle again.

By varying the current injected via R22 the time taken for the output of IC3/4 to ramp down to the point at which the comparator triggers is lessened. This results in an increase in the frequency of the sawtooth.

The output from the VCO is fed to the game display section, to the 'window' discriminator formed by ICs 4 and 5 and via IC7 to the sound generator IC8.

SOUND GENERATOR

The sound is generated by IC8 an NE555 operated in its astable mode.

The reset pin(4) is normally held low by R32 and hence circuit action is inhibited. A positive voltage applied from latch 1 via the play button enables the sound during the game.

The output is frequency modulated by applying the output of the sawtooth VCO, via buffer IC7 to provide the necessary low impedance drive, to the voltage control input (pin 5) of IC8.

WINDOW DISCRIMINATOR

The window discriminator is formed by two comparators IC4 and IC5 and two of the analogue switches in IC6.

Operation is as follows: if we assume that the output of the sawtooth VCO is high and ramping down the voltage on the — input of IC4 will be higher than that on the + input (a reference level established by RV2) and its output will be low. The output of IC3 will be high as the input to its + terminal is higher than that to its — input.

As the voltage ramps down, a point will be reached where the output of IC4 goes high as the voltage at its — input falls below that set by RV2 at its + terminal. At this stage the outputs of both IC4 and IC5 are high, as IC5 has not switched. As the voltage continues to ramp down, however, the voltage on IC5's + input falls to a point below that on its — input and the output of this IC goes low.

Thus the outputs of both ICs will be high for a small range of input voltages (the window) defined by the difference in voltage between the sliders of RV2 and RV3.

The outputs of these ICs are fed to the gates of two analogue switches. A positive voltage applied to these switches turns them "on".

Thus during the window a signal path exists from the input of IC6/4 to the output of IC6/2.

MONOSTABLE

The monostable is formed by IC2/1 and produces a short positive going pulse upon receipt of a negative spike produced by the release of the play button.

Current injected into the — terminal via R3 will normally hold the output low, however a negative pulse applied via C4 and R1 will "rob" this current from the input and causes the output to go high.

R7 latches the gate in this state after the negative pulse is removed. At this stage C6 begins charging, feeding back an increasing amount of current to the — input as the voltage at the junction of R6 and R3 rises.

There comes a point when this current is greater than that fed back via R7 and the output returns low. Diode D2 rapidly discharges C6 to provide reliable re-triggering.

The leading edge of the output pulse is coincident with the release of the play button. This pulse is used to turn on analogue switch IC6/3. It will be remembered that if the voltage of the VCO is within the 'window' at this point — switches IC6/4 and IC6/2 will also be on. This allows the supply voltage input to IC6/3 to set latch 2 and thus initiate the required actions, ie, blank game display, enable score display, etc.

The monostable also resets latch 1 IC2/3 to remove supply from the play button, this prevents cheating.

HOW IT WORKS

GAME DISPLAY

The output of the sawtooth VCO is fed via an inverting buffer, IC9, and a potential divider, RV4, to the input of IC10 a UAA170. The input circuitry of this device consists of a series of differential amplifiers with one input of each connected to the input terminal (pin 11) via an emitter follower. The other input of each is connected to a point in a potential divider chain consisting of equal value resistors. The differential amplifiers thus operate as analogue voltage comparators and as the input exceeds the reference voltage of a particular comparator, the output of that comparator will change state.

To reduce the package pin-out the LEDs of the display are not driven individually but are arranged in a four by four matrix pattern controlled by the row and column outputs of the UAA170 (A-D and E-F respectively). By enabling the appropriate row and column output any one of the sixteen LEDs may be selected. The matrix outputs are controlled by the internal logic of the UAA170.

The resistor chain R42, R44 and R45 sets up the reference voltage inputs of the device. The voltage on pin 12 establishes the lowest voltage to which the UAA170 will respond. If the input voltage is below this point the first LED of the display remains lit. As the voltage rises above this level the first LED is turned off, the second on — as the input rises the spot moves up the chain, until the voltage reaches that set on pin 13. This is the maximum voltage to which the display responds and if the input is taken above this level the last LED remains lit.

In addition to defining the indication range the voltage between pins 12 and 13 determines the abruptness of transition between any two LEDs. With this difference set to 1V4 the light point glides smoothly along the scale, with increasing voltage difference the passage becomes more abrupt until at 4V the light spot jumps from one LED to the next. We have set this voltage to a point between the two extremes.

The resistors R46, and R47 control the brightness of the display. Q1 supplies power to the display and is driven from latch 1 IC2/3. This you will recall, is reset, ie, its output is low, at the start of a game. A low voltage applied to Q1 via R41 turns this transistor on and enables the display. The latch is returned high at the end of a game, this turns Q1 off and blanks the display.

SCORE DISPLAY

The score display is formed by a second UAA170 (IC11). Much of the circuitry is the same as that of the game display except that we only wish to display eight LEDs. The diodes from unused outputs to the +VE supply act as 'dummy' LEDs, restricting the display to eight LEDs. you could use LEDs for extended scoring — but a larger box is needed. This display is powered by Q2 which is again fed from the output of latch 1 (IC2/3). This time, however, the display is blanked, Q2 off, when the latch is low and enabled, Q2 on, when the latch output is high.

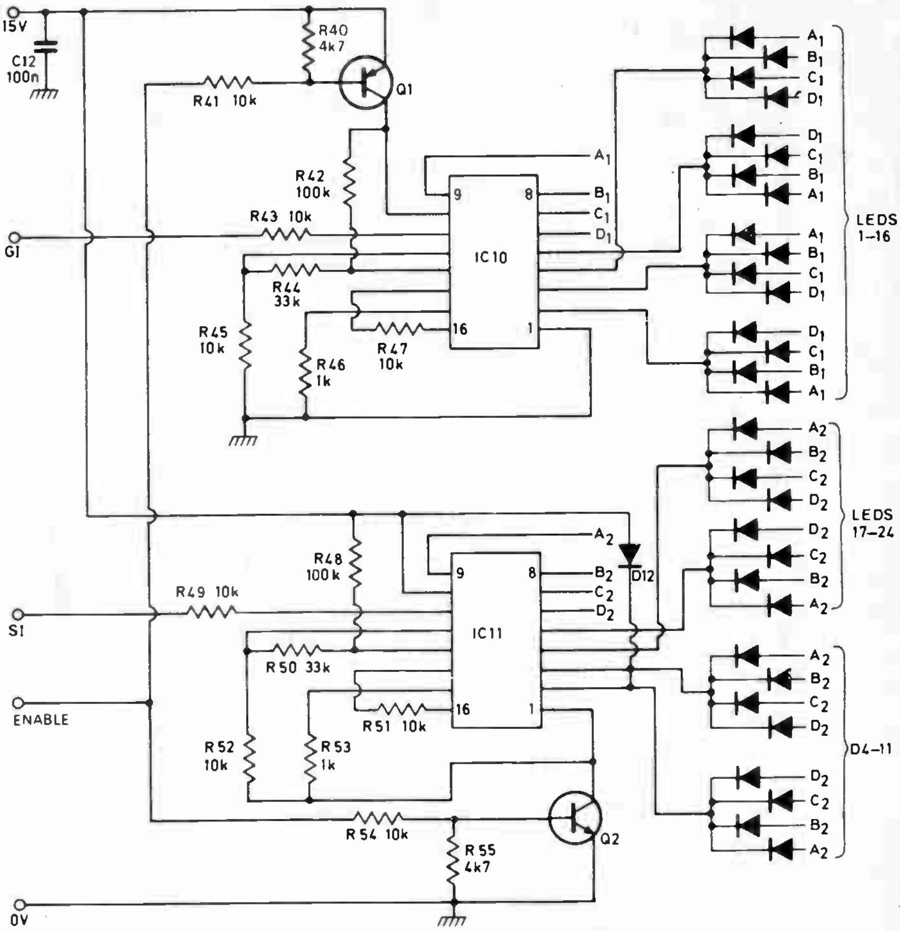


Fig. 4. Circuit diagram of game display section.

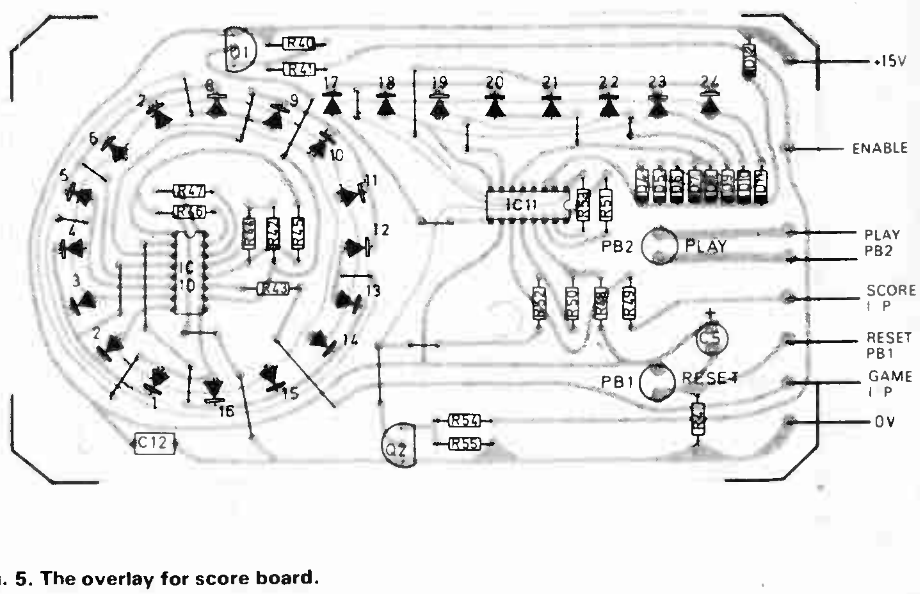


Fig. 5. The overlay for score board.

PARTS LIST

RESISTORS (all ¼W 5% unless stated)

R1,5,17,26,42,48	100k
R2,13,15	10M ½W 10%
R3,6,8,14,16,25, 30,37,38	1M0
R4,40.55	4k7
R7,18	2M2
R9,31	560k
R10	4M7
R11,12,28,29	820k
R20,21,34,36,39,41,43 45,47,49,51,52,54	10k
R22	220k
R23	150k
R24	2k2
R27	120k
R32,46,53	1k0
R33	56k
R35	100R
R44,50	33k
R19	47k

POTENTIOMETERS

RV1,3,4,5	100k min hor trim
RV2	10k min hor trim

CAPACITORS

C1	1000u	25 V electrolytic
C2	220n	polyester
C3	470n	polyester
C4	1n0	polystyrene
C5	10u	25 V electrolytic
C6	10n	polyester
C7,8	2u2	polyester
C9,10,12	100n	polyester
C11	100u	25 V electrolytic

SEMICONDUCTORS

IC1	78L15A
IC2,3	LM3900
IC4,5,7,9	741
IC6	4016
IC8	555
IC10,11	UAA 170
Q1	BC212L
Q2	BC184L
D1,2,3,4–12	1N914
LEDs 1–24	.2" type
BR1	4 pin DIL TYPE: 0.9 A 400 V (from R. S. Stockists)

TRANSFORMER

T1	240 V – 15 V 6VA

LOUDSPEAKER

LS1	G.P.O type insert

SWITCHES

PB1,2	Push to make
SW1	SPST toggle

CASE Vero type 65–2523

MISCELLANEOUS
Flex, PCBs as patterns, LED mounting clips, fuse and holder to suit.

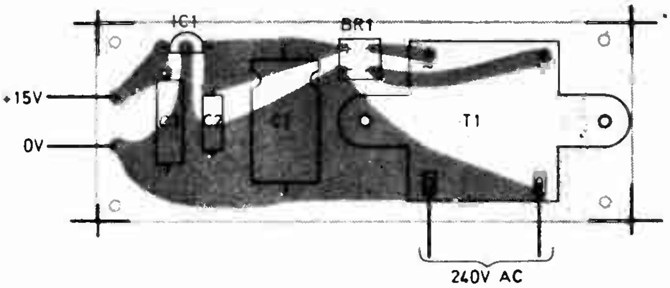


Fig. 6. Component overlay of PSU Mains earth is connected to T1 by a solder tag under the mounting bolt.

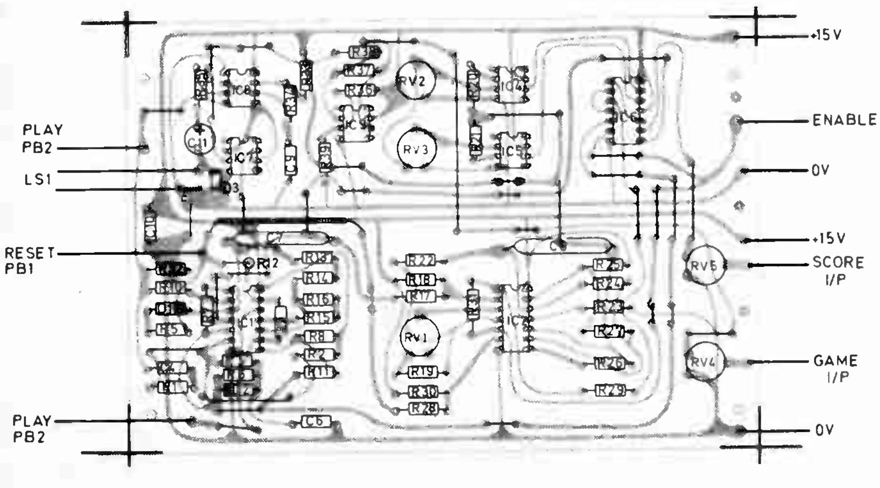


Fig. 7. The overlay for the control board.

BUYLINES

Some of the ICs used in this project may be unfamiliar but they are stocked by most of the larger component stores. Some of the high value resistors may also prove illusive, but again, if they are not available at your local shop try the advertisers in this issue.

POWER BULGE!

Astound your ears and annoy your neighbours with four times your normal sound level, courtesy of the ETI Power Bulge.

POWER AMPLIFIERS COME in all sorts of shapes and sizes, most small groups rely on 100 W types as they are widely available and relatively cheap. Even though the people next to the speakers think the sound is loud enough the performers usually want more power. The simple solution is to buy more powerful amplifiers — but it can be a lot cheaper to buy two less powerful ones.

The 'Power Bulge' is designed to be used with two low power amplifiers, and produce not just double power but four times the power of the separate amplifiers! The reason for the apparent power gain is that the voltage finally produced at the loudspeaker decides the power — and power is proportional to the square of the voltage.

Construction and Use

The prototype was built into a small Verobox. As large signals are involved screening in a metal box was not needed. The box size dictated the battery type, if you want to use a PP3 or other battery obviously a larger box will be needed.

When completed you need two power amplifiers (preferably of the same type) to use the unit. A normal stereo amplifier is ideal, if it has a tape monitor switch. A signal is taken out from the preamplifier and fed back into the power amplifier section (via the tape input if fitted). The loudspeaker is connected across the two positive speaker terminals as shown. ●

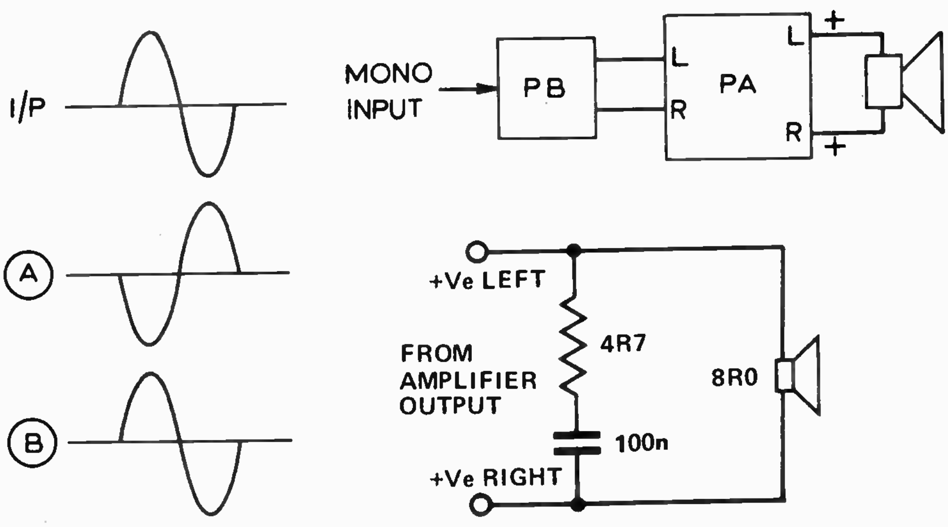


Fig 1. On the left is a diagram showing the input and output waveforms from the Power bulge, as can be seen the two outputs (A and B) are 180° out of phase with each other. Above right is how to connect the unit to any stereo amplifier, the lower circuit shows additional components suggested to stabilise the speaker load.

BUYLINES

No problems here, the case is stocked by most component outlets; the battery is available from photographic shops if not stocked by your friendly neighbourhood electronics shop.

This photograph clearly shows the neat layout of the prototype.

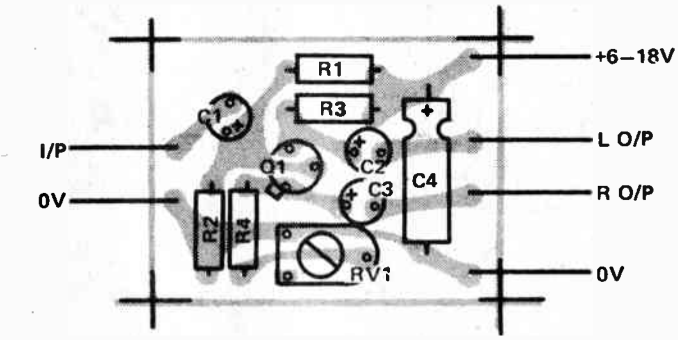
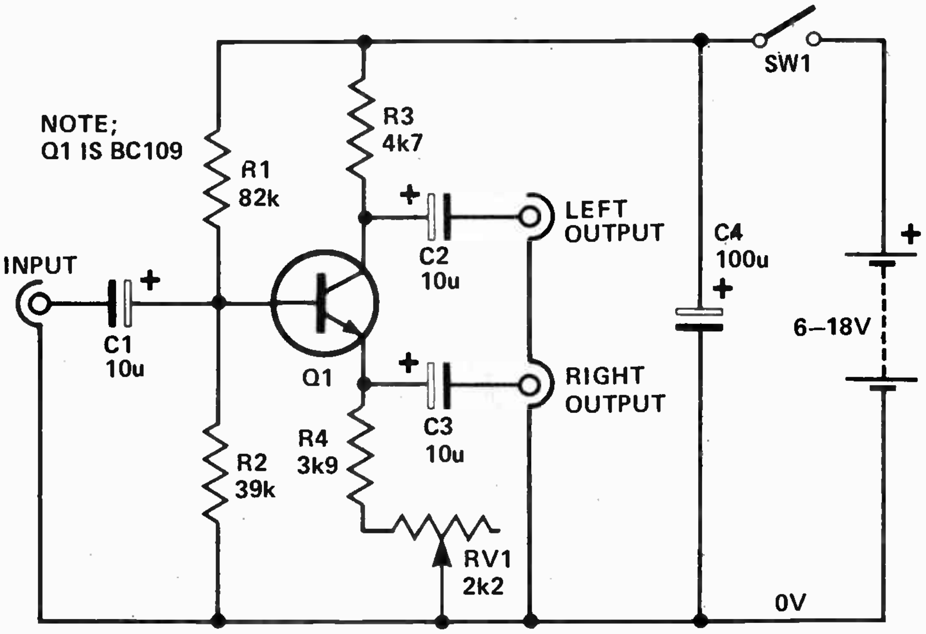


Fig. 2. The component overlay of the complete device is shown here. Make sure that the electrolytic capacitors are fitted the right way round.

Fig. 3. Circuit diagram of the Power Bulge.



PARTS LIST

RESISTORS (All ¼W 5%)

R1	82k
R2	39k
R3	4k7
R4	3k9

POTENTIOMETER

RV1	2k2 preset

CAPACITORS

C1, 2, 3	10u 16 V electrolytic
C4	100u 25 V electrolytic

SEMICONDUCTOR

Q1	BC109

MISCELLANEOUS

PCB as pattern, case (vero 202-21024B), battery B154, switch, phono sockets.

HOW IT WORKS

The idea of the unit is to produce two waveforms 180° out of phase. This is accomplished by Q1. The balance between the two waveforms is equalised with RV1. The three 10u capacitors are to AC couple the signal and C4 is to decouple the battery.

WINE TEMPERATURE METER

Ensure your wine is at the correct temperature with this little idea from our project team

WINE, WOMEN AND SNOG — no not anotner misprint but ETI's updated version of that phrase that so aptly describes that which a young man's fancy turns to in spring, or any other time of year for that matter. We at ETI can't do much about the provision of the above items but this project will at least ensure that when you get your hands on one of them it will be in perfect condition. Before going any further let's make it clear that it's the wine we're talking about in this connection.

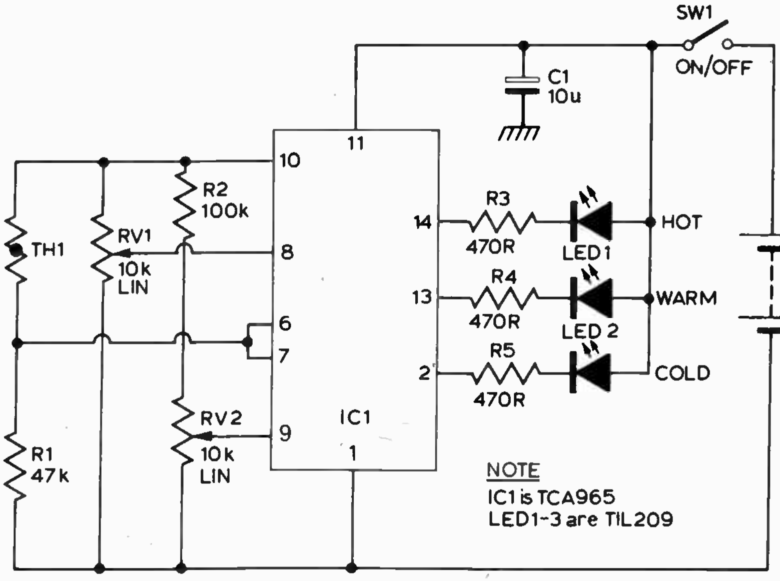
In use the wine temperature meter's sensor is clipped to the plonk of your choice and the condition of the booze, with regard to temperature, read off from the three LEDs on the meter's front panel. To set up the instrument consult our table showing the range of temperatures considered acceptable for the various types of wines. Turn RV2 fully anticlockwise and bring the sensor to a temperature that is in the middle of the desired range. Adjust RV1 until the centre LED just lights

Next lower the temperature of the sensor until it is at the lower temperature limit. Adjust RV2 until the lower LED is just extinguished.

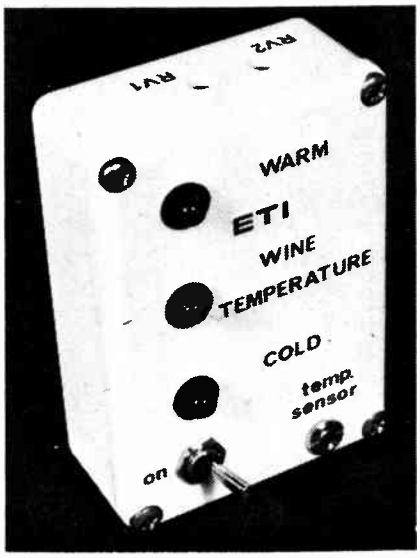
Construction of the project is quite straightforward. Assemble all the components according to the overlay shown. Space is at a premium if the case chosen for our prototype is used so keep everything tidy.

Our sensor was made from a bicycle clip. The thermistor was epoxied to the clip — we smeared a small amount of silicon grease on the clip before mounting the sensor — this provides a good thermal contact. We coated the sensor in a layer of black paint when it was complete leaving the area under the sensor as bare metal.

Insert the battery and start getting your grapes as they should be enjoyed. ●



Circuit diagram of the wine temperature meter.



Above, the complete unit while below the sensor, a bicycle clip painted black with the sensor epoxied to it.

HOW IT WORKS

The project is based on the TCA965 window discriminator IC. This device can be used in a number of different modes, the one selected for this application allows the potentiometers RV1 and RV2 to set up a "window height" and "window width" respectively.

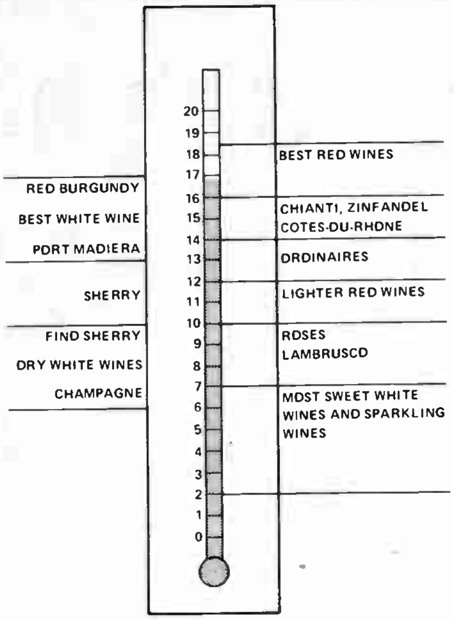
R1 and thermistor TH1 form a potential divider connected across the supply lines. The value of R1 is chosen such that at ambient temperature the voltage at the junction of these two components will be approximately half supply.

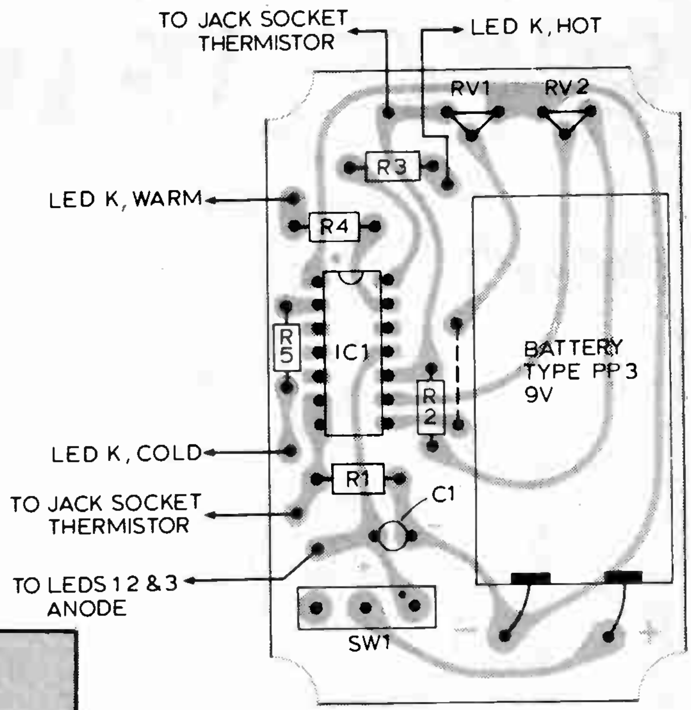
As the temperature of the sensor changes so the voltage will change and it is the temperature dependent voltage that is input to IC1.

RV1 will set the point which corresponds to the centre voltage of a window the width of which is set by RV2. The switching points of the IC feature a Schmitt characteristic with low hysteresis.

The outputs of IC1 indicate whether the input voltage is within the window or outside by virtue of being either too high or too low.

The outputs of IC1 are all open collectors capable of providing up to 50mA. In our circuit however they are only required to drive a LED via a current limiting resistor.





PARTS LIST

RESISTORS

R1	47k
R2	100k
R3, 4, 5	470R

POTENTIOMETERS

RV1, 2	10k sub. min. preset

CAPACITORS

C1	10u 10V tantalum

SEMICONDUCTORS

IC1	TCA965
LEDs1-3	TIL209

SWITCH

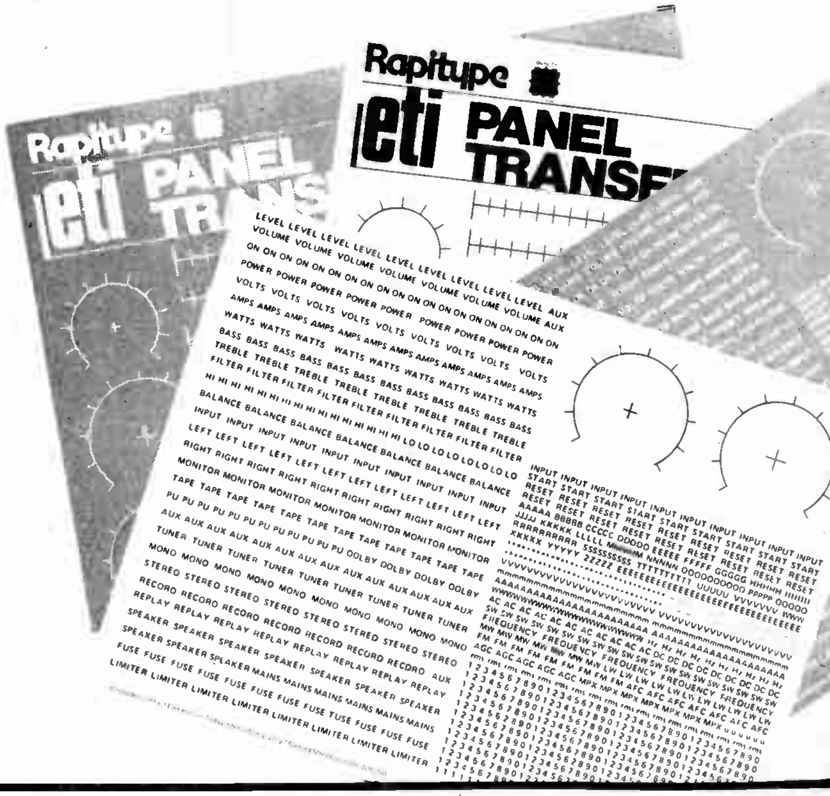
SW1	SPDT

MISCELLANEOUS

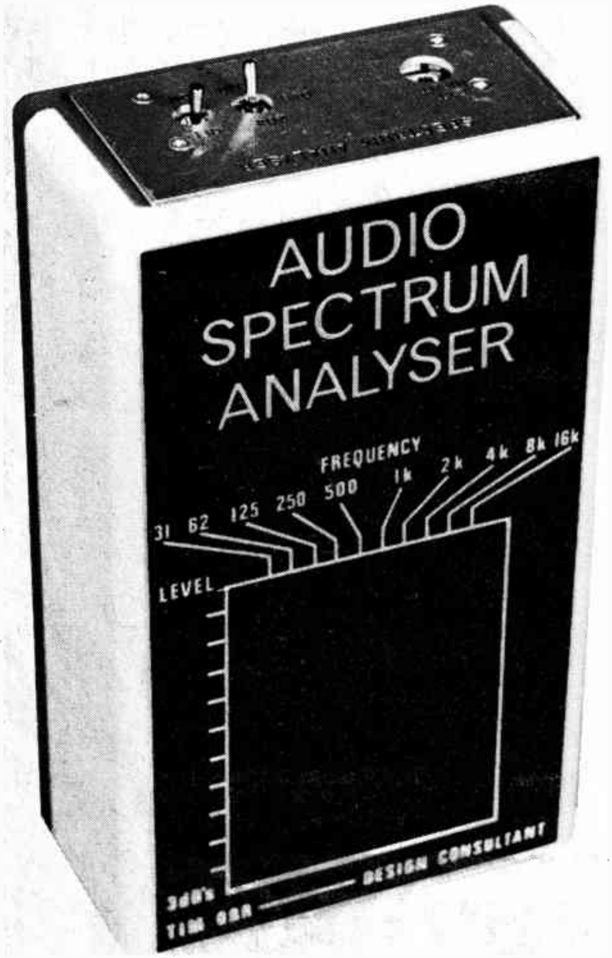
PCB as pattern, Vero potting box, 2.5mm jack socket, battery wire, wire etc

BUYLINES

All the components for this project should be available from most local shops with the exception of the TCA965 — this is available from Electrovalue, 28 St. Judes Road, Englefield Green, Egham, Surrey.



SPECTRUM ANALYSER



A ten channel unit designed for ETI by Tim Orr, who knows a thing or two about Active Filters and Op Amps.

AUDIO SPECTRUM analysers can be a valuable tool used in the setting up of a room acoustically, with a graphic equalizer such as the ETI design published in September 77, to monitor programme material or just as a gimmick to please yourself and friends.

When setting up rooms, pink noise is pumped into the room using an amplifier. A microphone is then used to monitor the sound and its output is the input to the analyser. Now by adjusting the graphic equalizer a flat response can (hopefully) be obtained.

Design Features

Spectrum analysis can be done by two main methods. The first is to have a tuneable filter which is swept across the band of interest. The output of the filter when displayed on an oscilloscope, will be a frequency/amplitude graph of the

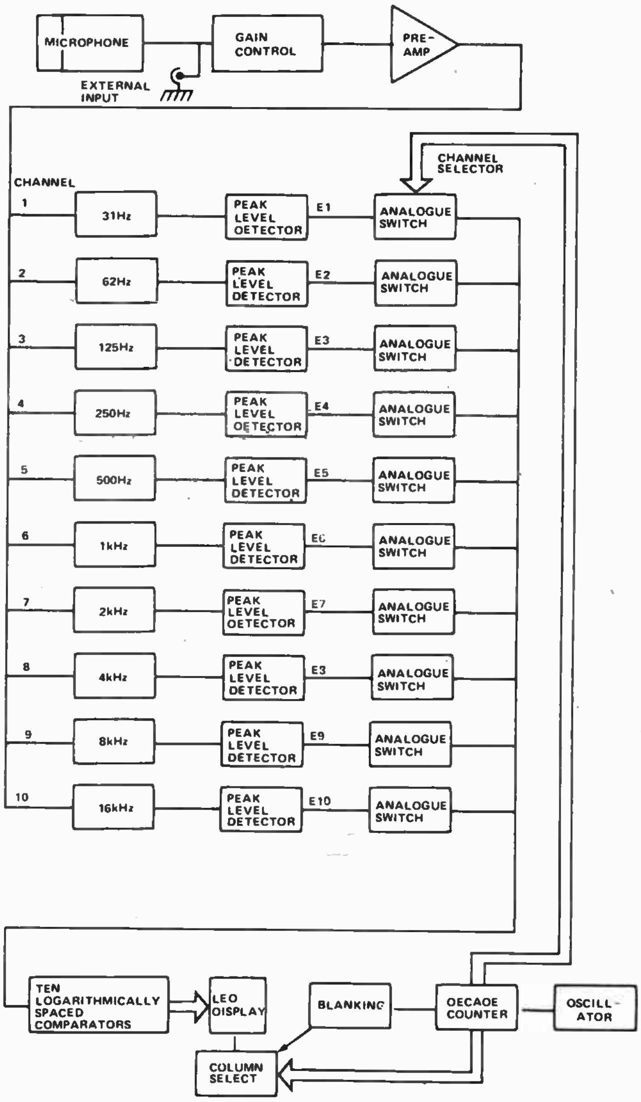


Fig. 1. Block diagram of the Spectrum Analyser.

HOW IT WORKS

GENERAL SYSTEM

The general system is shown in Fig. 1. A signal from an electret microphone (this one has quite a good frequency response) is amplified and fed into a filter bank. (An external signal could be plugged in instead of the microphone signal). The filter bank is a set of ten band pass filters, each covering a bandwidth of an octave. Thus a frequency range in excess of 31 Hz to 16 kHz is obtained. The frequencies given are in fact the centre frequencies of the bandpass sections. The filtered signals are then sent to ten peak envelope followers. These units determine the peak signal levels and display a PPM type of response. That is they react quickly to transients and decay relatively slowly. The display that they generate is easier to visually follow than, say, a VU response. The ten envelope signals represent the average signal energy throughout the spectrum. This information must now be displayed on the LED matrix.

To enable a low parts count solution, a multiplexed design was used. That is, the envelope signals are investigated serially in time. A ten-way analogue switch is used to look at each envelope signal in turn. This signal is fed into a set of ten comparators which are logarithmically spaced 3dBs apart. The comparators drive the LED matrix. The size of the envelope signal determines which LED in the column is lit up. The larger the signal the higher the LED. (However, this machine can be easily modified to give a bar display.)

The comparator that is on tries to light up all the LEDs in its row, but only one LED will light up. This is due to the ten transistor switches that drive the matrix columns. Thus, when the comparators are investigating envelope four, only the switch to column four is on. In this way the information is 'drawn' in the correct frequency column. This multiplexing procedure may seem a little complicated, but had we just used a comparator per LED then 100 comparators would have been needed, this method uses only ten! However you don't get something for nothing and there are a few problems to be encountered. The comparators used are LM324s. In fact they are op-amps, and tend to be rather slow. Their advantages are low power consumption and the ability to drive the LEDs directly. The speed problem means that when the multiplexer changes to the next channel, there is a short period of time when the comparators try to display 'garbage' because they are changing state. To overcome this, a blanking device turns off the LED matrix for a short period whilst the new information in the next channel is analysed. The multiplexing frequency is 500 Hz. This gives an analysis time of 2msec per channel and the whole display is repeated fifty times a second. If you shake the display it will strobe. Try the same thing on your pocket calculator!

INPUT AMPLIFIER

An electret microphone has been used as this is relatively inexpensive and yet provides a reasonably flat frequency response. It does however require a 1.5V power supply and this is generated inside the analyser.

A gain selecting switch SW1 gives a 40dB range of input sensitivities.

FILTER BANK

Each channel of the filter bank is made up of two band pass filters. The filters are double tuned. that is they have slightly different centre frequencies. There is a slight dip in the pass band but at either side roll off slopes are very steep indeed. The filters used are single op-amp multiple feed-back bandpass filters with 'Q's of five each. Each filter pair has a very large signal gain in their bandpass of about 50dB. The tolerance for the resistors and capacitors are 5%. Any components out of tolerance may significantly change the filter response curve. This will cause the gain of each channel to alter. If the gain change is significantly large then it may be necessary to alter the gain of the following envelope follower stage so that the display is not distorted. The op-amps used for the first 9 channels are LM324. These op-amps require a pulldown resistor on their output if gross crossover distortion is to be avoided. There may be some visible crossover distortion at the filter channel's output, but this will probably not adversely affect the analyser operation.

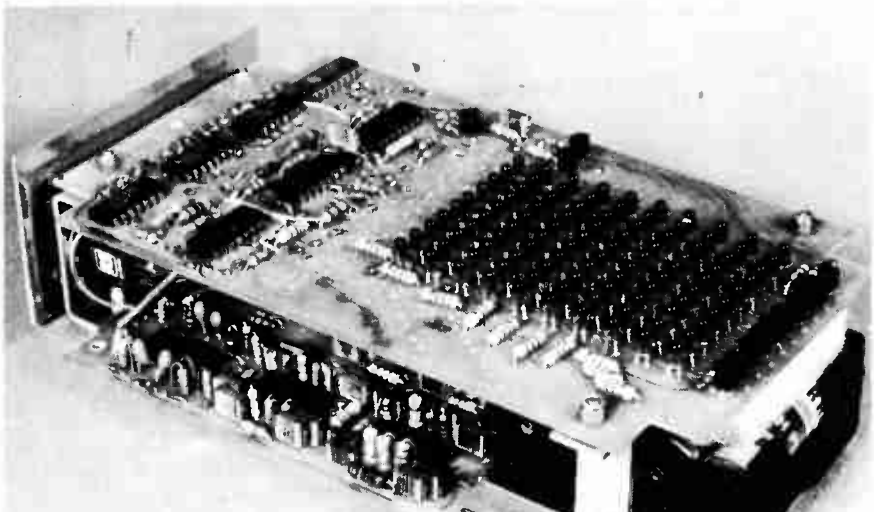
PEAK LEVEL DETECTORS

These devices are simple positive peak envelope detectors. The 1µF capacitor is charged up through the 3k3 resistor and discharged through the 180k resistor. Thus the output waveform quickly follows any signal level changes, but then slowly decays, exhibiting a PPM response.

MATRIX DISPLAY

IC11d is a single op-amp oscillator. It generates a square wave output at 500 Hz which clocks IC14, a CMOS decade counter/decoder. This has ten outputs, only one of which is high at any point in time. These ten outputs are used to control ten analogue transmission gates (switches), through which one of the ten envelope signals can pass. The switches are contained in ICs 15, 16 and 17. The output of the switches, this is in fact a multiplexer, is buffered by IC11c, and fed to the ten comparators. The comparators have a fixed reference voltage on one of their inputs (spaced at 3dB increments per device), and the envelope signal on the other. Thus, the comparators with reference voltages lower than the envelope signal try to go high. However, diode logic is used to make sure that the highest comparator ON is the only one that is on. The logic turns OFF all those comparators below it, so that only one LED is ON at any point in time. The correct column has to be turned ON at the right time and to do this 10 transistors, Q4-13 are used. They are also connected to the counter decoder and are thus synchronous with the multiplexer. To provide the blanking a mono stable period is generated from the counter clock with Q2, 3. On the positive going edge, Q2 is turned on by the 1µF capacitor. However the capacitor quickly discharges and so a short monostable period is generated by Q2. It is inverted by Q3 and used to turn off Q4-13 (and hence the matrix display), for a short period during which the comparators are changing.

By *omitting* diodes D26-D70 a bar display rather than dot will be obtained.



input. While this gives a well-formated and accurate display it is not 'real time' in that if an event occurs at one frequency while the filter is sweeping elsewhere it will not be recorded. For this reason this method is used normally where the spectral content is constant and the sweep is only over a small percentage of total frequency (such as the output of a radio transmitter).

For real time analysis the incoming signal is broken into several frequency bands, just like in a graphic equaliser, and the energy level in each band is displayed on a 'scope or, as in this project, with a vertical column of LEDs. Analysers with anything from ten one octave steps to thirty one third octave steps are available. The display is usually a large matrix of LEDs, frequency along ▶

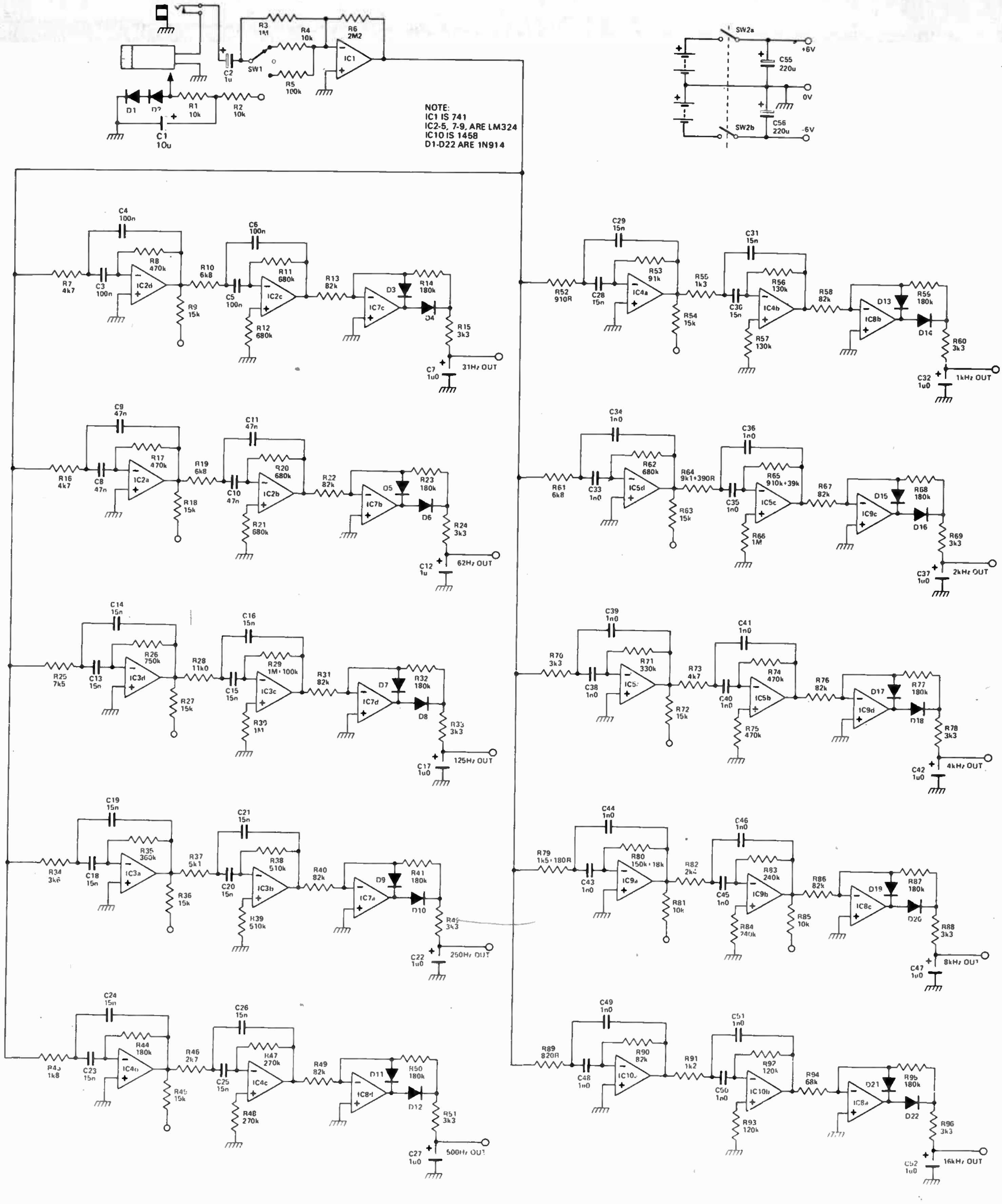


Fig. 2. Circuit diagram of the input amplifier, filters and envelope shapers that provide the required PPM response.

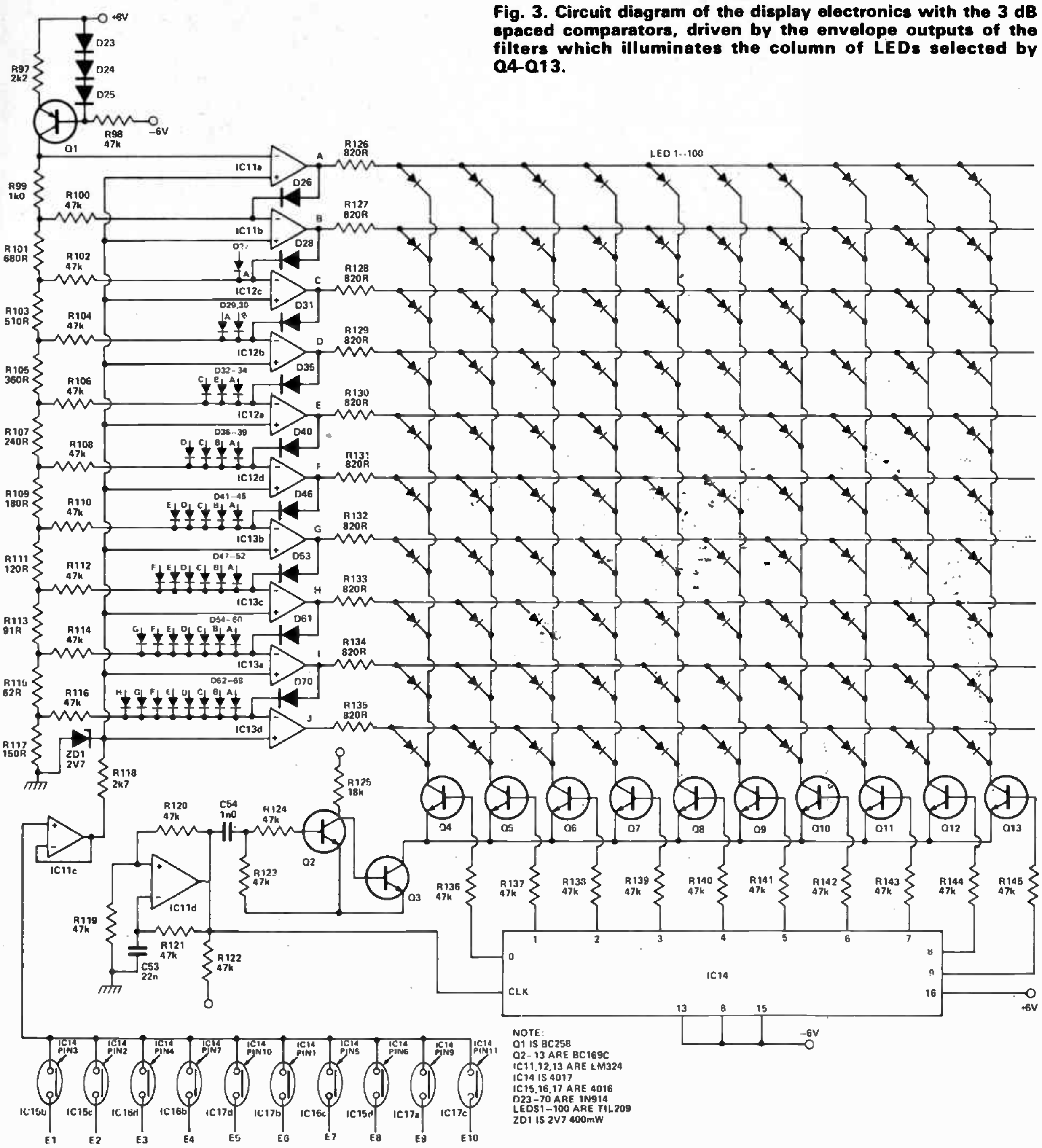


Fig. 3. Circuit diagram of the display electronics with the 3 dB spaced comparators, driven by the envelope outputs of the filters which illuminates the column of LEDs selected by Q4-Q13.

the horizontal axis and amplitude in dB steps vertically. This type of analyser will give a display of the average energy levels that exist and is not capable of discriminating between individual harmonics, this being due to the frequency spectrum having been indiscriminately broken up into octave chunks. Thus the analysis is grainy but it does enable you to instantaneously determine the average spectrum of a sound.

The spectrum analyser described here has ten frequency bands and ten level steps of 3dB each. The first prototype constructed used ordinary dual 741 op-amps and gobbled up 150 mA. This meant that it had to be mains powered and was thus not truly portable. The size of the box used was approximately 7½" by 4¼" by 2¼" and into this space was crowded: 100 LEDs, 70 diodes, 140 resistors, 13 transistors, four 14-pin ICs, 43 op-amps, 60 capacitors, two switches, a socket, a microphone and two printed circuit boards. This was not too much of a problem, the biggest problem was making the unit battery powered. By using the LM324 the problem was solved. This is a low power (0.8mA per package) quad op-amp. Thus, this device consumes one-tenth of the current per op-amp compared to the 741. The electronics consume only 20mA and the LED matrix display, when operating another 10mA. Therefore, ▶

PARTS LIST

RESISTORS (all ¼ watt 5%)	
R1, 2, 4, 81, 85	10k
R3, 30, 66	1M0
R5	100k
R6	2M2
R7, 16, 73	4k7
R8, 17, 74, 75	470k
R9, 18, 27, 36, 45, 54, 63, 72	15k
R10, 19, 61	6k8
R11, 12, 20, 21, 62	680k
R13, 22, 31, 40, 49, 58, 67, 76, 86, 90	82k
R14, 23, 32, 41, 44, 50, 59, 68, 77, 87, 95	180k
R15, 24, 33, 42, 51, 60, 69, 70, 78, 88, 96	3k3
R25	7k5
R26	750k
R28	11k
R29	1M0 + 100k
R34	3k6
R35	360k
R37	5k1
R38, 39	510k
R43	1k8
R46, 118	2k7
R47, 48	270k
R52	910R
R53	91k
R55	1k3
R56, 57	130k
R64	9k1 + 390R
R65	910k + 39k
R71	330k
R79	1k5 + 180R
R80	150k + 18k
R82	2k4
R83, 84	240k
R89, 126-135	820R
R91	1k2
R92, 93	120k
R94	68k
R97	2k2
R98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 119-124, 136-145	47k
R99	1k0
R101	680R
R103	510R
R105	360R
R107	240R
R109	180R
R111	120R
R113	91R
R115	62R
R117	150R

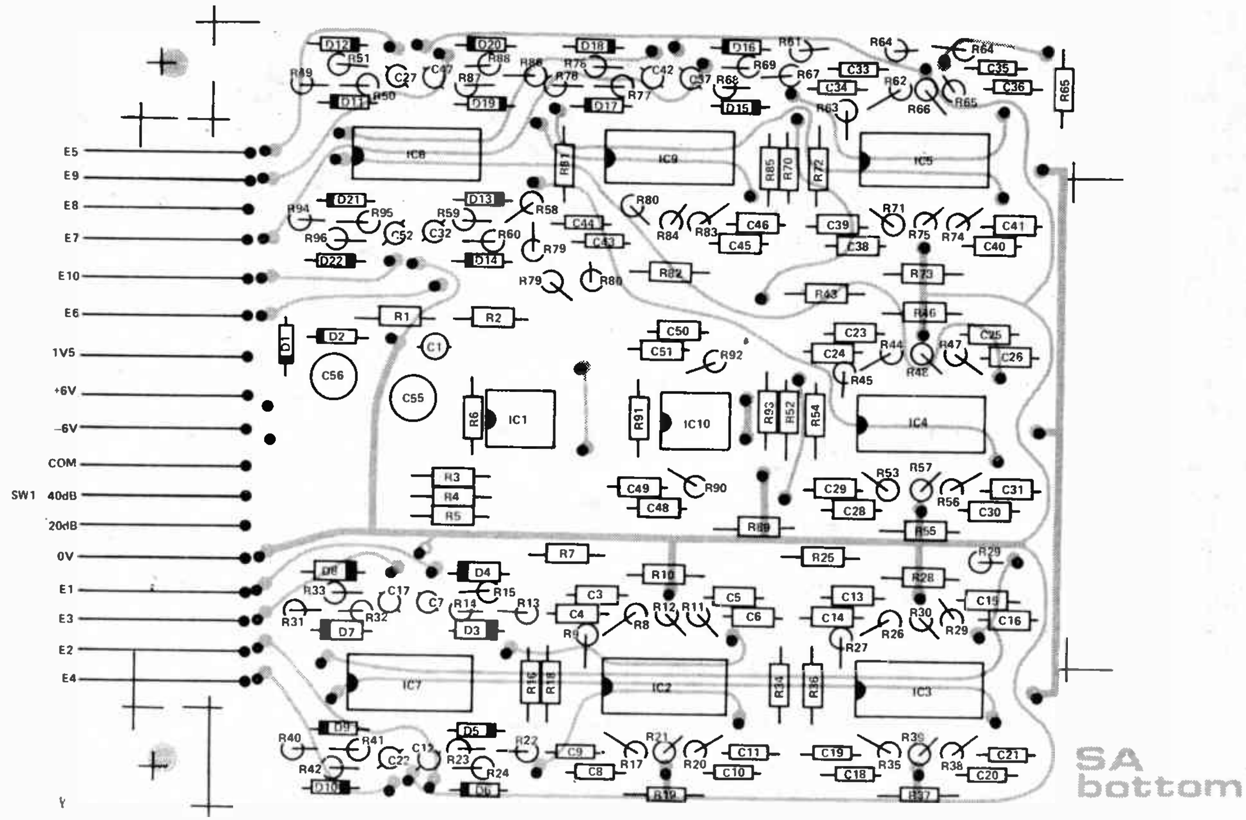


Fig. 4. Component overlays for the Spectrum Analyser boards. For reasons of clarity only the top side foil pattern is shown. Note that the above board has a large cutout to house the batteries. (See photographs.) For details of the foil patterns see page 94.

if the unit is used for two hours a day, 30 hours of usage will be obtained, as long as HP7s are used. If the usage period is only half an hour per day then 60 hours may be obtained.

Construction

This project is not one to be undertaken lightly. In order to keep the size of the unit down to hand held proportions, the two PCBs used have a very dense component layout and much care will be needed during construction.

Study the circuit diagram and draw out a contour of the filter, you will have to sweep the oscillator slowly to get a realistic impression of the response curve. If there are any substantial sensitivity changes from channel to channel, then by changing resistors R13, 22, 31 etc you can restore the overall flatness of the analyser.

The sensitivity tolerance shouldn't be more than ± 3dB. If it is in excess of this then there is probably a wrong component somewhere.

By feeding pink noise to the device each column should be approximately the same height. Due to the nature of the noise the top of the columns may jump up and down a bit but this should be averaged out by the eye.

The LED matrix may cause some problems. If certain LEDs won't light up then they are either broken or in the wrong way round. If one LED is unusually dim then change it. If a column is unusually dim, then change the transistor that drives that column. If a row is unusually dim, then change the comparator that drives that row. Check that IC11 d has a square wave of about 500 Hz (± 30%) at its output. ●

CAPACITORS	
C1	10µ 16V tantalum
C2, 7, 12, 17, 22, 27, 32, 37, 42, 47, 52	1µ0 16V tantalum
C3, 4, 5, 6	100n polycarbonate
C8, 9, 10, 11	47n polycarbonate
C13, 14, 15, 16, 18, 19, 20, 21, 23, 24, 25, 26, 28, 29, 30, 31	15n polycarbonate
C33, 34, 35, 36, 38, 39, 40, 41, 43, 44, 45, 46, 48, 49, 50, 51, 54	1n0 polycarbonate
C53	22n polycarbonate
C55, 56	220U 16V electrolytic
SEMI CONDUCTORS	
IC1	741
IC2-5, 7-9, 11-13	LM 324
IC10	1458
IC14	4017
IC 15, 16, 17	4016
Q1	BC 258
Q2-13	BC 169C
D1-70	IN 914
ZD1	2V7 400mW
LED 1-100	TIL 209
(IC6 is not used)	
SWITCHES	
SW1	SPDT centre off
SW2	DPDT

MISCELLANEOUS
PCBs. Electret tie microphone, case to suit, display filter, batteries plus holders, 3.5mm jack socket, screws, bolts etc.

BUYLINES

All components used in this project should be physically small — hence ¼w resistors and polycarbonate capacitors.

Try to secure discount prices for the hundred LEDS and possibly for the LM-324s.

The case we used was from the popular Vero range which is stocked by many local shops nowadays.

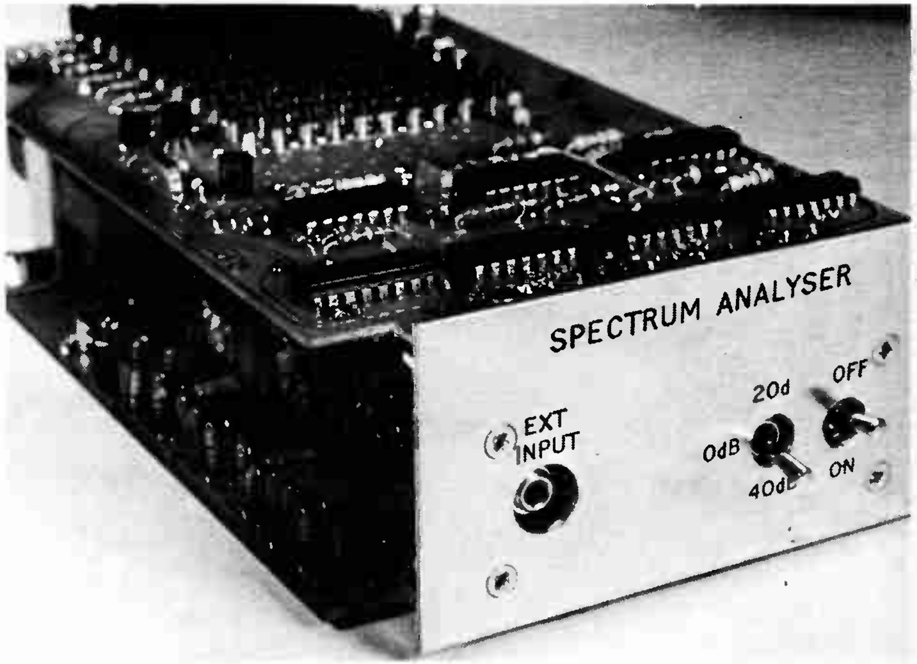
component overlays carefully before starting any work on the project. It is wise to insert, and check, all through hole links first, followed by passive and active devices.

