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NOVEMBER 1976

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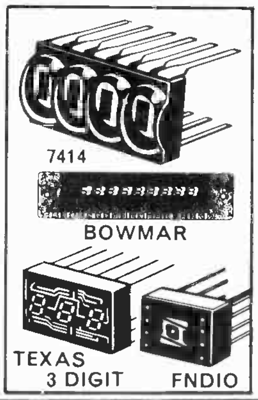

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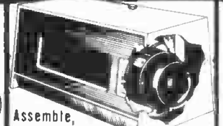

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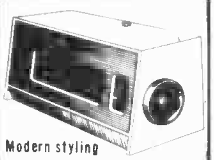

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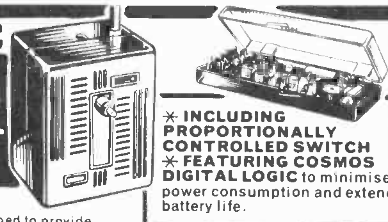

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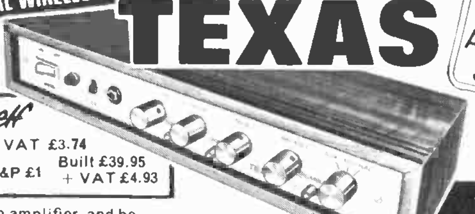

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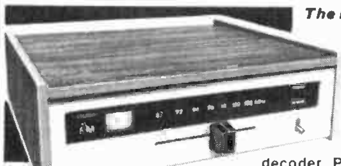

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This new AM/FM tuner kit incorporates 2 Mullard modules. Supplied as a pre-aligned and tested printed circuit, the constructor only has to build the PCB into the chassis, connect the power, aerial and output loads. Styled to match the Texan amp, mains operated.

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Projects

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Information

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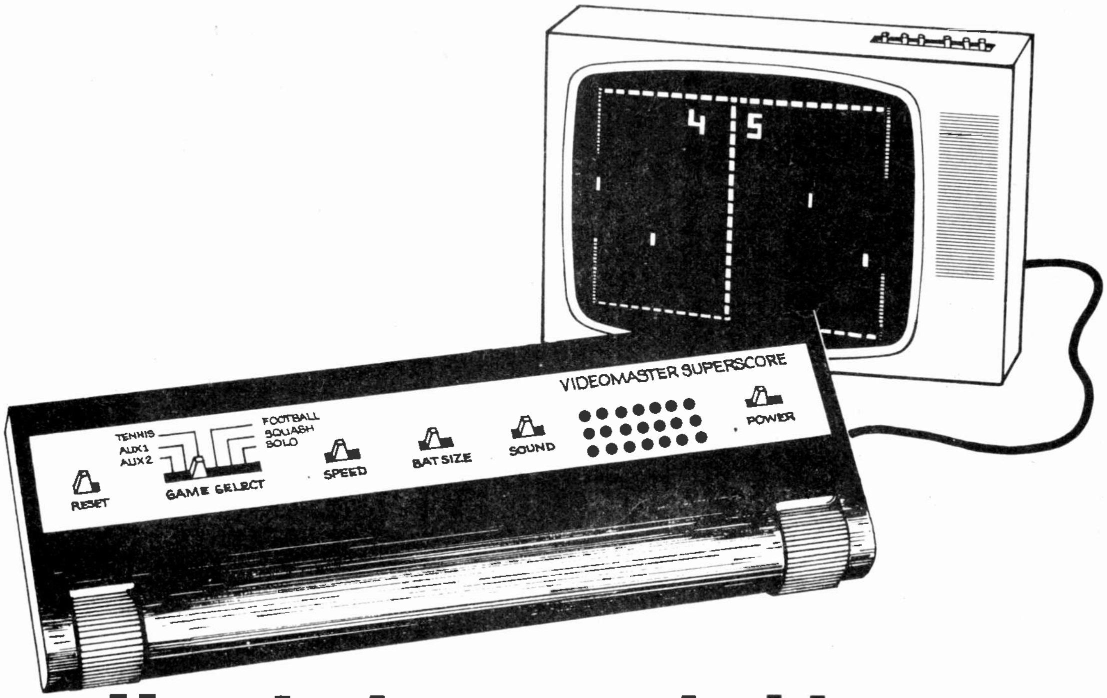
READERS' QUERIES: These can only be answered if they relate to recent articles published in the magazine. Rarely can we supply information in addition to that published. Written queries must be accompanied by a stamped addressed envelope, and telephone queries must be brief, not before 4pm and can only be answered subject to the availability of technical staff.

BACK NUMBERS: Back numbers of some issues are available for 40p each, plus 15p postage.

SUBSCRIPTIONS: Great Britain £5.00 per annum. Overseas £5.50. Payment in sterling only.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news digest

STEERING WHEEL? WOT STEERING WHEEL?

We had a very careful second look at this photograph, vowed to give up wine, women, and especially song, (for at least five minutes) then decided yes he was in the back seat, and yes the car was moving. Visions of a huge hoax flashed to the editorial mind — frenzied navvies rushing about with the backdrop to simulate movement — tiny men crammed into the wing mirrors steering via cunning Chinese arrangements of levers and gears. The mind boggled.

Alas the answer is nought so scandalous. Quite simply an Australian electronics enthusiast has packed his car full of voice recognition and MPU circuitry to the end that it will now obey verbal commands — even by walkie-talkie up to a range of 12 miles (Naturally it obeys only its owners voice).

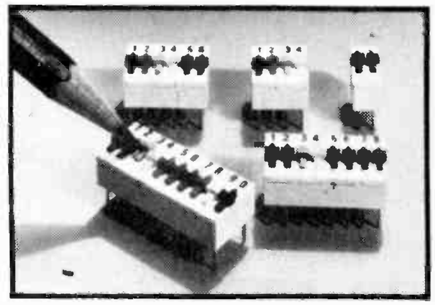
The car has a CCTV system installed which enables the driver to see behind him — very useful in injon country. Infra red sensors pick up red traffic lights and brake the car automatically — no we're not joking. Radar ranging maintains a constant distance with respect to the car in front, and sensors apply the brakes should the car come too close to any object — even people.

All this makes it a better driver than most of us.

INVERTED SNOBBERY

The 6233 a new ultra high power ≈200W per channel (8Ω : FCC) professional amp from JBL. It boasts power metering, fan cooling and a fully complementary output stage consisting of 12 150W transistors per channel. The power supply is novel — a 2000W invertor is employed rather than a transformer and rectifier — to keep down size and weight. If you feel you need this piece of monumental suicide engineering — JBL will relieve you of £1100 for the pleasure of its company.

IC SOME SMALL SWITCHES



This 'SpectraDIL' switch is available in 2, 4, 6, 8, 10 pole modules from 5 to 25mm in length. Features include gold plated spring loaded wiping contacts suitable for microvolt to lower power switching and a typical resistance to 10 milliohms, with a repeatability of less than one milliohm over several hundred operations is claimed. Life is said to be in excess of 10,000 operations at the full 10VA rating.

Prices start from only 10p per pole per switch. ERG Industrial Corporation Ltd, Luton Road, Dunstable, Bedfordshire LU5 4LJ.

THE TEST OF TIME

Aerial contractors and service engineers in the television trade will be well aware that BBC-2 trade test transmissions were curtailed to save energy. To assist the trade in making the maximum use of these transmissions, a system has been devised to show a single figure in one of the grey squares at the bottom right-hand corner to indicate whole minutes of Test Card left, counting down from nine to zero. Thus 'O' means that the Test Card will be faded out within one minute.

The system is to be tried for an experimental period beginning on 21 August and the BBC's Engineering Information Department would welcome comments or suggestions about its usefulness. These should be addressed to Engineering Information Department, Broadcasting House, London W1A 1AA.

HOW HIGH IS AN ELECTRON?

Hitachi have developed an instrument which provides a 3—D image from a scanning electron microscope, they say. It can be hooked up to provide height and width info up to 300A (height) and 30A° (width). It is rumoured somewhat facetiously we feel, that it will be first used to measure the height of Britains remaingold reserves.

HP AT A (CALCULATED) LOSS;

Hewlett-Packard – renowned for their up-market calculators, are apparently running this section of the business at a loss. Equipment and other activities are keeping then in the black, and H.P. cite the delays occurring on the introduction of new models as the cause for this. Also named as a culprit is "severe price erosion in the pocket calculator marketplace". Pick the bones out of that ye rivals of the beast.

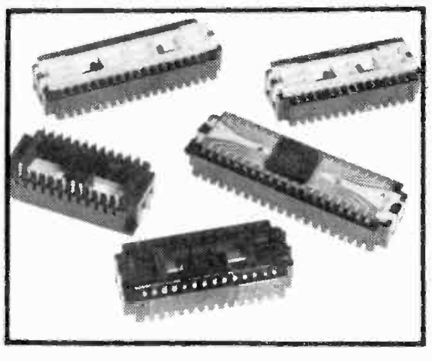
THE TOSHIBA GRANADA?

Ford Motors have placed an order with Toshiba, of all people for an unspecified quantity of 12-bit MPU's to be used in next years models. This is to control the ignition and the exhaust gas recirculator. Ford are apparently still looking for second sources.

Exhausting work wot?

SOCKET TO ME – BUT VERY VERY VERY GENTLY!

Designated Type 2944, this socket enables an LSI module to be inserted without any axial force being imposed on the ceramic base of the module, and hence the possibility of damage to its leads. The socket incorporates a simple mechanism which ensures that the module pins are free to enter without any obstruction or pressure from the individual contacts. Only when the module is correctly seated in position are the contacts pressed into contact with the leads.



Releasing the module for removal is effected by releasing the retaining clips.

The 2944 is available in 40, 36, 28 or 24 position versions, all designed for lead spacing of 0.65in. maximum, and LSI lead lengths from 0.155 to 0.21in. Price on application to Molex Electronics Ltd., 1 Holder Road, Aldershot, Hants GU12 4RH.

PIONEERING ULTRA–POWER

Some months ago we revealed the launch of an amazing machine from Pioneer hi-fi. At the time all we had was a picture of this creature hiding behind someones arms. Now however the SX1250 is becoming readily available, after an official launch on the Pioneer Express. So, as promised, here are the full details of what must be the statest-of-the-art receiver readily available to the home hi-fi enthusiast.

SPECIFICATION

POWER AMP

160W + 160W (8Ω) Both channels driven 20Hz – 20kHz. THD 20Hz–20kHz <0.05% at 80W output. IMD: <0.05%, at 80W output (50Hz:7kHz = 4:1). FREQUENCY RESPONSE: 5Hz–100kHz (+0, –1dB). DAMPING FACTOR: 30+ (20Hz–20kHz). HUM AND NOISE: 100dB (IHF). SENSITIVITY: 1V/50kΩ.

PREAMP

PHONO (x2) 2.5mV/50k – Overland 500mV. MIC 6mV/50k. AUX 150mV/50k. TAPE PLAY (x2) 150mV/50k. THD: <0.02% 20Hz–20kHz. FREQUENCY RESPONSE: 30Hz – 15kHz (±0.2dB) – PHONO 10Hz–50kHz +0dB –1dB AUX. TAPE. TONE CONTROLS: ±10dB at 100 Hz and 10kHz ±5dB at 50Hz and 20kHz. FILTERS: 30Hz (12dB/oct) and 8kHz (12dB/oct). HUM AND NOISE: Phono –75dB Aux, Tape –90dB (IHF).

