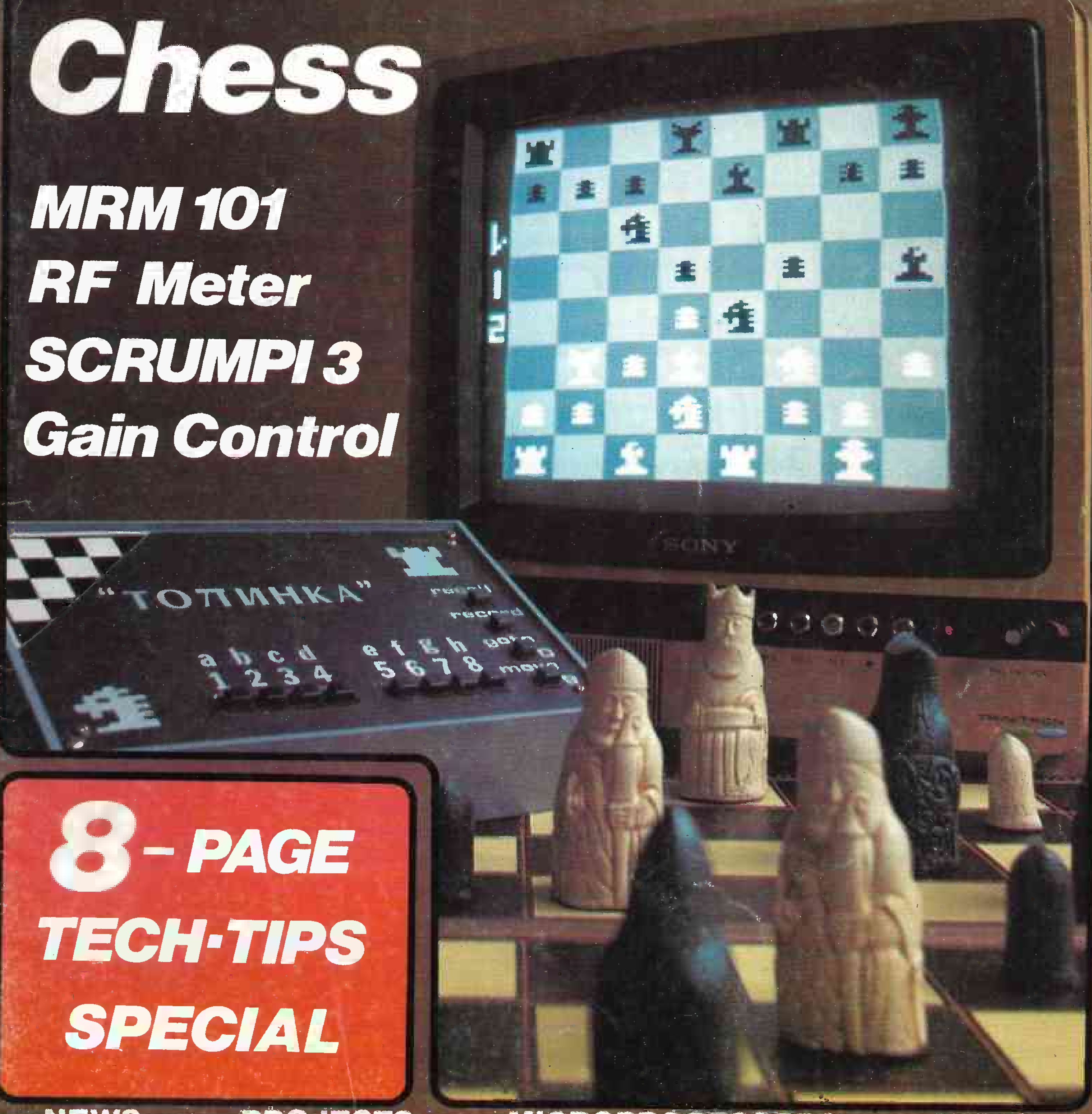
electronics today INTERNATIONAL

OCTOBER 1978

45p

Television Chess



MRM 101

RF Meter

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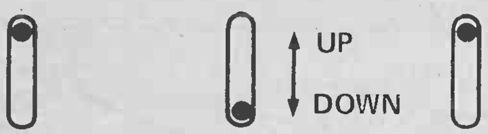


DOWN	DOWN	DOWN	VCO
DOWN	DOWN	UP	SLF/NOISE
DOWN	UP	DOWN	NOISE
DOWN	UP	UP	SLF/VCO
UP	DOWN	DOWN	SLF
UP	DOWN	UP	SLF/VCO/NOISE
UP	UP	DOWN	VCO/NOISE
UP	UP	UP	INHIBIT

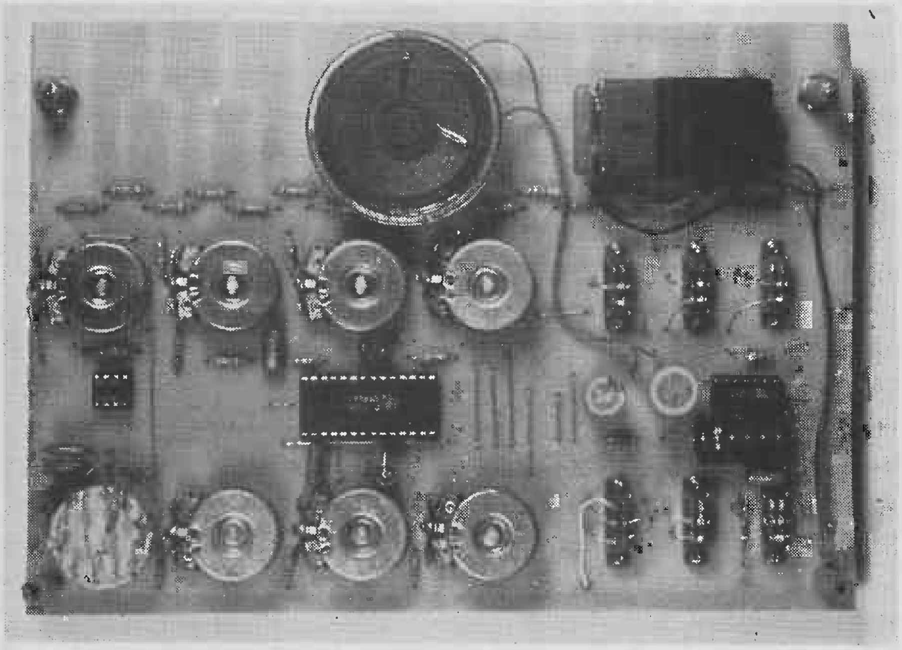
TABLE 1

Set the leftmost mixer switch to down again and move the right hand switch up, the output from the noise generator will now be heard.

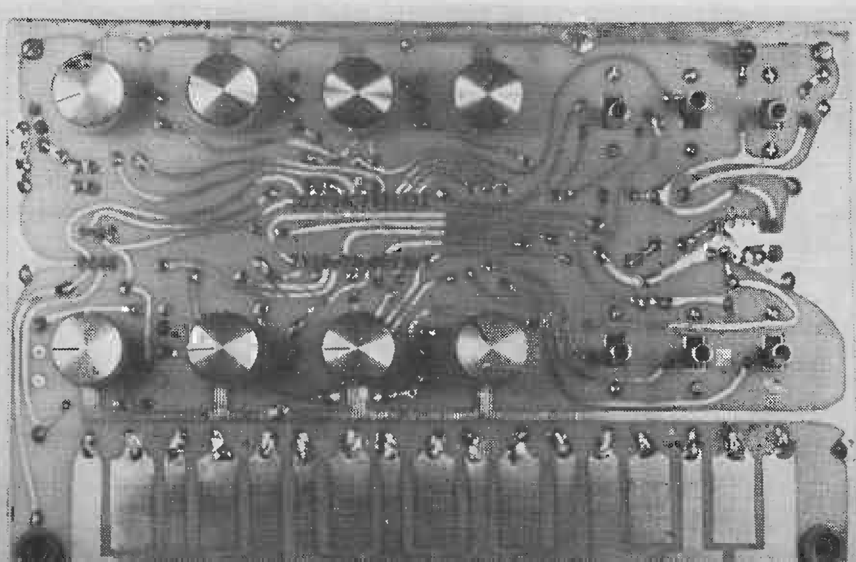
The various combinations of the oscillators and noise source corresponding to the settings of the mixer controls are shown in Table 1.

That then is a run down of the various controls and their effects, its now up to you to put them together and hopefully make a little music.

ETI



Two photographs showing the PCB from above and below. Note the front panel lettering on page 17 is in error — the attack and delay designations being reversed.



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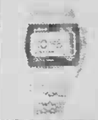

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GAIN CONTROL
PART ONE

THERE ARE MANY cases in signal processing where the control of the gain is necessary. Some common examples are automatic volume controls in cassette recorders and in the IF sections of radio receivers. Also in professional audio equipment there is a whole range of compressor, expander, limiter and noise gate devices which find great use in recording and broadcast studios. Maybe you have wondered how the volume of the music drops when the DJ starts to talk and then fades up again when he stops. This process, known as voice over or "ducking," uses *voltage control of gain*.

Noise reduction systems such as dolby and dBX employ voltage controlled amplifiers. Synthesisers and sound processors obtain effects such as ring modulation, automatic panning frequency shifting, dynamic filtering, tremolo and envelope shaping also by the use of this technique.

Gaining gain

There is a wide variety of methods which can be used to obtain the gain control. This can be anything from constructing the variable gain element yourself from basic parts, to buying IC or module designed specifically to solve your particular problem. Generally the solution is some sort of compromise, because unfortunately the problem of making high performance controlled gain cells (multipliers), is rather difficult and therefore the IC's tend to be rather expensive.

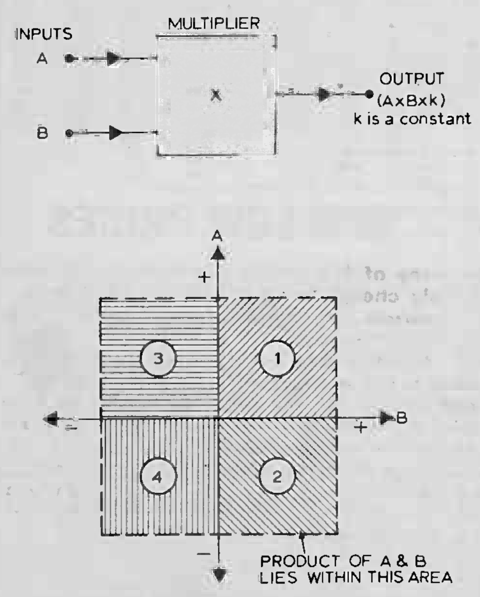
However with a bit of care a cost effective solution can usually be produced.

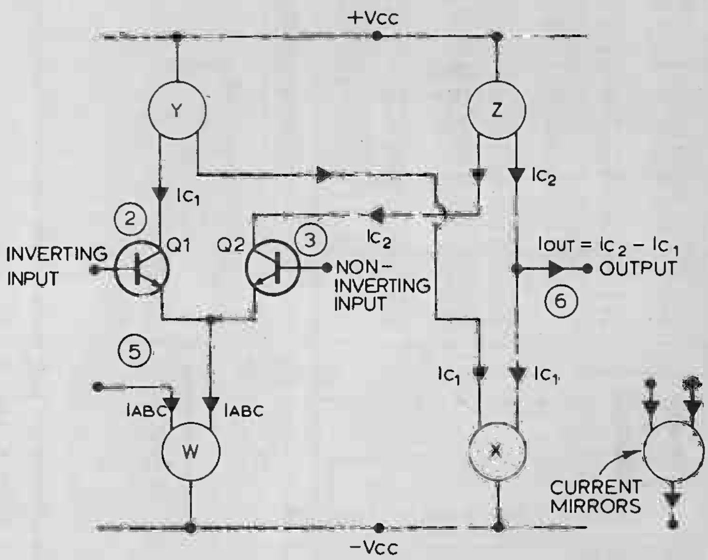
A good example is the AGC in a transistor radio. The transistors in the IF section have an h_{fe} that varied widely with the magnitude of their collector current. Thus, by sticking three transistors in series it is possible to vary their overall gain by about 40 dB, (x100), merely by controlling their collector currents. The AGC stops the audio output of the radio from varying as the radio reception conditions alter.

Electronic multipliers

When it is required to control the level of one signal with that of another, an electronic multiplier is used. This process is analogous to arithmetic multiplication. If input A is positive, Fig. 1, and input B is positive then the product (the output), will also be positive. If A goes negative then the product will be negative. If both A and B are negative then the product will be positive thus preserving the arithmetic rules.

If A and B are limited to be only one sign each then





Left: the principle behind electronic multipliers. The graph shows the possible outputs for a variety of combinations of input polarities.
Above: Internal workings of a CA3080, an Operational Transconductance Amplifier. Say that too fast and you'll need a new set of teeth.

Tim Orr continues his occasional series of circuits, methods and explanations with a detailed look at how gain can be controlled by another electronic signal, be it squarewave, sinewave or voice signal. This leads to some interesting circuits — from ducks to filters!

the multiplier is known as a one quadrant multiplier. That is the product can only lie in one quadrant. If A can be both +ve and —ve, and B only of one sign then the multiplier is known as a two quadrant multiplier. This is what is called an amplitude modulator. The audio signal which is bipolar is A and the control voltage is B.

If A and B can be both +ve and —ve, the product can lie anywhere in the four quadrants and hence the multiplier is known as a four quadrant multiplier. This type of device is found in frequency shifters and ring modulators.

CA3080 — An OTA!

The CA3080 is a two quadrant multiplier, or to give it its full title, it is an Operational Transconductance Amplifier. It has a differential input and a single quadrant current input known as I_{ABC}, (amplifier bias current), Fig. 2. The differential transistor pair is used to steer the I_{ABC} current between the two transistors Q2. There is a region where the input differential voltage is linearly proportional to the percentage of current steered between the two transistors. This voltage region is fairly small, being about 20 mV, but using the CA3080 in this area then a reasonably linear 2 quadrant multiplier can be obtained.

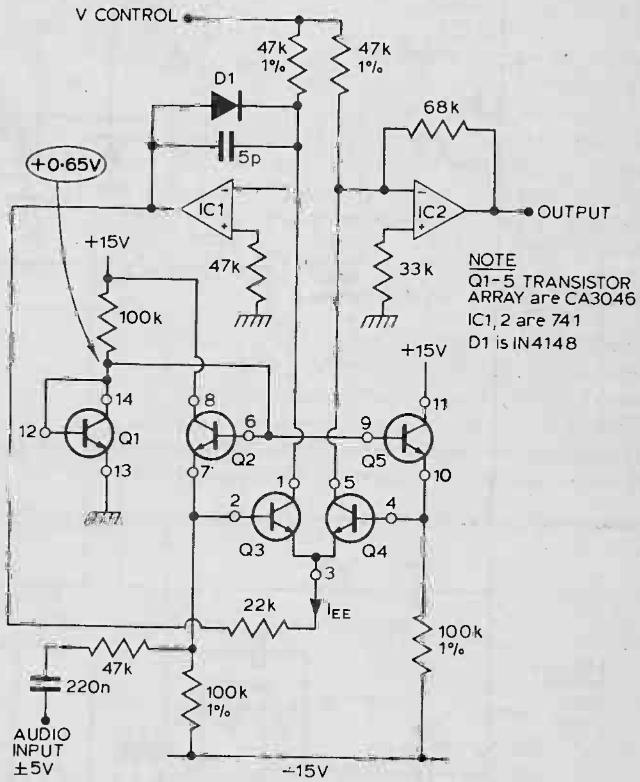
What has happened is the the I_{ABC} current has been multiplied by the input voltage. The product is the difference between the two collector currents. This difference is extracted by the use of mirrors, current mirrors that is. The current mirrors can be attached to either the +ve or the —ve supply rail.

They have two terminals, and whatever current flows into one terminal, then the same flows into the other, which is why they are called mirrors.

What we want to do is take the difference between the collector currents of Q1 and Q2, I_{C1} is reflected from mirror Y and then from mirror X and then appears at the output. I_{C2} is reflected from mirror Z and then appears at the output. The two currents are substracted from each other and the output current is thus (I_{C2}—I_{C1}), which is the product of I_{ABC} x V_{in} x K, where K is a constant. Note that the I_{ABC} current is also reflected from a current mirror on the negative rail.

The CA3080 is a low cost two quadrant multiplier and can be used to perform a wide variety of multiplication functions. The linearity of the device holds true for I_{ABC} variations of over three decades. When using this device keep I_{ABC} below 0.5 mA.

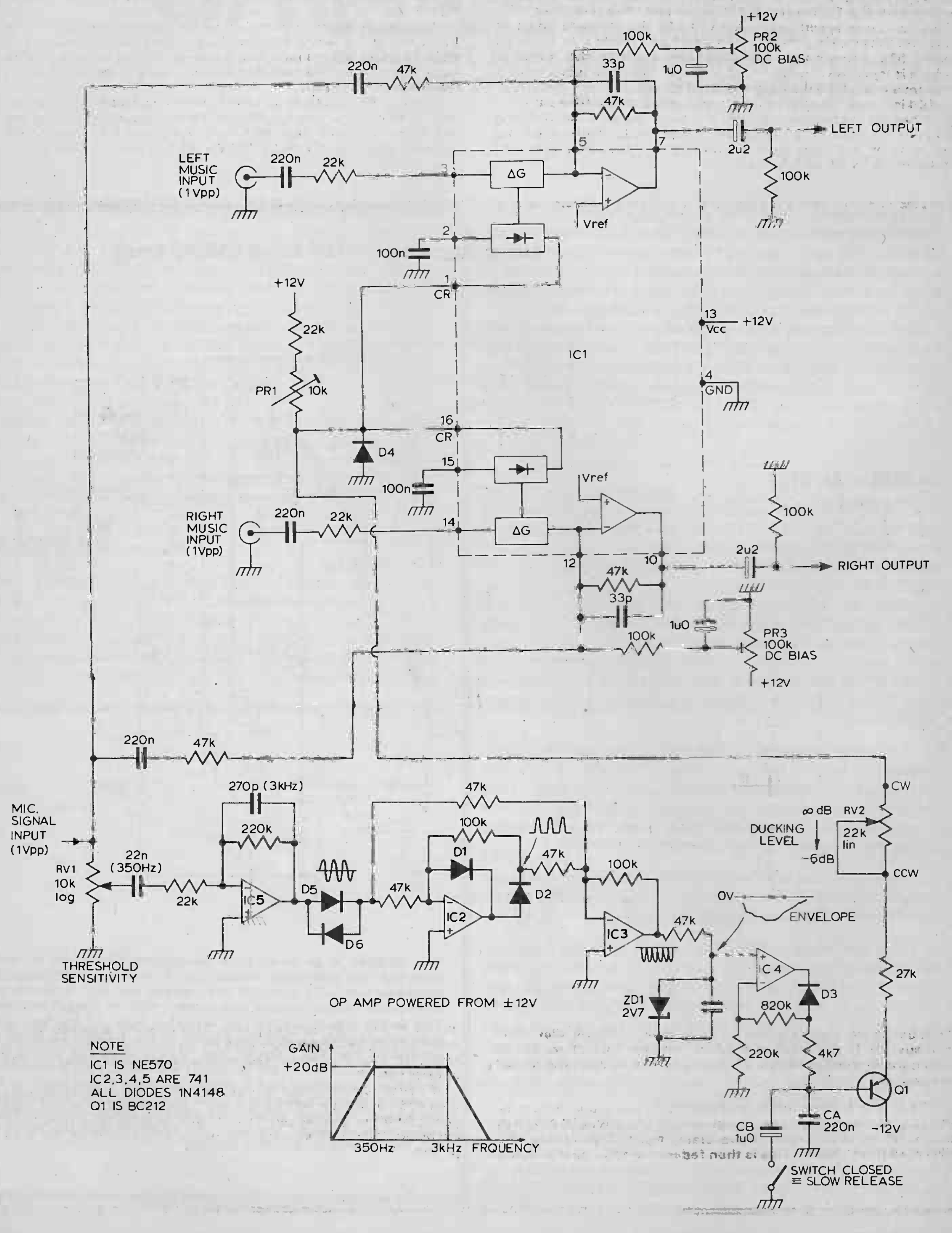
VCA Using CA3046 Array



The CA3046 is an array of 5 transistors which are all well matched and relatively cheap. Qe, 4 forms the differential transistor pair, IC1 controls the current and IC2 extracts the differential output current and turns it into an output voltage. The audio input is inserted into the base of Qe but also connected to this node is the emitter of Q2. Q2 and Q5 serve to predistort the input signal, but they distort the signal the opposite way to which the multiplier distorts it. This is known as distortion cancelling, and it allows a larger signal level to be applied to the multiplier for the same percentage of distortion at the output. The larger input signal allows a higher signal to noise ration to be obtained. Transistor Q1 is used to bias the bases of Q2, 5 to a suitable operating region.

▶

Stereo Voice Over (Ducking) Circuit for Disco Unit



NOTE
IC1 IS NE570
IC2,3,4,5 ARE 741
ALL DIODES 1N4148
Q1 IS BC212

The circuit operation is as follows. The microphone signal comes via VR1. This pot sets the sensitivity of the circuit to the microphone signal. If it is too sensitive the unit will be 'ducking' every time the DJ breathes. IC5 is an amplifier and filter. The filter has been specifically tailored to fit the characteristics of speech, thus making the ducking unit less sensitive to spurious noise. IC2, 3 forms a precision full wave rectifier, the output of which is low pass filtered and then fed to IC4. This wave form is the envelope of the microphone input signal.

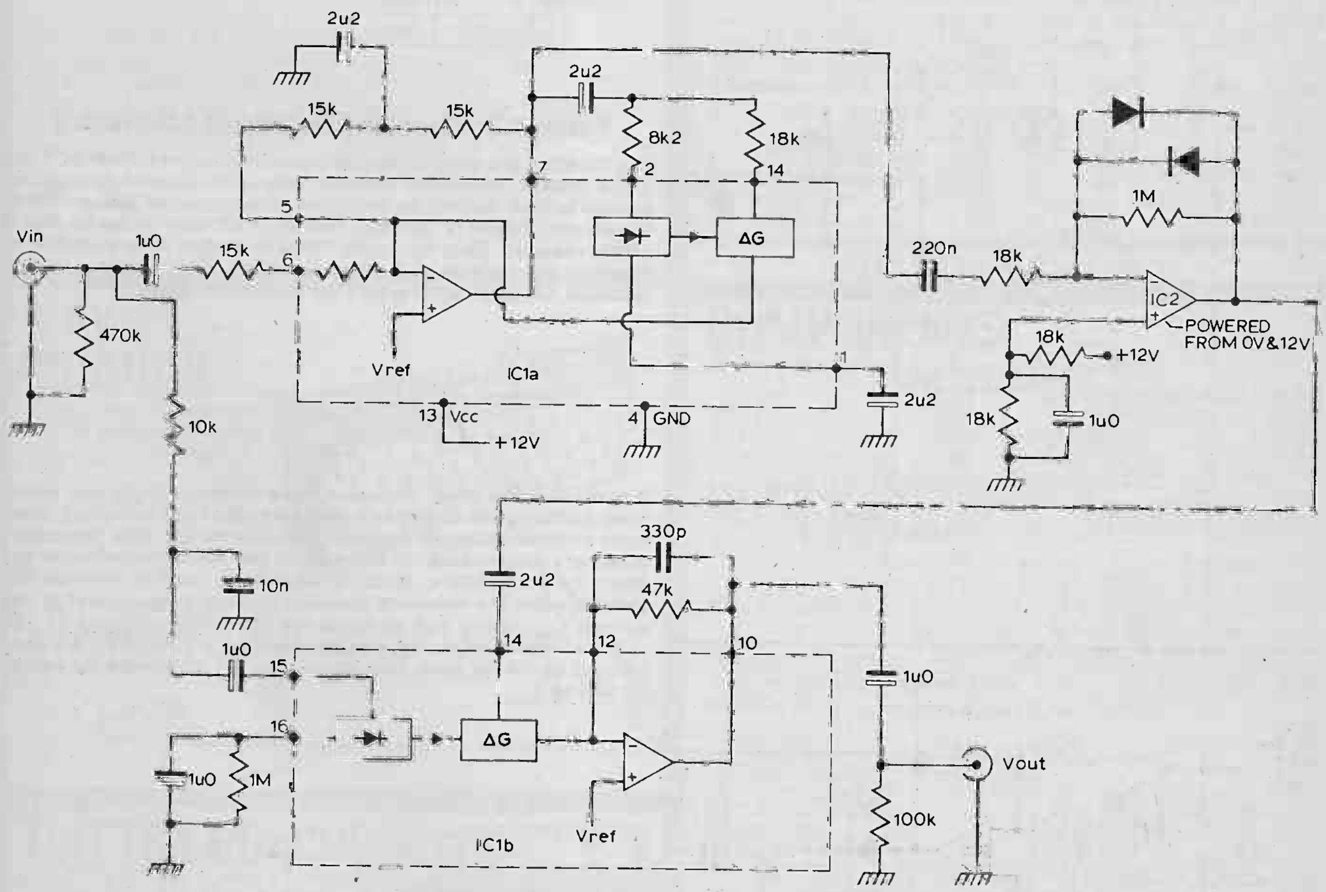
IC4 is a peak, negative going, voltage detector with a gain of x 5. When the DJ begins to speak, IC4 goes negative and in doing so pulls the base of G 1 negative. When the DJ stops speaking the base of G 1 rises back towards 0 V with a time constant determined by CA or CA + CB.

This is the release time and it controls the speed with which the faded down music comes back to full volume. G 1 is an emitter follower and is job is to rob current from the gain cells in the NE570.

This current sets the volume of the two music channels. When the base of G 1 is pulled down to the negative rail, the amount of robbed current is maximum, and when no current flows into pins 1 and 16 of the NE570 and all of it flows into g 1, then both nusic channels are turned off.

To set up PR1, put a large signal into the microphone channel, set RV2 so that it is a short circuit and then adjust PR1 so that the two music channels just close off. PR2 and PR3 should be adjusted so that pins 7 and 10 Of the NE570 are both +6 V.

Clever Fuzz Box



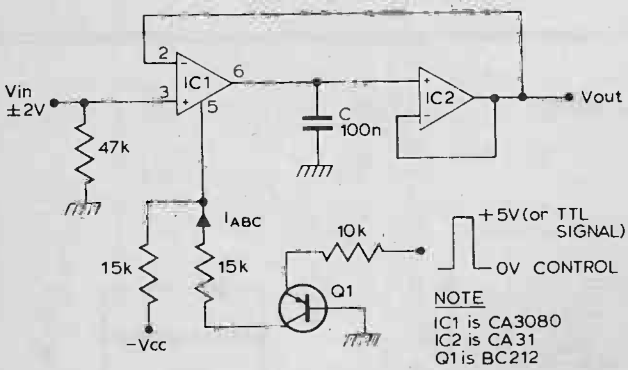
Fuzz boxes are used by guitarists to produce harmonic distortion and sustain. If you want to produce only the distortion, but to retain the original envelope of the signal then this is the circuit for you.

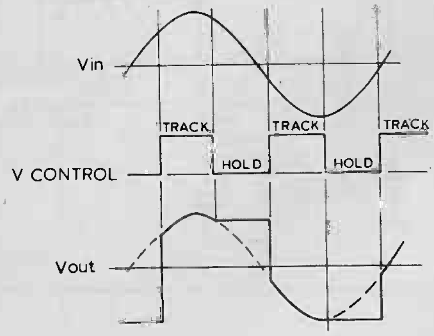
IC1 is a 2:1 compressor as described previosuly. This produces a relatively high level signal which then drives IC2, which is a x 50 amplifier with diode clamping. IC2 produces the distorted (fuzz) found. This is then fed into the IC3 gain cell, the output of which drives the op amp. This gain cell is driven by the rectified original signal (low pass filtered at 1k5 Hz), so that the distorted sound is given the envelope characteristics of the original sound.

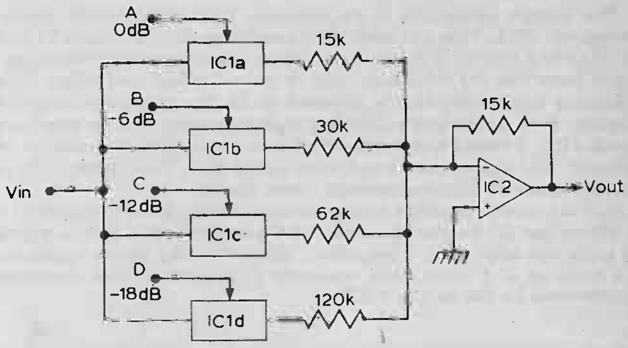
If a fuzz sustain sound is required rather than a dynamic fuzz then IC3 could be modified (by the inclusion of a clamped high gain amplifier driving pin 15) so that it acts as a low level expander. This will squelch the noise at the end of the fuzz period.

Track and Hold

In this example the CA3080 is used as a current controlled switch. When the control voltage is high, I_{ABC} is maximum, (0.44 mA) and the OTA gain is maximum. The voltage at pin 2 of IC1 adjusts itself so that it is the same as that on pin 3, this being due to the 100 per cent feedback via the high input impedance voltage follower IC2. When the control voltage is OV, I_{ABC} is zero and hence the gain of the OTA is zero. Therefore no current comes out of its output and so the voltage at the output of IC2 remains frozen (Hold mode). The maximum differential input voltage is 5 V and this must not be exceeded. The capacitor C should be selected to suit the speed of the operation.







0≡ −6V
1≡ +6V

A	B	C	D	GAIN
1	0	0	0	0dB
0	1	0	0	-6dB
0	0	1	0	-12dB
0	0	0	1	-18dB

POWERED BY ±6V

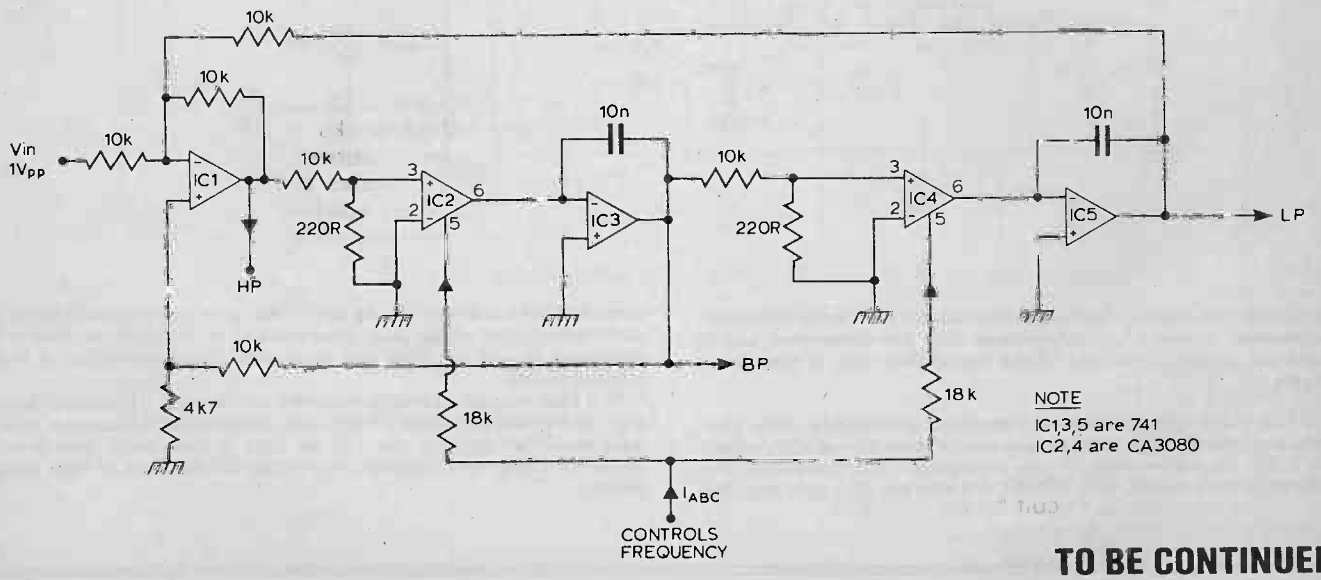
NOTE
IC1 is 4016
IC2 is 741

Voltage Controlled (Switched) Attenuator

The CD4016 is a quad analogue transmission gate. That is, it is a quad voltage controlled switch. When the control is high the switch is ON, having an effective resistance of about 400R. When the control is low the switch is off and ot looks like a 100M resistor. Thus by using 4016 switches it is possible to 'Switch' the voltage gain of an amplifier. The resistors in this example are selected to give 6 dB changes in gain.

Filter

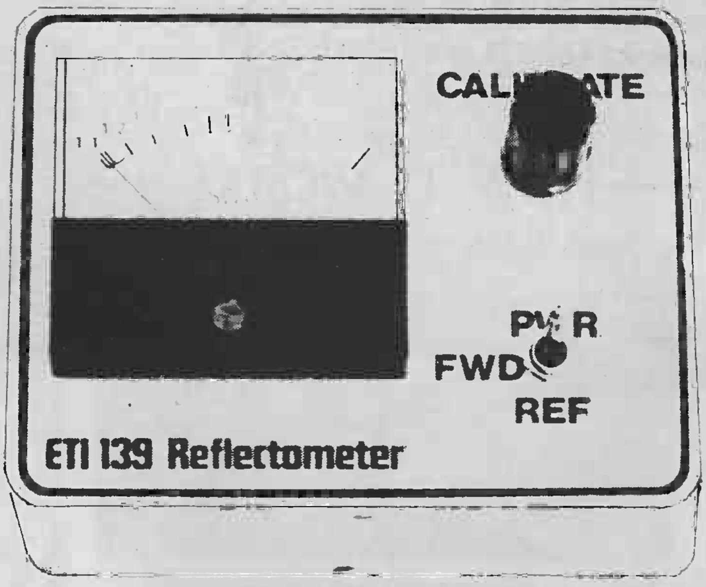
A state variable filter produces three outputs: highpass, bandpass, and lowpass. It is thus a very versatile filter structure, even more so if the resonant frequency can be varied. This frequency is linearly proportional to the gain of the two integrators in the filter. Two CA3080's, (IC2, 4) have been used to provide the variable gain, the resonant frequency being proportional to the current I_{ABC}. Using 741 op amps for IC3 a control range of 100 to 1, (resonant frequency) can be obtained. If CA3140's are used instead of 741's then this range can be extended to nearly 10,000 to 1.