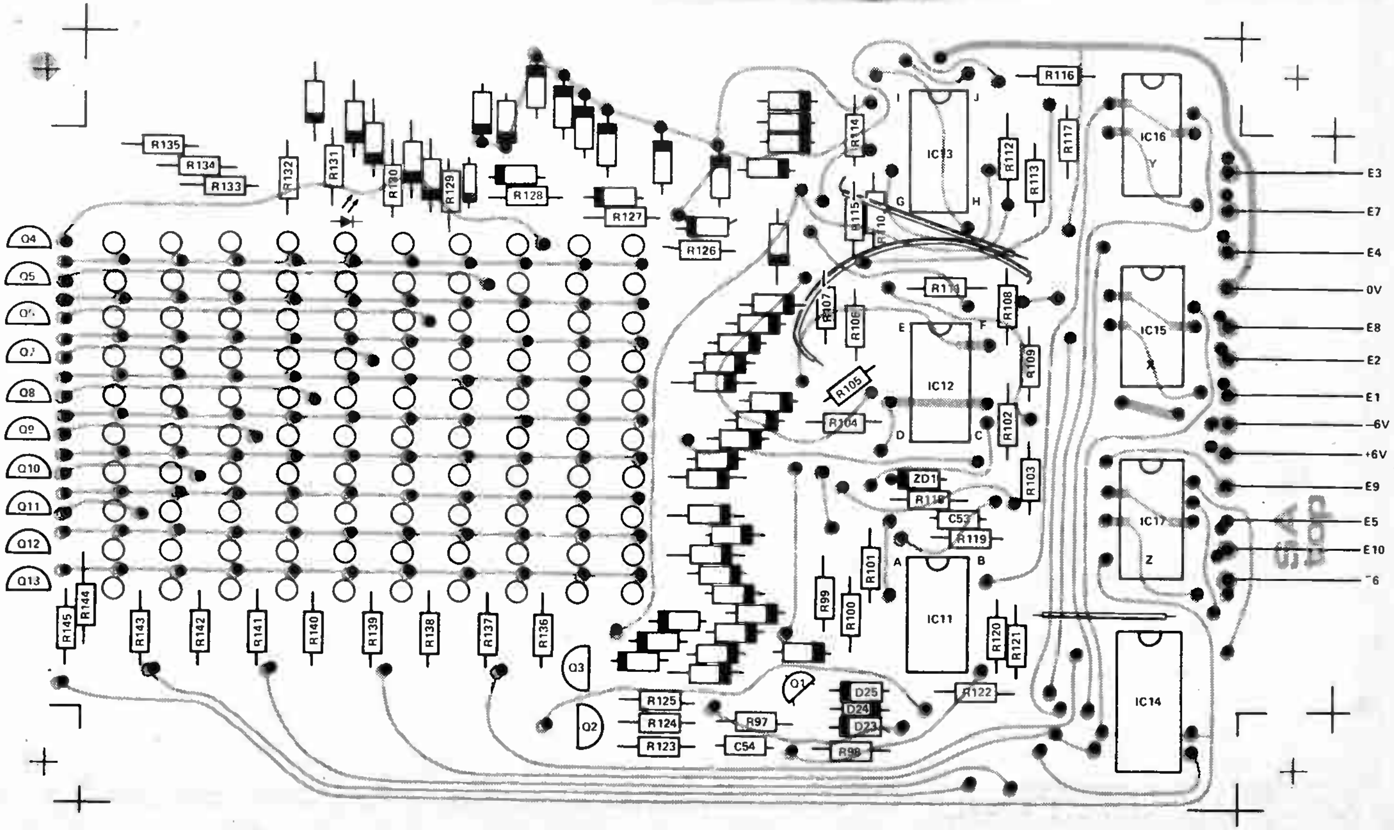
Each board, when complete, should be tested before final assembly.

Our photographs show how our unit went together, but the final appearance is very much a matter of personal taste.

Testing and setting up

The filter bank may be tested with a pink noise generator but preferably with a sine wave oscillator or for those lucky people with a swept oscillator (see ETI sweep oscillator, Top Projects No. 6). This is ideal. The envelope follower output should





SOIL MOISTURE INDICATOR

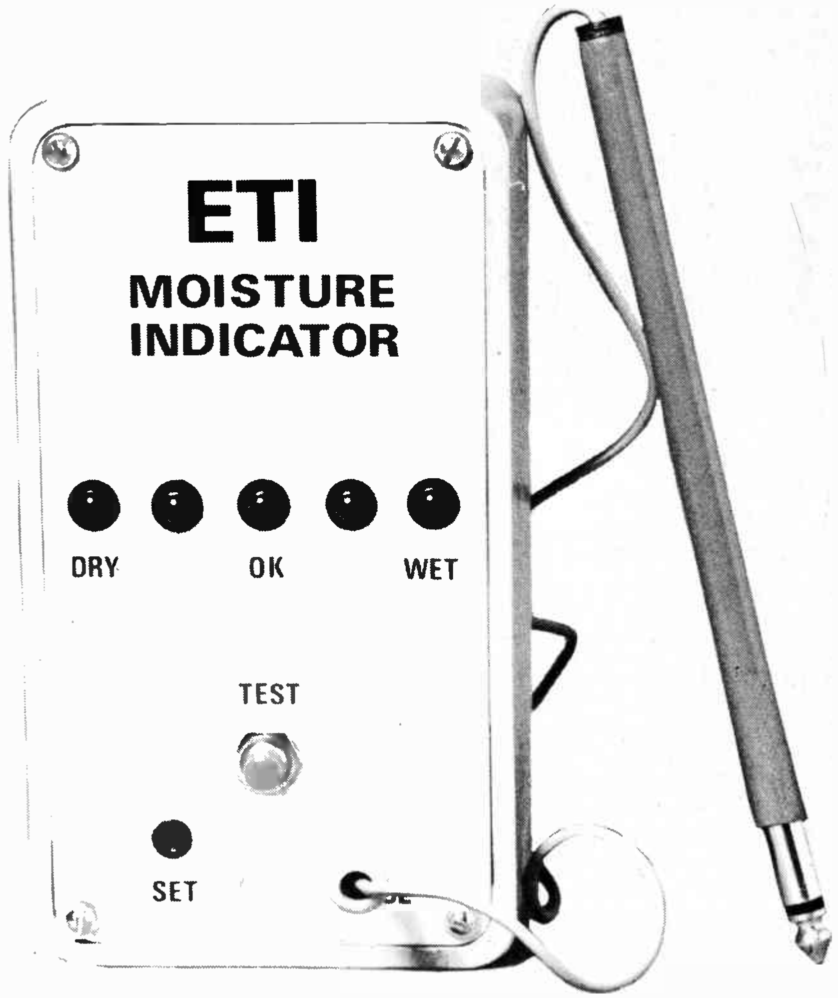
TO A GREENHOUSE OWNER, or indeed to many indoor and outdoor gardeners the degree of moisture within a plant pot's soil or compost is important but relatively unknown. When pots were made of fired clay an expert could rap the pot with his knuckles and the 'ring' or 'thud' would show the need for watering! Nowadays however, the use of polythene sleeves and plastic containers gives too variable a sound for adequate guidance.

This circuit was developed to give an easy and accurate indication of the need for water or - just as important, very often - of a state of excess that tends to drown the roots of a plant.

Development

Ohmmeter measurements between probes in various soils and composts showed a surprising range of resistances, from about 3 kΩ to about 30 kΩ and further enquiry proved (as might have been expected) that soil acidity and probe dimensions also varied the readings; in particular the use of dissimilar metals for the probe tips gave enormous variations. Indeed some soil-probe combinations seemed to be trying to produce a reverse resistance reading when used in one way and then nearly full-scale - zero resistance - when the probe connections were reversed. The probe electrodes *must* be of the same metal, preferably solid and not plated.

Initial circuitry suggested that a fairly sensitive micro-ammeter would be needed, or at least an amplifier to drive a less sensitive instrument. A gardener could easily drop the completed apparatus and this could be an expensive accident; also, a pointer-type instrument led to queries about the 'needle is 2 mm further than last time', and 'not the same reading as last week' when (potted?) field trials were carried out in greenhouses. An LED display was therefore chosen as being cheaper, very robust and giving sufficiently repeatable results.



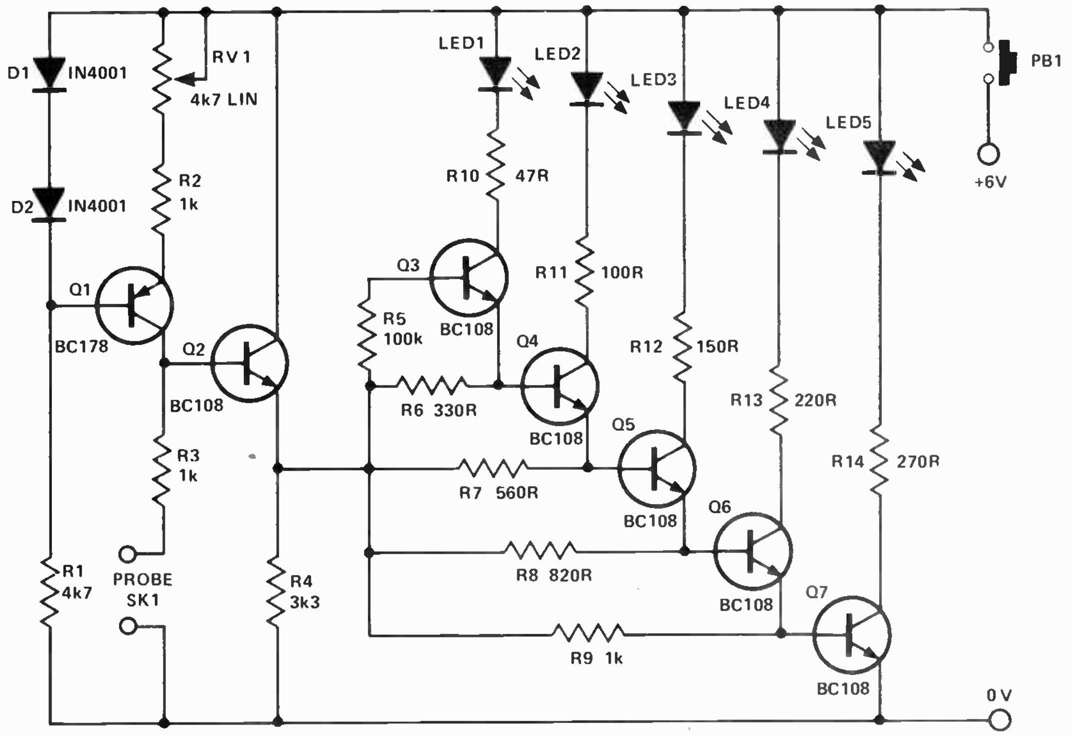
Construction

All the components with the exception of the LEDs, PB1, and SK1, which are mounted onto the front panel, are carried by the PCB. RV1, the sensitivity adjustment potentiometer, is made accessible via a hole drilled in the case.

The most taxing part of constructing the device is the actual 'building up' of the probe. Ours was fabricated from a Japanese ¼" mono jack plug.

Wiring from the probe to the box should be strong but as flexible as possible, so that continued use does not take its toll and incorrectly monitored moisture drowns both your plant and reputation as a genius!

Mounting the probe assembly is largely up to you, but we found that a ballpoint accepted the barrel like it was made for it.



Circuit of the moisture indicator

HOW IT WORKS

Fig.1 is the basic diagram of the system. A constant current (preset to suit local soil conditions) through the probe tips, and the moist soil, produces a volt drop that is proportional to the resistance of the soil. This voltage then turns on an LED, which typically requires some 2 V at 15 mA for adequate brightness. A soil

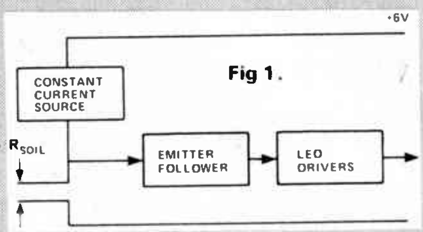


Fig 1.

resistance that is higher or lower than that given by the correct moisture content should also be indicated, so five LEDs are incorporated to cover the range of 'too wet' to 'too dry'.

Using silicon transistors, an emitter-base voltage of about 0.6 V is sufficient to turn on the emitter-collector current of Q7 and further increase in voltage (or base current) then results in additional emitter-collector current flow if the load allows. By connecting Q6 emitter to Q7 base, Q6 base needs to be 0.6 V more positive than Q7 case, hence at about 1.2 V (at the base) Q6 as well as Q7 is conducting. Similarly Q5, 4, 3 will conduct at base voltages of 1.8, 2.4, and 3.0 V respectively.

The current through an LED is limited to 15-20 mA by an additional series resistor (R10-14); the transistors Q3-7 are bottomed at this present collector current, a collector voltage then being only slightly more positive than its emitter when an LED is at full brilliance.

Resistors R5-9 are included to prevent the various base-emitter diodes from clamping the output of Q2 to a low value. The inclusion of these resistors and the required currents through them taken taken by the various bases means that the 0.6 V steps of voltage that should turn on Q3-7 are modified slightly. When the LEDs are illuminated the total base current drive for Q3-7 is in the order of 10-20 mA and this is supplied by Q2, an emitter follower.

A quick revision of theory reminds us that the collector characteristics of a transistor, Fig.2, shows a nearly constant-

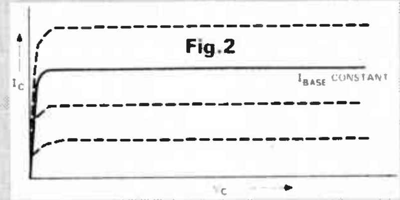


Fig.2

current curve when the base is supplied with a steady value of current and voltage, this voltage being about 0.6 V. In Fig.3 the base voltage is clamped or set by a zener diode to a particular value, say Vz, and the emitter voltage is therefore about (Vz – 0.6) V. The emitter current (and, for all practical purposes,

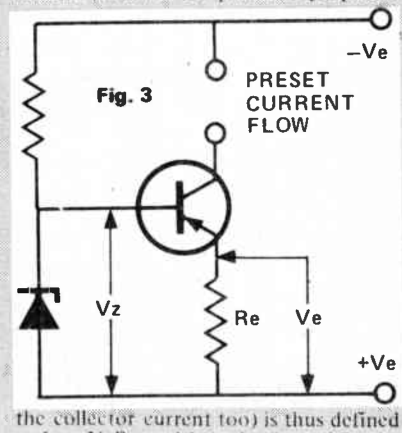


Fig. 3

the collector current too) is thus defined as Ie = VeRe and by selection of Re the value of Ie (or Ic) is determined. As long as there is about one volt between emitter and collector the collector current remains constant at this chosen value - or at least until a resistor or load of too large a voltage and so robs the collector of its working voltage.

With only a 6 V supply Vz must be as small as possible and once again the fact that a forward biased silicon diode drops about 0.6 V is used. The two series-connected diodes D1-2 maintain Q1 base at about –1.2 V and the voltage drop across R2-RV1 is about 0.6 V.

PARTS LIST

RESISTORS (all ¼ W 5%)

R1	4 k 7
R2,3,9	1 k
R4	3 k 3
R5,11	100 R
R6	330 R
R7	560 R
R8	820 R
R10	47 R
R12	150 R
R13	220 R
R14	270 R

POTENTIOMETER

RV1	4 k 7 hor. min. type

SEMICONDUCTORS

Q1	BC 178
Q2-7	BC 108
D1, 2	IN 4001
LED1-5	.2" type

SWITCH

P.B.1	Push to test type

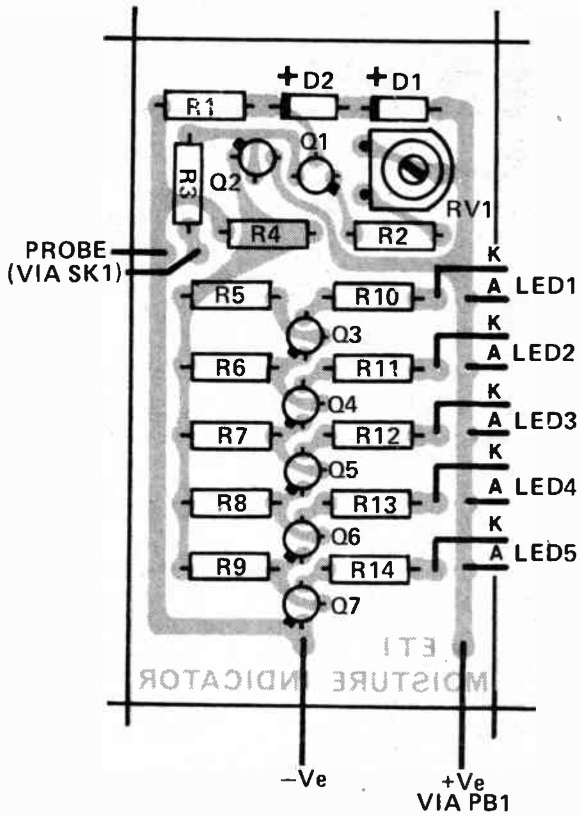
SOCKET

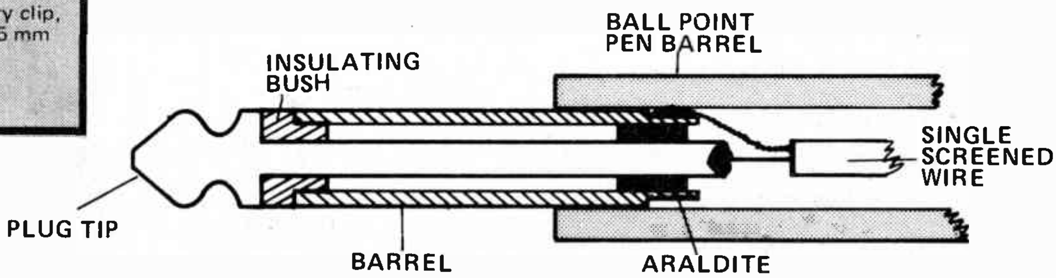
SK1	3.5 mm panel jack socket

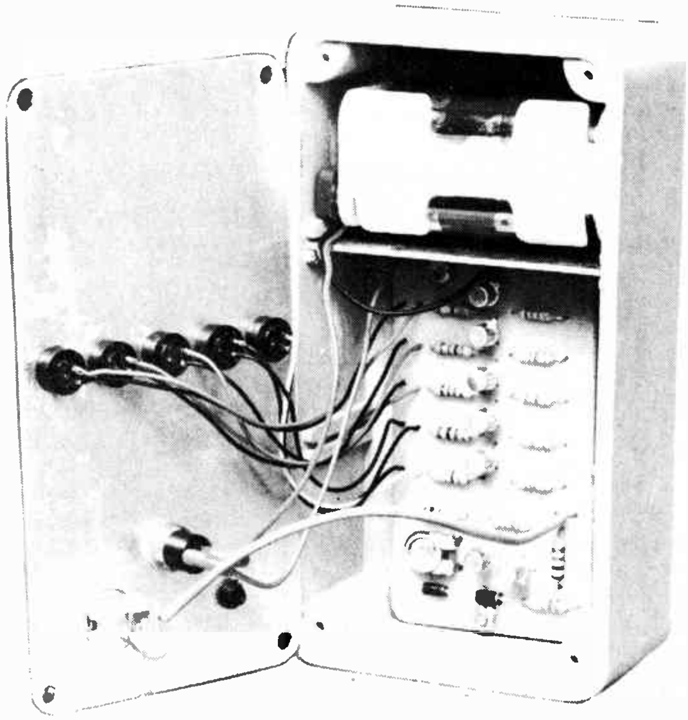
PROBE
See text

CASE
5¼" x 2⅞" x 1½" / 134 x 73 x 38 mm

MISCELLANEOUS
Battery holder (4 x HP7), battery clip, screened wire, wire, Araldite, 3.5 mm jack plug, pcb as pattern.







Testing and Using

Before connecting the supply to the board, check carefully there are no 'bridges' present lest they lead you to troubled waters.

With the probe 'dry' all the LEDs should come on. With a short-circuit across it (i.e. VERY wet!) not one should be lit. Check the range of current in the probe, by short-circuiting with a milliammeter, to be about 0.1 mA to 0.6 mA approx.

Push the probe into soil of what you consider correct moisture, and adjust RV1 to light three LEDs. More moisture than this then lights *fewer* LEDs, whilst a drier soil lights more.

Perhaps one usage for this would be if you trotted off on holiday, leaving some willing person to take care of the plant-life while you sample the night-life. Once set the indicator could ensure that your instructions are carried out faithfully, and you don't return to see your favorite rubber plant impersonating a water-lily.

RADIO CONTROL SYSTEM

A de-luxe R/C system designed with the true enthusiast in mind. The Strato is easily built and versatile to use.

THERE WERE SEVERAL criteria we considered important in any radio control system before this project came up, and these have been perhaps the main reason for ETI keeping out of this field thus far.

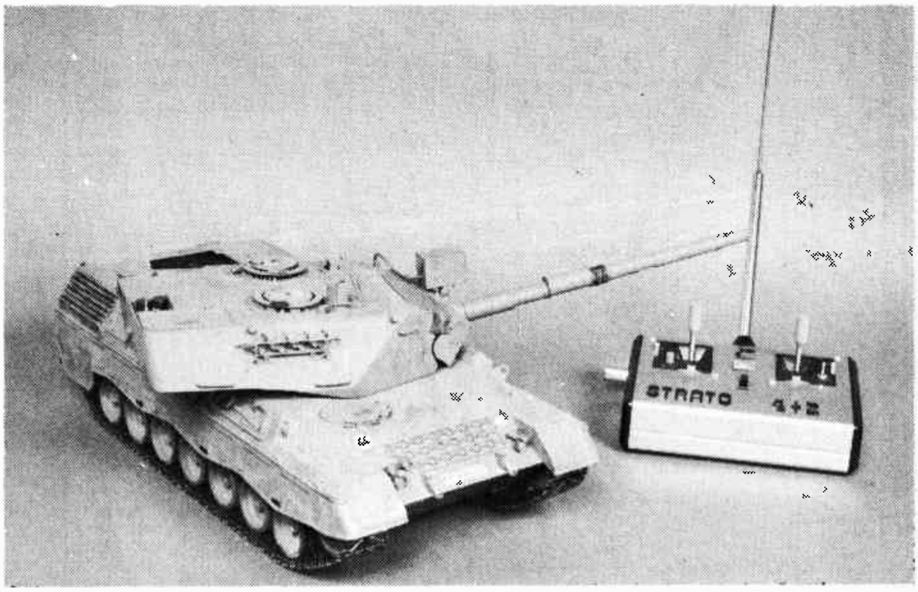
However Remcon's design, presented here, satisfies our requirements perfectly and fulfills a few we hadn't thought of. Firstly it is easily constructed and easy to set up — too many systems are marred by their requirements for expensive test gear in the alignment procedures. All that is needed here is a simple voltmeter.

Secondly the transmitter produces a 'clean' output which does not interfere with adjacent channels to any degree worth mentioning. This is an essential requirement since the receiver can handle 10kHz channel spacing, and interference would render this unusable. In any case this is now a legal requirement in many countries.

The charger for both transmitters and receiver can be built into the transmitter case itself, which any enthusiast will recognise as a decided convenience. A five pin socket fitted to the case allows access to the charger circuit for this facility, and the same socket holds the transmitter crystal (normally encased within a DIN plug). This means channels can be changed quickly — or the set disabled — simply by removing the plug.

Tune In

The Strato system can be built as either a four or six channel unit, and is suitable for any kind of model from airplane to boat. Choice of servo will be made according to the vehicle to be controlled.



We chose an armoured vehicle as the example upon which to base our articles, as this is more general in principle than most and allows easier illustration. The model we used was the excellent Tamiya 1/16th Leopard kit. This gives a splendid model of the W. German tank with Tamiya's usual superb moulding detail and a drive system designed for radio control through an ingenious twin clutch system.

It is an expensive kit, but in our opinion is well worth it, and includes everything right down to the servo rods.

A Case For It

The transmitter case is designed for four channels to be controlled by joystick and two by either pot or simple switch. The latter could be useful for aircraft undercarriage and the like.

The angled aerial produces a radiation pattern that reduces the risk of an aircraft (in particular) getting itself into an area of low strength and thus passing beyond operator control.

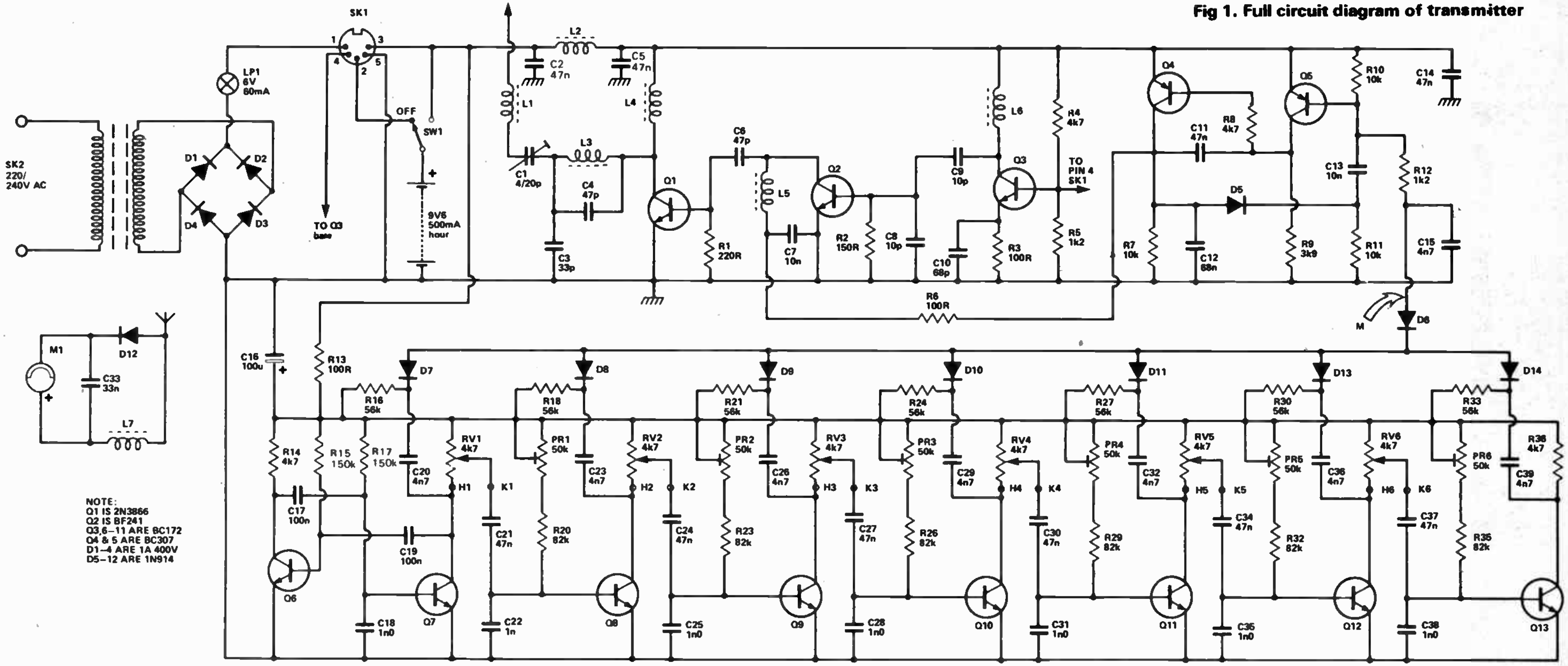
The meter on the front panel is a form of field strength meter and is used initally for setting the only tuning control in the Tx circuitry, and thereafter indicates RF output as a check upon performance.

Construction

Building the Tx should pose no problems to the average constructor, but when fitting the joystick and case, follow the photographs carefully otherwise it could cause unnecessary problems.

Assemble the PCB first, and check carefully the polarity of semiconductors etc. Fit the aerial and other sockets initially, then the passives and leave the transistors until last. Note the inductors are labelled. ▶

Fig 1. Full circuit diagram of transmitter



HOW IT WORKS

This has been designed to meet the stringent requirements of continental post offices in respect of harmonic radiation and sidebands and has adequate power output to ensure out-of-sight range for model aircraft. The following description refers to the 4-channel version but can be extended to cover the circuitry around Q12, Q13.

Referring to the transmitter circuit Q6, 7 R14-17, RV1, C16-19 comprise a conventional astable mutivibrator of unity M/S ratio, and period approximately 20mS. This is the system clock. If we look for a moment at Q8-11 it will be seen that these initially have their collectors close to the - ve rail potential due to their base bias. Now when the collector of Q7 goes to logic 0, the step change in voltage at the slider of channel 1 control potentiometer RV1, is passed via C21 to the base of Q8, cutting off its collector current. The collector of Q8 therefore goes to logic 1. The base potential of Q8 slowly rises on a time constant C21 (PR1+R20) until the base/emitter diode again becomes forward biased. At this point the collector goes to logic 0 once again. When this happens, the -ve going step voltage at the channel 2 control potentiometer RV2 cuts off Q9, followed by the same pattern of events as detailed for Q8. This sequence is followed by Q10 and Q11. Potentiometers RV1-4 are the operator controls, and PR1-4 permit setting of the pulse width with the channel controls centred. These adjustments are carried out to set the mid-travel position of the servos.

The encoding process is completed by the C,R and diode network at the collectors of Q7-11. Taking as an example, C26, R21, D9, capacitor C26 is normally charged to a potential approximately that on C16. When Q9 is cut-off by the pulse from Q8, C26 discharges on a time constant C26 (R21+RV3), which is much less than the 1ms minimum duration of channel data. When Q9 is again turned on, D9 and D6 are forward biased by the current through C26. During the recharging period of C26, the current pulse through R12 turns on Q5 which is part of the monostable which modulates the buffer stage Q2. Before triggering, Q5 is cut-off, and Q4 therefore turned on by base bias current through R9, R6. When triggered by an encoder pulse via D6, Q5 conducts and turns off Q4, which reverse biases D5. C13 then charges through R11, maintaining Q5 in its turned on state for a period determined by C13, R11. Since this occurs when Q7-11 collector go to logic 0 then five absolutely identical pulses will be generated by Q4 and Q5 in every 20 mS frame of data.

The RF section is one of elegant simplicity, having only one adjustment, C1. Q3 is the crystal oscillator using 27 MHz 3rd overtone crystal. Its 27MHz output is coupled to the base of buffer/modulator stage Q2 via C9. As we mentioned in the description of the encoder, Q4 is normally conducting, which means that collector voltage is applied to Q2 via R6 and L5. The amplified RF from Q2 to collector passes to the power amplifier Q1 via C6. Impedance matching from Q1 collector to the aerial is effected by pre-coupler C3, L3 C4, and base loading by adjustable network L1, C1. A simple RF meter circuit is included, comprising the meter, C33, L7, D12, it is used to peak the aerial matching adjustments during initial setting up. Thereafter it constantly indicates the carrier strength.

Before leaving the transmitter it is perhaps worth mentioning C2, L2, C5, C11, C14, C15, C18, C22, C25, C28, C31. They are all there to prevent R.F. from reaching unauthorised, and sensitive parts of the circuit!

BUYLINES

With a project of this type the metalwork is more important than for our usual endeavours. For the transmitter in particular, with the joysticks and aerial to be mounted, we cannot imagine anybody enjoying filing away for hours. In consequence we strongly recommend use of the hardware packs offered by the designers, Remcon. Our photographs and text employ these.

We estimate that, including four servos, the project will cost about £130 in total, which is approximately £60 less than a commercial set of approximately equal performance would cost.

The model we decided to base our installation on is the Tamiya Leopard A4 in 1/16th scale, which is designed for radio control. The kit is superb in all respects, both as a model and as a vehicle for radio control, and cannot be recommended highly enough. Beatties chain of stores stock the kit and it will cost around £90 including the gearbox/clutch/motor assembly for direction control.

From Remcon: —

Manual for system (worthwhile step-by-step constructional details) £2.75

£1.00 refundable against purchase of packs over £25

Transmitter hardware pack (everything except components and batteries):
4 channel £39.95
6 channel £45.00

All components available separately. SAE to Remcon for details.

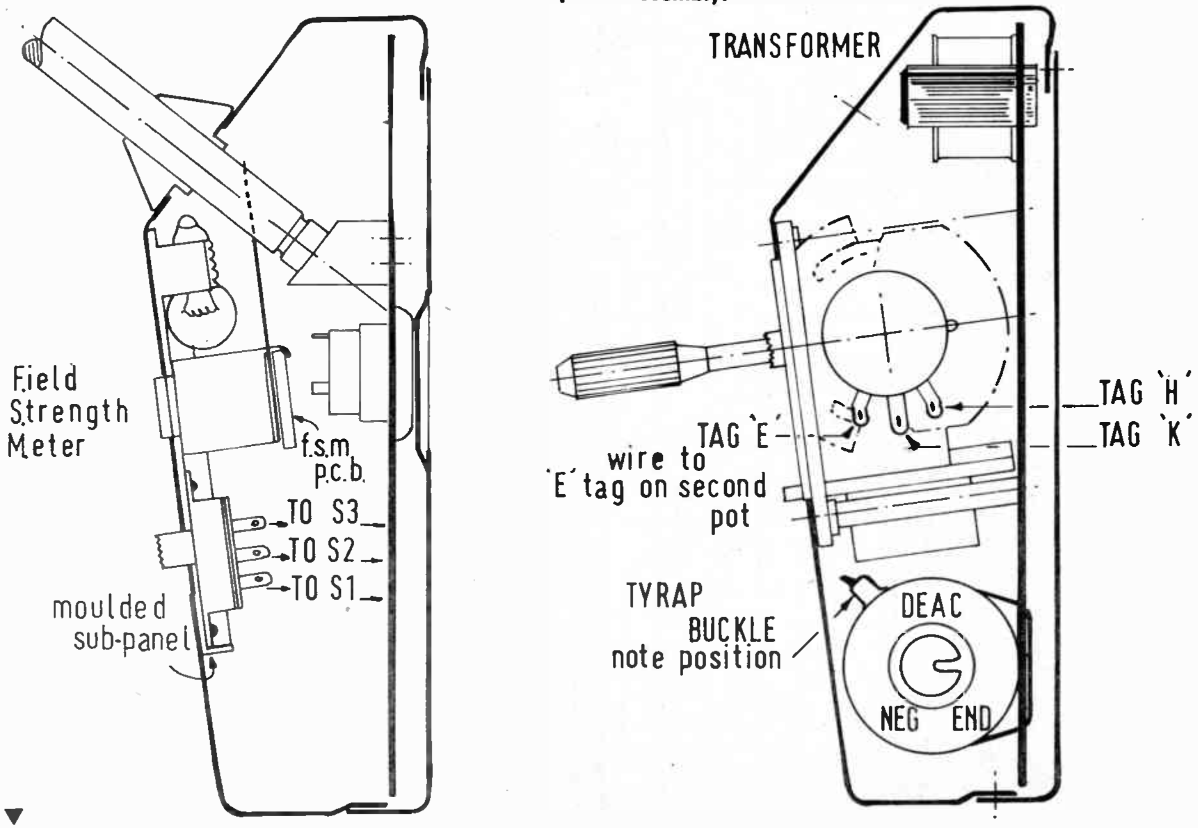
Receiver hardware pack complete (six channels) £18.50

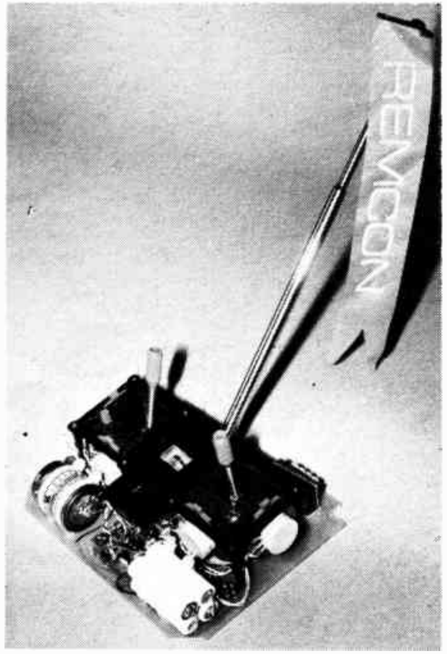
All components available separately.
Please add VAT to all prices except manuals.

After considering the market availability of servos, we found that World Engines of 97 Tudor Avenue, Watford, Herts, have at least a dozen types to offer in both kit and assembled form — mostly American.

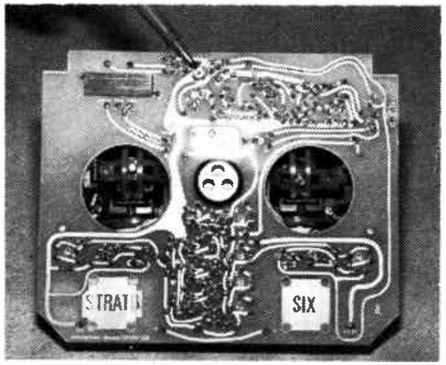
Fleet Electronics of 47 Fleet Road, Fleet, Hants can offer a design perfectly suited to our system in both kit and built form. There are undoubtedly many many more. Prices run from about £10 to about £15-£20 depending upon whether you intend to assemble it yourself.

Fig 2. Section through transmitter case. Should help with assembly.

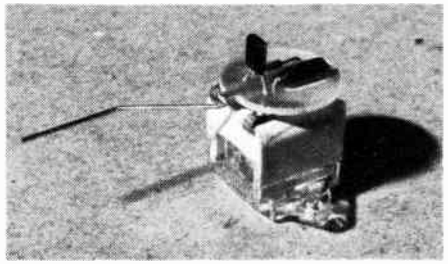




The complete Tx excluding case.



Copper side of PCB. Note earth bush.



The field strength meter with PCB bent over for fixing.

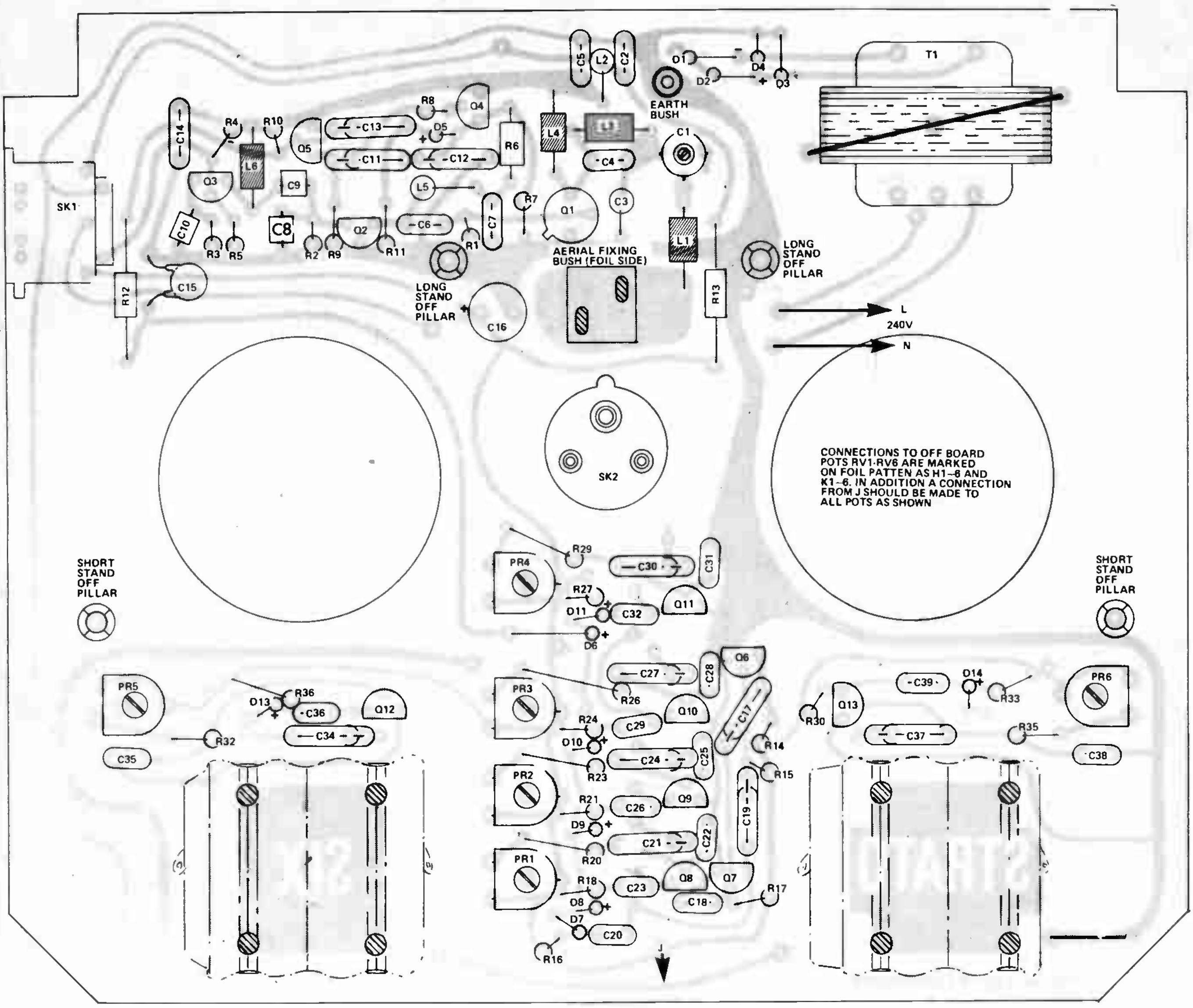


Fig 3. The main component overlay for the transmitter. Note that PR1-6 are 50k in value.

PARTS LIST

RESISTORS (all ¼W 5%)

R1,38	220R
R2	150R
R3,6,13,37	100R
R4,8,14,36	4k7
R5,12	1k2
R7,10,11	10k
R9	3k9
R18,21,24,27,30, 33,16	56k
R20,23,26,29,32, 35	82k
R15 17	150k

Note that R19,22,25,28,31,34 are annotated as PRI-6 to correspond to channel number. They are 50k presets.

POTENTIOMETERS

RV1-RV6	4k7

CAPACITORS

C1	4-20p trimmer
C2,5	47n polystyrene
C3	33p polystyrene
C4,6	47p polystyrene
C7	10n polyester 5%
C8,9	10p polystyrene
C10	68p polystyrene
C11,14	47n ceramic
C12	68n polyester 5%
C13	10n ceramic
C15,20,23,26,29, 32,36,39	4n7 ceramic
C16	100u electrolytic 25V
C17,19	100n polyester 5%
C18,22,25,28,31, 35,38	1n0 ceramic
C21,24,27,30,34, 37	47n ceramic
C33	33n ceramic

INDUCTORS

L1,2	4u7
L3	220n
L4	22u
L5	680n
L6	1u5
L7	10u

SEMICONDUCTORS

Q1	2N3866
Q2	BF241
Q3, 6-11	BC172
Q4,5	BC307
D1-D4	ITT 2002 or equivalent
D5-D12	1N914

MISCELLANEOUS (for charger version)
Mains skt, 6V 60mA bulb, 20V 1A secondary transformer, meter 200uA FSD, 5 pin DIN skt, metalwork (see Buylines), aerial — 1.4m long.

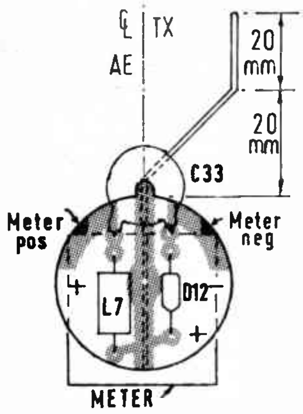


Fig 4. (Above) the overlay for the meter PCB. This mounts atop the meter itself

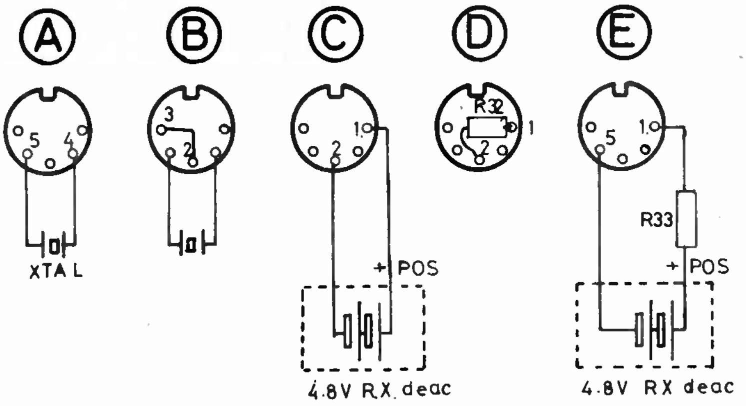
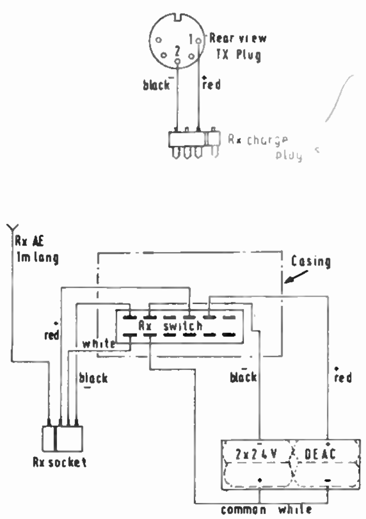


Fig 5. All the possible DIN plug configurations. See text for uses.



Wiring — charge plugs switch & battery.

The small PCB fits aback the meter and carries the components for the FSM.

Solder the output wires to the board at this stage as fitting the control pots later will be tricky Follow the installation drawings carefully and there should be no trouble. Check everything carefully though.

Power To The Aerial

Once the board is complete and the sticks wired fit the rechargeable cells, screw in the aerial (telescoped) and plug in your crystal. Switch on.

The meter should show a reading. Rotate C1 using a small insulated screwdriver or better yet a plastic control trimmer: the reading will rise and fall as C1 is rotated.

Extend the aerial fully and rotate C1 to get a maximum meter reading. It helps during this operation to keep a finger on the —ve of the cells to provide an earth load.

The reading should be about 80-90% of FSD so move the FSM aerial around slightly to obtain this.

The transmitter is now tuned. Pre-sets PR1-6 are used to set the centres of servo operation and do not interfere with RF output at all.

Fit the completed assembly to the case, lining up the aerial bush with the plastic grommet on the case top. For those not fitting the internal charger, cover the holes in the back of the case with some tape or card.

Charge

Remember that the cells used will take 14 hours to charge from flat, and the bulb will light quite brightly at first and then dim as charging progresses. To change the Tx batteries alone fit the DIN plug with R32 across pins 1 and 2 and plug in the mains lead to the rear socket.

That same DIN socket is utilised many ways. Pins 4 and 5 are the connections for the Tx crystal. Pins 1 (+ve) and pin 2 (—ve) allow charging of both the Tx and Rx cells together. Pins 2 and 3 if strapped together can switch on the Tx so that when removed 'locks off' the unit. Makes unauthorised use a little difficult! Pins 2 (+ve) and pin 5 (—ve) connect an external charger to the Tx cells. 50mA maximum please.

Pins 1 and 5 allow charging of the Rx batteries by themselves.

Crystal Clear

By changing crystal you change channel, and the colour can be used to identify operation easily. The standard system of coding is:—

Tx	Rx	Colour
26.995	26.54	Brown
27.045	26.59	Red
27.095	26.64	Orange
27.145	26.69	Yellow
27.195	26.74	Green
27.255	26.80	Blue

Licenced To . . .

So that's about it for the transmitter, except to remind you that to run a radio control system you NEED A LICENCE. This costs £2.80 for five years and obtained from:—

The Home Office
Radio Regulatory Dept
Waterloo Bridge House
London
SE1 8UA.

Mini Board

Construction of the receiver unit for our radio control system should pose most hobbyists no real problems, although the physical size is somewhat less than the average constructor might expect. The PCB itself is quite well packed, and for once IC sockets are a disadvantage as they both increase the weight and make casing tighter and more difficult to fit.

The reason for this drive to miniaturisation will be well understood by regular followers of the disciplines of radio control — aircraft need all the help they can

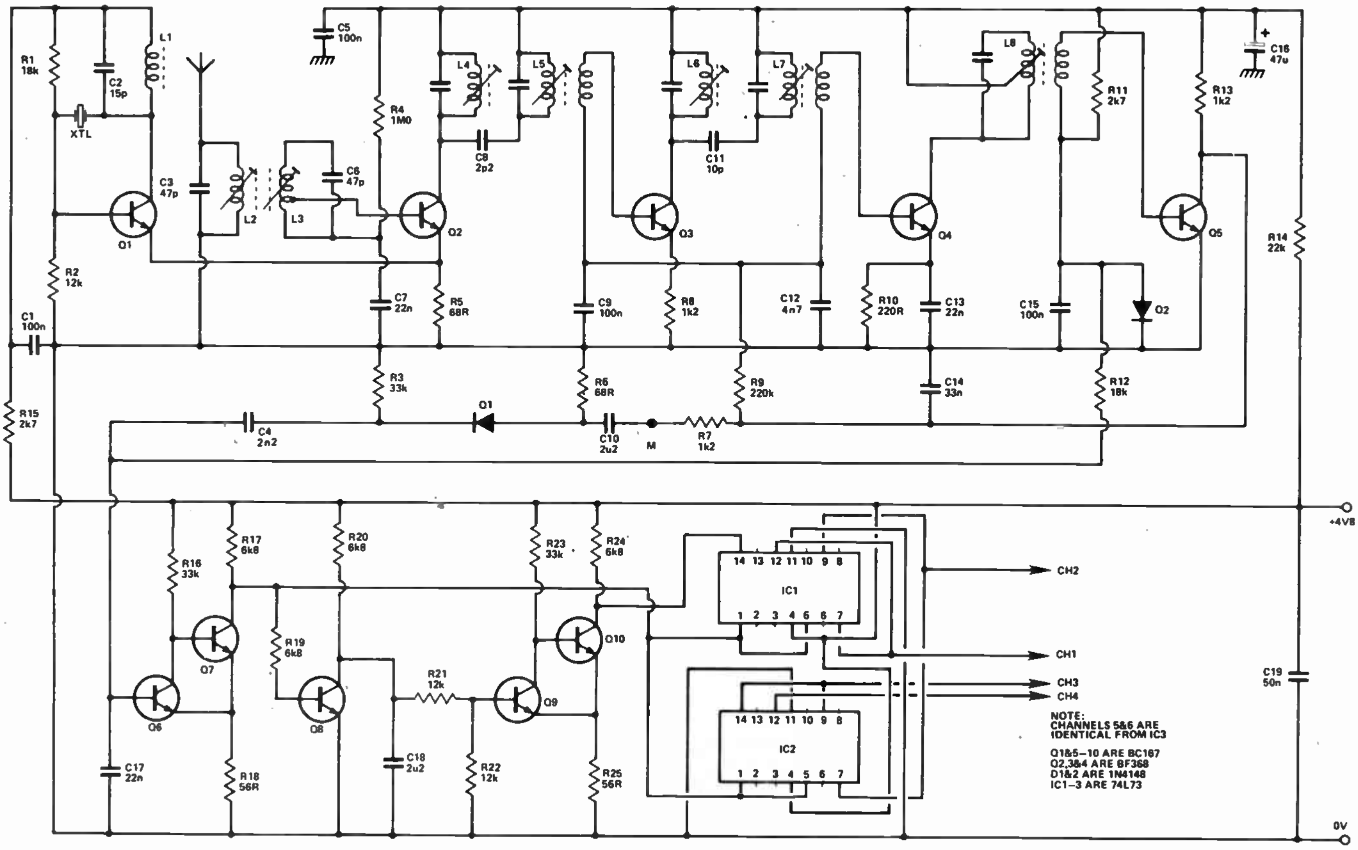


Fig 7 (Above) The full circuit diagram of the receiver unit. Note that power is best obtained from a rechargable cell. M is a normally bridged test point.

get. The Strato system is primarily a utility system, and as such must be suited to both vehicles and aero-models.

A Case For It

If you're building up the system using the kit, your coils have arrived ready wound on the PCB. For you more fortunate souls the next few paragraphs hold no interest. Pass on quickly, despairing of those who must tread the path of weird windings.

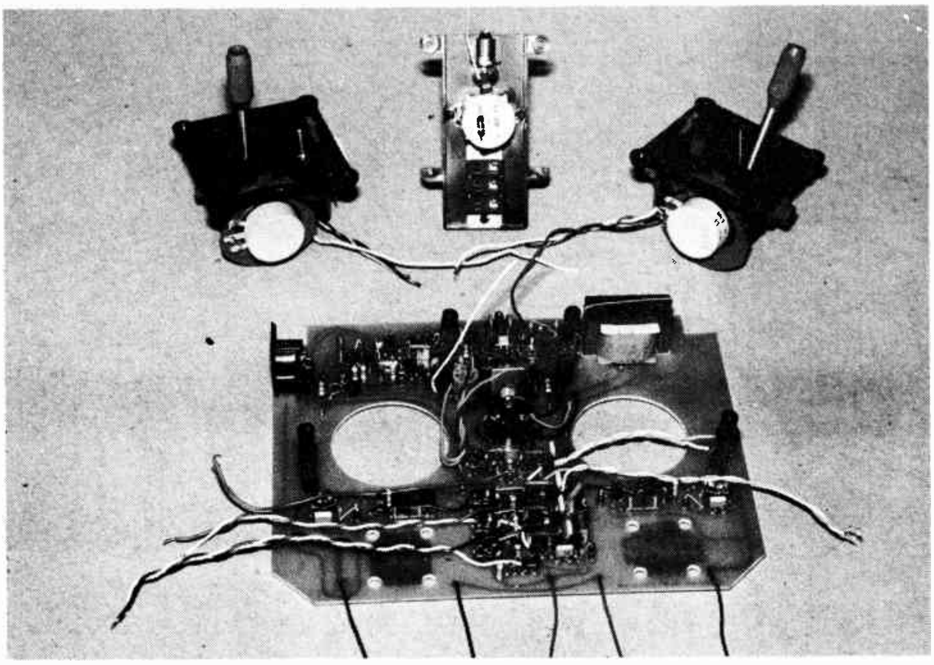
L2 and L3 are wound on 6mm x 15mm formers using 0.4mm wire. Wind L3 first, and mount the former on the PCB before you start. Insert one end of the wire into the pad at the junction of C7 and R4 and solder it there. The other end goes around the core approx. 2½ turns and is soldered to the pad at the base of Q2. The second winding on this core consists of approx. 6½ turns between the base of Q2 and the connection at C6.

Next to L2. Glue on the former, and start with one end of the wire

HOW IT WORKS

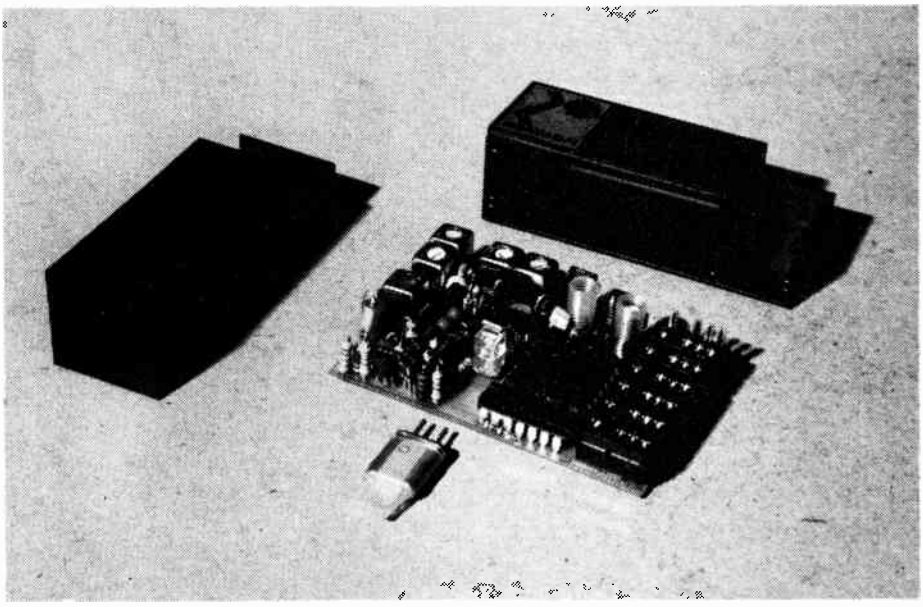
The RF section is of single conversion superhet design. Q1 is a crystal controlled local oscillator, using a third overtone circuit, it has emitter injection to the mixer Q2. The aerial circuit has L2, C3 as a preselector which is inductively loose coupled to L3, C6 and provides a useful amount of image rejection. The base of Q2 is tapped in near the earth end of L3 to provide impedence matching.

A similar arrangement is used for the first IF stage, Q3. The second IF stage, Q4, uses a conventional single tuned transformer to couple it to the detector D2 and AGC amplifier Q5. D2 and R11 provide temperature compensated bias for the working point of Q5 and Q6. Amplified AGC is taken to the two IF stages from Q5 collector, via R9. The somewhat unusual IF amplifier, detector and AGC arrangement provides better than average selectivity at 455 kHz, together with a good AGC dynamic range. In addition to an AGC amplifier, Q5 has another role to play. It is also a pulse amplifier for the demodulated pulse train. After passing the test point M, the DC component of the pulse train is lost in C10, R6. The forward drop of D1 allows only signals in excess of about 0.6V to be passed to Schmitt trigger Q6, 7 and in so doing improve the receiver's noise rejection capabilities. Q6 is turned on by the incoming +ve going pulses, and the regenerative action of Q7 ensures that clean rectangular pulses appear at the junction of R17 and R19. The nicely reconstituted pulse train is now fed to a shift register comprising IC1, 2 (and 3 if fitted). The channel outputs of the latter sequentially go from logic 0 to 1 in response to the clocking action of the incoming pulses. Now the pulse train from the collector Q7 is passed via R19 to the base of Q8, the pulse omission detector. With no input pulses, this stage is cut off, allowing C18 to charge positively through R20. Under this condition Q9 conducts, cutting off Q10. When the pulse train is present at Q7 collector, C18 is discharged repetitively, maintaining a voltage across it which is lower than the threshold level for Q9. Then the collector of Q10 remains at logic 0. However, after the last pulse in the train there is a minimum pause of 8mS the reset time. This is long enough for C18 to charge to a potential which triggers Q9, Q10, causing a logic 1 to be produced at the collector of Q10. This effectively resets the shift register, ready for the next frame of data. Individual pulse outputs to the servos are taken from the shift register.



Above: a denuded transmitter unit. The joysticks mount above the board.

Below: the receiver removed from its case. Note the crystal.



soldered to the connection at C3. Add on about 8½ turns which should take you to the other end of C3 and solder off there. Insert the slugs in both L2 and L3 and screw in until they just enter the windings.

Refer to the overlay throughout these machinations.

IF You Can

The IF transformers are colour coded, L4 is yellow (so is L6), L5 is white (so is L7) and L8 is black. Fit these to the PCB, but do not solder the centre pin of the group of three you will find on one side of the base. Make sure also that this rogue pin does not make contact with the board. If thine pin offends thee, cut it off.

L8, the black coil, is to be treated normally and all pins soldered.

The rest of the board should be assembled normally, but take the usual care with IC orientation and polarised components. Putting on the plugs and sockets should be easy — remember that the only plug fits at the bottom LH corner of the PCB, and the rest are sockets.

From this sole line of pins comes the aerial and goes the receiver power.

Xtal Clear

Changing the crystal changes the frequency of operation of the receiver, and so having the crystal mounted in a socket makes for easy switching around. These sockets are, however, expensive, but worth it for their usefulness. Pin money well spent.

It is probably worth noting that most components fit the board vertically and that at this frequency there is no room for overlong leads. Keep them as short as possible and watch the soldering iron does not burn its bridges!

Fit all the resistors and capacitors, leaving L1 until all are nestled nicely with solder around their ends. The semiconductors too should be sat sitting there looking at you before L1 joins them. As sockets are not to be used watch the orientation of the semiconductors.