FM TUNER

USABLE SENSITIVITY: 14.5dBf (stereo) 50dB QUIETING: 36.0dBf (stereo) ULTIMATE S/N RATIO: 74dB (stereo) DISTORTION (1kHZ): 0.2% (stereo). FREQUENCY RESPONSE: 30Hz–15kHz (+0.3dB, –1.0dB) CAPTURE RATIO: 1dB IF Rejection = 110dB. ALT. CHANNEL SELECTIVITY: 83dB AM Suppression = 60dB. SPURIOUS REJECTION: 110dB Separation = 50dB. IMAGE REJECTION: 110dB AM Band included.

30 REGISTERED SECRETS

The SR52 programmable calculator has thirty extra data registers, over and above the facilities publicised by the manufacturer, Texas Instruments. An American engineer, Philip R. Geffe, made the discovery that locations 70 to 99 can be used to store information when the machine is in the calculator mode.

A FAN OF MIRRORS IN ONE WAY

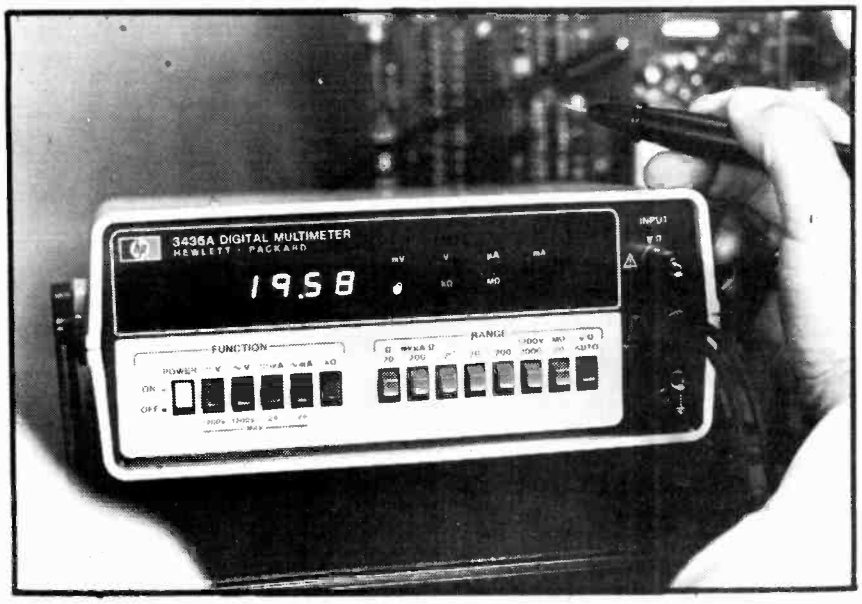
MIT scientists have developed thin films (less than a ten thousandth of an inch thick) which freely transmit sunlight in one directional but reflect heat radiation from the other. One of the scientists, Dr John C. C. Fan, claims that 2% of the total consumption of energy in the USA could be saved by fitting the heat mirrors to all buildings.

NOT GETTING IT IN BLACK AND WHITE

Manufacturers of one-eyed monsters (i.e. televisions) in Taiwan are being politely requested to restrain themselves in their imports to Britain. Following a 'heads-together' between the government and our own TV manufacturers, the Taiwan Board of Foreign Trade is itself encouraging restraint. We have already been in touch with Japan, amongst others in an attempt to get some voluntary restrictions, since the import level of black and white sets is soaring.

Success will probably depend on the Japanese stance on the issue. I'll bet our firms would give a lot for a gunboat to send.........

A TOUCHING THOUGHT!



This new Model 3435A, 3-1/2 digit multimeter from Hewlett-Packard has a 'touch-hold' probe available as an accessory. This lets the user 'freeze' the reading on the display -- an undoubted convenience when probing closely-packed circuit boards. The multimeter is autoranging an AC and DC volts and resistance. AC and DC current ranges are selected manually.

Front panel indication show the function in use and the units. Some idea of the ranges covered can be gleaned from the front panel switching. Price of the standard 3435A (with rechargeable lead acid batteries) is £291. The freeze reading probe is £29, extra.

Hewlett-Packard Ltd., King Street Lane, Winnersh, Wokingham, Berks. RG11 5AR.

TEXT FOR TELLIES

Spectrum Laboratories are able to offer immediate delivery on teletext decoders. Termed the Spectrum Telefax Decoder, the unit includes all standard features for receiving Ceefax and Oracle from the BBC and IBA respectively while providing optional facilities for decoding the PO Viewdata service.

Control is from a slim hand held keypad hard wired to the decoder — optionally an ultrasonic cordless unit may be supplied — with remote TV receiver on/off included as standard. Page number is continuously displayed at the top left of the information page. Unusual features include roll with pages changing continuously and a time display which is inserted into the top right of an ordinary TV programme. Prices at approximately £300, the Spectrum Telefax Decoder may be built-in to the TV receivers with sufficient space or alternatively mounted externally. Spectrum Laboratories Ltd., 32 Royal Avenue, Chelsea, London SW3 4QF.

KIT AND CLOCK SHOP?

A new chain of electronic hardware shops is about to be opened by Metac. The outlets will specialise in kits for the home constructor, as well as digital clocks and watches. We understand our projects will be prominently features. (What more reason do you need to rush down there?).

The first is now open in Daventry (where?) with others to follow in High Wycombe, Reading and Coventry.

IBM SEES RED

The US government has decided to allow IBM to supply Russia — the Soviet Intourist Agency — with a large scale computer, a 370/45. This is against an earlier veto, and prevents two British firms sneaking in with their computers.

Apparently the reason for the veto was that the machine had too large a disc storage for the CIA's liking, and they thought old Ivan would use it to track US agents.

Oh what a tangled tape we weave................

CONFESSION TIME

This is the item we hate to print. We must humbly apologise to all our our readers for the number of errors which galloped (not crept) into last months issue. No excuses, but we will do better in future!

ERRATA

September 1976: 100W DISCO:- *Q4 must be mounted on the output transistor heatsinks. This component is present to prevent thermal runaway. Mounting it on the PCB may well lead to trouble!*

September 1976: 560 VDU:- *The PCB layouts contained quite a few errors. The list below is complete as far as we know.*

1. *The master clock (MCKL) is synchronised by LS not LSD.*
2. *The circuit diagram shows IC15a as a NAND gate, the 7421 is a AND gate.*
3. *Having stabilised the picture by setting VR1 and VR2 the horizontal lines from RCLK will not appear until after IC9 has been inserted as RCLK is gated via IC9b.*
4. *The values of the components for the three oscillators associated with VR1, VR1 and VR5 may need changing to obtain optimum results, this is due to component tolerances.*
5. *On the layout of PCB-B pins 2 and 3 of IC12 are shown linked to FSD, this should read LSD.*
6. *No allowance was made on PCB-B for the inputs to IC7, ICs 9-13 should have their Vss line linked to that of ICs 8-16, IC9 was inadvertantly mirror-image reversed.*
7. *Several capacitor values in the parts list are given as "F" instead of pF. This affects C4 C6, C7, C8.*
8. *R20 should be 47k.*
9. *'VRF' should be VR5 — 1k vertical preset.*

October 1976: MULTIMETER:- *The patterns on page 45 are shown in reverse. To obtain the correct track layout draw the pattern through tracing paper, and then turn the paper over! A complete set of (correct) boards is available from Plessis Electronics (see ad) for £5 inc. In their ad last month, the board size was given as 7' 7". Now much as we're in favour of big projects — (can you imagine the size of the transformer?)........this was misprinted for 7.7".*

Penance will be served, and the sackcloth and ashes adorn our persons!

STD TIMER

This compact unit calcultes the total cost of STD phone calls by counting the number of local-call charges appropriate to the called distance and duration of the call

SUBSCRIBER TRUNK DIALLING STD, is now the preferred method of making trunk phone calls within Britain. STD calls are easier and faster to make and can be cheaper than the old "charge per three-minute period" system. However, the method of charging for STD has a hidden trap which can result in phone bills being unexpectedly high.

The STD billing system works by charging a fixed amount (equal to the local-call charge) for each time unit used in making the call. The time allocated to each unit varies according to the distance. Thus if the call is only over a short distance and at night you may be charged one local call every 180 seconds, but if over a long distance and during the day the charge may be as much as one local call every eight seconds. The disadvantage of this method as far as the subscriber is concerned is that he loses track of time when talking — there are no pips to warn him.

The ETI 543 STD Timer operates by counting the number of local call periods used. Thus at the end of the call you simply multiply the number held in the counter by the local call charge to get at an accurate cost. Local-call charges are frequently reviewed, so the timer is designed to count the number of local-call charges only.

To use the timer simply check the phone book before making the call to determine the number of seconds per charge applicable, then set this time on the selector switch of the timer. Now dial the number and when the called party answers press the start button. The timer will switch on, "1" will be added to the display and the display will be incremented by "1" at the end of each time period (as selected). When the call is finished, you press the stop button and read the total units used. After about five seconds the timer will switch off automatically.

Note that although the power is still connected in the off-state the power consumption (in this state) is so low that battery drain doesn't affect battery life. In fact on the prototype the current drain was 2×10^{-10} amps! Yes, we actually measured it — guess how?

CONSTRUCTION

As the unit will be used on the phone table small size and neat appearance is necessary. We therefore built our unit into a zippy box which although looking neat does become a little crammed inside. For this reason it is important to use the printed circuit boards specified if all the electronics is to fit.

Commence construction by assembling components to the display board, ETI 543A, starting by installing the tinned-copper wire links as shown on the overlay diagram. Watch the orientation of the integrated circuits: the two 4511s have opposite orientations.