TO BE CONTINUED

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.

The problem for most designs for reflectometers, or "Swar" meters as they tend to be called colloquially these days, is that they generally only cover about one decade in frequency range — usually 3 to 30 MHz or, if further, have discontinuities and drastic sensitivity variations at the extreme ends of their frequency range.

Sensitivity is a problem with the commercially available instruments also. Those with the best sensitivity — 5W full scale usually — are made for the (overseas) CB market, and while they will work over most of the HF spectrum (some extending beyond that), sensitivity is insufficient if you are working with low power solid state RF circuitry or doing a deal of antenna experimentation.

Performing antenna measurements at powers of 5W or more is discourteous to say the least, especially where sustained or many consecutive measurements need to be made.

The reflectomter / RF power meter described meets the requirements of most people involved in RF measurements requiring such an instrument and where a disparate variety of facilities are required.

This project will be extremely useful to radio amateurs, servicemen involved in communications, in laboratories, etc.

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.

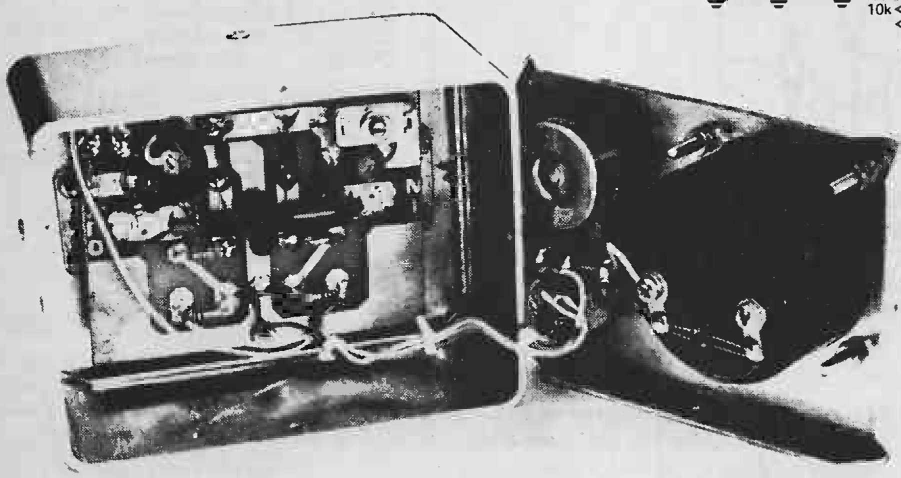
The PCB is then placed into position and the input/output pads soldered to the coax socket pins. Make sure that a good fillet of solder secures the pin to the PCB pad.

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



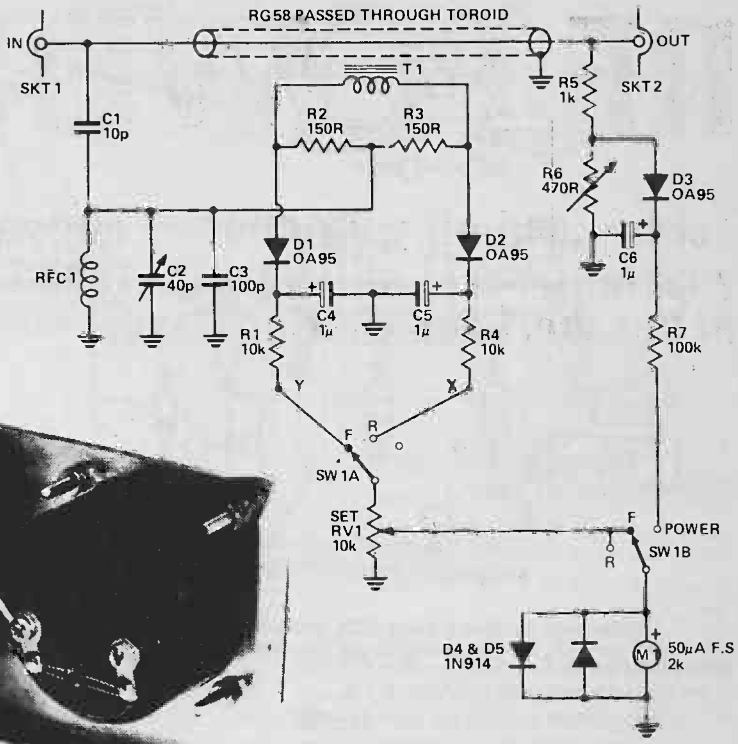


Fig.1. Circuit diagram of the SWR power meter. Note the unusual switch configuration, using a double pole three way switch.

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.

The sale on the meter may be hand-lettered using Letraset or other 'rub-on' lettering. The original lettering may be painted over and the new SWR scale inserted beneath the orignal scale.

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.

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.

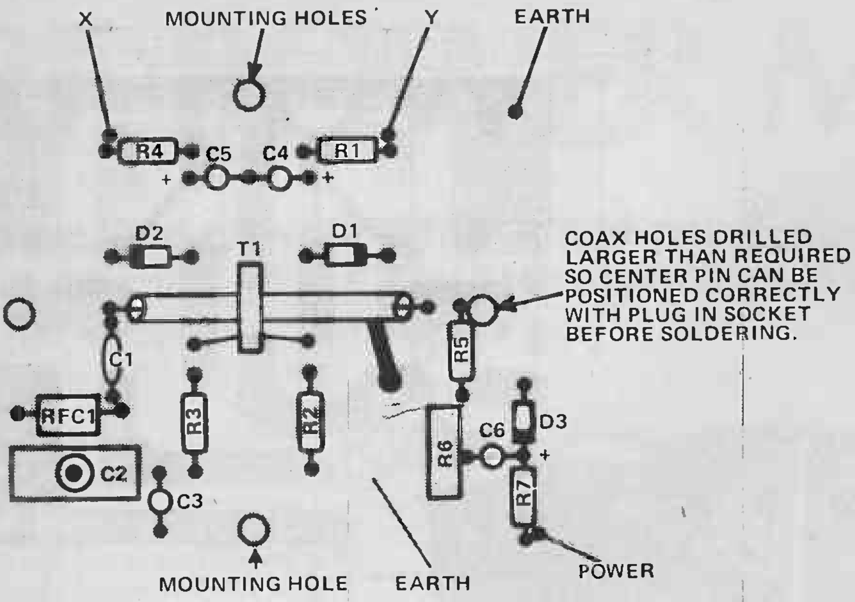


Fig. 2. Component overlay for the PCB. Note that, contrary to the usual practice, the components are mounted on the copper side of the board.

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. . . . . Horwood type 34/2/D (100 mm x 75 mm x 50 mm).
- PC board . . ETI 139

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	R2 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

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 inherent impedance of the prototype instrument was measured using a TEK 5 W dummy load and a Hewlett-Packard vector impedance voltmeter. The results are illustrated in Fig. 4.

The impedance discontinuities introduced by the prototype are well

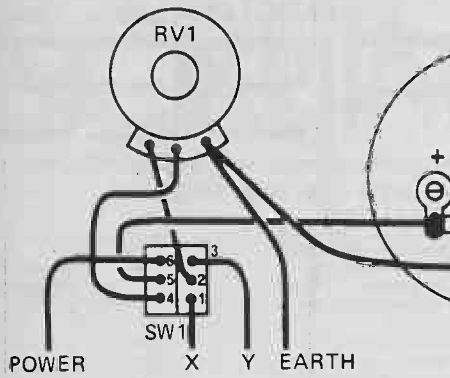


Fig. 3. The meter, sensitivity pot and switch connections. Leads X and Y go to the D2 and D1 respectively, while the lead marked 'POWER' goes to R7. Refer to Fig. 2.

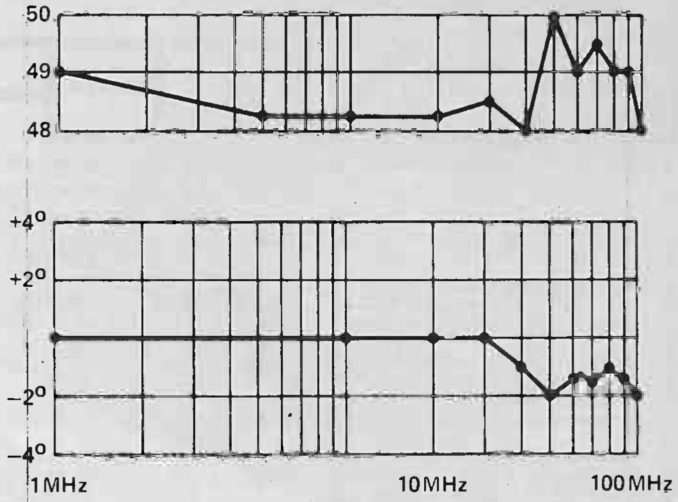


Fig 4. Top: real or resistive component of the prototype's inherent impedance. Lower: Reactive component.

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!

Modifications

For higher power applications, the basic sensitivity of the reflectometer can be reduced by one of several methods, or a combination.

If you are working with powers around 20 to 50 watts, R2 and R3 can be reduced to 47 ohms. For higher powers, the number of turns on the toroid can be reduced, and R2/R3 further reduced in value. As a guide, reduce the secondary of T1 to 20 turns and R2, 3 to 47 ohms. Everything else remains unchanged. This should suit power levels of 200 watts and higher.

Other types of coax sockets can be used, such as the BNC, type N or the inexpensive Belling-Lee sockets. No modifications to the PCB are necessary, however, mounting details of the sockets and board will need to be altered to suit.

The basic reflectometer construction is so simple and inexpensive that several can be built and installed to provide remote SWR/RF-output monitoring of antenna installations.

The RF portion can be mounted at a convenient place and the reflectometer output leads X and Y taken to remote metering facilities. Power output measurement circuitry is probably superfluous in these circumstances.

Protection circuitry for transceivers and power amplifiers may be simply realised using the basic reflectometer circuit and activating protection devices by comparing the output voltages of D1 and D2.

Swept VSWR measurement can be accomplished using the basic reflectometer circuit. The differential output from D1/D2 can be used to drive the vertical axis of a CRT display (via suitable amplification), the horizontal axis being driven by the sweep voltage of a voltage-controlled signal generator. Voila! — swept VSWR measurements.

Accurate SWR measurements for VSWR values below 2:1 can be made by driving an expanded-scale differential voltmeter circuit that measures the output difference between D1 and D2. This technique is well illustrated in reference 2.

This type of instrument is particularly useful when making VSWR performance plots of antennas over a narrow bandwidth (providing they closely match 50 ohms in the first place).

This reflectometer technique can also be used to measure power. However, the authors opted for the diode RF voltmeter method as it is somewhat more versatile, and is unaffected by the sensitivity bandwidth of the toroidal current transformer. See the two references for more details.

The sensitivity bandwidth may be shifted up in frequency by a decade or more, such that it rolls off around 1 MHz and 50 MHz, by employing a toroid for T1 of the same dimensions but made of F25 material. ETI

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.

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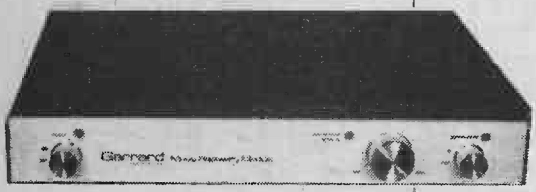
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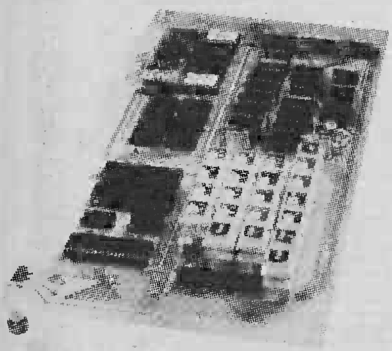
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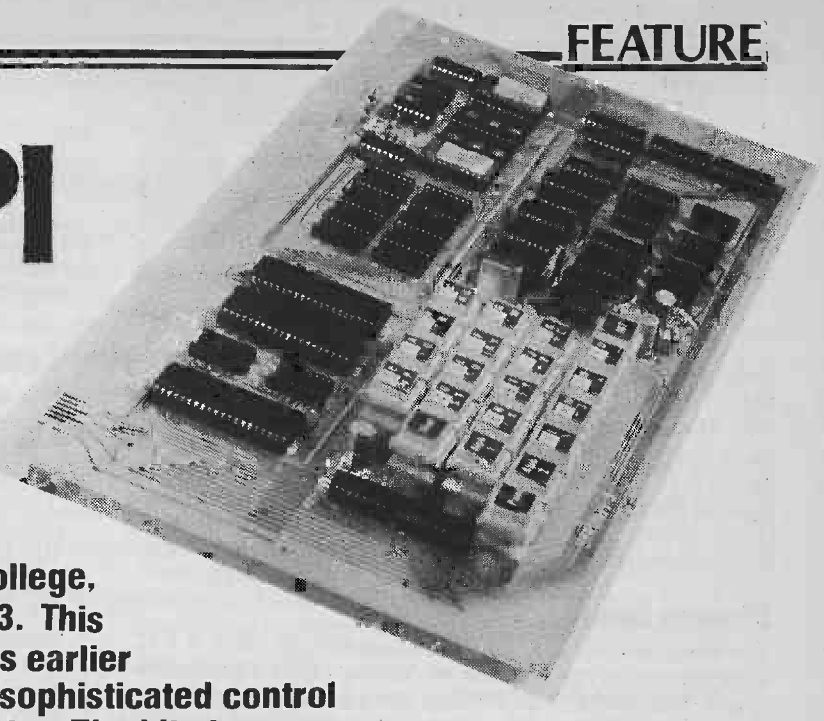
SCRUMPI 3



Justin A. T. Halls, of Queen Mary College, takes a look at Bywood's SCRUMPI 3. This kit is an improvement over Bywood's earlier LED switch kits but is still seen as a sophisticated control device rather than a personal computer. The kit also provides an excellent introduction to the worlds of MPUs.

Srumpi 3 is the cheapest currently available microprocessor kit with full alphanumeric input and a VDU type display. It is the successor to the Scrumpi 1 and 2, switch and LED kits and is based on the same MPU, National Semiconductor's SC/MP. The kit also provides facilities for cassette and teletype interfaces.

Scumpi 3 is built on a 380 X 190mm printed circuit board, with plated through holes and a clearly component overlay. High quality, low profile sockets are provided for all the ICs and two 16 pin DIL sockets are provided for access to the 16 I/O ports and the UART. Access to the TTY interface is via four pins at one side of the board, while power supply lines, reset line and video signal are taken to an eight way, 0.1'' edge connector. A UHF modulator is mounted on the underside of the board and provides a signal suitable for most 625 line TV sets via a standard phono socket. Data and address busses are not directly available, but test points are provided at either end of the board. Imput is via a 21 key keyboard, made up of good quality switches with transparent key caps, beneath which are fitted self-adhesive labels identifying the key functions.

Three main chips are the sc/mp ii, which has the advantage over the SC/MP 1 of being faster and requiring only a single +5 V power supply, the INS8154 RAM I/O, which contains 128 bytes of memory and provides 16 individually addressable I/O ports, and the AY-5-1013 UART. Two EPROMS, protected from accidental erasure by opaque labels over the quartz windows, hold the 512 byte monitor program and 512 bytes of user accessible I/O routines, A 7MHz crystal provides a clock from which are derived the VDU control signals as well as a 3.5 MHz clock for the MPU and a 15 kHz clock for the UART. The video interface circuitry occupies nearly half the board and uses the 8675bwf character generator to provide the full 64 upper case ASCII characters in white on black or black on white, either of which may be selected as standard and which may be mixed on the screen.

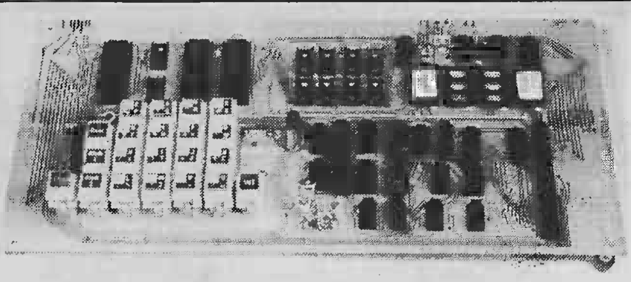
Data sheets are provided for the MPU and RAM I/O chips and two handbooks provide assembly and operating details. An SC/MP pocket instruction guide is also provided. The user has to provide a +5 V, −12 V power supply plus a 7.5V supply for the UHF modulator. It is also necessary to drill holes in the PCB to take mounting pillars if the kit is to be fitted in a case, or take legs if the kit is to be used naked. A reset switch is also needed.

Getting It All Together

Actual construction of the kit was quite straighforward, although the instruction manuals tended to be reminiscent of some car technical manuals, with instructions like 'all sockets, capacitors, resistors, diodes, links and keyswitches can be installed at this point', and the crystal and one of the ICs are never mentioned at all. One component that did cause some problems was the UHF modulator. The position of this is not marked on the board and the connections to it are not indicated. A phone call to Bywood confirmed that this does in fact fit beneath the board, the mounting pins having to be filed down to fit the holes provided. If the kit is not fitted in a case the presence of the modulator beneath the board means that legs must be fitted to enable the board to sit squarely on the table when in use.

When fitting the 21 keyswitches care must be taken as the holes for them are not too accurate and bending the pins too far to make them fit could damage the switch. Since many of the tracks run very close together, care should also be taken with the soldering and it is a good idea to leave the kit overnight after assembly and then re-checking very carefully for the presence of solder splashes or bridges.

To minimise the possibility of damage to delicate and expensive ICs and to ease trouble-shooting, the chips are inserted sequentially, checks being made at each stage to ensure that one part of the circuit works before proceeding to the next. Apart from TV synchronisation problems most of this setting up procedure was very simple, although some statements were a little misleading and a great deal of time was spent won- ▶



The assembled Scrumpi 3 kit. The system's firmware is resident in the two EPROMs seen top left with their protective labels. The three presets we had to fit to get the video levels right can be seen bottom centre.

dering why the address decoding wasn't decoding before we found that the NWDS line had to be earthed first. It is in cases like this that a circuit diagram would have been invaluable. The use of the INV line as a test probe was very clever and useful; if the line is taken to logic 1, the screen remains the same, but if taken to logic 0 the screen inverts (i.e. black characters on a white background instead of white on black).

Pictures Galore

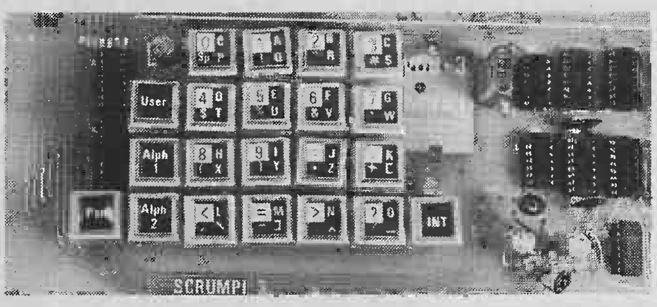
The video circuitry is basically quite simple, with a 7.02 MHz clock driving a series of dividers and a handful of gates. Two MM2112, 256X4 RMs hold the picture in a memory mapped display. The rest of the video circuitry simply consists of the character generator and a number of buffers.

The UHF modulator is pre-tuned to channel 36 and merely needs connecting to the aerial socket of a TV set. It can be run from the on-board +5 V line, but with some sets better resolution, especially when displaying black characters on a white background, is obtained by running the modulator from a separate supply of about 7.5 V. A simple, unregulated battery eliminator, set at 6 V (actual output about 7.5 V) is sifficient.

The Bywood errata sheet points out that some video monitors or converted TVs require a 4 V pk-pk video signal rather than the 1.5 V pk-pk signal provided by the kit, and that this can be obtained by adjusting the values of R3-R5. We had great difficulty in obtaining a stable picture and eventually had to resort to replacing the riesistors with 470R presets; even now picture stability is not as good as it might be and it is continually necessary to adjust the vertical and horizontal hold controls. It is quite possible however that these difficulties are due to the use of a cheap portable TV which may well not be set up correctly. No problems have been found with these modulators in other applications.

Key Features

Bywood have managed to squeeze all 64 upper case ASCII characters onto a 21 key keyboard. This is achieved by the use of three shift keys. One soon gets used to using the shift keys and although it would be more convenient for entering hexadecimal code if the lower case characters were 0-9 and A-F, the current layout has presumably been chosen to ease use as a general purpose teletype.



Close up view of Scrumpi's keyboard. By using the various shift functions this keypad can provide a full alpha-numeric set.

Getting In And Out

The teletype interface, supplies and receives a 20 mA current loop and is therefore compatible with many types of TTY. Control of this interface is purely by software, using the SC/MP 'flag 0' for output and 'sense B' line for input, each bit being set or sensed individually, with a delay instruction being used to set the bit rate to 110 baud or whatever rate is required. Unfortunately, details of sending and receiving routines are not supplied, although these should not prove too onorous to write.

Parallel I/O is provided for by the INS8154 RAM I/O chip which also contains the 128 bytes of RAM supplied with the kit. 16 I/O lines are available and these may be configured as two independant eight bit ports designated A and B, each of which may be specified as an input or an output port. This provides for very versatile interfacing with the outside world.

For these who prefer a serial interface however, an AY-5-1013 UART is provided. The rate at which data is output or received by the UART is determined by an extemal clock, this being set to sixteen times the desired baud rate. In the Scrumpi 3, the 15.625 kHz line frequency for the VDU is used, providing a baud rate of 960 (not 9600 as stated in the manual). If a more standard baud rate is desired, the internal clock can be disconnected and an external clock provided via one of the I/O sockets; 4 800 Hz will give 300 baud suitable for a cassette interface, while 1 760 Hz will give a rate of 110 baud. No details are given of how to use the UART, but these have been published in ETI (Dec. 1977).

All of these various I/O lines, except the TTY 20 mA loops, are available from two 16 pin DIL sockets. Each socket is provided with +5 V and ground connections, as well as the UART transmit and receive lines and the MPU 'sense A' line, used by SC/MP for software interrupts. In addition socket A has the eight bits of port B, reset, and the UART clock, while socket B looks after the eight bits of port A. Unfortunately the INTR line from the RAM I/O chip, which is used in handshaking routines, is not available, but it could be connected to an unused pin on one of the sockets, as could the serial input and output lines from the SC/MP which are also unavilable.

Where Its All At

The kit comes with 128 bytes of RAM (not counting the 256 bytes used by the VDU) of which 64 bytes are available to the user for writing programs. Of the remainder, 32 bytes are available as a user stack which may also be used by some of the Scrumpi sub-routines, eight bytes are used for storing labels and eight bytes are used as a monitor permanent area, the remainder being used as monitor stacks during various command routines, This RAM occupies the area of memory fron 0F80 to 0FFF (see Fig 1). The minitor PROM takes up 512 bytes from 0000 to 01FF, with 512 bytes of I/O sub-routines in PRO M at 0600-07FF. Keyboard, UART, VDU and parallel I/O takes up all the space from 0C00 to 0F80. Since the SC/MP only provides direct access to the lower twelve bits of the address bus, allowing for 4K of addessability, this leaves 2K to be accounted for. On-board sockets are available for all this, divided into 2×5 12 byte PROMS (5204 or 4214) and1K of RAMas eight 256 X 4 (2112). To expand further than this the top four bits of the address bus have to be latched at NADS time, when they appear on the data bus. However since it is assumed that very few users will want to go beyond the available1Kof RAM and1Kof PROM without the aid of an assembler, access to the control lines and busses is not provided. For testing purposes however, the busses are available at test points at either end of the board and control lines could be taken out be means of wire links fron convenient points.

Controlling Your Scumpi

The monitor contains five basic commands. Typing 'I', followed by a four digit hexadecimal address and 'INT', results in the display of the address called and the data stored there. A number of alternatives now exist. Typing in a two digit hex number followed by 'INT' will cause that number to be stored at that memory location and the address and contents of the next byte of memory are displayed. Instead of entering data you can type =n, where n is an integar from 0-7. The lowest two characters of the address are then stored and can be used later, by typing '?n', which will calculate the offset required for a programme counter relative jump to the address labelled by n. When using '=n' or '?n' the address is not incremented and the offset provided or fresh data may be entered at that location in the normal way. To return from the data input mode to command level, you can either press reset or type '>'. Typing the command 'L' followed by 'INT' will result in the display of the eight bytes of memory holding the labels.

The command 'H', followed by a four digit hex address, produces a hexadecimal dump of the next 48 bytes from the address given, arranged as six rows of eight bytes, each row preceded by the address of the first byte in that row.

Having entered a program using 'I' command and having checked it using a hex dump we now want to run it. This is done simply by typing 'G' and the address at which the program starts, bearing in mind that the first byte of a program is always ignored. Software breakpoints may be inserted in a program by using an XPPC 3 instruction, exchanging the program counter for the contents of pointer register 3, which returns control to the monitor and gives a current status dump. In this the contents of the three internawcpointer registers are shown, (P3 will always point to the address of the breakpoint), as well as the contents of the accumulator, extension register and status register. In addition, the 32 bytes of user stack are also displayed. The program can be continued from where it left off by typing the command 'C'

In addition to the monitor, eight I/O subroutines are provided for use by user programs. With these data may be entered from the keyboard or written to the VDU, or messages can be displayed on the VDU. Alternatively the value in the accumulator can be displayed as a hex number (rather than as an ASCII character) with or without a trailing space, or a hex number can be read from the keyboard. Finally four bytes from the user stack may be used to display a six digit number with its sign. All of these subroutines are accessed simply by exchanging the program counter and pointer 3 and most of them are re-enterable.

If additional PROMs are used to extend the monitor, they will be automatically detected by the existing monitor, which checks for a 00 at address 0200, and used directly. One additional PROM that is available from Bywood is a dissassembler, which will take a machine code program and translate it back into mnemonic form, producing a full assembler style listing.

Reading It Up

The two handbooks are well and entertainingly written, starting from absolute basics and working up, so that even someone who had never heard of a microprocessor before would soon be able to use the Scrumpi. Book 1 starts with an explanation of the hexadecimal number system and proceeds to build a micro-(macro-?) processor called PC/MP (Paper and Cardboard Micro Processor) with which it explains all the happenings inside the MPU, by making you do all the internal operations yourself. In this way a deep understanding of what actually occurs within the MPU is imparted.

Having explained the workings of MPUs in general the architecture of SC/MP is considered, along with the necessary associated components such as RAMs and PROMs. Book 1 then goes on to describe the construction and use of Scrumpi 2, most of which is of little interest to the Scrumpi 3 owner, although the final section on interfacing with the outside world via UARTs and ports is of interest even if lacking in detail.

Book 2 is more concerned with Scrumpi 3 and begins by describing the rationale behind the design of this kit. Construction and testing details follow, with a circuit diagram for the VDU and a block diagram for the rest of the system. Bywood consider that 'the PCB is its own circuit diagram' and that further documentation is therefore unnecessary. Having built and tested the kit, you are taken through a series of demonstration pro- ▶

Scrumpi 3's status dump displays the current value of the SC/MP's internal registers plus a hex dump of a section of memory.

grams which display the full character set, write messages on the screen and demonstrate all the internal logical and arithmetic functions that are available. Here again the text is clearly written and we soon got to know how to use the majority of the various facilities that are available. Finally the memory assignments are given as well as a description of the monitor routines, I/O subroutines and the optional disassembler. At the end of the book is a glossary of technical terms, some useful addresses and data on the SC/MP II and the INS8154.

What there is of the handbook is excellent, well written and well illustrated and without too many errors. However, a great deal of information is lacking, such as any details of how to use the UART or how to configure and use the I/O ports. It would also have been nice if a few simple user programs could have been included, say for a cassette interface, handling the teletype link and maybe some mathematical routines.

Terminal Device

In general this kit succeeds in doing what it sets out to do very well indeed. It is nicely produced, fulfills its designers requirements and the distributor, Bywood Electronics, are very helpful in the event of any difficulties or problems.

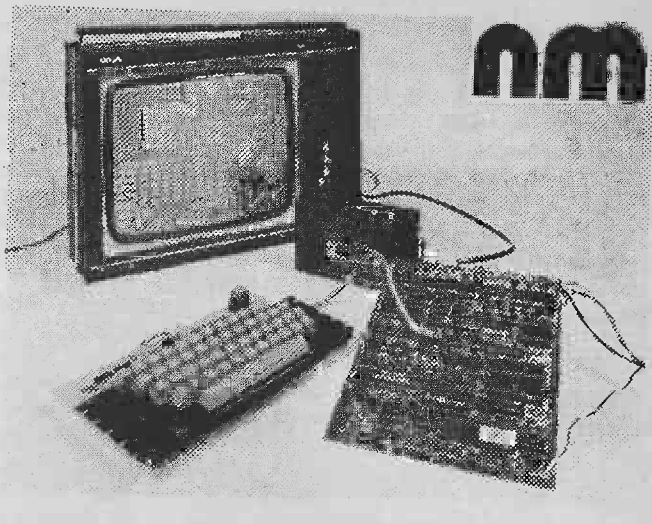
The quality of the product is let down however, on two counts. The main defect lies in the lack of information supplied with the kit and this is a very serious failing. A TTY. 20 mA loop interface is provided, with no indication of how to send data to it, or how to receive data from it and whith no mention of what format the data should be in. i.e. what should be supplied in the way of start, stop and parity bits. Also, no data or infornation is provided on the UART and even when a data sheet has been obtained, describing how to use the device, it is necessary to trace out the tracks on the PCB in order to identify the TBMT and DAV lines. Admittedly a data sheet is provided for the INS 8154, but this is only of marginal use when attempting to use the device and such a versatile chip as this deserves far more recognition in the manuals.

The other failings of the kit are relatively minor, but seem all the more unnecessary for that very reason. Things like not using the serial input and output lines from the SC/MP. The kit already has impressive I/O facilities, but why not make use of a facility that is sitting there waiting to be used. The unused INTR line from the RAM I/O chip is another case in point, since this negates a large proportion of the power of the I/O device, especially if you want to interface to devices such as A/D converters which require a certain amount of handshaking.

Once you have found out how to use them, the I/O facilities on this kit are very good, largely thanks to the versatility of the RAM I/O chip, which gives such a varied selection of I/O modes. The keyboard is not as convenient as a full QWERTY keyboard, but it is perfectly adequate for a kit that is intended for semi-dedicated applications. The 8 X 32 character TV display may seem limited in size when compared to full VDU systems, but is quite adequate for the vast majority of applications and it has even been found possible to play Conway's Game of Life on it, although this led to some rather interesting edge effects at times.

This kit is certainly a great advance over Bywood's previous, LED and switch kits and with a price tag of around £150 is certainly good value for those who are either hooked on SC/MP or who are prepared to use the full power of the kit to make it pay its way as an intelligent terminal for a larger or more powerful system.

ETI



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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 seperate amplifiers! The reason for the apparent power gain is that the voltage finally produced at the loud speaker 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.

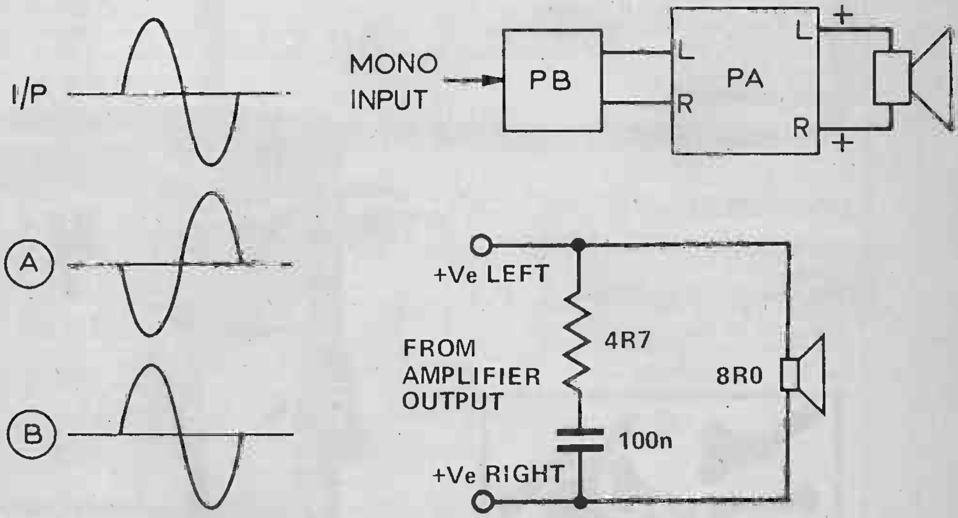


Fig 1. On the left is a diagram showing the input and output waveforms from the Power bulge, as can be seen the two outputs (A and B) are 180° out of phase with each other. Above right is how to connect the unit to any stereo amplifier, the lower circuit shows additional components suggested to stabilise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

▶

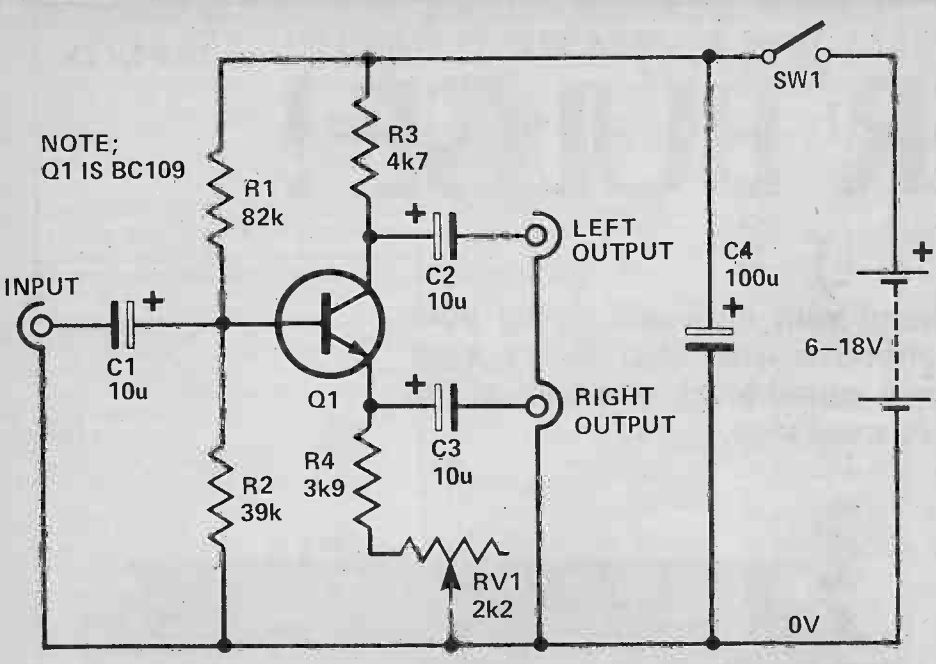


Fig. 1 Full circuit diagram

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.