Play A Tune

Once you've checked the PCB and are satisfied it is correct, check that it fits the case and that no solder clogs up the runners. Now the receiver needs tuning. Make up a power lead, connecting the battery and (39") aerial to the only socket on the board.

Connect a voltmeter with FSD around 5V between negative rail and the positive side of R7. The reading should be around 3V. Place the transmitter next to the receiver and switch it on. The meter should go down to about 1V. Remove the Tx aerial, and move it away until you get a reading of between 2V-2V5.

Core Wot A Job

Using a non-metallic tuning tool — even a piece of wood will do — screw in the core of L2 until you get a minimum reading on the meter. Go to L3—do not pass go or collect 200V — and tune that in to a minimum too. Work your way along all seven coils in this manner, tuning each in turn to get that minimum reading.

There may be some interaction so it is probably worth going through the whole thing a couple of times to make sure you've got it right. Once you're satisfied — that's it.

All this takes longer to read than it does to do, and the whole operation shouldn't take more than ten minutes.

Fit the board into its case and the receiver is now completed. However it's not all over yet. You still need to make up a charging lead to run from the Tx, if you're using the internal charger, or whatever source of power supplies the electrons. We have

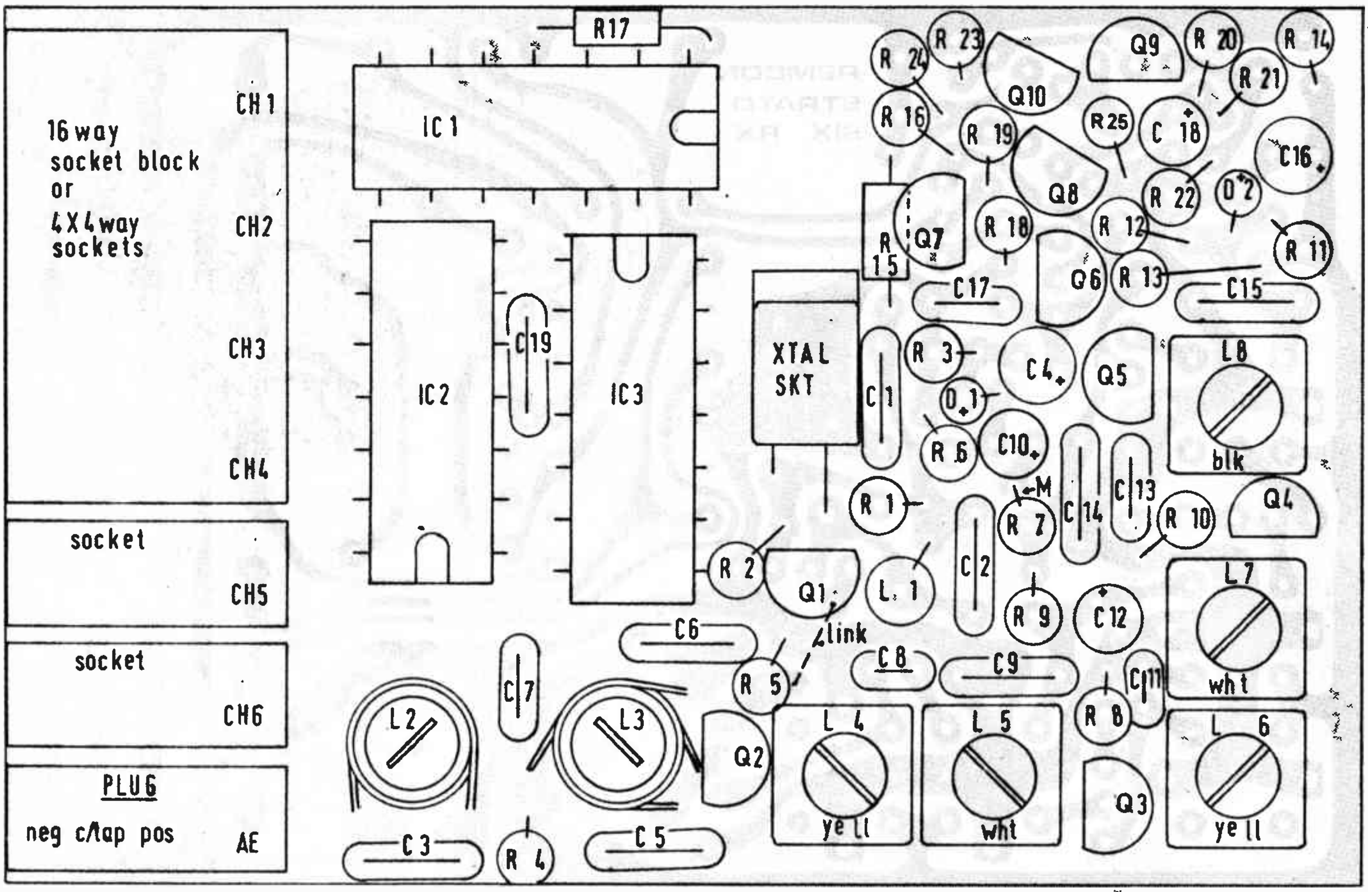


Fig 8 (Above) Component overlay for the radio control receiver board. In contrast to our usual style this is shown twice size to make construction easier. Since no sockets are employed take care with the ICs.

given the plug configurations to enable you to avoid two dimensional batteries.

Your Servo

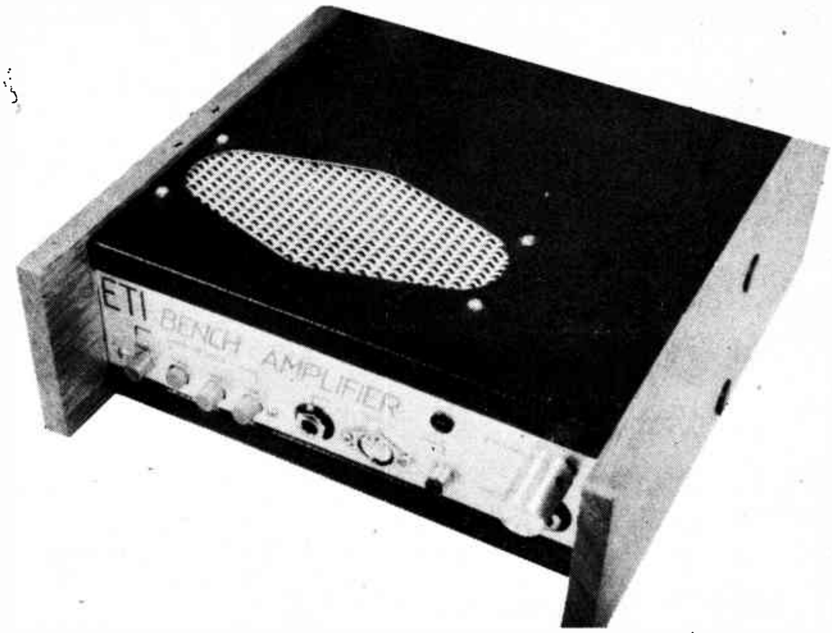
We have not given details of home build servos because the commercial market makes the exercise a singularly uneconomic and unattractive one. There are a very large number of servos available, both kit and complete, IC and discrete, and most of these will work with our system perfectly well.

The words which, upon incantation inside a shrine of servo supply, will conjure forth a compatible unit are: 4V8 supply, positive going signal, pulse width swing 1-2mS (1.5mS centre) and commutation rate 50 Hz.

With our system a tolerance of 20% surrounds the ideal. In order to set up the drive accurately, it is best to buy at least one ready built (and set up to 1.5 mS centre) servo. This can then be plugged in and used to set the output pulse widths of the transmitter, using the on board presets, to align with servo centre. ●

PARTS LIST

RESISTORS (All ¼W 5%)	
R1, R12	18k
R2, R21, R22	12k
R3, R16, R23	33k
R4	1M0
R5, R6	68R
R7, R8, R13	1k2
R9	220k
R10	220R
R11, R15	2k7
R14	22k
R17, R19, R20, R24	6k8
R18, R25	56R
CAPACITORS	
C1, C5, C9, C15	100n polyester
C2	15p ceramic
C3, C6	47p ceramic
C4	2n2 polyester
C7, C13, C17	22n polyester
C8	2p2 ceramic
C10, C18	2u2 polyester
C11	10p ceramic
C12	4n7 polyester
C14	33n polyester
C16	47u electrolytic
INDUCTORS	
L1	10u choke
L2,3	see text
L4-8	7mm IFTs, 455 kHz
(see text)	
SEMICONDUCTORS	
Q1, 5-10	BC167
Q2-4	BF368
D1, D2	IN4148
ICI-3	74L73
MISCELLANEOUS	
4 V 8 battery, case, PCB.	
Servos to suit application	
Switch to fit model	



A useful item of test gear designed with the audio constructor in mind.

BENCH AMPLIFIER

AN ESSENTIAL PIECE of equipment for any electronics workshop is an audio amplifier — useful for testing and checking other audio circuits. Ideally the amplifier should allow for a reasonably wide range of input signals and be adaptable for various outputs. The bench amplifier described here fulfills these criteria.

There are four inputs: (i) a high gain, flat response, intended for use with microphone or guitar, (ii) a phono (disc) input with RIAA equalisation, (iii) a medium gain, flat response for ceramic cartridge or tuner, (iv) an attenuated, flat response, for tape output.

Coupled with the master volume control the preamplifier section should cater for most audio signals.

A pre-amplifier output is obtainable (see case photograph) and also an extension speaker outlet via necessary output sockets on the rear panel. Also provided is a low level power output suitable for headphones.

Construction

The prototype was constructed with various input connectors wired in parallel, 5 pin DIN, ¼ inch Jack and Phono. This means that an input can be accepted from a signal lead with any of those three connector plugs. More can be added to personal preference, but it was felt that the chosen three would cover the majority of input functions.

The PCB is relatively uncluttered. Links 1 and 2 are provided to cut off the power supply to IC2 and IC3, the pre-amp and power amp stages. This may be useful in setting up and testing which can be done in three stages — the power supply, the power amplifier and finally the pre-amplifier.

Note that IC2 and IC3 are inserted into the board in opposite directions.

SW2 consists of four two pole changeover switches soldered directly onto the PCB, thus alleviating wiring-up problems. Different sizes are obtainable so make sure that you obtain the correct ones.

Use screened cable for input and pre-amp output and also for the lead to the volume control, to minimise mains hum.

Our finished amplifier had all the input sockets, the selector switch, volume control, power indicator and the headphone socket on the front panel, and the output sockets on the rear. ●

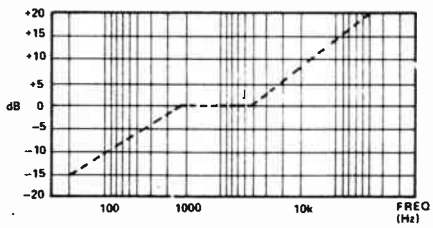


Fig. 1. Showing the variation of recorded signal with frequency.

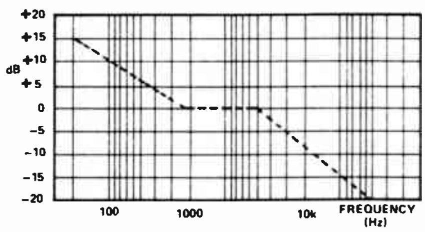


Fig. 2. Recorded playback signal attenuation with frequency.

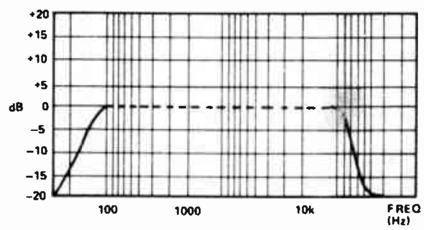


Fig. 3. Theoretical flat response output after pre-amp stage with associated equalization network.

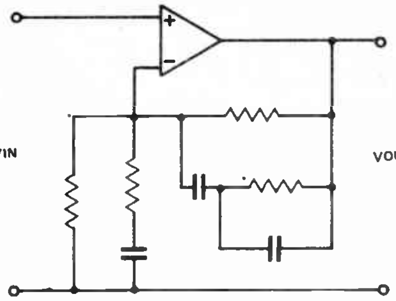


Fig. 4. An operational amplifier with equalization circuitry in its feedback loop.

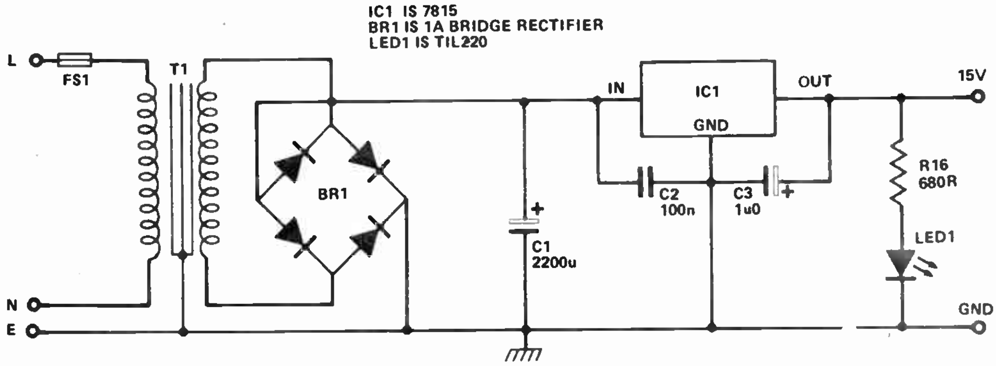
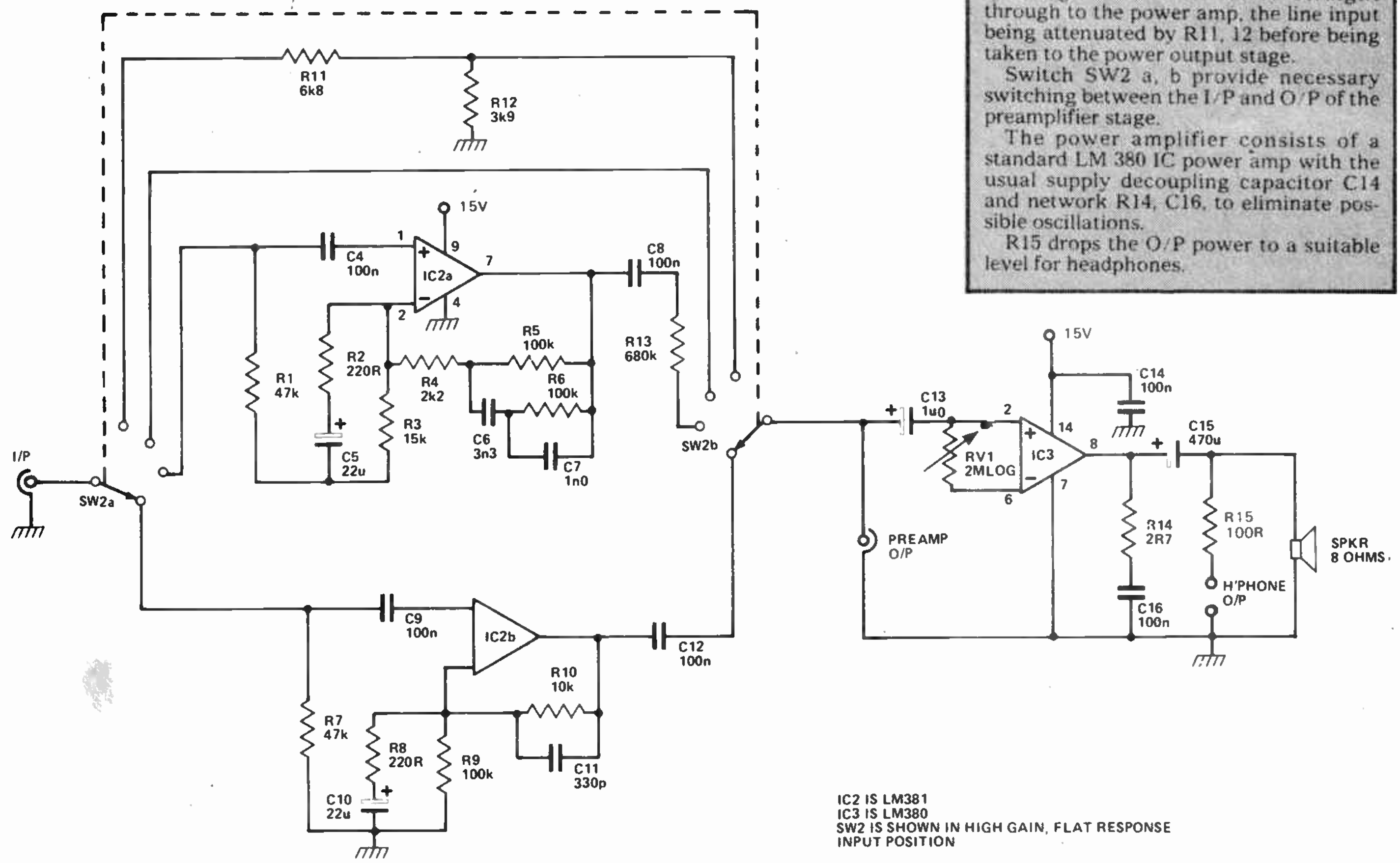


Fig. 5. Circuit diagram of the power supply.

Fig. 6. Main circuit diagram of the Bench Amplifier.



HOW IT WORKS

The preamplifier section is formed around the LM 381 dual operational amplifier. One channel is used as a magnetic phono pre-amp with equalisation to RIAA characteristics. For the uninitiated amongst us, RIAA (Record Industry Association of America) equalisation is necessary in the playback stage of recordings made on record, to counteract the effect added to the signal in the recording stage. Figure 1 shows the kind of effect. It is a graph of recorded signal vs frequency.

On playback, it is now necessary to have an amplifying stage which has a diminishing response with higher frequency as in Fig. 2. The overall effect is to produce an output as shown in Fig. 3 where the signal amplitude does not vary (apart from the inaudible extremities) with frequency — a flat response. The underlying theory for such a complicated system is that of high frequency noise. When the recorded signal has its higher frequency sounds amplified its noise is not, whereas at the playback stage, all frequencies at the top end of the scale are diminished, noise included. The final output, therefore, has theoretically less noise i.e. the signal/noise ratio has been increased.

The usual way to reproduce the graph in Fig. 2 is to use an amplifier with frequency dependent components in its feedback loop so that it amplifies bass frequencies more than treble. (See Fig. 4).

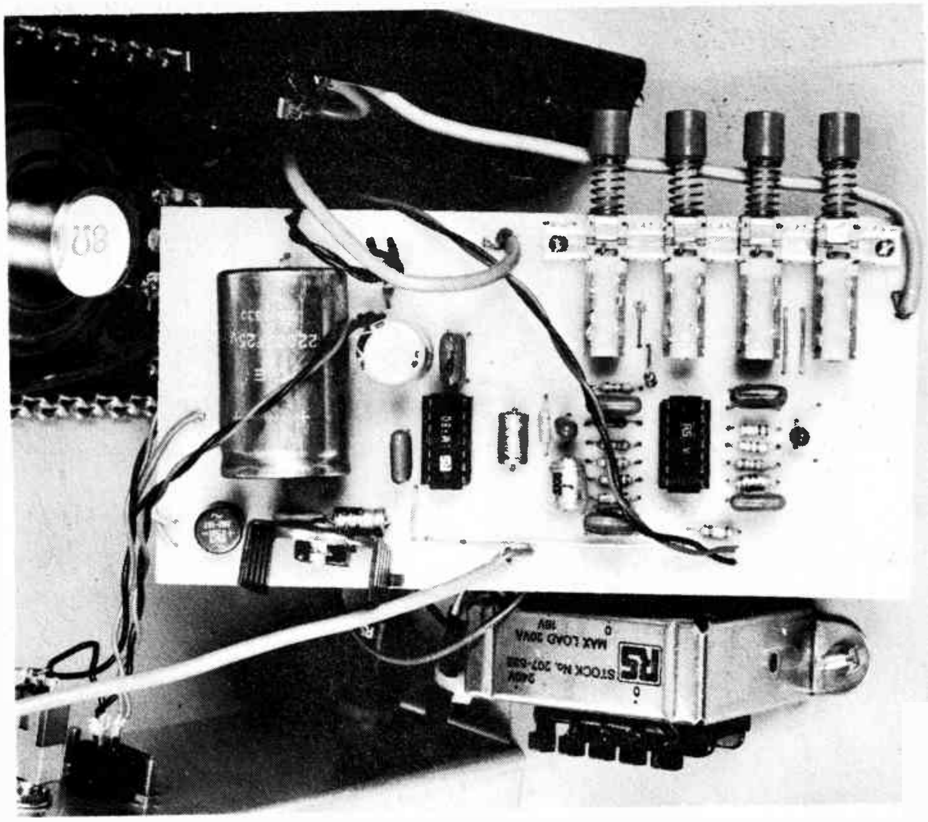
The other half of the chip is used as a high gain amplifier with an essentially flat response. This input suits microphones or electric guitars.

The medium gain input from a ceramic cartridge or a tuner is fed straight through to the power amp, the line input being attenuated by R11, 12 before being taken to the power output stage.

Switch SW2 a, b provide necessary switching between the I/P and O/P of the preamplifier stage.

The power amplifier consists of a standard LM 380 IC power amp with the usual supply decoupling capacitor C14 and network R14, C16, to eliminate possible oscillations.

R15 drops the O/P power to a suitable level for headphones.



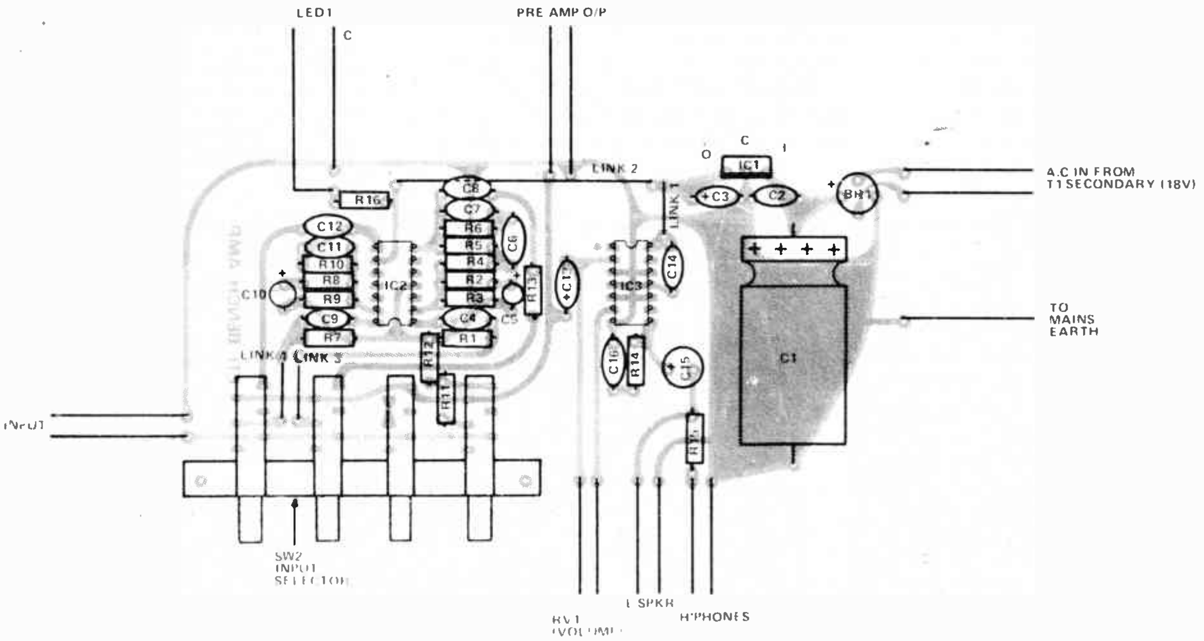
PARTS LIST

RESISTORS ALL ¼W 5%	
R1, 7	47k
R2, 8	220R
R3	14k
R4	2k2
R5, 6, 9	100k
R11	6k8
R12	3k9
R13	680k
R14	2R7
R15	100R
R16	680R
POTENTIOMETERS	
RV1	2M Log
CAPACITORS	
C1	2200u 25V electrolytic
C2, 4, 8, 9, 12, 14, 16	100n polyester
C3, 13	1u 16V electrolytic
C5, 10	22u 16V tantalum
C6	3n3 polyester
C7	1n polyester
C11	330p polytyrene
C15	470u 16V
SEMICONDUCTORS	
IC1	7815
IC2	LM381
IC3	LM380
BR1	1A bridge rectifier
LED 1	TIL 220
MISCELLANEOUS	
T1	18V 1A mains transformer
FS1 and holder	250 mA
I/P and O/P sockets	
8 ohm speaker	
SW2	4 off 2 pole changeover push switches and mounting bracket case to suit

BUYLINES

There is nothing in the circuit which will be difficult to obtain, with the possible exception of SW2 a.b. The ones we used came from RS Components — any other types probably won't fit the board.

Fig. 7. Component overlay.



WHEEL OF FORTUNE

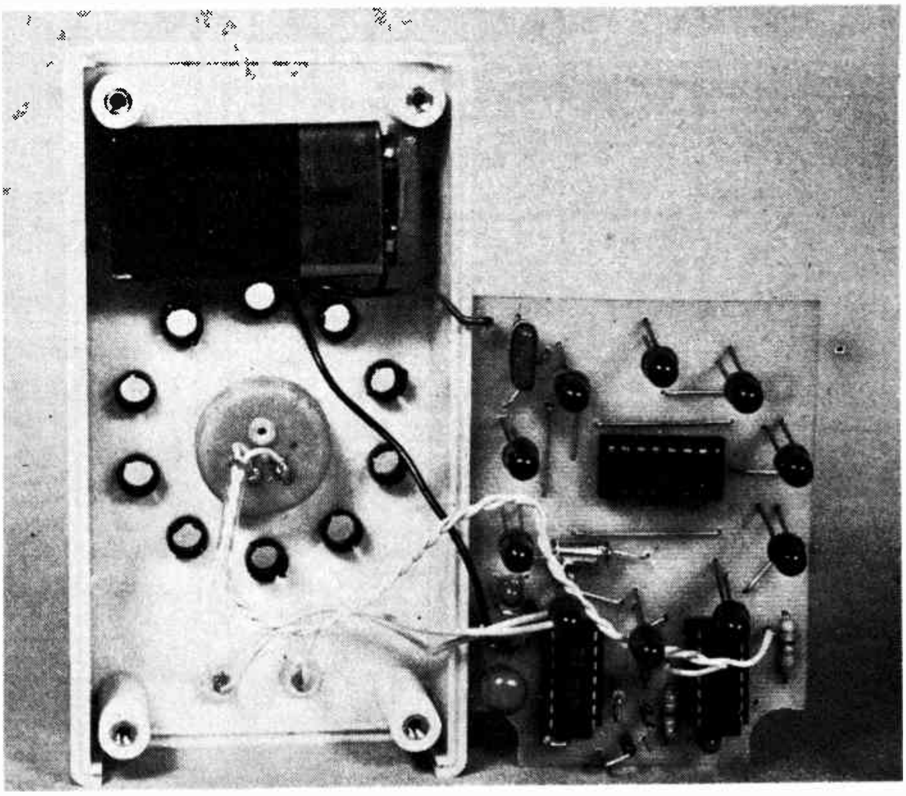
ETI's project team is in a real spin with their Wheel of Fortune game.

ONE ARMED BANDITS with no arms, Pinball tables with an MPU at their centre — the world of electronics has a lot to answer for. Is nothing sacred?

The answer to that last question as far as we at ETI are concerned is not a lot. We've taken the liberty of implementing that traditional fairground attraction, the Wheel Of Fortune in our own electronic fashion. The game usually features a large wooden wheel and ratchet arrangement, the stall either accepting bets on which of the ten numbers will be under the pointer when the wheel stops, or, perhaps, suggesting that a message under the pointer will give an indication of what the future holds in store for you — you will meet a tall dark stranger, you will marry young and have 2.4 mortgages, etc.

Wheel Meet Again

Our game accurately apes the real thing, the circle of LEDs simulating the spin of the Wheel getting under way as a pair of touch contacts are crossed with your palm (or more likely finger). The movement of the LEDs will then slow down to, it seems, an excruciatingly slow speed until it finally stops. All this visual activity is at the same time accompanied by a clicking sound that simulates the ratchet sound of the real game.



Photograph of the game's innards. Note that the back of the crystal earpiece has been removed to ensure sufficient clearance between it and the IC directly below when the box is assembled. The drawing pins that form the game's touch contacts are glued to the front panel with an epoxy adhesive, the tips of the pins can be seen at the bottom of the picture.

Construction

Start by mounting all the components on the PCB with the exception of the LEDs. Pay attention to the orientation of the polarity sensitive devices and, for choice, mount the ICs in holders. In order to

BUYLINES

None of the components used in the Wheel of Fortune game should prove hard to find as most will be stock items in many component shops. Make sure that the tantalum capacitors specified for C1, 2 and 3 are used as the circuit makes use of the low leakage characteristics of these components.

PARTS LIST

RESISTORS (all ¼W 10%)	
R1	2M2
R2	1M0
R3	100k
R4	470k
R5	4M7
R6	10k
R7	330R

CAPACITORS	
C1	100u 10 V tantalum
C2	1u0 10 V tantalum
C3	22u 10 V tantalum
C4	100n polyester
C5	1n0 polyester

SEMICONDUCTORS	
IC1,2	4011B
IC3	4017B
D1,2	1N914
LED1-10	TIL209

MISCELLANEOUS

Battery, crystal earpiece, drawing pins, vero box 202-21029J

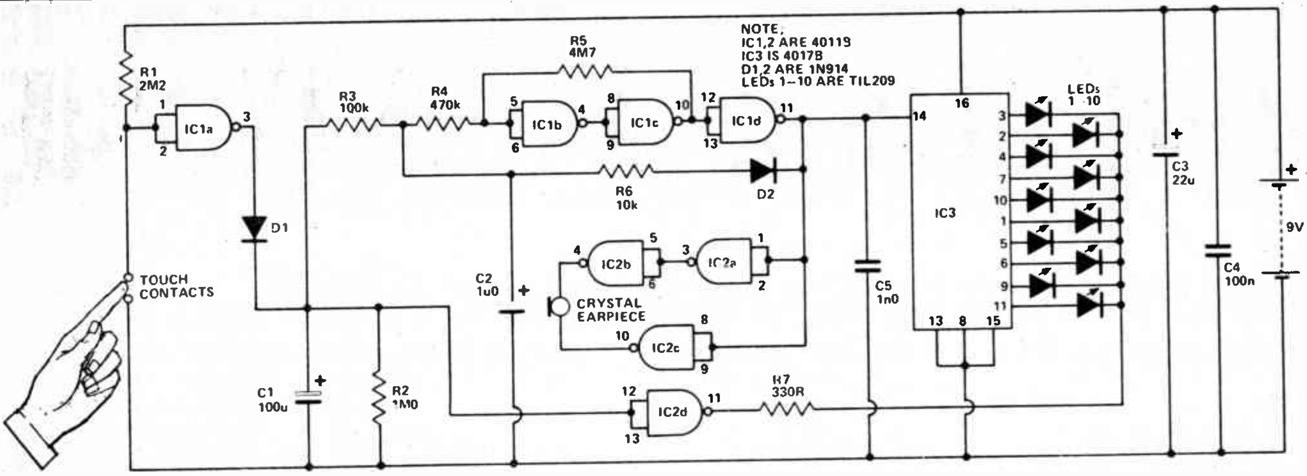


Fig. 3. Full circuit diagram of the Wheel of Fortune game.

HOW IT WORKS

THE Wheel of Fortune circuit can be broken down into a number of distinct sections; the display circuitry, an audio stage, a VCO, and a touch sensitive/monostable configuration.

In the "off" state R1 holds the input of IC1a high and hence the output of this gate, wired as an inverter, is low and C1 is discharged. Bridging the touch contacts causes the gate's output to go high and C1 to be charged up via D1. When the finger is removed from the touch contacts and the output of IC1a returns low, C1 is prevented from discharging into this gate as D1 is now reverse biased, instead C1 discharges slowly via R2.

The VCO is formed by the components associated with IC1b, c and d. The circuit in fact generates a series of constant duration negative going pulses separated by "spaces" whose duration can be varied by the control voltage.

When the control voltage (the voltage on C1) is below a threshold level that is equal to half supply voltage the circuit will not oscillate. If we now assume that the voltage on C1 rises to supply, as would be the case when the touch contacts are bridged, C2 will start to charge up. The voltage across C2 is applied, via R4, to the Schmitt trigger formed by IC1a and c. As the voltage applied to the Schmitt crosses its upper switching threshold the output of IC1d, which inverts and buffers the Schmitt's output, will go low. This will cause C2 to be rapidly discharged via the relatively low impedance path offered by R6 and D2. As the voltage on C2 crosses the lower threshold of the Schmitt the output of IC1d returns high and C2 once more begins to charge. The time taken for the voltage on C2 to reach the Schmitt's trigger point is dependent on the voltage across C1. Thus when the voltage on C1 is large, C2 quickly reaches the trigger point and the VCO produces a high frequency, this frequency reducing as the voltage of C1 falls.

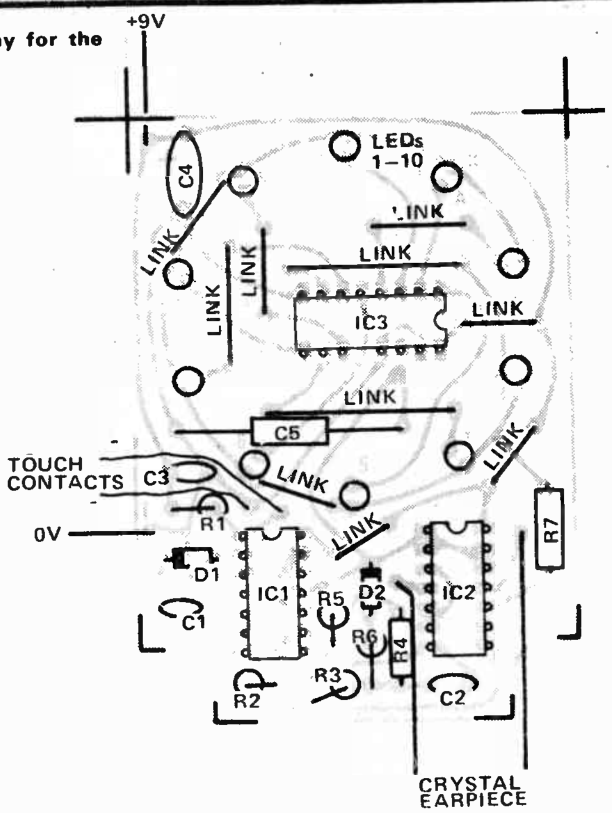
The output from the VCO is fed both to IC3 to drive the ring of LEDs and to IC2a, b and c to produce the audio output.

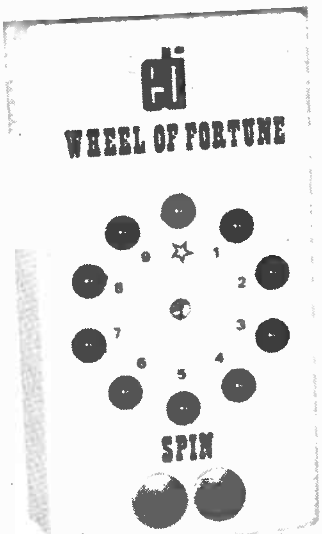
The crystal earpiece that provides the "clicking" is driven from a bridge circuit. This effectively doubles the voltage applied to the transducer and hence, from $P = V^2/R$, doubles the audio output.

The LEDs driven by IC3 have their cathodes connected via R7, to the output of IC2d. The output of this gate will normally be high, going low when the voltage on C1 is above half supply. As IC3 outputs are active high the display is thus enabled for a period of time that is slightly longer than the duration of the VCO's oscillation.

C3 and C4 are included to decouple the supply while C5 is needed to prevent any RF interference affecting the circuit's operation.

Fig. 2. (left Component overlay for the Wheel of Fortune game.





squeeze everything into the small box we used, the PCB tracks have been made quite fine so be careful when soldering that no excessive amounts of heat are applied to any sections of the board.

As can be seen from the internal photograph of the game, the back of the crystal earpiece is removed before mounting the device in the case. This is to ensure adequate room between the IC and earpiece. The touch contacts formed by two drawing pins are glued to the front panel. When the case has been prepared place, but do not soldér the LEDs, into the PCB and offer them up to the case. Solder one lead of each LED. At this stage make sure that all the devices are properly seated, then solder the second lead.

That just about completes the construction, just connect up to a battery and place your bets ●

TAPE NOISE LIMITER

Takes the hiss out of the quiet bits of your music, and does it in a way which is simple yet effective. This is a replay only process so it will work on any tape!

DESPITE the small size, the performance obtainable from a cassette tape in a good recording deck is quite remarkable. In fact the latest top quality decks are so good that it is difficult to tell the difference between the recording and the original sound.

Unfortunately this is not true of the cheaper units — in which 'tape hiss' can be very prominent. Tape hiss is caused by random irregularities in a tape's surface coating. The effect is common to all tapes but some are marginally worse than others.

The annoying characteristic of tape hiss delayed the acceptance of cassette tape recorders in hi-fi systems for some years — until the advent of the Dolby system which was primarily developed as a cure for the phenomenon.

The Dolby system is often misunderstood — *it only works if the cassette tape itself has been recorded using the Dolby process* — and few commercially produced tapes are. Unless the tape cassette says specifically that it is Dolby processed then it's not! You can of course record your own tapes using Dolby if you own a Dolby machine.

Upper Limit

To overcome this limitation a number of cassette recorders are fitted with noise reduction circuitry which reduces the level of hiss on non-Dolby recordings. Most of these noise reducing circuits work by progressively reducing all high frequency signals when the output level falls below a preset minimum. Above that minimum level all sounds are allowed through because tape hiss cannot be heard once the sound level is substantially louder than the hiss. This effect is called 'acoustic masking'.

The circuit described in this project is a simple but very effective unit which may be used with any cassette recorder which is connected to a hi-fi system.

The unit should preferably be connected between the cassette

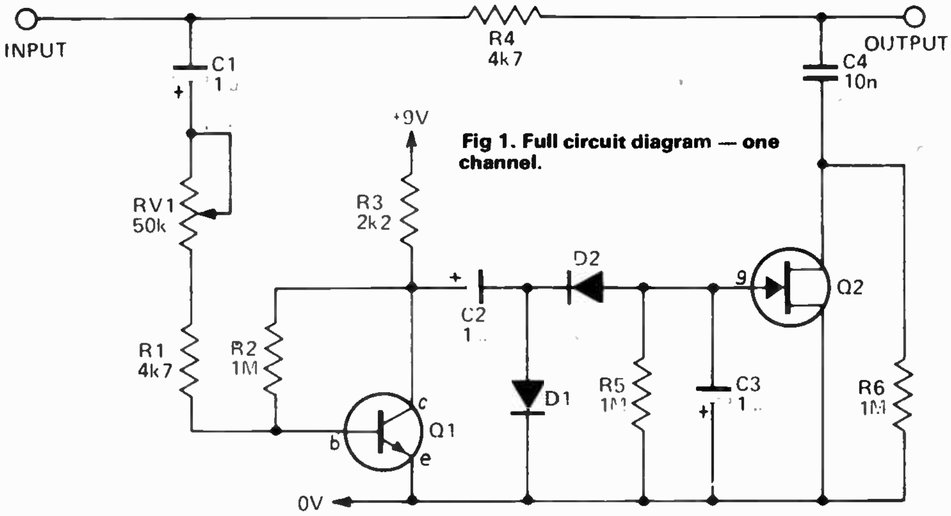


Fig 1. Full circuit diagram — one channel.

HOW IT WORKS

The circuit passes all frequencies (without attenuation) if the incoming signal is above a set minimum level. Signals below the preset minimum are progressively attenuated from 1 kHz upwards. The maximum attenuation of about 10 dB is applied at approx 10 kHz.

Resistor R4 and capacitor C4 form a filter in which Q2 is used as a variable resistor with the degree of resistance dependant on gate voltage. Thus, if the input voltage is at or near 0V then Q2 appears as a low resistance and C4 is in circuit. If on the other hand the input signal is higher than (say) four volts negative, Q2 has a very high resistance and C4 is effectively out of circuit.

The voltage applied to the gate of Q2 is that derived from Q1 — after rectification by D1 and D2. Transistor Q1 amplifies the input signal and with RV1 in minimum position, input signals above 10 mV or so will cause Q2 to be off.

Increasing RV1 raises the level below which high cut will occur. The change from full to zero cut occurs over a range of approx 5 dB input level change.

PARTS LIST

RESISTORS (½ W 5%)

R1, 4	4k7
R2, 5, 6	1M
R3	2k2

POTENTIOMETER

RV1	50 k trimpot

CAPACITORS

C1-C3	1 uF 25 V electrolytic
C4	10n polyester

TRANSISTORS

Q1	BC548
Q2	2N5459

DIODES

D1-D2	1N914

MISCELLANEOUS

Nine volt battery and clip, PCB, case

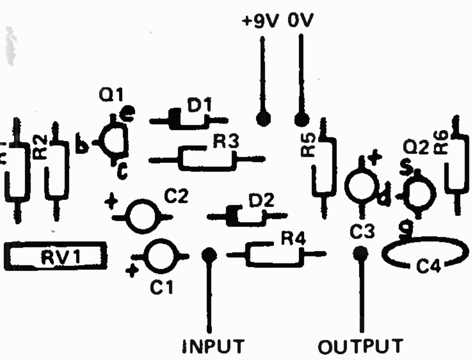


Fig 2. Above: Component overlay.

recorder and the amplifier input — using short lengths of screened cable and suitable connecting plugs. If you really know what you're doing it may be actually built into the tape recorder or amplifier. Alternatively it may be connected between the pre-amplifier and power amplifier on those units which are so separated (note that many apparently integral amplifiers still have 'pre-amp out' and 'power-amp in' connectors on the rear panel. These connectors are normally bridged by 'U' shaped links — which should be removed to enable this unit to be plugged in).

Construction

You can use either Veroboard or the special printed circuit board shown here.

Take the usual precautions about inserting components the right way round — taking particular care with the field effect transistor Q2. Note that the cathode lead of the diodes (shown as a horizontal bar on the circuit diagram) will be identified on the component by a black band or similar marking.

Unless the leads between this unit and the tape deck and amplifier are very short it is advisable to connect it via screened cable. Note that the 0V line shown on the circuit is also the 'earthy' side of the input/output connections.

To set up the unit simply choose a recording with a longish quiet passage and then adjust RV1 for the best compromise between tape hiss reduction and minimum loss of high frequency programme content.

NOTE: If you listen only to hard rock — where there aren't any quiet passages — then this unit will be of little value to you. Its main effect is to reduce annoying tape hiss during otherwise quiet programme material. ●

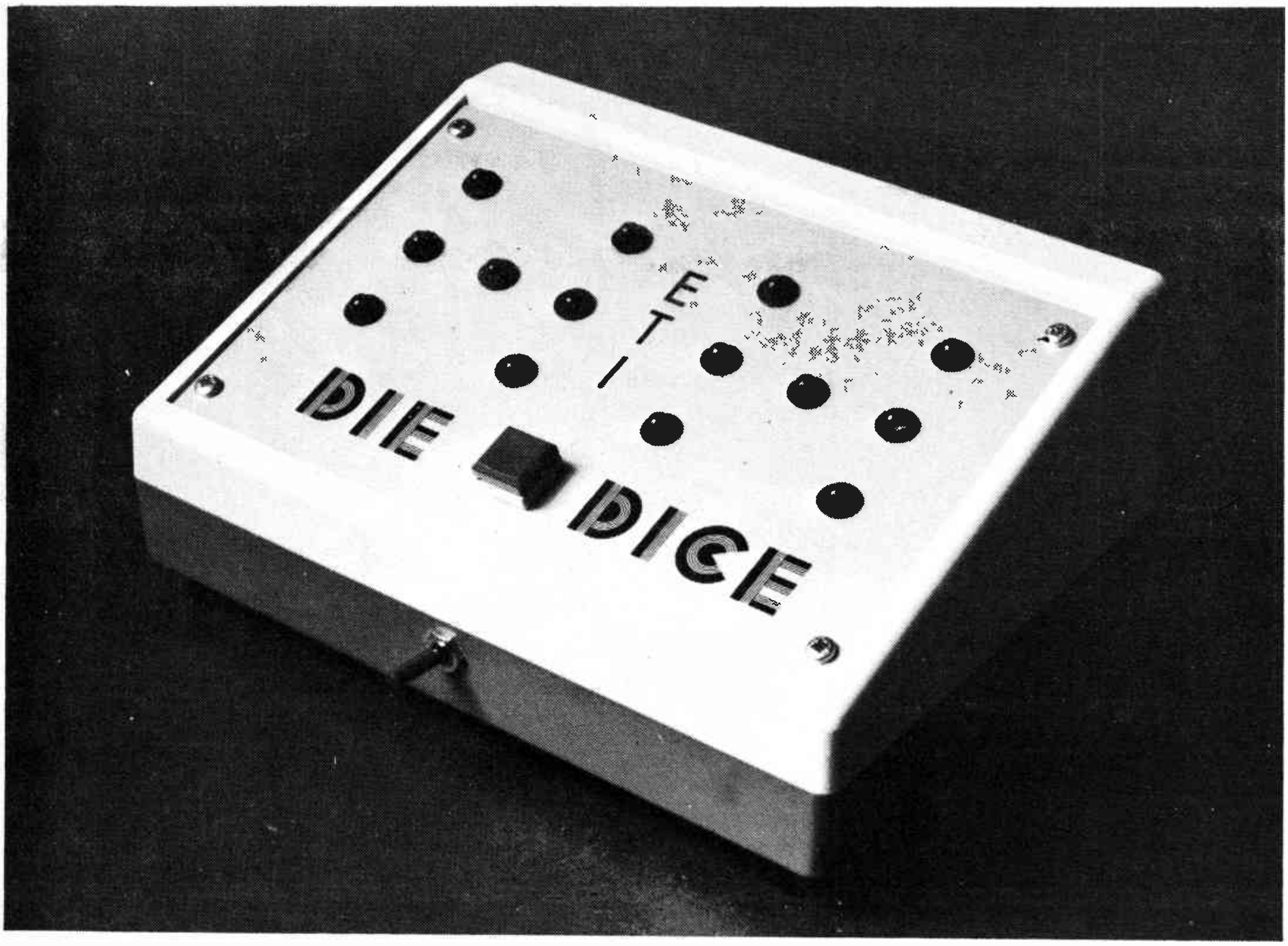
DOUBLE DIE

Don't gamble with inferior circuits — go for the best with ETI's dice device!

SO WHAT, YOU MAY ASK, is the advantage of an electronic dice over its conventional and inexpensive plastic (solid state?) counterpart? The answer is that, apart from looking better (and being a better conversation piece), the electronic die or dice is very fast: it can be 'thrown'' and read in a fraction of a second, compared to the several seconds needed for the mechanical item. That enables the rate of play of a game to be speeded up, and consequently makes most games more fun to play. The electric die-dice is a particular boon to the war-games enthusiast.

Our dice has a few unusual features. It has only two panel-mounted controls. One of these is a two-way switch that lets you select either a single die or a double die (dice) display: the displays are naturally presented in the conventional die format. The other control is a push-button that gives the roll-and-throw action. When the button is pressed the die are rolled and the display is blanked out. The die are thrown and displayed on release of the pushbutton. Once thrown, the die are displayed for about seven seconds, and then black out automatically. When using the device, you can roll-and-throw as fast as you like: you don't have to wait for an autoblanking phase between actions. The unit consumes negligible current when in the standby mode, so no on-off switch is required.

The ETI die-dice is designed around readily-available CMOS ICs. It is the most economical die-dice circuit that we've seen so far. It uses only five ICs and eight discrete components, apart from



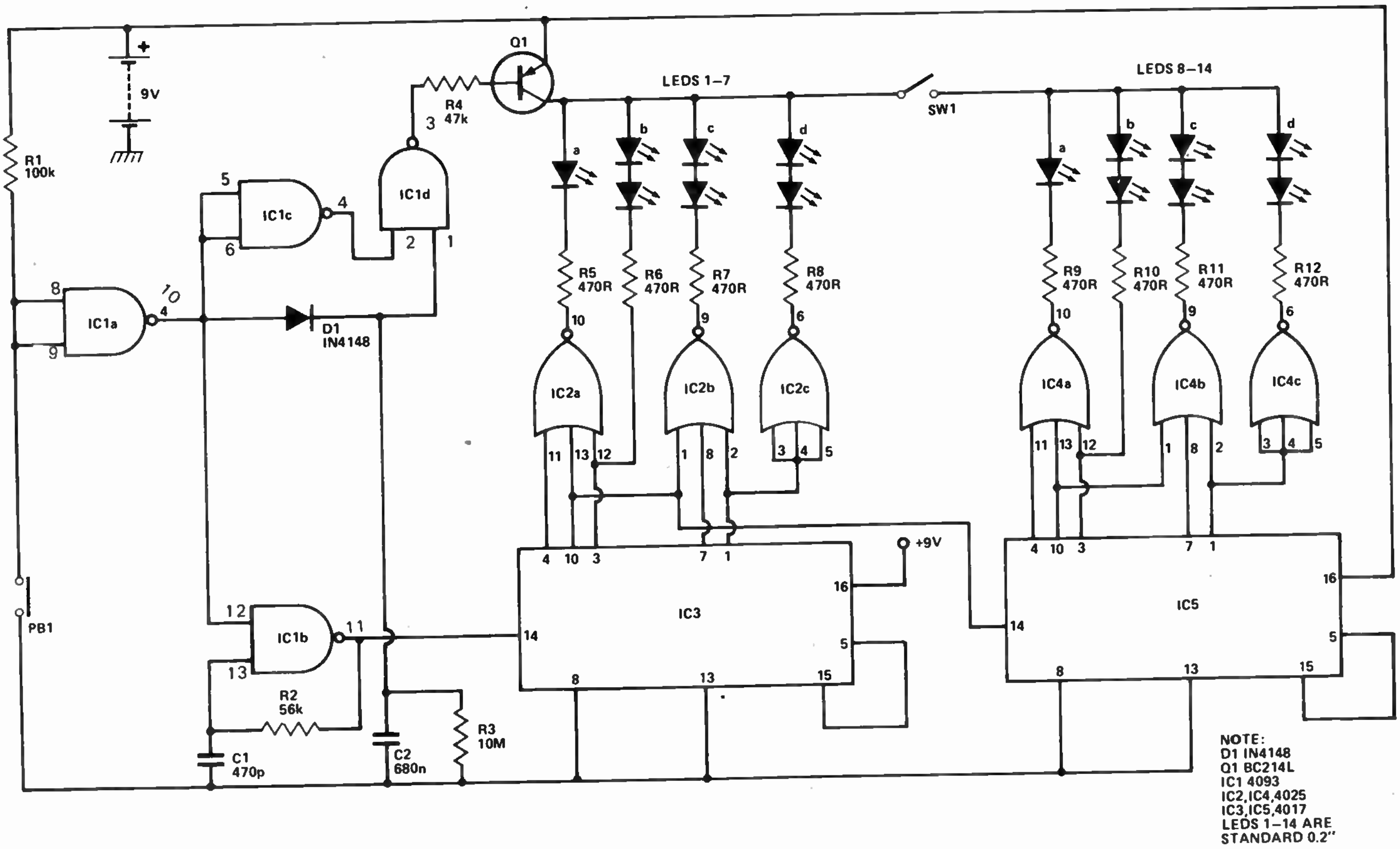


Fig. 1. The complete circuit diagram of Double Dice, as you can see the component count is significantly lower than any previously published design. ICs 3 and 5 are 4017s arranged as divide by six, counter-dividers.

the 14 LEDs and 8 limiting resistors associated with the actual display.

Construction

Not much to say here. All the electronics, except the LEDs, are mounted on a single PCB, so construction should present no problems. On our prototype we used red LEDs for the left-hand die display, and orange for the right. Not a good idea: the orange LEDs aren't contrasty enough, and are difficult to read. Our advice is use red LEDs for both displays.

Our prototype unit is housed in a sloping-front Verocase. The PCB is held in place by Sellotape sticky fixers. That's a good idea: it saves drilling holes in the case and the PCB. ●

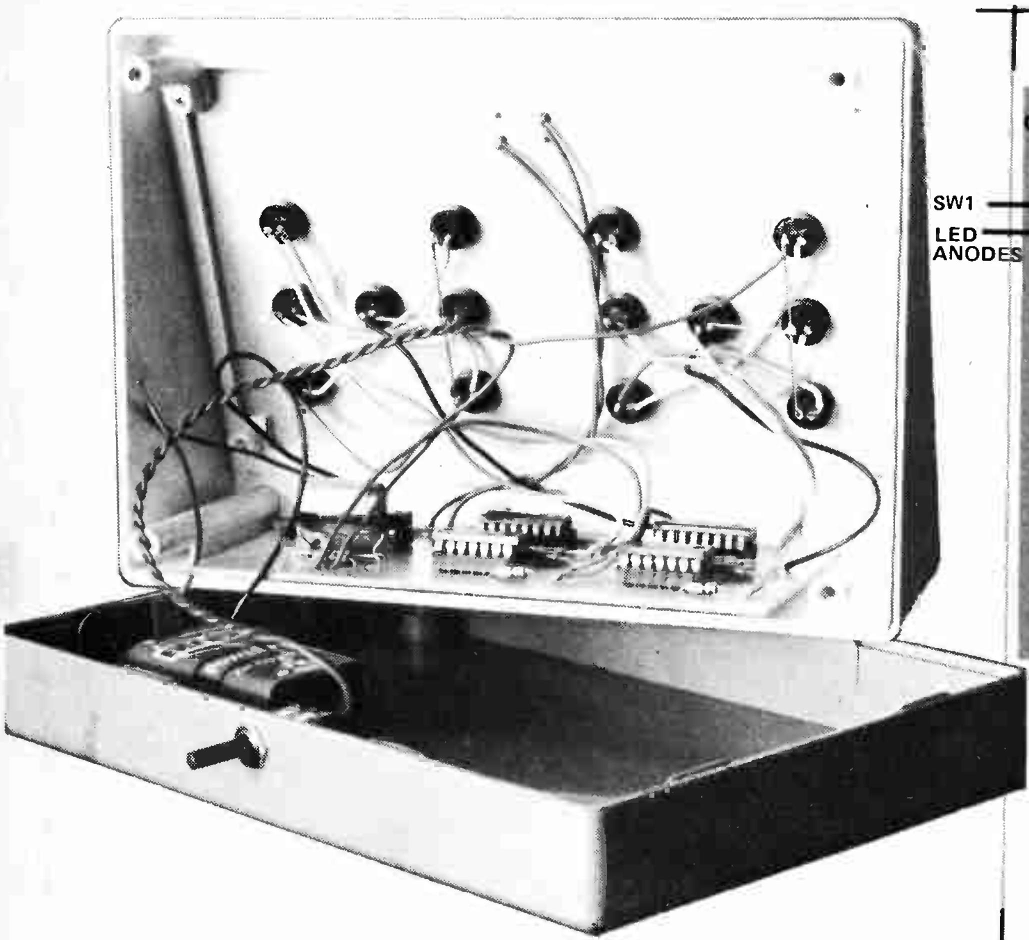
HOW IT WORKS

The circuit may be divided into three sections; the clock-control and two identical counter-decoder stages. IC1 handles the control function and generates the clock pulses to drive the 4017 counters IC3 and IC5. The output from these is then decoded to provide a conventional die display by IC2 and IC4.

When PB1 is depressed the output of IC1a goes high. This signal, inverted by IC1c, disables IC1d as long as the switch is closed and Q1 remains off so no LEDs are lit. During this time, C2 is charged to about 9 volts through D1 and the clock oscillator IC1b is enabled.

Clock pulses are input to IC3, a 4017 configured as a divide by 6 counter-decoder. This is achieved by connecting decoded output '6' to the rest input. As the outputs are numbered from zero, output '6' goes high on the seventh clock cycle resetting the counter and providing six decoded outputs which go high sequentially. The reset pulse generated is too short to reliably clock the second counter IC5 so one of the decoded outputs from IC3 is used.

When PB1 opens, IC3 and IC5 which have been cycling continuously will stop at a random position as clock oscillator IC1b is disabled. The output of IC1a will go low again and this signal inverted by IC1c enables one input IC1d. The other input of IC1d will be at a high level as C2 is still charged and so its output will go low turning on Q1 and the LEDs until the charge on C2 leaks away through R3 after about six seconds when the LEDs will extinguish. One or both displays will be illuminated depending on the position of SW1. If you wish to replace PB1 by a touch contact, R1 may be increased to 4M7.



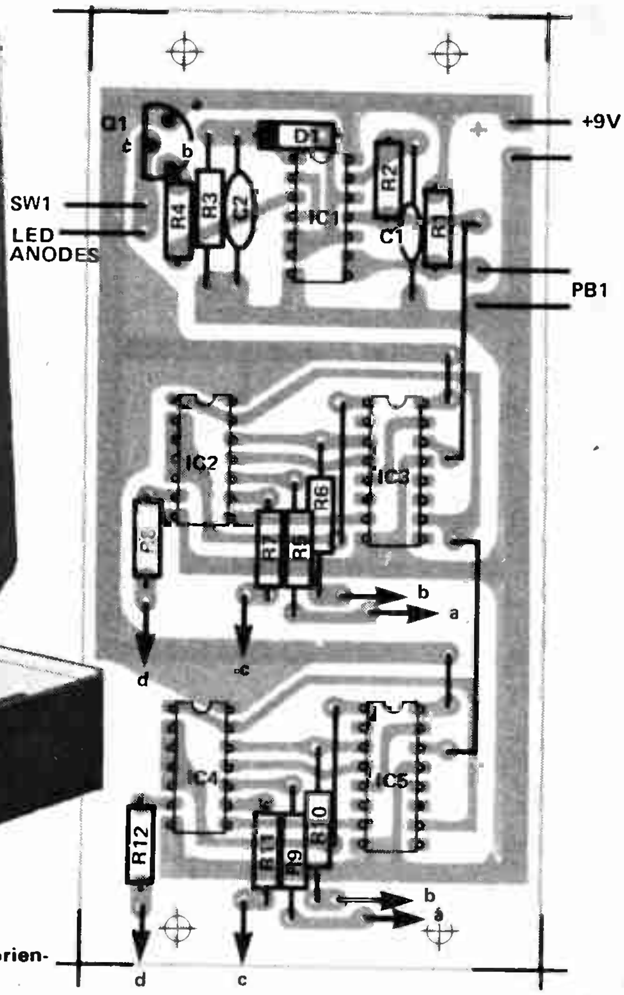


Fig. 2. Component overlay, note the orientation of the LCs.