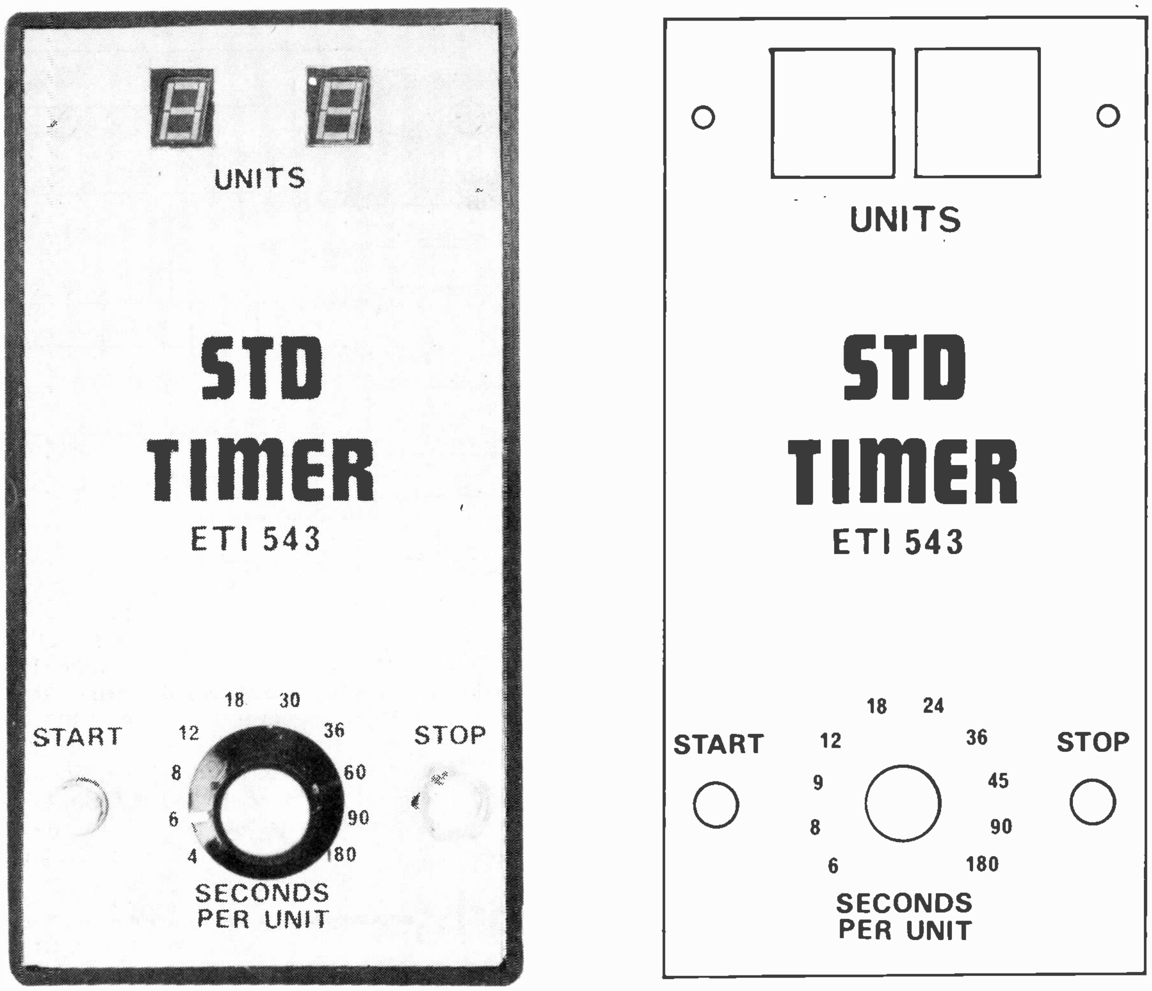
Now assemble the second board, again installing the links first. Do not mount R1 to R16 just yet. The rotary switch used for range selection must now be modified by removing the wafer, cutting the spacers in half and then reassembling (as shown in Fig. 2) on the printed-circuit board. The terminals of the switch should now be connected to the board by threading tinned-copper wire through the appropriate hole in the board (from the copperside) and through the terminal and then soldering to the terminal and the board. The resistors R1 to R16 may now be mounted into position and soldered, noting that they are mounted on-end — not flat.

Mount the two push-buttons to the front panel temporarily and then mount the completed second board and switch assembly to the front panel. Use spacing washers between the switch and the front panel. Connect the push-buttons to the board using tinned-copper wire and then remove the front panel.

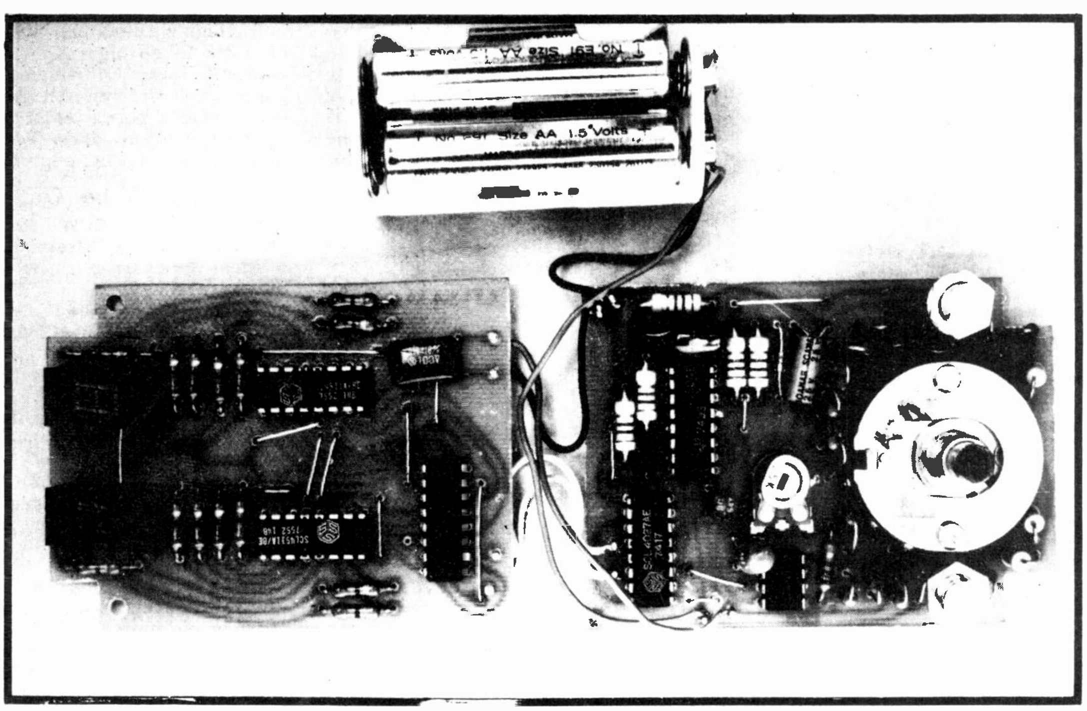
Now place the two boards end-to-end about 50 mm apart and wire them together as shown in Fig. 3. The 50 mm spacing ensures that when the boards are folded later the spacing will be OK. The battery holder may now be connected. However, note that there is insufficient room to allow a conventional battery power clip to be used. You have to solder the leads directly to the terminals.

Impedances around the switch are fairly high, and leakage through flux could affect timing accuracy.

So clean the copper side of the boards with turps or methylated spirits to remove excess flux. Insert the batteries in the holder and select the four second range. If the display is on press the stop button and after about five seconds the display should extinguish. Now press the start button and note that the display is "01" and should increment



Front panel for the timer. Full size



The two boards and battery assembly before being mounted in the case

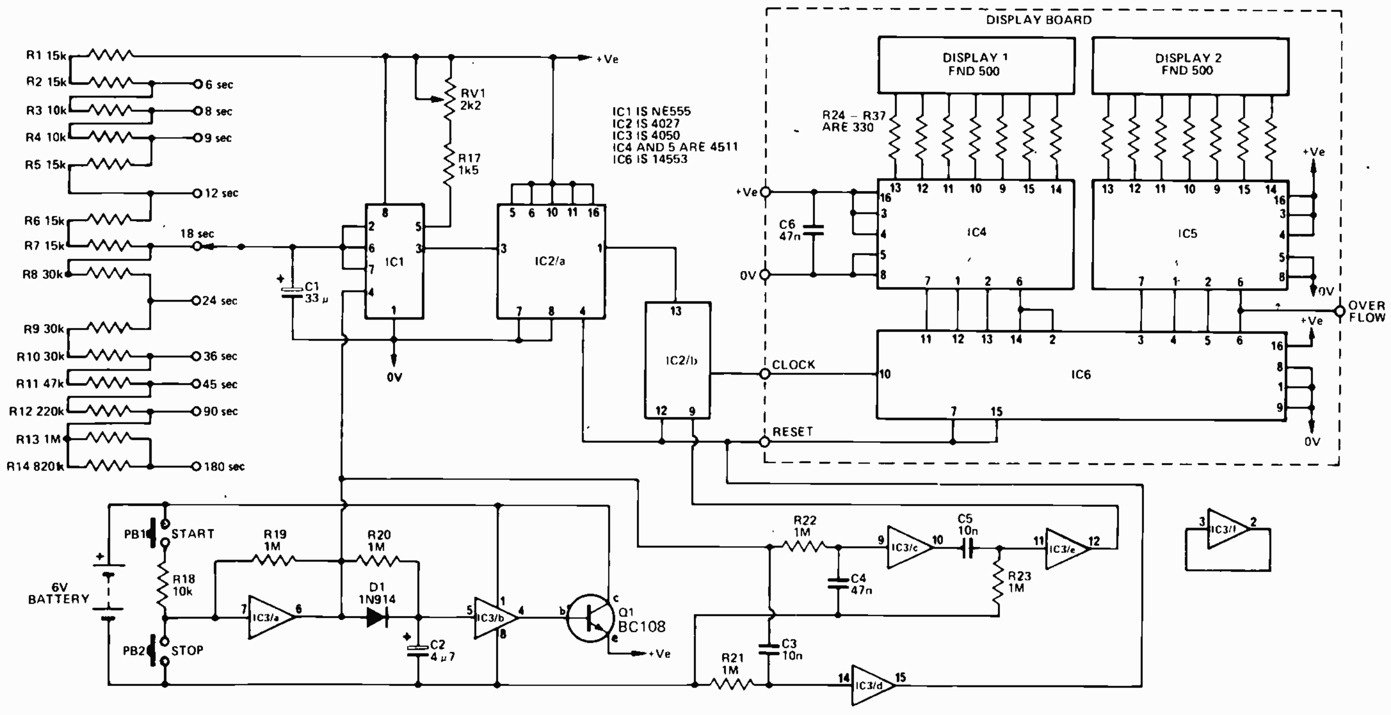


Fig.1 Circuit diagram of the STD timer unit

Specification

TIMING
Periods provided
6,8,9,12,18,24,36,45,90 and
180 seconds
Accuracy
first count –20%
successive counts ± 5%

DISPLAY
2 digit, seven-segment LED

POWER
Batteries
4 x pen cell (6V)
Battery drain
approx 50 mA in 'ON' state
" 1 µA in 'OFF' state

START AND STOP
by separate push buttons

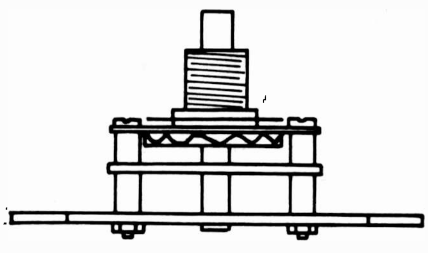


Fig.2 The switch must be disassembled, the spacers cut in halves and then reassembled to the PC board as shown in this diagram

How it works

The basic timing element is the familiar timing IC the 555. This is a convenient device as the timing may be altered by changing the value of a single resistor. The resistor in question is selected by switch SW1 to provide timing periods from one to 45 seconds in duration. As the timing of long intervals is difficult due to the leakage encountered in practical large-value capacitors, a divide by four stage is used to obtain the 6 to 180 second period required. To compensate for differences in the value of capacitor C1 a variable resistor is provided between 5 of the IC and the positive rail. Adjustment of this resistor varies the threshold voltage of the IC and thereby corrects the timing.

The first timing period of the 555 is about 50% longer than those following and to compensate for this the divider stage provides a by-three division, instead of the normal by-four division, on the first sequence. This is not, however, a problem: it can be an advantage. If a call is terminated just at the time the display changes the charge will be within the cheaper period.