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.

PARTS LIST

RESISTORS

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

POTENTIOMETER

RV1	2k2 preset

CAPACITORS

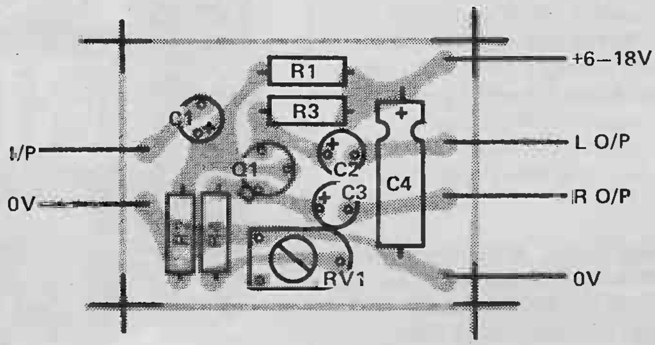
C1, 2, 3	10u 16 V electroytic
C4	100u 25 V electrolytic

SEMICONDUCTOR

Q1	BC109

MISCELLANEOUS

PCB as pattern, case (vero 75-1413E), battery
B154, switch, phono sockets.



Above is the component overlay of the complete device, below left is the PCB pattern shown full size (45 x 34mm). Neat layout of the prototypes can be seen clearly in the photograph below.

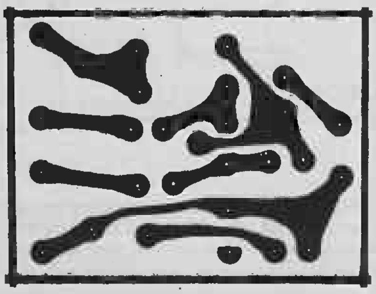


Fig. 3 PCB patterns shown full size

PIRATES AND JOLLY NOTCHES!

IT WAS ONLY a few years ago that private or 'bootleg' versions of Bob Dylan's Basement Tapes and Pink Floyd's Dark Side of the Moon, sold like the proverbial hotcakes, along with a host of others.

These recordings blatantly advertised the fact that they were pirated, and thus of illegal origin — transgressing not only performer's rights but also copyright. Many people were attracted to pirate recordings for there seemed to be something rather exciting about owning a recording which the artist did not approve. Often, the pirate recordings contained material not released on genuine recordings, or were of concert performances which often differ markedly from studio performances. Quality was almost inevitably low-fi!

Through a combination of circumstances, these bootleg recordings gradually disappeared from the market. Groups employed stewards to hunt through audiences looking for tape recorders, legal prosecutions were brought against bootleg distributors etc. Finally, high prices for low-fi killed the market.

New Track

Recently, however, the pirates have changed tack and are presenting recordings that are either made to mimic legitimate releases on well know labels or to appear like legitimate competition. For example, a recording stolen from EMI may either be packaged to look like an EMI recording, or packaged in a sleeve with an authentic-sounding company label, but not that of an authorised EMI trader. In neither case does the artist, EMI or anyone else (save the bootlegger and his outlets) receive any reward.

Those recordings that mimic legitimate releases are usually a straight, undoctored copy of the original, with slightly reduced fidelity. When released on a phony label, often the recording is altered in the transfer to disguise its origin, usually by dubbing applause or extra instruments onto the copy.

The problem arises here in that both these techniques are far harder to detect and prove as bootleg than the previous methods. The British Phonographic Industry (the UK recording industry trade association) have taken numerous court actions, with some success, resulting from pure detective work.

Self-Destruct

However, the final solution to professional piracy relies on technological aids. This can be achieved by either making the physical act of illegitimate copying technically impossible, or to make the technical detection of such copying unambiguous. Unfortunately, despite considerable efforts, little real practical headway has yet been made in either of these directions.

If record companies had their way, each disc or pre-recorded tape released and sold to the public, would self-destruct, refuse to play or produce unacceptable sounds if copying was attempted.

To date, anti-copy remains an impossible dream. Inventors still tackle the problem, the cash rewards for a workable system would be enormous. Inevitably, one red-herring scheme keeps being re-invented.

Back in 1967/68, the Beatles' Electronics Company, Apple, leaked a story about three patent applications on a new anti-copy system. Any attempt at recording a disc pressed according to this system would result in a high-pitched whistle they claimed. The idea attracted a certain amount of attention, but, in time, the patent applications were allowed to die, along with the publicity and Apple Electronics disintegrated.

Although details of the idea remain a secret, the system probably involved recording an ultrasonic carrier frequency on the disc. Thus, at any attempt to put the ▶

disc material on tape the carrier on the disc would beat with the tape recorder's ultrasonic bias signal and impress an audible signal on the tape.

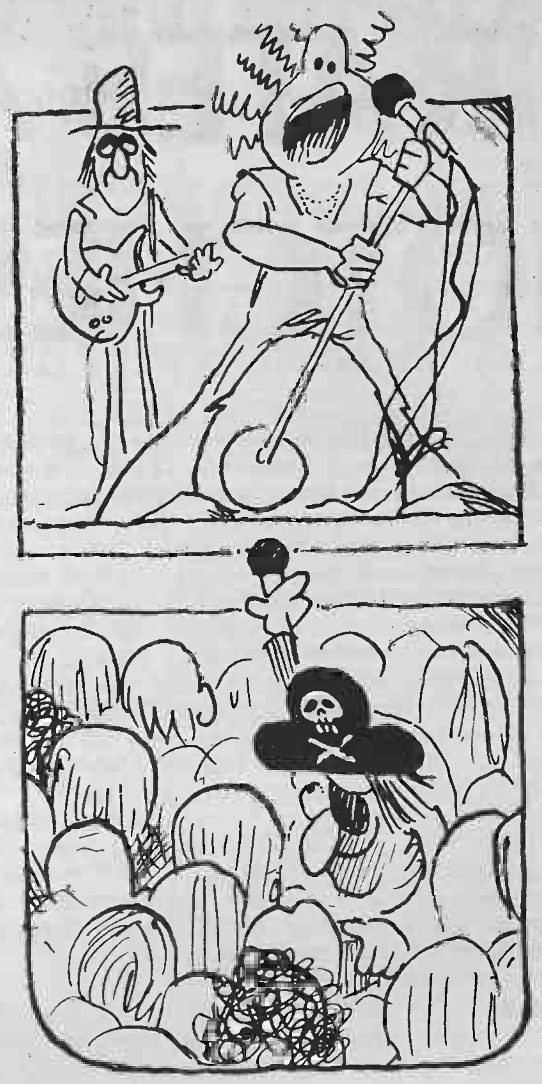
In this way, two inaudible frequencies are combined to produce an audible frequency which destroys the recording attempt.

A little thought shows the snags in the system. To produce an audible beat with the very high bias frequency used on tape recorders (around 70 kHz or higher) requires that a similar signal be recorded on the disc. The studio cutting machine won't cut it, the factory pressing machines won't press it and the would-be-recordist's cartridge wouldn't reproduce it.

It is also easily filtered out at any stage of the production chain, either intentionally or otherwise, with no loss of quality, because the carrier signal is inaudible anyway. Different tape recorders have widely different bias frequencies which also defeats the system.

The drawbacks are enough to discourage further reinvention of this system and doubtless account for the demise of the Apple patents.

There is another daunting aspect to anti-copy systems. It is likely that if anyone does devise a system that will prevent the copying of a disc or tape onto existing tape recording machines, the recorder manufacturers will soon devise a defeat button or circuit to make copying possible again.



Watermarks

Anti-copy systems appear defeated for the moment. However, the concept of an indelible watermark on the recorded sound appears somewhat less fanciful.

As with anti-copy, watermark systems have gone through numerous futile reinventions. The aim is to record an inaudible identification signal along with the recorded sound. The watermark signal is inaudible to the listener when the disc or tape is played on conventional equipment, but it can be identified or decoded by special equipment.

Ultrasonic (high frequency) and infrasonic (very low frequency) watermarks have similar limitations to the anti-copy schemes. For this reason, it is essential to adopt a sledge-hammer approach to prove the origin of copied material. One such attempt, by Capital Radio who recently broadcast some previously unpublished Beatles tapes, involved putting a loud station ident ('194') over the recording every few seconds. Thus, if ever a bootleg recording is issued, its origin will be audibly stamped all over it! With the station ident so loudly intrusive there would likely to be little incentive anyway.

Notches

There is another approach which a number of recording companies are seriously considering. This is the *Audicom* system invented by Murray Crosby.

It was originally intended for collating automatically the number of times a commercial was transmitted on a radio or TV station, for accounting and statistical purposes.

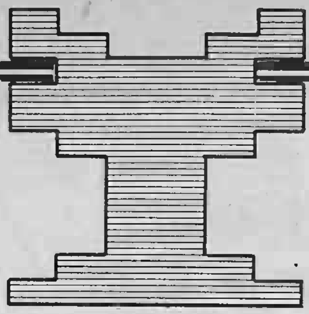
The system works like this: At a frequency around 2-3 kHz, a tight notch filter with a very narrow bandwidth (around 100 Hz) bites a small chunk out of the audio spectrum. At the same time a binary code watermark signal is modulated onto an audio frequency subcarrier of the corresponding frequency and bandwidth so that it fits neatly into the window left by the notch filter. The amplitude of the subcarrier frequency is varied so that it tracks the audio level of the surrounding programme. In this way, the coded identification signal is always submerged by the programme, but it is still recognisable by a decoder tuned to the narrow band notch frequency and designed to interpret the digital information modulated on the subcarrier.

Sounds like a great system for discs and tapes. However, several difficulties arise. If, for instance, the coded subcarrier is at such a low level, might it not be lost in noise after transmission or the copying process? This is one area which EMI, RIAA and others are investigating. Even if they get results, we are not likely to read, or hear about. Because, if the system is adopted, it would not be prudent for the record companies to indicate the level at which noise destroys the code.

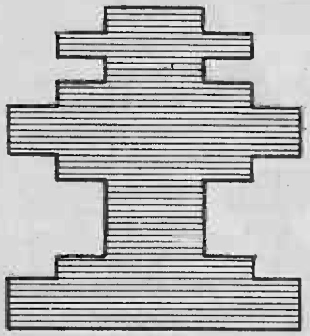
Sub-Noise

One set of technical specifications indicates that when the programme audio level is zero, the subcarrier coded signal will be 55 dB below the peak level the carrier would be at peak audio programme level. When the programme audio is at peak level then the audio sub-carrier in the notch will be 40 dB below the programme level. Thus, the subcarrier is always submerged by the programme but would still be detectable by a decoder tuned to the narrow band notch frequency so that the digital watermark code is recognisable by the digital decoder. ETI

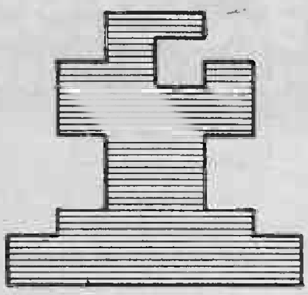
TELEVISION



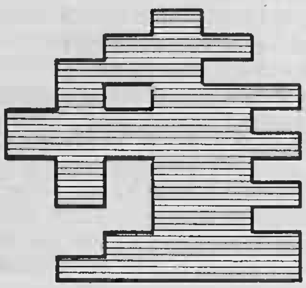
QUEEN



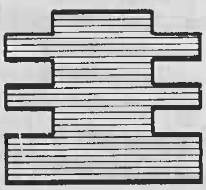
KING



BISHOP



KNIGHT



PAWN

TOLINKA IS A device which is genuinely useful to the chess-player, performing automatically all the housework of listing, analysis and filing of chess information. It is not like a TV game, nor is it one of those machines which plays chess from an internally stored programme, which is little more than chess-like solitaire.

The project is based on a SC/MP MPU, which with some RAM, ROM and various support ICs performs all the work that goes on in this chess players comfort. Don't be worried by the mention of the term MPU — to use Tolinka you won't need to think — or curse — in Hex, manipulate machine code and be generally au fait with ALUs. The machine has been designed to be both straightforward to use and to build.

Design Philosophy

Tolinka was designed with cost and availability in mind. When a function could be performed by a few, cheap adily available parts instead of one ecial expensive chip, the former urse was taken. The chess set, for example, appears to have been made from Lego bricks. If a character generator ROM with more bits in it had been used in conjunction with a highspeed clock, a chess set which would have met the approval of Lewis Carroll could be produced (though I suspect that gentleman would like the present one). If you have sufficient memory, then you have sufficient resolution to transmit pictures even of Raquel Welch digitally, but no intelligence would be added by this course in spite of the doubled cost — faster memories, more power, bigger box etc.

The piece design has been subjected to much consideration and choice became, in the end, a matter of taste. The intention is to represent a Staunton Chess Set without conflict of symbolism or departure from family likeness. It is true that representations are not beyond reproach and any suggestions will be welcomed.

In each square 128 bits are available, eight horizontal and sixteen vertical divisions. A border must be left around the piece —

CHESS
PART ONE

Tolinka, the name coined by Victor Korchnoi to describe this machine that can display a full chess set on the TV screen. The pieces may be moved around at will, and all the moves of a game recorded on a cassette tape for later playback and analysis. Barry Savage, the designer, describes this secret weapon of the West.

BUYLINES

A complete kit of parts for this project will be available only from Videotime Products, 56 Queens Road, Basingstoke, Hants, RG21 1REA for the all inclusive price of £109.50.

Individual parts are also to be made available but Videotime will offer help, advice and a repair service only to readers who purchase the complete kit. Note also that software, piece design PCB pattern, etc, are subject to copyright.

partly so that identification of the square's colour may be made. So a six by thirteen grid is left. With the exception of the pawns it is thought more uniform if the pieces stand upon a level base. The major pieces are bilaterally symmetrical (both halves the same, if you must), the centre of each of the major pieces is therefore a double column.

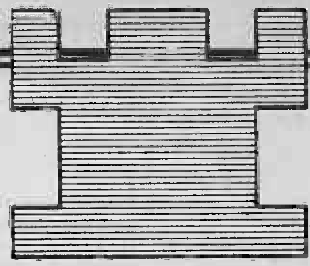
The Facts Of Life, Or, How Little Computers Are Made

Son, it is time you were told about the birds and the bees. The creation of computers like the creation of new human beings depends upon the combination of hardware with software. Unlike humans, however, the labour involved cannot be said to be unskilled. Once Tolinka had a mother system to which it was joined by an umbilical cord of wires through which was fed power and information.

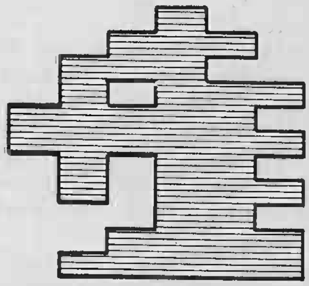
During this time of gestation Tolinka's programme was undeveloped and volatile. It was stored on cassette tape whilst the inventor was not working on it. The instructions were entered in Tolinka's surrogate memory from a hexadecimal keyboard, because little computers do not use ASCII or high level languages which do not use memory space in the most economical way. The author did not use assembly language either because continuous conversations with an MPU in machine code soon render even this mnemonic aid superfluous.

The whole purpose of parenthood lies in teaching the offspring how to manage without parents: little birds are taught to fly alone. So Tolinka's mother system eventually generated Tolinka's software package in the form of a PROM and worked herself out of a job. The umbilical cord was severed, a separate power supply constructed, and Tolinka set up house alone in a small box instead of a 19" card frame.

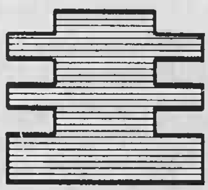
The first prototype circuit boards were made. And modified. And made again. Etc. Until a version of Tolinka was made which represented all of the most desirable features that it was possible to get into the available ▶



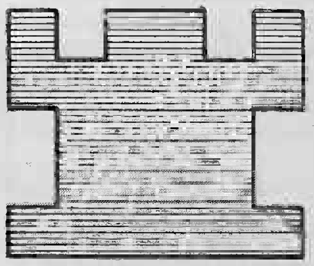
ROOK



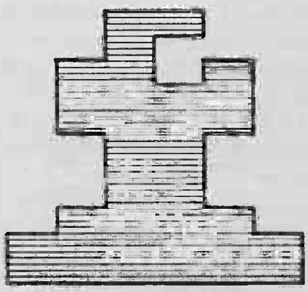
KNIGHT



PAWN



ROOK



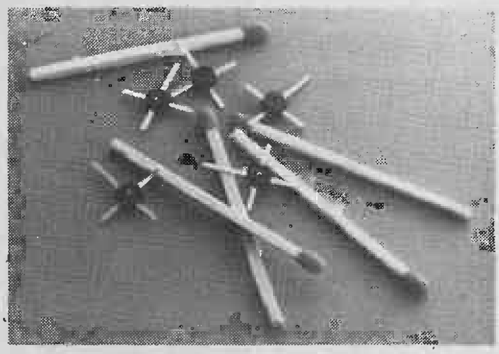
BISHOP

news digest. . .

for light music

These charming little blobs are Motorola's new BF900 MOSFETs, designed for use in FM tuner designs. They possess a power gain of 20 dB at 200 MHz and low capacitance. The dual gate configuration is intended for AGC operation where the first gate receives the RF while the second controls the transconductance (DC). Both gates are diode protected. Dead clever these blobs . . .

Motorola Ltd, Semiconductor Division, York House, Empire Way, Wembley, Middx.



Hong Kong King

Some numbers to tick off on your fingers. In the first six months of the year Hong Kong exported 16 million watches (worth £77m). These break down as 61% mechanical, 29% LCD and only 10% LED and quartz analogue combined. Surprising LED figures eh?

Germany developed a sudden lust for these non-tockers and their imports leapt up by 287%, putting them as the second largest consumers — behind the US and ahead of us!

forget who not?

You know we've quite forgotten why we used this photo at all. Now let's see something to do with TV games? Anyway the editorial desks have been bereft of nice lady photos lately — so this one appeared as an oasis amid the dusty filing trays.

P.S. Binatone the people who make the box in front — don't ask what box or in front of what or we won't speak to you again — claim to now taken over half the TV game market — the magic 51% in fact.

son of eti . . . . .

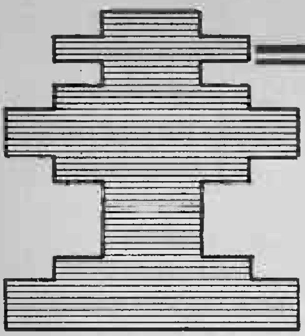
The word is out. For months at ETI we've been planning a second magazine for the electronics enthusiast. Because of the intense competition in this field we've kept quiet about it but now all can be revealed.

ETI has been remarkably successful but we've never pretended that we are ideal reading for the newcomer to electronics—we have assumed that the reader is already hooked into the hobby.

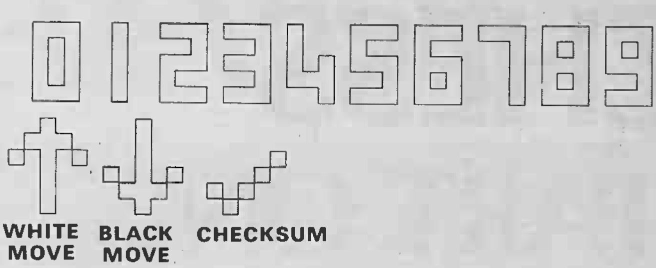
Hobby Electronics will hit the newstands in just over a month and is designed as a companion to ETI—indeed it is being prepared by the same editorial team.

HE is written for the person wanting to find out about electronics—there'll be projects of course but we reckon we've got some pretty good features as well including 'Into Electronics' a major introductory series linked to the O/A level Electronics course.

In next month's ETI we'll give you a complete breakdown of the contents of No. 1. The cover shown here is of a 'dry-run' issue that has already been produced in small quantities.



The chess set and the numerals were carefully designed to ensure easy recognition without recourse to shapes that would require a high resolution character generator.



memory space. But even now there is more than one software package available and the machine which is in use by Viktor Korchnoi's team is different in certain essential respects from that which is used on the World Championship reports or on the BBC 2 late news.

Further obstetric details and examination of the parent system would form another story.

Tolinka is a Microcomputer

Tolinka is a box measuring 8" x 5" x 3" with a 12 switch keyboard, a DIN socket to interface a cassette recorder and UHF output to drive a domestic TV set.

The picture is in black and white. (Why do people keep asking if it can be done in colour? They never ask for yellow and green chessmen. Yes, it **can** be done in colour, but it isn't as experience with video games has shown that monochrome is easier on the eyes — this remark can be justified by many quotations from manufacturers. Monochrome sets also have wider bandwidth and better resolution.)

What follows is a description of how to use Tolinka — when everything else has failed you might try reading it.

When connection has been made with the TV and cassette recorder, the TV must be tuned to receive a stable picture. If there is a push button tuner, one of the buttons may be left tuned to Tolinka. The output signal Tolinka is producing is assembled from digital waveforms in a preset fashion and there are no adjustable controls. If the TV is overscanning and losing some of the picture it must be adjusted by someone who knows what he is doing. A TV which is set up correctly does not lose any intelligence, but the chessboard sits rather high in the frame and slightly right of centre so that the status information shown on the left of the board may be seen.

On switching on the pieces appear correctly set for the start of a game. On the left of the picture a two digit move number appears with an arrow indicating which player is to move. It is important to remember that Tolinka always considers the move number as having two digits. If the number is less than 10 it has a leading zero.

Making A Move

Tolinka works by moving the contents of one location in memory to another i.e. the contents of one square to another. The eight move-entry keys are divided mnemonically into two groups, kingside / queenside, and labelled both alphabetically and numerically on the standard 'alpha' chess notation system.

Moving A Piece

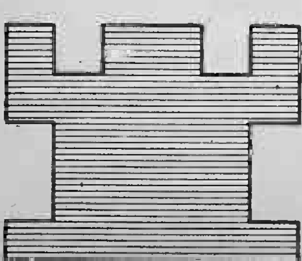
Four keystrokes enter a move. d2d4 is a move. b1c3 is another. When the machine has received a total of four keystrokes it will 'flash' the move on screen, moving the piece back and forth three times. This is not yet a permanent move, it is the machine inquiring about you intentions. If you are satisfied that the move which is flashing is the move you intended, the MOVE key may be pressed. Tolinka will the make the move final and update the move counter; if it was white's move the arrow will transfer to indicate black is to play next, if it was black's move the arrow will shift to white's end and the counter will increment.

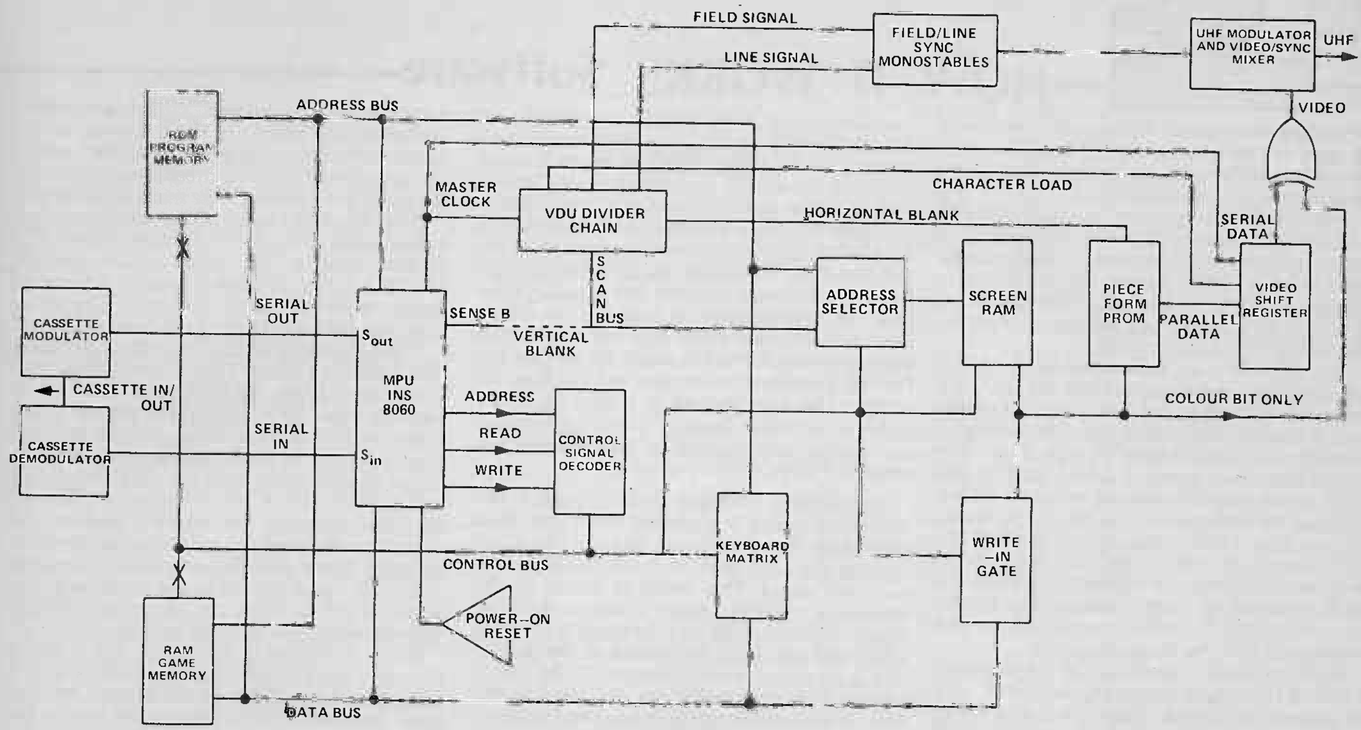
The same keys are used for letters and numbers so it is important to know where you are in the entry sequence. For this reason a STROKECOUNT appears during partial entry at the bottom left of the screen and denotes th number of entry strokes Tolinka has received. If a total entry has been received the location is blank, otherwise it contains 1, 2 or 3. The machine will not accept further instructions unless a proper entry has been made: the STROKECOUNT must be blank on pressing a function key. If the move which is flashed is not the one desired it may be overwritten by a correct entry of four keystrokes. The game does not progress until the MOVE key is pressed. This maintains integrity with the rules of chess, which state that a move is not made until one's hand has released the piece. If there is a partial entry any key may be pressed until the STROKECOUNT clears, then the correct sequence entered.

Tolinka will allow you to move anything anywhere and does not care whether you break every rule in the book, except in three special circumstances. It is never necessary to make more than one move, even when Castling, capturing en passant or Queening a pawn. Tolinka presumes that if you move your king two spaces you intend to castle, and completes the move for you. If you put a white pawn on the back rank Tolinka presumes that you want a queen instead. (Tolinka might not be right in all cases. You might want a knight or a rook to avoid stalemate. Of all the people who will use Tolinka for the rest of thier chess lives, there are a few who might meet this eventuality once or even twice. To these unfortunate few we suggest you extend this apology: "Sorry, couldn't you think of it as a knight, just this once?") If a pawn is moved diagonally into a square where there is no piece to capture, Tolinka presumes and executes the en passant move.

It is not possible to beat Tolinka by fast entry. It is not necessary to wait for the flashing to stop. There is never any point in holding down any key because Tolinka is only waiting for you to let go. Keystrokes should not overlap: one finger entry prevents this. Touch typists should stick to QWERTY keyboards — Tolinka, like the calculator, is a woodpecker's tool.

Tolinka runs out of memory after black's move 62. If the game must





The block diagram of Tolinka. The hardware sections of the design will be described in detail next month.

be continued then it must be set up as a position — after 62 moves there are not many pieces left. Positions and Chess Problems can be set up my moving pieces without regard to the rules. There is no legal sequence of moves to the position of many chess problems anyway.

The GO TO Function

During the entry of a game the position which is current is always shown. But any other position in the game may be brought to view by pressing the GOTO key followed by a two digit move number. Do not forget the leading zero for numbers less than 10. When, for example, GOTO, 0, 9 has been keyed in the position will instantly revert to the position at white's ninth move, which will flash on screen. Remember then the flashing is interrogation, and a different move may be entered, or if the move is satisfactory the MOVE key may be pressed. Thus it is possible to step through the game, making modifications as necessary, or go instantly to any point in it.

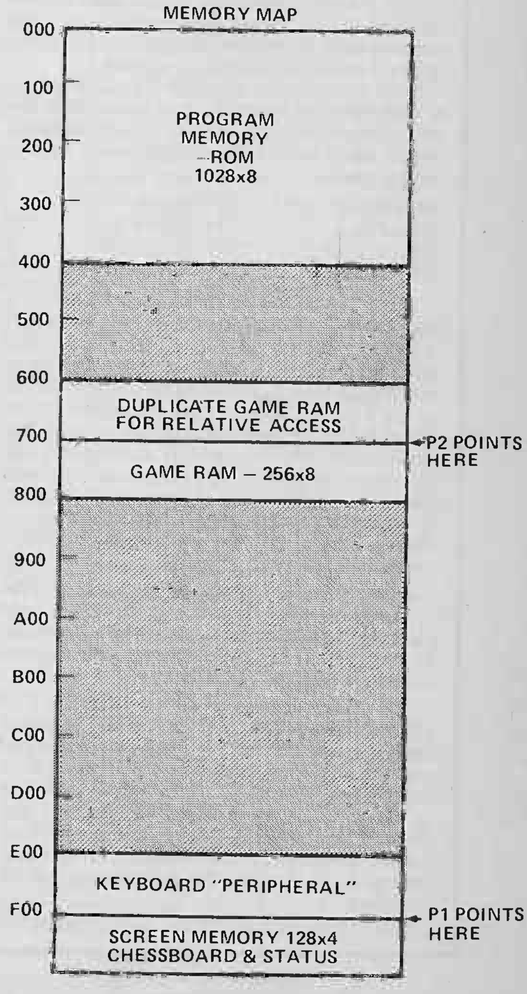
Pressing GOTO followed by a RECALL or RECORD function key brings trouble. Tolinka identifies RECALL and RECORD with a hexadecimal numer greater than 10. It therefore cannot increment the decimal counter to equal it — but will willingly spend the rest of eternity trying. The only cure is to switch off.

You see Tolinka starts again at the beginning of the game when the GOTO button is pressed and plays quickly through to reach the requested point. Note that the GOTO key doubles as zero and the MOVE key doubles as 9.

Tolinka Is A Videorecorder

There is no need to write down a game sequence. Tolinka records chess games on tape. It records them as a three second leader tone followed by a four second data burst which contains the complete contents of the game memory — up to 62 moves by each player. It follows that a single C60 cassette will hold about 500 games. That's a lot of chess!

Recording time is cheap, less than a penny a game, so it pays to keep two copies of all information and use some tape space between games to make them easy to find. If the tape recorder has a counter a written index should be made, if there is no counter then a single spoken number between games is the best system. To record on the tape a description of opponent, event, date, etc., isn't much help in finding a game in a long tape. These comments are for guidance only, and you will no doubt find your own system for using Tolinka.



—HOW IT WORKS Software

A detailed description of the software would fill most of this issue of ETI. What follows is an outline of the various sections that go to make up the systems software.

It is not necessary to be familiar with the detailed architecture of the SC/MP MPU on which the project is based to understand what follows. Briefly, however, the SC/MP is an eight bit MPU with a set of 46 instructions covering arithmetic, logical, data transfer and miscellaneous operations.

The SC/MP has four on board 16 bit pointer registers designed PO-P3. SC/MP forms the address of the next program (data) byte it requires by adding (or subtracting) a displacement, which may be zero, from any one of these four pointers. PO is used by the MPU as the program counter while P1-P3 are assigned by the software. A Power on Reset ensures that when power is first applied the MPU starts by examining location one in program memory, the instructions here set these pointers to indicate locations in the memory field which correspond to the chessboard and the game sequence.

The pointer P3 is reserved for subroutines, while P1 is used to indicate both the chessboard and the keyboard, it being set to the boundary between them. A positive value added to this pointer will find the chessboard, a negative value the keyboard. P2 is used to indicate the game sequence.

The first routine used is called CLEARALL which clears all locations in game RAM and board RAM. Clearall is not a subroutine because it will never be needed again. Its purpose is to overwrite the 'garbage' present in RAM when power is first applied.

Next a subroutine is called. The subroutine is referred to as DEBOX. At a location in the program memory is a table of the chesspieces which have been defined according to following codes:

000 = Blank	100 = Rook
001 = Pawn	101 = Queen
010 = Knight	110 = King
011 = Bishop	111 = Not assigned

These are the lower three bits: if bit four is high then the piece is white, if it is low then it is black. DEBOX takes the pieces from the table and places them in the 64 locations making up Board. Thus the pieces will be set up for a game. The piece codes stored in the Board RAM are used in conjunction with the piece form PROM, which stores the bit patterns corresponding to the various chess pieces, an address selector and various items of hardware to generate the game display. The operation of this section will be discussed next month.

DEBOX is a subroutine because it will be called again from another part of the programme. A part of this subroutine is to set the Move Number back to '01' and the arrow to indicate white has the move.

The next subroutine to be called is EXTRACT. this examines location one in game memory and places information about the current move in temporary storage. This information includes the 'from' square, the 'to' square, the piece being moved and the piece being captured if any. The purpose of storing this information is that it should not be lost in the move flash sequence to be described.