PARTS LIST

RESISTORS (5% all ¼-watt)	
R1	100k
R2	56k
R3	10M
R4	47k
R5, 6, 7, 8, 9, 10, 11, 12	470R
CAPACITORS	
C1	470p
C2	680n
SEMICONDUCTORS	
D1	IN4148
Q1	BC214L
IC1	4093
IC2, IC4	4025
IC3, IC5	4017
LEDs red, standard 0.2"	
MISCELLANEOUS	
PB1 push-button SPST	
SW1 SPST	
P.C.B. Vero-case to suit	

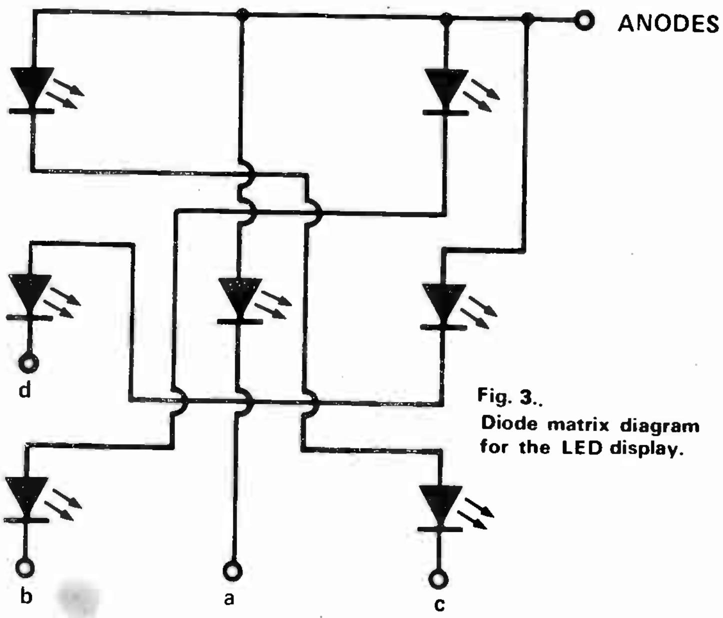


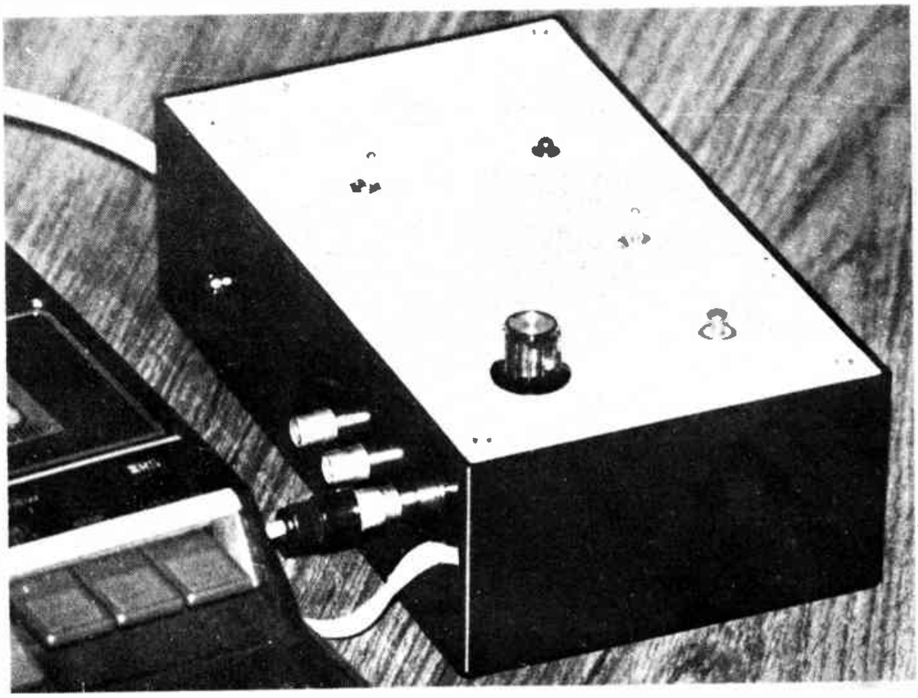
Fig. 3. Diode matrix diagram for the LED display.

BUYLINES

There should be no problem in obtaining any of the components used in this project. The ICs are common types available from most electronics hobby shops.

TAPE SLIDE SYNCHRONISER

This must rate as one of the most requested projects of all time for us! This tape synchroniser uses a notched 100Hz tone to achieve its ends as neatly as possible.



WHEN PUTTING on a slide show for your friends or a business meeting, it is usually necessary to have some commentary with it. If it is a one-time presentation this is no problem, but if the show is to be repeated or if you simply want to be able to recall good memories a couple of years later then a tape recording of the commentary is ideal. The problem now is to keep the slides changing in synchronization with the commentary, without having to record that obtrusive phrase 'change slide now' onto the tape.

This unit allows a control tone (100 Hz) to be recorded on the tape along with the normal voice recording; when replayed the tone will activate a relay which will change the slide while a notch filter removes the tone so it is not heard through the speaker.

Construction

Assemble the PCB with the aid of the component overlay in Fig. 1. With the 240 V wiring it is better not to use pins but solder the wires directly onto the PCB. A covering of epoxy glue over the tracks leading to the transformer will help to prevent accidental contact.

We built the prototype into a large plastic box with the controls on the front panel and the tape recorder / amplifier connections on the rear. The wiring of the front panel is given in Fig. 1. We used an electret microphone insert mounted just behind the front panel. However the noise of the relay operating could be heard on the tape and therefore an external microphone is recommended. A socket can be mounted on the front panel in the microphone position.

Using the Unit

With this unit a separate amplifier / speaker system is needed. Also the slide projector must have a remote change button using normally open contacts. Connection has to be made between these contacts and the relay in the unit. Check that these wires are isolated from the 240 V mains and if not be very careful with the connections.

Connect the unit to the tape recorder and projector, assemble the slides in the correct order and switch on. With the record / playback switch in the record position and the recorder set to record, commence the commentary, changing slides with the button on the unit. The high level input on the recorder should be used and the microphone level pot set to give the correct recording level.

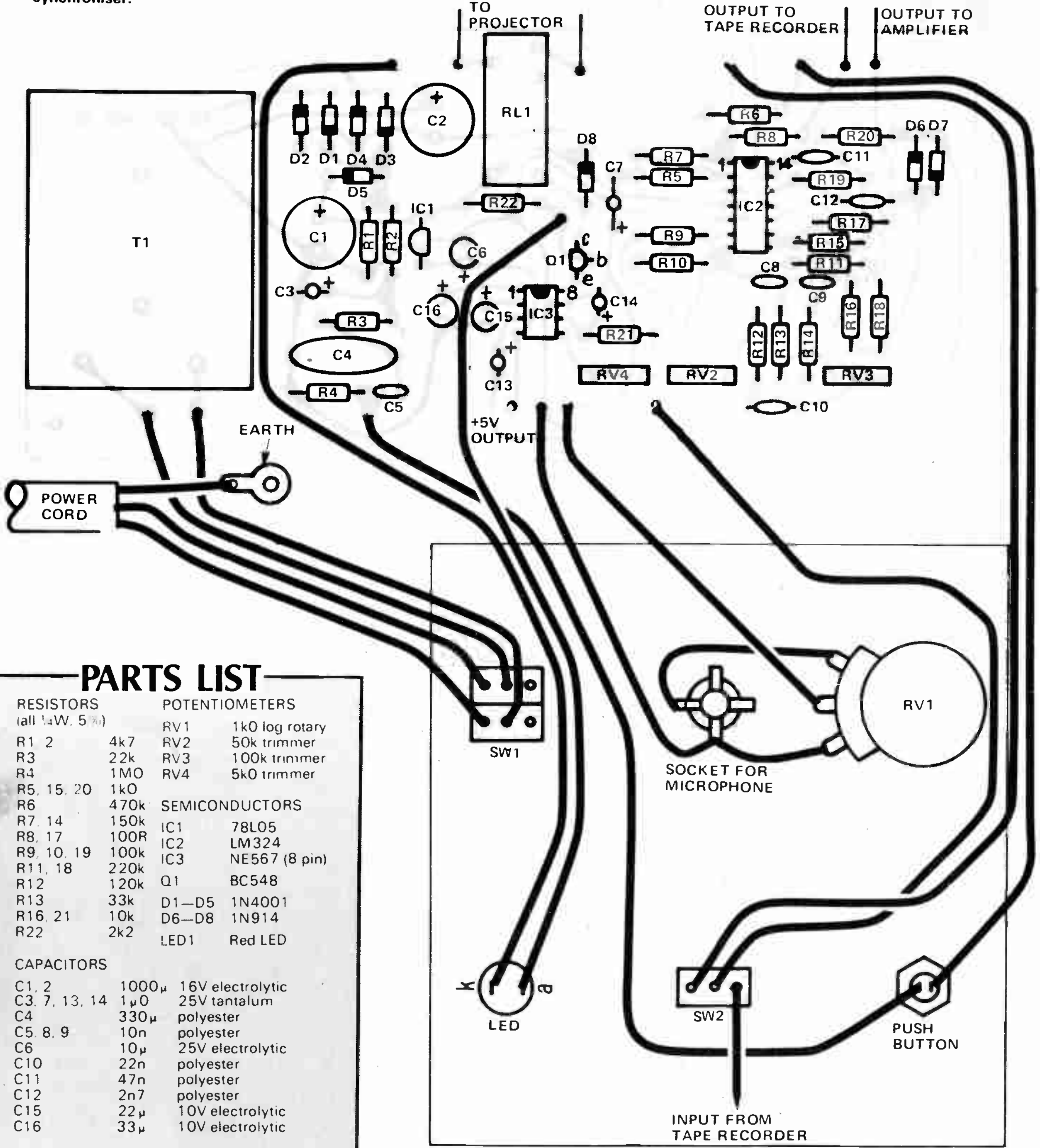
When playing back simply set the record / playback switch to playback and replay the tape.

Adjustments

Set the unit up to record and with all trimpots at the centre of their travel and the microphone level at minimum, hold the slide change button down. Probably some 100 Hz signal will be heard on the output of the amplifier. Alternately adjust RV2 and RV3 to minimise this signal. It should be necessary to wind up the volume of the amplifier to finally adjust for a minimum level.

The other adjustment is of the phase locked loop centre frequency. With the push button pressed slowly rotate RV4 until the relay either opens or closes. If it closes, continue ▶

Fig 1. Component overlay for the slide synchroniser.



PARTS LIST

RESISTORS
(all ¼W, 5%)

R1, 2	4k7
R3	22k
R4	1M0
R5, 15, 20	1k0
R6	470k
R7, 14	150k
R8, 17	100R
R9, 10, 19	100k
R11, 18	220k
R12	120k
R13	33k
R16, 21	10k
R22	2k2

POTENTIOMETERS

RV1	1k0 log rotary
RV2	50k trimmer
RV3	100k trimmer
RV4	5k0 trimmer

SEMICONDUCTORS

IC1	78L05
IC2	LM324
IC3	NE567 (8 pin)
Q1	BC548
D1—D5	1N4001
D6—D8	1N914
LED1	Red LED

CAPACITORS

C1, 2	1000µ	16V electrolytic
C3, 7, 13, 14	1µ0	25V tantalum
C4	330µ	polyester
C5, 8, 9	10n	polyester
C6	10µ	25V electrolytic
C10	22n	polyester
C11	47n	polyester
C12	2n7	polyester
C15	22µ	10V electrolytic
C16	33µ	10V electrolytic

MISCELLANEOUS

Relay 12V 280Ω (Watford type RL6 SPDT)
Transformer 240V—18V
SW1 DPDT Toggle
SW2 SPDT Toggle
One push button switch N/O
Box to suit
3 core flex and plug
Output sockets etc

BUYLINES

Try as we might we can envisage no problems obtaining the components required for this project. The semiconductors should all be available from such stalwart companies as Marshalls, Technomatic, Watford et al. Any case will do, as will any transformer although some may not fit the PCB directly.

to rotate it until it drops out then bring the pot back to the half way point. If the relay opened, reverse the rotation to find the other point at which it opens and leave RV4 midway between these two points.

Check the operation of the relay when pressing the button. There should be about half a second delay before it closes. ●

HOW IT WORKS

With this unit, unlike our previous design, we record a 100 Hz tone burst on the same channel as the speech whenever we require a slide to be changed. The tone is derived by full wave rectifying the output of the transformer and filtering out the harmonics by R2, 3/C3,4.

Pressing the slide change button mixes this tone with the output from the microphone which is amplified by IC2/1. This combined output is recorded on the tape.

In the record mode SW2 connects the output of IC2/1 to the buffer amplifier IC2/2. In the playback mode it connects the output from the tape recorder to the amplifier. The output of this amplifier is split into two paths. One of these is through a 100 Hz notch filter to IC2/3 effectively removing the 100 Hz tone without much change to the rest of the spectrum. This is used to drive an amplifier/speaker system.

The other path for the signal after IC2/2 is via a low pass filter IC2/4. This removes frequencies above 150Hz. When the 100 Hz tone occurs, this filter passes it, rejecting speech frequencies, and it is passed to IC3. This is a phase locked loop tone decoder and its output on pin 8 turns on when the correct frequency tone is received. The output stage of this IC is an open collector NPN transistor which can sink but not source current. With no incoming tone this transistor will be off, preventing any emitter current in Q1, hence turning it off also. The voltage on the base of Q1 in this case will be set at 2V by LED1. When a tone occurs the output of the IC will saturate to about 0V6, forward biasing Q1, turning it on, and closing the relay. The current in R22 is now bypassed into the base of Q1, giving about 1V2 on the base. This is too low for the LED to conduct and it will go out.

The power supply is simply full wave rectified and filtered for IC2, and a 5V regulator is used for the PLL IC and the microphone amp.

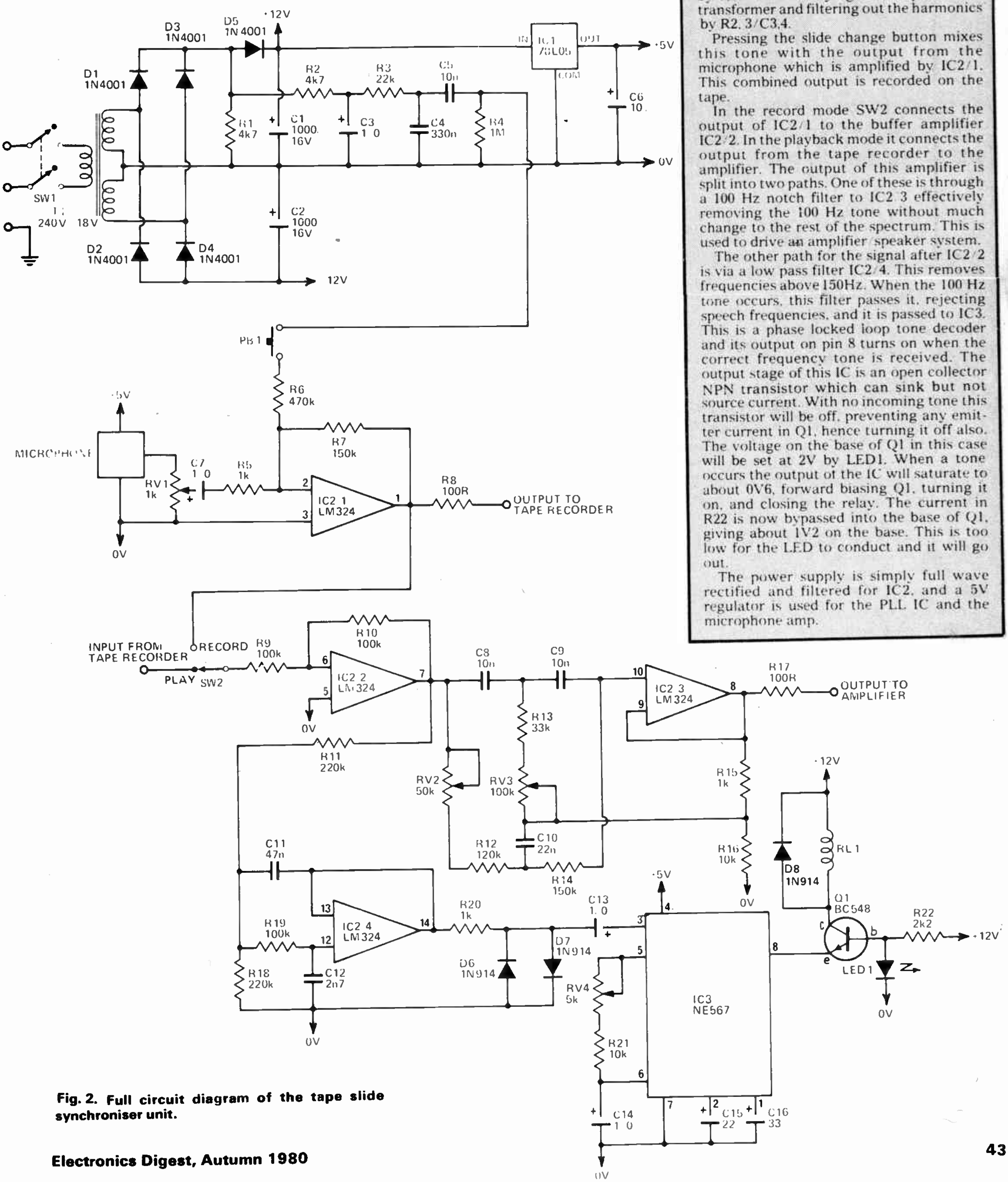
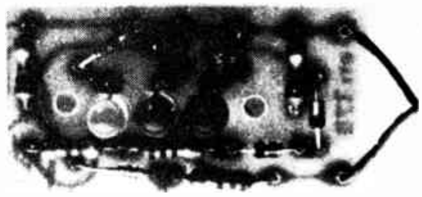


Fig. 2. Full circuit diagram of the tape slide synchroniser unit.

BATTERY INDICATOR



Ever been caught by a battery that went flat at an embarrassing moment — like when you've just offered a friend a lift? The conversation goes a little flat when you're both riding the bus to work, 20 minutes late. Jonathan Scott found a solution . . .

THE OLD, RELIABLE lead-acid battery may be way ahead of whaever is in second place for vehicle electrical systems, but they do need a 'weather eye' kept on them. Particularly if they're out of warranty. The same applies to 'reconditioned' batteries, so often found in secondhand vehicles of some age.

That's the problem with cars — running out of petrol and running out of battery produces the same heart-rending result. Immobility.

Most vehicles have a petrol gauge. Few have an equivalent for the battery. Many 'older' cars included a 'charging current' meter. This told you something about the car's generator-regulator and required some interpretation to figure out whether the battery was in good health.

Probably the best way to check on the state of your battery is to use a hydrometer. However, hydrometers have a number of drawbacks. Being made of glass, they're fragile and can't be used while a car is in motion. The small amount of battery acid that remains on them presents a storage problem — the drips and fumes attack most metals and materials. They're okay for the corner garage but justifying their cost,for the occasional use they get in home workshops, is not always possible.

Another method of testing battery condition is by checking the voltage 'on load'. A lead-acid vehicle battery in a reasonable state of charge will have a terminal voltage under normal working load somewhere between 11.6 and 14.2 volts. When a battery shows a terminal voltage below 11.6 volts its capacity is markedly decreased and it will discharge fairly quickly. Like as not, it won't turn the starter motor for very long! On the other hand, if the voltage on load is above 14.5 volts then the battery is definitely fully charged! However, if it remains that way for any length of time while the car is on the road, the vehicle's alternator-regulator system is faulty and the battery may be damaged by overcharging.

Reading the battery voltage can be done in a number of ways. You could use a digital panel meter, set up as a voltmeter. Their drawback is that they cost nearly ten times as much as a hydrometer! The next best method is to use an 'expanded-scale voltmeter'. Reading the voltage range between 11 and 15 volts on a meter face calibrated 0-16 volts is a squint-and-peer exercise. On a 0-30 volts scale, as used on many modern multimeters, it's worse. A meter which reads between 11 volts at the low end of the scale and 16 volts at the high end is ideal. Hence, the term 'expanded-scale'.

However, you don't want to be peering at a meter on the dash board when you're driving through traffic. The range of voltage over which your battery is healthy is some two volts. An indicator which simply requires the occasional glance, and needs no 'interpretation', is what is really needed.

With this project, that's exactly what we've done.

Go, caution, stop

We have devised a simple circuit that indicates as follows:

Yellow:	battery 'low'
Green:	battery okay
Red:	battery overcharging

When the battery voltage is below 11.6 volts, a yellow indicator lights. This indicates the battery is most likely undercharged or a heavy load (such as high power driving lights) is drawing excess current. When it is between 11.7 and about 14.2 volts the green indicator lights, letting you know all is sweet. If the red indicator lights, as it will if the voltage rises above 14.2 volts, maybe the vehicle's voltage regulator needs adjusting or there is some other problem.

The circuit

The circuit is ingeniously simple, having barely a handful of parts. Reliability should be excellent.

We actually started out with a somewhat complex circuit. It used only two indicators and required you to 'interpret' what was happening. In trying to convert that to a yellow-green-red style of indication it sort of grew like topsy. This circuit had four transistors, a dozen resistors etc and didn't look at all attractive as a simple project that the average hobbyist or even handyman could build one Saturday afternoon and get going immediately. A rival circuit was devised by another staff member using a common IC. This sparked a controversy as to which was the better! Certainly, both did the job required . . . but maybe there was a simpler method.

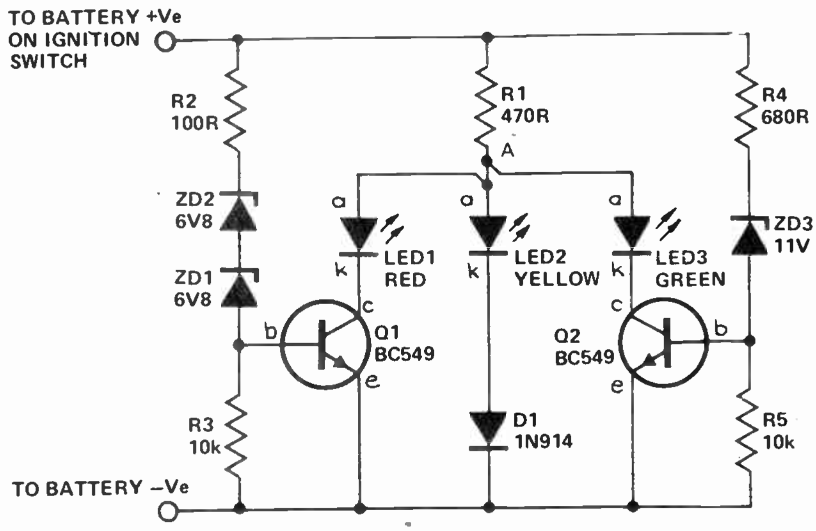
It was discovered that different coloured light emitting diodes (LEDs), which we had decided to use for the indicators in the project, had different voltage drops when run at the same current. Seizing on this idea, the original circuit (four transistors, a dozen resistors . . .) was modified to exploit this characteristic and the simple circuit you see here was the result.

Construction

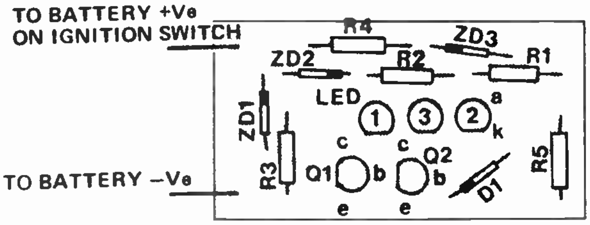
Construction is straightforward. If you haven't soldered electronic components before — and this project was designed for the motorist/handyman as well as electronics enthusiasts — then we suggest you practice on something before tackling this project.

We recommend you use the printed circuit board designed for this project. The actual layout of the components themselves is not critical but a printed circuit board reduces the possibility of errors.

It is best to mount and solder the resistors first. Follow this by soldering in the diode D1 and the zener diodes



The circuit diagram and component overlay (below). During construction, make sure all of the diodes and LEDs are the right way round.



HOW IT WORKS

This circuit depends for its operation upon the different voltage drops across different colour LEDs.

At 20 mA the voltage drops across red, yellow and green LEDs are typically 1.7, 3.0 and 2.3 volts respectively. When the vehicle battery voltage is too low to cause either ZD1/ZD2 or ZD3 to conduct, Q1 and Q2 are held off by R3 and R5. Under these conditions the yellow LED is forward biased and conducts via D1 producing a potential of about 3.7 volts at point A (see circuit diagram). When the supply rises above about 11.6 volts ZD3 conducts, biasing Q2 on. By virtue of its lower voltage requirements the green LED conducts, reducing the voltage at point A to approximately 2.6 volts. This is not enough to bias D1/LED3 on, so the yellow LED goes off. The green LED 'steals' the bias from the yellow LED. When the supply rises above about 14.2 volts, Q1 is biased on and the red LED 'steals' the bias from the green. The potential at point A falls to two volts and only the red LED conducts.

R1 limits the current through the LEDs. R2 and R4 limit the base currents into Q1 and Q2.

PARTS LIST

RESISTORS (all ¼W, 5%)

R1	470R
R2	100R
R3, R5	10k
R4	680R

SEMICONDUCTORS

D1	1N914
ZD1, ZD2	6V8 400 mW zener
ZD3	11V 400 mW zener
Q1, Q2	BC547,8,9 or BC107,8,9 or common silicon NPN type

MISCELLANEOUS

PCB

Aluminium angle bracket for under-dash mounting.

BUYLINES

Nothing to worry about here really, but make sure the LEDs are the correct colours, otherwise the voltage drops will not be correct!

ZD1, ZD2 and ZD3. Carefully follow the accompanying component overlay making sure the diodes are all inserted the correct way around. Next, mount the transistors, again referring to the overlay, checking to see they are inserted correctly before soldering.

Finally, mount the light emitting diodes. These too may only be inserted one way. Check with the component overlay and connection diagrams. Make sure they are in the correct sequence. On the component overlay, LED 1 is the red LED, located at the left. The yellow LED is on the right, marked with a '2'. The green LED, marked '3' is between them.

Mounting

As vehicles vary so much in dash panel layout, we can only make general suggestions.

Clearly, the indicator should be mounted such that the three LEDs are not in direct sunlight. A low part of the dash, but make sure it's readily visible from your normal driving position, will pretty well ensure the display may be easily read during the daytime. Alternatively, if you have an 'overhung' dash, or a portion which overhangs (usually where the instruments are mounted anyway), then a suitable position will generally suggest itself.

Exact mechanical details will have to be determined according to your particular situation. Two holes are provided in the board for mounting bolts. Alternatively, the whole assembly may be mounted from the LEDs. Three LED holders inserted through part of the dash panel, or an escutcheon plate mounted on the dash, will hold the LEDs quite securely. Providing the leads on the LEDs are fairly short, the board will place little strain on them and the assembly should be mechanically secure.

Connection

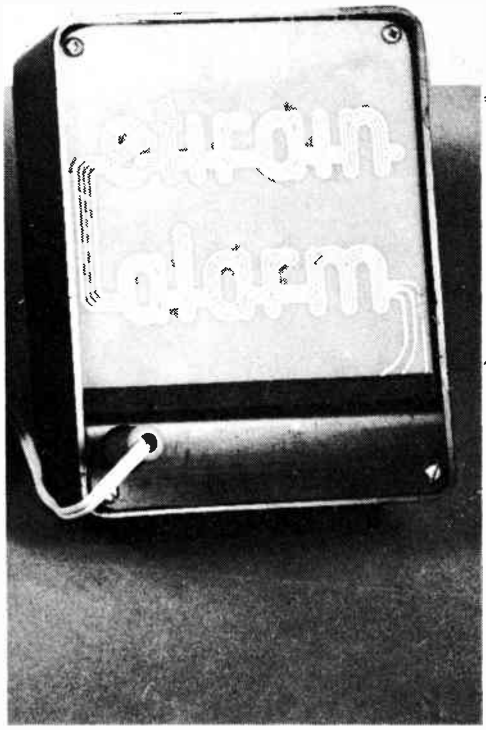
The indicator may be installed in vehicles having positive or negative earth electrical systems.

The component overlay shows the connection for a **negative** earth vehicle. The 'battery +ve' lead goes to the ignition switch — the indicator only operates when the vehicle is being used — the battery negative lead should be taken to a good 'earth' point on the vehicle frame.

For a **positive** earth vehicle, the lead marked 'battery −ve' goes to the ignition switch connection, while the 'battery +ve' lead goes to the vehicle frame. ●

Avoid the horrors of heavenly H_2O with our Project Teams

RAIN ALARM



THE WEATHER — one of the great joys of being British. Hours of endless fun can be had trying to make better guesses than the forecasters. Every trip to the seaside becomes an exciting game of chance. It provides an opportunity to strike up a conversation with total strangers. However, words of a different kind will flow forth from the lips of housewives who discover that hanging out the washing is more effective than hiring a whole tribe of rain-dancers.

It May Rain!

It's here that the good guys of the ETI project team come to the rescue with their Rain Alarm. This little fellow might well upstage any canine companion as a housewife's best friend, at least on washday, by giving a warning at the first sign of rain, giving plenty of time to get the washing in before it gets too wet.

The rain alarm should be placed out in the open and a length of two core wire run between it and an eight ohm speaker. We used an old intercom sub-station to provide a home for our speaker but a car extension speaker or indeed any suitably boxed eight ohm device would be fine.

Any rain falling on the sensor track, formed as part of the PCB (neat innit?), will set off the alarm and produce a distinctive, intermittent bleep-bleep.

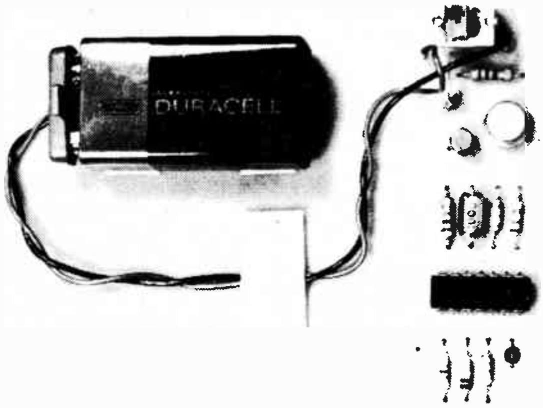
Construction

Construction is straightforward if the PCB layout shown is used and in the case of this project we would recommend that the PCB is used, as this adds to the attractiveness of the project.

Assemble the components according to the overlay, ensuring that the tantalum capacitor is connected the right way round. If you do not use a socket for IC1, solder pins seven and fourteen before the others (this allows the device's internal protection circuitry to function).

In our prototype we used a value of 4M7 for R1 which acts as a sensitivity adjustment. This value leads to a 'hair trigger' alarm and the value could well be reduced according to the level of sensitivity required.

When construction is complete and the alarm has been tested the area of the PCB that holds the components should be covered with some suitable non-conducting potting compound — epoxy resin should do — to render it waterproof.



Power To Your . . .

Power consumption of the unit is so low when the alarm is not triggered that it was not thought necessary to provide an on/off switch.

While this unit is not as effective as a device to control the weather — still working on that one — it should at least prevent some of those washday blues. ●

BUYLINES

The PCB will be available from any of the usual suppliers that advertise in ETI. C1 must be a low leakage tantalum but this component should be widely available. All of the other components are likewise obtainable from most electronic retailers.

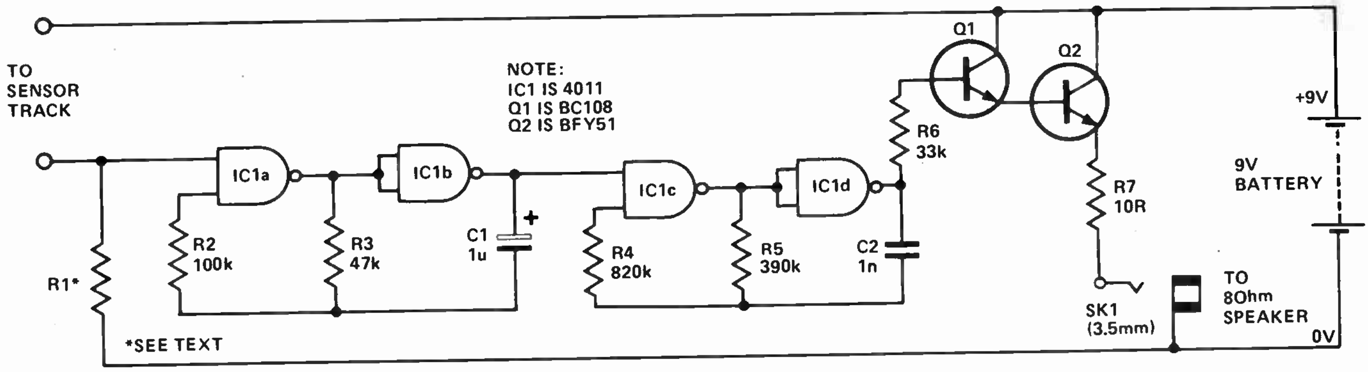


Fig. 1. Circuit diagram of Rain Alarm.

HOW IT WORKS

THE rain alarm is formed by two gated CMOS oscillators and an audio output stage.

The basic CMOS oscillator is shown in Fig. 2. Upon switch on, with C discharged, the output of inverter B will be low, the input to A low and its output high. Capacitor C will now commence to charge towards supply, the voltage level at A's output, via resistor R.

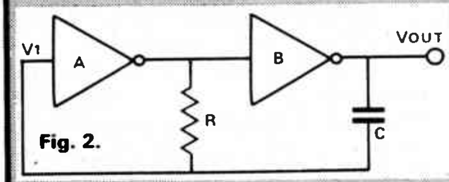


Fig. 2.

We can consider a CMOS gate to be a comparator that will change output state when the level of voltage at its input reaches a specified value, the transfer voltage (Vtr), usually about half supply. Thus as the voltage on C increases due to the charge current being supplied by R there will come a point when the voltage on the input of A will pass its transfer voltage and the output of B will go high.

At this point the charge on C corresponds to a voltage level of approximately half supply.

As the inverters A and B change states the end of C that was held at 0 volts is now at supply and the end of C that was connected to supply via R is now returned to 0 volts via the same resistor.

These changes together with the charge stored on C mean that the potential across C is now supply plus the transfer voltage of gate A. This is shown in Fig. 3.

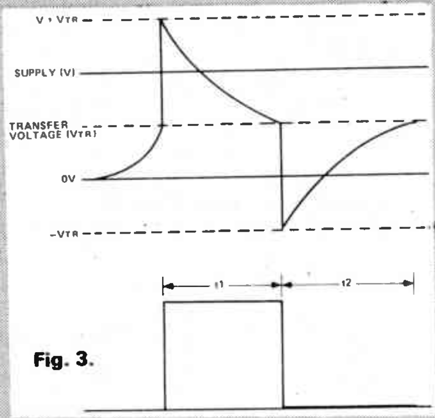


Fig. 3.

Capacitor C will now discharge via R until once again the transfer voltage of A is reached whereupon the outputs of the inverters will assume their original states.

The conditions are not quite the same as at switch on because, as can be seen in Fig. 3, the potential across C is now a negative value equal to A's transfer voltage.

From this point C charges via R again to repeat the cycle.

The output is shown in Fig. 3 where $t_1 = t_2 = 1.1$ RC (the time taken for C to charge (discharge) via R to two-thirds of the maximum value of voltage across it).

In practice, due to the protection networks associated with modern CMOS devices, it is necessary to include a resistor in series with the input of A in order to ensure that the voltages across C are allowed to reach the values shown in Fig. 3.

The final circuit diagram (Fig. 1) of the Rain Alarm shows that the inverters are in fact formed from the four NAND gates of a 4011 package. In each oscillator, while one gate is configured as a straightforward inverter, the other has one input that can act as a control input, oscillator action being inhibited if this input is held low.

The first oscillator (IC1a and IC1b) has this input tied low via a high value resistor (R1) that acts as a sensitivity control. Thus this oscillator will be disabled until the control input is taken high. Any moisture bridging the sensor track will so enable the output which is a square wave at about 10 Hz. This in turn will gate on and off the 500 Hz oscillator formed by IC1c and IC1d.

This latter oscillator drives the loudspeaker via R6, the Darlington pair formed by Q1 and Q2 and resistor R7.

PARTS LIST

RESISTORS (all ¼W 5%)

R1	See text
R2	100k
R3	47k
R4	820k
R5	390k
R6	33k
R7	10R

CAPACITORS

C1	1u0 16 V tantalum
C2	1n0 polyester

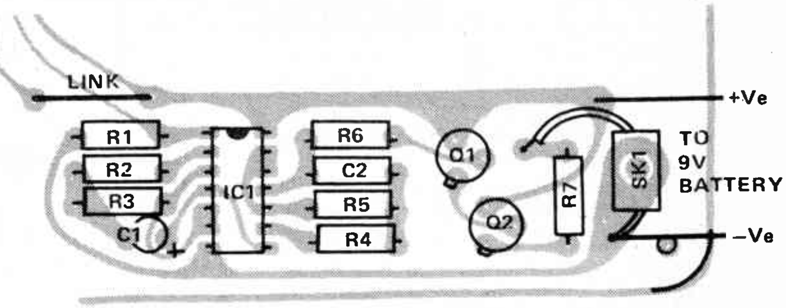
SEMICONDUCTORS

IC1	4011
Q1	BC 108
Q2	BFY 51

MISCELLANEOUS

PCB as pattern, 3.5mm jack socket, 8R speaker, battery.

Fig. 4. Overlay of the section of the Rain Alarm PCB that holds the components.



CANNIBALS AND MISSIONARIES

HERE'S A PARTICULARLY perplexing problem provided for people with painstaking propensities. It's an electrical model of the puzzle which goes like this: three missionaries and three cannibals come to a river they want to cross. A little boat at the bank will carry only two people. All the missionaries can row, but only one of the cannibals can row — he'd been to Oxford. He also wears a red shirt! If at any time, on either side of the river, cannibals outnumber missionaries then the cannibals will eat the missionaries, which, understandably, the missionaries don't want. Problem: how do they cross safely?

In the model shown in Fig. 1 the missionaries are represented by three switches M1, M2 and M3, and the cannibals by three switches C1, C2 and C3. The missionary switches have white levers. Two of the cannibal switches have black levers, but the switch representing the cannibal who wears a shirt and learned to row at Oxford — (C2), has a red lever.

By operating the switches to represent crossings of the people involved — never more than two at a time as that's the limit of the boat, you try to solve the problem. If at any time a situation arises where, on either bank, cannibals outnumber missionaries then an alarm sounds and you've failed.

The circuitry detects situations where cannibals can satisfy their taste for eating missionaries, but it does not detect cheating — such as putting three people in the boat, or allowing a cannibal who can't row to be in the boat on his own.

Construction

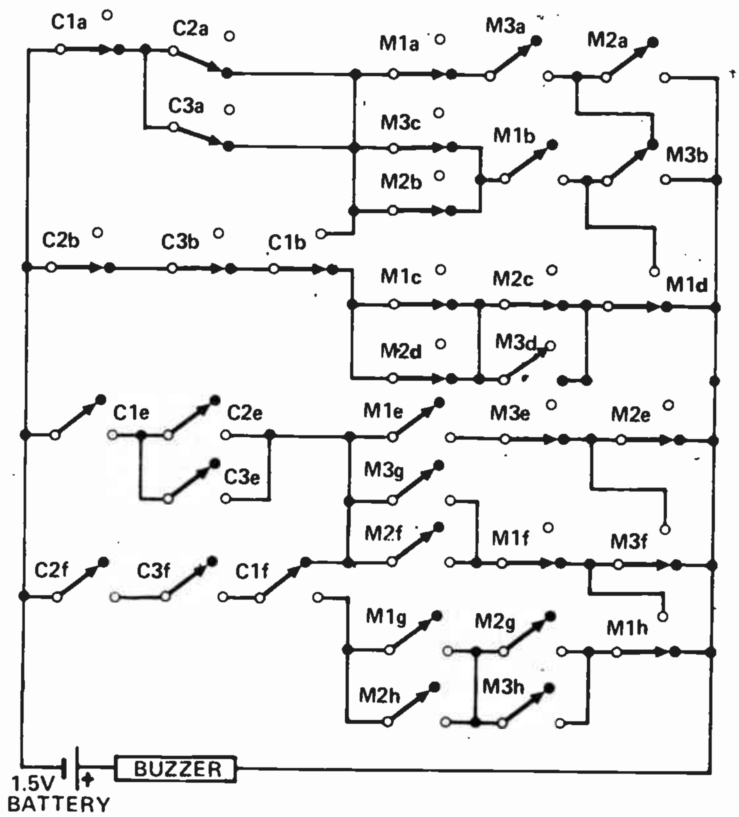
The prototype was assembled in a plastic box 140 mm × 100 mm × 75 mm high with an aluminium front panel. Modern telephone-type key switches were used each having four changeover switches on each side of the switch.

Figure 2 shows the bottom view of one of the switches and how its terminals are laid out. It also shows, by means of the arrow-headed lines, which terminals connect with the moving parts of the switches. The eight changeover switches which comprise one key switch have been lettered a to h for convenience and to tie in with the lettering in Fig. 1.

Note carefully that the switches in Fig. 2 are shown making the circuits which they make when the switch lever is in its *central* position. When the switch lever is moved from the central position to the start side of the river it changes over only the switches on the opposite half of the switch — i.e. switches a, b, c, d. When the switch lever is moved from the centre position to the far side of the river it changes over only switches e, f, g, h.

Although key switches each containing a total of eight changeover switches were used in the original, actually it is only the missionaries who need all eight switches. The cannibals need only five changeovers, but it was thought simpler to buy six identical switches.

Fig. 1. The circuit diagram with all switches shown with levers on the start side of the river.



Wiring must be done carefully — very carefully! Bare wire was used in the prototype. Figure 3 shows the wiring diagram for the start side half of the switches and Fig. 4 shows the wiring of the other half. They are shown separately to minimise confusion. As can be seen from this, the switch wiring needs considerable care. On each of Fig 3 and Fig. 4 one lead is marked 'To Buzzer' and another 'To battery —ve.' These leads, i.e. both buzzer leads are joined together and to the buzzer; and both battery —ve leads are joined together and run to battery —ve.

When wiring up — work logically. Start with switch M3 which is on the left when the panel is upside down. Start with the top left hand terminal and make all connections to it. Then move down each terminal in turn down the left hand row of terminals. Proceed row by row to the right making and checking connections to each terminal. It's a good idea to cross off with a pencil, each connection shown on the wiring diagrams, as soon as that connection has been made on the switches. Be sure not to miss the short connection between switches M3e and M3f.

If you want to check through the wiring diagrams, the circuit, and the switch diagram — bear in mind that the switch diagram shows connections with the switch lever in the central position, and the circuit diagram shows the connections with the levers in the start side position.

On completion of the wiring and after insertion of the cell, the puzzle should work. Check out all the alarm situations on both banks and see that the alarm sounds when it should. Also check the no-alarm situations — i.e. when cannibals do not outnumber missionaries on either bank of the river.

Fault finding is not as daunting as it may appear at first. A logical working through the circuit diagram should help to pin point any problem. ●

PARTS LIST

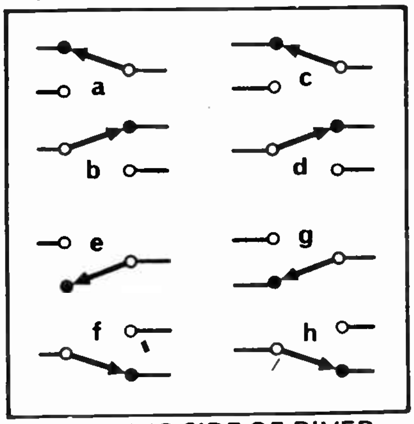
Six standard phone type key switches, 4-pole changeover locking each side (e.g. RS Components 338-018) plus knobs to suit.
One buzzer and battery holder (e.g. ex bicycle horn)
Box to suit, hook up wire etc

BUYLINES

Those with access to disposal stores could probably buy enough old style key switches comparatively cheaply, to build up the necessary number of switching functions needed. Otherwise, this could prove to be an expensive project as the list price for new key switches from RS Components is £3.23 each!

Fig. 2 Terminal layout on standard key switch with four changeover on each half. Contacts shown as being made in this diagram are with the lever in the central position

FINISHING SIDE OF RIVER



STARTING SIDE OF RIVER

HOW IT WORKS

The circuit is a switching logic circuit. See Fig. 2. The cell and buzzer are between the outer vertical rails, and if ever a way between these two rails is set up by the switches then the alarm sounds. The circuit shows all the switches in the *starting* position i.e. all the missionaries and cannibals are on the near bank. Note that when any person goes over the river *all* switches changeover. The customary dotted lines showing the connections between coupled switches have been omitted for clarity. Thus, if M1 crosses the river, switches M1a, M1b, M1c, M1d, M1e, M1f, M1g and M1h all change over.

You can work out the circuits for the alarm to sound. Here are three examples. Suppose all three cannibals stay on the start side and M1 goes over. Then the cannibals outnumber the missionaries on the start side and so the alarm sounds through C2b, C3b, C1b, M2d, M2c and M1d which has changed over.

Similarly if M2 went over alone then the alarm would sound through C2b, C3b, C1b, M3d, M1d, M3b and M2a which has changed over.

And if M3 went over alone the alarm sounds through C2b, C3b, C1b, M1c, M2c, M1d and M3b which has changed over.

You can check all the alarm should sound configurations on each bank of the river by visualising an alarming situation, cannibals outnumbering missionaries, and then tracing through the switches to find a circuit. Similarly the 'alarm should not sound' circuits or rather 'no' circuits can be checked in the same way.

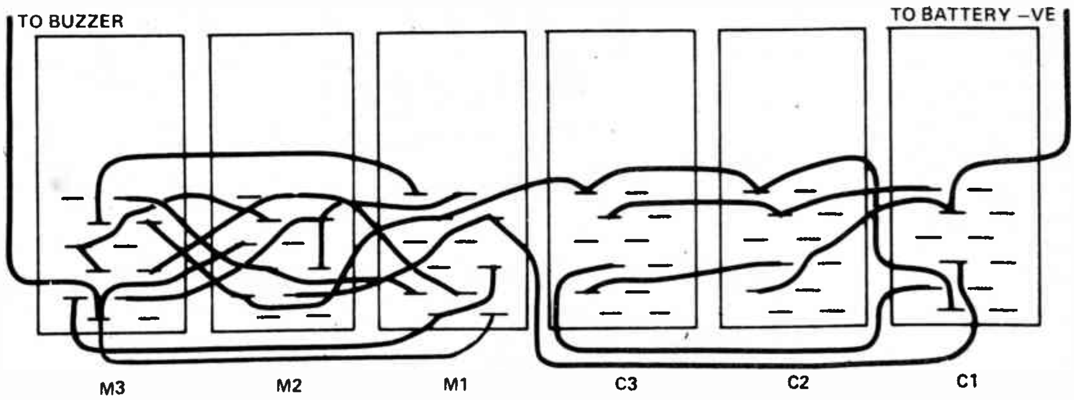
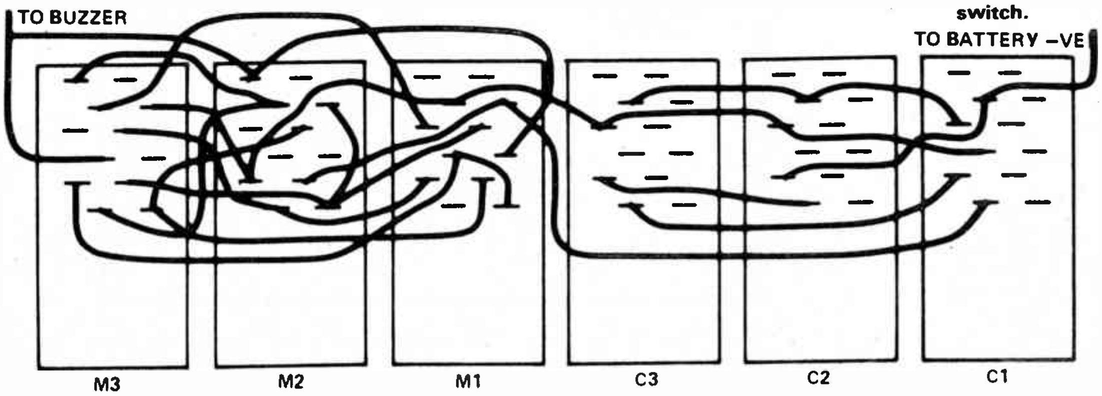


Fig. 3. Wiring on switches on the start side i.e. on switches 'e' to 'h' of each key switch.

Fig. 4. Wiring on switches on finish side i.e. on switches 'a' to 'd' of each key switch.



LOUDHAILER

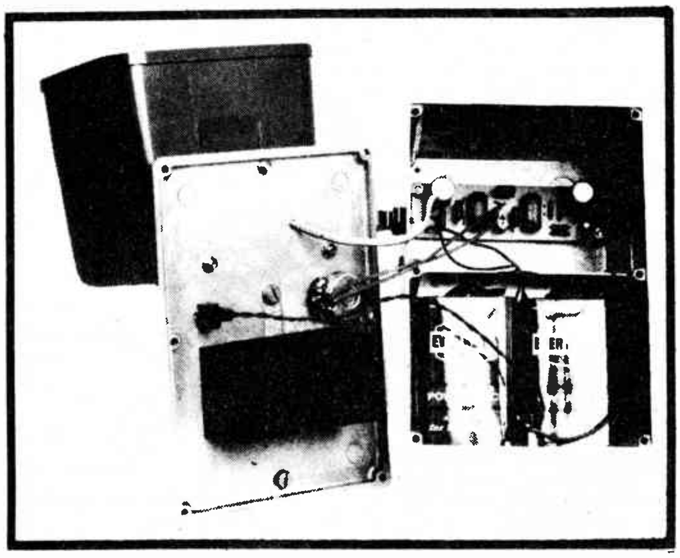
"COME IN NUMBER SIX" is the call heard at boating lakes, however you need large lungs and good health to shout as loud as the professionals. A simpler way for electronics enthusiasts is to build our Loudhailer, guaranteed to make you heard above the general noise at fetes, street parties, etc. Most commercial designs are expensive and need to be held up like a megaphone, ours is cheap and can be used in a variety of ways. The electronics and batteries, complete with speaker, are separate from the microphone — this enables you to hold the heavy part in one hand at a comfortable position, and talk through the microphone. You can also hand the microphone to some other person or even conduct an interview!

The diecast box used makes the unit impervious to 3 inches of water if placed on the ground, and the stick-on rubber feet stop it scratching the paint, if placed on a car bonnet or roof. When held in the hand the volume control can be operated with a thumb (to prevent acoustic feedback), also if the microphone used has no on/off switch the unit's switch can be used. In fact acoustic feedback with our system is not a great problem, as the microphone can be up to 100 feet from the loudspeaker!

Design

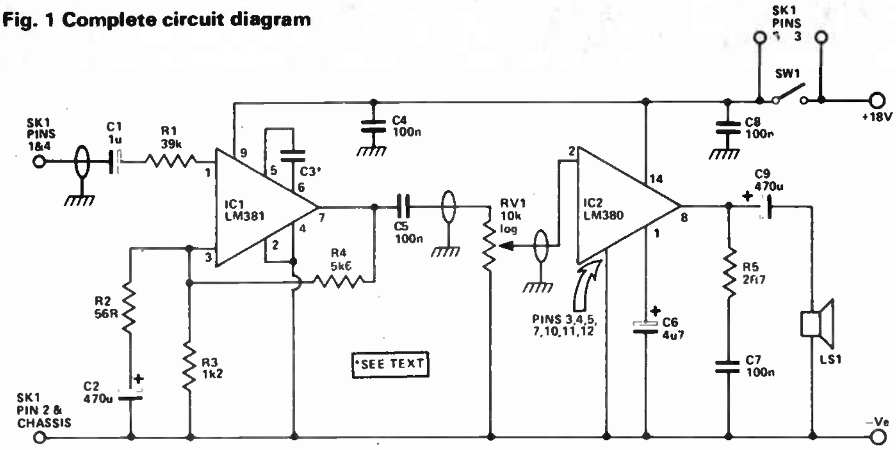
A low impedance microphone was used for a couple of reasons, firstly you can use far longer cable without noise and hum pickup. Second reason is that virtually all cassette recorders are supplied with low impedance microphones, so most of our readers will have one!

The first prototype used 12V as a supply, the final version (shown here) uses 18V. Power output is about 3W at 18V, and if run off a car battery (12V) will give out 2W — still quite loud. A socket can be fitted for an external power source if needed with a changeover switch. The output of 3W may not seem very much, but the HDB4 speaker specified is very efficient, and sounds very loud!



Internal view of the completed loudhailer. Note foam to hold batteries in place.

Fig. 1 Complete circuit diagram



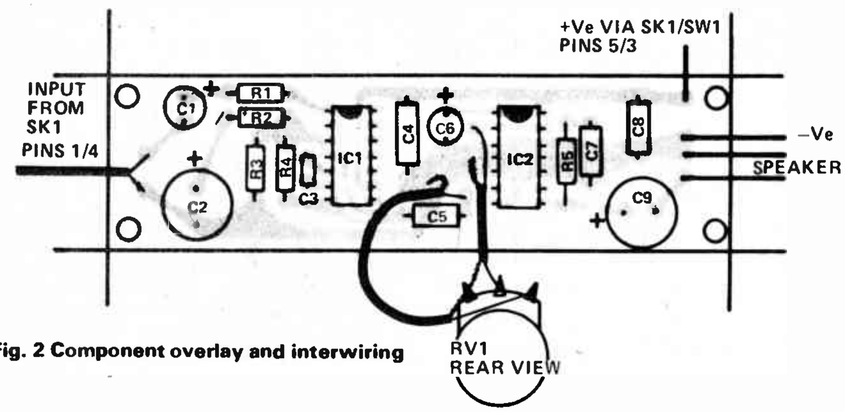


Fig. 2 Component overlay and interwiring

HOW IT WORKS

The LM381 is a dual low noise preamplifier — only half is used in this application. Most of the compensation network is inside the chip, hence the low parts count outside! Resistors R3 and R4 provide negative input bias current, and establish the DC output level at one-half the supply voltage.

Gain is set by the ratio of R4 to R2 which in this design is 100. C2 establishes the low frequency −3dB point, the value of 470µF used stops the system sounding "boomy". For more bass C2 can be reduced to 100µF.

High frequency roll off is set by C3, with the DM82 no capacitor was needed. With a condenser electret microphone 100pF was required to reduce the high frequency gain, so if you use a different type C3 can be varied between 10pF and 100pF for best response.

C1 reduces the effect of L/F noise currents at low frequencies.

The output of the LM381 passes through C5 and RV1 to the LM380 general purpose power amp. R5 and C7 act as a Zobel network on the output to stop instability, when driving reactive loads (like P.A. horn speakers!).

Construction

The microphone we used (Eagle DM82), and most others, is fitted with 3.5 and 2.5 mm jack plugs — these are changed for a 180° 5 pin DIN plug, this is to stop earthing problems with miniature jack sockets. Pin connections (for plug and socket) are as follows: Pins 1 and 4 live microphone connection. Pin 2 screen of microphone and equipment earth. Pins 3 and 5 used for remote ON/OFF on microphone switch.

Toggle switch SW1 is connected across pins 3 and 5, to act as another on/off control if your microphone has no switch (or you want to use very long single screened cable). Screening is important, pin 2 on the DIN socket is shorted to the earth tag on the socket. The input screen is also taken to the board input, the output screen from the LM381 is looped, via the earthy end of RV1, to the input screen of the LM380 ie: back to itself. RV1 itself is not earthed separately, just bolted tight to the case. This might seem strange to hi-fi boffins, but prevents instability in the circuit — we know because we did it!

The rest of the construction is reasonably straightforward. A large piece of foam is glued to the lid, to prevent the batteries from rolling around inside the box. Finishing touch is a clip for the microphone. ●

PARTS LIST

RESISTORS
(all ¼W 5% except where stated)

R1	39k
R2	56R
R3	1k2
R4	5k6
R5	2R7 ½W 5%

CAPACITORS

C1	1u0 25V
C2, 9	470u 16V
C3	See "How It Works"
C4, 5, 7, 8	100n polyester
C6	4u7 16V

POTENTIOMETER
RV1 10k log rotary

SEMICONDUCTORS
IC1 LM381
IC2 LM380

SWITCH
SW1 Subminiature SPST

LOUDSPEAKER & MICROPHONE
LS1 Eagle PA type HDB4
Microphone Eagle DM82

CASE & HANDLE
Diecast box 171 x 121 x 106mm (509-743)
Handle 107 x 12.7 x 27.4mm (509-917)

MISCELLANEOUS
5 pin DIN plug and chassis socket (180°), PCB to pattern, nuts, bolts, spacers, etc. Screened wire, knob, foam, microphone clip. Batteries (2 x PP9) and connectors, 4 stick-on feet and connecting wire, etc.

BUYLINES

Most parts are readily obtainable from mail order, or your local component shop. Numbers in brackets on parts list are RS stocknumbers, the handle may be difficult from other suppliers. The loudspeaker and microphone both came from Eagle, HDB4 and DM82 respectively, if any difficulty phone Eagle at 01-902 8832 and ask sales distribution for your nearest stockist. Total cost of construction should be at least half the commercial price of a similar unit.

BATTERY SAVERS

These simple 'battery savers' will provide 9 volts at up to 250 mA.

MANY BATTERY operated portable appliances are provided with a socket to enable them to be connected to a suitable external DC power supply.

This article describes the construction of two external power supplies, or 'battery savers', that may be used to energize many different types of tape recorders, record players, transistor radios, etc.

One unit is mains operated and is intended for use in the home — the second unit is intended for use in cars or trucks and operates from the vehicle's electrical system.

Both units are very simple to construct, provide adequate regulation and have sufficient power handling capacity to operate practically any small domestic (normally battery operated) appliance.

As the majority of battery operated appliances use a nine volt supply, both units described here have been designed for a nominal nine volt output. However for some purposes a six volt or a four-and-a-half volt output may be required. This may be readily achieved by replacing the components ZD1 and R1 by those shown in Table 1.

Construction

The 12 volt version has few components and the simplest method of construction is that shown in Fig. 1. As can be clearly seen, all components are soldered directly onto the power transistor.

After checking that it operates satisfactorily and that all joints are properly soldered, the complete unit may then be placed in a small plastic box and encapsulated in epoxy resin.

A cigarette lighter adaptor is fitted to the input lead and an appropriate power plug to the output.

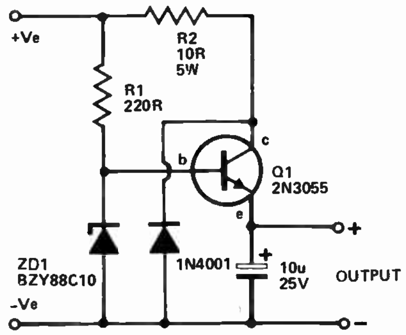
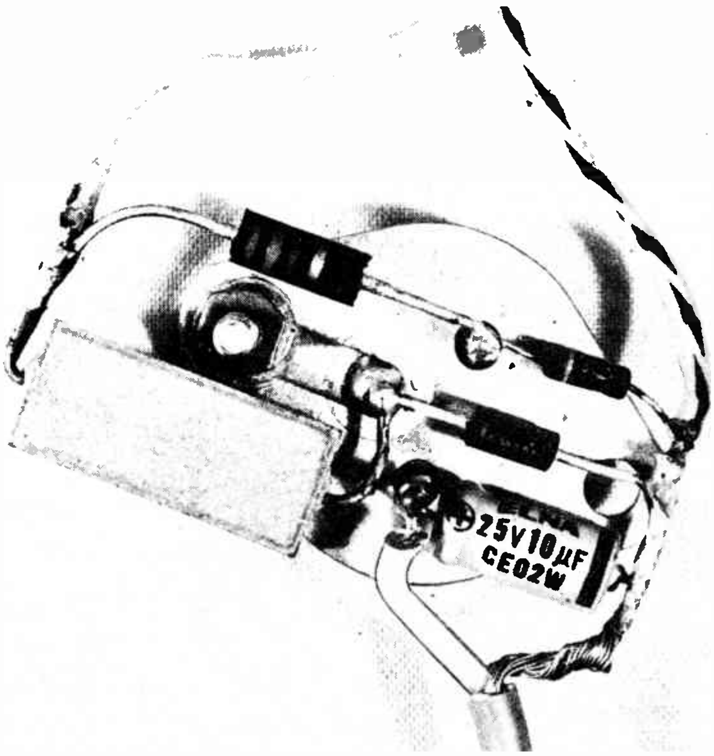


Table 1

Output	ZD1	R1 (12V)	R1 (240V)
9	10V	220R	330R
7.5	8V2	330R	470R
6	6V8	470R	680R
4.5	5V1	470R	680R

Fig. 1. Circuit diagram of the 12 volt version.

Fig 2. This shows a simple way of constructing the 12 volt version.