The output of IC2 clocks the dual-decade counter IC6 which has a four-line BCD output code. This is decoded to seven-segment format by ICs four and five to drive the seven-segment LED displays. These decoders also have a store facility which is not used in this application. A link is therefore used to connect the store input to zero volta thus disabling it. The use of a link allows the store to be made available if the board is to be used for another application.

The timer is controlled by IC3 which is a hex (6) non-inverting buffer (if input is high, output is high etc). The cycle commences when pushbutton PB1 is pressed. This pulls pin 7 of IC3/1 high causing the output of the IC to go high (pin 6). IC3/1 latches in this state and stays there until the stop button is pressed — when the output goes low again. When the start button is pressed and the output of IC3/1 goes high the input of IC3/2 is also pulled high via diode D1 causing the output of IC3/2 to go high. This high turns on emitter-follower Q1 which then provides power to all circuits with the exception of IC3 which is permanently powered. The off-state current drain of IC3 on the prototype was measured at 200 nanoamps! Thus by using this technique the need to switch the unit on and off has been avoided as battery life in the OFF state will exceed the shelf-life of the battery.

When the 'start' push button is pressed the high at the output of IC3/1 is also fed to pin 4 of the 555 timer IC which starts to cycle at the rate selected by SW1. Pin 14 of IC3/4 also goes high until C3 is discharged by R21. This causes a 10 millisecond pulse to be generated at pin 15 of IC3/4 and this pulse is used to reset the display decade counter, IC6, and also IC2 at initial switch-on. In addition, after a 50 millisecond delay (due to R22 and C4) the output of IC3/3 goes high and this transition in conjunction with C5 and R23 produces another 10 millisecond pulse from IC3/5 which sets IC2/3 causing IC6 to be incremented by one.

When the stop button is pressed the 555 timer is disabled and the timing stops. However, due to the charge on C2, the power remains on for a further 5 to 10 seconds.

—STD TIMER

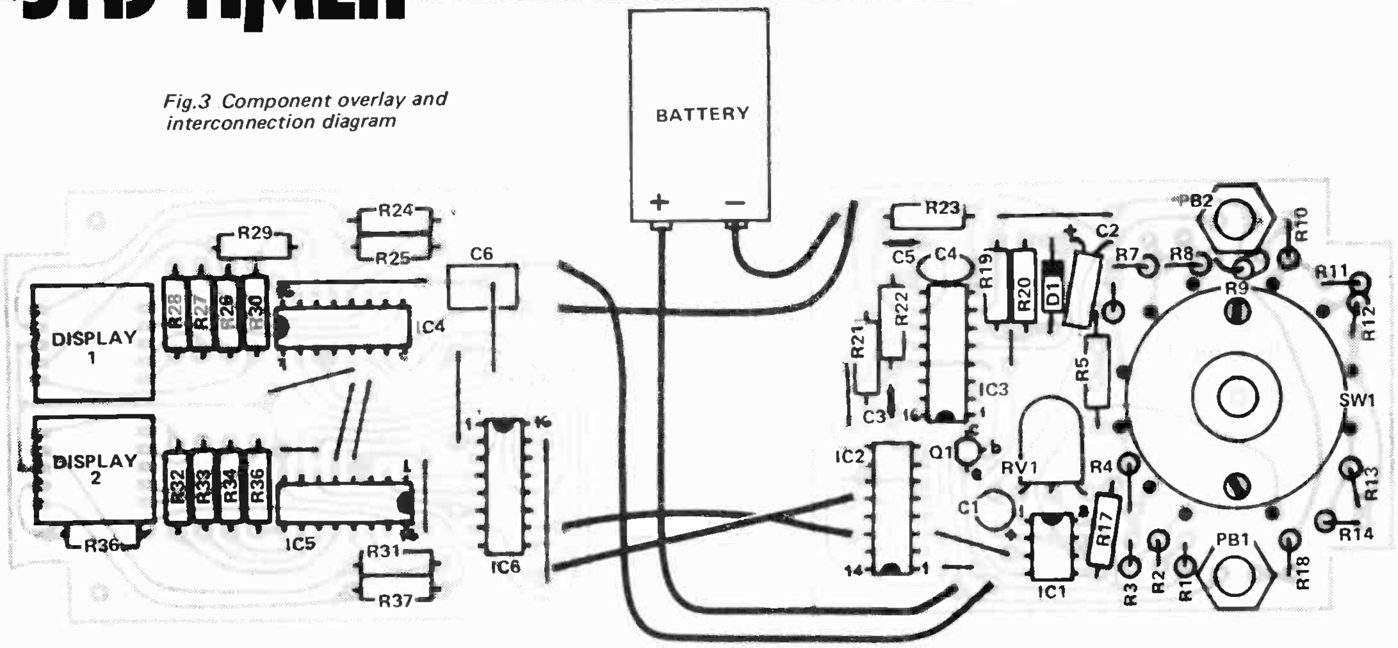


Fig.3 Component overlay and interconnection diagram

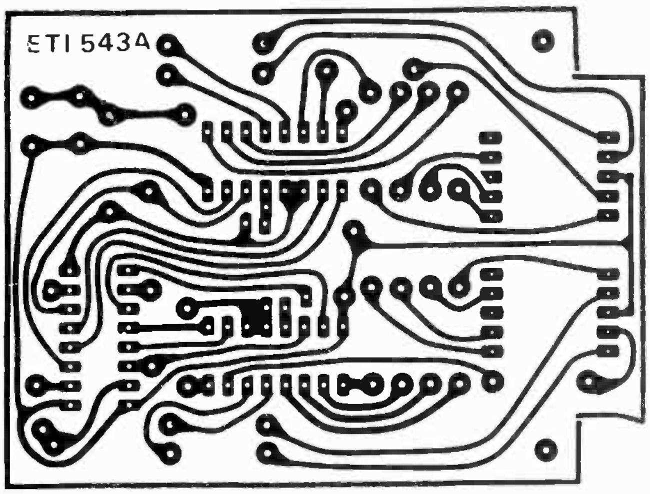


Fig.5 Printed circuit pattern for the display board. Full size 83 x 61mm

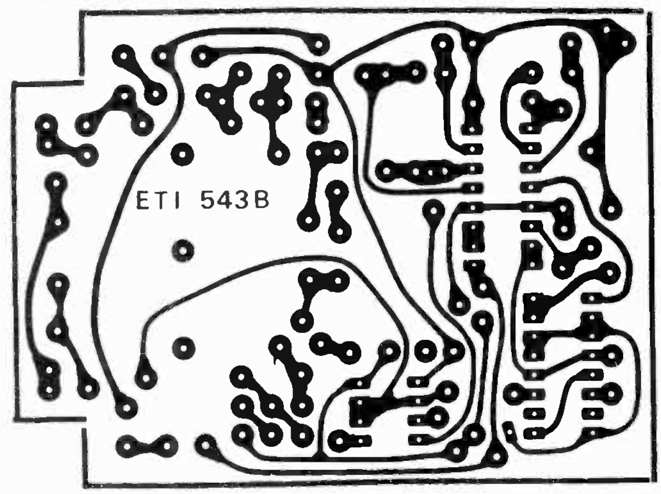


Fig.6 Printed circuit pattern for the timing board. Full size 83 x 61mm

Parts List

Resistors

R1,2	15 k	½W	5%
R3,4	10 k	"	"
R5-R7	15 k	"	"
R8-R10	30 k	"	"
R11	47 k	"	"
R12	220 k	"	"
R13	1 M	"	"
R14	820 k	"	"
R17	1 k5	"	"
R18	10k	"	"
R19-R23	1 M	"	"
R24-R37	330	"	"

Capacitor

C1	33 µ	10 V Tantalum
C2	4µ7	25 V electrolytic
C3	10 n	polyester
C4	47 n	"
C5	10 n	"
C6	47 n	"

Potentiometer

RV1 2k2 Trimpot (VTU)

Integrated Circuits

IC1	NE555
IC2	4027 (CMOS)
IC3	4050 "
IC4,5	4511 "
IC6	4518 "

Semiconductors

D1 IN914 or similar
Q1 BC108 or similar
Display 1,2 FND 500

Miscellaneous

SW1 single pole 11 position switch
PB1,2 single make push buttons
PC Boards ETI 543A, ETI 543B
six pc board pins
plastic box
knob
4xAA size battery holder

by one every four seconds. Check the timing accuracy over a number of increments with a watch and adjust RV1 to obtain increments of exactly 4 seconds. Check the other ranges for accuracy and if greatly in error check and adjust the values of the appropriate resistors in the R1 to R16 chain.

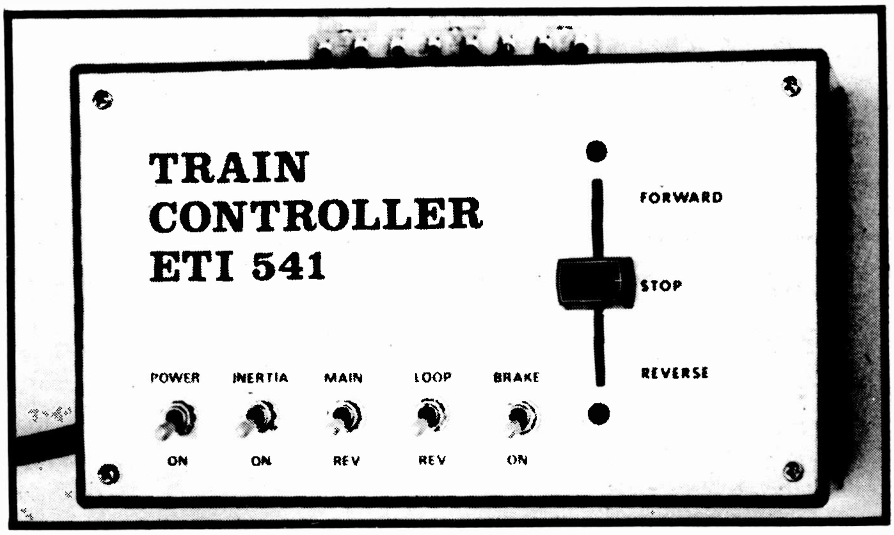
Remove the batteries and mount the display board onto the front panel using 6 BA screws and spacers. If the box as specified is used the front panel will have to be cut to allow the displays to protrude through, thus allowing more room for the batteries. A quick assembly check will show how much extra room is required. Now mount the second board and the push buttons and mount the completed unit into the box.

That completes the unit; the only thing to do is to instruct the family how to use it and to persuade them to do so on every STD call. Best of luck. ●

TRAIN CONTROLLER

A simple project offering auto-reverse, inertia, emergency brake and loop track facilities

MODEL TRAINS HAVE ALWAYS BEEN popular with both lads and dads — with dads perhaps coming first. Many a boy has complained "Daddy won't give me a turn". It seems there is some inexplicable attraction in playing trains which never dims with the passing years. A couple of our friends have recently decided to buy train sets — for the kids (they say). Our model train controller project was designed to give them many features that are not found in commercially available controllers (for roughly the same cost). Most commercial devices consist of a transformer followed by a selenium rectifier, a high power rheostat and an automotive globe. Such controllers have numerous operating disadvantages mainly due to their very poor voltage regulation.