The SCAN subroutine is now entered. A location called KEYWORD is cleared and SCANCOUNT is set to a predetermined value. Also FLASHCOUNT is set to a value which determines the number of flashes which will be made following a Move write-in. Three flashes are considered enough. The SCANCOUNT determines the duration of the the final byte. The serial output is placed high for three seconds to form the Leader Tone and the transmission is made. Each word does not contain eight bits but six, so an asynchronous format is made by setting the first bit in each word to zero and the final bit to one. This corresponds to a start bit and a interval between flashes. These operations are carried out regardless of whether we require a piece to flash or not.

To perform a single scan sequence the keyboard, which is matrixed from four data lines and three address lines is read, all locations at once, and the result examined for non-zero value. This result is stored in the extension register. After a delay of about seven milliseconds the keyboard is read again and the result compared to the first — this is to defeat switchbounce. If the result after the delay period is not the same as the first, or both are zero, there has been no valid keypress and control is passed back to the start of the loop. If there is still a non-zero value then the keyboard is examined one line at a time by changing the address location and adding four to the keyword on zero result, to find the row of switches which contains the valid key. When the row has been found the data is shifted out of the end of the register, adding one to the keyword for each shift, until the result is a clear register. At this point the keyword has a value unique to the individual key. Release is then awaited and debounced as before and return is made to the main programme with a keyword for processing.

When first entered the 'from' and 'to' squares will have been set to zero by the CLEARALL routine. This will mean that when the flash sequence occurs the piece corresponding to square-zero- top left hand square's rook- will be made to flash back and forth **to the same square.** It will thus seem as if the piece is not flashing.

The MOVE subroutine first examines the STATUS register and hands control back to the keyboard if the Strokecount does not equal zero. This is to prevent spurious moves being made. Then the serial output of the MPU is brought high briefly to record a tone on tape should the tape recorder be operating. The piece moved is examined for 'Kingship' and if it is a king the 'From' location is compared with the 'To' location for a castling situation. The castling routine is entered if necessary, the corresponding Rook being placed on the appropriate side of the King. If the piece fails the 'Kingship' test it is tested for 'Pawnhood'. If it is a pawn it is tested for a diagonal move and if there is no captured piece in a diagonal move situation an EN PASSANT move is presumed and the piece in the square adjacent to the diagonal is removed. If the pawn is moved to the final rank a Queen is substituted. A move is made by accessing the board RAM and writing a blank in the memory location corresponding to the FROM square, derived from the EXTRACT routine, and the corresponding piece code to the TO square. The arrow which indicates the player is then moved to the opposite location and if this be white's end of the board the Move Counter is incremented. Return is then made to the main programme.

If the Keyword is GOTO the scan routine is called twice to fetch the Request Point. The DEBOX routine sets up the pieces and the MOVE routine is called until the Request Point equals the Move Counter. Control is then handed back to the keyboard.

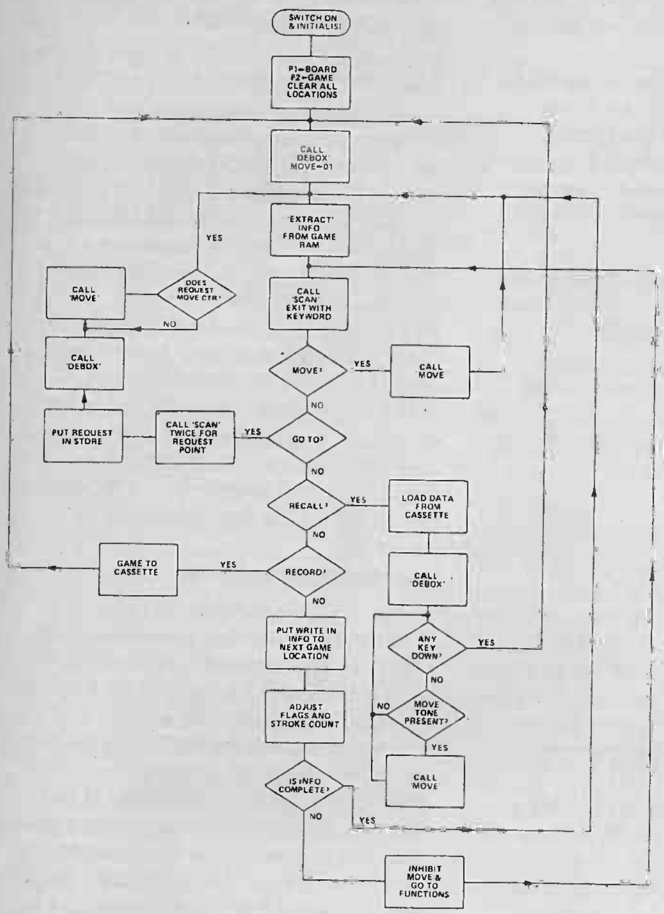
If the Keyword is RECORD the subroutine RECORD is called. This transmits all the contents of Game RAM in serial form on to cassette tape. First a digit 9 is placed in the Cassette Status location on-screen and the final locations in Game Memory are cleared. These locations are used for FLASHCOUNT and SCANCOUNT, etc. The entire contents of Game memory are added together and complemented and the complement stored in stop bit. When the transmission is complete control is handed back to the keyboard. The Baud Rate is not conventional being approximately 460 bits per second.

If the Keyword is RECALL then a six is placed in the Cassette Status position which forms the bitcounter. When a start bit has been received, and verified after half a bit interval, a word of six bits is clocked in at the serial input, right-justified and stored in the next Game RAM location. After a complete Game reception the whole contents of game memory is added together and tested for zero result. If the total equals zero a tick is placed in the cassette status position. Compensating errors would have to be received for a transmission to pass this test and still be incorrect. Control is retained in the Recall routine after a transmission and if a tone is received at the serial input the next move in memory is made. (The Subroutine calls other subroutines DEBOX and MOVE.) If a leader tone comes along or any key is pressed control reverts to the keyboard.

If the Keyword is not a Function, then it is Move Information which is being written-in. Bit 2 of the Status register, which keeps account of whether a letter or a figure was entered last, is examined and the appropriate Letter or Figure routine is chosen. The word is processed to make its binary value equivalent to the requested rank or file on the Chessboard and stored in the Game Memory in the appropriate From or To locations which are addressed alternately. The actual form in which the word is stored bears little relationship to the letters/figures code, the top left square being 00 (base 16) and the bottom right 3F. Only six bits are necessary to define the squares of a chessboard, these being 26 in number.

As each keystroke is entered the Status register is examined and a Tally, called the Strokecount, is entered in an offboard location on the bottom left of screen memory. The strokecount informs the user of how many keystrokes have been entered. A partial move entry transfers control back to the main routine **After** the "Extract' sequence so that spurious moves are not flashed. A total entry passes control to **before** the "Extract" sequence so that the intended move is flashed for verification.

The MOVE and GOTO operations will be inhibited until the appropriate entry sequence is complete.



The flow chart for Tolinka's software is shown above.

The SCAN subroutine (reproduced in full below) is one section of Tolinka's software.

SCAN — SUBROUTINE

Video Interval?	06	Copy Status to Accumulator
	D420	And Immediate 20 (Check Sense B)
	9C4E	Back to Keyscan if not zero
Examine Flash	C15D	Get Flashcount from P1 + 5D
	D40F	And OF = Strip off top 4 bits
	9848	Go to keyscan if zero
	B95D	Decrement Flascount
Examine From/To	06	Copy Status to Accumulator
	D401	And 01
	9C16	Go to 'Back' if odd
'Forth'	C400	Load Immediate zero
	01	Clear Extension Register
	C2FC	Load Fromloc from P2
	01	Fromloc to Extension (Zero to Acc.)
	C980	Storezero to Fromloc at P1 (Board) Implied Address.
	C145	Get piece from P1 'Extract'
	01	Piece to Extension
	C2FD	Load Toloc from P2
	01	Toloc to Ext. Piece to Acc.
	C980	Store Piece in Toloc at P1 — Implied Address
	06	Copy Status to Accumulator
	DC01	Or Immediate 01. = Adjust From/To flag
	07	Copy Accumulator to Status
	901A	Back to Keyscan
'Back'	C145	Get piece from P1 'Extract'
	01	Piece to Extension
	C2FC	Load Toloc from P2
	01	Exchange Extension with Accumulator
	C980	Replace piece in Fromloc
	C146	Load captured piece from P1 Extract

	01	Capture to Extension
	C2FD	Load Tloc from P2
	01	Exchange Accumulator and Extension
	C980	Restore Capture in Toloc
	06	Copy Status to Accumulator
	D4FE	Set last bit low
	07	Copy Accumulator to Status
	9004	Skip over Flascount Set.
Entry Point	C407	Load 7 = Flashcount
	C95D	Store Flashcount
	C430	Load 30 = Scancount
	CAFF	Store Scancount at P2
	C400	Load zero
	C94D	Clear Keyword
	C2FF	Load Scancount
	9C03	Go to Scan if not zero
	98B0	Otherwise go to 'Video Interval?'
Scan Keyboard	BAFF	Decrement and load scancount
	C1FF	Read Allkeys
	D40F	Strip off top 4 bits
	E40F	Exclusive or OF (Any down?)
	01	Result to Extension
	8F07	Delay 7 milliseconds. (Debounce)
	C1FF	Read Allkeys
	D40F	Strip off top 4 bits
	E40F	Exclusive or OF
	50	And Extension
	98E5	Back to Scan if zero (No key down)
Adjust piece	06	Copy Status to Accumulator
	D401	Examine From/To bit
	9CBE	Make move if set (Go to 'Forth')
Findrow	C4F4	Load Rowcount
	01	Rowcounter to Extension
	C180	Read Keyboard at implied address
	D40F	Strip off top 4 bits
	E40F	Exclusive of OF
	9C12	If not zero go to Rowfound
	C14D	Load Keyword
	02	Clear carry
	F404	Add 4 to Keyword
	C94D	Restore Keyword
	01	Keyword to Extension (Rowcounter to Acc)
	03	Set Carry
	1F	Rotate Accumulator right with link
	01	Rowcounter back to extension
	C4FF	Load FF (Set all bits high)
	60	Exclusive-or Extension
	98BD	If zero No Row Found. Back to Scan
	90E6	Otherwise back to Findrow
Rowfound	1C	Shift right
	9806	If zero go to Release
	01	Switchboard to Extension
	A94D	Increment Keyword
	01	Switchboard back to Accumulator
	90F7	Jump to Rowfound
Release	C1FF	Real Allkeys
	D40F	Strip off top 4 bits
	E40F	Exclusive-or OF
	01	Result to Extension
	8F07	Delay 7 millisecond (Debounce Release)
	C1FF	Readl allkeys
	D40F	Strip off top 4 bits
	E40F	Exclusive or OF
	50	And Extension — Is any Key down?
	9CEE	Go to Release if key still pressed
	C14D	Fetch Keyword
	D40F	Strip off Top 4 bits
	01	Keyword to Extension
	3F	Exchange Pointer Register with Program Counter
		Exit from Subroutine with keyword in Extension

▶

(Why is the Subroutine entered in the centre? It is because jumps relative to the Program Counter may only be −128 or +127 locations and it is therefore politic to keep the main decision lines central to the block).

Recording A Game

To record a game the recorder is started in the recording mode, and then Tolinka's RECORD button is pressed. Some tape recorders have a monitor, which means one can hear what is being recorded, and some do not. During the recording time a 9 appears in the 'Cassette Status' position at the top left of the screen. When the 9 disappears recording is complete and the game resets to the opening move. The game in Tolinka's memory is not destroyed by the recording process and it may be recorded as many times as is required. The game may also be modified, other versions tried, and these be recorded as well.

If the move key is pressed whilst the tape is still recording, a tone will be recorded on tape which indicates to Tolinka that it should make a move when the tape is replayed in the RECALL mode. The tone does not contain any information other than to tell Tolinka to make the next move in its memory.

Recalling A Recorded Game

First the game to be recovered must be found on tape, by means of one of the indexing systems previously described. When the leader tone is heard the RECALL key must be pressed. The leader tone has two purposes: to overcome any noise problem leading into game data and to allow the tape recorder's internal Automatic Volume Control to stabilize. The RECALL key must be pressed **and** released during the three second continuous leader, to transfer control to the cassette recorder.

A 6 will then appear in the 'Cassette Status' position and should remain stationary for the rest of the leader, change to a running digit during the data transmission and be replaced by a tick if the game is received correctly. The tick denotes that a 'Checksum' appended at transmission time has been correctly received. A Checksum is a way of checking data transmissions. Simply all the words in the data are added together and the total complemented. This complement is then transmitted as the last byte. When the data is added together it should total zero and the tick denotes that the contents of game memory has been totalled and does, in fact, equal zero.

If a recall is executed when there is no signal connected the machine will check in an all zero game — this is a useful way of clearing game memory. It is also the reason that zero was chosen as the checksum, so that one could be aware that memory was cleared without further checking.

If there is any symbol in the Cassette Status position it means that the Cassette has control, and move tones on tape will cause moves to be executed as they occur. It is also possible to record speech on the tape between the move tones, and explain to anyone who is willing to sit and watch how cleverly you demolished your opponent, blow by blow. Pressing any key such as MOVE or GOTO etc. causes control to revert to the keyboard and tones on tape will be ignored. The only time control may be passed to the Cassette Recorder is during the leader tone. If the Recorder is left playing and another game comes along the leader will pass control back to the keyboard. Operation of the controls is nearly foolproof and almost everyone becomes expert in ten minutes.

Reliability Of The Recording system

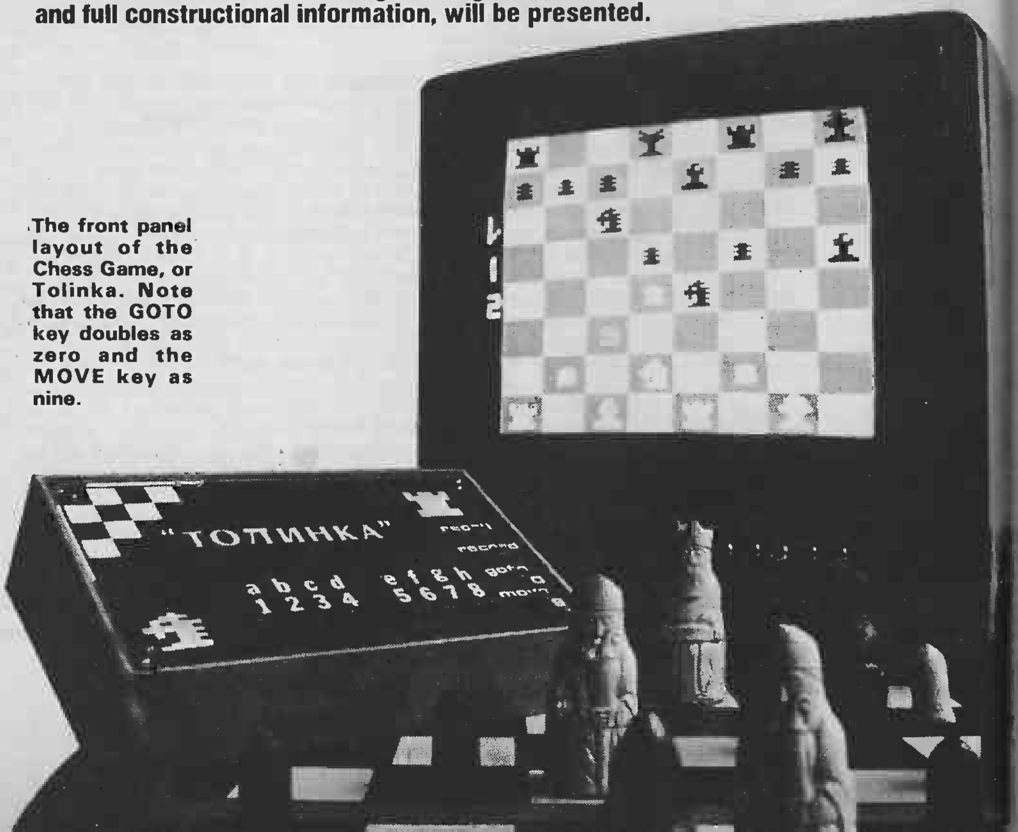
For absolute reliability a high quality studio recorder and data certified cassettes should be specified. In practice any recorder which works properly and a good quality audio tape will be quite all right. If possible the same recorder should be used for recording and replay because differences in motor speeds can introduce errors.

When acquaintances in pubs air their ability to read and learn new words tell you about 'dropouts' thank them admiringly. It costs little to spread happiness and they might buy you a drink. The author has never had any problem with dropouts but this may be the influence of fraternity.

Useful Example

Here is an example of use: the French Defence has been decided upon as this season's reply to e2e4 and a tape will be kept of all French Defences played. The same information will be recorded perhaps on other tapes which are chronological or event files. It only takes a few seconds to record a game and the process may be repeated at will. The French Defence tape begins with analysis from the precedent in literature: standard lines are recorded as an aid to learning the strategy. Later in the tape the actual games are listed followed by their post-mortems, in the light of hindsight. This is a powerful aid to learning. ETI

Next month the full circuit diagram, together with Hardware How It Works and full constructional information, will be presented.



The front panel layout of the Chess Game, or Tolinka. Note that the GOTO key doubles as zero and the MOVE key as nine.

NEWS

data sheet

ICM 7217/7227 SERIES **INTERSIL**

The ICM 7217 and ICM 7227 are four digit, presetable up/down counters with an onboard presetable register continuously compared to the counter. The ICM 7217 versions are intended for use in hardwired applications where thumbwheel switches are used for loading data and simple SPDT switches are used for chip control. The ICM 7227 versions are intended for use in processor-based systems where presetting and control functions are performed under processor control.

These circuits provide multiplexed seven segment LED display outputs, with common anode or common cathode configurations available. Digit and segment drivers are provided to dirrectly drive displays of up to 250mm character height at a 25% duty cycle. The frequency of the onboard oscillator (and thus the multiplex frequency) may be controlled with a single capacitor, or the oscillator may be allowed to free run. Leading zeroes are blanked, and the display drivers may be disabled allowing the display to be used for other purposes. The data appearing at the seven segment and BCD outputs is latched; the content of the counter is transferred into the latches under external control by means of the Store pin.

The ICM7217/7227 (common anode) and ICM1721A/7227A (common cathode) versions are decade counters, providing a maximum count of 9999, while the ICM 7217B, 7227B (common anode) and ICM7217C/7227C (common cathode) are intended for timing purposes, providing a maximum count of 5959.

These circuits provide three main outputs; a carry/borrow output which allows for direct cascading of counters, a zero output which indicates when the count is zero, and an equal output which indicates when the count is equal to the value contained in the register. Data is multiplexed into and out of the device by means of a tri-state BCD I/O port, which acts as a high impedence input when loading, and provides a multiplexed BCD output. The carry/borrow, equal, and zero outputs, and the BCD port functioning as an output, will drive one standard TTL load.

In order to permit operation in noisly environments and to prevent multiple triggering with slowly changing inputs, the count input is provided with a Schmitt trigger.

The carry/borrow output is a positive going signal occurring typically 500nS after the positive going edge of the count input advancing the counter from 9999 to 0000 counting up and from 0000 to 9999 counting down. This output allows direct cascading of counters.

The equal output assumes a negative level when the contents of the counter and register are equal (i.e., for the duration of one period of the count input until the count is changed by a positive going edge on the count input).

The zero output assumes a negative level when the content of the counter is 0000.

The digit and segment drivers provide a decoded seven segment display system, capable of directly driving common anode LED displays at typical peak currents of 40mA per seg. This corresponds to average current of 10mA/seg with the 25% multiplex duty cycle. For the common cathode versions peak segment currents are 12.5mA, corresponding to average segment currents of 3.1mA. The display control pin controls the display output using three level logic. The pin is self-biased to a voltage approximately half way between rails which corresponds to normal operation. When this pin is connected to V+, the segments are inhibited, thus disabling the display and reducing power. When this pin is connected to V the leading zero blanking feature is inhibited. For normal operation (display on with leading zero blanking) the pin may be left open. The display may be controlled with a 3 position SPDT switch as in the test circuits.

The BCD input/output port provides a means of transferring data into and out of the device in BCD format. The ICI 7217 versions self-multiplex data into the counter or register via thumbwheel switches in response to inputs at the load counter or load register pins, while in the ICI 7227 versions input/output control and timing must be provided externally. When functioning as outputs, the BCD I/O pins will also drive one standard TTL load.

The onboard multiplex scan oscillator has a nominal free-running frequency of 10kHz. This may be reduced by the addition of a single capacitor between the Scan pin and the positive supply, or the oscillator may be directly overdriven to about 20kHz.

FEATURES

Four decade, presetable up-down counter with parallel zero detect.

Setable register with contents continuously compared to counter.

Directly drives multiplexed seven segment common anode or common cathode LED displays.

On-board multiplex scan oscillator.

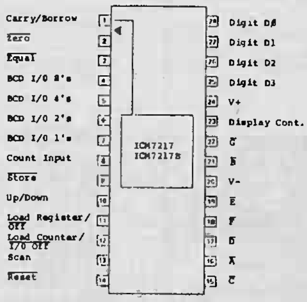
Schmitt trigger on count input.

TTL compatible BCD I/O port, carry/borrow, equal and zero outputs.

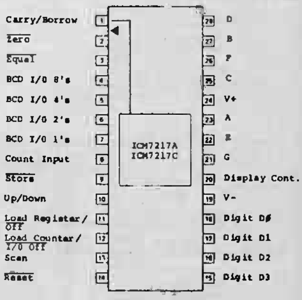
Display blank control for low power operation; quiescent power dissipation less than 5mW.

Display off control to allow use of display for other purposes.

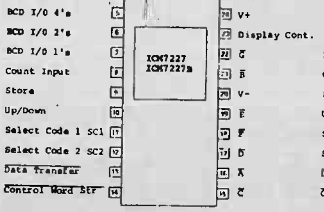
7217 numbers refer to hardwired control versions of the device, while 7227 numbers refer to the processor control versions.

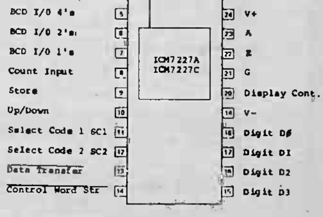


COMMON ANODE



COMMON CATHODE





The Store pin of the 7217 will allow the output latches to be updated only if it is held low. The device will count up if the Up/Down pin is high and down if low. The Reset pin will allow normal operation when high, resetting the device when taken low. The Load Counter pin has three states. When high the counter is loaded with BCD data, when floating normal operation is selected and when the pin is low the BCD port is forced to a high impedance. The Load Register pin also has three states. High loads the register with BCD data, floating allows normal operation while low disables the display drivers. The three state Display Control disables the segment drivers when high, allows normal operation when floating and inhibits the leading zero blanking when low.

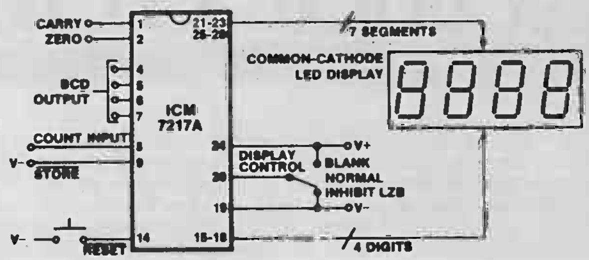
The 7227 pin configurations are somewhat different. The Data Transfer pin will allow normal operation when high, and when pulsed low will cause a transfer of data as directed by the select code set up on pins Select Code Bits 1 and 2. If these are set to 00 there will be no data transfer, 01 will latch the output data, 10 will preset the counter while 11 will preset the register. The Control Word Stobe will allow normal operation when high and when pulsed low will cause the control word set up on the Store and Up/Down pins to be written to the control latches. The Store pin will update the latches if high during CWS's active period, not allowing updates if low. The counter will count up if Up/Down is high, down if low. The display control is a three state input, blanking if low and allowing normal operation if left floating.

blanking if low and allowing normal operation of left floating.

The ICM 7217/7227 series provides in one easy to interface circuit (1) a high speed four decade up/down counter with carry out and parallel zero detext) (2) setable register and comparator; (3) output latches for (4) a multiplexed LED display decoder/driver system and (5) multiplexed (or directly addressed in the ICM7227) BCD outputs. These five subsystems can be used together or separately to provide a large number of circuit configurations.

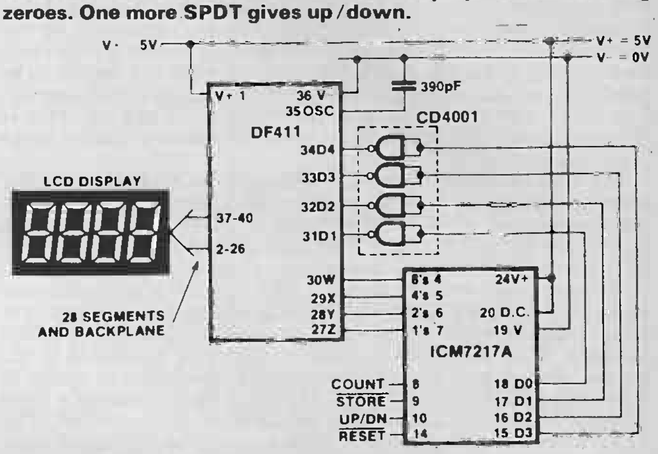
A few possible applications are shown below.

TIMER	DISPLAY	COUNTER/
ICM7217	Common Anode	Decade/9999
ICM7217A	Common Cathode	Decade/9999
ICM7217B	Common Anode	Timer/5959
ICM7217C	Common Cathode	Timer/5959
ICM7227	Common Anode	Decade/9999
ICM7227A	Common Cathode	Decade/9999
ICM7227B	Common Anode	Timer/5959
ICM7227C	Common Cathode	Timer/5959



UNIT COUNTER WITH BCD OUTPUT

The simplest application of the ICM217 is as a four digit unit counter. All that is required is an ICM7217, a power supply and a four digit display. Add a momentary switch for reset and an SPDT centre-off switch to blank the display or view leading zeroes. One more SPDT gives up/down.



LCD DISPLAY INTERFACE

The low-power operation of the ICM7217 makes an LCD interface desirable. The Siliconix DF411 four digit BCD to LCD display driver easily interfaces to the ICM7217A with one CD4000-series package to provide a total system power consumption of less than 5mW. The common-cathode devices should be used since in these versions the digit drivers are CMOS, while in the common-anode devices the digit drivers are NPN devices and will not provide full logic swing.

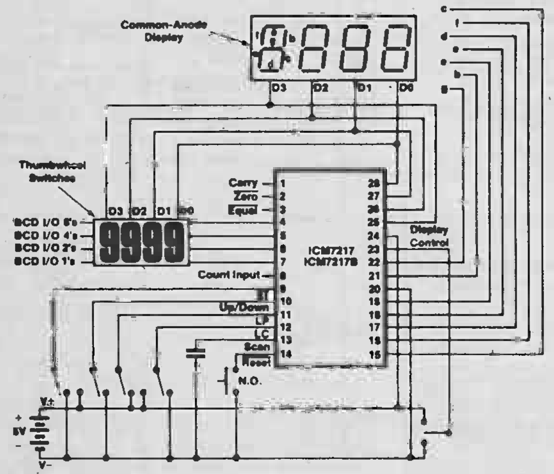


Fig. 1. The 7217 (common anode) version. The display and power connections are the same for the 7217B, 7227 and 7227B.

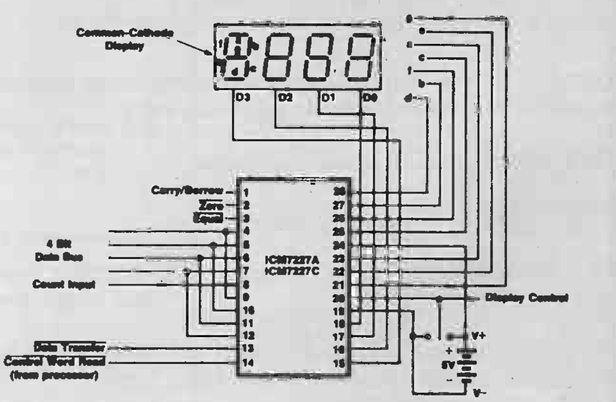
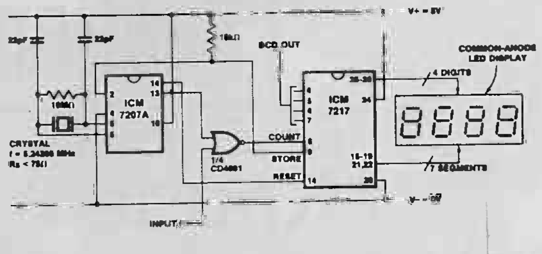


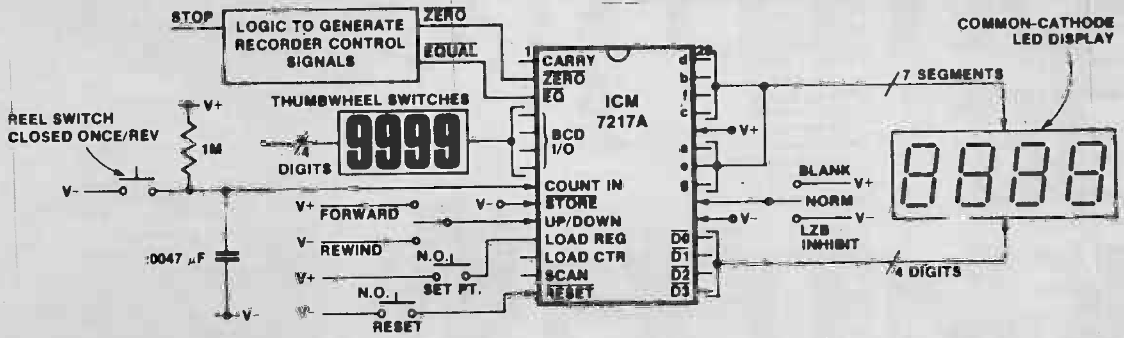
Fig. 2. The 7227A (common cathode) version. The display and power connections are the same for the 7227C, 7217A and 7217C.



PRECISION FREQUENCY COUNTER/TACHOMETER

This circuit is a simple implementation of a four digit frequency counter, using an ICM7207A to provide the one second gating window and the store and reset signals. In this configuration, the display reads hertz directly. With Pin 11 of the ICM7207A connected to V+, the gating time will be 0.1 second which will give tens of hertz in the least significant digit. For shorter gating times an ICM7207 may be used (with a 6.5536 MHZ crystal), giving a 0.01 second gating with Pin 11 connected to V+ and a 0.1 second gating with Pin 11 open.

To implement a four digit tachometer, the ICM7207A with a one second gating should be used. In order to get the display to read directly in RPM, the rotational frequency of the object to be measured must be multiplied by 60 (or 600 using a 0.1 second gating for faster update). This can be done electronically using a phase-locked loop or mechanically by using a disc rotating with the object with the appropriate number of holes drilled around its edge to interrupt the light from an LED to a photo-dector.



TAPE RECORDER POSITION INDICATOR/CONTROLLER

This circuit shows an application which uses the up down counting feature of the ICM7217 to keep track of tape position on a tape recorder. This circuit is representative of the many applications of up/down counting in monitoring dimensional position.

In the tape recorder application, the preset register, equal and zero outputs can be used to control the recorder. To make the recorder stop at a particular point on the tape, the register can be set with the stop point and the equal output used to stop the recorder (either on fast forward, play or rewind).

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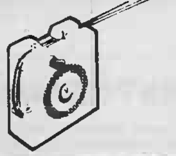

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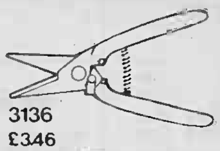

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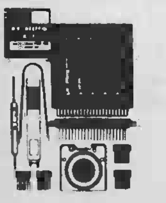

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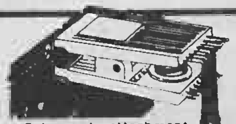

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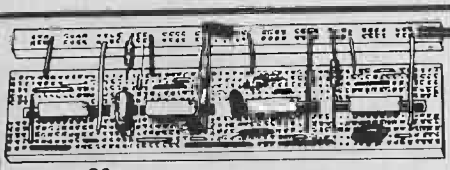

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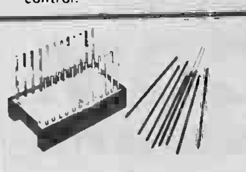

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MANY TIMES WHILE you're working in the garden the phone may ring and by the time it is heard, if it is at all, it is often too late to reach the phone. While the GPO will install a remote bell for you it has to be rented and for people who are hard 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. 2 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.

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.