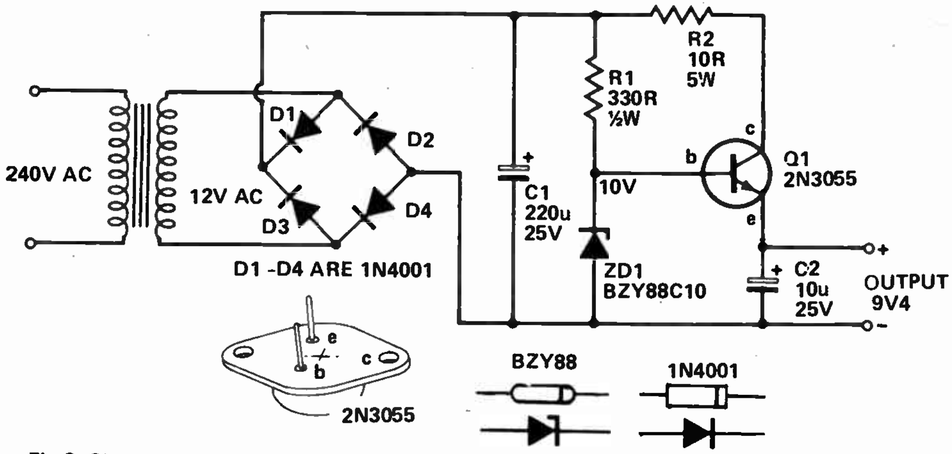


Fig 3. Circuit diagram of the mains operated unit.

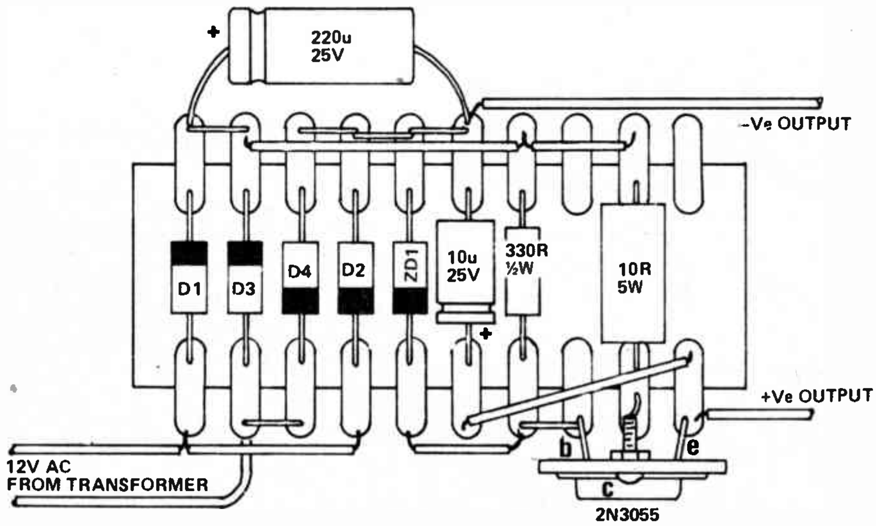


Fig 4. A method of constructing the mains version on tagstrip.

PARTS LIST

TWELVE VOLT VERSION

RESISTORS

R1	220R ½W, 10%
R2	10R 5W, 10%

CAPACITORS

C1	10u 25V electrolytic

SEMICONDUCTORS

Q1	2N3055
ZD1	BZY88C10 Zener
D1	1N4001

MISCELLANEOUS

Plastic box, epoxy resin, cable, solder tag, plug.
(Note: components above are for nine volt output. See Table 1 for alternative output voltages).

MAINS VERSION

RESISTORS

R1	330R ½W, 10%
R2	10R 5W, 10%

CAPACITORS

C1	220u 25V electrolytic
C2	10u 25V electrolytic

SEMICONDUCTORS

Q1	2N3055
ZD1	BZY88C10 Zener
D1-D4	1N4001

MISCELLANEOUS

Transformer (12V secondary, 100mA minimum), tag strip, cable, solder tag, plug.
(Note: components above are for nine volt output. See Table 1 for alternative output voltages).

HOW IT WORKS

Q1 is a 'series pass' transistor and drops the supply voltage to the required regulated output voltage.

The output of the transistor is controlled by the Zener diode ZD1. Resistor R1 supplies current for the correct operation of ZD1 and also provides base current for Q1.

The 10 ohm series resistor prevents damage to the transistor if the output of the unit is accidentally short circuited.

The 1N4001 diode prevents reverse polarity of the supply voltage. If a polarized plug is fitted to your vehicle, this diode may be omitted. Again if there is no possibility at all of accidentally shorting the output — the 10 ohm resistor may be replaced by a link.

The 2N3055 'series pass' transistor is much larger than required. We have specified this device as it provides very good overload capability and is readily available at low cost (under £1.00 from many suppliers).

The mains operated version is complicated only by the addition of a power transformer, diode bridge, and a smoothing capacitor. The 1N4001 diode used to protect against reverse polarity is obviously not required. Operation is otherwise as described above.

The mains-operated version is larger than the simple 12 volt operated unit. This unit should be constructed using tag strips or matrix board.

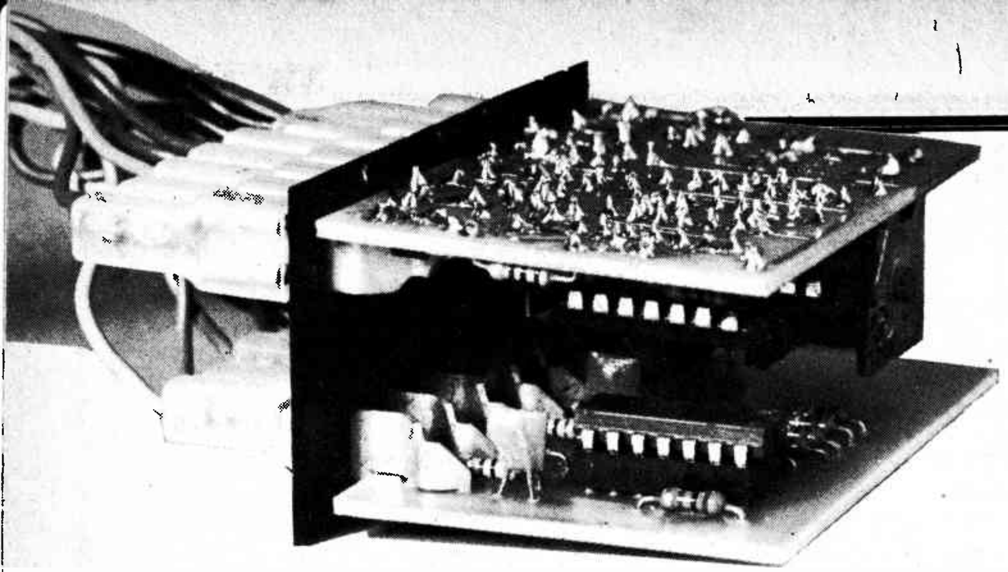
A layout showing tag strip construction is shown in Fig 2. The completed unit, when finished, should be mounted in a suitable box.

The units in use

Both units have been designed so that they will not be damaged if the output is accidentally short circuited. Nevertheless a continual short circuit must not be applied as this will cause excessive heat to be generated within the 10 ohm resistor.

If the appliance already has a socket for an external power supply this will almost certainly be of a type in which the plug cannot be accidentally shorted. If no socket is fitted then an external power supply socket should be installed. Standard plug/sockets for this purpose are readily available from most parts suppliers, but note that plugs/sockets intended for nine volt use are not interchangeable with those intended for six volt use — the centre pins are of different diameters.

The socket should be of the type which has a contact for disconnecting the internal battery when the power supply is plugged in. ●



A straightforward, low cost design, with a number of sophisticated features, that should protect your car from unwelcome attention.

CAR ALARM

THERE IS ONLY ONE way to ensure that you never have a car stolen and that is not to be stupid enough to buy one in the first place. However accepting the fact that many of us will feel the need to own a car how do we ensure that it remains ours amongst the ever increasing crime levels in this country? Well you could do worse than to fit the alarm system described here. Not only does this system protect the car itself, monitoring all doors and disabling the ignition when set, but also offers protection to the car's accessories.

The alarm provides an entry and exit delay before the horn is sounded, this means that there is no need to fit an external lock switch to the car. When leaving, the concealed alarm switch is activated whereupon the owner has 30 seconds before the alarm is set. On entry a 15 second delay is provided.

When triggered the system will sound the horn intermittantly for two minutes before resetting. However, if the initial cause of the alarm is still present, the alarm will retrigger.

The alarm provides for both active high and active low inputs allowing all types of sensor to be employed.

An additional accessory protection module provides an independent monitor of the car's accessories.

Construction is quite straightforward. The use of ¼" tab connectors will allow the unit to be readily fitted and removed from any car. These connectors should be fitted first. The rest of the components can then be fitted as shown in the appropriate overlay. Note that any polarity sensitive device is mounted in the correct position. The main board's jumper should be fitted when construction is complete. If your car's horn has one wire coming from it fit jumper A, if it has two wires with one going to earth also fit jumper A. If the horn has two wires neither going to earth, fit jumper B.

With construction complete the PCBs can be glued into the housing chosen for the alarm.

Installation of the alarm in the car must be left up to the constructor. The overall interconnection diagram is shown and it should be clear how to proceed in general. The detailed installation will however vary widely from car to car. ●

BUYLINES

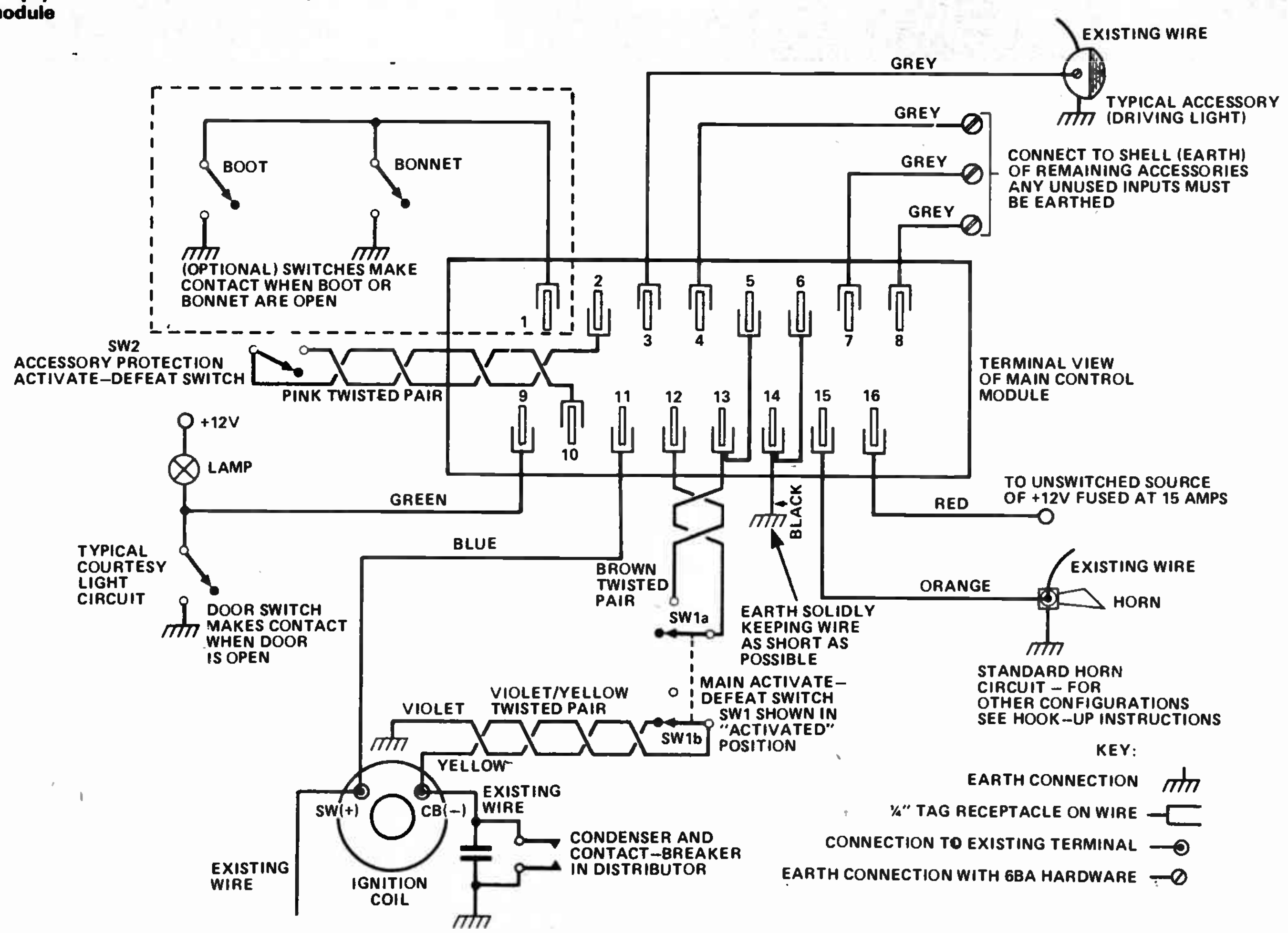
A kit of parts for this project is available from the designers, Compu-Tech Systems of Laundry Loke Estate, North Walsham, Norfolk (Tel: 06924-5189), for £14.75. They can also supply the (copyright) PCBs separately for £1.25 each.

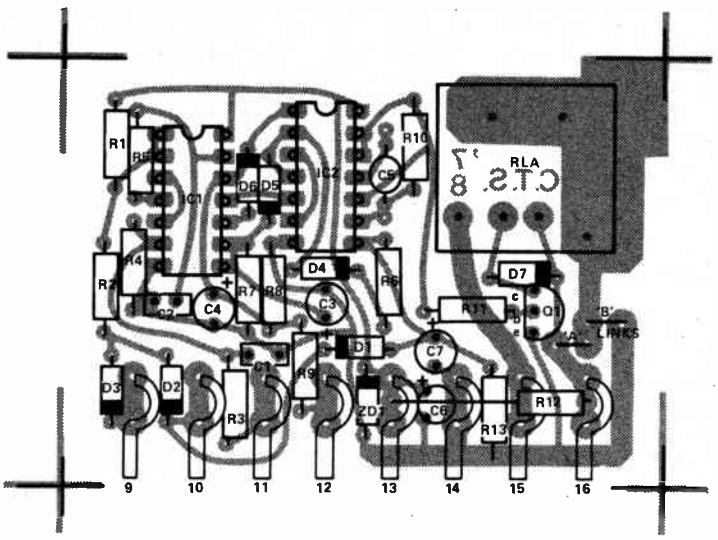
If you want the complete kit, which includes the add-on Light Flasher and Siren Driver featured in the April '80 ETI, it will cost £29.95.

PARTS LIST

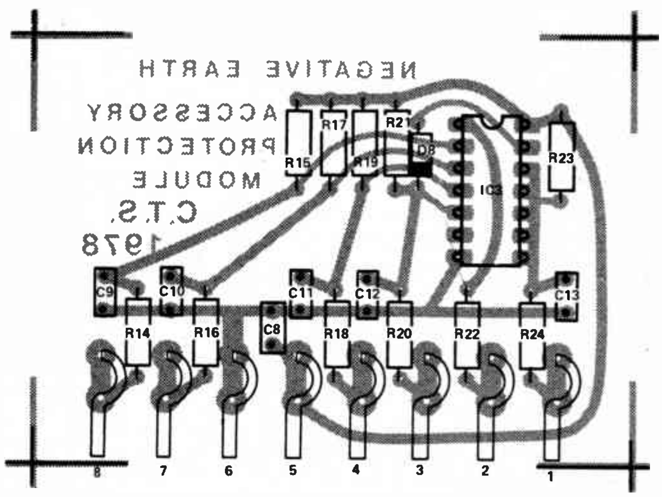
RESISTORS (All ¼W 10%)	
R1,9	1k0
R2	100R
R3	1M0
R4,5,7,8,10	10M
R6,11	4k7
R12	47R
R13	4M7
CAPACITORS	
C1,2	10n ceramic
C3	15u 16 V tantalum
C4,6,7	4u7 16 V tantalum
C5	47n polyester
SEMICONDUCTORS	
IC1,2	4001
Q1	BC337
D1-7	1N4148
ZD1	15 V 400mW
SWITCH	
SW1	DPDT
RELAY	
RLA	12 V 85R with 15A contacts
MISCELLANEOUS	
PCB as pattern, connectors, case to suit, cable, etc.	
RESISTORS	
R14,16,18,20	10k
R15,17,19,21	100k
R22,24	100R
R23	1k0
CAPACITORS	
C8-13	10n ceramic
SEMICONDUCTORS	
IC3	4002
D8	1N4148
SWITCH	
SW2	SPST
MISCELLANEOUS	
PCB as pattern, connectors, cable, etc	

Interconnection diagram for the car alarm units. If the accessory module is not fitted simply omit all wire connected to that module

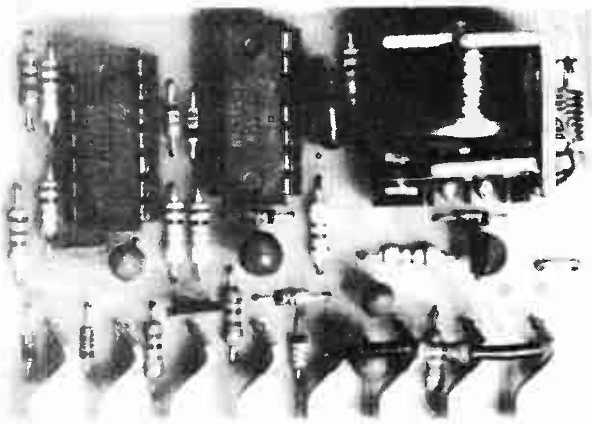


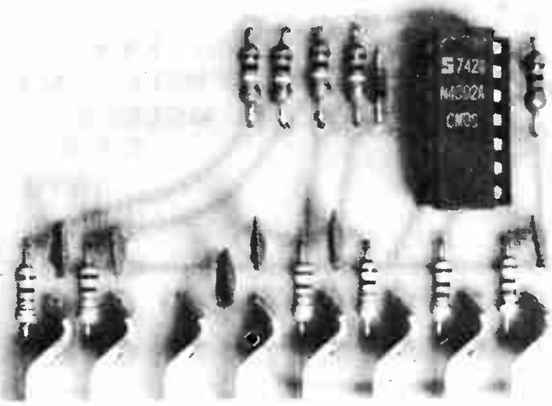


Overlay for main control board.



Overlay for the accessory protection board.





HOW IT WORKS

In the quiesent state with the alarm defeated via SW1 the following logic levels are present at the outputs of the gates indicated. IC1a-0, IC1b-1, IC1c-0, IC1d-0, IC2a-1, IC2b-0, IC2c-0, IC2d-1, transistor Q1 is cut-off, and RLA is de-energized. R12, ZD1 and C6 form an overvoltage and electrical noise suppression circuit that protects the power supply rail of the circuit from spikes and battery overvoltage. The input of IC1a is held at logic 1 by pull-up resistor R1. R2 protects the input of IC1a from noise spikes.

If an earth appears at the inputs taken to D2 and D3 the logic 1 normally present at the input of IC1a changes to logic 0 which is inverted to a logic 1 by IC1a and connected to pin 5 of IC1b. D2 and D3 isolate the two inputs from each other. The input at D2 has a special function which is explained at the end of the text. Pin 6 of IC1b is held at logic 0 by pull-down resistor R4. R3 and C1 form a noise suppression circuit for this input. If this input goes to +12 volts a logic 1 will be present at pin 6 of IC1b. Thus under normal conditions both inputs of IC1b are at logic 0 and in any alarm condition the input (s) will be at logic 1. Any logic 1 at the input of IC1b will force its output to logic 0. R5 and C2 form another noise suppression circuit to increase the noise immunity and prevent any noise spikes from reaching pin 13 of IC1c.

Whenever SW1 is in the DEFEAT position a logic 1 is present at pin 12 of IC1c and pin 1 of IC2b. This logic 1 is buffered by R9 (spike protection). With a logic 1 at pin 12 of IC1c the output of this gate will remain logic 0 and ignore the input at pin 13. The vehicle's ignition system works normally with SW1 in the DEFEAT position. By placing SW1 in the ACTIVATE position an earth is placed across the contact breaker and the vehicle's ignition system will be disabled. Also when SW1 is in the ACTIVATE position the logic 1 is removed from R9 and C4 will begin to discharge through R8: D6 prevents C4 from discharging into IC1d.

In approximately 30 seconds C4 will have discharged to the threshold of IC2b pin 1 and IC1c pin 12 and a logic 0 will now be present at these points. The logic 0 present at pin 12 of IC1c will enable it and any alarm condition sensed by the inputs will be reflected by a logic 1 being present at the output of IC1c which is passed to IC2a pin 5. The 30 second delay after SW1 changes state to the ACTIVATE position and IC1c being enabled is the EXIT delay.

IC2a and IC2b form a set-reset flip-flop with the normal state as a logic 1 at pin 4 of IC2a. It is set by a logic 1 at pin 5 of IC2a (alarm condition) and is reset by a logic 1 at pin 1 of IC2b (defeated or timed reset/validate condition). Once the flip-flop changes state it can only be changed back again by applying a logic 1 to the opposing input. Thus even a momentary logic 1 at pin 5 of IC2a would latch the flip-flop into the alarm status and initiate the alarm sequence. A momentary logic 1 would be generated by opening one of the vehicle's doors and then closing it. When the flip-flop senses a logic 1 at pin 5 of IC2a it will change state and lock with a logic 0 at pin 4 of IC2a.

When the logic 0 appears at pin 4 two things happen: first C7 will begin to discharge through R13: D4 prevents C7 from discharging into IC2a. In approximately 15 seconds C7 will have discharged to the threshold of IC2c and a logic 0 will be present. With a logic 0 at pin 8 of IC2c the 1 Hertz astable multivibrator formed by IC2c, IC2d, R10 and C5 is enabled. Pin 10 of IC2c will alternate between logic 0 and logic 1 at a 1 Hertz rate driving Q1 in and out of conduction via R11. As Q1 goes in and out of conduction RLA energizes and de-energizes, closing and opening the contacts. These contacts are wired through jumper "A" or "B" providing a pulsating +12V or pulsating earth which is connected to the horn circuit sounding the horn and raising the alarm. The 15 second delay between the flip-flop changing state (alarm detected) and the horn beginning to sound is the ENTRY delay.

The second thing that happens when the flip-flop changes state is that C3 will begin to discharge through R7: D5 prevents C3 from discharging into IC2a. In approximately 2 minutes C3 will have discharged to the threshold potential of IC1d and a logic 0 will be present. IC1d inverts this to a logic 1 and presents it via D6 to pin 1 of IC2b resetting the flip-flop and to pin 12 of IC1c inhibiting the alarm condition (if present) from reaching IC2a. When the flip-flop resets a regenerative action takes place and begins to recharge C3 and C7. When C3 has charged past the threshold of IC1d a logic 0 will be present at its output and IC1c will be enabled in a few seconds as the small charge placed on C4 prior to the regenerative action will have discharged through R8. If the alarm is no longer present C3 and C7 will completely charge and the alarm will reset and wait for another intrusion. If the alarm condition is still present the flip-flop will again latch and the small charges that developed on C3 and C7 will discharge through R7 and R13 respectively in a few seconds. Thus every two minutes the alarm will reset itself for approximately 3 seconds and then start over again.

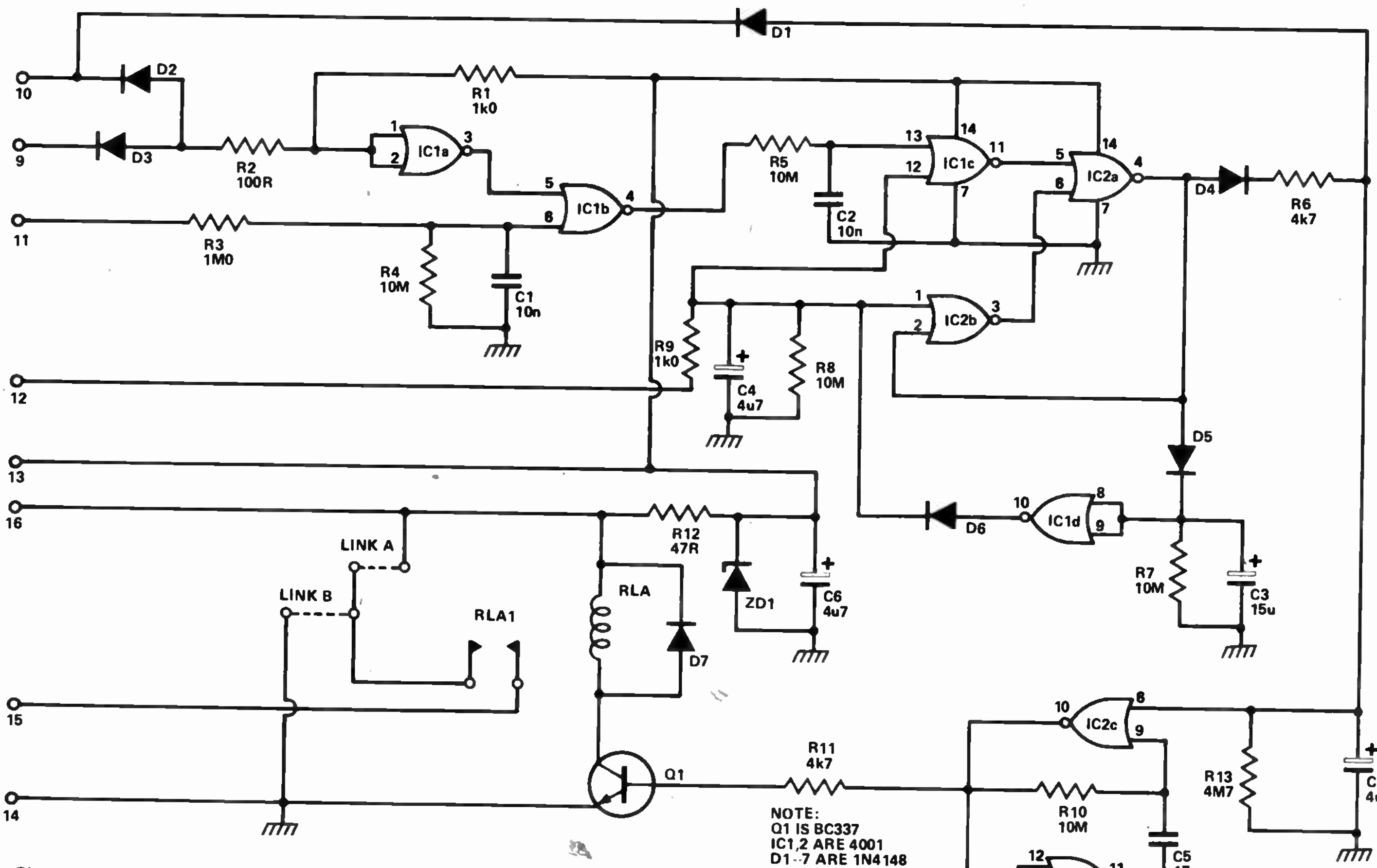
This cycle is the RESET/VALIDATE cycle and is provided to prevent the battery from being completely dicharged by a momentary intrusion. The input to D2 is a special function input and is for use with the accessory protection module. When this input goes to earth C7 is immediately discharged via D1 and the alarm will begin to sound. R6 prevents IC2a from being destroyed by the pull-down action. This earth is sensed by IC1a and will latch the alarm (providing the exit delay cycle is complete). This input is verified by the RESET/VALIDATE cycle in the manner described above. The main ACTIVATE/DEFEAT switch SW1 does not affect this input making it completely independent of the main system.

Accessory Protection Module — Theory of Operation

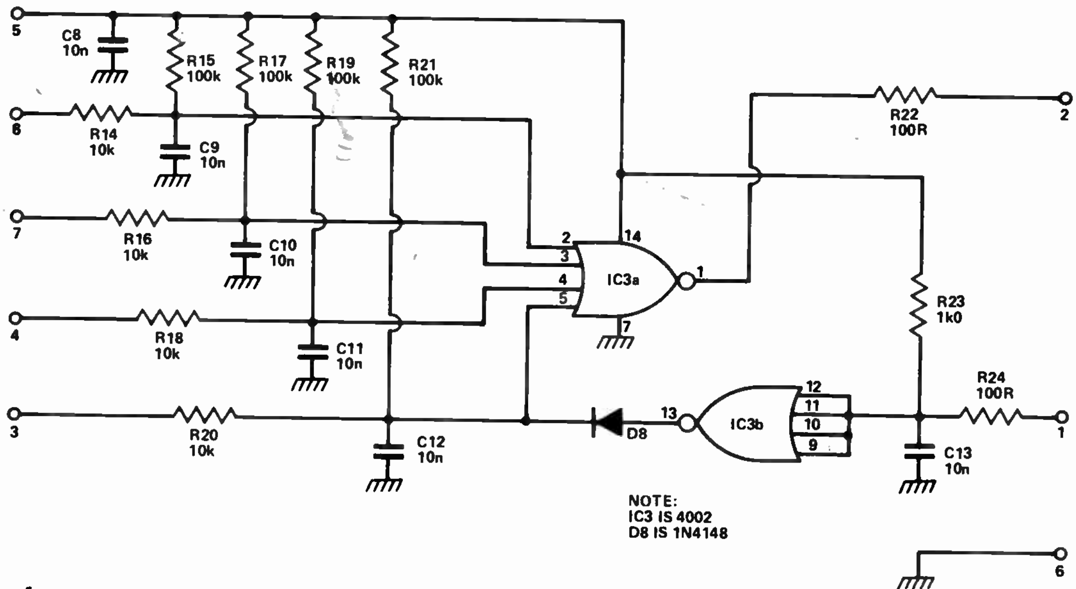
In the quiesent state IC3a output is logic 1 and the output of IC3b is logic 0. Under normal conditions, i.e. no alarms sensed, all inputs to IC3a will logic 0 (sunk to earth via R14, R16, R18, R20 and the sense wires). The input to IC3b will be open or at +12 volts. R23 being the pull-up resistor for an open circuit, R24-C13 are noise suppression components. C8 bypasses any noise present on the supply rail to earth. If any of the sense wires open R15, R17, R19, or R21 will pull the respective input to logic 1. C9 through C12 in conjunction with R14, R16, R18, R20 form a noise suppression circuit for these inputs. Any logic 1 present at IC3a inputs will result in a logic 0 at the output which is connected via buffer resistor R22 to the unit's output. This is connected through ACTIVATE/DEFEAT switch SW2 to the main control unit. SW2 has been provided to make the accessory protection system independent of the main system and will normally be activated continuously.

An earth at the active low I/P will force the output of IC3b to logic 1. This logic 1 is coupled via D8 to IC3a forcing pin 5 to logic 1 regardless of the status of the sense wire: this will result in a logic 0 at the output of IC3 as explained above. D8 is provided so that IC3b can only force pin 5 of IC3a to logic 1, it cannot force it to logic 0.

Any time a logic 0 is present at terminal (1) and SW2 is in the activate position the alarm will sound immediately as explained in the description of the main control unit.



Circuit diagram of main control board.



Circuit diagram of accessory protection board.

MICROAMP

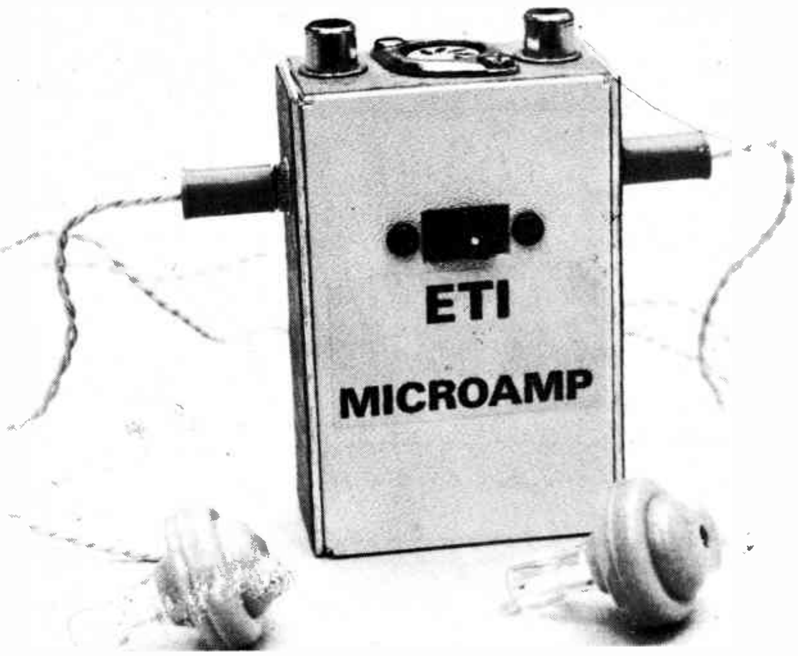
This project is very cheap, very small, very easy, and very useful. Build one today!

THERE IS OFTEN A NEED for a piece of equipment which can give a reliable answer as to another unit's state of being. In audio, for instance, a repaired amplifier might need to be tried without risking a pair of expensive monitor loudspeakers, or even headphones (which are worth a few bob themselves these days!).

Crystal Clear Sound

Our micro-amp is designed to be a portable stereo test amp, capable of betraying any faults or distortions inherent in the suspect unit. The transducers utilised are low-cost crystal earpieces, for which the design has been optimised. Although there are only a handful of components in the design, the amp gives exceptionally good sound quality suitable, say, in checking whether that cassette deck in 'Rip-Off Hi-Fi' has 1% or 100% distortion.

Quality is ultimately limited by the earpieces, but they are capable of doing better than the two-transistor 'Super-Squawk' portable radios to which they are more usually mated.



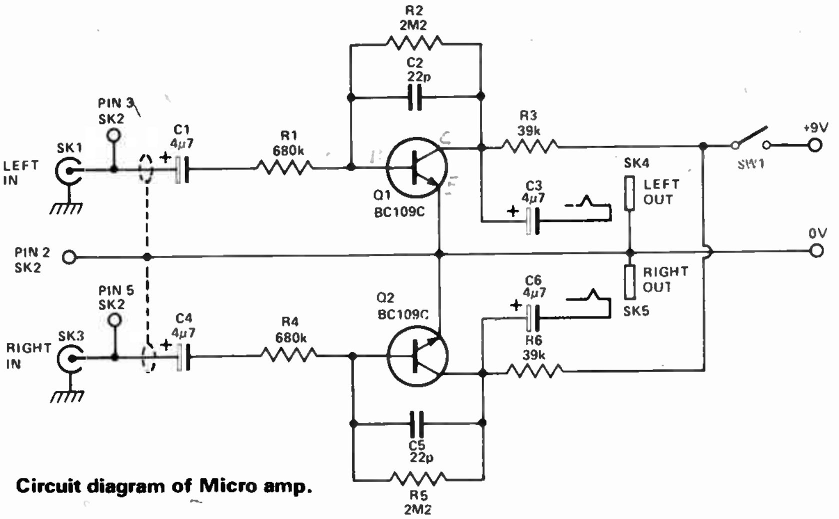
View of completed Micro amp

In and Out and In . . .

In the prototype, sockets were provided for a 'tape input' type of signal, i.e. from a cassette recorder at the DIN socket pins 3 and 5. If a signal is to be input from a tuner or amplifier, either use the phono sockets

BUYLINES

There should be no problems with anything used in this project. Crystal earpieces are available from all the major mail order companies, as indeed are all the other components.



Circuit diagram of Micro amp.

HOW IT WORKS

Q1 and Q2 are base biased single stage amplifiers. The feedback capacitors C2 and C5 are there to provide high frequency correction, and experimentation with the value will change the resultant sound quite noticeably.

C1 and C4 decouple the input from preceding circuits, and the resistors R1 and R4 will set the level seen by the amplifier, and hence by the earpieces. No volume controls are provided, as none proved to be necessary with the prototype. C3 and C6 serve to decouple output from dc. Crystal earpieces only are recommended.

or pins 1 and 4 so that you keep things standard.

Input level is ideally around 100 mV; if vastly different to this, R1 can be juggled in value to compensate. Increase if the level is higher.

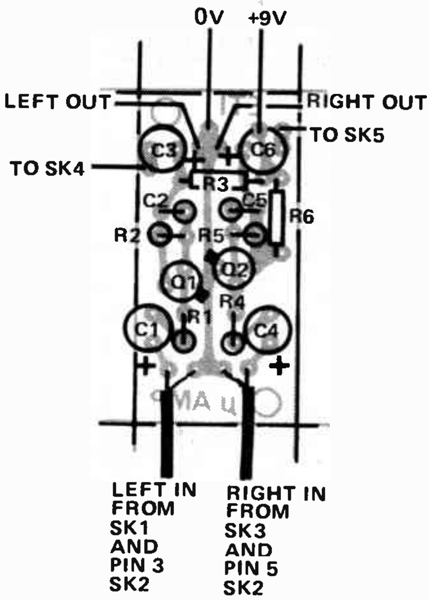
As seems to be usual for us nowadays, space within the box is very restricted, but it *will* go into the case if you take some care over the layout. Perhaps our photographs will help.

Power and Construction

A PP3 is all that will fit into our box and is all that is needed. Current drain is around 300 uA (hence the name!) and so even this will have a life-span approaching that which it *would* have enjoyed had you left it sat sitting merrily on a shelf.

The PCB is smaller than most, so take care when soldering it up: too long with the iron in one place, and the track will become emotionally attached to the bit, and not wish to leave it!

BC109Cs must be used to give a high enough output from the specified input. Surplus transistors will obviously work, but don't blame us if the sound is bad! ●



Component overlay of Micro amp.

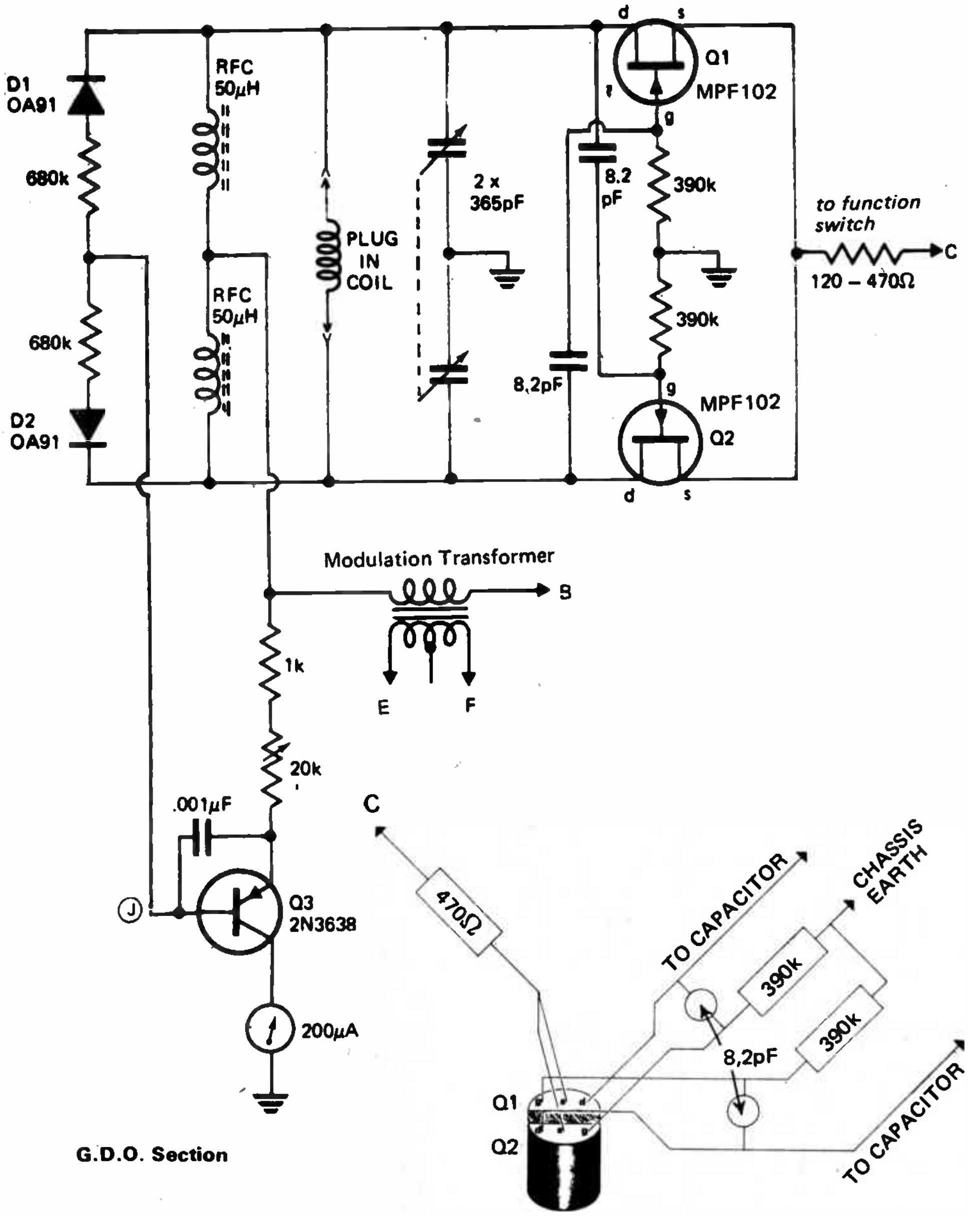
PARTS LIST

RESISTORS (all ¼ W 5%)	
R1,4	680 k
R2,5	2M2
R3,6	39 k
CAPACITORS	
C1,3,4,6	4u7 tantalum
C2,5	22 p polystyrene
SEMICONDUCTORS	
Q1,2	BC109 C - see text
SWITCH	
SW1	On-off rocker, or slide type
SOCKETS	
SK1,3	Chassis phono sockets
SK2	Chassis 5 pin DIN 180° socket
SK4,5	3.5 mm chassis jack socket

MISCELLANEOUS
PP3 battery, clip to suit,
Miniature screened wire flex
Nuts, bolts, spacers etc.
PCB as pattern
2 off crystal earpieces with 3.5 mm jack plugs,

Case 3" × 2" × 1"

VERSATILE GDO



G.D.O. Section

GRID DIP OSCILLATORS are commercially available, but most are either expensive (£30 upwards) or have various performance failings — in particular frequency variations with different potentiometer settings and a very large amplitude variation across the dial.

This unit does not suffer from either problem.

It is unique in that if it is switched to 'Diode', the oscillator is switched off — if it is now brought near an oscillating tuned circuit the unit will not only indicate oscillation but in the 'Dip' position the unit will oscillate at exactly the same frequency as the external oscillating tuned circuit. (This facility has hitherto only been possible with valve GDOs.)

Another most useful facility is that the frequency of prototype tuned circuits can be speedily checked by connecting the coil to a spare plug, plugging it into the GDO unit and then measuring the frequency on a digital frequency meter.

Modulator

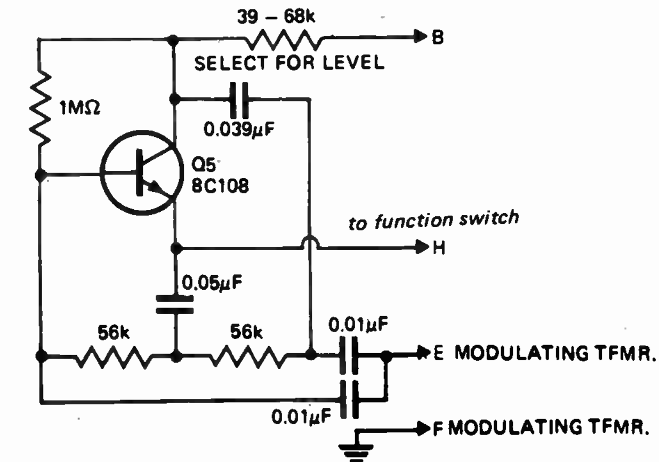
The low-level modulator provides AM and very slight FM. The AM level is about 5%, quite adequate for most applications. If the DC resistance of the primary winding across EF is too low (less than 50R), the circuit may not oscillate. The circuit is switched on by connecting "H" to ground via the function switch.

The alternative high-level modulator modulates over 100%. Connect EF across the low impedance side of the transformer.

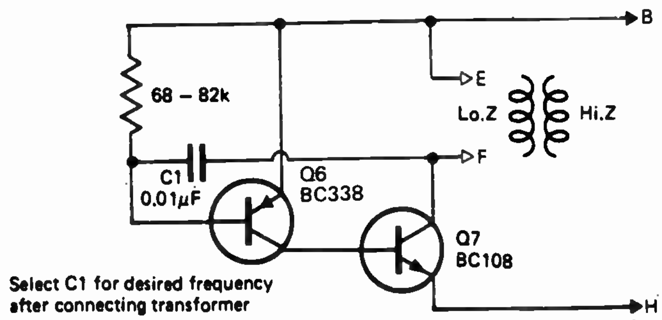
Crystal Checker

Useful range of this section is 2-20 MHz. When (if) the crystal oscillates , diodes D5 and D6 rectify the waveform and apply a turnoff bias to the base of Q3.

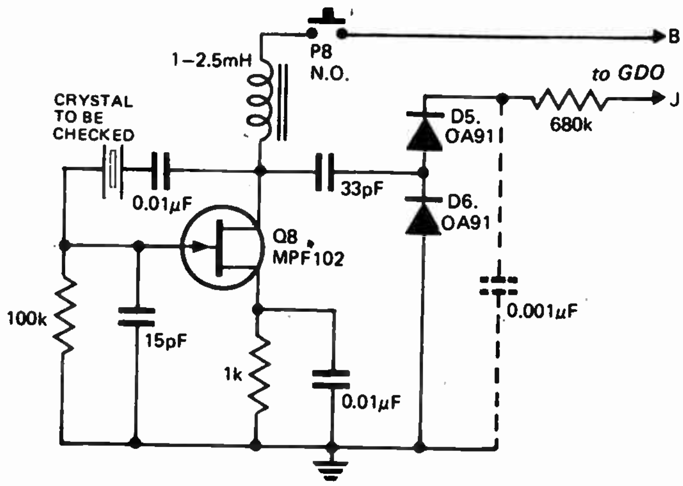
To use this facility the GDO section is switched to "DIP" and the



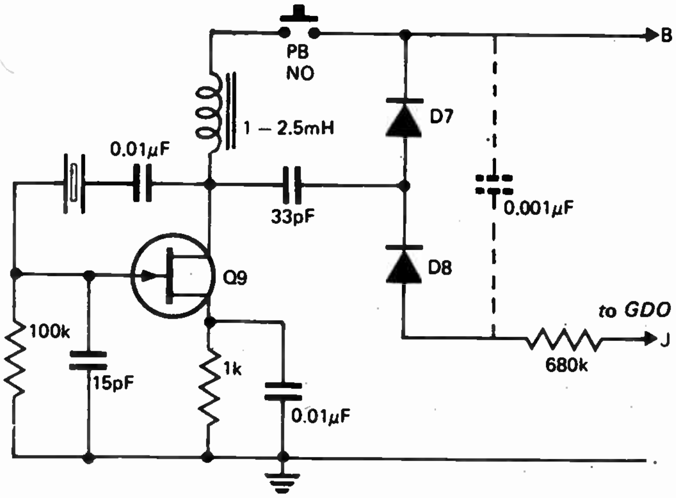
Low-level modulator (~5%)



High-level modulator (~100%)



Crystal checker.



Alternative connection for diodes in crystal checker for forward meter reading with GDO in 'diode' position. Capacitor shown in dotted lines, may not be needed.

coil is removed, (although this is not essential). Unplugging the coil causes the circuit to oscillate at VHF and a bias is generated turning on Q3. If the pushbutton on the crystal checker is depressed, the circuit will oscillate at the crystal's fundamental frequency and diodes D5 and D6 will generate a voltage opposing that generated by D1 and D2 and the needle will dip.

If it is desired that the reading be made in the forward direction, the alternative connection for the diodes can be made and the GDO function switch set to the "DIODE" position.

Note, however, that with this device crystals will be oscillating in their fundamental mode, and sometimes a crystal that will not operate in any other circuit will still operate in this circuit.

Power Supply

The power supply regulates the voltage supplied to the oscillator. This ensures long term stability.

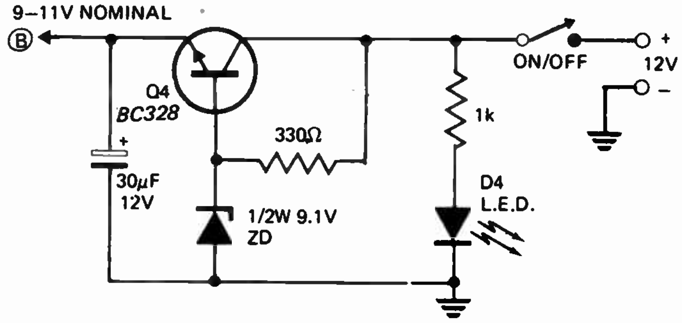
Construction Notes

The meter section should be left as is and not converted to NPN as many may be tempted to do.

The more sensitive the meter the better but an ordinary 0-200μA edge type uncalibrated meter is suitable. A 0-1 mA is satisfactory up to about 40 MHz. Use thick wire or brazing rod from capacitors to coil socket.

The modulation transformer is from the junk box. It should be a miniature type — one side centre tapped — both sides should have fairly high DC resistance. Some work better than others. If more than one is available try them all.

Two versions of the basic circuit



Power supply.

have been built, one — as shown — using 0-365 pF and another version using 0-15 pF dual gang capacitors.

If the device will not oscillate reliably, increase the 8.2 pF capacitors to 12 pF or so, and the RF chokes to about 100μH (for use below 15 MHz).

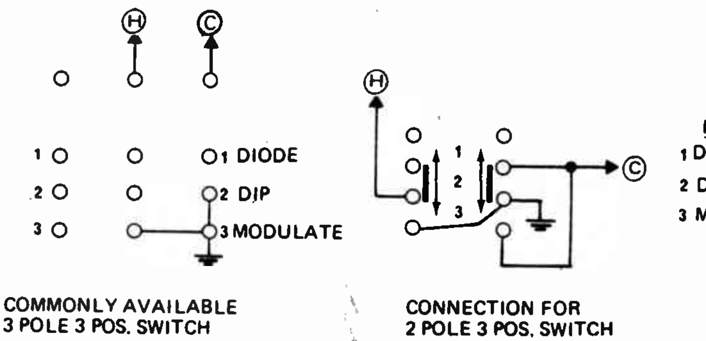
If the oscillator does not start instantly, pull the coil out. The unit should now be oscillating at VHF. If not, double check connections and check the earth on capacitors.

The two FETs, 8.2 pF capacitors and two 390 k resistors are assembled as shown, and mounted directly on the capacitors. Keep leads from capacitors to coil very short.

Note that even if the unit is assembled in a metal box, with only the coil protruding, it can cause severe TVI at distances up to 100 metres (on the fundamental frequency).

Harmonic content is low but nevertheless there is some, the strongest appearing at 3 f. FM deviation is very slight but can be useful on harmonics due to the multiplier effect.

Wiring Up The Function Switch



Two different function switches are shown. The one on the left is a three-pole three-way device, that on the right is a two-pole, three-way device.

HEADLIGHT DELAY

Use your car headlights to give post-parking illumination with this simple unit.

THIS SIMPLE LITTLE UNIT lets you use your car head or spot lights to illuminate your pathway for a pre-set period of about 50 seconds after you have parked the vehicle. At the end of this period the unit turns the lights off automatically.

The unit thus enables you to avoid walking into dustbins or tripping over junk that may be obstructing your private driveway, and helps you avoid stepping into various nasty bits that may be lying on the public sidewalk. The unit is easy to install in the vehicle.

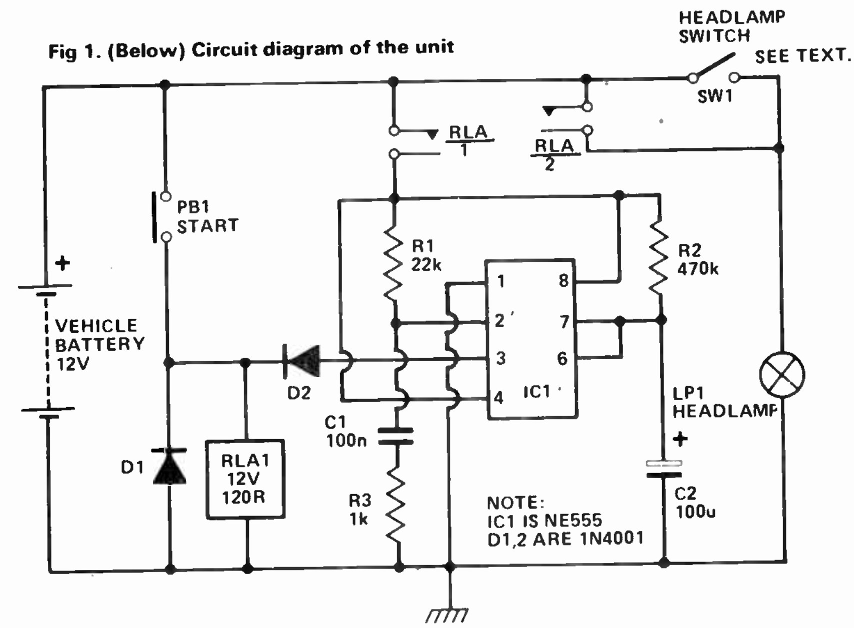
Construction and Use

Construction of the unit should present no problems at all. The relay can be any 12V type with a coil resistance of 120 ohms or greater, and with two or more sets of N.O. contacts that are rated at 3 amps or greater.

When it comes to installing the unit, note that two methods of connection to the vehicle are possible. On some vehicles the headlight switch is connected directly to he battery so that the headlights operate even when the ignition is turned off (see Fig 2a). In this case take connection 4 of the 5-way terminal block directly to the live side of headlamp switch SW1, and connection 5 to the headlamp side of SW1.

The alternative connection is shown in Fig 2b. Here, the headlight switch is wired in series with the vehicle's ignition switch, so that the headlights only operate when the ignition is turned on. If your vehicle uses this type of connection, take connection 4 of the 5-way terminal block to the live side of the ignition switch, and take connection 5 to the headlamp side of SW1. ●

Fig 1. (Below) Circuit diagram of the unit



HOW IT WORKS

The unit is designed around a type-555 timer with a relay output. The relay has two sets of normally-open contacts. Normally, START switch PB1 and the relay contacts are open, so zero power is fed to the timer circuit and (assuming that HEADLIGHT switch SW1 is open) the headlights are off. Circuit action is initiated by briefly closing push-button switch PB1.

When PB1 is momentarily closed power is fed directly to the relay coil, and the relay turns on. As the relay turns on contacts RLA 2 close and apply power to the headlights and contacts RLA 1 close and apply power to the timer circuit, but pin 2 of the IC is briefly tied to ground via C1 and R3 at this moment, so a negative trigger pulse is immediately fed to pin 2 of the IC and a timing cycle is initiated. Consequently, pin 3 of the IC switches high at the moment that the relay contacts close, and thus locks the relay on irrespective of the subsequent state of switch PB1.

The 555 is wired as a one-shot timer or monostable with a timing period of about 50 seconds (determined by R2 and C2). Thus, the relay and headlights are held on for the duration of this 50 second timing period. At the end of the timing period pin 3 of the IC switches to the low state, so the relay turns off and contacts RLA/1 and RLA/2 open, removing power from the timing circuit and the headlights. The operating sequence is then complete.

BUYLINES

With the small number of components involved, it would be surprising if there were any problems in obtaining them.

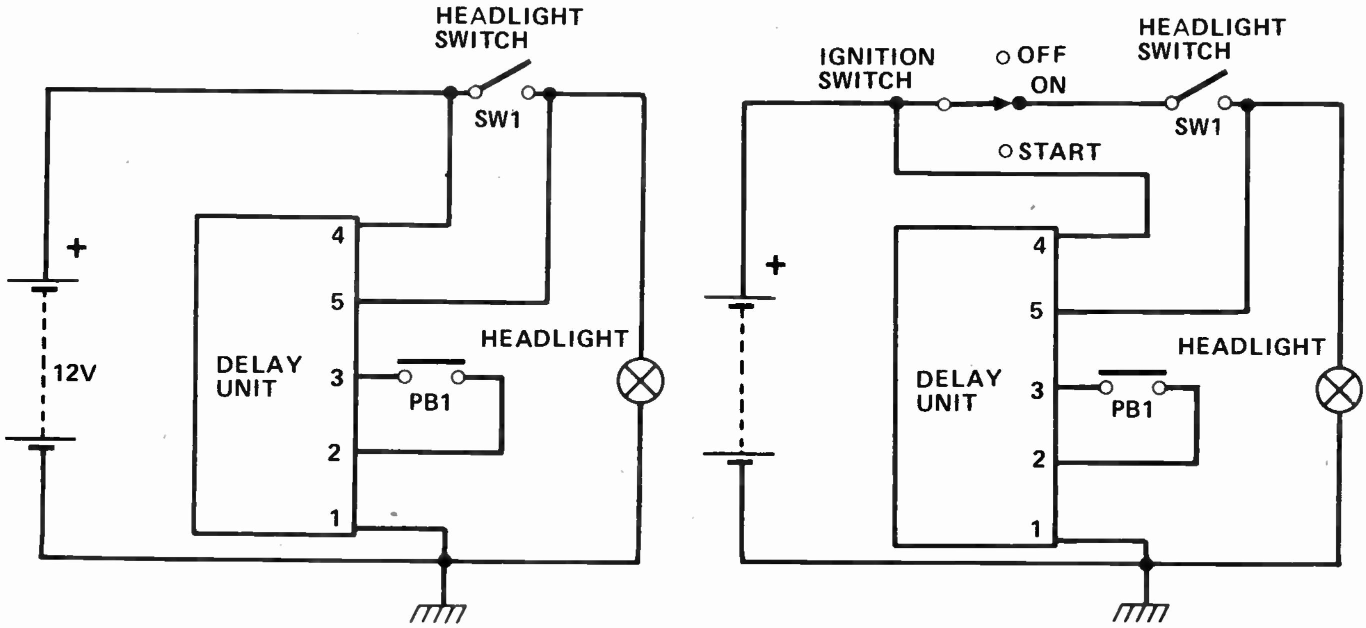


Fig. 2. (Left). Connection of the delay unit to a car system where the headlights are independent of the ignition switch. (Right), connection to all other systems!

PARTS LIST

RESISTORS (All ¼W 5%)

R1	22k
R2	470k
R3	1k0

CAPACITORS

C1	100n polyester
C2	100u electrolytic

SEMICONDUCTORS

IC1	NE555
D1, 2	1N4001

MISCELLANEOUS
Relay rated at 3A 2 pole c/o Coil 120R SPST push button 5 way terminal Block rated at 5A Die-cast case

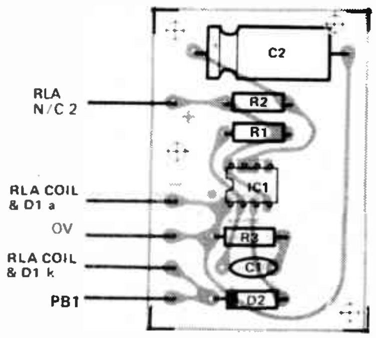


Fig. 3. Component overlay for the delay unit.

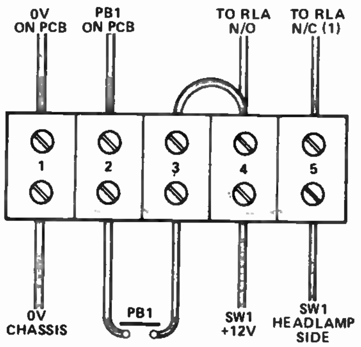


Fig. 4. Wiring of the delay unit to a 5 terminal connection block.