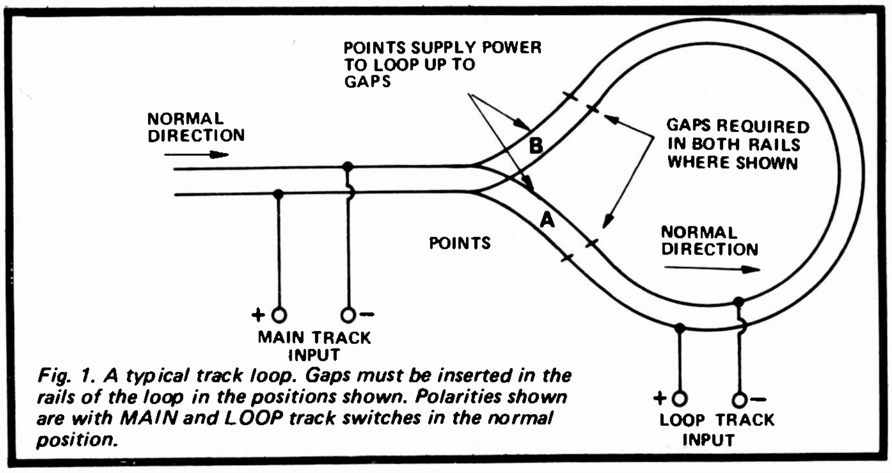


Fig. 1. A typical track loop. Gaps must be inserted in the rails of the loop in the positions shown. Polarities shown are with MAIN and LOOP track switches in the normal position.

Our controller It may look a little complex but in fact it is very simple to build and quite inexpensive. If the full capability is used the features of the controller are:

- Forward or reverse control by a single slide potentiometer (centre for stop)
- Separate reversing switch for the main track
- Short-circuit proof
- Regulator-type control circuitry
- Emergency brake (which stope the train instantly regardless of the position of other controls
- Simulated inertia (gives more realistic starts and stops)
- The facility to operate with track loops

Loops operation Although not possible with simple controllers, loop operation adds much operating fun and realism to any model railroad and the feature is well worth including. A typical loop is shown in Fig. 1. and the operational problems of such a loop are as follows:

If a train is approaching the loop and the 'main' and 'loop' switches are both set at normal, the polarity of the voltages to the track will be as shown. If the points are set so that the train enters the loop towards 'A' it will continue normally around the loop. If the points are now set to 'B' sp that the train may leave the loop then the train, once it passes the breaks in the track, will find the wrong polarity on the main track. It will be unable to continue in the same direction. To overcome this problem the main-track switch must be changed to 'reverse' whilst the train is within the loop. If the train enters the loop towards 'B' then the loop switch must be reversed before the train enters the loop. Once again the mainline polarity is reversed whilst the train is within the loop. Providing the section of the loop between 'A' and 'B' is longer than the train, loop operation will be simple and trouble free.

Simpler versions If all the facilities of the controller are not required then it may quite easily be simplified. If only a single direction is required from the throttle control then the same printed circuit board and the circuit in Fig. 5. may be used. If loop operation is not required then the controller may be further simplified by deleting SW5 and the associated wiring.

CONSTRUCTION

We built our controller into a plastic box with an aluminium lid. Some people may wish to build the controller into a complete control panel or some other box. This is quite acceptable as the method of construction is not critical. We suggest however that the printed circuit board specified be used as this greatly simplifies con-

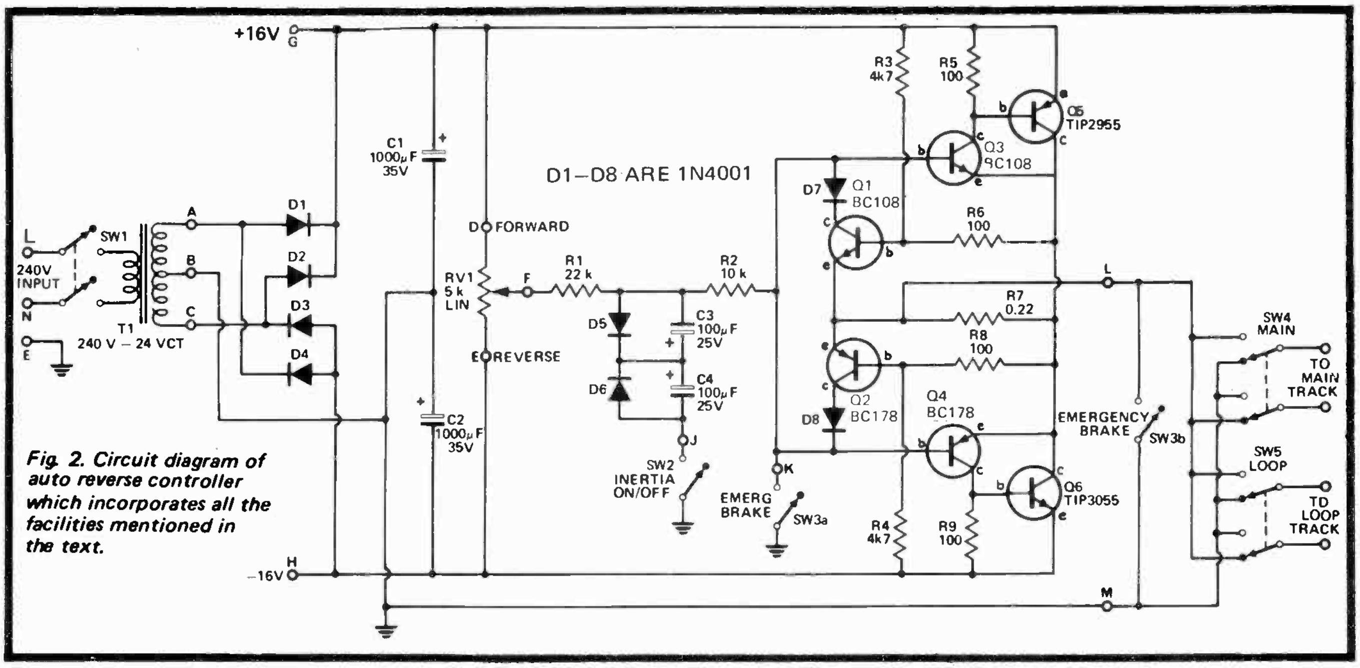


Fig. 2. Circuit diagram of auto reverse controller which incorporates all the facilities mentioned in the text.

How it works

TRANSFORMER T1 reduces the 240 volt mains to a supply of 24 volts (centre tapped) which is then rectified by D1 to D4 to provide supplies of +16 and −16 volts dc. The speed control potentiometer is connected between these supplies so that its wiper may select any potential between plus and minus 16 volts depending on setting.

The output of the potentiometer must be well buffered before it can supply enough power to run a train. This is achieved by transistors Q3 and Q5, for the forward direction (that is for output voltages between zero and +15 volts), and by Q4 and Q6, for the reverse direction (that is for output voltages between zero and ..15 volts). The output voltage at the collectors of Q5 and Q6 will be about 0.6 volts closer to zero than the voltage at point 'K' (providing the voltage at point 'K' is more than .6 volts away from zero). This means that the control potentiometer will have a small dead band in the centre of its travel where the output voltage remains at zero. Tnis is an advantage because it is frequently necessary to set the controller for exact zero output.

To protect the transistors from damage in the event of an overload or a short circuit, transistors Q1 and Q2 are used to monitor and output current (by measuring the voltage across R7) and the voltage across the output transistors. By this method the power dissipation in the output transistors is controlled such that when driving into a short circuit only about one ampere is available. Yet when set to about 12 volts, about two amps is available to drive normal loads. The diodes D7 and D8 are included to protect the transistors Q1 and Q2 against reverse bias which can occur under certain conditions.

To add the 'inertia' facility or 'momentum' as it is sometimes called the control voltage from RV1 is filtered by C3 and C4. This means that if the potentiometer is suddenly moved from stop to full forward (for example) the voltage applied to the transistor buffer rises only slowly. The train accelerates at a realistic rate without wheel spin. A similar action takes place when the train is stopped. If the controller is moved from full forward to full reverse the train will slow down then stop for a short time and then start off and increase speed in the reverse direction. The diodes D5 and D6 allow normal electrolytics to be used in this position.

If inertia is being used and an emergency situation occurs, eg train moving into a siding that it should not be entering, the brake facility may be used to short the track (SW3B) and also the input to the buffer stage (SW3a). The brake over-rides the speed control and by its use the train will be stopped in a much shorter distance than it would if the power were simply switched off.

When loops in the track system are used, as described in the introduction, a separate reversing switch is used to control the polarity in the loop with respect to the main line so that the train may go into and come out of the loop without any change in speed. The two controller outputs required for this mode of operation must each be reversible and this is performed by SW4 and SW5.

If a second controller is required for another train in the system then it may be built without the power supply. The second controller may be powered by linking the +16, 0 and −16 volt lines between the two controllers.

Parts List

AUTOMATIC-REVERSE CONTROLLER

Resistors

R1	22 k	½ W	5%
R2	10 k	"	"
R3,4	4 k7	"	"
R5,6	100 ohm	"	"
R7	0.22 ohm	5 W	"
R8,9	100 ohm	½ W	"

RV1 — 5 k lin 45 mm slide potentiometer

Capacitors

C1,2 — 1000 µF 35 V pc mounting electro
C3,4 — 100 µF 25 V pc mounting electro

Transistors

Q1, 3 — BC108
Q2, 4 — BC178
Q5 — TIP 2955 *
Q6 — TIP 3055 *
* with insulation kit

Diodes

D1-D8 — 1N4001 or similar

Miscellaneous

PC board ETI 541
Transformer 24V, 1A
SW1 toggleswitch DPDT 240 V rated
SW2 toggle switch SPDT
SW3-SW5 toggle switch DPDT
Plastic box 196x113x60 mm
12 Pc board pins
3 core flex, plug and clamp
Heatsink/support to Fig. 8.
8-way connector strip
2-way connector strip
2 6BA c/s screws & nuts 10 mm long
Front panel

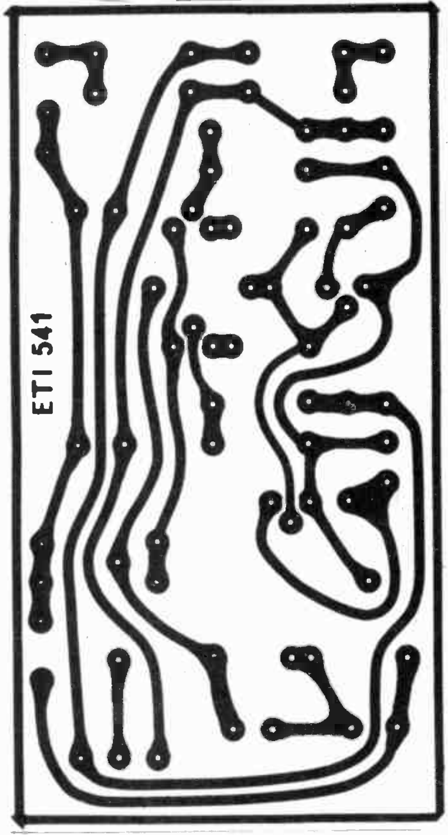
FOR MANUAL REVERSE CONTROLLER

Delete
R4, R8 and R9
C2 and C3
Diodes D3-D8
Transistors Q2, 4 and 6

If no loops are involved in the track layout SW4 and SW5 can be deleted on automatic reverse controller and SW5 on manual reverse controller.