▶

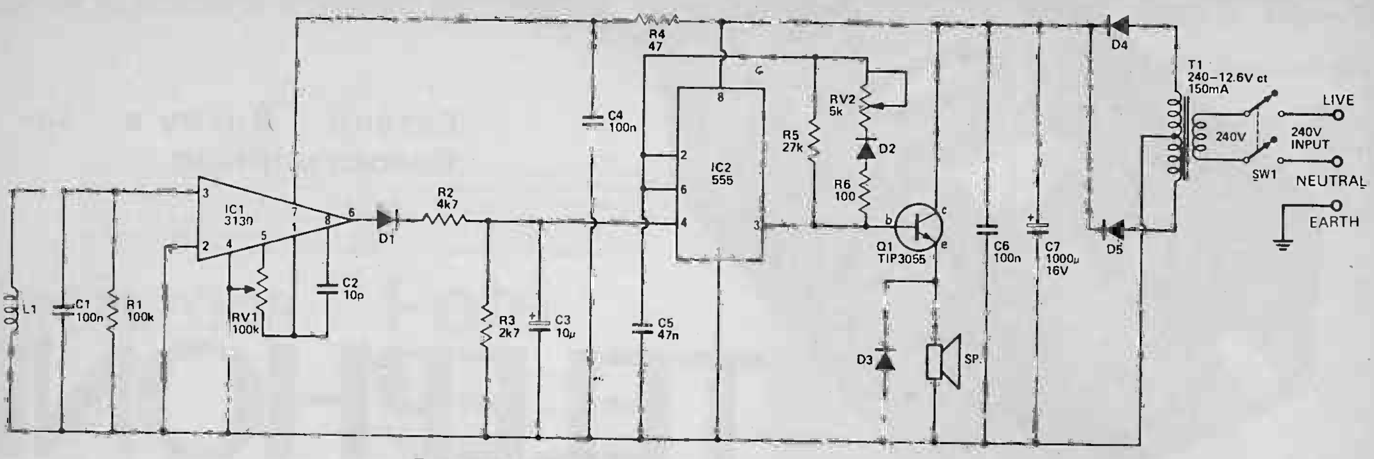
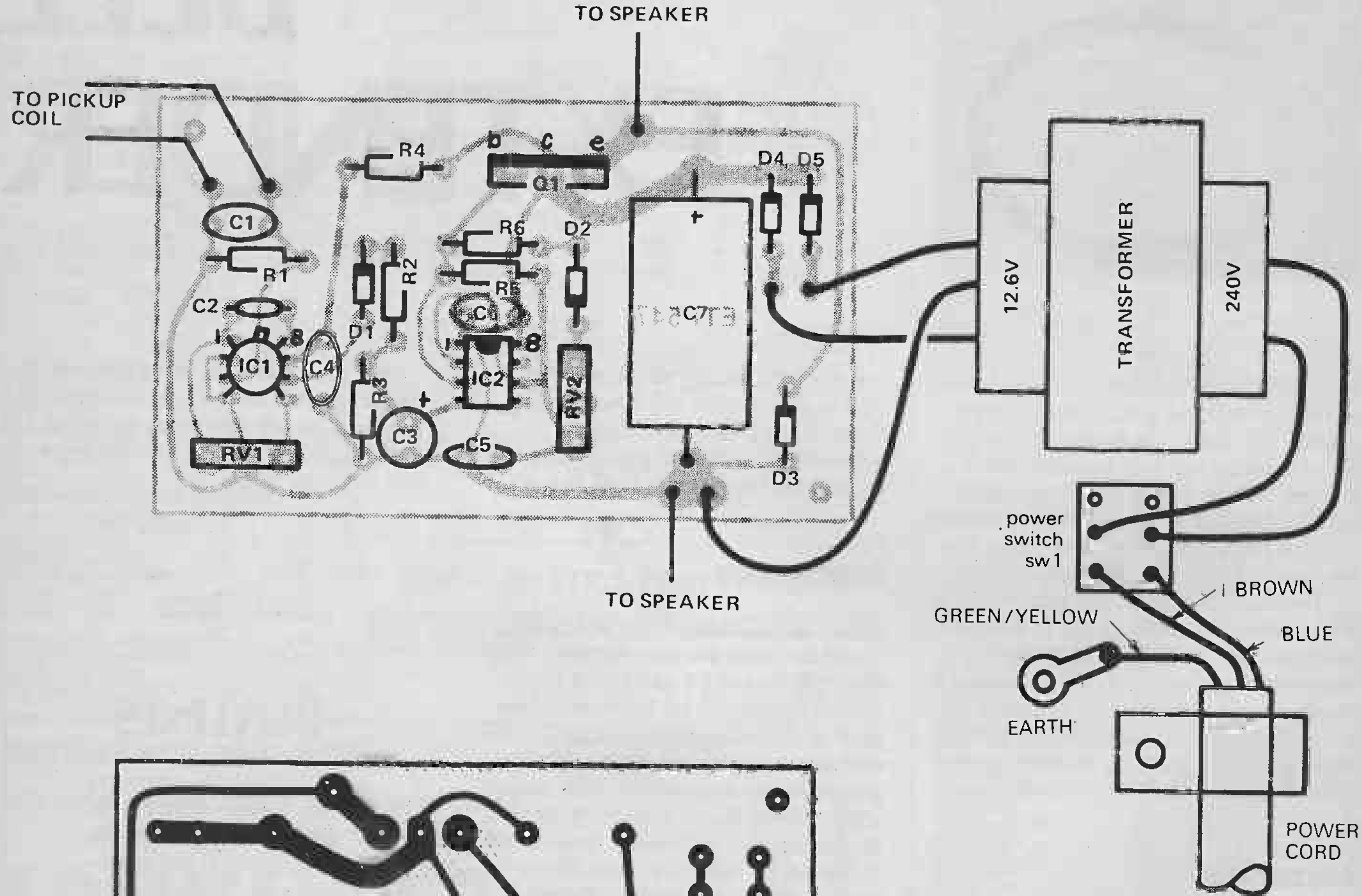


Fig. 1. Full circuit diagram of the tele bell extender.



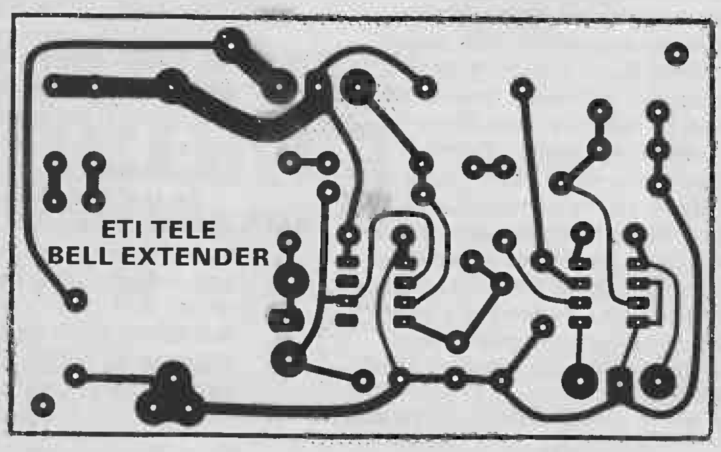


Fig. 2. (above) overlay for the extender's PCB

Fig. 3 (left) full size foil pattern for the telephone bell extender printed circuit board.

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drool here

Now before we go any further this lot costs about £2,000, and is definitely pie in the sky for most of us — but its lovely all the same. For once we're gonna let someone describe their own product — take it away HP.

Called the Hewlett-Packard Model 1742A Delta Time Oscilloscope, the instrument is also available with an optional 3-1/2 digit autoranging digital multimeter which displays time in seconds, milliseconds, or microseconds. This DMM option (034 or 035) can be ordered installed initially, or added later in the field because the delta time capability is built-in the basic oscilloscope. The DMM can also be used to measure ac and dc voltage and current as well as resistance.

In the delta time mode, the oscilloscope measures time between two events on either channel A or B, or between an event on one channel and an event on the other. Measurements of high-speed digital timing, transition times, propagation delay, and clock phasing are rapid and with greater accuracy than with traditional differential delay time base oscilloscopes.

Stable internal triggering to 100 MHz requires 1 cm vertical deflection (only 0.3 cm to 25 MHz).

Excuse us while our workbench gently weeps.

close encounters calls

There are probably only a handful of ETI readers who aren't 'Star Wars' fans and most of the staff here have seen it more than once. At the beginning of August one of our people was in North America and saw the first follow-up, 'Battlestar Galactica', made by John Dykstra, the principle effects man on 'Star Wars'.

Battlestar Galactica itself is the equivalent of a battleship and the only survivor of twelve such giant fighting ships from a sneak attack launched by the Cylons. The mission of Galactica is to gather together the human survivors of the Galaxy and to find the lost planet Earth which was colonised in the long distant past by other humans.

Like 'Star Wars', the film is full of parables, in this case the Old Testament escape of Moses from Egypt is only thinly disguised. Throughout the film you can't help noticing the Star Wars parallels, even down to the noise made by the laser guns.

Galactica is a film you'll have to see if you get the chance — it lacks the novelty of 'Star Wars', there's no R2D2, Darth Vader or light sabres but the effects are excellent none the less.

Universal, who handle the film, have not yet decided if the film will be distributed here. It is a major, and very expensive (at $14,000,000), pilot for a TV series. If it is shown it will not be before next spring.

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.

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, C4	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

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PCB as pattern
Transformer 240V — 12V 6V ct
Mains switch, 3 core flex
Box, speaker, pickup coil

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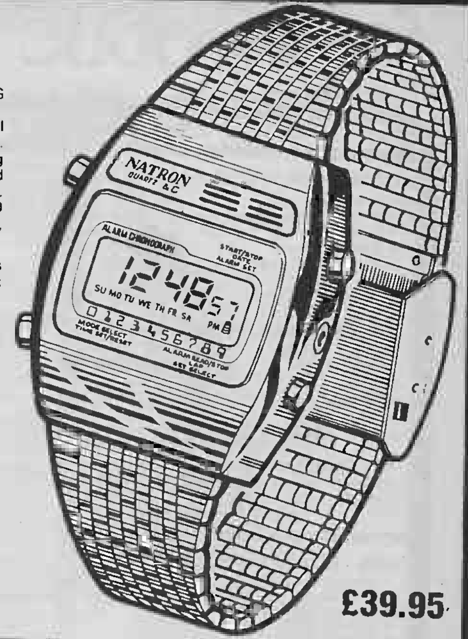
If you could write the specification for your own ideal watch you would probably want everything this one has. As for styling, without a close inspection nobody is going to be able to tell the difference between this watch and that world famous James Bond classic selling for £145. However, this one goes one better and has 1/100 second timing of net, lap and 1st and 2nd place times, with dual time facility.
- Constant LCD display of hours and minutes plus optional seconds or date display plus day of the week and am/pm indication.
- Perpetual calendar; day, date, month and year.
- 24 hour alarm with on/off indication.
- 1/100 second chronograph measuring net, lap and first & second place times.
- Dual time zone facility. Night light.
- Fully adjustable stainless steel bracelet.
- Stainless steel case. Mineral glass face.

This watch should not be confused with cheaper models with chrome plated cases and plastic lens. Manufactured by National Electronics, it runs a close second to Casio, Citizen and Seiko for quality and reliability, with undeniable value for money. It is fully guaranteed for 12 months, with first-class service back-up.
The first very limited quota will be available in mid-September with another small consignment in October, so order now to avoid disappointment. We will quote you a delivery date by return of post.



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52QS-14B. S/S encased version and bracelet.
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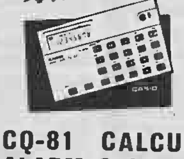

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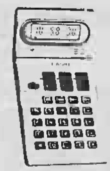

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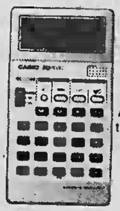

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GARRARD MRM 101

MUSIC RECOVERY MODULE

GORDON KING examines the new Garrard Music Recovery Module for ETI. This machine is designed to remove the transient noise created by damaged grooves on an LP. How effective is it and how does it work? Read on ......

THIS INTERESTING BRITISH innovation is a small, self-contained, mains-powered unit designed for connecting between the left and right outputs of a magnetic pickup and the left and right auxiliary or tuner inputs of a hi-fi amplifier. The unit processes the signals passing through it so that the disconcerting clicks produced by badly scratched records are virtually eliminated. In other words, the unit can be regarded as a record 'scratch remover'

Basic principle of operation is fairly straightforward. The clicks are processed to form large amplitude pulses which are then applied to an electro-optical fader which, at the precise moment of the clicks, severely attenuates both audio channels, thereby exchanging the clicks for very short periods of 'silence.' Record clicks have a fast rise-time and the effective slewing-rate is determined by the primary parameters of the cartridge, which are the effective tip mass, compliance and, to some extent, the mechanical resistance or damping of the cartridge.

Provided that the attenuation is large enough, that it switches on and switches off swiftly enough just to straddle the periods of the clicks and that it is accurately synchronised to the occurrence of the clicks in the audio channels, then the effect is singularly dramatic — the loss of information during the time of the attenuation appears to be of little subjective moment.

The effect is akin to tape dropouts, but it appears to be less affected by the accompanying S/N ratio impairment of these. Experimental work has suggested that provided the period of program loss or attenuation does not exceed about 10 ms, then the result is not unduly obtrusive subjectively. The attenuation period of the MRM-101 is a trifle above 2 mS hence the 'gaps' come and go unnoticed.

Built to A Standard

The unit is built into a shallow enclosure and the front forms a brushed aluminium fascia carrying three controls and three light emitting diodes (LEDs). One control is for power on/off, another for suppressor on/off and the third provides a continuous threshold adjustment for the suppressor action. In use, this is set for the best subjective improvement in reproduction.

If the control is too far advanced music peaks as well as scratch clicks may be processed; if insufficiently advanced only very large amplitude scratch clicks will be processed. It is easy to determine the most desirable setting because one of the LEDs flashes each time a scratch is detected. Thus, when playing a record of given mutilation the control is slowly turned up until the suppressor activity LED flashes on all the significant scratches yet remains unaffected by high-frequency music peaks. Another LED merely glows when the mains is switched on, while the third LED signifies that the suppressor mode switch is on.

The rear is equipped with 'phono' type and DIN input and output sockets, making it is a simple matter to connect the unit to virtually any contemporary hi-fi amplifier. There is sufficient output to drive a power amplifier direct, but to control the volume this would need its own volume control. Not all power amplifiers are equipped with a volume control, so it is a pity that Garrard did not see fit to include an output gain control. When driving from the unit direct to our power amplifier high quality reproduction was achieved.

Operations

Operation of the unit can be appreciated from the diagram in Fig. 1. This is partly schematic and partly in *simplified* block format. With the suppressor off, the signal is directed from the output of the front-end, which is a partly equalised preamplifier composed of Q1-Q4 to the output buffer amplifier (RC4136DB), which provides the remainder of the RIAA equalisation.

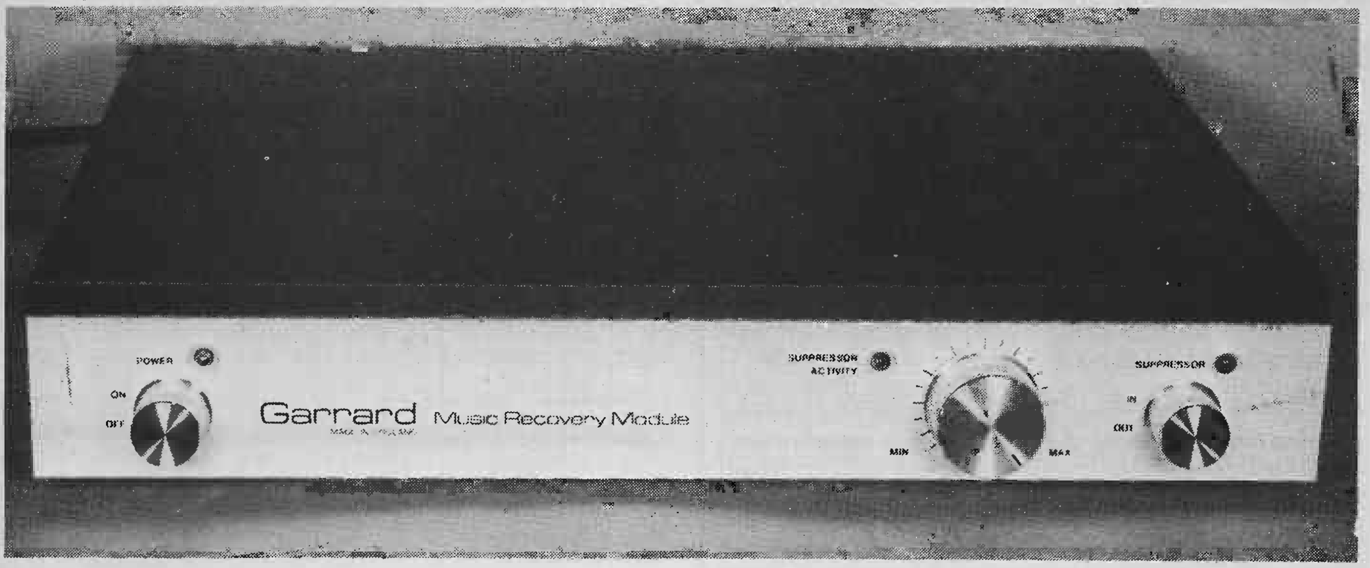
Equalisation of the front-end is provided by the usual frequency-selective feedback arrangement which gives the 'bass boost' requirements of 3180 and 318 μ S. The 75 μ S. de-emphasis equalisation is provided by the 51k resistor and 1n5 capacitor in the feedback path of the output buffer. The circuit as a whole is also engineered to cater for the more recent IEC-98/4 specification corresponding to a 20 Hz additional turnover, equivalent to a time-constant of 7950 μ S.

A Gain Gained

Front-end gain is about 34dB at middle frequencies, and an extra 1.6 dB is provided by the output buffer. The circuit has some desirable aspects, including the differential input stage Q1, 2 and the 'Darlington' Q3, 4 stage which provides a high input impedance and low output impedance from Q4 emitter. Operating in the 'suppressor off' mode extremely good quality pickup signals are obtained.

The split equalisation, where the de-emphasis is provided at the output, helps to provide a high S/N ratio, and the circuit overall demonstrates an input overload threshold of about 37 dB at 1 kHz ref. 2 mV input.

Accuracy of the overall RIAA equalisation is revealed by the pen chart response in Fig. 2. This is maintained within 0.25 dB between the left and right channels over the entire spectrum. With the suppressor on the accuracy is almost the same, but our sample did exhibit a very



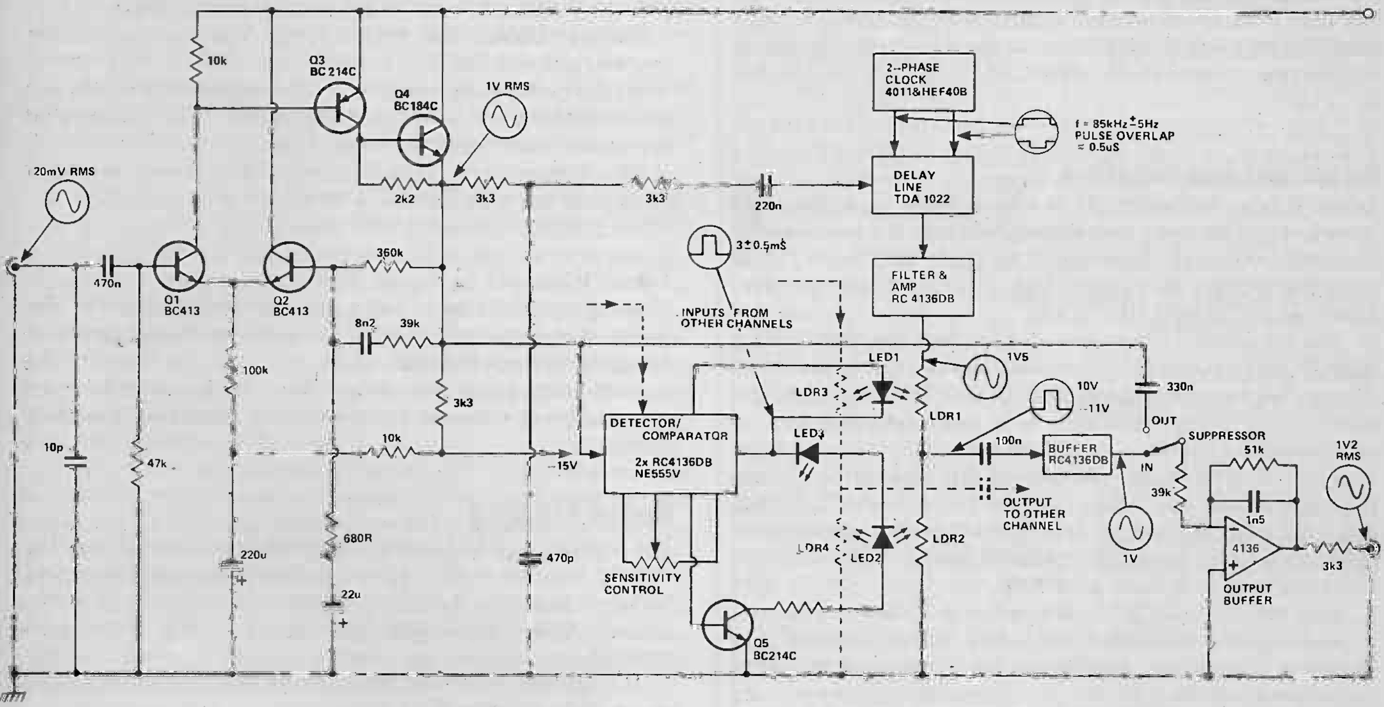
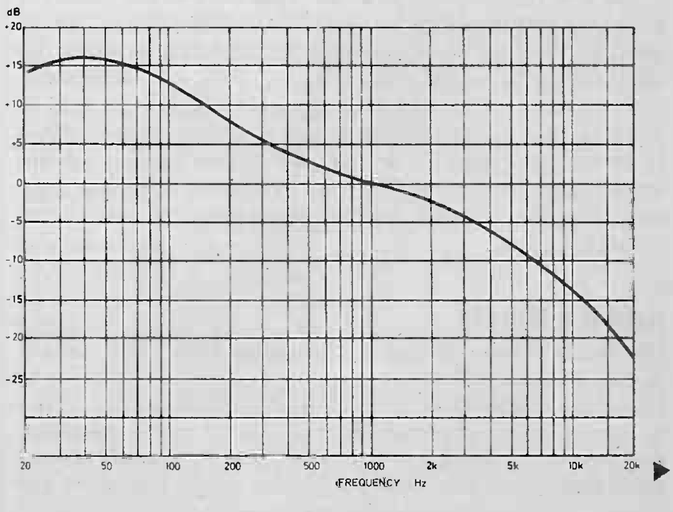


Fig. 1 (Above) The block diagram of the Garrard click eliminator MRM 101. The pickup amplification and equalisation stages were found to give a very high quality signal output. Note the use of quad op-amp 4136.

Fig. 2 (Right) RIAA equalisation curve for the unit. Channel balance was an excellent 0.25dB!

mild error round 15 kHz which was subsequently proved to be caused by a poor tolerance component. The tolerance in this area is being tightened by the manufacturer.

To the onset of peak clipping the amplifier is capable of providing an output of 9 V RMS at middle and low frequencies, with adequate reserve up to 20 kHz, resulting in an output slewing rate of round 0.15V/µsec., which will accommodate all disc material played on top-flight pickups. With the suppressor active the output is reduced by approximately 10 dB, but this is still more than adequate, even when driving direct to a power amplifier. The measured S/N ratio was 75 dB (CCIR/ARM weighting) ref. 7 mV RMS input.



Lines of Frequency

The spectrogram in Fig. 3. gives an excellent impression of the spectra purity with a 200 Hz signal of *2V RMS output level*. Ripple components are below our measuring floor of -90 dB, and the only harmonic of significance is the 2nd at -79 dB, corresponding to 0.0112%!! With the suppressor active the distortion is greater, as shown by the spectrogram in Fig. 4, again at 2V RMS output. The 2nd harmonic again predominates, but this time it is -50 dB (0.3%). The 3rd harmonic is down at -59 dB (0.112%), while all subsequent harmonics are at levels of insignificance.

The relatively high value of 2nd harmonic distortion is not disconcerting. Indeed, recent tests have suggested that a controlled amount of even-order non-linearity can, in fact, enhance rather than detract from the reproduction.

There seems to be a tendency for it to 'disguise' the heavy odd-order distortion carried by some program signal sources, including gramaphone records, and that this can lead to improved auditioning of some highly specified transistor amplifiers — owing to the resulting 'valve type sound,' no doubt!

Circuitous Examination

Looking now at the circuit in Fig. 1 with the suppressor active, it will be seen that the sighal from the front-end is directed two ways. One way is to delay line (TDA1022) and the other way is to the detector/comparator (2xRC4136DB and NE555V).

The detector recognises the whole waveform of a scratch and isolates it from the peaks of the recorded music. Two monostables (one in the NE555V and the other the bipolar transistor Q5) are switched by the scratches to generate pulses of about 3 mS. duration and 10 V amplitude (shown on the diagram). These pulses are then caused to operate LEDs 1 and 2, which are optically-coupled to two pairs of light dependent resistors (LDRs). One pair relates to the right channel and the other pair to the left channel.

Just one channel is shown in the diagram.

The LDRs associated with the other channel are drawn in broken line, as also are the inputs and output of the other channel.

Each pair of LDR forms an attenuator (called a fader) and is arranged to control the level of the audio signal eminating from the delay line prior to the signal arriving at the first buffer (RC4136DB). This part of the circuit is deliberately simplified for the sake of description, but in practice the degree of attenuation amounts to some 50 dB in the audio signal channels each time a pulse occurs.

Now, since it takes a little time for the pulses fully to develop, the signals in the audio channels proper need to be delayed slightly so that the scratch pulse on the music signal arrives at the fader at exactly the same time as the pulse created by the detector and associated circuits.

Hold it a Minute

The delay is provided by a 256-stage TDA1022, which is two-phase-clocked by a pair of ICs HEF4011 and HEF40B. The clock is running at 85 kHz, and the overlap of the two associated waveforms (shown in the diagram) ensures the required delay time. The net result is that each time a scratch click occurs the audio channels are

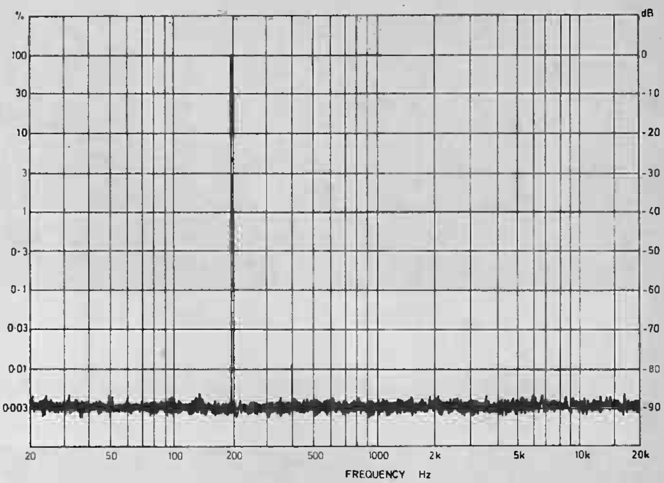


Fig. 3 Spectrogram of the 200Hz drive signal, suppressor switched out.

faded by about 50 dB for a period a shade over 2 mS.

This straddles the time of the 'real' scratch click, thereby eliminating it.

LED3 is the suppressor activity indicator on the fascia which, being in series with a fader LED, flashes in sympathy with the suppressor action.

The detector circuit includes auto and manual threshold control, while a filter in the amplifier IC, RC4136DB, following the delay line eliminates the spikes and spurious signals produced by the delay line action. It should be noted that although the maximum clipping output is les in the suppressor mode than in the direct mode, the gain of the amplifier sections remains the same in both modes.

It is thus possible to achieve A/B comparisons without level change by switching between the two modes.

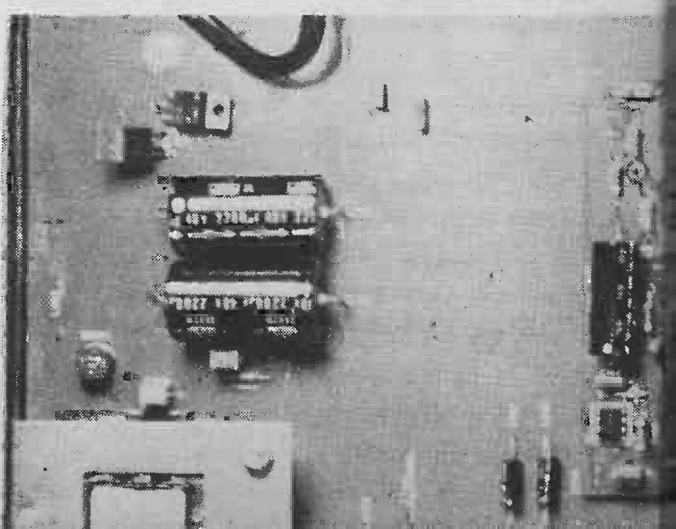
House Training

The sample unit has been operating very successfully for several months under typical domestic conditions in our test hi-fi system. It certainly removes the very disconcerting staccoto clicks caused by badly scratched records.

It does not, however, remove the general background noise from worn or dirty records.

Such noises occur in almost continuous manner, so advancing the threshold control to achieve a response to these noises would lead to the elimination of a substantial proportion of the music.

Operated as the designers intended, the unit constitutes a valuable item of record playing hardware which, at the probable selling price of £80 or so, would soon pay for itself, records costing what they do today.



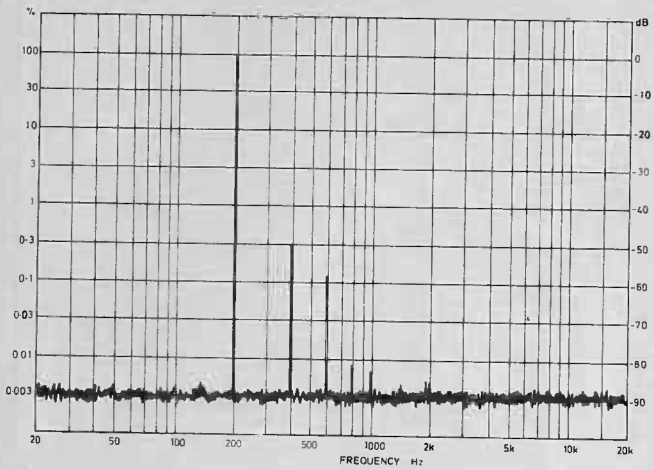


Fig. 4. Spectrogram of the 200Hz drive signal with the suppressor active.

In spite of the rise in distortion with the suppressor active, the reproduction is very satisfying provided the threshold control is not over-advanced.

In the suppressor off mode, the unit can be regarded as a top-flight RIAA-equalised preamplifier of potentially high audio output which could, if required, be connected direct to a power amplifier, thereby bypassing the circuits and tone controls of conventional preamplifiers, which are regarded by some enthusiasts as an impairment to 'musicality.'

A Cabled Reason?

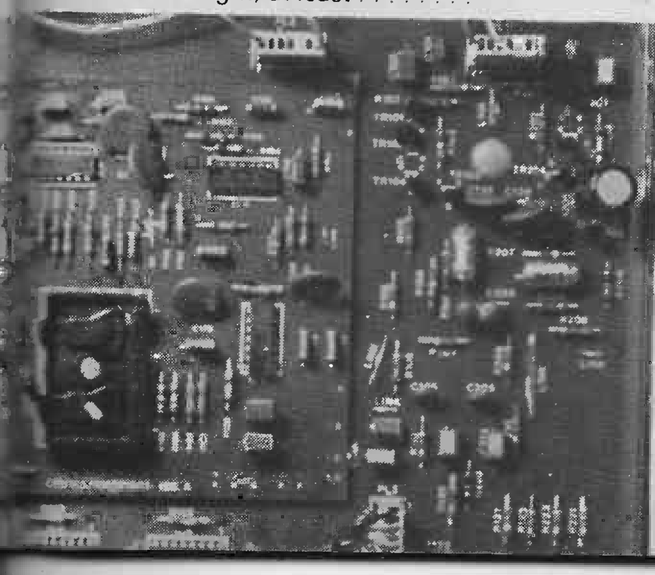
Although acoustical feedback (below the howl-round threshold) is currently being blamed for one aspect of adverse auditioning of some record decks, we have recently isolated other, probably more important, causes of auditioning differences.

We have discovered that signal from the power amplifier section can get back to the high gain pickup input via a common impedance or by magnetic induction (from the loud-speaker cables, for example) or electrostatic coupling somewhere.

The degree of response to the delayed spurious signals of this nature can be **as great as, if not greater than, the spurious and delayed signals attributable to mild acoustical feedback!**

Perhaps this is one reason why the 'special' loudspeaker and source cables are receiving acclaim, because the improved shielding of these cables is reducing the amount of signal back-coupling.

Anyway, during experiments with the MRM101 we found that by using this unit for disc signal amplification the degree of back-coupling was substantially reduced with respect to certain integrated power amplifiers. Food for thought, at least .... **ETI**



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K041 Zener diodes, 400mW 5% BZY88, etc. 10 of each value from 27V to 36V, E24 series. Total 280 for **£15.30**
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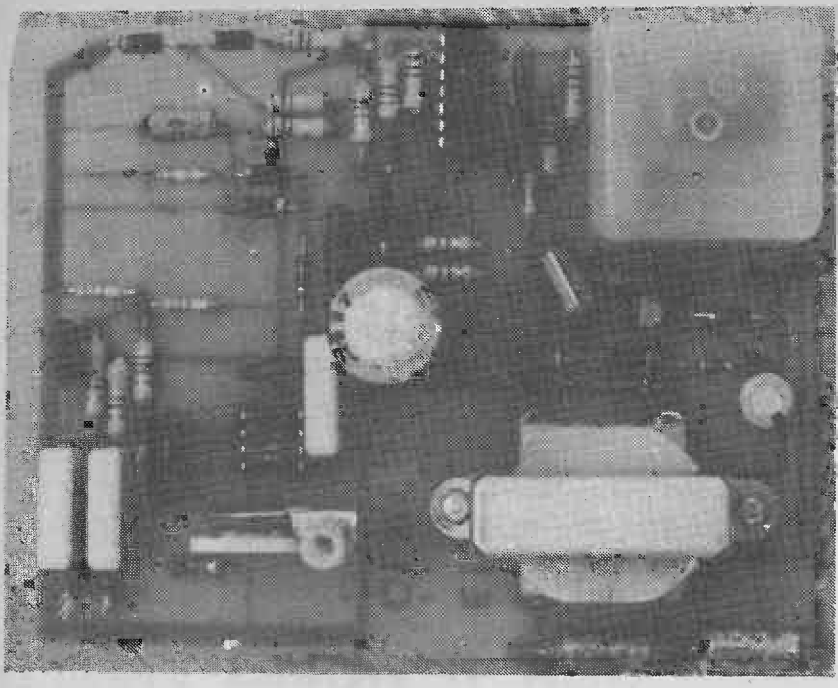


It was touch and go with ETI's project team this month during the design of this project

PROXIMITY SWITCH

ALTHOUGH THIS PROJECT may look a bit complicated for a 'mere' switch, it has some unique features, both in design and function, as will be clear from the following:

1. It is a true proximity switch. You do not have to actually touch anything to operate it.
2. There are no light beams, sound waves etc. While radio frequencies are used, switching action results solely from the capacitance of 'approaching bodies.'
3. The sensor may be some distance away from the device, and also may extend several feet in length.
4. The sensor — and, if you want to mystify your friends, the switch itself — can be completely concealed from view.
5. The switch latches ON or OFF each time it is operated. No special re-set provision is needed.
6. Since a relay is used for the actual switching, the 240V circuit and the 'electronics' are isolated from each other.