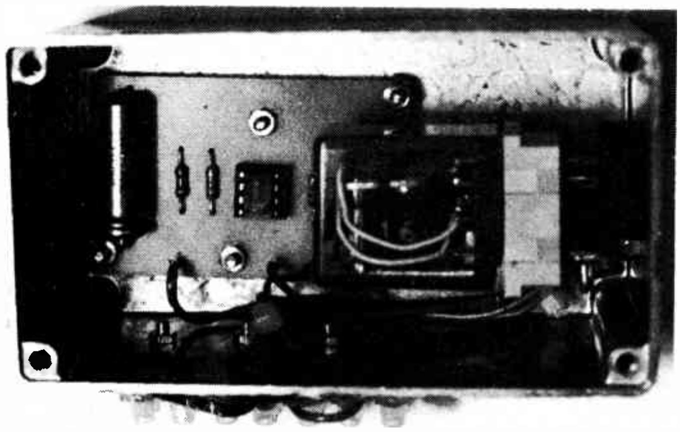
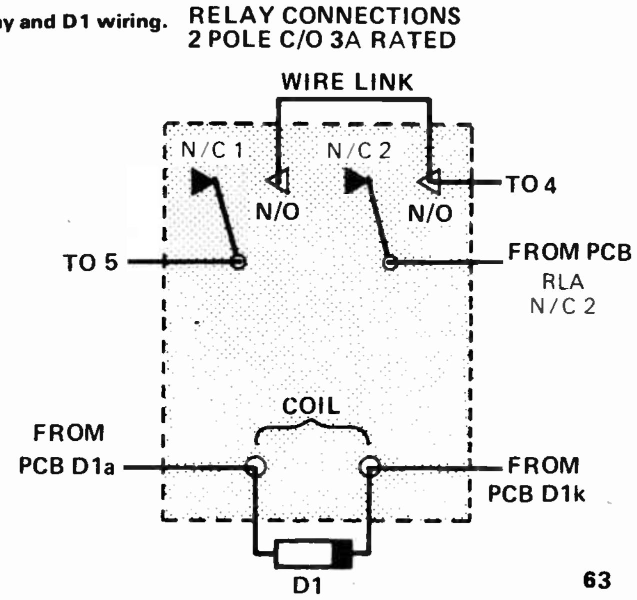
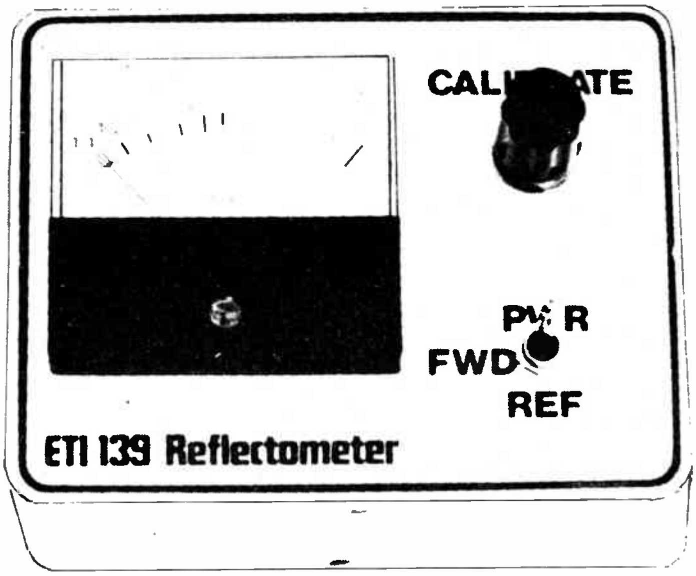


Fig. 5. The relay and D1 wiring.



RF POWER METER

Take a load off your mind — and put a proper and useful load on your antenna — with the ETI Project Team's venture into the realms of the short and shorter wave.



THIS REFLECTOMETER design, apart from being simple, elegant and easy to construct, covers three decades — from 100 kHz to 100 MHz, and can be constructed for RF powers as low as 500 mW or up to 500 watts.

Construction

Construction is very straightforward. The printed circuit design given is recommended, as variations in layout may affect performance.

All the components are mounted on the *copper side* of the PCB, which is subsequently assembled onto the coax sockets and mounting bolts.

Commence by winding the toroid current transformer secondary turns. Refer to the circuit diagram. Cut a 45 mm length of RG58, stripping back the braid and insulation as illustrated in the component overlay and photographs. This is not all that critical, but maintain as much braid as you can to reduce problems with errors creeping in at the top end of the frequency range due to discontinuities here.

Slip the toroid over the short length of coax and mount this assembly on the PCB. Position the toroid centrally and fix it in place with a small amount of pliable plastic cement compound.

Mount all the other components next. Pay particular attention to the orientation of the diodes D1, D2, D3.

The trimmer capacitor, C2, is shown as a mica compression type. Any suitable trimmer — such as the Philips film trimmers — can be used, however, the mica compression trimmer provides a certain amount of 'vernier' adjustment.

The PCB and major components are assembled into a suitable metal box.

The completed PCB is mounted in the following way:

Once the coax sockets are mounted, and the two mounting bolts are in position, a coax plug (with cable) should be plugged into each of the sockets in order to locate the centre-conductor pins of each socket.

The PCB is then placed into position and the input/output pads soldered to the coax socket pins. Make sure that a good fillet of solder secures the pin to the PCB pad.

Two nuts on the mounting bolts, one under the PCB, one on top of the PCB, then secure the board mechanically as well as providing a ground connection. Refer to the pictures and components overlay.

Connections to the meter, pot, and switch — located on the front panel, can then be made with short lengths of hookup wire.

Calibration

A suitable RF source, a dummy load and an RF voltmeter or a known-accurate RF power meter are required for test calibration of the instrument. Any of the standard amateur texts (ARRL, RSGB handbooks etc) provide excellent construction details of dummy loads to dissipate a variety of powers. The same texts describe suitable RF voltmeter probes that may be used in conjunction with a multimeter.

SWR Scale

The instrument is connected between the RF source and the dummy load. Turn the sensitivity control fully anticlockwise. Switch to read forward power.

Key the RF source and slowly rotate the sensitivity control clockwise. The meter reading should increase. If it doesn't, check wiring. If it goes in reverse, you've got D1 back to front!

If all is well, advance the sensitivity control until the meter reads full scale. Switch to read reverse power. Adjust the trimmer C2 to obtain a minimum meter reading. It should go to zero; increase the sensitivity when a very low reading is reached to ensure that C2 is adjusted correctly.

This completes the adjustment of the Reflectometer section. The scale calibration can be obtained from Table 1.

Power

The circuit (Fig. 1) shows a divider network, consisting of R5 and R6, tapped across the RF on the coax line.

The lower divider resistance R6 is shown as a variable element. A miniature deposited carbon track trimpot was used in the prototype. The low value types seem to perform quite well over a wide frequency range and one was used here for convenience. It was set so that the full-scale reading of M1 corresponded to a particular peak power dissipated by the dummy load (as measured with an RF voltmeter or known-accurate RF power meter).

Fixed resistors may be substituted for a trimpot, necessitating only a check of the accuracy of the full scale peak power reading. Values for particular full-scale power readings are given in Table 2.

The power scale should be calibrated to suit the individual instrument. It will be non-linear, particularly at the bottom end.

Performance

The impedance discontinuities introduced by the prototype are well inside the basic accuracy capability of the meter movement! The real part of the instrument's impedance is within 5% of the nominal 50 ohms — most of this is probably due to connectors and construction discontinuities.

The variation in the real part of the impedance is within ± one ohm across the frequency range of the instrument, and can be essentially ignored.

The reactive (imaginary) component of the instrument's inherent impedance is negligible up to 20 MHz when it begins to become slightly capacitive.

The overall impedance decreases rapidly above 100 MHz.

Sensitivity and sensitivity bandwidth of the prototype is excellent. The half-power points of the sensitivity bandwidth of the reflectometer are at approximately 350 kHz and 25 MHz.

Full-scale deflection at 27 MHz requires 0.8 watts into 50 ohms. Mid-band sensitivity is under half a watt!

References

Whilst not the 'definitive' texts on this type of reflectometer, these two references provide good practical sources of information.

1. "Frequency Independent Directional Wattmeters"; P. G. Martin, Radio Communication (RSGB journal), July, 1972.
2. "Test Equipment for the Radio Amateur"; H. C. Gibson G8CGA, published by the RSGB, 1974.

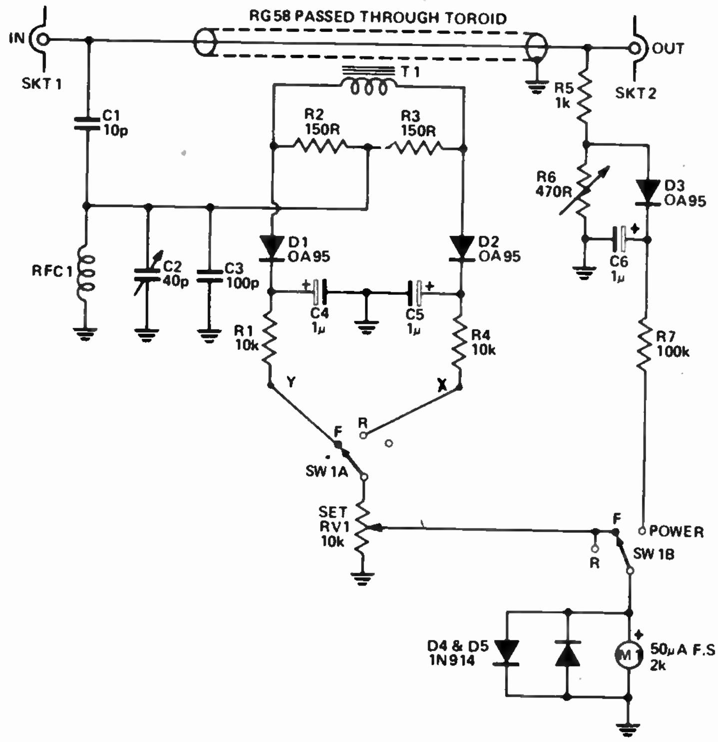


Fig.1. Circuit diagram of the SWR power meter. Note the unusual switch configuration, using a double pole three way switch.

BUYLINES

As with all RF projects, some of the components will not be stock items with the majority of suppliers.

In case of difficulty with any of the items Catronics at Communications House, 20 Wallington Square, Wallington, Surrey should be able to help.

HOW IT WORKS

The reflectometer employs a "current transformer" having an electrostatically-shielded primary with a high-ratio secondary winding driving a low value load resistance.

A short length of coaxial cable, passed through a ferrite toroid, forms the primary with the braid connected so as to form an electrostatic shield.

The secondary of the current transformer consists of a winding around the circumference of the toroid, coupled to the magnetic component of the 'leakage' field of the short length of coax cable.

The secondary drives a centre-tapped resistive load (R2/R3) connected to a voltage sampling network (C1-C2/C3) tapped across the RF input such that sum and difference voltages will appear across the ends of the current transformer (T1) secondary winding.

Diodes D1 and D2 rectify the sum and difference voltages from the secondary of T1, RF and audio (modulation) bypassing being provided by C4 and C5. The RF choke, RFC1, provides a low-resistance DC return for the signal rectifiers, D1 and D2.

The power measurement facility is obtained by tapping off a portion of the RF voltage on the line via R5 and R6, and rectifying this with D3. Capacitor C6 provides RF and audio (modulation) bypassing.

As the load on the rectifier is so light — R7 being 100 k and the meter being 2 k, peak power is measured.

Diodes D4 and D5 provide protection for the meter.

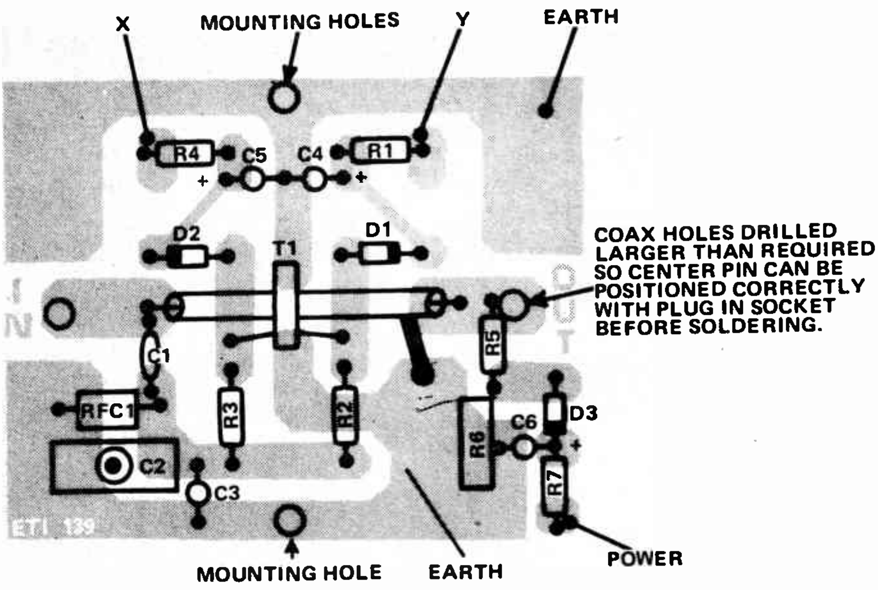


Fig. 2. Component overlay for the PCB. Note that, contrary to the usual practice, the components are mounted on the copper side of the board.

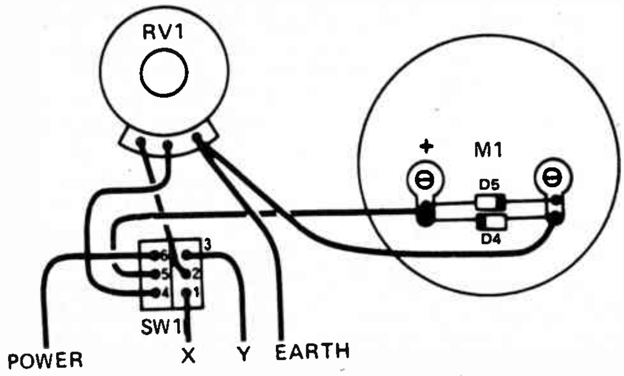


Fig. 3. The meter, sensitivity pot and switch connections. Leads X and Y go to R4 and R1 respectively, while the lead marked 'POWER' goes to R7. Refer to Fig. 2.

PARTS LIST

Resistors all ¼W, 5%
R1 . . . . . 10k
R2,R3 . . . 150R
R4 . . . . . 10k
R5 . . . . . 1k
R6 . . . . . 470R trimpot or fixed —see text
R7 . . . . . 100k

Potentiometer
RV1 . . . . 10k/C pot

Capacitors
C1. . . . . . 10p ceramic
C2. . . . . . 40p trimmer
C3. . . . . . 100p ceramic
C4 - C6 . . . 1u solid dipped tantalum

Semiconductors
D1 - D3. . . OA95
D4,5 . . . . 1N914

Miscellaneous
RFC1. . . . Any moulded RF choke, 1mH or more (value not critical).
SW1. . . . Two pole three way
M1 . . . . . 50 μA meter T.E.W. type 2k resistance.
T1. . . . . . 40 turns of 35 gauge B & S enamelled wire, around circumference of Neosid toroid type 28-511-31, 12.7 mm o.d., 6.35 mm i.d., 3.18 mm thick, F14 material (see text)
Coax sockets . . . SO239 or other type to suit
Case. . . . . (100 mm x 75 mm x 50 mm).

PC board . .
Two 25 mm long bolts with three nuts and two lock washers each; nuts and bolts for coax sockets (if required); length of RG58 coax; 6 mm dia. sleeving; hookup wire, etc.

TABLE 1

SWR	Scale reading
3:1	0.5 full scale
2.5:1	0.42 full scale
2:1	0.34 full scale
1.5:1	0.2 full scale
1.2:1	0.1 full scale
1.1:1	0.05 full scale

TABLE 2

Peak Power, full scale	R6 value
500 W	6R8
200 W	2 x 33R in parallel
100 W	33R
50 W	68R
20 W	2 x 330R in parallel
10 W	330R
5 W	680R
3 W	1k + 100R in series *

*linearity suffers

CLICK ELIMINATOR

Snap, crackle and pop is OK for breakfast but doesn't do much for your enjoyment of records. Here's a design to soothe damaged discs.

EVEN THE MOST fastidious of record collectors must have some records in his collection which during their career have picked up the odd scratch or two. Perhaps your record collection dates back to the time before you obtained that second mortgage, sold the wife or whatever, to get the latest in laser controlled, fluid damped, tangential tracking phonograms, sorry record deck, and the previous system has left its mark on these early platters.

In The Click Of Time

However the scratches got there, they are bound to be obtrusive on any reasonably hi-fi set up and even if you do not qualify for the title hi-fi purist — someone who listens, not to the music, but to the defects, real or imagined, in the hi-fi chain — the clicks will detract from your enjoyment.

Enter ETI — we can help. The click suppressor described here will remove or greatly reduce the audible transient sounds — nice phrase — resulting from scratches on a record's surface.

Design Decisions

When designing a click suppressor it is fairly obvious that we have to be able to tell the click from the cacophony as it were. Fortunately a click has several unique characteristics which set it apart from a music signal. For instance it will have very fast attack and delay times — even high frequency percussive sounds will delay slowly, although attack will be fast. A click will also be of a very short duration — again musical sounds are in general of a longer duration.

Once we have spotted our click, it is necessary to remove it. In our case we substitute a short period of silence — subjectively unnoticable — in place of the click.

As our click detection circuit requires a finite time in which to operate, we will also have to provide some sort of delay for the music signal within the system. Our circuit, and all the commercially available units, use a CCD delay line to provide this delay. It is the recent availability of this device that has made the click suppressor possible, or rather brought it within the financial reach of the constructor.

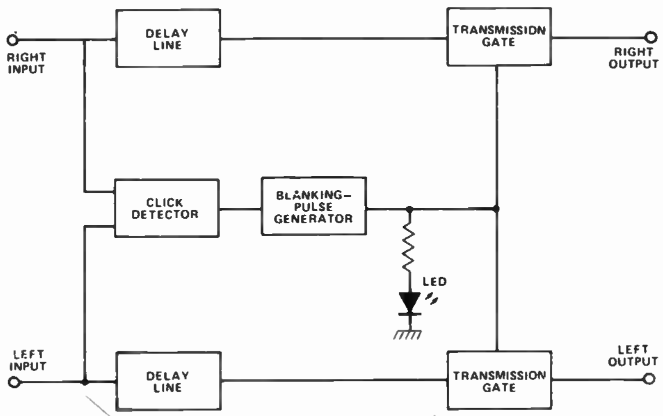


Fig 1. Basic block diagram for Click Eliminator

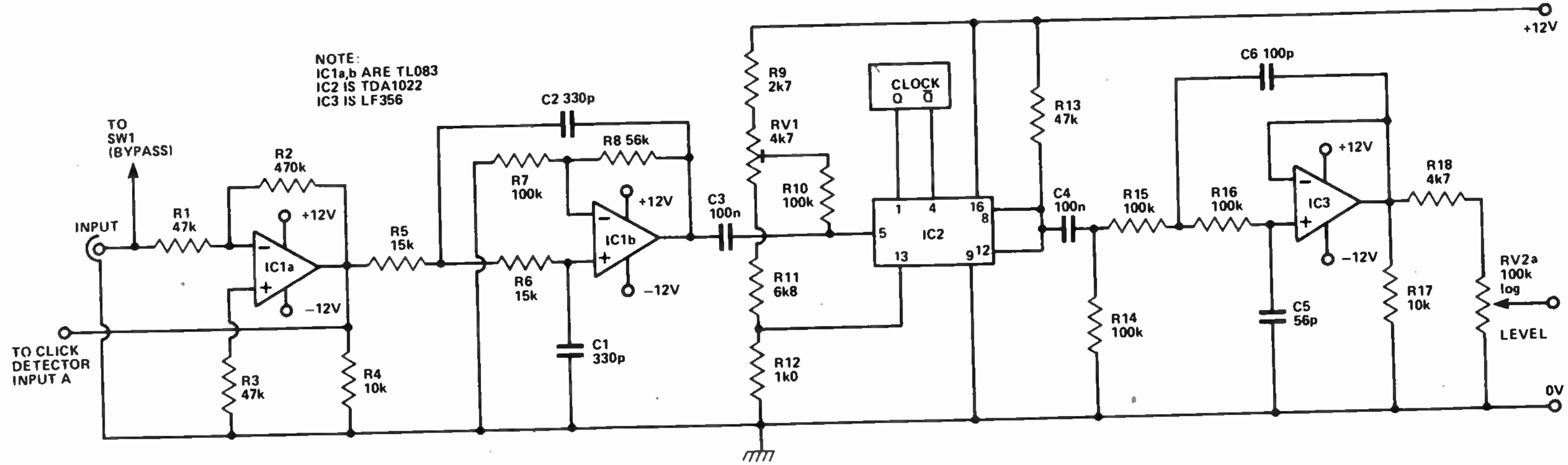


Fig 2. Circuit diagram for the audio pre-amplifier and delay line sections of the Eliminator unit. Note that only one channel is shown, but both are identical.

HOW IT WORKS

The full circuit of the right pre-amp and delay line block is shown in Figure 2. The left channel circuit block is identical.

The input signal from the pick-up is fed to IC1a, which is wired as a x10 inverting amplifier with an input impedance of 47k. The output of this stage is fed to the click detector circuit and to IC1b, which is wired as a second order low pass Butterworth filter with a turnover point of about 18 kHz. This stage also has a small amount of gain in its pass band.

The output of the Butterworth filter is fed into input pin-5 of IC2, which is a TDA 1022 512-stage charge-coupled delay line. The R9-RV1-R11-R12 and R10 network at the input of the IC is used to set pin-13 at about 1 volt above ground, to ensure maximum dynamic range on the delay line, and to bias pin-5 into class A at minimum distortion. The delay line is clocked by symmetrical anti-phase signals to pins 1 and 4 at a few hundred kHz, to provide a total delay of about 1 mS.

The output of the delay line is taken, via C4, to another second order Butterworth filter (IC3), which removes the unwanted high frequency clock signals that are imposed on the audio signal by the delay line, and the cleaned-up signals are then passed on to the click blanking circuit via volume control RV2.

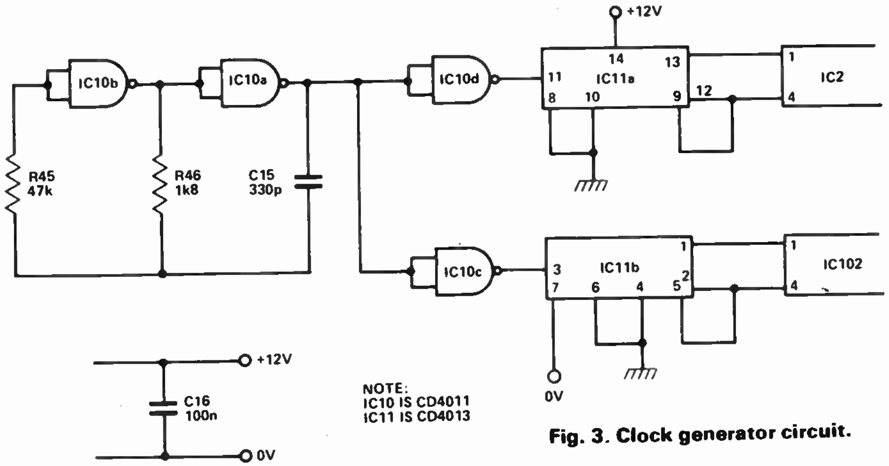


Fig. 3. Clock generator circuit.

HOW IT WORKS

Pins 1 and 4 of the TDA 1022 delay line IC must be presented with symmetrical anti-phase clock signals for correct operation. The basic clock signal of a few hundred kHz is generated by a CMOS astable multivibrator formed by IC10a and IC10b. The clock signal is taken to each channel via a buffer stage (IC10d or IC10c) and a D-type flip-flop (IC11a or IC11b), which provides the required anti-phase drive signals (from the Q and Q̄ outputs) for the delay line. The clock generator has RF decoupling provided by C16, which is mounted close to the supply pins of IC10 and IC11.

The block diagram of Fig. 1 shows the basic system. The incoming audio is delayed by a TDA 1022, long enough for the circuit to detect the click and generate a pulse which shuts off the transmission gate (4016) as the 'Click' arrives.

Circuits and Components

Figures 2-8 show the schematic for the Click Eliminator. Figure 2 is the audio input and delay line circuit. Figure 4 shows the click detection and blanking pulse generation components. Inputs A and B come from points A and B marked on the left and right audio inputs respectively.

Circuits 5 and 3 are the output blanking (and bypass) and system clock respectively. The latter is referred in the audio circuit simply as Q and $\bar{Q}$.

Construction

The unit is assembled onto a single PCB, and so construction is really quite straightforward. Assemble the board carefully, remembering to fit resistors and capacitors first, and ICs last. Sockets are best used for these devices, especially the high cost items. This will facilitate checking and servicing should this be needed.

The easiest place to make a mistake is in fitting the polarised components — electrolytics, diodes, ICs etc so check these carefully. It is best to build up the PSU first and check this before connecting to the rest of the circuit. ▶

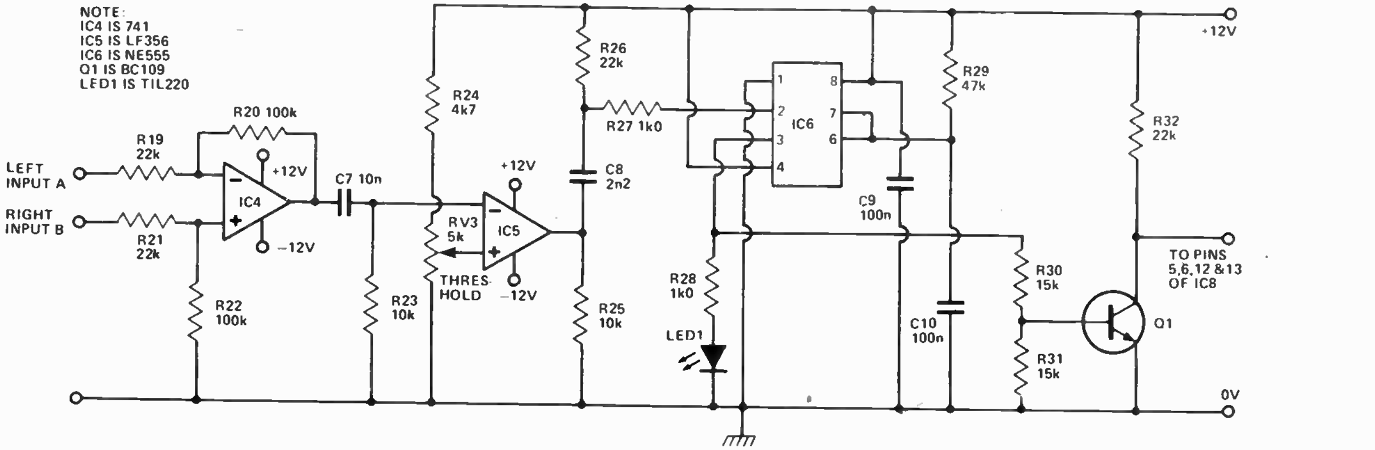
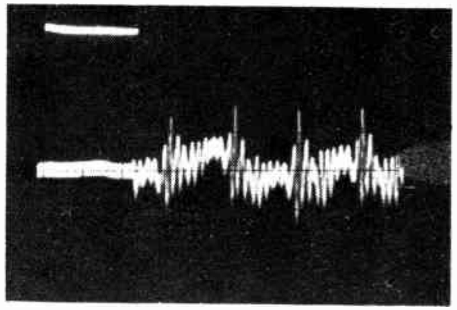
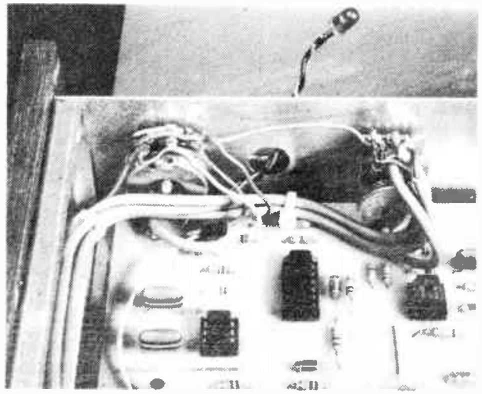


Fig. 4. Circuit of the click detector section of the Mk 2 Click Eliminator. The LED flashes to indicate operation.



This photograph shows the combined waveform showing the blank period inserted into the music.



Close up of the socket wiring for the Click Eliminator. Keep these as close to your boards as possible, and use screened leads if this is not possible, earthing only one end of the screen. Terminate the earthy side of RV3 to the ground of the input sockets.

HOW IT WORKS

The full circuit diagram of the click detector block, which incorporates a "click identifier," a threshold detector, and a blanking pulse generator, is shown in Figure 3.

A "click" or scratch has a number of unique characteristics. It has fast attack and decay times, and its output is consequently rich in high-frequency components. Also, it appears to a stereo pick-up head as a set of recorded anti-phase signals, since it causes purely vertical displacement of the stylus, whereas normal recorded signals tend to be in phase and cause predominantly horizontal movement of the stylus. The ETI Click Eliminator uses these unique phase characteristics to provide its primary means of click identification.

In the circuit, the amplified pick-up signals are taken from the outputs of the two channel pre-amplifiers (IC1a, Fig 2) and are passed to one or other of the two input terminals of IC4 in Fig 3. IC4 is wired as a differential amplifier or "subtractor," and has a gain of about five on each input. The action of this IC is such that it amplifies the anti-phase "click" signals, but tends to cancel the predominantly in-phase recorded signals, so that the output of the IC consists of an audio signal with greatly emphasised "clicks." This signal is passed to threshold detector IC5, which is wired as an open-loop voltage comparator, with its output normally at positive saturation.

The "threshold" level of IC5 can be adjusted via panel-mounted control RV3, so that the output of the IC is just held high throughout the passage of a "clean" record. Then, each time that a "click" arrives, the output of IC5 switches to negative saturation, to produce a large negative-going pulse. This pulse is used to trigger monostable multi-vibrator IC6, which has a period of about 5 mS, and which drives "click indicator" LED 1 on and drives output transistor Q1 to saturation for the duration of the 5 mS pulse. The output of Q1 appears as a blanking pulse, and is fed to the click blanking circuit of Fig 4.

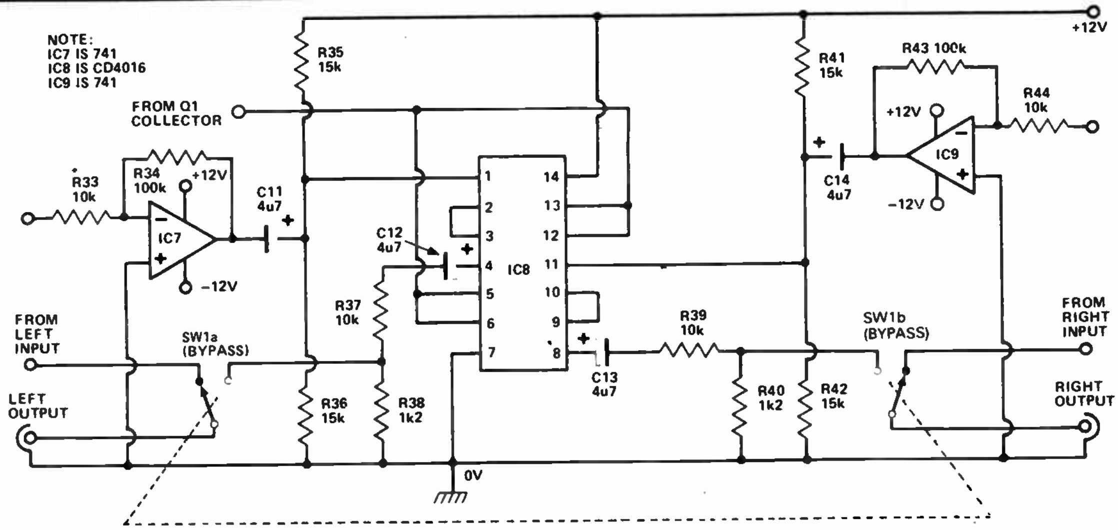


Fig 5. Click blanking circuit. Note that SW1 is the bypass switch.

HOW IT WORKS

The circuit of the click blanking block is shown in Figure 5. Circuit operation is fairly straightforward. The output of each channel is taken from its volume control (Fig 2) and is fed through a times-ten inverting amplifier (IC7 or IC9), and is then passed to one half of IC8, a 4016 quad bilateral switch. In each channel, two of the internal "switches" of the 4016 are wired in series, and are normally held on by the high control signal from the collector of Q1 (Fig 4), but turn off for 5 mS when a blanking pulse arrives from the click detector circuit. The output of each channel is then passed on to the outside world via a divide-by-ten (approx) attenuator network.

Thus, during "clean" parts of the record the output signal from the delay line is passed through the click blanking circuit of Fig 5 via the two series-connected on switches of IC8 with negligible loss or gain, but in the presence of a "click" the two series-connected switches of IC8 open 1 mS before the arrival of the click and remain open for about 5 mS, thus replacing the click with an imperceptible "blank."

Note in the circuit that the inputs of IC8 are biased at half-supply volts to enable the IC to pass signals with a minimum of distortion when operated from a single-ended power supply. The 4016 IC suffers from a certain amount of control-signal breakthrough; by using a times-ten amplifier before the input and a divide-by-ten attenuator after the output of the IC, this breakthrough is reduced to insignificant levels relative to those of the basic audio signal.

The power supply is a straightforward design based on a pair of three-terminal IC regulators, which provide plus or minus twelve volt outputs. LED 2 is a panel-mounted component, which indicates the power on state.

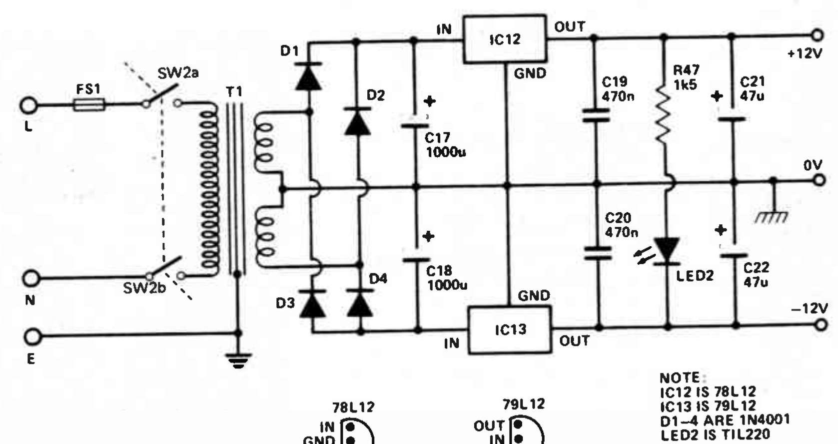


Fig 6. Power supply for the unit.

Next assemble and check the audio circuitry. Make sure a signal is present at the level control RV2a and RV2b. Normally the IC8 gates will be 'open' and so an audio output should be present at the phono sockets if all is well.

If no output is present, check the audio through to RV2, and if a signal is present here, the fault probably lies with IC6 and Q1. Disconnecting the base of Q1 will restore output if this is the case.

Over the Threshold

In use, the unit is connected between the output of a record player pick-up and the input of a stereo amplifier. Volume control RV2 should be adjusted so that no perceptible difference occurs in audio sound levels when the bypass switch is switched in and out. Pre-sets RV1 and RV101 should be adjusted for minimum distortion on the Right and Left channels respectively. Threshold control RV3 should be adjusted in use so that LED 1 just operates in the presence of a 'click'.

It should be noted that the relative amplitude of a 'click' is proportional to the velocity of the record track past the pick-up head, and decreases as the head moves towards the centre of the disc: the threshold control may consequently need occasional readjustment as the record progresses through its play.

There is no equalisation circuitry within our design, and so it cannot be used in place of the preamp in your system, it must be used in front of it instead.

When playing damaged LPs simply advance the Threshold control, RV3 from its minimum setting until the click is removed. This is the correct setting.

LED 1 will indicate the unit operation, and if it flashes on musical peaks, chances are you have the threshold control set too high and are removing some of the signal as well.

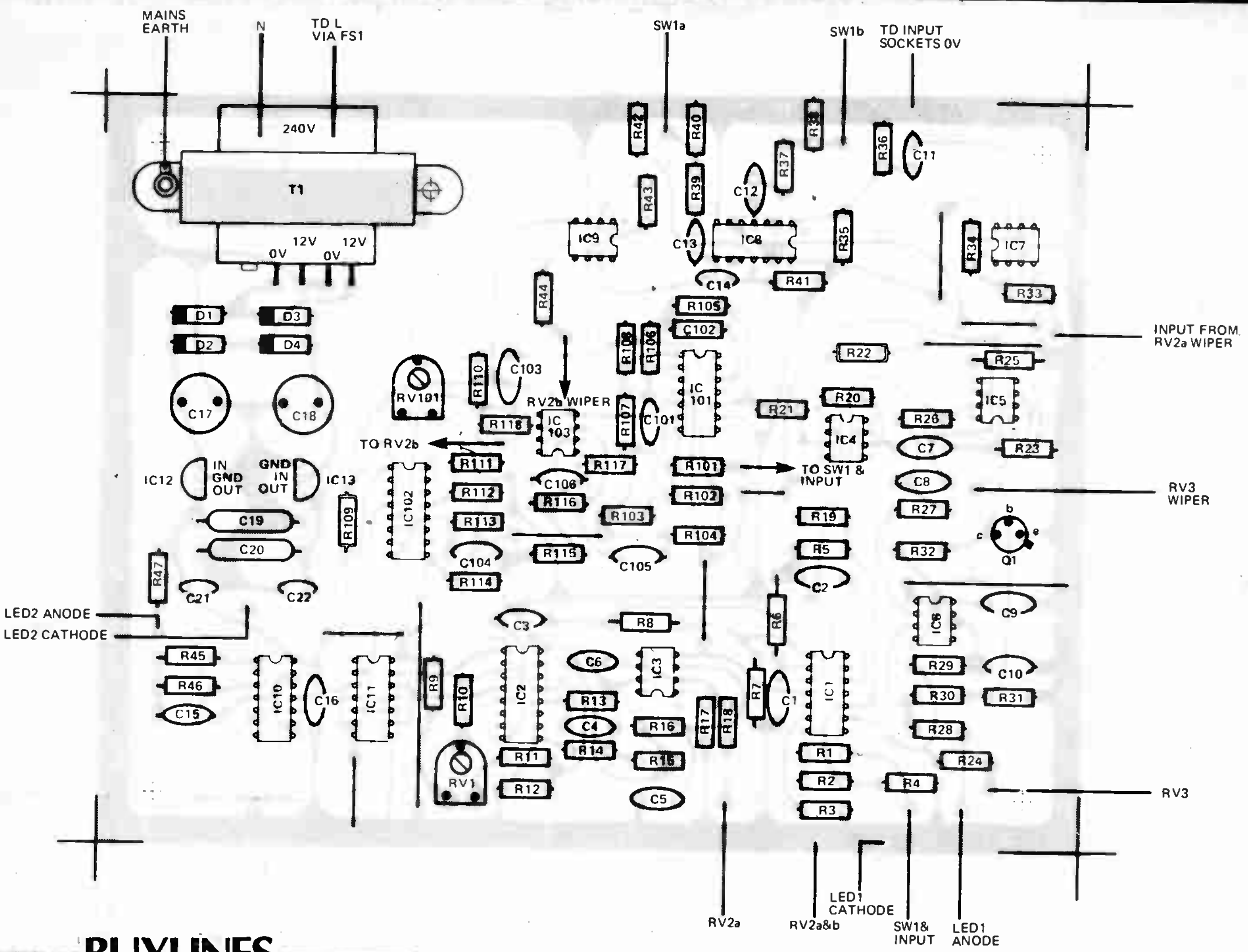


Fig 7. Component overlay for the Click Eliminator unit. Note that all the components bar the potentiometers mount on this PCB. The operation LED is also best front panel mounted.

BUYLINES

Being composed mainly of 'standard' components, the Eliminator should pose most component shops no problems. The LF 356 is available from Watford in case of difficulty.

PARTS LIST

RESISTORS (all ¼W 5%)

R1, 3, 13, 29, 45	47k
R2	470k
R4, 17, 23, 25, 33, 37, 39, 44	10k
R5, 6, 30, 31, 35, 36, 41, 42	15k
R7, 10, 14, 15, 16, 20, 22, 34, 43	100k
R8	56k
R9	2k7
R11	6k8
R12, 27, 28	1k
R18, 24	4k7
R21, 26, 32, 19	22k
R38, 40	1k2
R46	1k8
R47	1k5

Resistors 101-118 for RH channel identical to R1-18

POTENTIOMETERS

RV1	4k7 preset
RV2	100k log twin gang
RV3	5k Lin

CAPACITORS

C1, 2, 15	330p polystyrene
C3, 4, 9, 10, 16	100n polyester
C5	56p ceramic
C6	100p ceramic
C7	10n polyester
C8	2n2 polyester
C11-14	4u7 25V electrolytic
C17, 18	1000u 25V electrolytic
C19, 20	470n polyester
C21, 22	47u 25V electrolytic

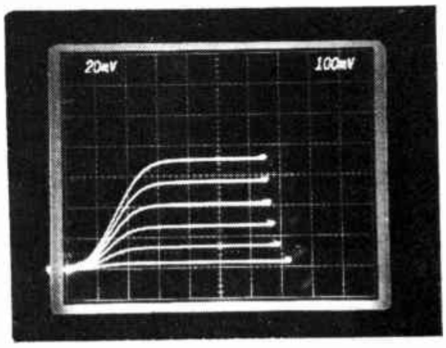
SEMICONDUCTORS

IC1	TL083
IC2	TDA1022
IC3, 5	LF 356
IC4, 7, 9	741
IC6	555
IC8	4016
IC10	4011
IC11	4013
IC12	78L12
IC13	79L12
Q1	BC 109
D1-D4	1N 4001
LED1, 2	TIL 220

MISCELLANEOUS

240/12-0-12 transformer (100mA), fuse (3A) and holder, case to suit, DPDT mains switch control knobs, PCB, four phono sockets.

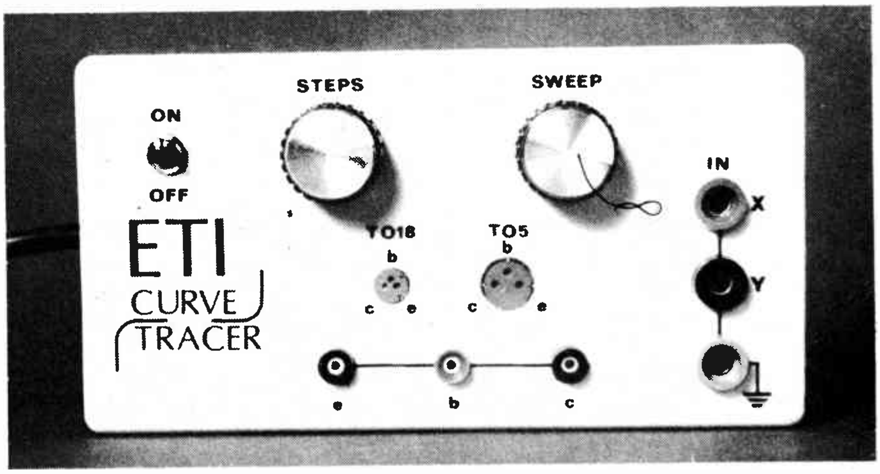
CURVE TRACER



Display the dynamic characteristics of a variety of semiconductor devices with our curve tracer. Design by J. H. Adams.

THE CURVES INVOLVED in this design are not unfortunately those of the Bardots and Welchs of this world but curves that, to some, are just as interesting. The design will allow the dynamic voltage-current characteristics of diodes and transistors to be displayed on the screen of a DC 'scope capable of taking an external X input.

Various transistor sockets are provided so that a wide range of types can be tested.



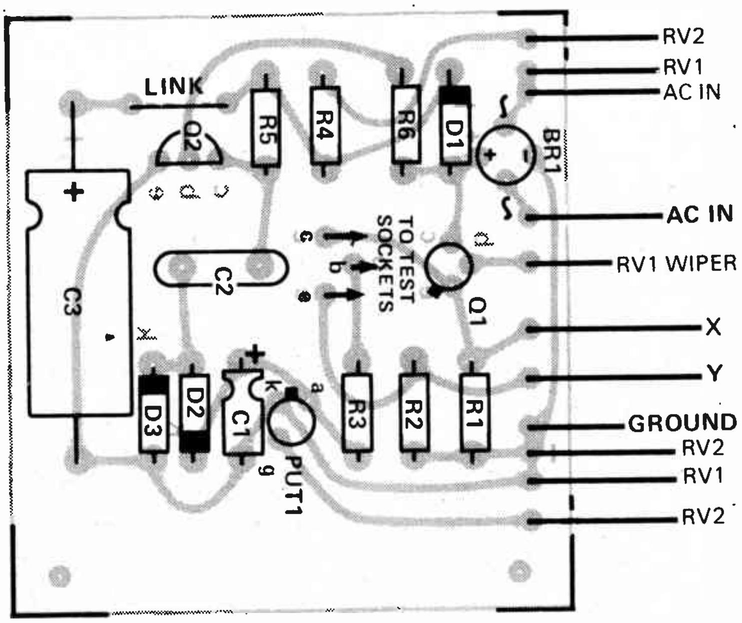
Cheap Curves

The performance of the unit will not be up to that of a commercial machine but considering such commercial designs are priced in the thousand pound range while our design could be built for around five pounds, we're not doing too badly.

Construction of the curve tracer is straightforward. Mount all the components on the PCB according to the overlay. The front panel layout of our prototype is shown in the photograph. The unit is mains powered and a battery supply is not suitable for this circuit.

Initially try the curve tracer with a high gain NPN transistor, a BC108 will be ideal. Connect it to one of the tracer's sockets and connect the unit to the 'scope. Set the Y gain on the 'scope at maximum and set up the maximum required level of collector voltage by adjusting RV1. RV2 will control the number of steps displayed on the screen. The X sensitivity of the 'scope should be 1V per division.

The performance of the unit is degraded by the slight drop in the DC potential on C1 during the 10mS sweep and the slight effect of the 100R sampling resistor, in that its volt drop is included in the observed collector potential. However as stated above the unit will give a good indication of the dynamic performance of a wide range of semiconductor devices (as the photograph shows) at a price that is a fraction of similar commercial equipment.



Component overlay of the Curve Tracer.

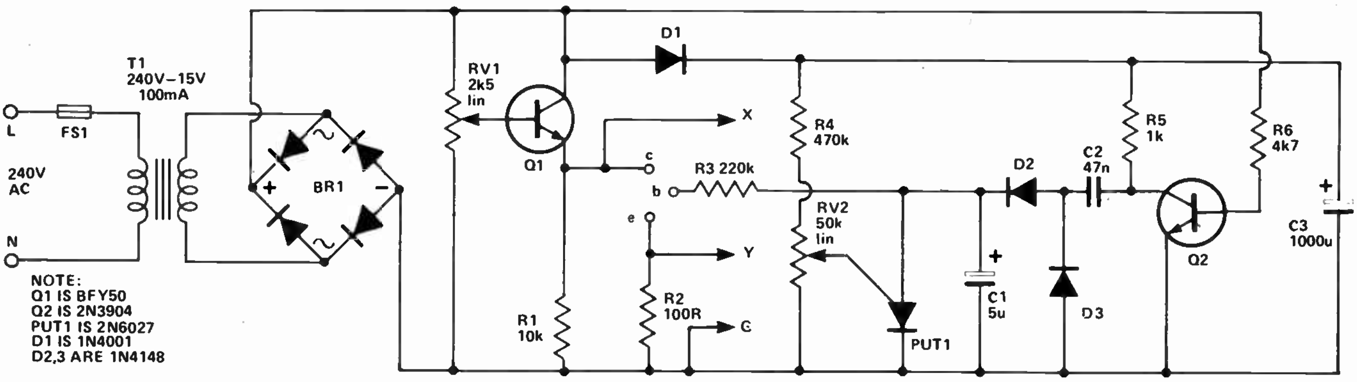


Fig. 1. Full circuit diagram of the curve tracer.

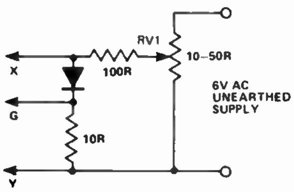


Fig. 2. Simple diode tester

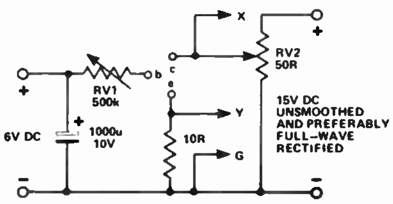


Fig. 3. Fixed current transistor tester

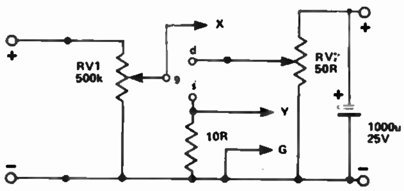


Fig. 4. Circuit for investigating FET transfer characteristics.

HOW IT WORKS

The principles of the full circuit can perhaps be best explained by consideration of a simpler form of the circuit. Figs. 2 and 3 show circuits for investigating the dynamic characteristics of a diode and transistor (at fixed base current) respectively.

The 'diode circuit' will, unless an inverter is available, produce a trace that will appear upside down.

Operation of this circuit (Fig. 2) is quite straight forward. RV1, allows the peak value of the AC supply to be adjusted. This is then applied to the device under test via a current limiting resistor as well as to the X input of the scope. The current flow in the device at any time is proportional to the voltage developed across a low value sampling resistor in the current path. This voltage is fed to the Y input of the scope.

The simple transistor tester (Fig.3) functions in much the same way. RV1 allows the base current to be adjusted within the range10uA to 100uA.

The characteristics of an N-Channel FET (2N3819) may also be examined with this basic building block. The output characteristics are displayed for a gate voltage selected by RV1. Transfer characteristics (gate voltage VS. drain current) may be shown by transferring lead X to the gate terminal and moving the 1000µF capacitor to the 15V supply (observing the change in polarity). See Fig. 4.

We move now to the full circuit of Fig 1 that allows a far more informative display providing, as it does, simultaneous displays of the characteristic curves for several equally spaced values of base current.

The circuit operates as follows. Every 10 ms the collector supply swings up and back over a half cycle of the full-wave rectified supply. At the end of each half cycle, there is a short period during which the supply potential is below about 0.6 V, and during this time, Q2 turns off, sending a pulse from its collector into the charge store C1 C2 D3 D2. Each pulse increases the potential in C1 by approximately 0.2 V. This would go on until the potential on C1 was 20 V were it not for Q2, the little known and much mis-described programmable unijunction transistor, PUT. This device is the semiconductor version of a neon lamp, insulating up to a certain p.d. and conducting heavily at potentials above this breakdown value, but with the added advantage in that, through a third terminal, this breakdown potential is programmable over quite a wide range. Varying this control potential through the setting of RV2 sets the number of steps that will occur before the potential on C1 is great enough to make Q2 fire, reducing the capacitor's potential to approximately 0.6 V and so re-starting the sweep sequence.

The tracer can hardly be expected to match all the performance of a commercial curve tracer, the prices of which range into thousands of pounds. There are errors, due to the slight droop in d.c. potential on C1, and hence in base current, during the 10ms sweep, and due to the slight effect of the 100R sampling resistor, in that its volt drop is included in the observed collector potential, but as can be seen, these are quite insignificant as regards the final display. The only problem which may arise is the appearance of Radio 4 on the current axis (seen as a thickening of the trace). This is easily cured by placing a 10n disc capacitor across the actual Y-inputs of the oscilloscope.

A suitable transistor for the device under test is any reasonably high gain NPN transistor, e.g. BC108. RV1 controls the maximum collector voltage, whilst RV2 sets the number of sweeps displayed. With the values given, the difference in base current between one step and the next is approximately given by:

$$\frac{1}{5R}\ \mu A, \text{ where } R \text{ is in megohms.}$$

PARTS LIST

RESISTORS (All ¼W 5%)

R1	10k
R2	100R
R3	220k
R4	470k
R5	1k0
R6	4k7

CAPACITORS

C1	5u0 25 V electrolytic
C2	47n polyester
C3	1 000 25 V electrolytic

SEMICONDUCTORS

Q1	BFY50
Q2	2N3904
PUT1	2N6027
D1	1N4001
D2,3	1N4148
BR1	0.9A 400V

POTENTIOMETERS

RV1	2k5 Linear
RV2	50k Linear

MISCELLANEOUS

PCB as pattern, case to suit, sockets, knobs, cable, etc.

BUYLINES

The components used in this project should in the main, be generally available — the only component likely to cause problems is the PUT, but this should be available from the larger Watford and Marshall's.

AUDIO DISPLAY

Kinaesthetic kicks with scintillating new display which puts your music on show to the world. A superb ETI Project Team design.

SO MANY electronic projects rise phoenix-like from the smoke of the soldering iron and when shown to family and friends are greeted with looks of blank amazement and the inevitable question, 'I'm sure it's very clever, but what does it do?'

It is easy to understand how many projects can be confusing and uninteresting to a non-technical person. This attractive project is simple in operation and yet sophisticated in the effect it produces and will be enjoyed by anyone with an eye and an ear to spare.

Small Is Beautiful

The SCINTALITE LED audio display translates the dynamic flow of sound into a visual analogue. The circuit follows conventional lines with the input signal being amplified and filtered to extract the upper and lower frequencies. The outputs from the filters are then rectified and the peak and mean DC levels detected and made available at the 'mood' switch. Operation of this control allows the relatively fast peaks of the music or the more slowly changing levels of the overall sound to control the display.

A novel feature of the display is the ability to produce a moving dot or bar of light. The upper frequencies are displayed using both techniques and the circuit switches between them as the input level rises and falls. The lower bass range is always displayed in bar form.

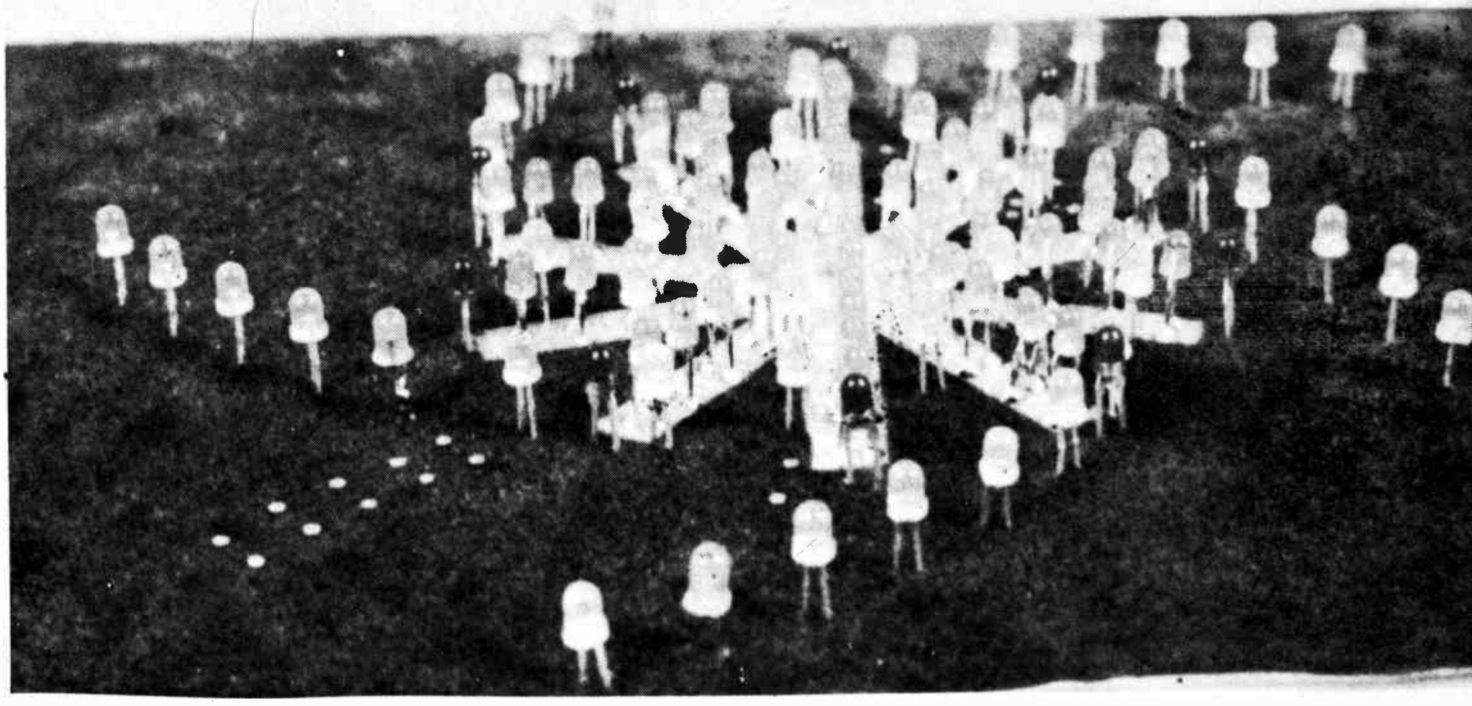
As can be seen in our photos the display is based on a pentagon and is about six inches in diameter. The upper frequencies drive five spiral arms of ten LEDs each and the bass frequencies are displayed on ten shorter straight radiating arms. There is also a circle of ten LEDs whose brilliance is controlled by the overall input signal.

Tripping The Light Fantastic

Scintalite can accept input signals from a wide variety of sources. Its sensitivity is variable from about five millivolts to five volts. Although designed primarily as an audio display, any input voltage within specified limits may be used to control the unit by replacing the input capacitor with a wire link. In this way, Scintalite could for example form the display device for a bio-feedback system. In such an application it should be noted that, except for very quickly changing signals, only the bass section will give a display and, as half-wave rectifiers are used, a negative going input signal is required owing to signal inversion in the first amplifier.

Construction and Use

The unit is assembled on one PCB with a separate power supply. The PCB holds all the signal conditioning



PARTS LIST

MAIN BOARD

RESISTORS (all ¼W 5%)	
R1, 5, 15	1M0
R2, 3, 16	47k
R4, 28	1k0
R6, 13, 19, 20	15k
R7	33k
R8, 10, 21, 23	100k
R9, 22	100R
R11, 24	220k
R12, 17, 18, 25	10k
R14	10M
R26	2k2
R27	680R

CAPACITORS	
C1	10n polyester
C2	10u 35V electrolytic
C3, 4	3n3 polystyrene
C5, 6, 10, 11, 12	10u 25V tantalum
C7	1u0 35V tantalum
C8	100n polyester
C9	47n polyester

SEMICONDUCTORS	
IC1	LM3914
IC2	4016B
IC3	LM324
IC4	741
IC5	3140
IC6	4093B
Q1, 3	BC214L
Q2, 4	BFX88
D1-7	1N4148
LEDs	0.125"

MISCELLANEOUS	
SW1, 2	SPDT slide
PCB	

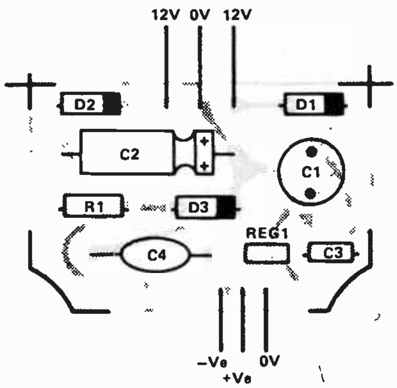
PSU

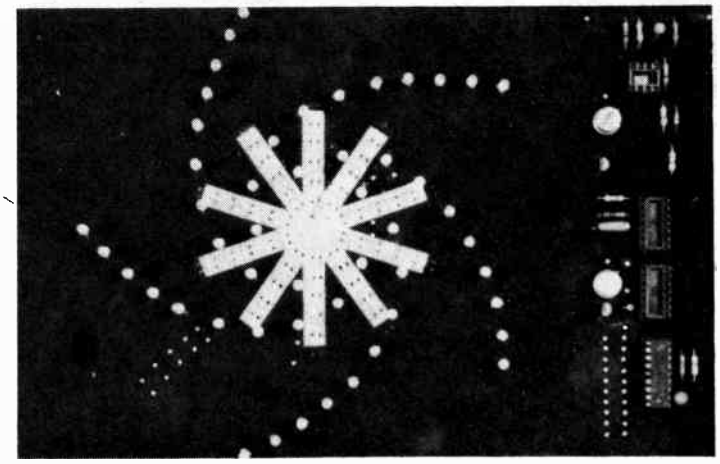
RESISTORS	
R1	470R ½W

CAPACITORS	
C1	1000u 25V electrolytic
C2	470u 25V electrolytic
C3	220n polycarbonate
C4	470n polyester

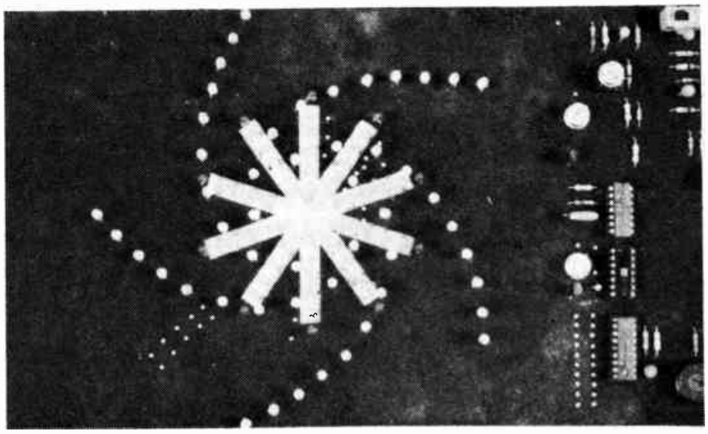
SEMICONDUCTORS	
D1, 2	1N4001
ZD1	12V 400mW
IC1	7812

MISCELLANEOUS
12-0-12, 6VA transformer, PCB, cable etc.