For a second controller delete T1, SW1, D1-D4 and the power cord in the second controller.

GETTING HOLD OF THE COMPONENTS
Nothing here to trouble the constructor — all the semiconductors are common, and the boxing is not critical.



Printed-circuit board layout ETI 541 train controller. Full size 65 x 105 mm.

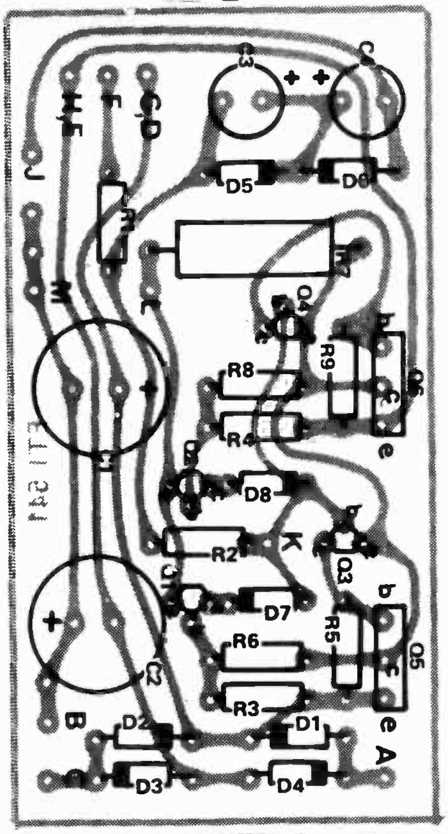


Fig. 3. Component overlay – auto reverse controller.

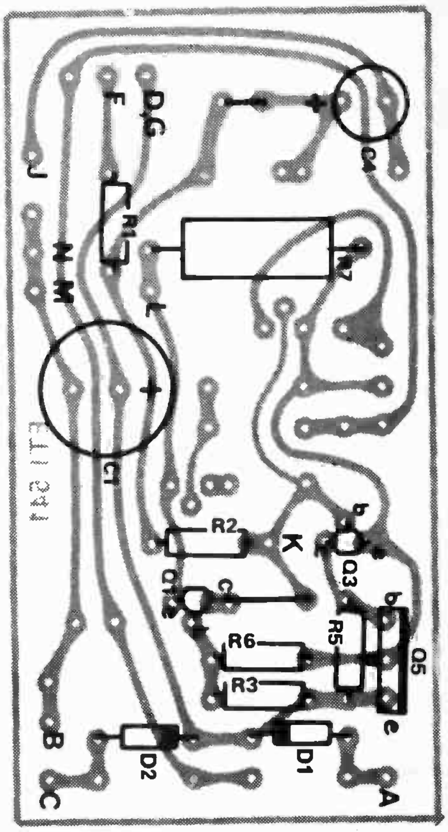
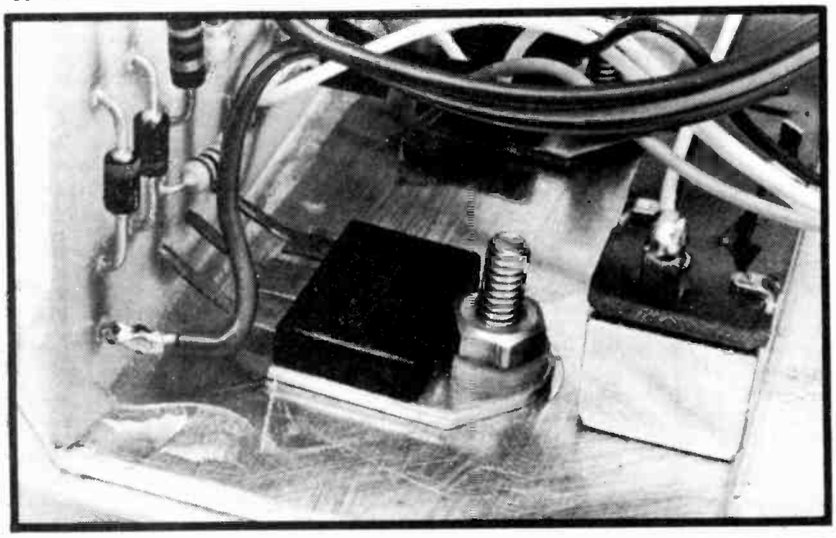


Fig. 4. Component overlay – simple controller.



The power transistors are mounted to a bracket with countersink bolts. They can, if desired, be mounted directly on the front panel. Note how the pcb is mounted – by epoxying to the bracket.

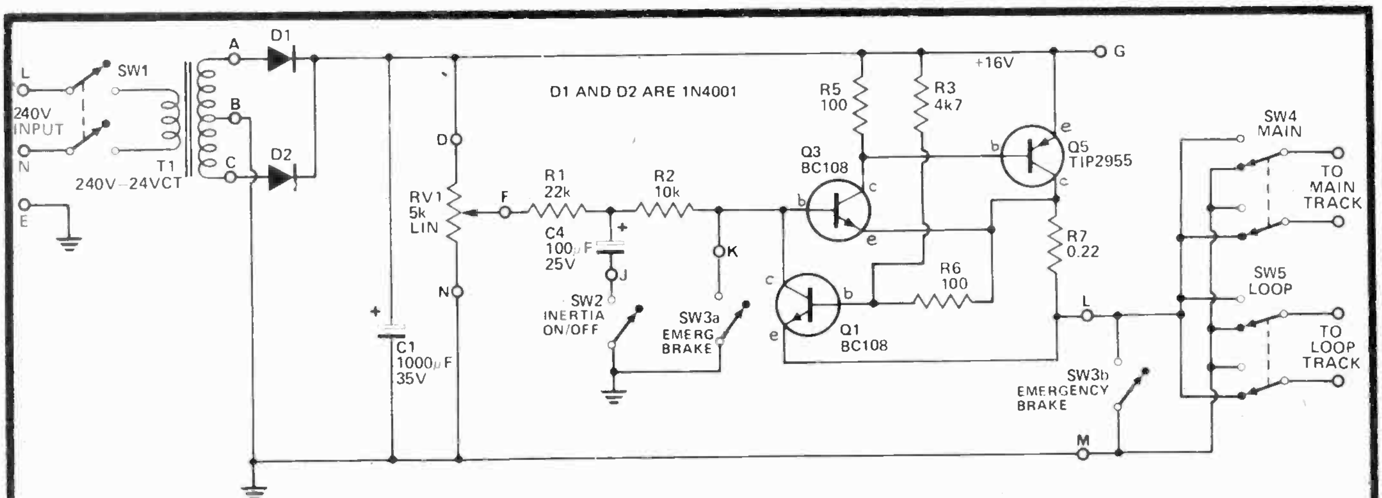
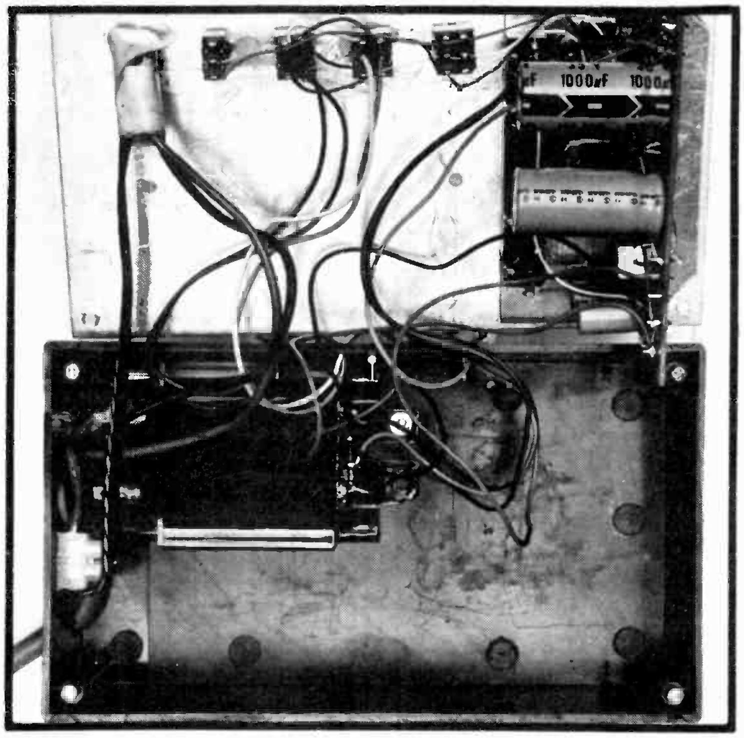


Fig. 5. Circuit diagram of simplified controller without the auto-reverse facility.



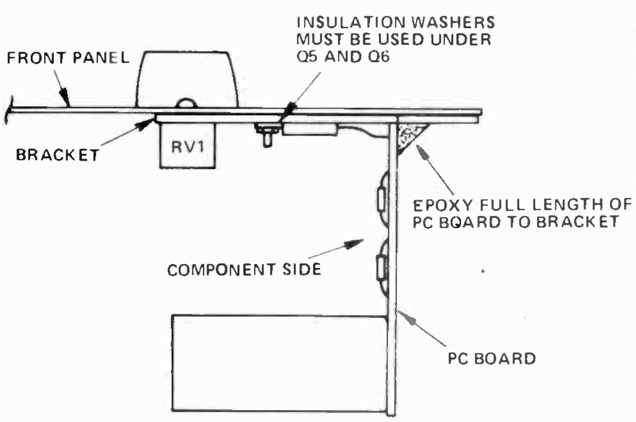


Fig. 6. Assembly of the printed-circuit board and bracket to the front panel.

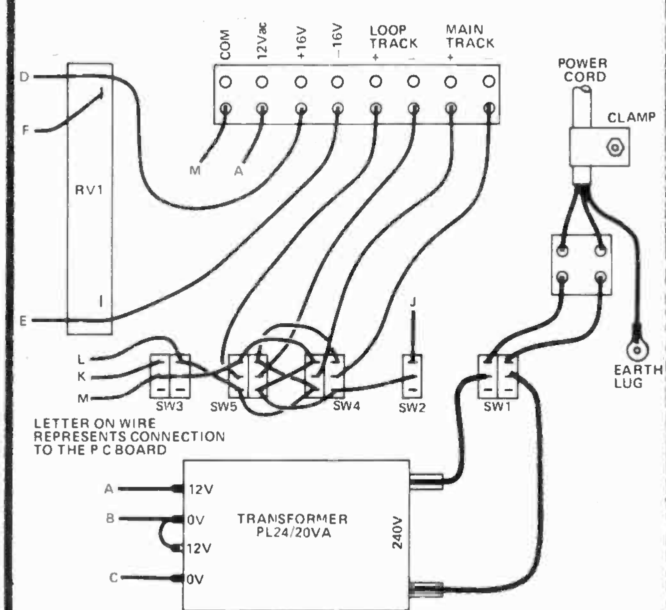


Fig. 7. Interconnection diagram for the auto-reverse controller given in the circuit of Fig. 2.

struction and minimizes the possibility of wiring errors.