Making Magic

In our application, the 'Magic Switch' was installed so that when one walked through a doorway a light in the further room automatically went on. Also, the sensor extended close to the floor, so that even the family dog was able to ''light the way'.
(Admittedly, this at first struck terror and bewilderment into the mind of the canine, but, as usual, he soon came to accept the miracle as just one more example of human omnipotence!) Other applications could well include burglar alarms etc., all of which is to say nothing of its main function, which is to impress your friends.

Construction

Use of the PCB of Fig. 4 is recommended, though three prototypes were built using different layouts, and all worked well. Note that this PCB has space for the power transformer and relay, but is left blank as far as the foil pattern for those units is concerned. This enables you to use whatever components you happen to have, or which may be available to you. You can either fill in your own foil pattern, or hard-wire the units into the circuit. Beyond this, no special comments are necessary, except to mention that it is preferable to use IC sockets. Since 240V AC will be present on-board, the unit should be housed in a suitable cabinet such as a 7-¾'' x 4-⅜'' plastic utility box. An AC outlet receptacle could be mounted to the box, plus a main switch if desired.

Adjustment

The success of the project depends on the oscillator being just, but only just, within its tolerance limits, and the operating point is set by RV1 (coarse) and RV2. This adjustment is critical, but as a rule RV1 can be preset on the bench and RV2 adjusted at the time of installation. The exact operating point, and hence sensitivity, depends on the length of sensor used.

In a very few cases, RV1 needs to be more than 2k2. The easiest thing is to pad the control with a oto0 series resistor. This can easily be mounted on board and the existing track connecting RV1 to RV2 broken, the additional resistor being 'tapped in' in its place.

When you have completed wiring the switch, and have carefully checked your work, plug it in and clip a length of wire 200-300mm to the sensor input at point A. Set RV2 to mid-rotation, and adjust RV1 until you hear the relay clicking. This is an approximate adjustment, but at some nearby setting you will find that the relay clicks every time you approach the sensor wire with your hand. If you clip the sensor wire to point B you will find the circuit somewhat less sensitive; since sensitivity increases with sensor length, this is ▶

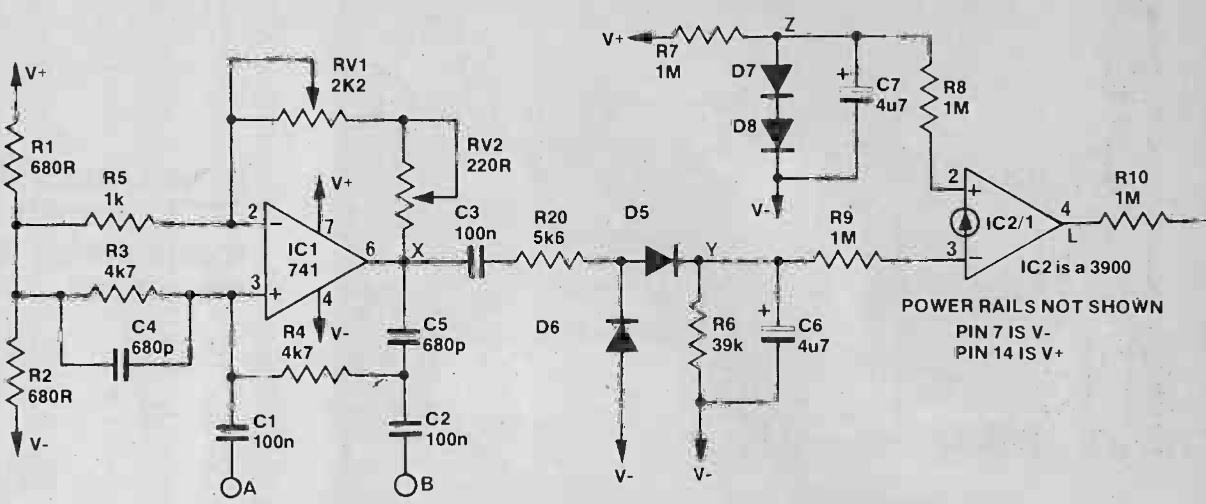


Fig. 1. Main circuit diagram of the proximity switch.

HOW IT WORKS

IC1 is a standard LM741 Op Amp configured as an oscillator operating at a supersonic frequency. The circuit is adjusted so that it is 'on the edge', and the capacitance effect of a body approaching its sensor causes it to "drop out." The rectified signal is fed to section 1 of IC2 (an LM3900 quad 'current differencing' amplifier) where it is compared with a reference voltage obtained from the R7-D7-D8 network. When the oscillator drops out, the signal voltage falls below the reference level, causing the comparator to produce a pulse at its output. This is 'squared up' by section 2 of IC2 to positively trigger a flipflop, composed of sections 3 and 4, and the output of this is used to operate a relay via driver Q2.

Because the relay draws enough current to cause a change in supply volts every time it is ON, and this would de-stabilise the oscillator, a simple voltage regulator of the series pass transistor type is used. This works like an emitter follower, in which the circuit as a whole is the load. The emitter of Q2 tracks the base, which is clamped by a zener diode to 15 V. In addition we reap the advantage of 'capacity multiplication,' since C11 smooths any ripple etc. present in the base supply. Though C11 is small, the filtering effect is impressed on the output, and in practice the value of the capacitor is multiplied by the gain on the transistor.

useful where long sensors are to be used.

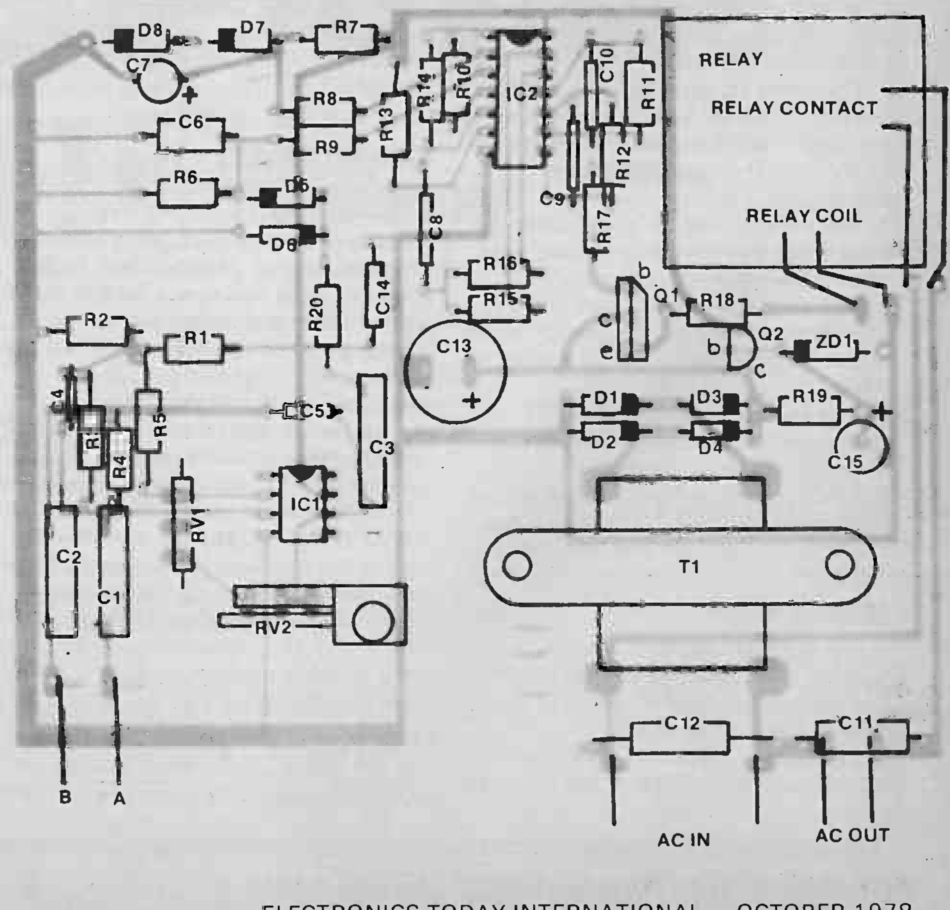
You can trace the sequence of events using an ordinary voltmeter. Point Y, the rectified oscillator signal, should read about 3 V, and drop to 0 V every time the sensor is approached. The reference voltage can also be measured at point Z. If you have a 'scope, you can display the waveform at point X, and see it 'collapse' when the switch is operated. Further tracing can be done at point L (comparator output), M (shaper) and N(flipflop), which makes it easy to pinpoint problems should they arise.

Installation

This will depend on the purpose for which your 'Magic Switch' is intended, but the following hints and observations will apply.

1. Aluminium foil strip (30mm wide) makes a good sensor. It can be 3m or even longer, and is easy to conceal behind vinyl decorator tape, wallpaper, tile etc. If the switch is to be some distance away from the sensor, a length of wire can be used to connect it, but this will add to the effective length.

2. The longer the sensor is the more sensitive the switch will be, and you will find the provision of two inputs helpful. While it is true that you do not have to actually touch the switch to operate it, long sensors and



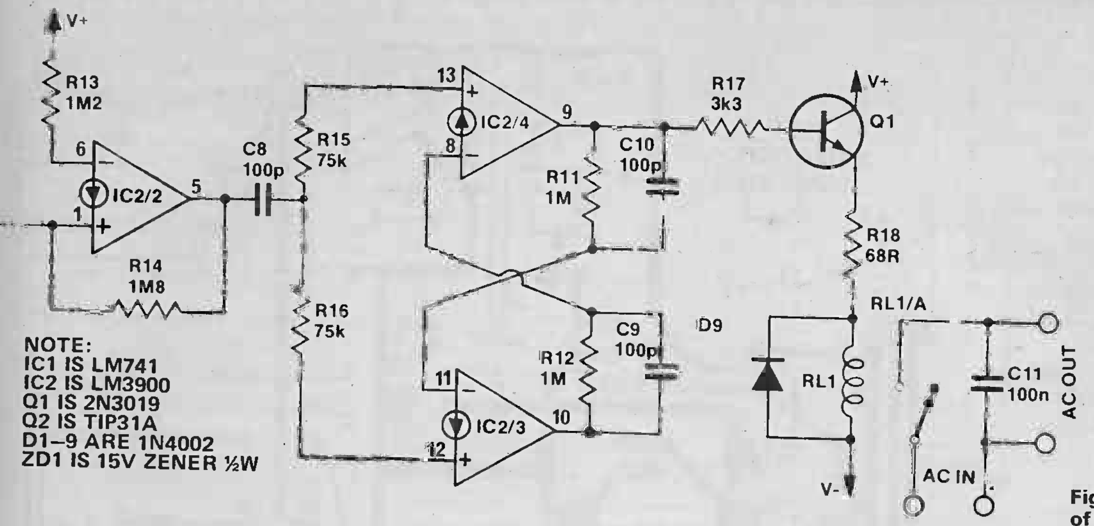
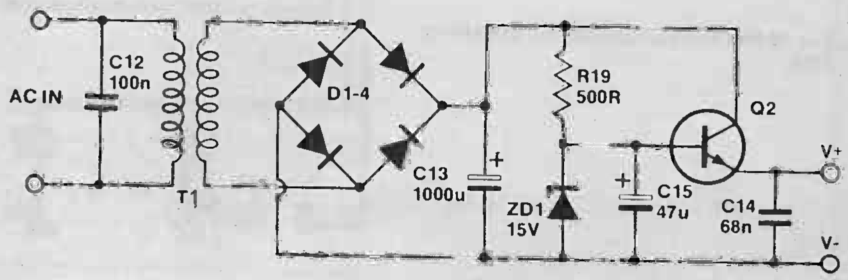


Fig. 3. (Below) Circuit diagram of the switch's power supply.



PARTS LIST

RESISTORS
All ¼ W 5% unless stated

R1,2	680R
R3,4	4k7
R5	1k0
R6	39k
R7-12	1M0
R13	1M2
R14	1M8
R15,16	75k
R17	3k3
R18	68R ½ W
R19	470R
R20	5k6

CAPACITORS

C1,2,3,11,12	100n	polyester
C4,5	680p	polystyrene
C6,7	4u7 16 V	electrolytic
C8,9,10	100p	polystyrene
C13	1 000u 16 V	electrolytic
C14	68n	polyester
C15	47u 16 V	electrolytic

Note C11 and C12 should be rated at 400 V

SEMICONDUCTORS

IC1	741
IC2	3900
Q1	2N3019
Q2	TIP31A
D1-9	1N4002
ZD1	15 V 400 mW

TRANSFORMER

T1	240 V/ 12 V 300mA

MISCELLANEOUS
PCB as pattern, Relay (10-30mA, 15 V or less), case to suit, sensor, etc.

Fig. 2. Overlay for the proximity switch PCB (left).

BUYLINES

All of the parts used in this project should be available from most of the advertisers in this issue. Make sure the 100n capacitors C11 and C12 are adequately rated at 400V.

The case should be earthed if it is metal as 240V is present on board. Our prototype, however, was built into a plastic box.

extreme sensitivity can raise problems. If, for instance, the switch is made sensitive out to 1m from the sensor, merely walking around will probably cause it to switch on and off erratically. This is due to local capacitance-field effects and not to any shortcoming in the switch itself, and therefore makes it desirable to operate with more limited sensitivity.

3. If operation is erratic, it will usually help to connect circuit (-) to a true ground (waterpipe etc.) In most cases, however, this is not necessary.

4. The switch can be directly connected to any metal object (e.g., filing cabinet) you might wish to protect. Likewise, it can be used to operate any external circuit, such as an alarm. As a protection device, the 'Magic Switch' will baffle any intruder, if not psych him out completely.

Interference

The 'Magic Switch' is relatively immune to interference such as mains surges, field disturbances etc. About the only time trouble may possibly arise is when the switch is run off the same 240V circuit as is used to power some inductive load, e.g., a refrigerator. The reason is that every time the inductive device is switched on, a large transient voltage is developed on the AC line (chiefly across the 1 ohm resistance of the ▶

main fuse). If your room lights dim every time the 'fridge goes into action, you will appreciate the magnitude of this type of surge. Experience has shown that the 'Magic Switch' can cope with most things — SCR dimmers, tape recorders, vacuum cleaners, to name but three which we have operated off the same 240V line — but in a few cases special precautions are necessary. Mains surge suppressors may be fitted, but generally it is simplest just to run the 'Magic Switch' off a different AC circuit. ETI

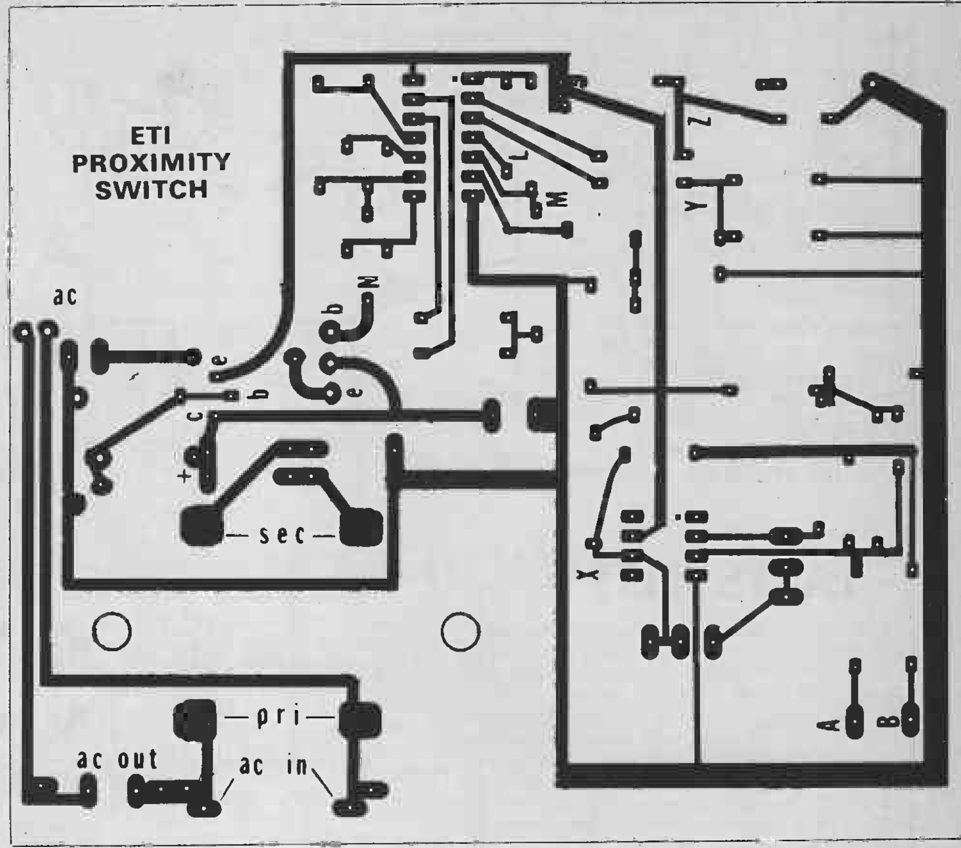


Fig. 4. Full size foil pattern for the switch's PCB.

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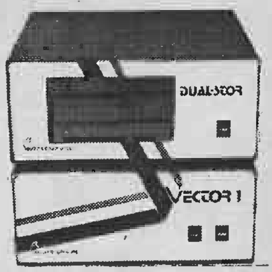

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microfile.......

Go north young man they said and Gary Evans did this month to see Liverpool's new Personal Computing store.

TAKING LIFE, LIMB and day return ticket in hand, I headed North this month. The carrot that induced this seemingly irrational behaviour was the fact that a new computer store was to open in Liverpool, which for those of you whose sense of direction is as bad as mine, is north of London.

Microdigital is Liverpool's first Computing Store and, as far as I know only the second shop in the country to sell a broad range of low cost computing equipment (the other being the Byte Shop). The range of items Microdigital will sell you is indeed large, everything from that dreadful MPU door-chime, through video games and chess machines to PETs and APPLEs taking in the MK14 and NASCOMI on the way. The reason for this wide range, which includes items that many of us would not associate with personal computing, back to the door-chime, is quite straightforward. The aim is to hook people with these items that can be considered impulse purchases in the hope that when installed in the family home they will promote the idea that the computer does have a place in the home.

The site of the shop, like the items stocked, has also been chosen with care. The site is not what would be considered prime by the likes of Dixons, being situated in the business area of the city. The idea behind siting Microdigital here was again to do with hooking potential customers, but here the potential victims are the City Gents of Liverpool. A shop in the "jean jungle" that now forms the heart of Liverpool would not have exposed the shops name to this market. The site in Brunswick Street will mean that many of the aforesaid business men will not be able to avoid the name of Microdigital and it is the hope of the company that some of them may even walk through the door. Don't get the idea that the shop is too far from the centre of the city, it's just a few moments walk away so those interested in the novelty value of the shop will still make the trip as well as the already converted Computer Hobbyist.

The staff at Microdigital will offer advice and as one of them comes from a background as an accountant, it should mean that the advice given will be formed with an appreciation of the businessman's needs. The shop will also sell a wide variety of literature and software to enable the best use to be made of the different hardware packages available.

The firm's range of systems is detailed in their catalogue and an SAE to them should secure a copy of same. Better still, why not call in and pick one up in person, you'll probably find chatting to the staff very helpful.

Microdigital
25 Brunswick Street
Liverpool 2

Gary Evans, to photography what Cyril Smith is to the world of ballet, took this photo of Liverpool's new computing store on its opening day.

Disk-O-Spec

Floppy disk drives will probably be one of the items that will fall in price considerably over the next year, they have to. The cost of producing a drive will fall as the volumes demanded by the world markets increase, after all if you want a handmade cassette deck expect to pay the earth for it, buy 100,000 and the price comes down to a reasonable figure. As we see the price come down we'll also see more people offering hardware/software packages to enable you to hook the drive up to your particular breed of machine. At the present floppies for even the most popular of machines are hard to find, but I've heard of a couple of people who might be able to help.

James Clarke and Co Ltd are interested in developing a 512K or 1.2M drive which they see as having some additional memory and, of course, an operating system. They are interested in hearing from anyone who might be interested in such a product.

The other company, Ocean Electronics, have a single card controller for the Shugart SA400, suitable for interfacing this drive to the PET (the company can also offer controllers for 6800 and 8080 based systems).

The card is expected to sell for £120, and with the SA400 at around £225, this seems like an attractive package.

The companies can be reached at the addresses shown below.

James Clarke and Co
7 All Saints Passage
Cambridge
CB2 3LS

and

Ocean Electronics
3 Pavillion Parade
Brighton
BN2 1RA

digest..

watch reaction

Once more into the breach . . . and all that stuff. Why is it that buying anything these days turns into a battle between salesman and (intended) victim? Are there nought but sharks lurking on the far side of the counters? Are all the good men honest and true working for ETI? (ouch).

Forgive the outpourings of despair gentle reader but there really are times when we do wonder. With apologies to all the excellent retail outlets in the trade that we and you know and love, for we feel it may serve to recount this little tale of what happened when one of our staff was perusing digital watches in a nameless emporium in Tottenham Court Road.

Sales Person: *(Closing in with a glint;* Can I help you sir?

ETI Dupe: It is O.K. thanks I'm just looking at your men's watches — do you have any in stainless steel?

Sales Person: *(Rubs hands speculatively)* You can see all we have down there – those Seiko are very nice machines(?)

ETI Dupe: How much?

Sales Person: £90.50 — plus VAT of course. Worth every penny though. Rolls-Royce of watches these — fantastic.

ETI Dupe: Yes very nice — but why are they so much more expensive than those others?

Sales Person: Oh there's no comparison. These work on a totally different principle to ANY other digital watch, and this method is much more expensive to make. Quartz you know.

ETI Dupe: *(Displaying his full range of knowledge on the subject)* But they all use quartz crystals in the oscillators, and most use the same frequency even don't they?

Sales Person: *(Gives smug look and shakes head sagely)* No, no, no, no – you've been reading some of these Sunday supplements. Absolute rubbish those. Seiko don't even use an oscillator at all – none of these frequencies at all. Not a moving part in the entire watch.

ETI Dupe: *(Beginning to lose contact with reality)* But if it doesn't use an oscillator what does it count to keep time?

Sales Person: *(Totally confident):* Days sir. Very reliable these. Accurate to five secs a month. LCD display, backlight, the whole bit.

ETI Dupe: *(Mystified)* LCD? What's that stand for?

Sales Person: *(Efficiently and knowledgable)* Lit Continuously sir. No need to push a button to find the time out here. . . .

At that point we'll drawn an editorial veil over the proceedings. Believe us or not as you wish — but perhaps shops should show the discourse to their staff, and fire anyone who can find nought wrong.

P.S. We're working on a project for a watch that counts days, rather than messy 32k oscillator signals. Ours times the intervals between ice ages by periods of the moon, and divides by 11,500,000,000,000.

Texas at home

A users club now exists for those fortunate to own TI machines. Called the '59 Club' it resides at 27 Montem Lane, Slough, Berks under the watchful eye of one Tim London. A program library is in there somewhere too, and a newsletter is envisaged. So if you're into Texas keystrokes you know where to go now.

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Callers by appointment only

See The Show, Join The Club

A couple of quick items now. First the Personal Computer World Show will be held at the West Centre Hotel between September 21 and 23. The last day will be devoted to home systems but the whole three days should be worthwhile. Next the North London polytechnic Department of Electronic and Communications Engineering are to form a computer club. The inaugural meeting will be on Wednesday the 5th of October, I hope to be there in room 47 of the old building (their refetence not mine) in the Holloway road just opposite Holloway Road tube for the event. With three PETs and four SWTPC systems available for playing with the club will hopefully prove a fruitful activity for all concerned.

An update on the MK14 review of last month. I have received the new monitor PROM for this machine and as well as making the entry of data far easier, the RPOM contains an offset calculation routine as well as the software to drive the cassette interface for the MK14. A single step mode of operation is also possible with a small amount of additional hardware.

An update to the TRS-80 review as well. Phil Cornes, one of the panel who reviewed the machine has discovered a few memory saving tricks that can be used with the computer.

1. Whenever the last character of a PRINT statement are the final inverted commas of a printed message, those inverted commas may be omitted so that, for example —

```
10 PR.; "GALLONS USED"
```

could be abbreviated to —

```
10 PR.; "GALLONS USED
```

2. The abbreviation IN for the INPUT statement can be abbreviated still further to I so that —

```
45 I.X,Y,Z
```

becomes an acceptable INPUT statement.

3. This abbreviation is the most interesting of the three, and deals with the setting and resetting of flags within programs.

For example, suppose the following appears in one of your programs.

```
20 F=0
200 IF A=B THEN F=1
```

This could staggeringly be reduced to the following single statement:

```
200 F=A=B
```

In this example the second = is being used as a comparison operator and not as an arithmetic operator. Put into English, this statement would therefore read —

Let the value of F depend on the result of comparing the equality of A and B.

If A does equal B so that the result is a logical "TRUE" then set F to 1 or if A does not equal B (logical "FLASE") set F to 0.

The same type of statement can be made to work with any of the comparison operators, ><,<,>,=,<=,>=; so that —

```
200 F=C>B
```

would set F to 1 if C were greater than B otherwise it would set F to 0.

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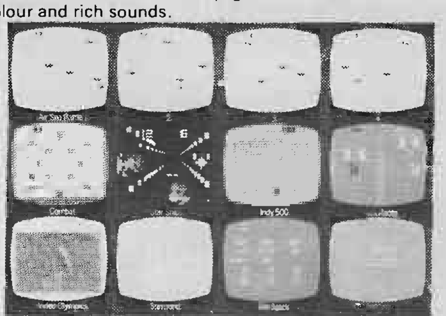

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audiophile......

This month Ron Harris lends an ear (and an eye) to a new turntable aid that you can see through immediately; what could be the ultimate in DIY pre-amps and takes note of news about an amplifier in a class of its own.

FIRST — the brickbats. My prize for most inappropriate act of the month goes to Discount Audio in Tottenham Court Road for having the atheistic gall to use an SME Series III as a display stand for a £5 transistor radio. May your fuses continually blow. . . .

It was also amusing to note a Pioneer SA9500 offered for sale nearby, in the window of a large establishment of some repute. Nothing wrong with that you might say — except that is upside down. No doubt a new-fangled output stage is in use here — the electrons are propelled across the junction by gravity — only someone somewhere put the chips in the wrong way round.

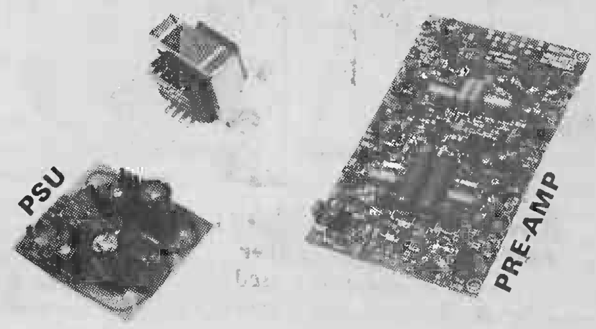
Enough To Make You Blush!

For some time now Crimson Electrik have enjoyed a good reputation based upon the excellence of their power amp modules. And quite right too. The amps are well designed and if assembled carefully offer very good sound reproduction.

The appearance of a pre-amp from the same stable thus aroused the editorial interest and a sample procured. The photo shows the board sat sitting alongside its PSU, and as is evident the PCB is built to a very high standard. The specs are faultless and well detailed, and also too long to give here. Versions are available for both moving coil and moving magnet cartridge types.

To say they come with instructions is probably misleading. Application notes in the best sense of the word are provided, and good detail on usage (and abuse) are given to enable the customer to adapt the modules to his own requirements.

All that's left to tell you is how they sounded — and that I'm afraid I cannot do properly until next month, simply because, as always, the modules arrived very late in the month and there was simply no time to conduct the tests demanded by a product of this pedigree. Initial impressions, however, are very very favourable. Sorry folks but I'm saying no more till next time. Same time, same page — November!



The collection of items which make up one Crimson Electrik pre-amp. The large board on the right is the actual stereo pre-amp, the smaller one is the PSU stabiliser. To construct a seperately powered pre-amp you need all three, but normally the pre-amp would be added to a Crimson power amp to produce an integrated unit.

Raise Your Glasses

One of the latest 'tuning' aids to appear on the hi-fi market are various types of turntable mat, which claim to improve the sound quality by offering more nearly ideal conditions for information retrieval from the LP. One of these that has risen to my eye from a small British firm, GA Audio, is composed of glass.

With the success of the Planar 3 vaguely in mind, experiments with this refugee from a window frame were to prove interesting. It didn't take much to interest some other folks with inclination in this direction, and so a variety of turntables were available at various times to carry the mat.

Glass does have quite a few advantages for this sort of work if you think about it. It is extremely rigid, of good even mass distribution and of course easily kept clean. The felt mats which appear around so many spindles these days gather dust easier than booze attracts ETI staff and are infernally difficult to clean (as are ETI staff!)

By changing turntable mats around the overall sound from a system can be markedly altered — more so in my experience than with these 'super-cables' much vaunted of late as a cheap upgrade.

Turning Tables

The first machine we tried the 'Sound disc' glass mat on was a Technics SL 120 — a unit not much in favour with the musical mites of this world. However if the machine is properly sited on a wall mounted shelf, then its only real disadvantage is overcome that of being more sensitive to outside vibration than is perhaps needed. Used like this the SL 120 turns in a good all round performance and one that is not improved by use of a felt mat instead of the thick rubber platter provided. ▶

However, the Soundisc *did* offer an improvement. The image was clearly improved and better defined. Best without the thin felt circle supplied by GA Audio, who would save themselves some money — and improve the product — by losing that completely and improving the instruction sheet instead. Spelling bass with an 'e' is just not *musical* lads, you can do better than that.

On a variety of other turntables, including the dreaded Linn, we found the Soundisc to offer variable results. On the Linn it seemed to make things worse, while it improved a Transciptor Reference out of all recognition, to the extent that with the Soundisc mounted atop its little black blobs, the Reference came out sounding better than any other deck we tried (including you-know-what!)

A Painful Gain

Overall then the Soundisc is a good investment, unless you own a Linn or a Rega 3 where no gams can be expected. By supporting the LP properly the glass does appear to bring more information forth from the grooves, and to bring it forth more precisely. At its price of £10.30 I feel it's worth a try if you're unhappy with your present record playing system for reasons of clarity — but make sure it isn't the cartridge at fault first eh? Address: GA Audio, 82 Bromsgrove Road, Redditch, Worcs. B97 4RN.

H-bomb

From the States comes news of the first class H amplifier (Did I hear groans of "Oh no" from that weary music lover in the back row?) Like class G of Hitachi parentry H operates on the PSU.

This time, however, what is described as 'vari-proportional analogue logic circuitry' (??) is employed to sense the line voltage needed by looking at the output power required at that time. A second power supply is also present, and is used to help beef up transients. If I were Hitachi I'd be looking pretty closely at this little lot. Soundcraftsmen are guilty of class H, and the model number is MA 5002.

Is it now eyes down for I?

The Write Way To Do It

To all you nice people out there who have written in with questions for the Audiophile service — thank you and I hope I've answered you! Replies have been taking up to four weeks because there were so many of you. I've cleared the backlog now and replies should normally be return of post unless I get kidnapped, shot by bandits attacked by Felicity Kendal etc. (If the latter occurs allow 10 yrs for reply).

The service is still operating (just) so for newcomers: it is intended to be an enquiry service for matters relating to hi-fi. Please include full details of the system you're running and be as specific as possible. Address your envelopes to 'Audiophile,' ETI, 25-27 Oxford Street, London W1R 1RF.

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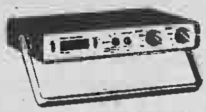
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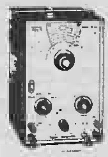
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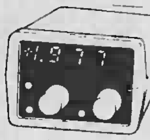
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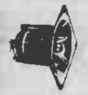
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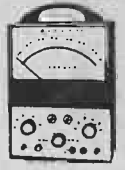
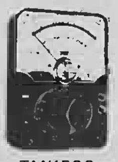

TM11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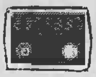
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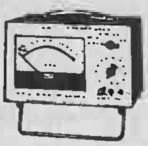
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electronics tomorrow......

by John Miller-Kirkpatrick

SOME months ago I mentioned a form of multi-voltage logic which was being developed by an American company. Recently I was discussing microprocessors with somebody, and they "invented" multi-voltage logic on the spot, after I told them that it had been done before they went on to discuss the ideas they had and with a few ideas of my own we came up with a logic system for the 1990s.

One problem with multi-voltage logic is that it is alien to the TRUE or FALSE logic used with binary or boolean logic. It seems that a logic system expressed in ten different voltage levels would be represented by 10 levels of possibility ranging from FALSE at zero volts to TRUE at 10 voltage units passing through REASONABLY TRUE at say 7 voltage units and SNOWFLAKE-IN-HELL at perhaps 1 voltage unit. Problems arise when you try to carry out logical operations such as ANDing 7 units with 1 unit — is the result (7+1)/2, 7/1, 1/7 or what "?" arithmetic is simple, it is even in decimal, for example 7 ADD 1 is undoubtedly 8 and 1 minus (Complement and ADD) 7 is 3 isn't it?