Two stages in the construction of Scintalite. The spiral arms are fitted Above and then the straight lines of LEDs Below



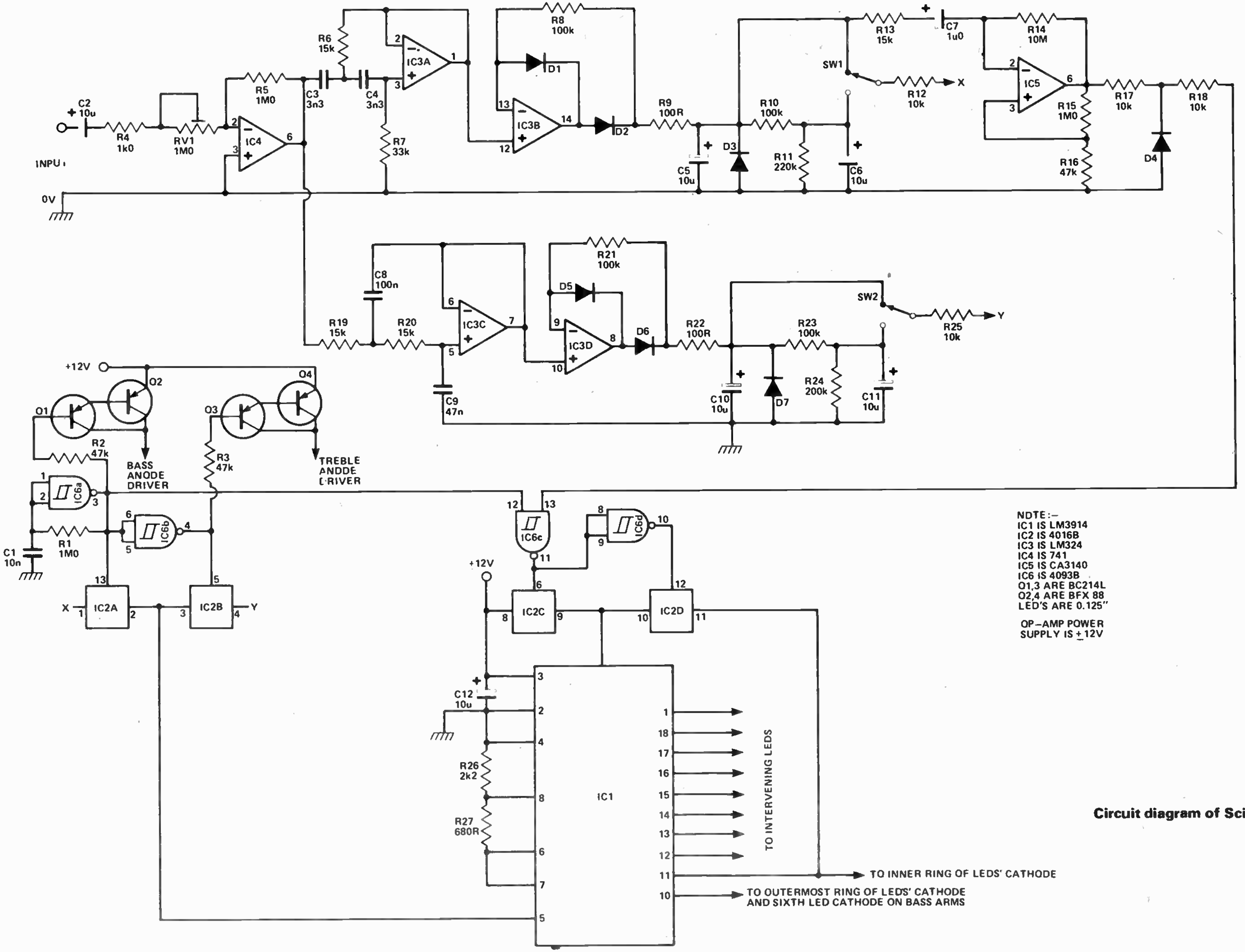
circuits, the LED driver chip and associated multiplexing circuitry and the display itself. Owing to circuit complexity, especially of the display, a double sided PCB has been designed. Use of our PCB will greatly simplify construction.

As the LEDs are wired in series, it is necessary to pre-select them or you may find that some will light very dimly or not at all. Use of a matrix board such as S-DEC or Proto board makes this job very easy and it should present few problems. In any case, the eye is very tolerant of individual differences in LED brilliance when they are assembled into a cohesive display.

The selected LEDs should be mounted on the board first. Note that some will be soldered on the top surface of the board. Then solder all the links in place and mount the IC holders, resistors and capacitors. Flying leads should be taken from the driver chip to the LED display. Check the connections carefully against the circuit diagram and overlay. Next, insert the display anode driver transistors, Q1, 2, 3, 4, as shown in the overlay. Finally insert ICs 2, 5 and the driver chip IC1. ICs 2 and 5 are CMOS chips and the usual handling precautions should be observed. Power can now be applied to the circuit and a voltage of up to five volts applied to the switch sides of resistors R12 and R25 located near the mood switches. The display should now illuminate.

If all is well, disconnect the power supply and insert the remaining components. Then re-connect the supply and apply an audio signal to the input and adjust RV1 until the display operates over its whole area.

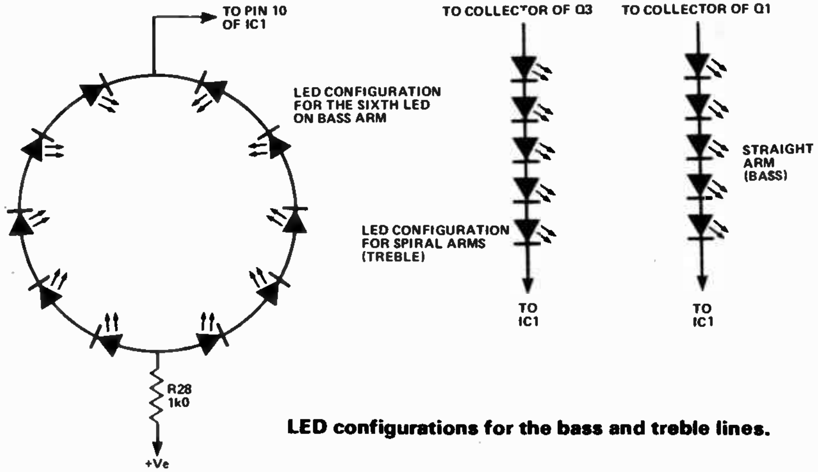
That completes construction. A feature of our display which has a very novel appearance is the use of flock paper fixed over the PCB and tinted perspex to cover the completed unit which, used in the right setting, assures complete kinaesthesia.



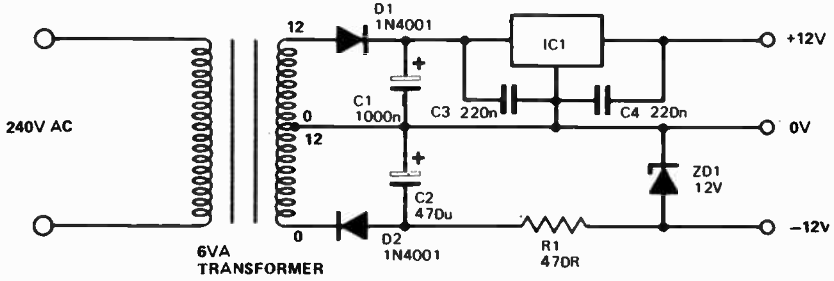
NOTE:–
IC1 IS LM3914
IC2 IS 4016B
IC3 IS LM324
IC4 IS 741
IC5 IS CA3140
IC6 IS 4093B
Q1,3 ARE BC214L
Q2,4 ARE BFX 88
LED'S ARE 0.125"

OP–AMP POWER SUPPLY IS ± 12V

Circuit diagram of Scintalite.

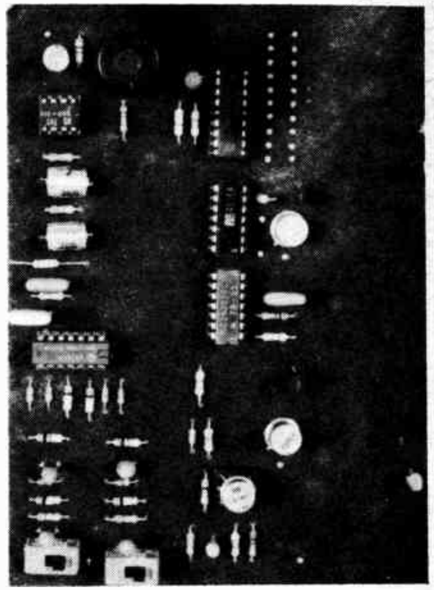


LED configurations for the bass and treble lines.



BUYLINES

The LM3914 bargraph display driver should be available from Technomatic Watford or Maplin. All the other components should be readily available from the usual suppliers.



(Above) The business end of the Scintalite PCB.

HOW IT WORKS

The signal is input to IC4, a conventional inverting amplifier, via C2, R4 and RV1 which sets the gain of this stage. The output, about ten volts peak to peak, drives filters IC3a and IC3c. These are second-order with a Butterworth response.

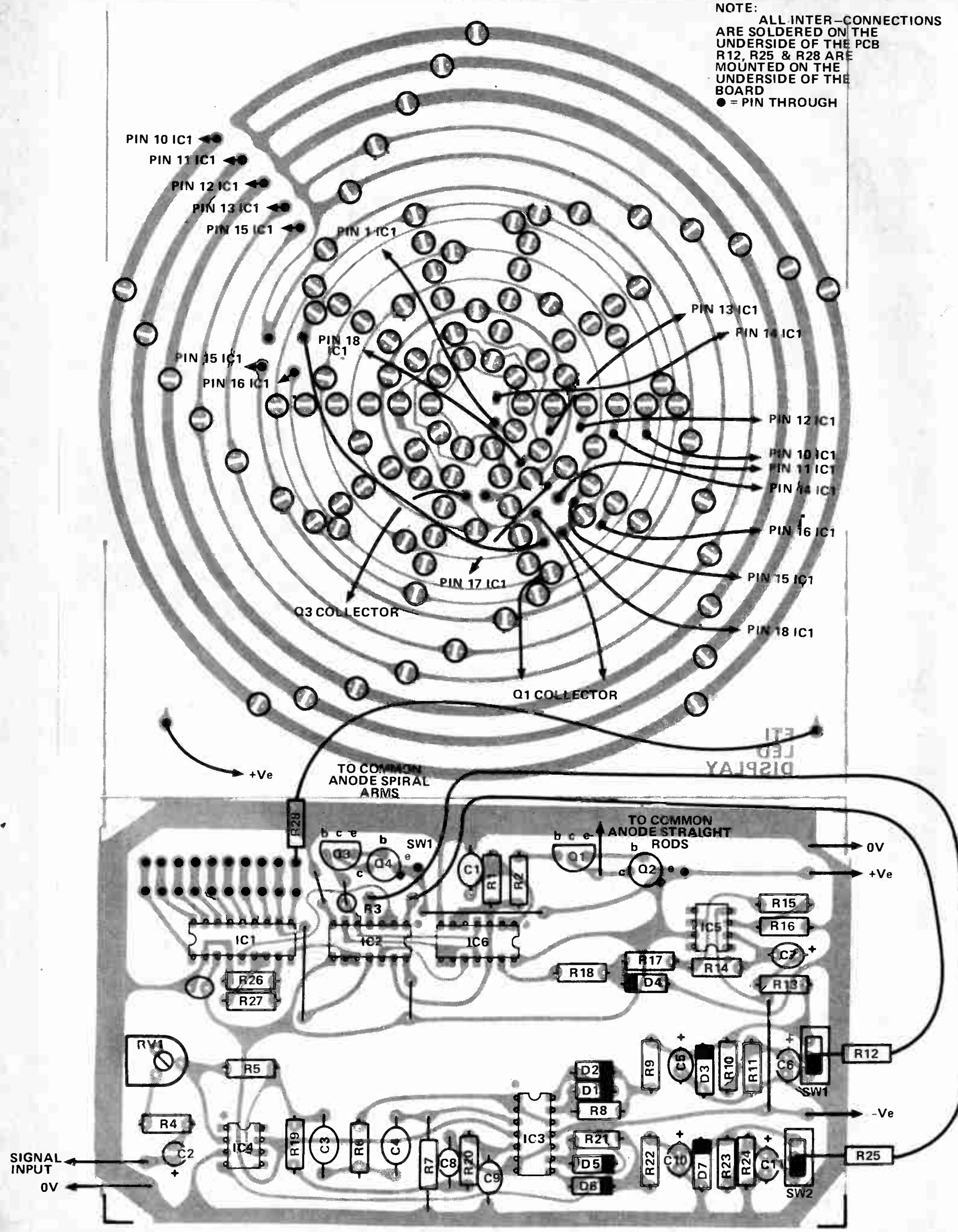
IC3a is a highpass circuit and has a turnover point around 2.5 kHz. IC3c is lowpass with a turnover point around 250 Hz. The output from the filters drives identical half-wave rectifying peak detector circuits. Two signals are available from these stages; the peak signal from the top of C5 or C10 and a low pass filtered signal from C6 or C11. The signal required is selected by operation of the mood switches SW1 and SW2.

To reduce component count and conserve power the LED displays are multiplexed IC2a and IC2b select the input signal for display driver IC1. IC6a is an oscillator running at a few kHz and around 50% duty cycle. Its output is inverted by IC6b. The antiphase signals from this network control the Darlington anode drivers Q1, 2, 3, 4 and analogue switches IC2a and IC2b. The remaining gates in these two chips are used to select dot or bar mode in the display driver chip.

The bass display select signal at pin 12 of IC6c forces a bar display. However, the treble display operates according to the output level of IC5. This is a differentiating circuit whose output sign follows the slope of the treble peak detector output as the signal rises and falls. Some Schmitt action is provided by R15, 16.

IC1 is programmed by R26 and R27 for a full scale input of about five volts and a LED current of 20 mA. We used green LEDs for the bass display and yellow for the treble. It is important to use a regulated 12V positive supply as chip dissipation could otherwise be excessive.

The same problem could arise if red LEDs are used owing to their lower forward voltage drop. The negative supply is low-power and uncritical but should anyway be kept below 15V.



Above: Component overlay for the Scintellate Audio Display unit. Note that this PCB is in fact a double sided board, but that for clarity we have only shown one side of the foil pattern.

CAR TACHOMETER

One of the difficulties in designing a digital car tacho is trading off resolution against response speed. However, this Phase Locked Loop design overcomes this quite neatly — so here it is!

WE HAD OFTEN considered the design of a digital tacho for automobile use, but had rejected several schemes as we were unable to get both good resolution and response time — the two seemed to provide a very good demonstration of Heisenberg's Uncertainty Principle.

Consequently, we were rather pleased when Mike Pratt of SM Electronics came to us with his phase-locked loop based design which got round the problem. Would we like to do it as a project, he asked? Obviously, we said yes, and here it is.

This tacho features a fast response time, coupled with 10 Hz resolution, through the use of a phase locked loop frequency multiplier. It can be set up, by means of a single link, to work on 4, 6 or 8 cylinder motors.

Design Features

To measure the revolutions per minute of a motor is simply a matter of counting the number of ignition pulses over a given time. With a four-cylinder, four-stroke motor there is such a pulse twice per revolution. Therefore if we count these pulses for 30 seconds we will have revs/min with a one cycle resolution. Obviously this is much too long a sample period for practical use in a motor car and some compromise has to be made.

The usual solution is to use a 100 rev resolution and a sample time of 0.3 seconds (on 4 cylinders). We considered this inadequate which is why we have not published a design until now.

In this design an oscillator is used which is phase locked to the ignition pulses except at a higher frequency (x8 for 4 cylinder) allowing a short sample time (0.375sec) with a 10 rev resolution. By using a different multiplication factor compensation for different numbers of cylinders can be made. Unfortunately with the multiplication factors used (x8, x6, x4) the sample time for 6 cylinders is not exactly the same as that used for 4 and 8 cylinder motors. Altering the ratios to x12, x8 and x6 would enable a 0.25 second sample time to be used for all ranges, but this is not possible with the divider IC utilised in this design.

Construction

Assemble the PCB with the aid of the overlay ensuring the components are orientated correctly. The tantalum capacitors normally have a + mark indicating the positive load, or a dot on the side. When soldering the CMOS ICs (4, 6, 7) earth the tip of the soldering iron.

Note that there is one feedthrough or link between the two sides of the board near C10. The display is attached at right angles to the main PCB. Solder short lengths of tinned copper wire through the relevant pads along the base of the display board (pad numbers 1, 3, 4, 7, 8, 10, 11, 12, 13, 14, 16), then solder these directly to the corresponding tracks at the front end of the PCB. The photograph should make things clear.

Calibration

Initially place a link between the point 'C' and the terminal corresponding to the number of cylinders. Now with the power supply connected feed a 50 Hz signal of between 12 and 30 V into the points input using the 0 V as common. Now adjust RV1 until the display reads 1500 RPM for 4 cylinders, 1000 for 6 or 750 for an eight cylinder car. ►

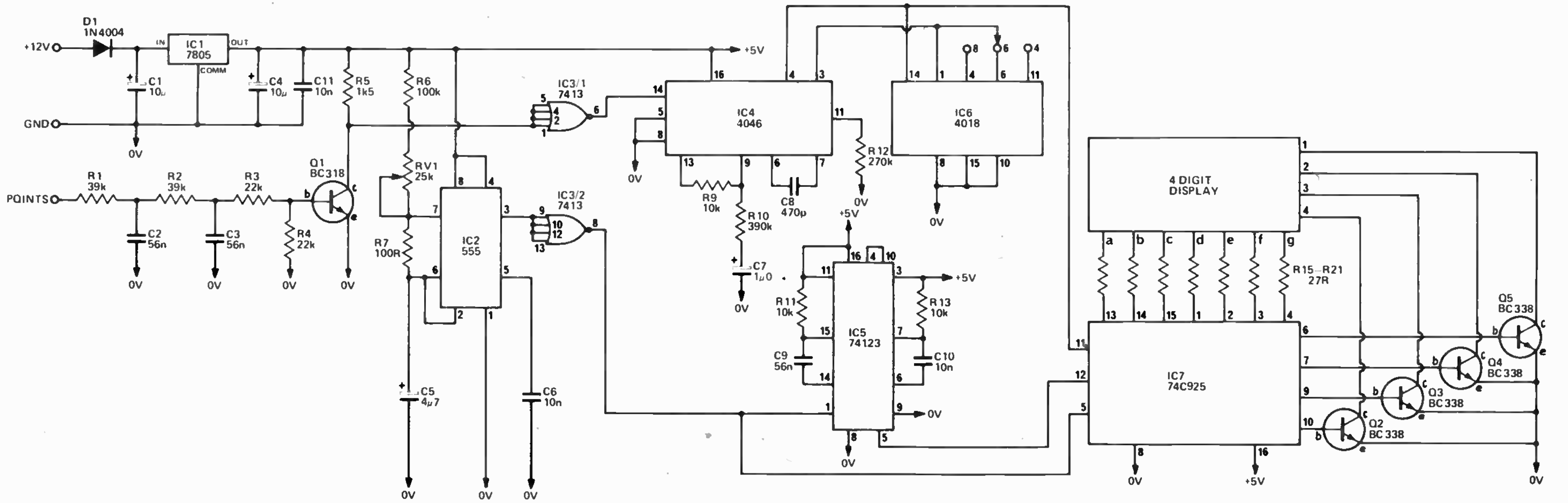


Fig. 1. Full circuit diagram for the digital car tacho unit.

HOW IT WORKS

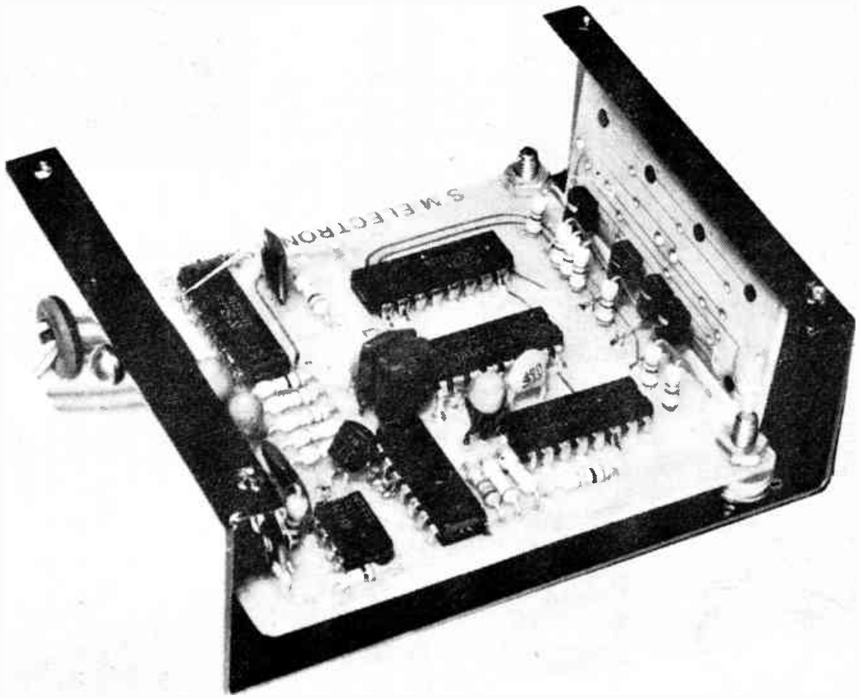
The output from the points of the distributor is basically a 0 to 12V square wave with a 200 volt pulse on the rising edge. A filter network, R1-R4, C2, 3 is used to remove the high voltage pulse (and points bounce) and Q1 buffers it giving a +5 to 0V output on its collector. As the filter network removes the sharp edge of the input a schmitt trigger is needed on the output of Q1 to give fast edges. IC3/1 is used for this.

The output of IC3/1 is connected to the input of the phase-locked loop IC (4046). This IC has an internal voltage controlled oscillator and its output is divided by 4, 6 or 8 by IC6 and this lower frequency is fed back to the phase-locked loop IC. The IC then compares this frequency to that at its input and adjusts the internal oscillator until it is the same. The result is a frequency which is an exact multiple of the input.

The time base is generated by IC2 (555) which has a negative output pulse, about 300 μs wide every 375 ms (or 333 ms for 6 cylinder). This is inverted by IC3/2 and is used as the strobe pulse for the 4 digit counter IC7. This pulse also triggers the first of the monostables in IC5 which gives a 200 μs delay before triggering the second half of IC5; this gives a 40 μs pulse to reset IC7 back to zero.

IC7 is a 4 digit counter with a latch (store) and seven segment decoder driver. It needs four external transistors to drive the digits but the segment drivers are internal. As we need only a three digit counter, i.e. for good resolution, with the right hand permanently zero the least significant digit is connected to the second right digit, etc, with the most significant digit connected to the right hand digit. Provided one does not exceed 9990 RPM this digit will remain on 0 as intended!

The 555 timer, the TTL and the 74C925 needs a regulated +5V and IC1 provides this with D1 preventing damage due to reverse polarity inputs.



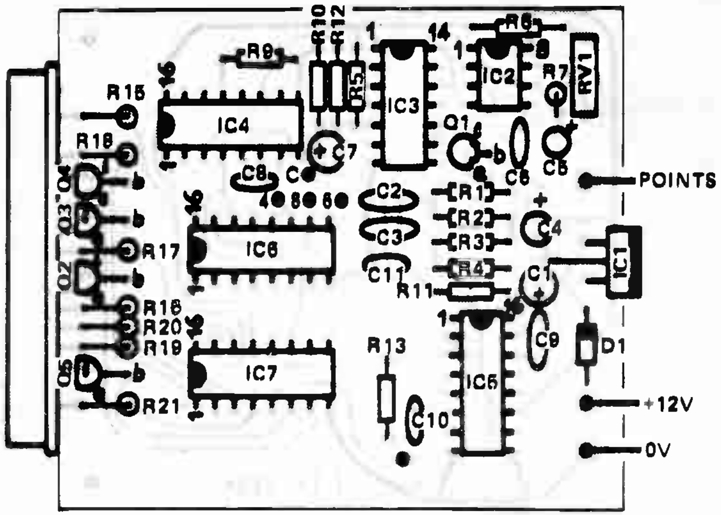


Fig. 2. The component overlay for the board. The board is double sided although only the lower surface is shown here. Note the link between the two surfaces of the board near C10.

PARTS LIST

RESISTORS (all ¼W 5%)	
R1,2	39k
R3,4	22k
R5	1k5
R6	100k
R7	100R
R8	not used
R9	10k
R10	390k
R11	10k
R12	270k
R13	10k
R14	not used
R15-R21	27R
POTENTIOMETER	
RV1	25k trim
CAPACITORS	
C1	10u 25V tantalum
C2,3	56n polyester
C4	10u 25V tantalum
C5	4µ7 25V tantalum
C6	10n polyester
C7	1µ0 25V tantalum
C8	470p ceramic
C9	56n polyester
C10	10n polyester
C11	10n ceramic
SEMICONDUCTORS	
IC1	7805 regulator
IC2	555 timer
IC3	7413 dual schmitt
IC4	4046 PLL
IC5	74123 dual mono
IC6	4018 divide by n
IC7	74C925 4 digit counter
Q1	BC318
Q2-Q5	BC338
D1	1N4004
Display	NSB5881
MISCELLANEOUS	
PCB	
Case to suit	

BUYLINES

Most of the components used here are readily available from any of the major mail order companies advertising in ETI. In case of difficulty the 74C925 is available from Marshall's, and the NSB5881, a National product, is obtainable from National stockists e.g. Technomatic, Marshall's.

Note that the counter is a CMOS chip, and not a standard bipolar TTL chip. The standard component will not operate in this mode.

SPECIFICATION

Range	**100 to 9990 RPM**
Resolution	**10 RPM**
Reading rate	
4 or 8 cylinders	**2.66 per second**
6 cylinders	**3 per second**
Power supply	**7 to 15V @ 400mA**
Suitable ignition systems	**standard**
	CDI
	transistor assisted
	'it will not operate on 'pointless' systems

TEMPERATURE METER

A simple yet accurate temperature meter based on the 7106 LCD panel meter.

This temperature meter will allow transistor temperatures to be measured and the appropriate heatsink chosen. It is just as useful outside the electronic scene measuring liquid or gas temperature especially where the readout needs to be physically separate from the sensor.

Use and Accuracy

The accuracy of the unit depends on the calibration; provided it has been calibrated around the temperature at which it will be used, accuracy of 0.1 degree should be possible. We could not accurately check linearity but it appeared to be within 1° from 0° to 100°C.

Construction

To save on real estate, the main IC is mounted under the display. We used Soldercon pins for the display and soldered the IC directly into the board. If you want to mount the IC in a socket a low profile type should be used, with a high one for the display. As a socket is not available for the display a standard 40 pin one can be cut up to fit.

However before fitting either the display sockets or the IC, fit all the other components first. The overlay in Fig. 3 shows the positioning of the components. The large capacitors are laid on their side to minimise height.

When fitting the IC solder pins 1 and 26 first (the power supply pins) so that the protection diodes on the inputs can operate, thus preventing damage by static electricity. It is necessary that a small tipped iron and fine solder be used to prevent bridging tracks. The IC sockets can now be fitted in two strips of 20 with the top connecting pieces being broken off using long nosed pliers after they are soldered in.

As there are no polarity marks on the display it is necessary to hold it at an angle to the light and look for the outline of the digits. The full format of the display is shown in Fig. 1. In this unit the arrow, semicolon and the vertical part of the + sign are not used. The decimal point drive should be connected to the righthand decimal point. The additional components can be assembled on a tag strip as shown.

We mounted our unit on a tag strip as shown in the photo. While we have not given any details, knocking up a case should be no problem. For a power supply we used eight penlight Nicad cells giving a 10 V supply. If dry batteries are used six penlight cells are recommended although a PP3-type 9 V transistor battery will give about 300 hours of operation.

The sensor should be mounted in a probe as shown in Fig. 4 if other than air temperature will be measured. This provides the electrical insulation needed for working in liquids etc. It should be noted however that the quick dry epoxies are not normally good near or above 100°C and if higher temperatures than this are expected one of the slow dry epoxies should be used.

Calibration

To calibrate this unit two accurately known temperatures are required, one of which is preferably zero degrees and the second in the area where the meter will normally be used and highest accuracy is required. For a general-purpose unit 100°C is suitable. The easiest way of obtaining these references is by heating or cooling a container of distilled water. However temperature gradients can cause problems, especially at zero degrees.

One method of obtaining water at

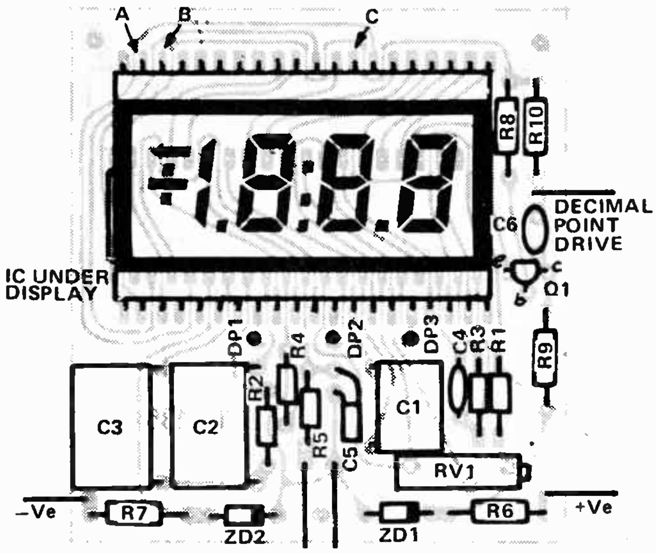


Fig. 1. (Above). Overlay with the display in place. Points A, B, and C are the unused display segments. R4, R6, R7, ZD1 and ZD2 were used in the original LCD meter and are not required.

Fig. 2. (Below). The layout of the external components needed.

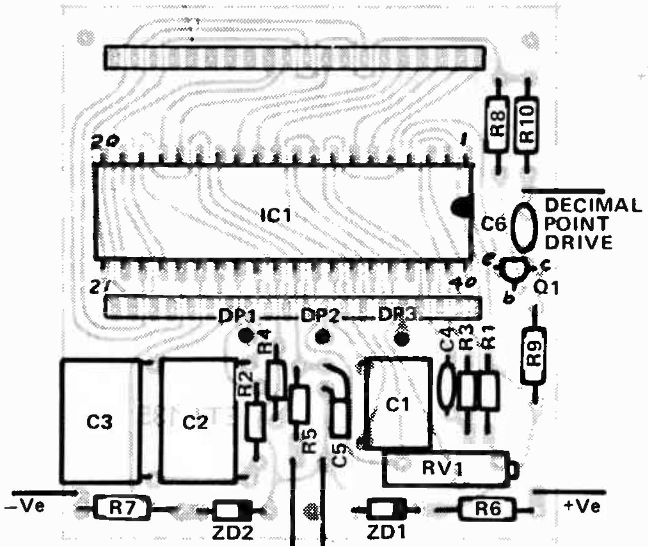
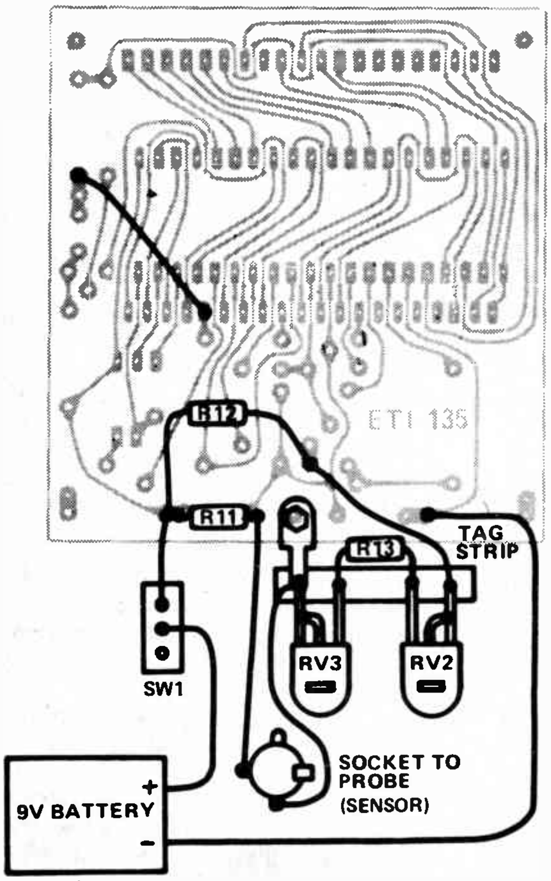


Fig. 3. The component overlay without the display showing the positioning of the integrated circuit.



PARTS LIST

RESISTORS	
R1, 11	10k
R2	47k
R3, 9	100k
R4	not used
R5	1M0
R6, 7	not used
R8, 10	4M7
R12	27k
R13	5k6
POTENTIOMETERS	
RV1	1k 10 turn trim
RV2	2k preset
RV3	200R preset
CAPACITORS	
C1	100n polyester
C2	470n polyester
C3	220n polyester
C4	100p ceramic
C5, 6	10n polyester
SEMICONDUCTORS	
IC1	ICL7106
Q1	BC549
D1	1N914

MISCELLANEOUS
PCB, tag strip, LCD display, socket for display, box, switch and 9 V battery.

BUYLINES

The original LCD meter was based on the Intersil evaluation kit but since then a number of advertisers have put together kits for our project. Such a kit is probably the best place to start although the ICL7106 and suitable displays, the only components likely to prove difficult to find, are now available from most of the larger mail order firms advertising in ETI.

SPECIFICATION

Temperature range	– 50°C to +150°C – 60°F to +199.9°F
Resolution	0.1°C or F
Sensor	silicon diode
Power consumption	1.5mA @ 9 V dc

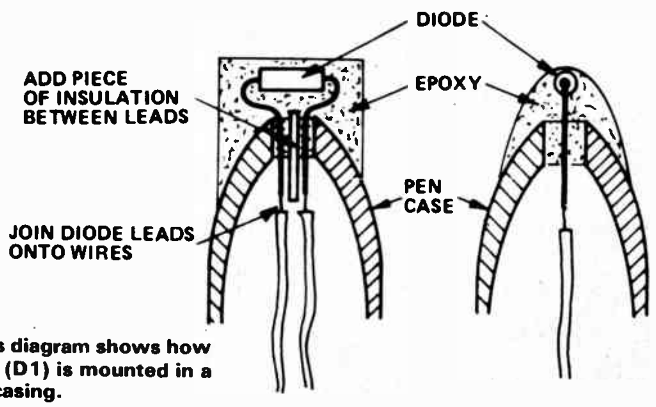


Fig. 4. This diagram shows how the sensor (D1) is mounted in a ball-point casing.

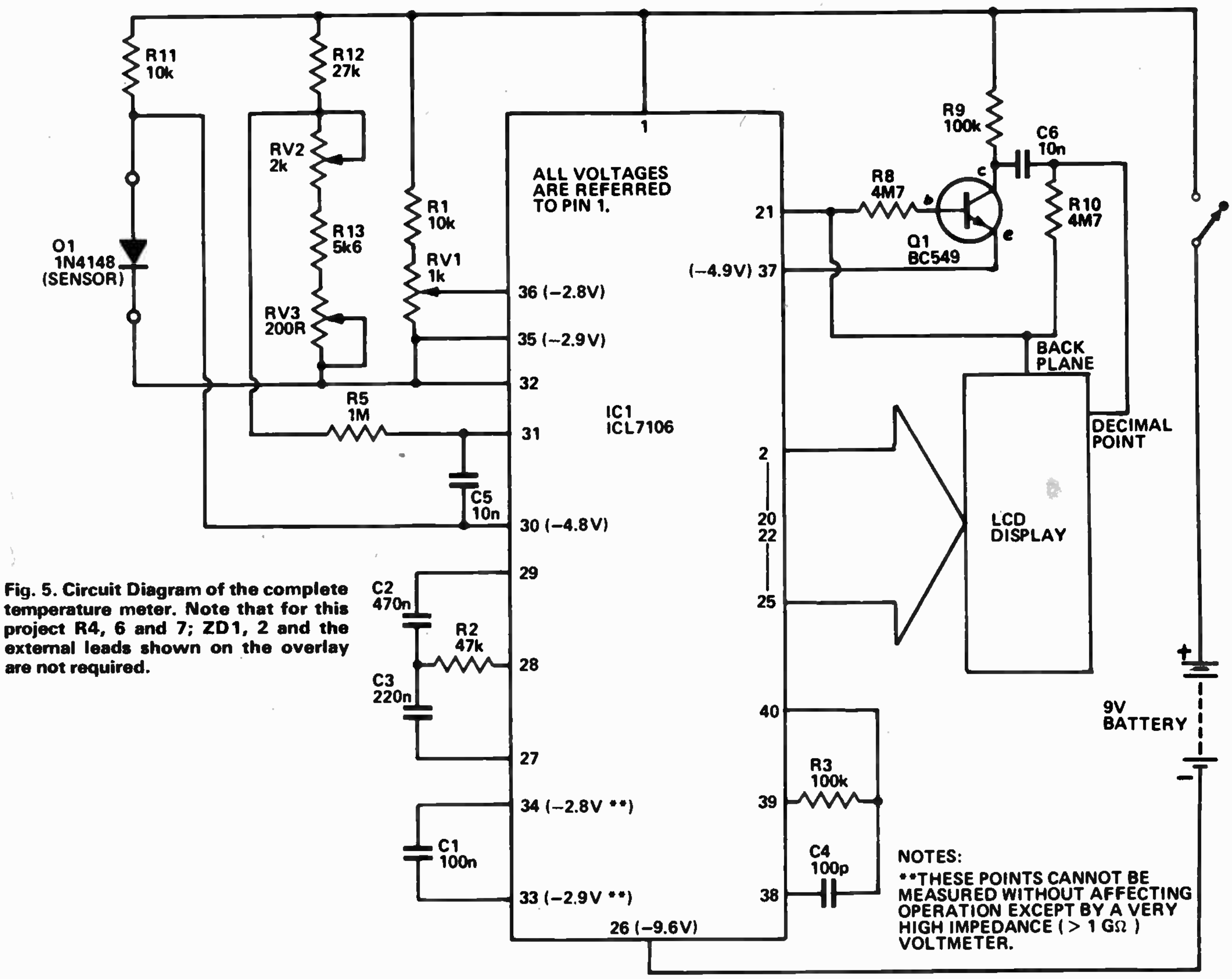


Fig. 5. Circuit Diagram of the complete temperature meter. Note that for this project R4, 6 and 7; ZD1, 2 and the external leads shown on the overlay are not required.

HOW IT WORKS

While the voltage across a silicon diode is nominally about 600 mV it is dependent upon the ambient temperature and current in the device. The temperature coefficient is negative, i.e. the voltage falls with increasing temperature but fortunately is linear in the region of interest. The actual value varies with current and from device to device, but is typically —2.2 mV/° at 250μA.

By measuring the voltage across the diode with a suitable offset voltage to balance the voltage at zero degrees an accurate temperature meter results. The digital panel meter has a stable reference voltage available (between pins 1 and 32) of about 2.9 V; with the 10k resistor R11 this provides a constant current for D1 (the sensor). The offset voltage is also derived from this reference voltage by R12, RV2 and RV3. The panel meter is used as a differential voltmeter and measures the potential difference between the offset voltage and the diode. We have used two trimpots in series in the offset adjustment to give better resolution. If desired a 10-turn trimpot can be used (2k2). Adjustment of the three potentiometers allows the meter to be calibrated in either °C or °F with the upper limit of 199.9°F due to the panel meter over-ranging.

exactly zero degrees is to use a test tube of distilled water in a flask of iced water and allowing it to cool to near zero. Now by adding salt to the iced water its temperature can be lowered to below zero. If you are very careful, the test tube water will also drop below zero without freezing (you should be able to get to about —2° C). However, the slightest disturbance at this temperature will instantly cause some of the water to freeze and the remaining water to rise to exactly zero, providing an ideal reference.

For a hot reference the boiling point of distilled water is very close to 100° C especially if the container has a solid base and is evenly heated e.g. on an electric hotplate.

The actual calibration is done as follows

1. In the 0° C reference adjust RV2 and RV3 until the unit reads zero.

2. In the hot reference adjust RV1 to give the correct reading.

This should be all the adjustment required.

If zero degrees is not available, e.g. if setting up for ° F, the following method can be used:

1. In the cold reference use RV2 and RV3 to adjust reading to zero.

2. In the hot reference use RV1 to adjust the reading to indicate the temperature difference between the two standards. If freezing and boiling points are used, this will be 180° F.

3. Now, back in the cold bath, adjust RV2 and RV3 to give the correct reading.

No further adjustment should be required.

OVERSPEED ALARM

This unit activates when your vehicle's engine or road speed exceeds pre-set limits.

THE ETI OVER-SPEED ALARM is designed for use in petrol-engined vehicles fitted with 12 volt negative-ground electrical systems only. It is driven from the engine's contact-breaker points, and can be set to activate when the engine RPM exceeds a pre-set limit, or when the vehicle's top-gear road speed exceeds one of four pre-set values.

The unit switches on a LED and energises an optional load, such as a relay or an audible warning device, when it is activated.

The over-speed alarm is inexpensive, is easy to build and is quite easy to install in the vehicle.

Construction, Installation And Use

Before starting construction, note the following points and add or delete components to or from the design as appropriate.

(1). If you intend to use the unit purely as a single-range excess-RPM alarm, delete SW1 and RV2 to RV4 from the circuit, and connect pin 3 of the IC to ground via RV1 and R6. In this case the circuit's positive supply rail can be taken to the vehicle's battery via the ignition switch, so that the system is permanently enabled when the vehicle is in use.

(2). If you are going to use the unit as a 4-range excess road-speed alarm, note that the system works on the assumption that you will always be in top gear when you exceed a speed limit and is thus designed to be effective only when the vehicle is in top gear. In this case, therefore, the unit's positive supply rail should be taken to the vehicle's battery via the ignition switch and an on/off switch. The on/off switch can either be a manually-operated type, or can be a microswitch that is activated by the vehicle's gear lever.

(3). If you decide to fit the unit with an optional load, such as a relay or an audible warning device, the load must have an impedance greater than 100R.

(4). The C2 value of the circuit must be chosen to suit the required RPM trigger range of your vehicle. A value of 100n enables an RPM span of 1500 to 6000 to be covered on a 4-cylindered 4-stroke engine. If your vehicle is an 8-cylinder 4-stroke, or a 4-cylinder 2-stroke, halve the value of C2 to get the same RPM span. ▶

PARTS LIST

RESISTORS (All ¼W5%)

R1, R2, R8	10k
R3, R4, R10	22k
R5	270R
R6	27k
R7	4k7
R9	470R
R11, R12	12k

POTENTIOMETERS

RV1-4	100k sub min presets

CAPACITORS

C1	22n polyester
C2	100n polyester (see text)
C3, C4	1u0 63V electrolytic

SEMICONDUCTORS

IC1	LM2917N
Q1	BC184L
ZD1	BZY88 12V
D1	1N4148
LED1	0.2" standard red LED

MISCELLANEOUS

SW1, single pole 4-way rotary switch.

BUYLINES

The LM2917N can be obtained from Maplin Electronics. The optional load is a 12V, 15mA audible warning device available from most major mail order companies, as are all the rest of the bits.

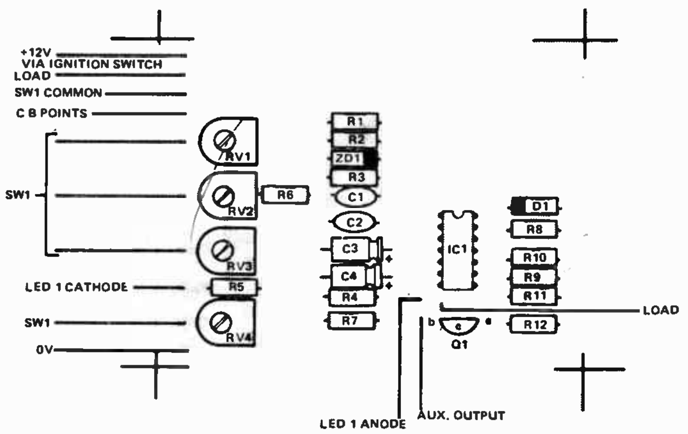
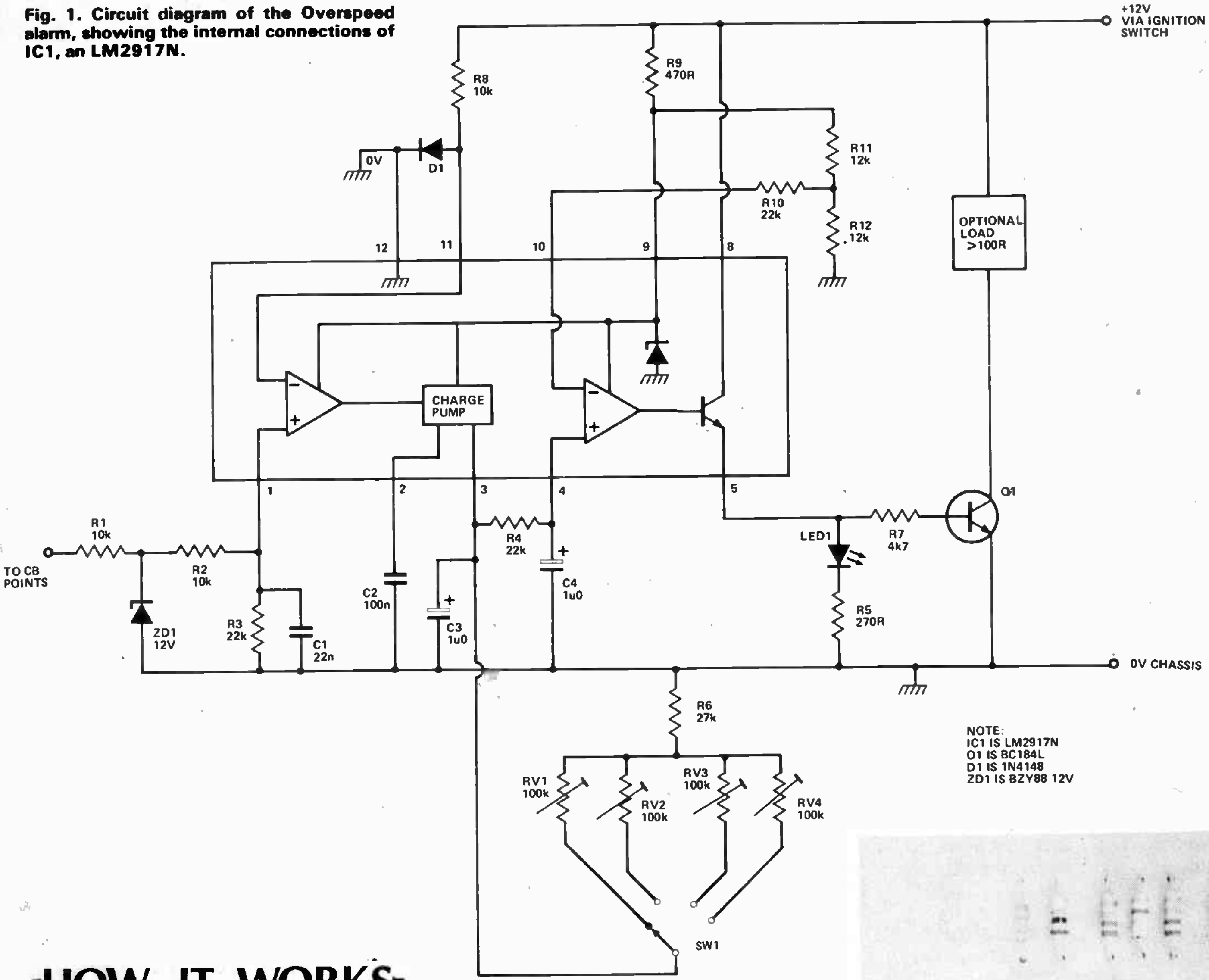


Fig. 2. Component overlay.

Fig. 1. Circuit diagram of the Overspeed alarm, showing the internal connections of IC1, an LM2917N.



HOW IT WORKS

The over-speed alarm works by detecting the engine RPM rate via the vehicle's contact-breaker points, converting the resulting C-B frequency into a linearly proportional voltage and feeding this voltage to a comparator that trips and activates a LED and an audible warning device when the voltage (and thus the RPM) exceeds a pre-set value.

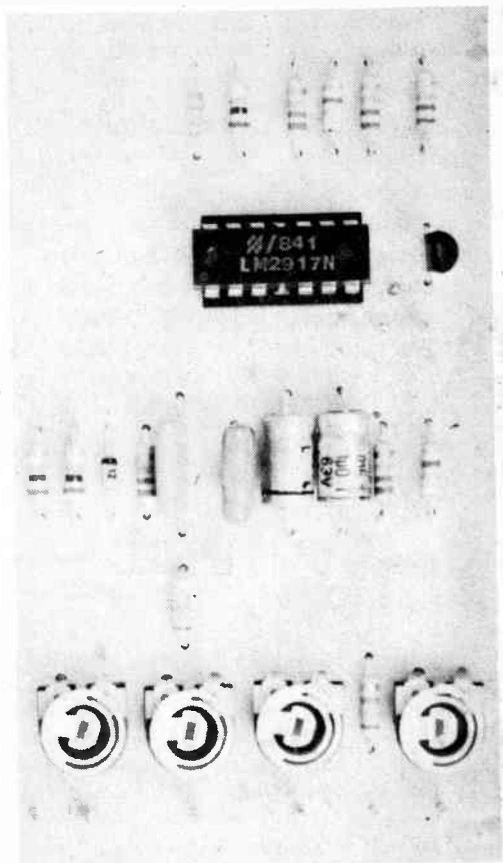
The assumption is made that the unit will only be used as an excess road-speed alarm when the vehicle is being driven in top gear (the engine RPM is directly proportional to road speed). In this case the unit's positive supply rail connection should be broken when the vehicle is not in top gear.

Most of the work of the unit is done by IC1, a frequency-to-voltage converter chip. Components R1-ZD1-R2-R3 and C1 'condition' the contact-breaker signal and make it suitable for driving the chip. C2 and RV1-RV4 and R6 determine the frequency-to-voltage conversion rate of the IC and C3-R4-C4 remove ripple from the resulting DC signal that is fed to one side of the IC's voltage comparator stage. The output of the IC is used to drive LED 1 and to switch on Q1, which is capable of providing a 120 mA load current.

One you've sorted out these four points, you can go ahead with the construction and installation of the unit. Construction is simplicity itself, and should present no problems.

Installation is simply a matter of connecting the unit's 0-volt line to chassis, the positive rail to the vehicle's battery via the ignition switch (and possibly an on/off switch), the input to the vehicle's contact-breaker points and the output to a suitable audible warning unit as already described.

Calibration of the unit is a two-man operation, with one driving the vehicle to the required trip speeds and the other adjusting the unit's pre-set pots to give the required trigger action! ●



GUITAR EFFECTS UNIT

Our guitar effects unit isn't just a fuzz box. Use it to give you a new sound to play with.

LIKE US, YOU probably thought that one guitar effects unit was much the same as any other. After fuzz and Wah-Wah, what do you do? Well, we think we have come up with a new one, which we have christened ***struzz.***

With this unit you can select either a conventional fuzz effect or our new struzz effect. A depth control allows you to alter the sustain rate of the effect. If the neighbours start banging the wall, you can instantly cut out the crunchy effects with a bypass switch.

PARTS LIST

RESISTORS (All 5% ¼W)	
R1	680k
R2	6k8
R3	270R
R4, 6, 10, 11, 12	10k
R5	3k3
R7	100k
R8	39k
R9	820R
R13, 14	1k
POTENTIOMETERS	
RV1	1M0
CAPACITORS	
C1, 3	1u0 63V electrolytic
C2	560p polystyrene
SEMICONDUCTORS	
Q1	BC109
IC1	741
IC2	LF356
D1, 2	IN4148
SWITCHES	
SW1	SPDT Footswitch
SW2	SPDT
SW2	DPDT
MISCELLANEOUS	
Two ¼in. mono jack sockets	
PCB	
Verocase to suit	

Smashing sound

Now you are wondering what struzz sounds like, aren't you. Well, it's a distortion of fuzz. The fundamental frequency of the input is full wave rectified but the numerous harmonics are not. The result sounds rather like an antique piano finally succumbing to the ravages of woodworm, and collapsing. If you play the guitar (we don't) you will, no doubt, find many more musical uses for this effect than we could.

Switching between fuzz and struzz while playing produces an interesting sound. You might like to use a footswitch for this purpose.

Make-up

Construction should not pose any problems. It's even easier if you use our PCB. Make sure the electrolytic capacitors are put in the correct way round. As always, don't plug in the ICs until you have checked the circuit thoroughly.
Happy fuzzing and struzzing. ●

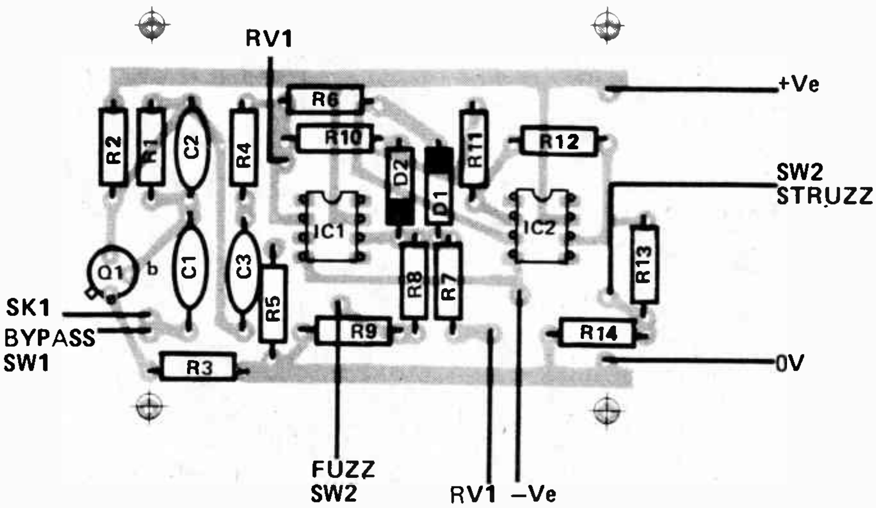
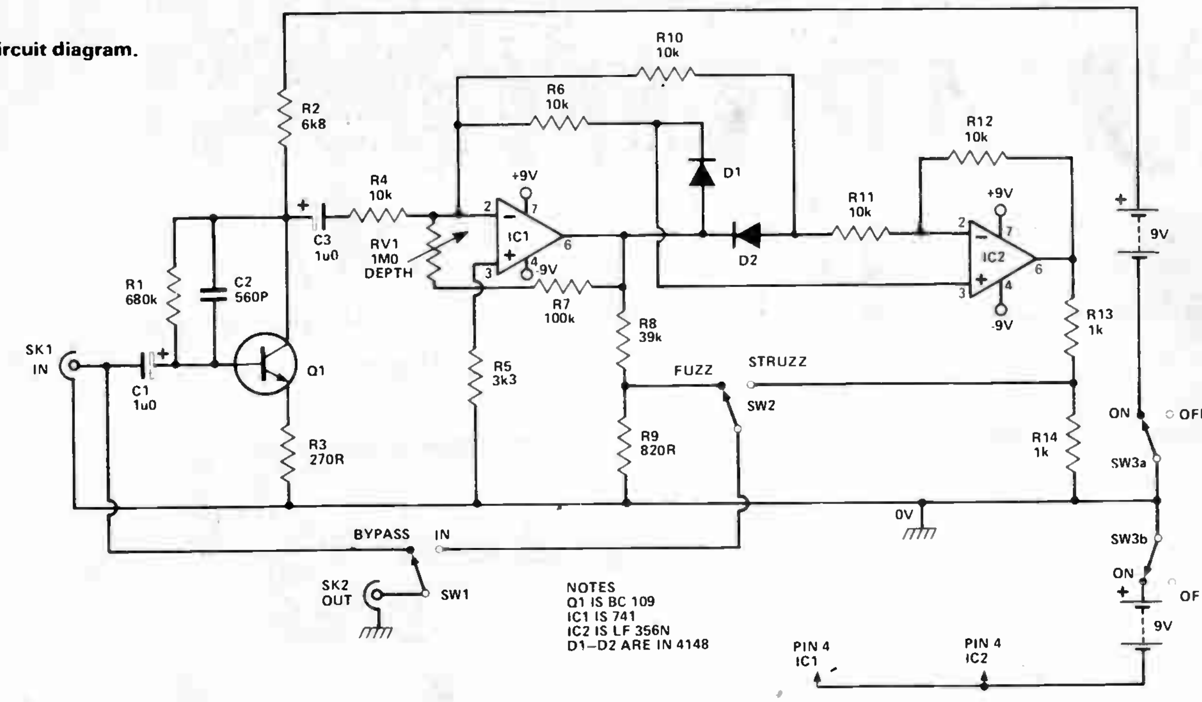


Fig.1. (above) PCB component overlay

Fig. 2. Circuit diagram.



HOW IT WORKS

THE SIGNAL from the guitar pick-up is fed to common-emitter amplifier Q1 via blocking capacitor C1. Q1 has a voltage gain of about twenty-five, and brings the guitar signal up to a reasonable level for driving the fuzz and struzz circuitry. The upper frequency response of Q1 is restricted by C2, in the interest of circuit stability.

Operational amplifiers IC1 and IC2 are wired together as a 'precision' full wave rectifier, with its true output signal appearing at pin 6 of FET op-amp IC2. A very heavily clipped version of the input (Q1 collector) signal appears at pin 6 of IC1, and has a peak-to-peak amplitude of about 1.2 volts. RV1 enables the small-signal voltage gain of IC1 to be varied from ×10 to about ×110, and controls the depth and 'sustain' characteristics of the sound effect unit: IC1 has a 'large-signal' gain of unity.