Assemble the components to the printed circuit board in accordance to the relevant component overlay. Watch that the polarities of components suchs as diodes, capacitors, and specially transistors, are correct. Note that two different pin connections are available in the BC108 and BC178 transistors, depending on the manufacturer. The Philips type is the one shown on the overlays.

A small bracket was used to hold the printed circuit board in such a way as to hide the two screws which hold the power transistor. If two extra screw-heads on the front panel do not worry you, then this bracket need not be used. Bolt the power transistor onto the bracket using the insulation kit provided. Mount the bracket to the rear of the front panel by means of the slide potentiometer and its mounting screws and then mount the rest of the switches. Drill a hole through the side of the plastic box for the power cord and then fit the cord, the cable clamp and the transformer into the box. Then mount the terminal block to the box and drill small holes for the wires from inside the box to be terminated to it. Finally wire the complete unit and test it.

Once sure that the controller works as it should the board edge should be glued to the front panel (or bracket) with a little epoxy glue. Once this has dried, and you are sure that there is a seal all along the edge of the board, pour epoxy glue along the join so as to form a fillet of glue about 5 to 10mm wide. (A piece of sticky tape at either end will prevent the glue from running out at the ends). Once the glue has dried the completed front panel assembly may be screwed into the box. ●

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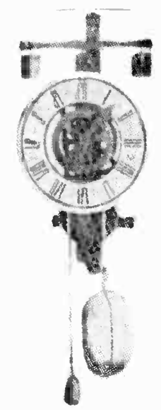

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TCOM AEROSTATS

Microwave relay by balloon

FOLLOWING THE MONTGOLFIER'S soaring successes and a brief resurrection in the form of the Zeppelin, the balloon has hardly been at the forefront of technological advance, and certainly hasn't had much impact on the modern world of instant communication by electronics. It has found a place in the meteorologists' "tool kit" however, by carrying radio sondes to probe the behaviour of the upper atmosphere. On a more down-to-earth note, balloons (often surplus met types) have been used by amateurs to support vertical wire aerials. Until now, however, the world of ballooning has barely encountered the world of electronics.

Recent work by TCOM (Tethered COMmunication) Corp, Columbia, Maryland, promises to change this. They are advancing a new concept of airborne telecommunications aimed primarily at developing countries and utilising — yes, you've guessed it — balloons.

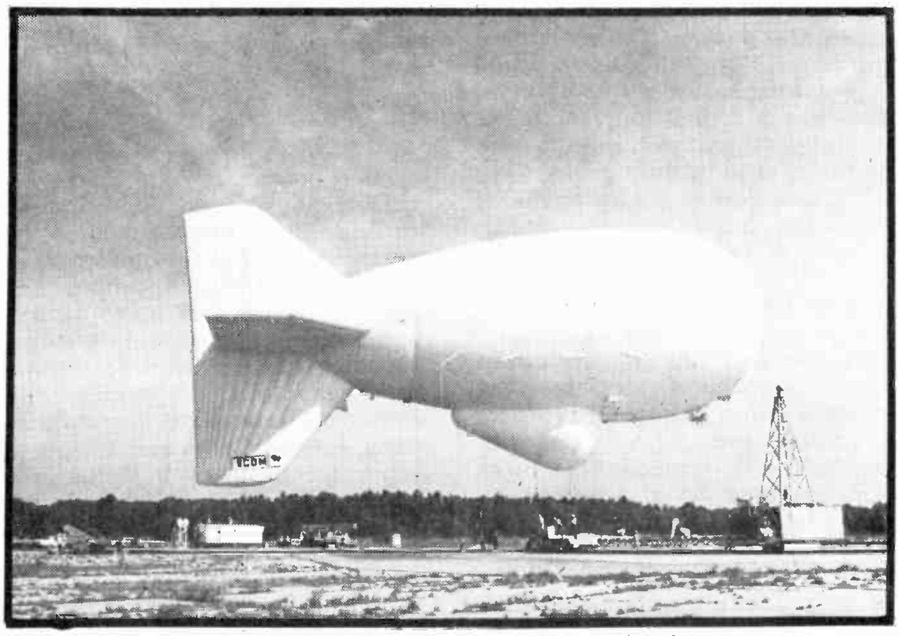

Fig. 1 The size of this 27m TCOM aerostat can be judged by the size of the men on the ground.

NEW BALLOONS

Stability problems, lift restrictions and airborne powering difficulties curtailed the widespread use of balloons for communications until recently when several technological advances were made in materials science, computer-aided aerodynamic design and electronic equipment miniaturisation. The major components of the system are an aerostat (aerodynamically stable tethered balloon), a mooring system, power generation equipment, a tether, telemetry and command equipment and the electronics payload.

The family of TCOM aerostats ranges in size from the 7000 m^3 volume 54m long Mark VII, shown in Fig 1, to the 10,000 m^3 66m long Mark VII S. The tail fins of this beast are over 27m tall, which is about the height of a seven-storey building! Electrically powered blowers and valves automatically maintain correct pressurisation of the aerostat.

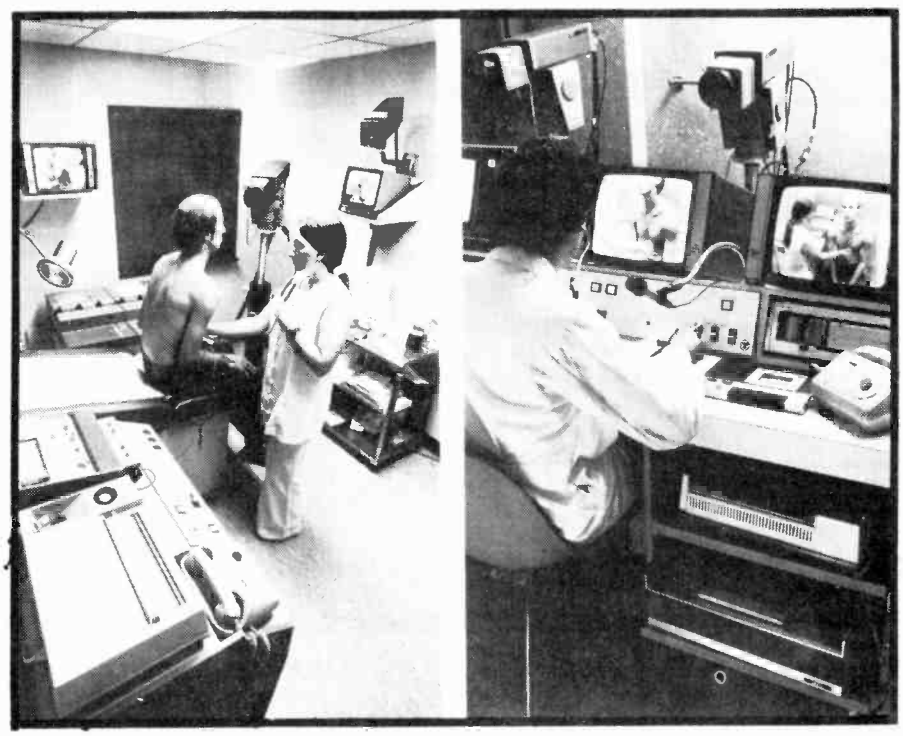

Fig. 2 The TCOM system can bring health care to rural communities while the doctor remains in his office!

The aerostats can support electronic transmitting and receiving equipment at altitudes of three to five kilometres through hurricane-force winds supplying broadcast TV and radio signals and providing other communications services to a 125,000 to 180,000 square km area.

TV AND RADIO BROADCASTING

A conventional broadcast system relies on "bending" of radio waves to give coverage beyond the typical 30-mile line-of-sight radius of a broadcasting tower. The strength of the radio or television signal decreases substantially with longer distances or higher frequencies, as the ground partially reflects and partically absorbs the signals.

However, when the transmitter is supported by an aerostat at an altitude of 3km, or higher, the radio and TV signals are broadcast through free space instead of along the ground. This method substantially reduces transmitter power requirements and increases the effective broadcasting area. As an example, the signal strength received at a location 100 miles from a conventional broadcasting tower with a radiating power of 100,000 watts could be equalled with only 3.2 watts from the aerostat-supported transmitter.

The electronics on the aerostat can simultaneously transmit VHF or UHF TV channels, and FM and AM radio. Commercial, informational or educational TV programming (monochrome or colour) can originate at a distant city, be transmitted to the TCOM aerostat by microwave link and then broadcast from the aerostat. Programming can also originate at the TCOM control station or standard television programming can be picked off the air and rebroadcast. The same principles apply to AM and FM radio.

TELECOMMS

A TCOM aerostat system can simultaneously provide a highly flexible line-of-sight telecommunications capability, augmented by aerostat-to-aerostat microwave relaying techniques where the aerostats are located up to 400km apart. The telecommunications capability can include several thousand channels of mobile and stationary telephone communications, Teletype, telex and Telephoto channels, high-speed digital and analog data channels and the collection and relaying of meteorological and other types of data over a wide area.

HEALTH CARE

The TCOM aerostat installation is used in a health care delivery system (fig 2) developed by the health systems department of Westinghouse. This substitutes the physical presence of a doctor with a two-way TV link — doctor and patient can see and talk to each other although they may be hundreds of kilometres apart. In addition, the patient's heart beat and electrocardiogram (EKG) information can be transmitted to the physician's location.

The electronics package suspended from the aerostat is designed so that it will always stay pointed in the same direction and speed. Electric power is supplied to the electronic transmitting and receiving equipment by an efficient, lightweight Wankel engine-driven generator, and the aerostat can carry over a week's supply of fuel.