If you want to play with multi-value logic try using some CMOS devices run off about a 10v supply, CMOS switches from 0v to the supply voltage (near enough) and thus a CMOS output on this supply will switch from 0v to 10v. If the outputs in question are outputs from a 74C42 1 of 10 decoder then the outputs can be connected to a series of 9 resistors (all say 1K) arranged as a potential divider so that a common point will have a voltage of between 0v and 9v in 1v increments when the 74C42 inputs are driven from a BCD input. You now have a boolean to decan (?) logic converter, there are several methods of going the other way. One of the simplest methods is probably to use a set of transistors which will switch on at 10 different voltages (0-9) and then encode this with binary logic gates to give a 1 of ten and this BCD result.

Of course, you could simply use a variable power supply or two coupled to voltmeters, but somehow this seems to be cheating. Anyway, when you have your generator and readout device you can start to work out some of the rules involved in ten level logic — your ideas are probably just as valid as anyone else's. Perhaps you would like to send in any circuits or ideas to us at ETI so that we can publish them and start a whole new revolution in electronics.

Battery Logic

The logic generators described above could be run from a 9V battery and as they are simply CMOS, resistors and meters the current consumption would be very low. If you simply use some 9V batteries, switched potentiometers and meters as in the second example above you would not require any binary logic gates at all. Consider what is happening in this case (taking into account that I just passed "O" level physics and failed chemstry). The voltage in the battery is generated because of one of several types of chemical reaction, some alterations to this voltage may then be caused by logical or arithmetic operations and the result is used to activate a mechanical lever on an analogue voltmeter.

Would it be possible to use chemical reactions as logic elements and thus cut out some or all of the electrical interface. My knowledge of chemistry becomes obvious when I try to recollect the number of ways a chemical can be classified, one way is acid and alkali which I seem to remember are opposites. Surely a mixture of a percentage acidity could be mixed with another of a different acidity under certain conditions to create some form of logical combination which would be accurately repeatable? In which case the resultant could be used in another reaction to give a voltage output and/or a mechanical reaction?

If you consider the reactions of two complex chemicals such as hydrocarbons, nucleic acids, DNA and other things that I know little about, then the complexity of the logic operations which could be handled seems very varied. Having mentioned DNA perhaps I should point out that I see such chemical reactions taking place and being measured on a very small scale, nearly molecular rather than with 100ml beakers.

The microprocessor of the future may require feeding with sugar rather than any form of electricity, temperature and humidity may become more important factors than they are at present and it could get very upset if you spill hot tea on it. The output devices would of course be such things as a chemical print head working on pre-sensitised paper or tape (or screen), the input devices would measure chemical reactions on treated plates which would react to external chemicals such as the human skin. Increasing the memory capacity could be as simple as buying 1lb (500g) of fillet steak or even digging up a few carrots from the garden.

Although this may seem like mid-summer madness it could be a feasible alternative at some future date, after all, if you can operate on things like sugar, fillet steak and carrots (not necessarily together) then why not a microprocessor. Now there is a project for the NEB to invest £50million in!

Data Catalogues

When I first became interested in electronics as a hobby one of my main reference books was Henry's catalogue which was full of useful and seemingly useless items. The main attraction of the catalogue was the fact that there were many small but understandable circuit diagrams showing various applications of some of the more complex components. I based my very first digital clock circuit on the circuit by Dave Hunt in one of their catalogues and learnt a lot about digital electronics from what was effectively a sales catalogue.

Recently several manufacturers have donated their latest data books/catalogues to the JMK library (writing Electronics Tomorrow has hidden advantages). These data books are available (at a price) to anyone who cares to contact the manufacturers or their agents and together form a very comprehensive library of LSI components in and around micros, TV games, calculators and telecommunications. I can recommend all of the following books which are the ones I use now and are the latest in a series which I have used for several years now. I realise that several manufacturers other than those mentioned have similar books but these seem to cover a wide range and anyway I get these for free!

GIM produce a very comprehensive range of MPU, memory, clock, calculator, TV series, communications and industrial chips. The 1978 catalogue contains data on all of the TV games and interface circuits from the simple bat and ball to the complete home entertainment system. To take an example try looking up the data on the AY-3-1013 UART, the data, descriptions and applications for this IC goes on for about 15 pages and just when you think you have finished and just about exhausted UARTs you turn the page to find that GI also make a 1014, 1015, 1016, etc, with multitudinous options and alternatives on the basic design. The GI 1978 Data Catalogue costs £3.00 from General Instrument Microelectronics Ltd, 1-4 Warwick Street, London W1R 5WB. Tel. 01-439 1891.

Arming Intel

After a lost of arm twisting Intel were finally persuaded to part with their 1977 Data Catalogue which has a price of 2.50 dollars printed on it. This includes data on RAMs (including 2114). PROMs (including 2716), CCD memory, four MPU chips and associated components, Microcomputer systems and development systems. This book is a must for MPU addicts as Intel uses the "Microbus" approach on MPU add-on ICs which makes them usable on most MPU chips not just those made by Intel. After speaking to a young lady at Intel I am now informed that the 1978 catalogue is now available at £4.00 and that they can handle a few hundred orders easily but if everybody wants one . . . Intel are at: Intel Corporation UK Ltd, Broadfield House, 4 Between Towns Road, Cowley, Oxford OX4 3NB. Tel (0865) 771431.

Naturally National

National Semiconductors would probably claim that their 1977 data books are so far ahead that their contents will remain current during 1978. Natsemi have a range of data books to cover their vast range of products including specialist books for linear, transducers and data acquisition. My library includes the 1976 Linear and 1976 TTL books and the 1977 issues of MOS/LSI (clocks, counters, watches, calcs, CB, COPS, displays, etc); Memory (you name it) and CMOS. The Natsemi CMOS book includes a 4000 series, the 74C TTL compatible series, some applications of these and also data and applications on many unique devices in the CMOS/LSI category. These latter include telephone diallers, TV clock/channel units, DVMs, A/D converters, display and keyboard controllers and 7 seg to BCD converters amongst many other clever and low-cost circuits which have the additional advantages of CMOS.

ETI

tech.tips

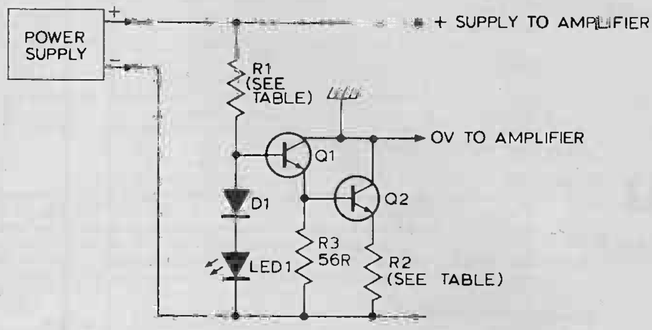
Protection For Power Amplifiers

A. Hiley

In many amplifiers, the only protection against overload is a single fuse. Experience has shown that output transistors can blow faster than fuses. The simple circuit shown below will protect the amplifier in the event of a fault or gross overload.

Normally, the current through R1 biases both the transistors fully on. The P.D. across the LED is less than 2V, and it will not light up. In the event of a fault or overload, the current consumption of the amplifier will increase. The forward bias on the transistors will decrease, and they will tend to turn off. This will cause the potentisl across R to decrease, which will increase the bias on the transistors, turning them on again. The overall effect is that current limiting takes place. Under these conditions, the LED will light up, indicating a fault condition. If the fault or overload persists, the main fuse in the amplifier will probably blow. The actual protection circuitry needs no resetting.

Under fault conditions, the dissapation in Q2 will be very high, and so it must be bolted onto the chassis or the heatsink.



SUPPLY VOLTAGE	R1
10V to 22V	1k, ½W
22V to 40V	1.8k, 1W
40V to 70V	2.7k, 2W

AMPLIFIER POWER (RMS Watts)	R2
15W, 8R or 4W + 4W, 8R or 4W, 4R	0.5R
60W, 8R or 15W +15W, 8R or 15W, 4R	0.2R
30W +30W, 8R or 30W, 4R	0.15R

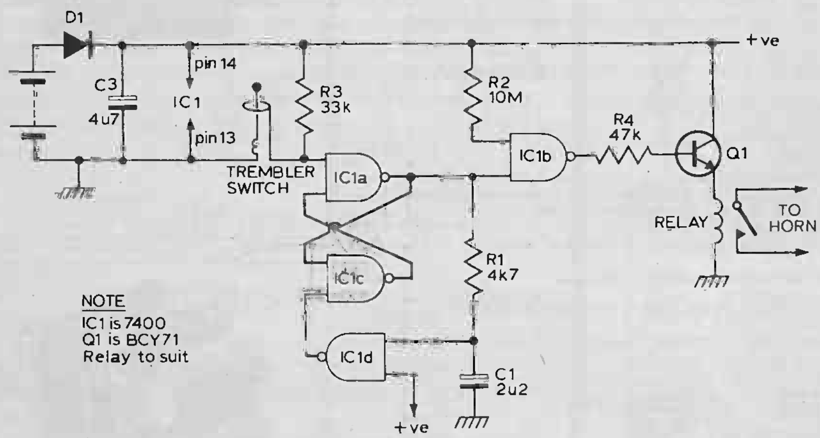
NOTE
Q1 is BD131 (up to 45V supply) or BD139 (up to 90V supply)
Q2 is 2N3055
D1 is 1N914
LED1 is a RED LED

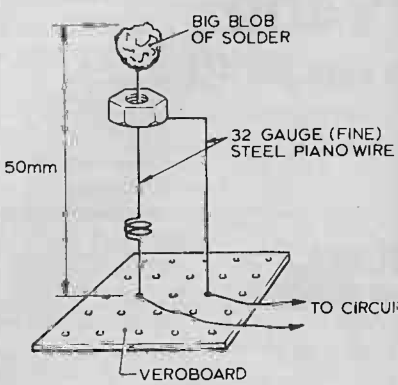
Motorcycle Burglar Alarm

N. Hone

Currently available motorcycle alarms are either very expensive or ineffective. This circuit provides protection against theft, or tampering with the machine.

The alarm, a cross coupled latch is activated by a trembler switch (whose construction is shown), which will sound the alarm for 5 seconds before resetting. As the device is very sensitive, there is a 10 second delay (set by R2, C2) which gives enough time for the trembler switch to stop oscillating, and the keys to be removed. D1 and C3 prevent the supply to the circuit dropping when horn draws a high current and pulls the battery voltage down.





Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

special

Audio Millivoltmeter

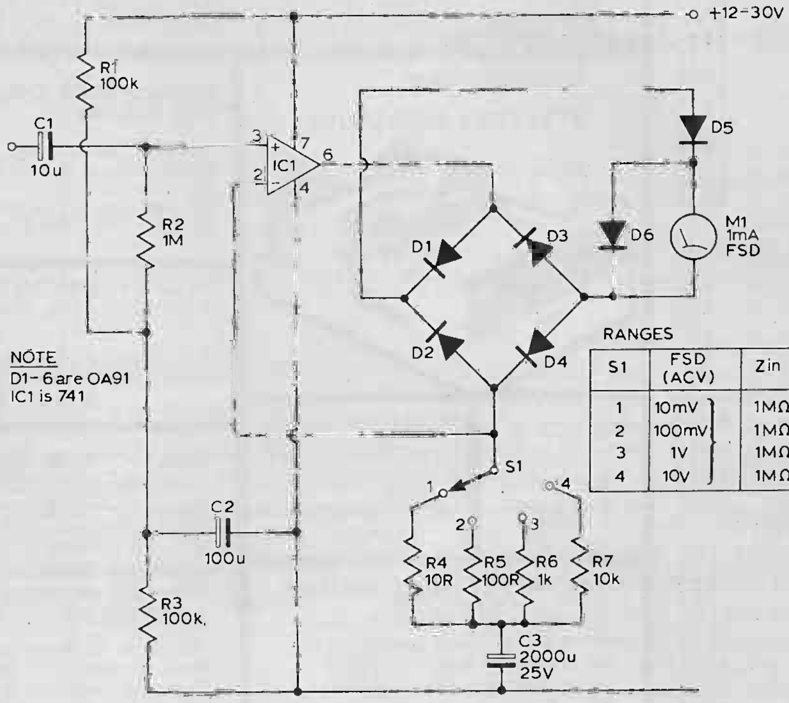
J. P. Macaulay

The circuit shown is of a very simple but effective and accurate millivoltmeter. The non inverting input is biased at half supply by the voltage divider R1 / R2, decoupled by C2. The input impedance is defined by R3, whilst C1 isolates unwanted DC.

Due to normal op-amp action the inverting input follows any voltage present at the non inverting input. Because of this the current flowing through the meter, and the resistor selected by S1 is V_{RMS}/R. C3 prevents any DC flowing and hence makes offset nulling unnecessary.

With the component values shown the circuit has a flat response from 8Hz-50kHz (-3db) on the 10mV range. The upper limit remains the same on the less sensitive ranges but the lower frequency limit goes under 1Hz.

D5 and D6 provide protection for the meter under reverse bias and overload conditions respectively. The circuit will work from supply rails between 12 and 30V, and in the quiescent state consumes only 2mA.



RANGES

S1	FSD (ACV)	Zin
1	10mV	1MΩ
2	100mV	1MΩ
3	1V	1MΩ
4	10V	1MΩ

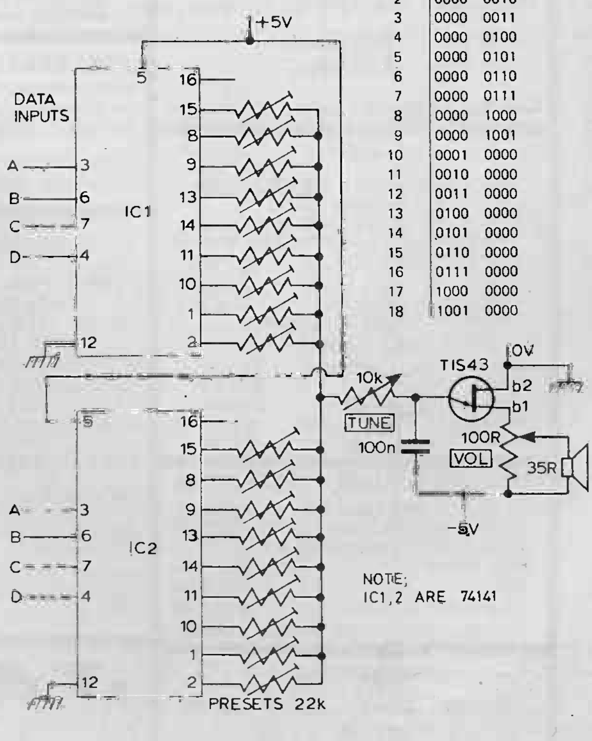
BCD Tone Generator

P. Bailey

When one of the binary codes in the table is set up on the data inputs, a corresponding preset connected to IC1 and 2 will be grounded, and the unijunction will start to oscillate. The frequency of oscillation depending on which output of the ICs is grounded.

If the 18 presets are tuned to form a chromatic scale and the inputs interfaced to your MPU data bus — hey presto you have a simple MPU controlled organ!

NOTE No.	CODE (BINARY) HGFE DCBA
1	0000 0001
2	0000 0010
3	0000 0011
4	0000 0100
5	0000 0101
6	0000 0110
7	0000 0111
8	0000 1000
9	0000 1001
10	0001 0000
11	0010 0000
12	0011 0000
13	0100 0000
14	0101 0000
15	0110 0000
16	0111 0000
17	1000 0000
18	1001 0000



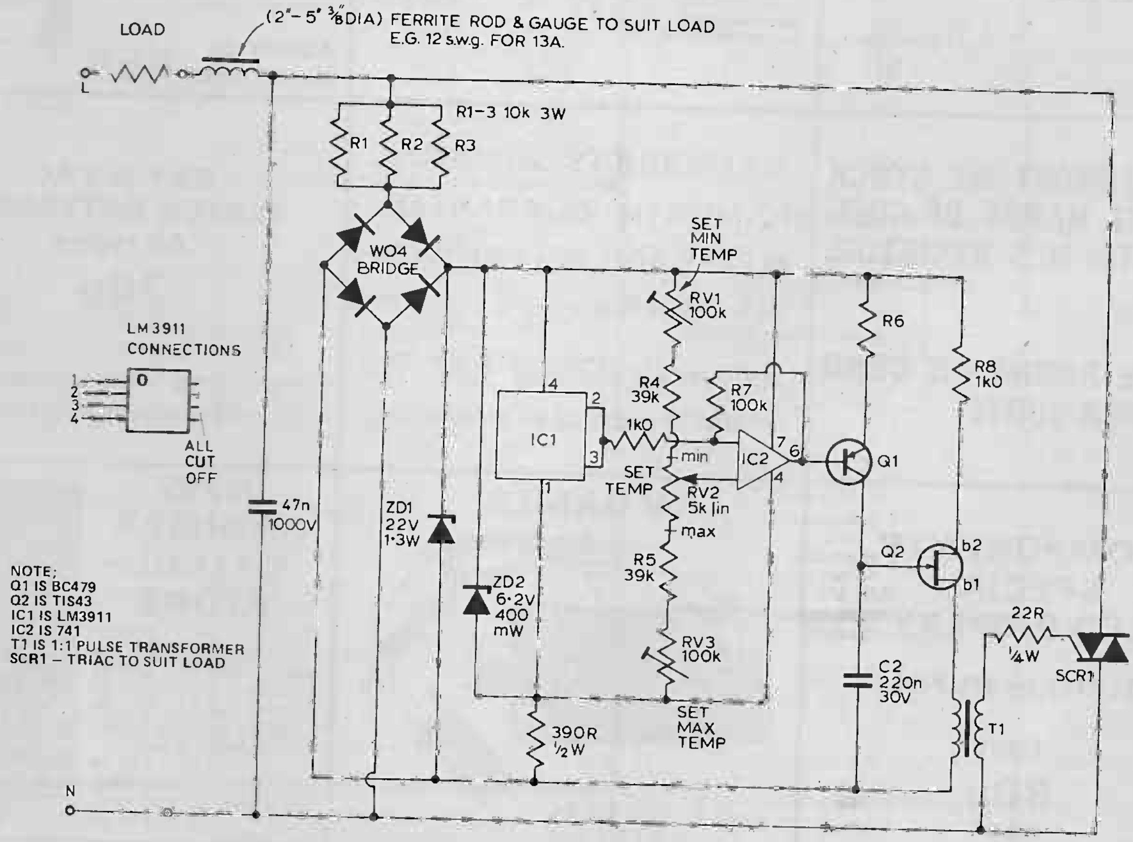
Temperature Control

S. H. Alsop

This circuit provides full phase proportion control of a heater, infrared lamp etc, uses no expensive transformers for its own power, and is extremely sensitive.

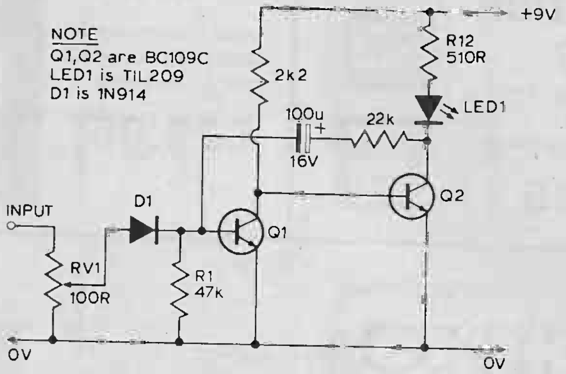
The LM3911 sensor is connected to the sensor via a 3 core cable, and enclosed in a rubber sleeve to enable it to be used as a probe. The output of the LM3911 varies by 10mV/° C and the minute change is amplified by the 741. Any increase in temperature will increase the output of the 741 which will lower the base current through Q1 and so reducing the constant charge current to C2. This variation of charge current with temperature will alter the time taken for the UJT to fire, changing the phase angle of the power to the load.

The 5k lin pot is set to the temperature required and is linear over its entire range. The upper and lower limits of this control can be changed by adjusting the 100k presets.



Peak Level Indicator

T. Norris



The diagram shows a simple monostable multivibrator with a LED which is normally lit, but will be briefly extinguished if the input exceeds a preset (by RV1) level. A possible application is to monitor the output voltage across a loudspeaker, when the LED will flicker with large signals.

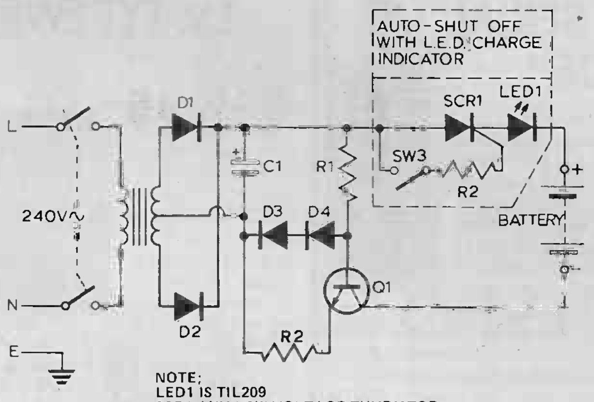
tech tips special

Ni-Cad Charger Mod.

B. V. Barton

This modification was made to the ETI 519 Ni-cad charger to protect the cells in case a power cut occured while the cells were charging. Normally the cells on charge would rapidly discharge through the charging circuitry, causing possible damage.

The modification involved the addition of a low voltage thyristor in series with the battery. If power fails, the battery cannot discharge. When power is reapplied, the battery will not continue to charge until SW3 is closed momentarily.

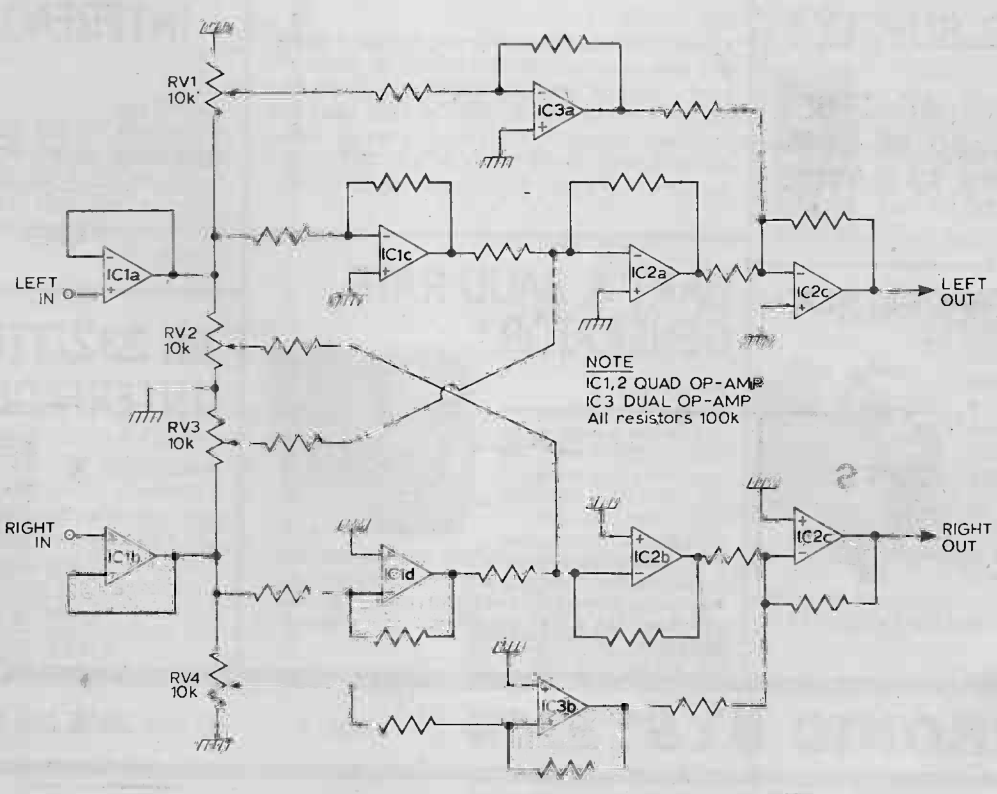


NOTE:
LED1 IS TIL209
SCR1 ANY LOW VOLTAGE THYRISTOR
R2 SELECTED TO GIVE ONLY ONE CHARGE RATE OF 45mA INSTEAD OF SIX POSITION RANGE SWITCH GIVEN IN ORIGINAL DESIGN

4 Channel Synthesizer

T. Huffinley

This circuit will synthesize two rear channels for 'quadraphonic' sound when fed with a stereo signal. The rear output for the Left channel, is a combination of the left channel input 180° out of phase, added to a proportion of the right hand channel (also out of phase). The right hand rear output is obtained in a similar way.



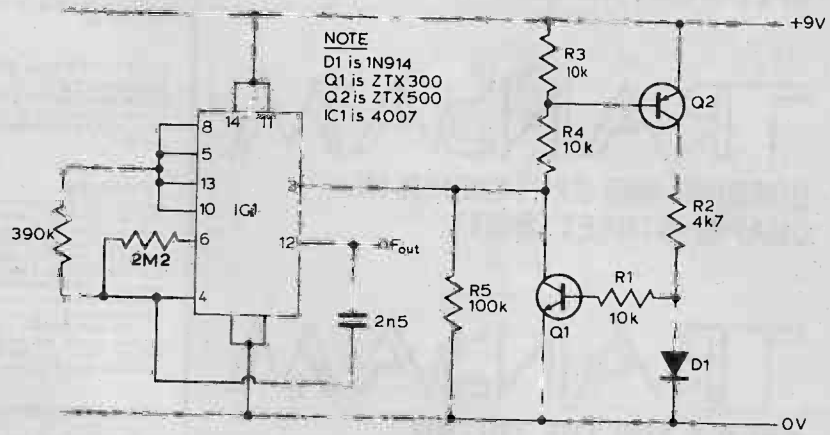
tech tips special

Temperature to Frequency Convertor

P. Reynolds

This circuit uses the fact that when fed from a constant current source, the forward voltage of a silicon diode varies with temperature, in a reasonably linear way.

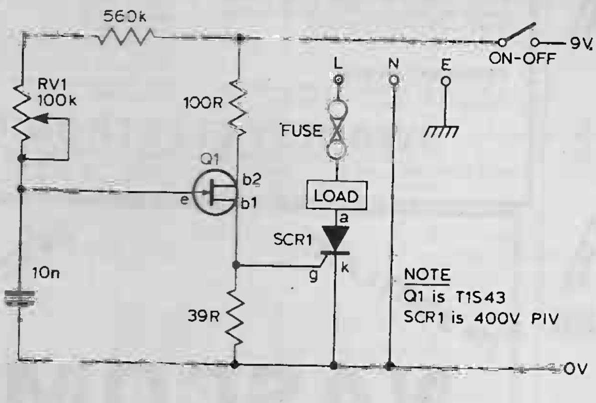
Diode D1, and resistor R2 form a potential divider, fed from the constant current source. As the temperature rises the forward voltage of D1 falls tending to turn Q1 off. The output voltage from Q1 will thus rise, and this is used as the control voltage for the CMOS VCO. With the values shown, the device gave an increase of just under 3HzC⁻¹ (between 0°C and 60°C) giving a frequency of 470Hz at 0°C.



Lighting Effects

D. Stewart

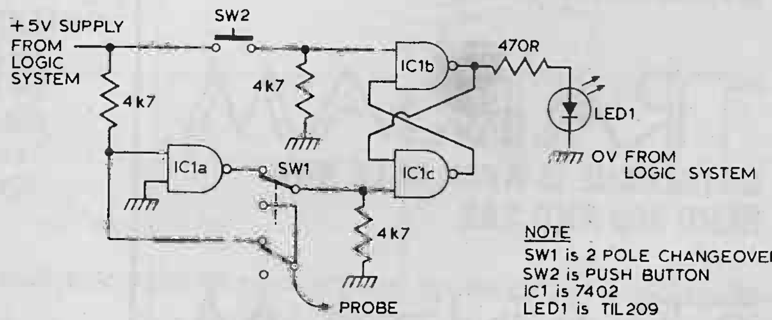
This circuit can be used to produce some interesting lighting effects. A unijunction relaxation oscillator is used to trigger the thyristor. The frequency of the oscillator is controlled by RV1. The load (a light bulb) will not be triggered at the same frequency as the unijunction oscillator, and some interesting effects can result. Care should be taken with this circuit as it is not isolated from the mains.



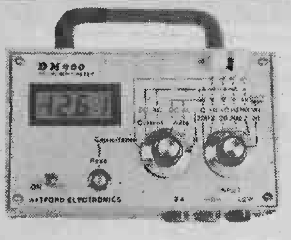
Logic Noise Detector

G. Robinson

Ever since the advent of binary logic, spurious noise spikes and pulses have been the curse of the designers of even elementary systems. This circuit will help detect 'noisy' logic levels. With SW1 in position I, any logic zero spikes occuring on a steady logic 'I' will set the R-S latch and the LED will be illuminated. With SW1 in position 2, an extra inverter is brought in, and the circuit will be triggered by any logic 'I' spikes.



WATFORD ELECTRONICS



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(Demonstration on at our Shop)

JACK PLUGS	Screened chrome	Plastic body	SOCKETS open metal	moulded with break contacts	in line couplers
2.5mm	12p	8p	8p		11p
3.5mm	15p	10p	8p		12p
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker	11p	7p	18p
3, 4, 5 Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours	9p	5p single	15p
Metal screened	12p	8p double	—
		10p 3-way	—
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	7p	7p	—
WANDER 3 mm	8p	8p	
DC Type	15p	20p	
AC 2-pin American	15p	15p	

SWITCHES★
TOGGLE 2A, 250V.
SPST 28p
DPST 34p
DPOT 38p
4 pole on/off 54p

SUB-MIN TOGGLE
SP changeover 59p
SPST on/off 54p
SPST biased 85p
DPOT 6 tags 70p
DPDT centre off 79p
DPDT Biased 115p

SLIDE 250V:
1A OPDT 14p
1A DPDT c/over 15p
½A DPDT 13p
4 pole 2-way 24p

PUSH BUTTON
Spring loaded
SPST on/off 60p
SPDT c/over 65p
DPDT 6 Tag 85p

MINIATURE
Non Locking
Push to Make 15p
Push Break 25p

ROTARY: Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers 69p
Mains Switch DPST to fit 34p
Break Before Make Wafers. 1 pole/12 way. 2p/6 way. 3p/4 way. 4p/3 way. 6p/2 way 47p
Spacer and Screen 5p
ROTARY: (Adjustable Stop)
1 pole/2 to 12 way. 2p/2 to 6 way, 3 pole/2 to 4 way. 4 pole/2 to 3 way 41p
ROTARY: Mains 250V AC. 4 Amp 45p

VOLTAGE★ REGULATORS
TO3 Can Type p
1A +ve 5V, 12V, 15V, 18V 145
MVR5 or 12 180
1A —ve 5V, 12V 220
Plastic (TO92) +ve 0.1A 5V, 6V, 8V, 12V, 15V 30
+ve 1A (TO220) 5V, 12V, 15V, 18V, 24V 85
—ve 0.5A 5V, 6V, 8V, 12V, 15V 95
—ve 1A 5V, 12V 125
—ve 0.1A (TO92) 5V, 12V, 15V 60
LM309K 135
LM320-12 165
LM320-15 165
LM323K 625
LM304H 240
LM317H 100
LM317K 350
LM325N 240
LM326N 240
LM723 45

TRANSFORMERS★ (Mains Prim. 220-240V)
6-0-6V 100mA 90p
9-0-9V 75mA 95p
12-0-12V 100mA 98p
0-12 0-12V 150mA 140p
0-6 0-6V 280mA 160p
0-15 0-15V 0.3A 260p+
0-4.5 0-4.5V 0.6A 260p+
12-0 12V 0.5A 280p+
0-12 0-12 0.5A 280p+
15-0 15V 0.5A 260p+
24-0 24V 0.5A 260p+
9-0 9V 1A 275p+
12-0-12V 1A 275p+
0-12 0-12V 1A 295p+
30-24-20-15-12-0 1A Multi tappings 360p+
30-24-20-15-12-0 2A multi tap 445p+
15-0 15V 1A 275p+
18-0 18V 1A 295p+
30-0-30V 1A 315p+
20-0-20 2A 340p+
6-0-6V 1.5A 345p+
0-18 0-18V 1.5A 379p+
9-0 9V 2A 315p+
12-0 12V 2A 320p+
30-25-20-0-20-25-30 2A 497p+
0-6 0-6V 6VA 240p
0-12 0-12A 6VA 240p
0-15 0-15V 6VA 240p
0-20 0-20V 6VA 240p
LT44 42p
LT700 Mia. O/P Pri. 1.2K. Sec. 3.2Ω 42p
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5x4x2" 82
6x4x2" 88
7x5x2½" 114
8x6x3" 148
10x7x3" 172
10x4¼x3" 142
12x5x3" 165
12x8x3" 210

PANEL METERS★
FSD 60x46x 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
475p each

4¼x3¼x1½
0-50μA
0-100μA
0-500μA
595p each

SPEAKERS
8Ω 0.3W p
2" 2¼" 65
2.5 3" 58
40Ω 2.5" 65
64Ω 2.5" 65
8Ω 5W 7"x4" 190
8Ω 3W 6"x4" 160

KNOBS★ to fit ¼ shaft
K1 Black Pointer type 9p
K1a White Pointer type 11p
K2 Slim Silvered Aluminium 12p
K3 Satin Black Ribbed 22mm diam. 12p
K4 Black Serrated Metal top with line Indicator 35mm diam. 22p
K4a As K4 but 25mm diam. 20p
K5 Black Fluted, metal top & skirt, calibrated 0.9, 37mm diam. 28p
K6 As K5 but with pointer on skirt 28p
K7 Black Knurled, tapered, metal top & skirt. Caliberated 0-9 30mm 26p
K7a As above but pointer on skirt 26p
K8 Black or Silvered for Slider Pot 10p
K12 Aluminised plastic with line indicator, 22mm diam. 16p
K19 Solid Aluminium Amplifier Knob Etchline indicator, skirted 22mm 30p

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3.5mm 18p
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ULTRASONIC TRANSDUCERS £3.95★ per pair

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COMPLEX SOUND GENERATOR
ETI Oct. 1978 Parts now available. Send SAE for List.

74LS★ cont.