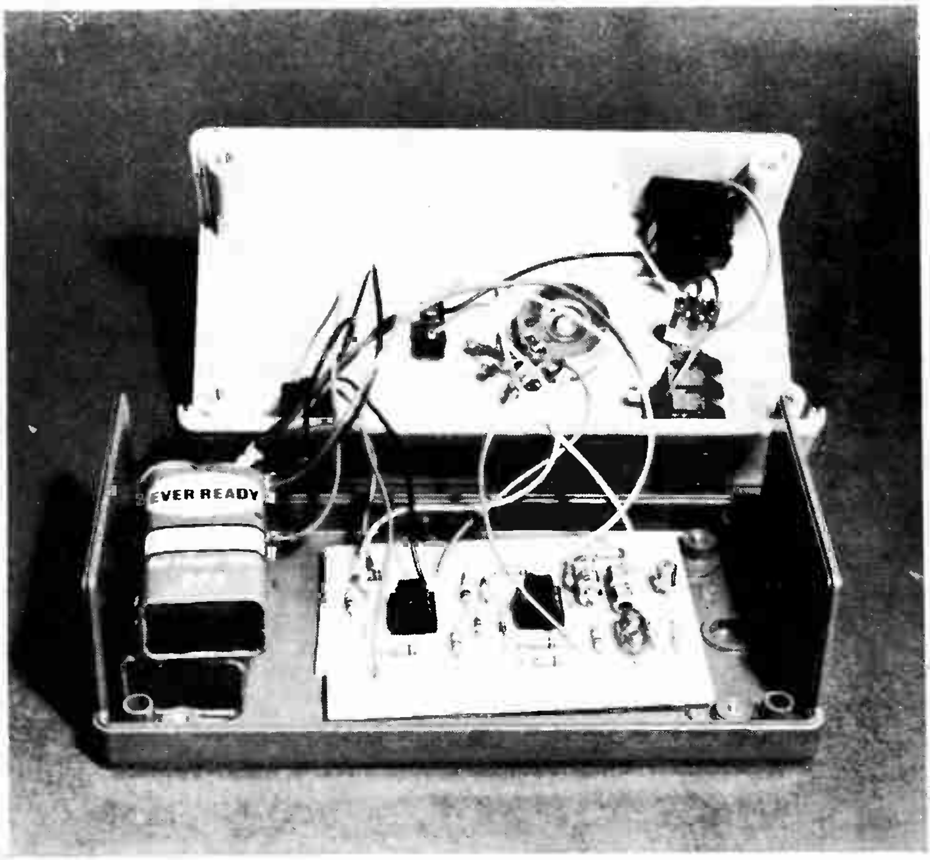
The fuzz output of the unit is taken from the output of IC1 via potential divider R8-R9, and is a perfectly conventional, heavily-clipped, fuzz signal, with variable depth and sustain. The struzz output, on the other hand, is very unusual, and is taken from the output of IC2 via potential divider R13-R14. In the struzz mode the original guitar signal is full-wave rectified, so that its fundamental tone (which passes through zero cross-over points in each cycle) has its frequency doubled, but the overtones (which modulate the fundamental and do not pass through zero cross-over points) do not have their frequencies altered. The struzz output signal also has amplitude distortion imparted to it, due to the full-wave rectifier action.

Thus, the fuzz output signal has very heavy amplitude distortion, and the struzz output has both amplitude and frequency distortion. The sound effects unit can be switched in and out via bypass switch SW1, and should be interposed between the guitar and the main amplifier.

BUYLINES

The only component that may be difficult to find is the LF356 FET op-amp. Watford Electronics can supply this IC.

Internal view of the effects unit



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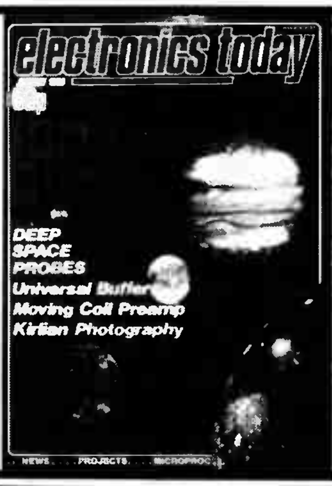
Whether you're a seasoned project builder of many summers or you've just unwrapped your first soldering iron, there's something in ETI for you. From month to month you can find constructional details of projects ranging from simple electronic games to the latest thing in music synthesisers and hi-fi amplifiers. Just pick the one that suits your needs, your pocket and your ability.



There's more to ETI than projects, though. Keep up to date with what's going on in the world of electronics with the regular features – Dave Raven of Metac Electronics brings news from the electronics industry in 'Raven On . . . .', while Ray Marston's 'Designer's Notebook' gives you the inside story on the problems of project design and development and Ron Harris keeps you abreast of the latest developments on the hi-fi front.

EVERY MONTH . . . .
FEATURE . . Designer's Notebook
FEATURE . . . . Audiophile
FEATURE . . . . Raven On
FEATURE . . . . Microfile
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FEATURE . . . . Digest

CAR IMMOBILISER

Here's a low-cost project that gives your car good protection against joy riders and a drunken driver.

THE ETI AUTOMATIC CAR Immobiliser is an inexpensive but highly original car protection device. It has been designed to prevent a car being driven away by the 'joy rider' type of thief, or by a drunken owner-driver. Major features of the design are lack of circuit complexity, low building costs, and simple installation of the unit in any vehicle.

The circuit is designed to immobilise a vehicle's ignition system, by shorting out its contact-breaker points via a pair of relay contacts, as soon as the ignition is turned on. The owner then has five seconds to turn the immobiliser off by sequentially operating a set of four push buttons. If the four buttons are not correctly operated within the five second period, the ignition system remains immobilised and the vehicle's engine cannot be started. The automatic immobiliser timing sequence restarts each time the ignition is turned on.

There are four basic concepts behind the ETI Automatic Immobiliser system. The first of these is that, since the immobiliser activates automatically as soon as the vehicle's ignition is turned on, the vehicle is given a good degree of protection against the drive-away car thief, even if the owner leaves the car doors open and leaves the ignition key in its lock.

The second concept is that a thief entering the vehicle will have no idea of the purpose of the four push-button switches associated with the immobiliser, so these switches can be quite openly displayed on the vehicle's instrument panel, together with a LED that tells its legitimate owner the immobiliser circuit state.

Thirdly, because only five seconds are available to de-activate the immobiliser via the four sequentially-operated switches after first turning the ignition on, the system gives a good deal of protection against the fumble-fingered drunken owner-driver.

The final concept is that, because of the three factors already outlined above, the final circuit does not need to be super-sophisticated or to have an unbreakable 'key' sequence network in order to be highly effective in its functioning. Simplicity and effectiveness are thus the key features in the design of this ETI Automatic Immobiliser unit. ▶

PARTS LIST

RESISTORS (All ¼ watt 5%)

R1	1M0
R2	560k
R3, R4, R5, R6	100k
R7,10	47k
R8	270R
R9	680R

CAPACITORS

C1	100n polyester
C2	10u 16V electrolytic
C3	220u 16V electrolytic

SEMICONDUCTORS

Q1	BC109
Q2	2N3053
IC1, IC2	4013
D1	IN4001
ZD1	BZY88 C9V1 400mW 9 volt zener

MISCELLANEOUS

PB1, PB2, PB3, PB4	push to make pushbutton switches
RLA	12V relay with contacts rated at 3A (see text)

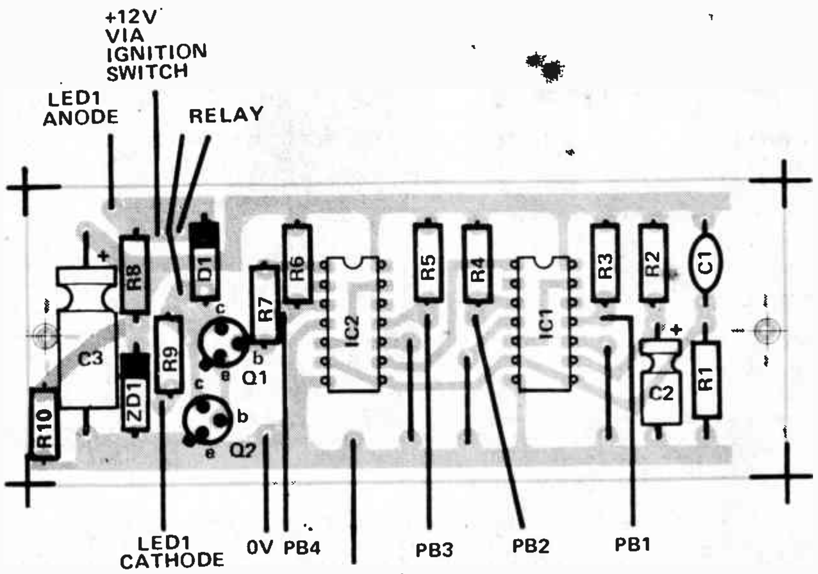


Fig. 1. Component overlay.

BUYLINES

No problems whatsoever with any of the parts for the Car Immobiliser, Maplin and Watford should be able to supply all the parts. The case is very much up to the individual, a strong watertight case however is essential to prevent any 'false alarms' due to ingress of water.

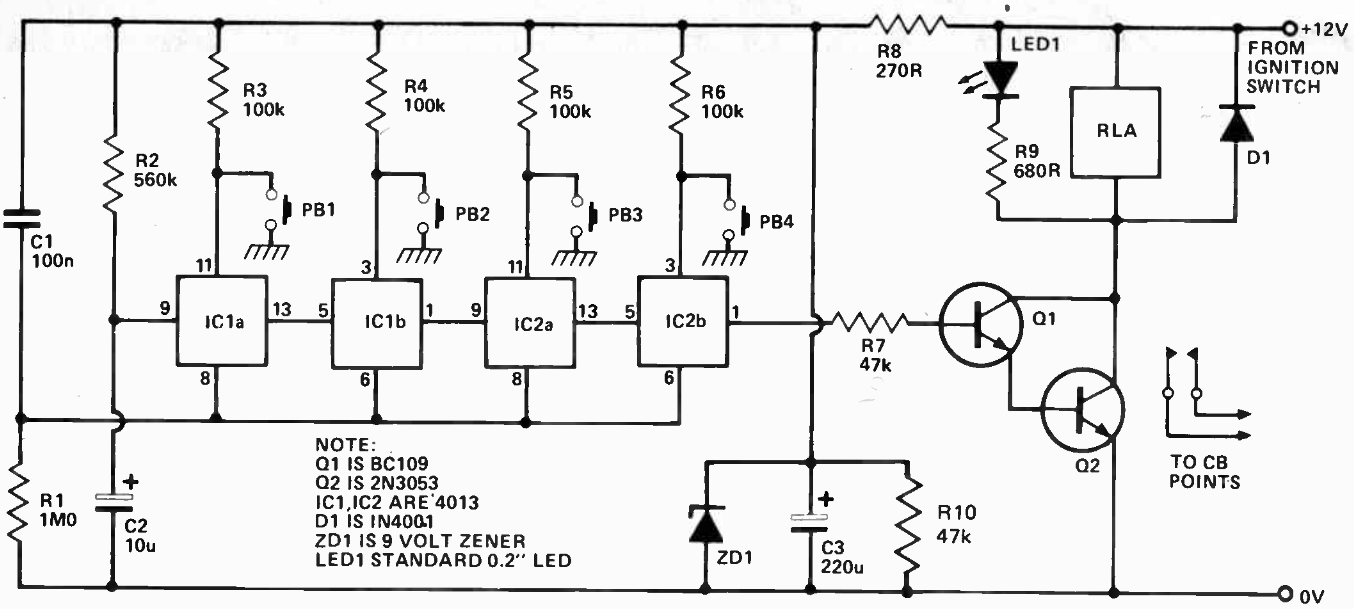


Fig. 2. Circuit diagram for immobiliser.

Construction

There should be no problems here. The relay can be any 12-volt type with a coil resistance greater than 100 ohms, and with one or more sets of normally-open contacts. The PCB and relay can be fitted in a metal box, or can be simply mounted on an aluminium plate that is screwed to the rear of the vehicle's instrument panel.

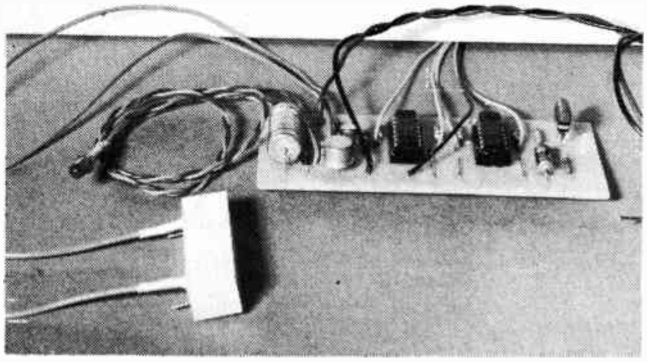
The unit's 12-volt rails must be connected to the vehicle's supply via the ignition switch. The normally-open relay contacts should be connected across the vehicle's contact breaker points. The LED and the four push-buttons can be mounted on the vehicle's instrument panel, either directly or via a screw-on panel. ●

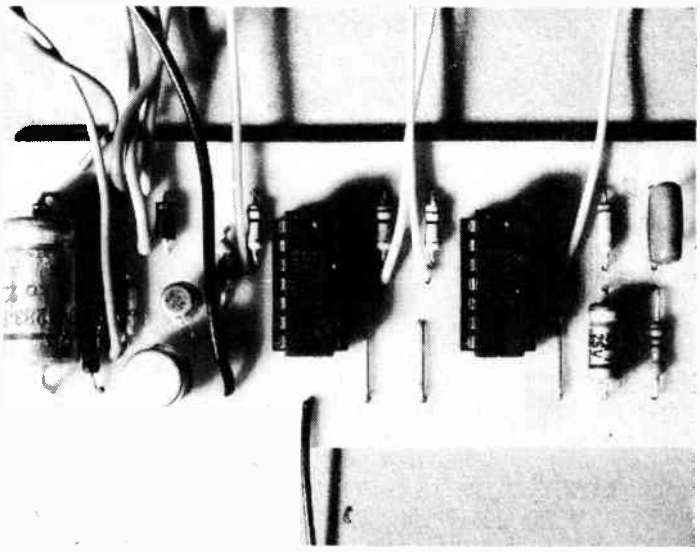
HOW IT WORKS

The circuit is designed around the 4013 D type flip-flop. It derives its power from the car battery via R8 with stabilization provided by ZD1, C3. The chip features direct set and clear inputs and complementary outputs. Data at the D input is transferred to the outputs on the positive going edge of the clock. The clear inputs are not used in this design and are tied to ground, the set inputs are connected together to the junction of R1, C1. This ensures that on switch-on the flip-flops will start up in the same state and a high level, logic 1, will be present at the output of IC2b. This voltage is fed to the base of Q1 via R7 and will cause the relay to turn on, disabling the car. Q1 and Q2 are connected as a super-alpha pair which effectively produces a super high gain transistor whose gain equals that of Q1 multiplied by Q2. D1 protects the transistors against the back EMF of the relay. System status is indicated by LED1.

To re-enable the system and start the car a logic 'O' must be present at the output of IC2b. This is produced by passing it down the line from the input of IC1a by depressing PB1, 2, 3 and 4 in turn. A novel feature is introduced here. At switch-on C2 is discharged and IC1a will see a low level logic 'O' at its input. This must be transferred to the output by depressing PB1 before the voltage rises above the transition level of the D input as C2 charges via R2. If PB1 is not depressed until about five seconds after switch-on then the junction of R2, C2 will present a logic '1' disabling the system until power is removed and re-applied. To make the system really difficult to beat, resistor, capacitor networks could be inserted between stages. R10 is included to discharge C3 when the ignition is switched off. Without this, the stored charge is sufficient to run the CMOS chips for at least 20 minutes.

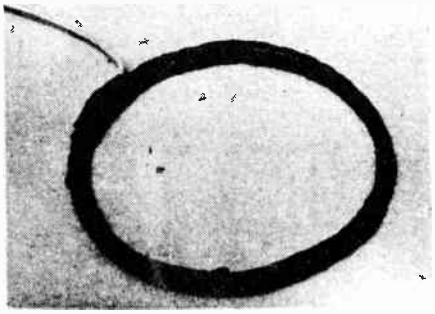
ETI A.I.





Extend Buzby's influence with our

TELEPHONE BELL EXTENDER



MANY TIMES WHILE you're working in the garden the phone may ring and by the time it is heard, if it is at all, it is often too late to reach the phone. While the GPO will install a remote bell for you it has to be rented and for people who are hard of hearing it may not be loud enough.

This bell extender will allow you to add, without touching the phone, an external bell, buzzer or speaker anywhere it is desired. When using a horn loaded speaker the sound level is high enough to be heard over high ambient noise making it ideal for the industrial environment.

Adjustment

There are two controls to be set, these being sensitivity and volume. The volume can be set first by rotating RV1 until the tone starts then adjusting RV2 to give the desired volume. To adjust the sensitivity first tape the sensor coil to the underside of the phone and then adjust RV1 until the sound stops. Note however that it should be rotated slowly as C3 gives a delay on switch off. Check that picking up and replacing the phone does not operate the alarm then get someone to ring you to check that the phone tone does. It may be necessary to experiment with the position of the pickup coil to get the best results.

Construction

While any construction method could be used we recommend that the PCB board be used and the overlay in Fig. 1 be followed. The pickup coil was made out of 0.125 mm enamelled wire, although the gauge is not important, with about 200 turns wound around a former about 50 mm diameter. The former can then be removed, the wires terminated in some thin plastic insulated wires (twin "bell" wire is ideal) and then the complete coil wrapped with plastic insulation tape.

We built our unit into a small plastic box using an external speaker The unit can be mounted anywhere suitable, taking care however with the 240 V wiring. The speaker used will depend on the volume required with a larger speaker producing more sound. If a horn speaker is used a very high sound level can be produced.

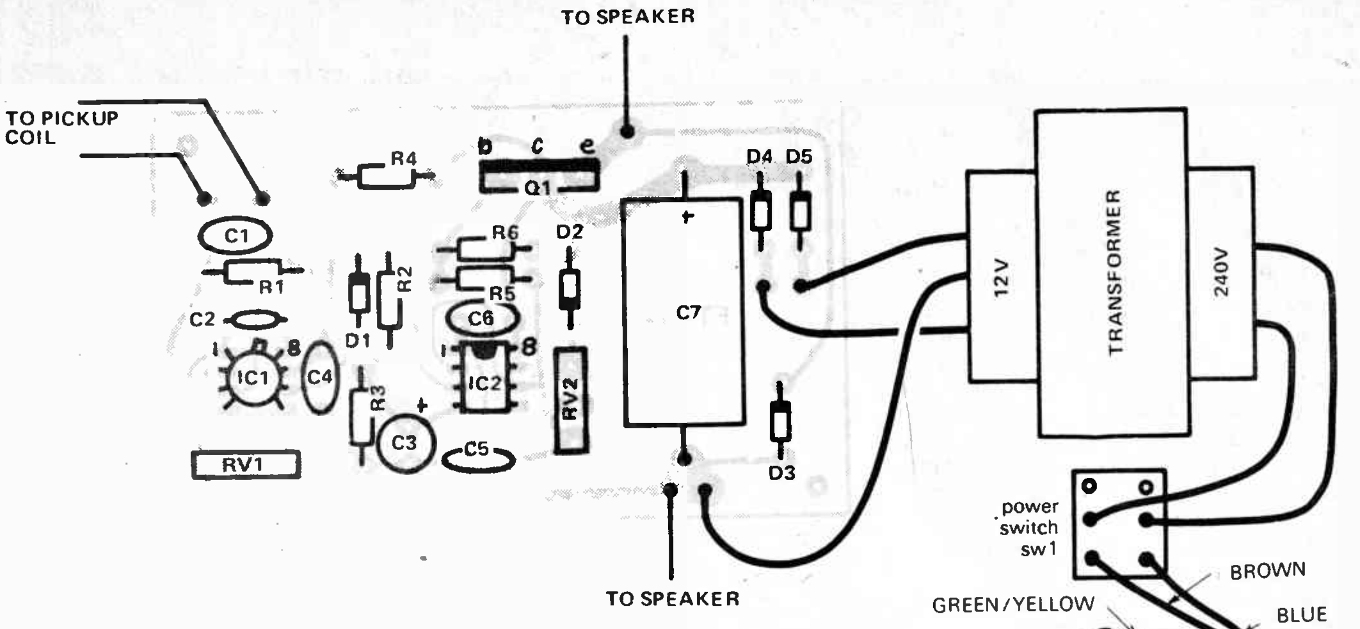
If it is required only to operate a buzzer the second IC can be altered to be an on-off device by deleting C5, R5, R6, D2 and RV2 and fitting a link in place of C5. ●

HOW IT WORKS

Inside the telephone there is a solenoid which operates a striker which hits a pair of bells to give the ring tone. When it operates there is a high magnetic field generated and we detect this field to give the indication that the bell is ringing. To do this we use a coil wire under the telephone and use an IC to detect the presence of a signal. IC1 has its offset voltage adjusted by RV1 such that a slight positive voltage is needed to make the output go high. It is used in the open loop mode as a comparator only. The capacitor C1 is used to remove the unwanted higher frequency signals.

The oscillator used to operate the speaker is simply a 555 timer with a TIP3055 to buffer the output. The frequency is determined by C5 and the volume by RV2. Changing the volume does change the frequency slightly. Oscillation can however only occur if the voltage at pin 4 is greater than 0.6V. If the output of IC1 is low, R3 ensures that pin 4 is less than this voltage. However when the bell rings the output of IC1 oscillates high and low in time with the ring tone of the bell. This lifts pin 4 high, allowing IC2 to oscillate and C3 holds pin 4 for a short time to prevent the oscillator turning on and off at the ring tone frequency.

The power supply is a simple full wave rectifier with no regulation with IC1 being decoupled further by R4 and C4. Batteries could be used but the drain is reasonably high.



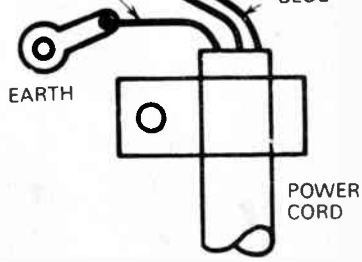


Fig. 1. Component overlay for the Telephone Bell Extender. We have shown IC1 as a TO5 case style but you can use the 8-pin DIL version (It's cheaper too!)

PARTS LIST

RESISTORS (all ½W 5%)

R1	100k
R2	4k7
R3	2k7
R4	47R
R5	27k
R6	100R

POTENTIOMETERS

RV1	100k trim
RV2	5k trim

CAPACITORS

C1, 4, 6	100n polyester
C2	10p ceramic
C3	10u 16V electrolytic
C5	47n polyester
C7	1000u 16V electrolytic

SEMICONDUCTORS

IC1	CA3130
IC2	NE555
Q1	TIP 3055
D1-D5	1N4001

MISCELLANEOUS

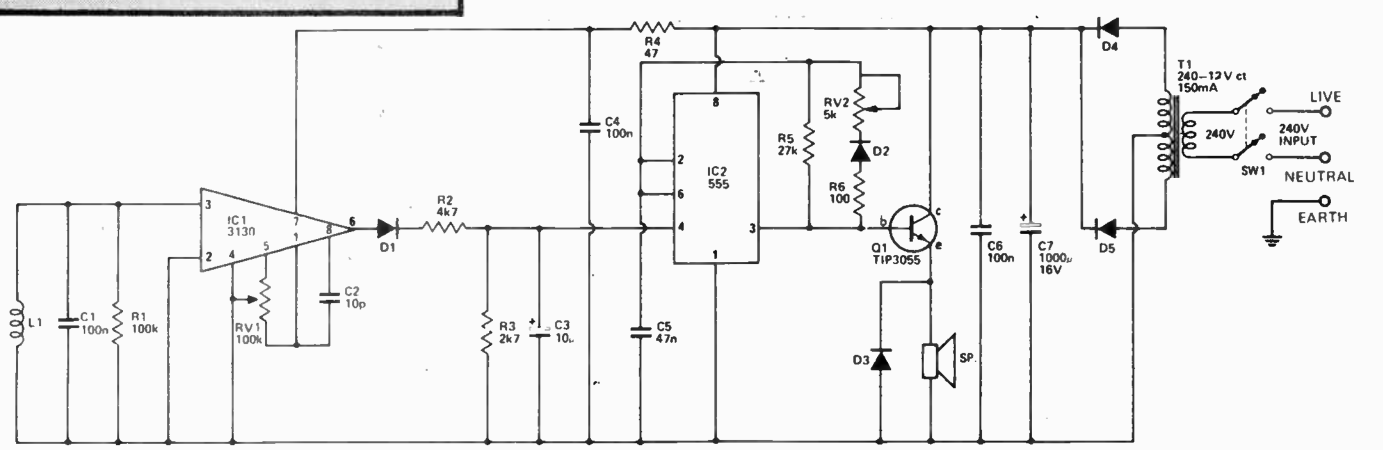
PCB as pattern
Transformer 240V — 12V ct
Mains switch, 3 core flex
Box, speaker, pickup coil

BUYLINES

All the components used in this programme are freely available from component stores and mail order firms.

As the text points out the pick up coil is by no means critical, and most enamelled wire will do, the number of turns being adjusted to achieve a satisfactory performance.

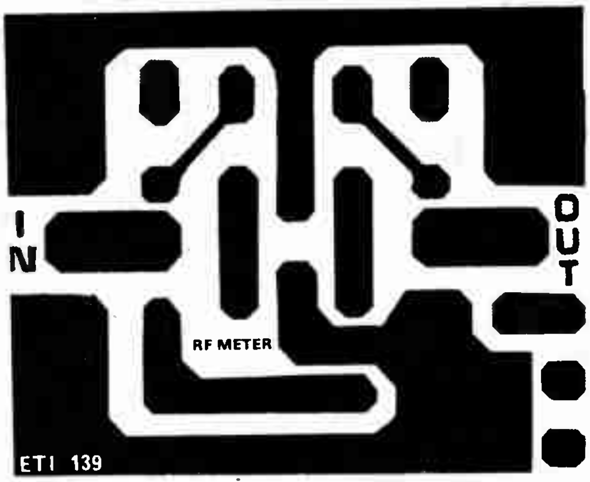
Fig. 2. Circuit diagram for the Bell Extender.

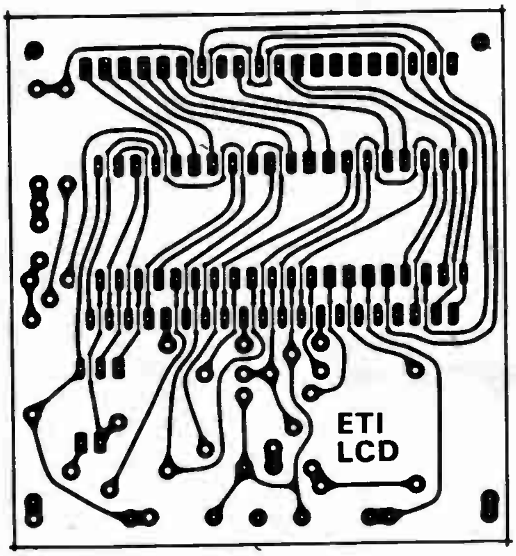


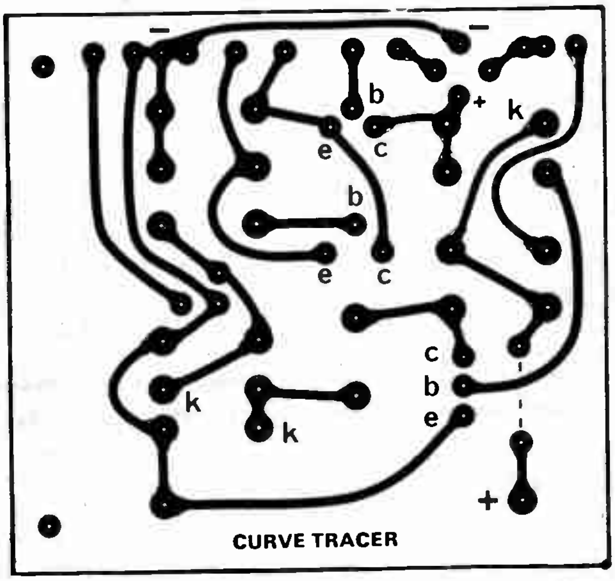
PCB FOIL PATTERNS

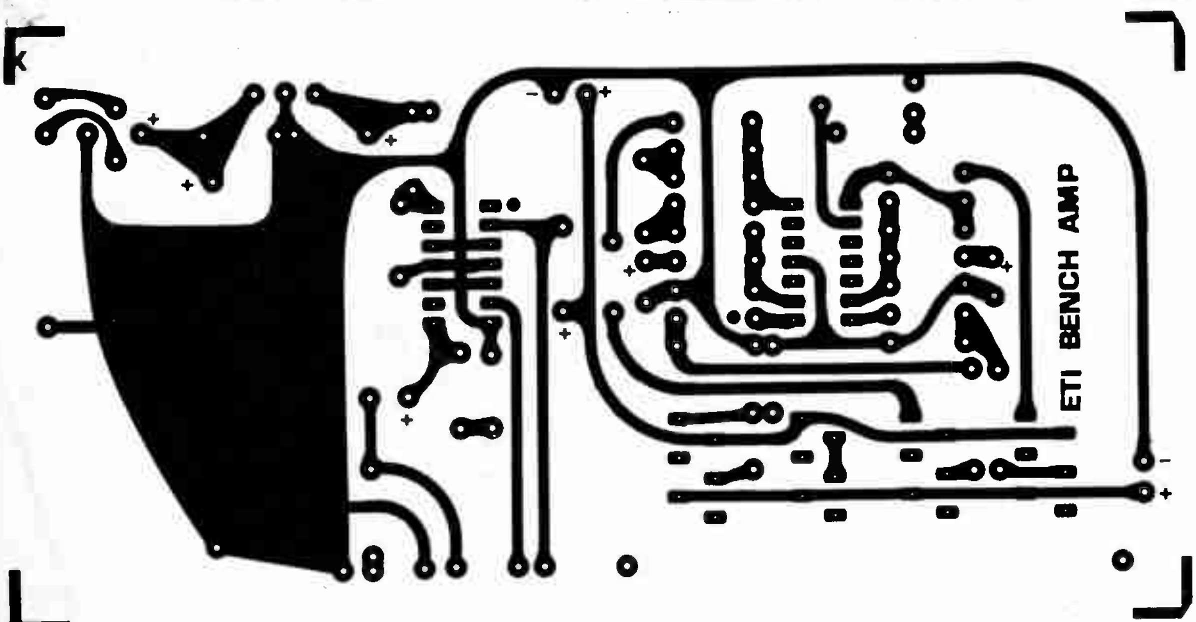
The following pages contain the foil patterns for all of the projects in this magazine that have single sided PCBs. The double-sided boards have been omitted as we have found that most readers prefer to buy these ready-made. However, for those hardy souls who wish to grapple with the problems of accurate registration, foil patterns are available from our Charing Cross Road offices. Please send a large SAE. These projects (Spectrum Analyser, Audio Display and Car Tachometer) will also be available as ETIPRINTS.

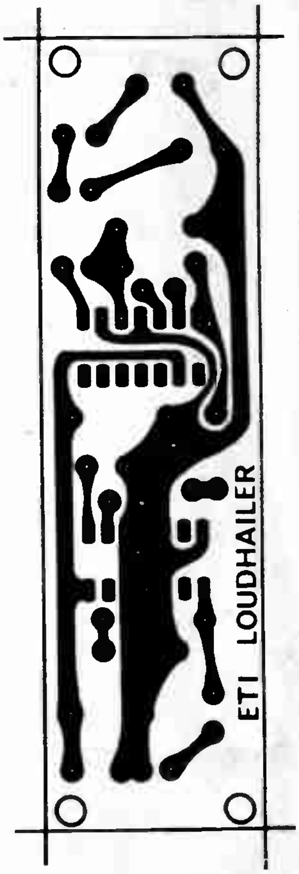
Please note that the PCBs for the Radio Control System are available only from Remcon.

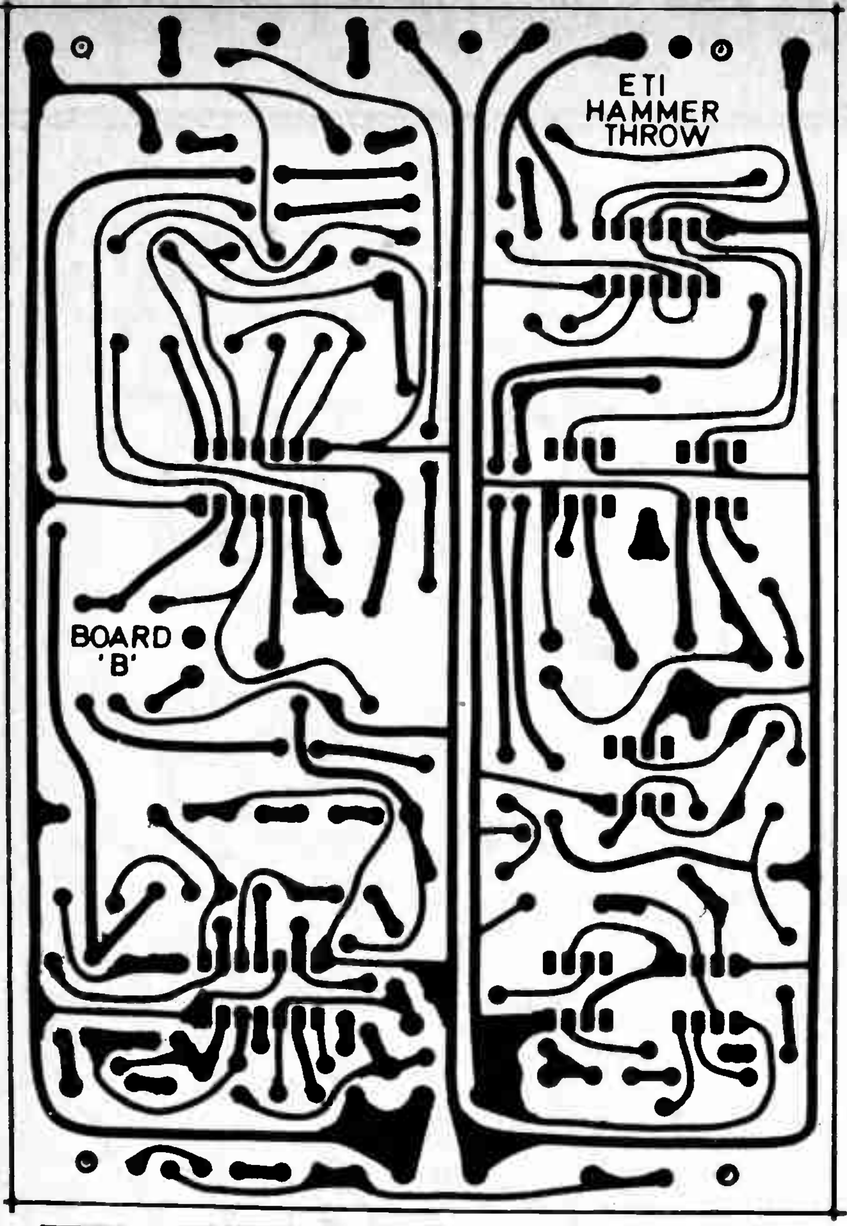


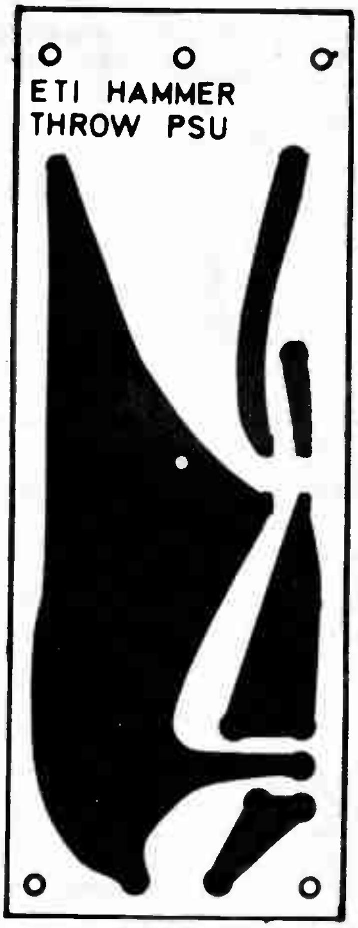


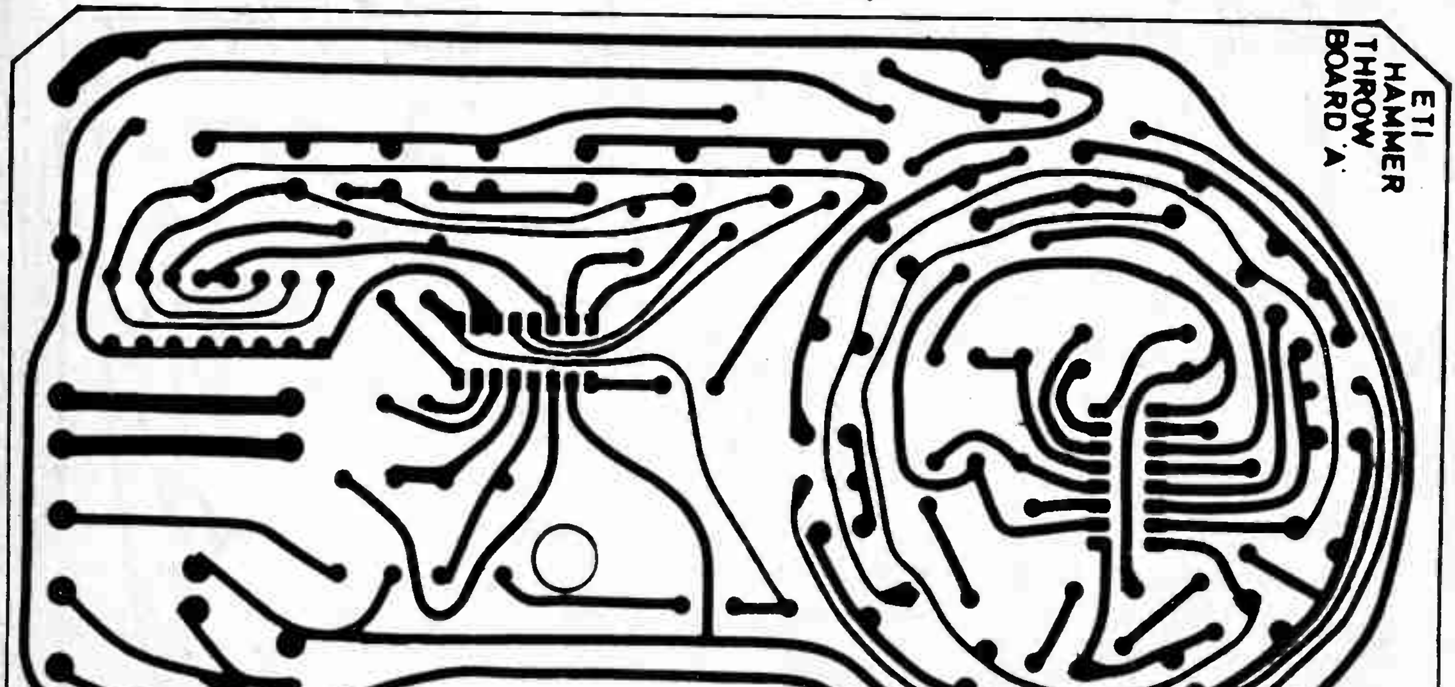


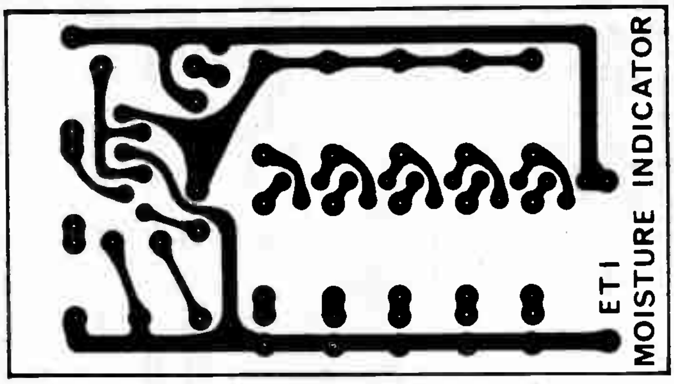


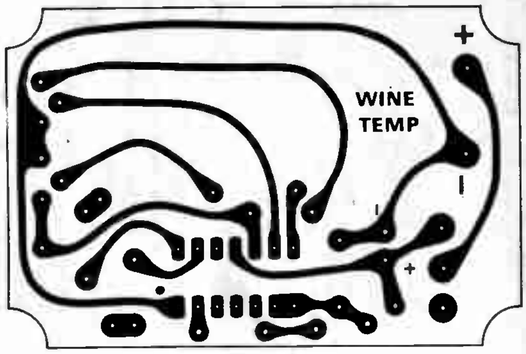


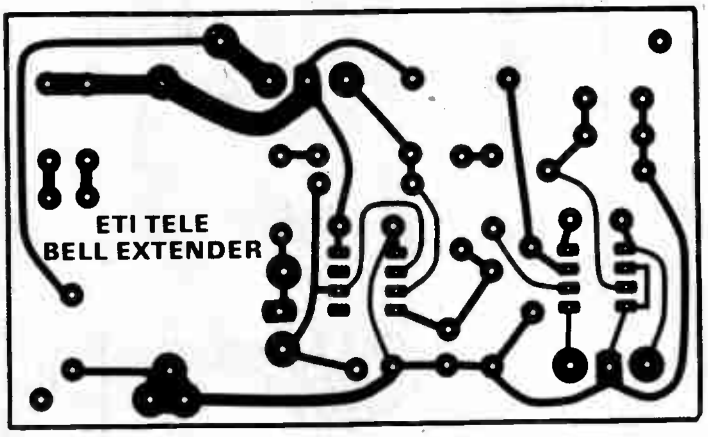

ETI
HAMMER
THROW
BOARD
'B'

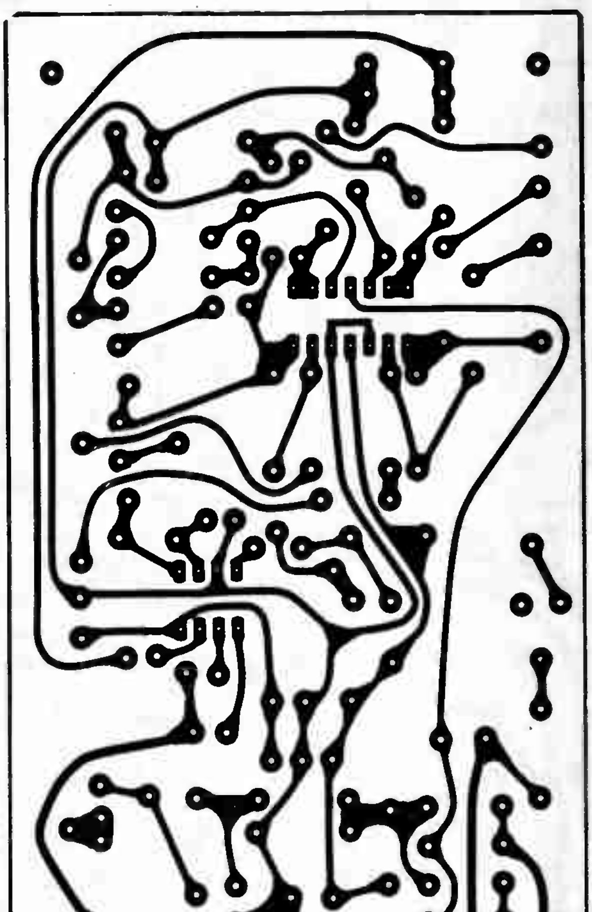

ETI HAMMER
THROW PSU


ETI
HAMMER
THROW
BOARD 'A'


ETI
MOISTURE INDICATOR


WINE
TEMP


ETI TELE
BELL EXTENDER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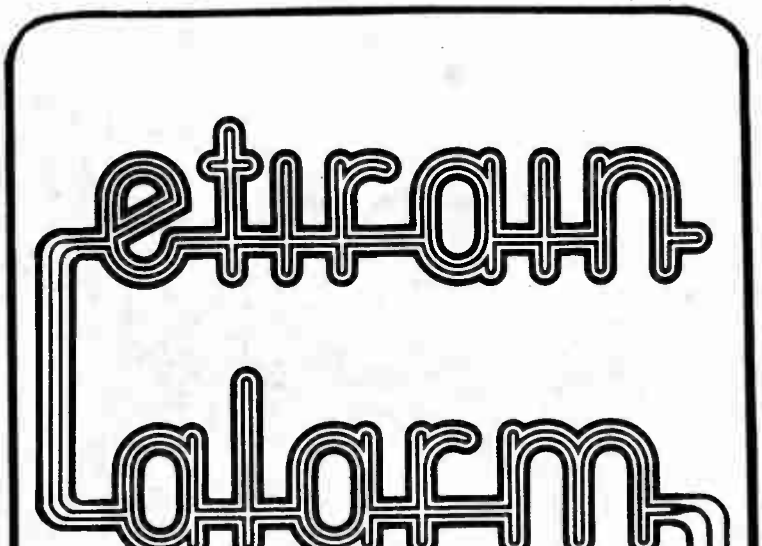
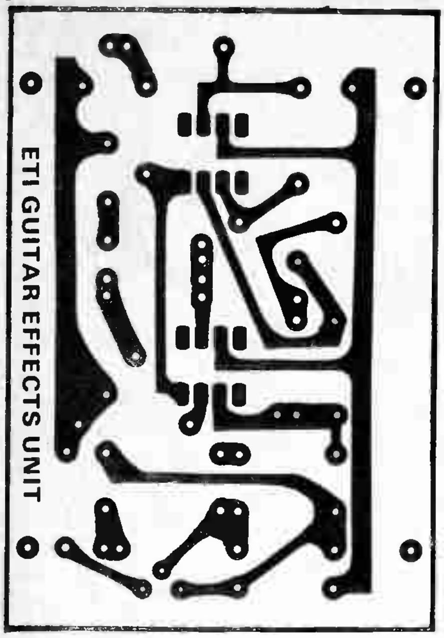
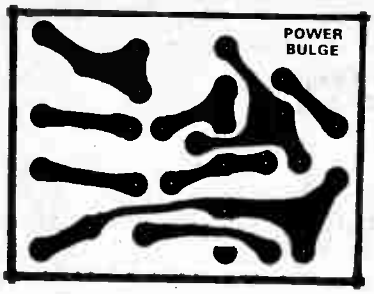
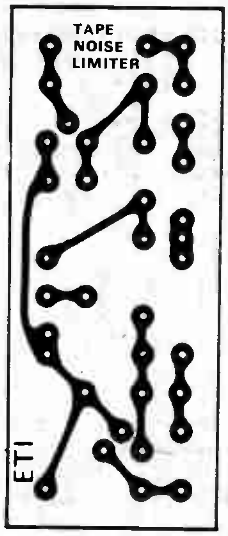
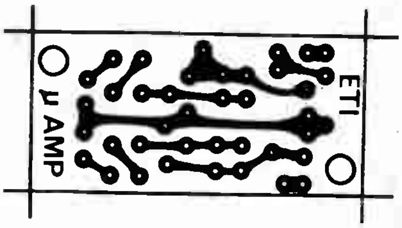
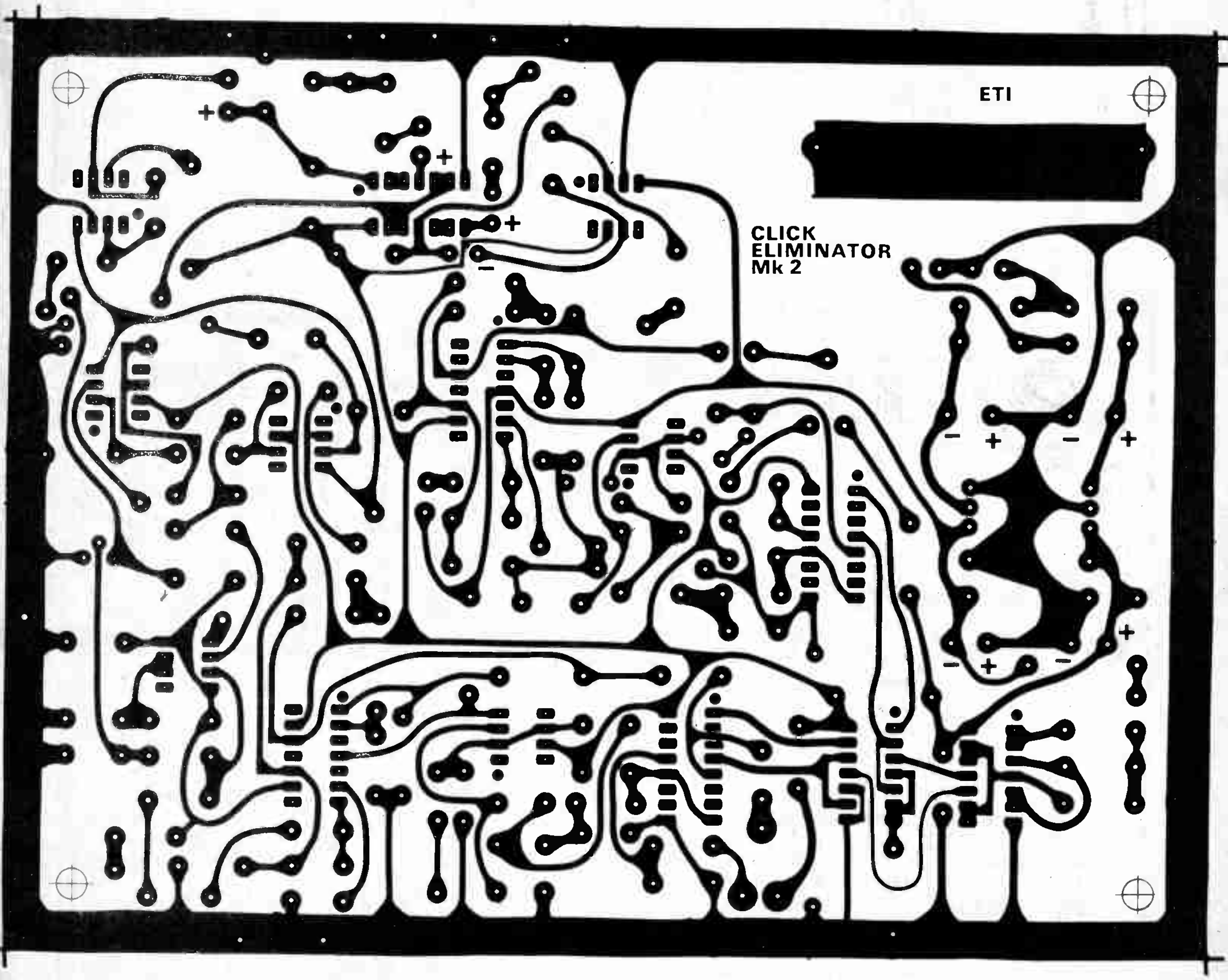

etirain
alarm

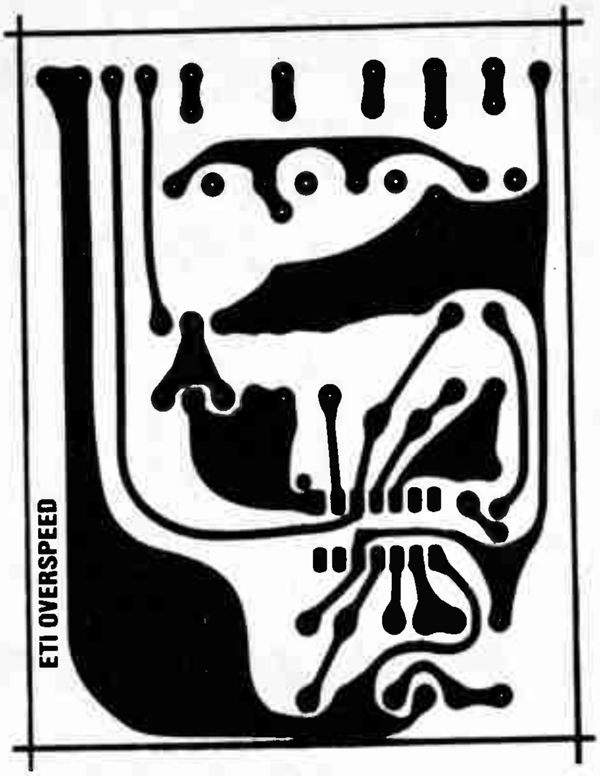

ETI GUITAR EFFECTS UNIT


POWER
BULGE

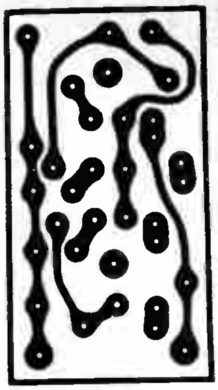

TAPE
NOISE
LIMITER
ETI

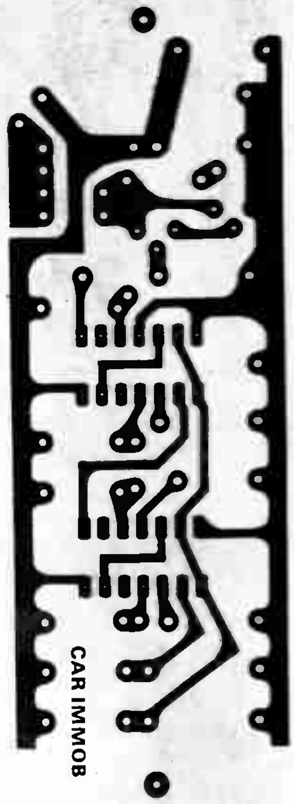

ETI
μ AMP

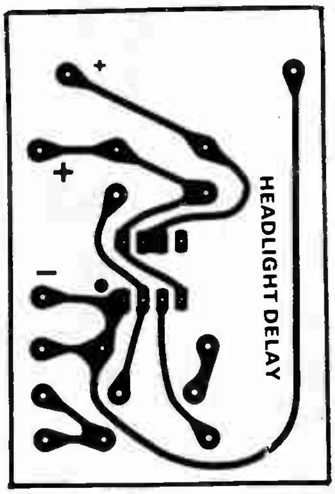

ETI
CLICK
ELIMINATOR
Mk 2

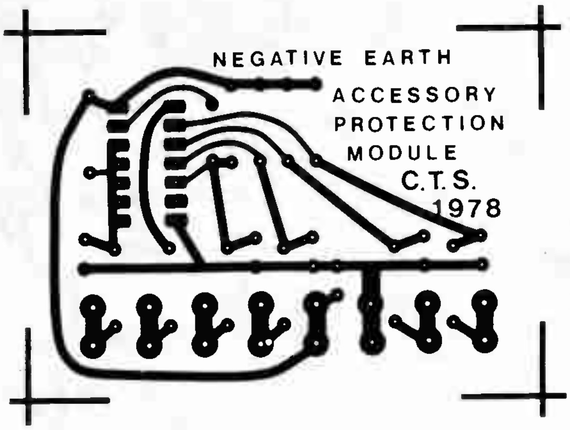


BATTERY INDICATOR

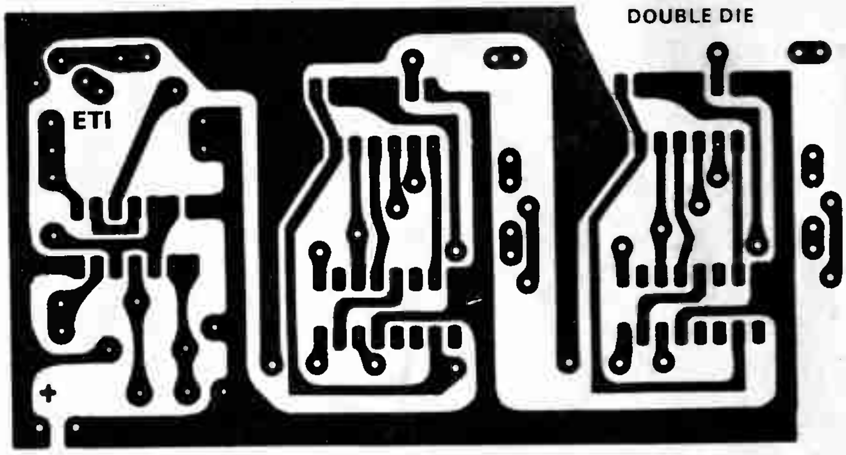


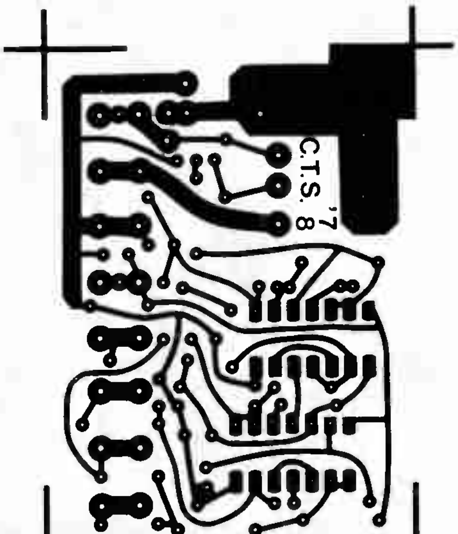


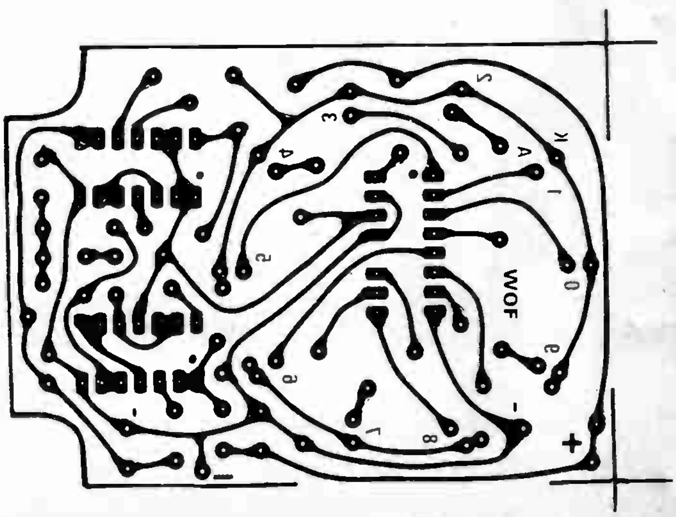




DOUBLE DIE







ETIPRINTS

ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

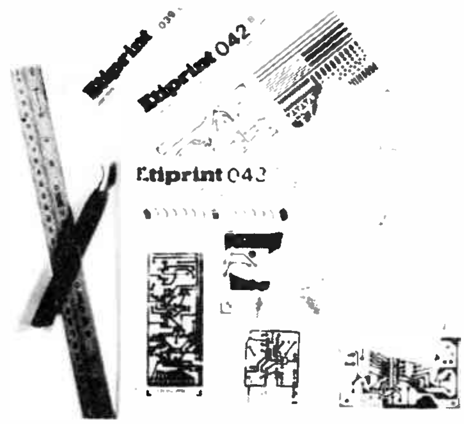
PARTS LIST

Shown below is the listing for the last year's ETIPRINTS.

Earlier sheets are available, ring Tim Salmon for details.

Sheet	Contents	Date
038	Buffer Moving Coil Preamp Process Controller	Jan 80
039A	Hum Filter Logic Probe	Dec 79
039B	Long Period Timer Rain Alarm Touch Switch Flash Trigger Pseudo Random Noise Gen	Dec 79
039C	Function Generator	Dec 79
040A	ETI 80 – VCO and VCLFO	Feb 80
040B	ETI 80 – PSU Tuning Fork Filter Coin Toss	Feb 80
041A	ETI Audiophile ETI VCA Signal Trace ETI HC Electromyogram	Mar 80
041B	VCM Heater Controller	Mar 80
042A	300W Amp Module	Apr 80
033	Fuel Level Monitor, Alarm, Screen Controller Dynamic Noise Reducer	Sep 79
042B	Touch Dimmer, Battery Charger RC Guardian (Top,Bottom) 1&2	Apr 80
043	IR60 preamp, Receiver, PSU, Servo Tester, VU – PPM	May 80
044A	IR60 Function Board (Top & underside) Control Circuit, Line Transmitter, Tape Response Meter Ohmmeter	June 80
044B	FM receiver PSU & Monitor Amp Drum Synth (function board)	June 80

HOW IT WORKS



Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

ETIPRINTS

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