		86	43	157	76	259	160	245	270
		90	60	158	96	261	450	247	190
		91	104	160	128	266	52	248	190
		92	89	161	98	273	244	249	190
26	48	93	89	162	138	275	250	251	134
27	28	95	116	163	118	279	66	253	142
28	48	96	116	164	114	283	192	257	110
30	22	107	44	165	75	290	128	258	146
32	27	109	55	166	226	293	128	384	86
33	39	112	55	170	288	295	185	386	86
37	39	113	50	173	105	298	168	390	230
38	39	114	50	174	106	324	240	393	230
40	28	122	70	175	110	325	290	395	218
42	98	123	70	181	398	326	294	396	215
47	90	124	180	183	298	327	286	398	276
48	120	125	60	190	140	347	148	399	230
49	120	126	60	191	140	348	186	445	150
51	24	132	95	192	130	352	228		
54	28	136	55	193	130	353	228	447	144
55	30	138	85	194	166	365	65	490	180
63	150	139	85	195	136	366	65	668	182
73	46	145	108	196	100	367	65	669	182
74	41	147	170	197	140	368	66	670	248
75	48	148	173	221	96	373	189		
76	40	151	96	240	236	375	160		
78	40	153	76	241	232	377	212		
83	115	155	96	242	232	378	184		
85	118	156	96	243	232	379	215		

VOU Chip and MODULE for TV
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KEYBOARDS★
Full Ascii Coded 56 Key £45.50★

...news digest..

feeling sporty?

Somewhere amid the teeming multitudes of watches that don't go tick in the night, this button ridden wristband from Casio appealed to us. Apart from the usual watch type functions the F100 is a 1/100S stop-watch with lap time facility. Depending on whether you go for the black case or the posh stainless one, it will cost you between £25 and £50.

rca has disc trouble

Oh for a standard that is a *standard* standard. Witness this latest piece of lunacy:

Sometime next year video discs will impact on our lives. Japanese firms are meeting to try and agree a standard format in an effort to avoid shades of four channel lunacy being seen again. So far so good. Unbelievably good in fact.

However just to be b . . . . y awkward both RCA and Philips have their own totally incompatible systems all set to burst forth like over-ripe spots. It can be confidently expected that both will hang onto their own like grim death — if they take part in the talks at all — and thus create another battle which at best only one can win, and both will probably get clobbered in.

Informal talks are reported to have already begun in Japan and great interest being shown in combining both video and digital audio retrieval in one product. Good luck to those who would standardise and thus software nicely, and a plague of tolerance failures be upon those who would confound and confuse.

stand before the bench

Although designed as a component handling system, it seems to us this little array would make a handy addition to the home constructors workbench. A wide array of bins are available and all come in four colours to satisfy the houseproud or colour blind. Designated the 40-12-H it is produced by Link-Hampson Ltd of 5 Bone Lane, Newbury, Berkshire. Look ye thence for further details.

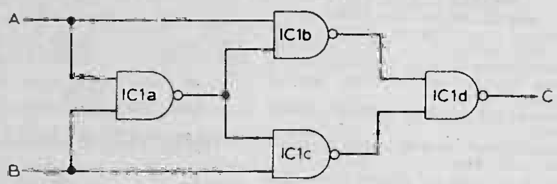
tech tips special

Exclusive OR and NOR gates

D. S. Smith

When constructing logic circuits which need either an exclusive OR or exclusive NOR gate, and one is not available, the following arrangement of NAND or NOR gates can produce the required results. The circuits can be constructed using standard TTL or CMOS gates.

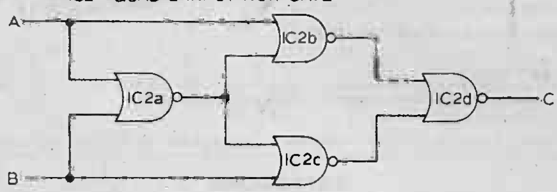
IC1-QUAD 2 INPUT NAND GATE



TRUTH TABLE

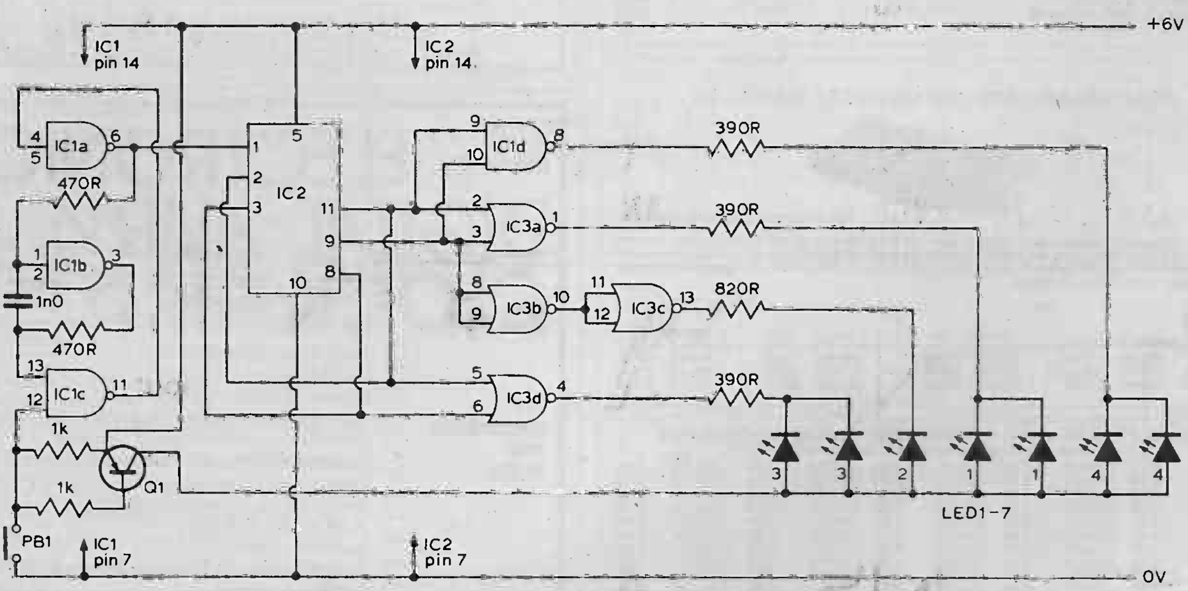
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

IC2-QUAD 2 INPUT NOR GATE

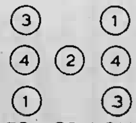


TRUTH TABLE

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1



NOTE
LED1-7 are TIL209 or equivalent
IC1 is 7400
IC2 is 7493
IC3 is 7402
Q1 gen. purp. PNP Ic max > 50mA
PB1 is normally closed



LED ARRANGEMENT

Electronic Dice

G. Vance

This dice circuit is interesting, as the six LEDs are arranged to produce a display the same as the dots on a dice. When PBI is depressed, the display is blanked and the oscillator (IC7a, b, c) clocks IC2 at about 1MHz. IC2 counts from zero and resets on seven. When PBI is released, the display is enabled and a novel decoding system produce the correct output on the LEDs.

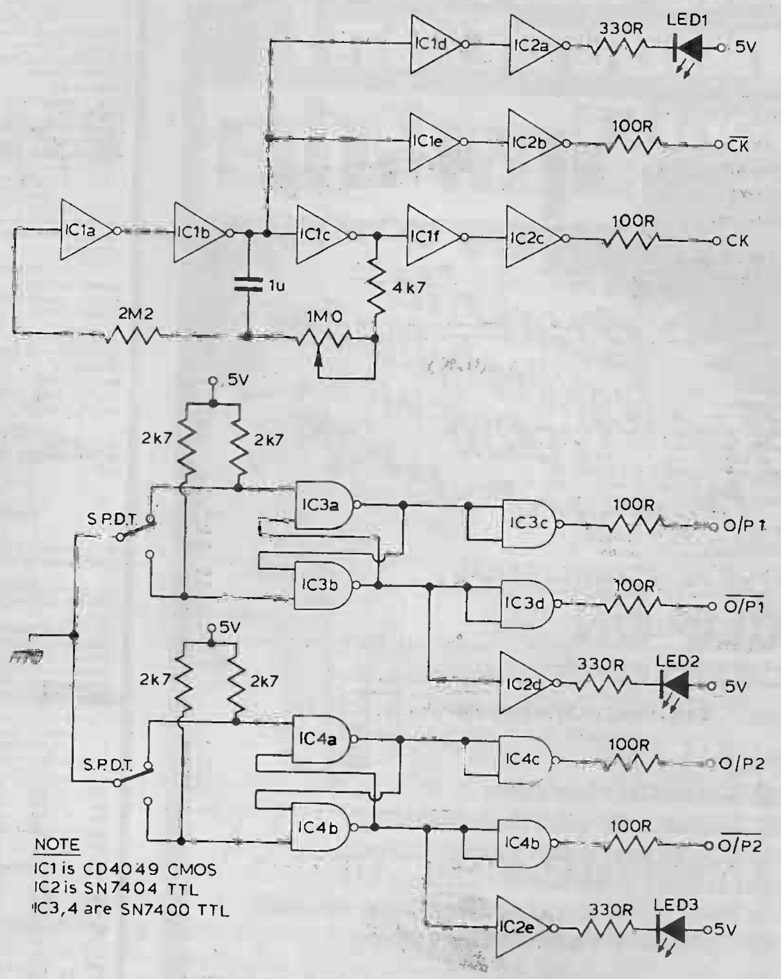
Test Unit for Sequential Logic

D. Rayner

Any one testing a sequential logic circuit requires input pulses free of contact bounce. This unit does this, providing two switched, jitter-free outputs and a 'slow' variable speed clock. The complements of these signals are also provided.

The components shown give the clock a frequency range of 1-200Hz. The clock's buffered output will drive up to two TTL inputs.

The 100R resistors on all outputs provide some measure of accidental short circuit protection.



Speaker Power Indicator

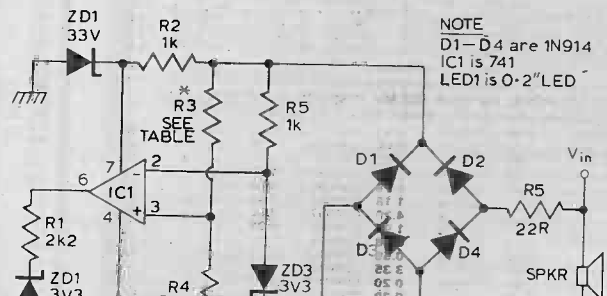
J. Macauley

This circuit will indicate the peak level of an input signal applied to a speaker. It is primarily intended as a fail safe device when connected to an amplifier of higher power rating than the speaker.

The circuit is unique in that no separate DC power supply is required since the circuitry operates from the input voltage to the speaker.

R5 isolates the amplifier's output stage from possible fault conditions in the circuit. D1 to D4 full wave rectify the input signal and the resulting DC is used to supply the op amp.

The 741 is used as a comparator a reference voltage being obtained from across ZD3 and fed into the inverting input of the op-amp. The non inverting input samples the rectified input signal. When a peak is fed into the circuit the IC's output goes high and the led flashes. ZD1 prevents the LED turning on when the output of IC1 is low due to the output being unable to go less than 1.5V above earth under these circumstances. ZD2 defines the upper limit of the op amp's supply voltage in the presence of large transients whilst R2 is the current limit resistor. It should be obvious that the level at which the led lights is dependent upon the value of R3. The accompanying table shows the value required for this component for different input powers across an 8 ohm load. If different load values are to be used for the speaker the value of R3 can be determined from the equation,

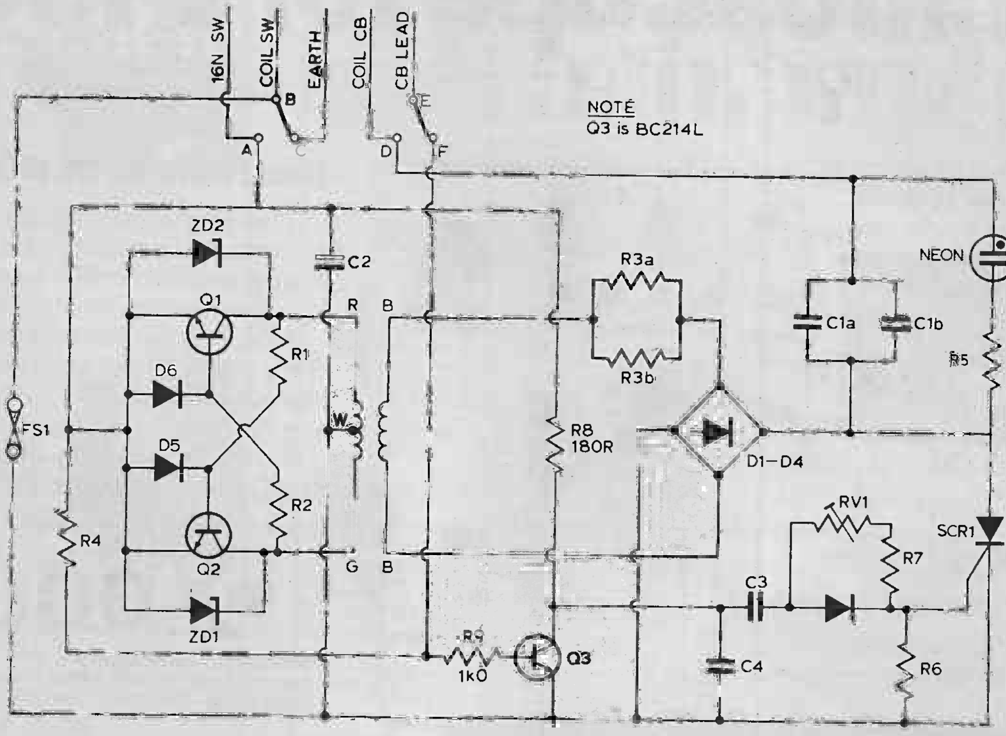


WATT/8Ω	5	10	15	20	25	30	35
R3kΩ	5·6k	9·1k	12k	15k	16k	18k	22k

$$R3 = 1.4\sqrt{PR} - 3.3\ k\Omega$$

P = Pout
R = load in Ω

tech tips special



CDI for Positive Earth

R. Vivian

The CDI Mk II ignition published in the May issue has been designed for negative earth cars. Attempting to install it in positive earth vehicles by reversing the supply connections will lead to problems caused by SCR1 triggering as C3 is discharged (ie as the contact points close, and not as they open).

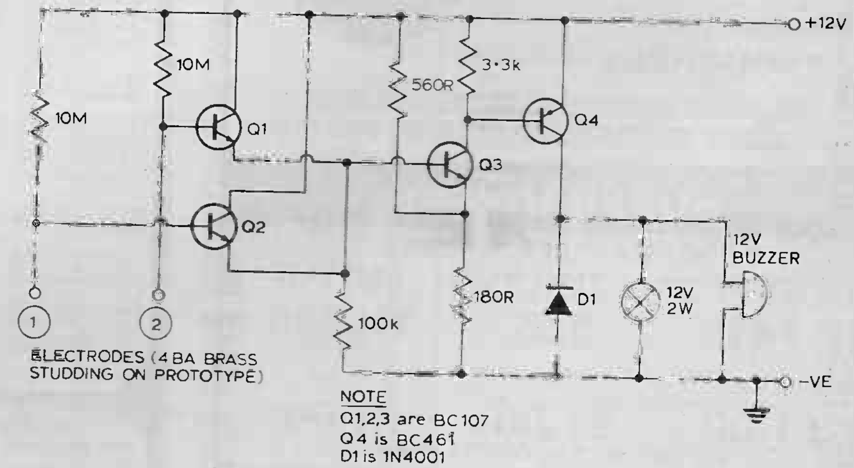
This modification provides a solution by discharging (C3) through a transistor (Q3) which conducts when the points open. Any general purpose PNP transistor capable of sinking 200mA (eg BC212, BC214L) will do.

Brake Fluid Indicator

D. Shorthouse

This circuit indicates by means of a warning light and a buzzer when the fluid in the tank of a braking system is getting low.

Normally both electrodes are immersed in the brake fluid, and the bases of Q1 and Q2 are at ground potential (the fluid makes a connection between the electrodes and the brake cylinder which is connected to the car chassis). If the fluid level should fall, and either of the electrodes becomes dry, Q1 or Q2 will turn on which will turn on Q3 and Q4 and the alarm energised.



COMPLEX SOUND GENERATOR

Not quite a synthesizer, but more than your average stylus organ — that's the ETI project team's musical offering this month

WHILE WE WOULD not claim that our Minisynth is the latest in polyphonic synthesizers (It'd never stand up in court) we want to emphasise that this is definitely not another in the never ending stream of Rolf Harris multivibrators.

Complex Chip, Easy Sound

The project is based on a new sound generator IC from Texas Instruments. This device has an on board VCO, low frequency oscillator, noise scource, envelope generator and a number of mixing circuits.

The final instrument can be used to provide a number of sounds, some musical, some not. You can use it to entertain, or, in case of those of us whose talents lie in fields other than music, annoy friends and foe alike.

Construction

Construction of the project is relatively straight-forward. Carefully follow the component overlay, as usual, noting the orientation of all electrolytic and tantalum capacitors. It makes sense to use IC sockets for the three ICs.

Before starting construction of the electronic components it might be an idea to tin the keyboard area in order that a more reliable contact is made.

Tinning can be carried out by coating the 'keys' with blobs of solder, heating the whole area up (large soldering iron required — we hope you won't use this for the rest of the construction) and quickly wiping away excess solder with a wet cloth.

The probe can be fashioned from an old biro, which has had its innards replaced by a wire that is connected to the original pall point.

The choice case for the project is much up to personal taste. We put our instrument in a case we made ourselves from thin plywood painted black.

Playing With

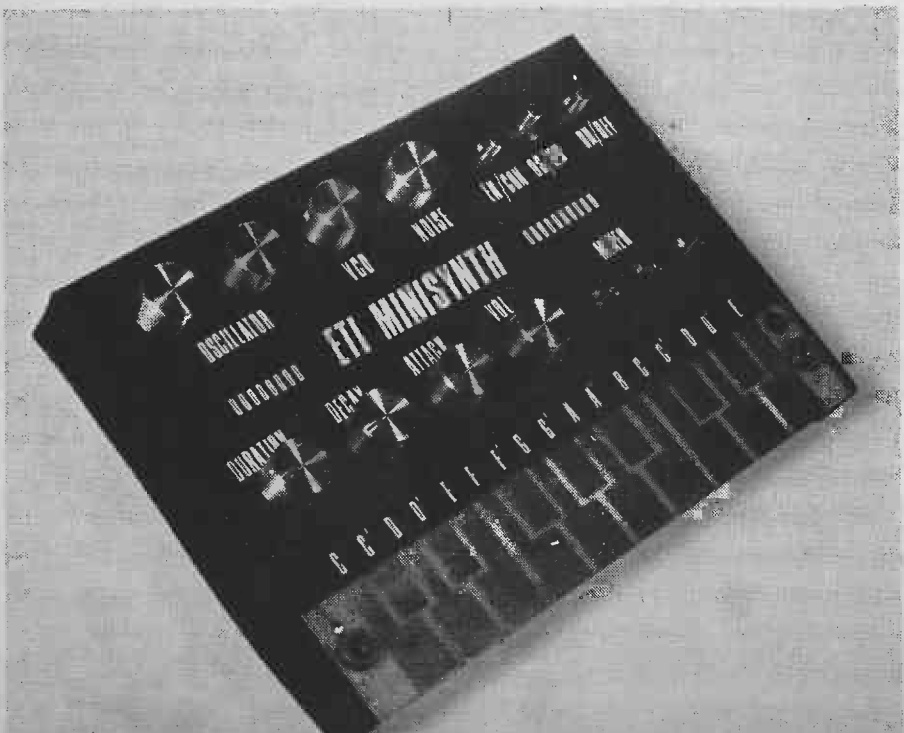
The only way to become familiar with the Minisynth is to sit down with the instrument and play with it. This is a painful experience for all concerned and while it won't make you blind could well make you deaf if the voume is up too far. Some of the sounds produced at this stage are, to say the least, gruesome and for the sake of all concerned this learning period should take place in private. You can expose your talents when the mechanics of playing the machine have been mastered.

A good starting point for the controls is to set the DURATION, ATTACK and DECAY controls to minimum, the SLF OSCILLATOR's course control to the highest frequency range with the fine control set at minimum. Set the VCO and NOISE controls to their mid points and all the MIXER switches down (towards you) — this will select the output from the main VCO. The ENVELOPE/CONTINUOUS control should be down and the OSCILLATOR/KEYBOARD control away from you.

Switching the instrument on should produce a note, the frequency of which can be altered by the VCO control. At this stage the note will be unaffected by the keyboard.

By moving the OSCILLATOR/KEYBOARD control to the down position the Minisynth can be played via the keyboard, the VCO control as a tune facility.

With the ENVELOPE/CONTINUOUS control in irs present position the note selected by the keyboard will be maintained until the probe is removed from the keyboard. Moving the switch to the up position will mean that the notes selected will be modified by the output of an envelope generator. The envelope generator is set up by the DURATION, ATTACK and DELAY controls. The control functions are self-explanatory, the only point to



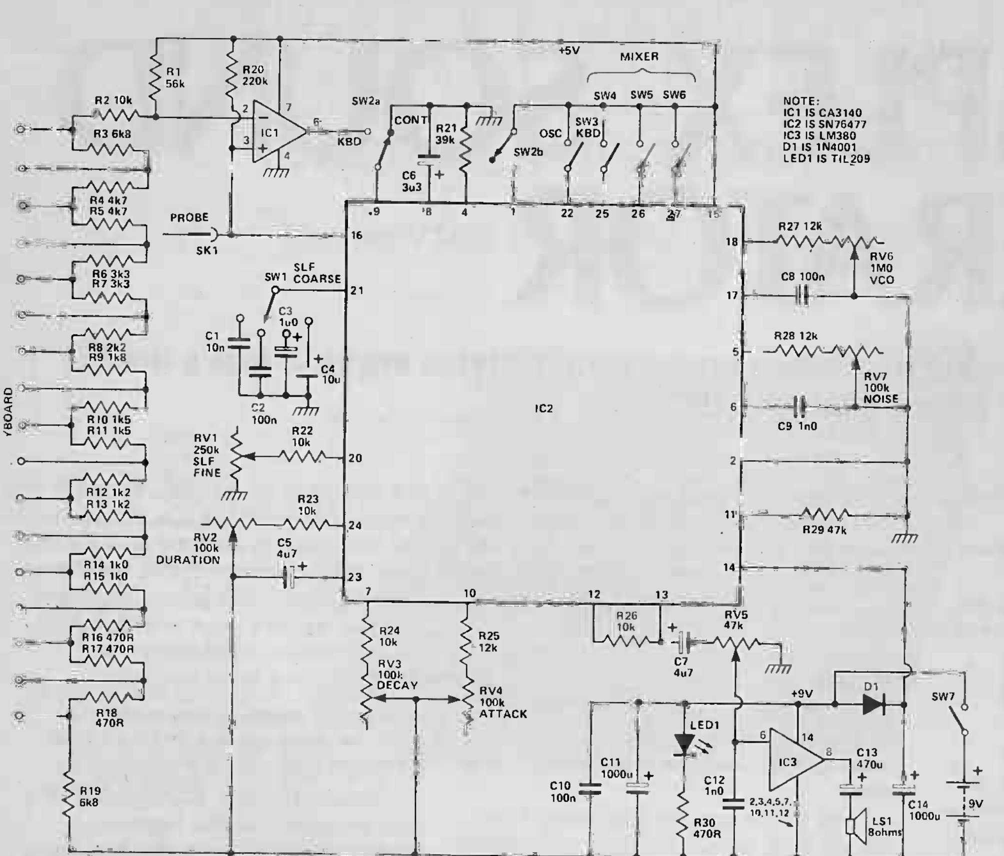
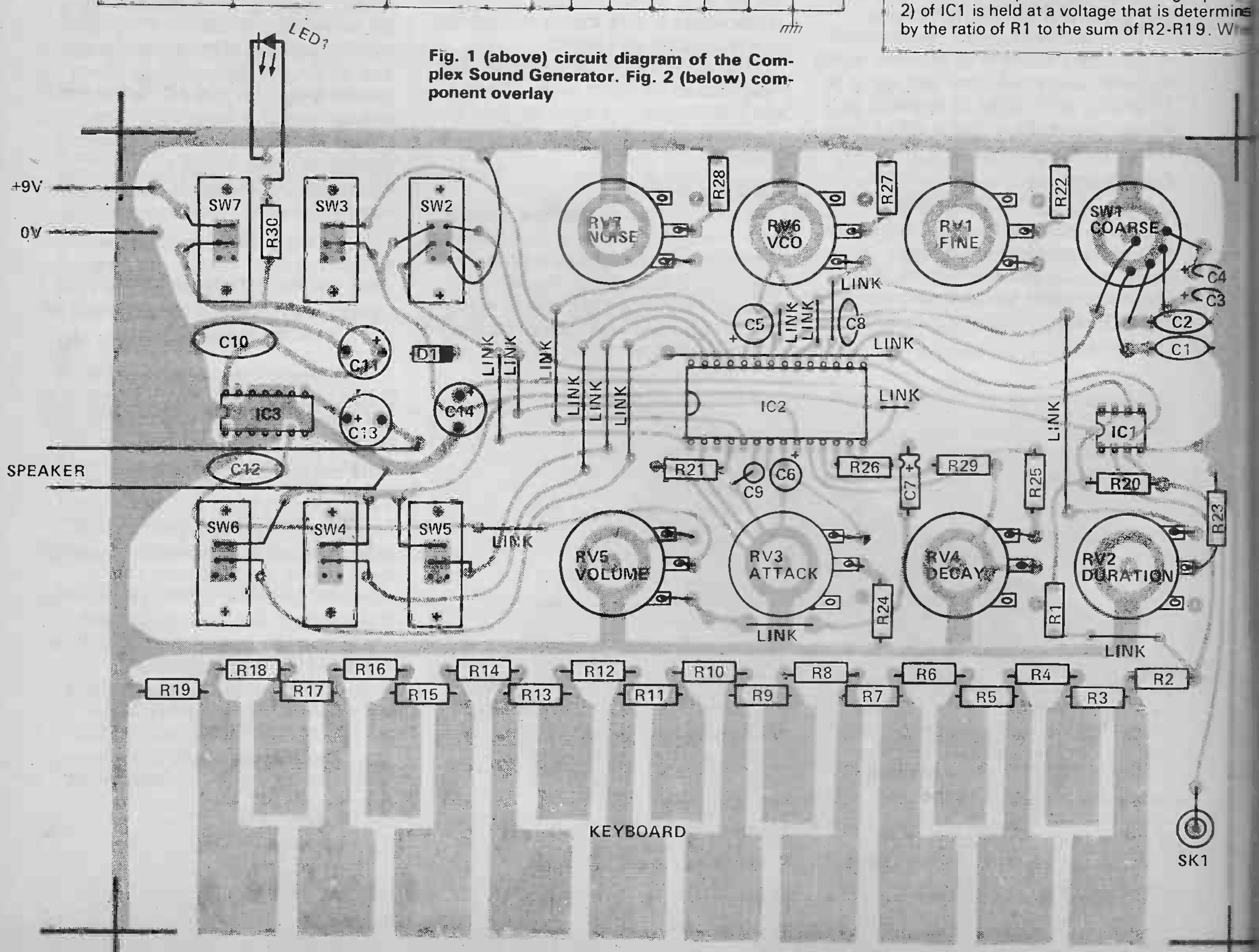


Fig. 1 (above) circuit diagram of the Complex Sound Generator. Fig. 2 (below) component overlay



The SN76477 IC that forms the basis of th project is a bipolar/I²L device that provides VCO, low frequency oscillator, noise source a filter, an envelope generator plus various othe mixing and control logic all in a 28 pin D package. The block daigram shows the intern arrangement of the various blocks within the and the pins to which external control netwo are connected. For full data on the device consult the data sheet published in February ETI.

Although the SN76477 does most of th work, we require two additional ICs, IC3 provide adequate audio output and IC1, whi forms part of the keyboard circuit — the secti we shall now look at in detail.

VCO and Keyboard

A voltage applied to pin 16 of IC2 will, if th external VCO select (pin22) is Low, determ the frequency of oscillation of the IC's on ch VCO. The Higher the external control voltag the lower the frequency produced. The range the VCO is internally set at a ratio of 10:1, wh the minimum frequency of operation is det mined by C8 and by the series combination RV7 and RV6(tune). The duty cycle of th oscillator is set at 50% by leaving pin 19 ope

The external control voltage is derived fro the potential divider chain formed by th resistors R1-R19, the particular value bei tapped off by the stylus.

IC1 provides an indication that the stylus h touched the keyboard. The inverting input (p 2) of IC1 is held at a voltage that is determin by the ratio of R1 to the sum of R2-R19. Wh

HOW IT WORKS

the stylus is not in contact with the keyboard R20 ensures that the non-inverting input (pin 3) is above this fixed voltage, the output of IC1 is thus high.

As the stylus touches the keyboard, the voltage at pin 3 will be pulled down to a level below that on pin 2 by the relatively low impedance voltage determined by the lower leg of the resistor chain. This will cause the output of IC1 to go low. The output of IC1 is taken to SW2a which selects either this signal or 0 V as the output to pin 9 of IC2.

Pin 9 is the system enable input. IC2 is inhibited when this pin is held high, taking it low enables the various sections of the IC. The transition of this pin from high to low (IC1's action as the keyboard is touched) also initiates the one shot logic (enabled by SW2b) that can provide sounds of short duration — this is described in detail below.

SLF Oscillator
The on chip VCO, as well as being controlled from the external voltage derived from the potential divider chain, can be modulated by an on chip Super Low Frequency oscillator. The VCO is controlled by this oscillator when the VCO select (pin 22) is high.

The SLF can be operated in the range 0.1-30 Hz, the particular frequency being set by the capacitors C1-C4 (selected by SW1) and by the combined resistance of R22 and RV1 (oscillator fine).

As well as providing a sawtooth output for control of the VCO, the SLF oscillator provides an output that is taken to the mixer section of IC2 described below.

Noise Generator and Filter
The on chip noise oscillator's input is taken, via R21, to ground. This sets up the conditions for correct operation of this section the output of which is fed to a noise filter. This modifies the noise generator's output by reducing the high frequency content of the signal. The specific 3dB point is set by C9 and by the value of R28 and RV7 (filter) in series.

Mixer
Outputs from the noise filter, VCO and SLF oscillator are fed to a mixer circuit. This combines the three signals in a manner determined by the logic levels on pins 25, 26 and 27 of the IC2 (mixer select). The particular output or combination of outputs corresponding to the eight possible states of these pins is shown in table 1. The output of the mixer is fed to the envelope generator and modulator.

It should be noted that as opposed to TTL ICs, unconnected inputs of the SN76477 assume a low state.

One Shot Logic
The one shot logic is used to provide sounds of a short duration. The circuit is triggered by a negative going edge on the system enable input, the duration of the "one shot" being determined by C5 and R23 plus RV2 (duration).

ADL
The attack/decay logic determines the envelope of the IC's output controlling as it does the envelope generator.

The ADL mode is selected by logic level signals on pins 1 and 28. In our circuit pin 28 is left unconnected while pin 1 is taken to SW2b. This selects the output of the one shot when held high and of the VCO when taken low.

Envelope Generator and Modulator
The attack/decay characteristics of the output are determined by C8 in conjunction with R25 and RV4 (attack) and R24 and RV3 (decay).

Output Amplifier
The output of the envelope generator is taken internally to an on chip amplifier the gain of which is set by the ratio of R26:R29. The output of the amplifier appears at pin 13 and is taken via C7 and the volume control RV7 to IC3 an LM380. This IC acts as a power output stage. C11 ensures that the LM380 is stable under all operating conditions, while C12 provides DC isolation between IC3's output and the loudspeaker LSI.

Power Supply
The 9 V input is used to power IC3 directly and is then taken via D1 (to drop 0.6 V) to pin 14 of IC2. This is the input to an internal voltage regulator that powers the IC and also provides a stable 5 V at pin 15 for use elsewhere in the circuit. C10, C11 and C14 provide supply decoupling while LED1, together with current limiting resistor R30, provide an indication that power is applied to the circuit.

PARTS LIST

RESISTORS (all ¼W 5%)

R1	56k
R2,22,23 24,26	10k
R3,19	6k8
R4,5	4k7
R6,7	3k3
R8	2k2
R9	1k8
R10,11	1k5
R12,13	1k2
R14,15	1k0
R16,17, 18,30	470R
R20	220k
R21	39k
R25,27, 28	12k
R29	47k

POTENTIOMETERS

RV1	250k linear
RV2,3, 4,7	100k linear
RV5	47k log
RV6	1M0 linear

CAPACITORS

C1	10n polyester
C2,8,10	100n polyester
C3	1u0 35 V tantalum
C4	10u 35 V tantalum
C5,7	4u7 10 V electrolytic
C6	3u3 35 V tantalum
C9,12	1n0 polystyrene
C11	1 000u 16 V electrolytic
C13,14	470 16 V electrolytic

SEMICONDUCTORS

ICI	CA3140
IC2	SN76477
IC3	LM380
D1	1N4001
LED1	TIL209

SWITCHES

SW1	single pole, four way rotary
SW2	DPDT
SW3-7	SPST

MISELLANEOUS
PCB as pattern, case to suit, probe, 8 ohm loudspeaker, battery eliminator.

BUYLINES

All the components except IC2 should be widely available while IC2 will be stocked by Watford, Technomatic and other Texas suppliers. Watford are also to supply a complete kit for the project.

We do not have enough space to reproduce the foil pattern but it will be available on ETIPRINTS or can be obtained by sending an SAE to our offices. Please mark your envelope Complex Sound Foil Patterns.

note is that because the Minisynth does not have a sample and hold facility in the keyboard section, the note required must be maintained throughout the period of the envelope.

The mixer controls select the outputs from the various noise sources and oscillators on the instrument. At present it is the output of the main VCO that we are hearing. By setting the ENVELOPE/CONTINUOUS control back to its former position and moving the leftmost mixer control up the output from the SLF OSCILLATOR can be heard. This oscillator is controlled by the fine and course controls at the top right hand corner of the instrument ▶