A three-mile restricted flight zone is normally declared around a TCOM station for the safety of aircraft. In addition, the aerostats and tether cables are clearly lighted, and in fact, the system can be used as a valuable aid to air navigation. ●

TTLs by TEXAS	
7400	17p
7401	18p
7402	18p
7403	18p
7404	25p
7405	25p
7406	45p
7407	39p
7408	22p
7409	22p
7410	18p
7411	26p
7412	27p
7413	38p
7414	80p
7416	34p
7417	34p
7420	18p
7421	43p
7422	24p
7423	40p
7425	33p
7427	40p
7428	39p
7430	18p
7432	30p
7437	32p
7438	32p
7440	18p
7441	75p
7442	75p
7443	116p
7444	116p
7445	90p
7446	90p
7447	81p
7448	85p
7451	20p
7453	20p
7454	20p
7460	20p
7470	32p
7472	30p
7473	34p
7474	36p
7475	48p
7476	34p
7480	54p
7481	103p
7482	75p
7483	97p

7484	103p
7485	130p
7486	36p
7489	291p
7490	43p
7491	81p
7492	55p
7493	43p
7494	81p
7495	70p
7496	84p
7497	291p
74100	116p
74104	60p
74105	60p
74107	32p
74110	55p
74118	90p
74121	32p
74122	52p
74123	73p
74126	75p
74132	75p
74136	81p
74141	80p
74142	300p
74145	75p
74148	173p
74150	155p
74151	77p
74153	92p
74154	164p
74155	96p
74156	96p
74157	97p
74160	116p
74161	116p
74162	116p
74163	116p
74164	130p
74166	136p
74167	370p
74174	131p
74175	92p
74176	131p
74177	120p
74180	120p
74181	322p
74182	89p
74185	146p
74190	155p
74191	156p
74192	130p
74193	130p
74194	130p
74195	96p
74196	120p
74197	120p
74198	214p
74199	220p

C-MOS ICs	
4000	19p
4001	19p
4002	19p
4006	120p
4007	19p
4009	67p
4011	19p
4012	19p
4013	55p
4015	90p
4016	54p
4017	110p
4018	247p
4020	140p
4022	180p
4023	19p
4024	100p
4025	19p
4026	200p
4027	81p
4028	152p
4029	130p
4030	59p
4042	150p
4043	218p
4046	150p
4047	110p
4049	68p
4050	50p
4054	130p
4055	140p
4056	145p
4060	130p
4069	30p
4071	29p
4072	29p
4081	19p
4082	29p
4510	142p
4511	200p
4516	140p
4518	108p
4528	130p

VOLTAGE REGULATORS
Fixed-Plastic 3 Terminals

1 Amp	+ve		−Ve	
5V	7805	150p	7905	215p
12V	7812	150p	7912	215p
15V	7812	150p	7915	215p
18V	7818	150p	7918	215p
24V	7824	150p	7924	215p
LM309K 5V	1 Amp		TO3	150p
LM323K 5V	3 Amp		TO3	700p
TBA625B 12V	0 5A		TO5	106p

VARIABLE
723 14pin DIL 45p

LOW PROFILE OIL SKTS BY TEXAS

8 pin	12p	16 pin	14p
14 pin	13p	24 pin	54p

OP. AMPS

301A	Ext Comp	8 pin DIL	40p
536T	FET Op Amp	TO 99	300p
709	Ext Comp	8/14 pin DIL	36p
741	Int Comp	8/14 pin DIL	25p
747	Dual 741	14 pin DIL	70p
748	Ext Comp	8/14 pin DIL	40p
776	Prog Op Amp	TO 99	160p
1458	Dual Op Amp	8 pin DIL	70p
3130	CMOS Op Amp	8 pin DIL	108p
3900	Quad Op Amp	14 pin DIL	60p

LINEAR I.C.s

CA3028A	Diff Cascade Amp	TO99	112p
CA3046	5 Transistor Array	14 pin DIL	75p
CA3048	4 Lo Noise Amp	16 pin DIL	250p
CA3053	Diff Cascade Amp	TO5/DIL	60p
CA3089E	FM IF System	16 pin DIL	250p
CA3090AQ	FM Stereo Decoder	QIL	500p
ICL8038CC	VCO Fun Gen	16 pin DIL	370p
LM380N	2W Audio Amp	14 pin DIL	115p
LM381N	Stereo Pre Amp	14 pin DIL	175p
M252	Rhythm Generator	16 pin DIL	1000p
MC1310P	FM Stereo Decoder	14 pin DIL	190p
MC1351P	Lim/Det Aud Pre amp		104p
MC3340P	Elec Attenuator	8 pin DIL	160p
MFC4000B	¼W Audio Amp	PCB	75p
NE540L	Aud Pwr Driver	TO5	140p
NE555V	Timer	8 pin DIL	40p
NE556	Dual 555	14 pin DIL	96p
NE561B	PLL with AM Demod		425p
NE562B	PLL with VCO	16 pin DIL	425p
NE565	PLL	14 pin DIL	200p
NE566V	PLL Fun Gen	8 pin DIL	200p
NE567V	PLL Tone Decoder	8 pin DIL	200p
2567	Dual 567	16 pin DIL	400p
SN72710	Diff Comparator	14 pin DIL	54p
SN72733	Video Amp	14 pin DIL	150p
SN76003N	Aud Pwr Amp with int HS	16 pin DIL	275p
SN76013N	Aud Pwr Amp with int HS	16 pin DIL	175p
SN76023N	Aud Pwr Amp with int HS	16 pin DIL	175p
SN76033N	Aud Pwr Amp with int HS	16 pin DIL	275p
TAA621A	Aud Amp for TV	QIL	270p
TAA661B	FM/IF Amp Lim/Det	QIL	150p
TBA641B	Audio Amp	QIL	300p
TBA800	5W Audio Amp	QIL	100p
TBA810	7W Audio Amp	QIL	125p
TBA820	2W Audio Amp	QIL	100p
TDA2020	20W Audio Amp	QIL	375p
XR2240	Prog Timer/Counter	16 pin DIL	400p
ZN414	TRF Radio Receiver	TO18	140p

OPTO-ELECTRONICS

PHOTO-TRANSISTORS		LEDS	
OCP70	33p	TIL209 Red	16p
OCP71	120p	TIL211 Green	32p
2N5777	50p	TIL 32 Infrared	81p
LDRs		0 2"	
ORP12	60p	Red	18p
ORP60	75p	Green	29p
ORP61	75p	Yellow	32p

SEVEN SEGMENT DISPLAYS

3015F	175p	DL707	160p
DL704	160p	DL747	250p

ORIVERS

75491	84p	75492	104p

MEMORY

2513 Character Generator	850p
2112 R A M	450p

TRANSISTORS	
AC125	20p
AC126	20p
AC127	20p
AC128	18p
AC176	20p
AC187	20p
AC187K	25p
AC188	20p
AC188K	25p
AD149	46p
AD161	39p
AD162	39p
AF115	22p
AF116	22p
AF117	22p
AF139	43p
AF239	48p
BC107/B	10p
BC108/B	10p
BC109/C	11p
BC147	9p
BC148	9p
BC149	10p
BC157	11p
BC158	13p
BC159	13p
BC169C	15p
BC171	12p
BC172	12p
BC173	13p
BC177	20p
BC178	17p
BC179	20p
BC182	12p
BC183	12p
BC184	14p
BC187	32p
BC212	14p
BC213	12p
BC214	17p
BC478	32p
BC547	12p
BC557	12p
BCY70	20p
BCY71	24p
BD124	120p
BD131	39p
BD132	43p
BD135	54p
BD136	55p
BD139	60p
BD140	67p
BF115	24p
BF167	25p
BF173	27p

BF178	30p
BF194	13p
BF195	11p
BF196	17p
BF197	19p
BF200	40p
BF257	34p
BF258	39p
BFR39	34p
BFR40	34p
BFR79	34p
BFR80	34p
BFR88	37p
BFX30	32p
BFX84	30p
BFX85	30p
BFX86	30p
BFX87	30p
BFX88	30p
BFY50	18p
BFY51	16p
BFY52	18p
BRY39	45p
BSX19	20p
BSX20	20p
BU105	175p
BU108	312p
MJE340	49p
MJ2955	120p
MJE2955	120p
MJE3055	80p
MPSA06	40p
MPSA12	62p
MPSU06	78p
MPSU56	98p
OC28	75p
OC35	75p
OC71	25p
TIP29A	50p
TIP29C	62p
TIP30A	60p
TIP30C	72p
TIP31A	56p
TIP31C	68p
TIP32A	63p
TIP32C	85p
TIP33A	97p
TIP33C	120p
TIP34A	124p
TIP34C	160p
TIP35A	243p
TIP35C	290p
TIP36A	297p
TIP36C	380p
TIP41A	70p
TIP41C	81p
TIP42A	76p

TIP42C	88p
TIP2955	76p
TIP3055	60p
TIS93	30p
ZTX108	11p
ZX300	16p
ZTX500	19p
ZTX504	60p
2N697	25p
2N698	32p
2N706	22p
2N708	22p
2N918	43p
2N930	19p
2N1131	20p
2N1132	20p
2N1304	40p
2N1305	40p
2N1306	43p
2N1613	27p
2N1711	27p
2N1893	32p
2N2219	25p
2N2222	25p
2N2369	15p
2N2484	32p
2N2904/A	25p
2N2905/A	25p
2N2906	25p
2N2026RB	9p
2N2926OG	11p
2N3053	19p
2N3054	54p
2N3055	54p
2N3442	151p
2N3702	14p
2N3703	14p
2N3704	14p
2N3705	14p
2N3706	12p
2N3708	12p
2N3709	12p
2N3707	14p
2N3773	270p
2N3866	90p
2N3904	22p
2N3905	25p
2N3906	22p
2N4058	19p
2N4060	19p
2N4123	22p
2N4124	22p
2N4125	22p
2N4126	22p
2N4371	142p
2N4348	173p
2N4401	34p

2N4403	34p
2N5089	34p
2N5296	65p
2N5401	62p
2N6107	70p
2N6247 (Comp to 2N3055)	175p
2N6254	130p
2N6292	70p
40360	43p
40361	43p
40362	45p
40410	65p
40409	65p
40411	243p
40594	85p
40595	97p

FETs	
BF244	36p
MPF102	40p
MPF103	40p
MPF104	40p
MPF105	40p
2N3819	27p
2N3820	50p
2N3823	54p
2N5457	40p
2N5458	40p
2N5459	40p
3N128	90p
3N140	92p
3N141	90p
40603	63p
40673	63p

UJTS	
TIS43	40p
2N2160	95p
2N2646	48p
2N4871	40p

PUJT	
2N6D27	60p

OIOOES SIGNAL	
OA81	15p
OA85	15p
OA90	7p
OA91	9p
OA95	9p
OA200	8p
OA202	10p
1N914	4p
1N916	11p
1N4148	4p

RECTIFIER	
BY100	31p
BY126	12p
BY127	12p
1N4001	6p
1N4002	6p
1N4004	7p
1N4005	7p
1N4007	8p

ZENER 2 7 to 33V	
400mW	11p
1W	22p

VARICAP	
BB105	33p

NOISE	
Z5J	140p

OIAC	
BR100	30p

BRIDGE RECTIFIERS		
1A	50V	25p
1A	100V	27p
1A	400V	31p
1A	600V	37p
2A	50V	37p
2A	100V	44p
2A	400V	56p
4A	100V	75p
6A	50V	75p
6A	100V	78p
6A	200V	84p
6A	400V	90p

TRIACS Amp	Volts	
3	400	130p
6	400	162p
6	500	194p
10	400	200p
10	500	270p
15	400	310p
15	500	340p
40430		108p
40669		105p

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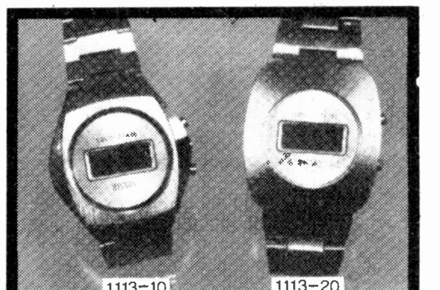

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ETI project 445

GENERAL PURPOSE PREAMPLIFIER

A general purpose preamplifier using a single LM382 IC which can be used with magnetic pickups, tape recorders or microphones by changing a few components.

TABLE 1.

FUNCTION	C3, 4	C5, 6	C7, 8	C9, 10	R1, 2
Phono preamp (RIAA)	330n	10μF	10μF	1n5	1k
Tape preamp (NAB)	68n	10μF	10μF	–	–
Flat 40dB gain	–	–	10μF	–	–
Flat 55dB gain	–	10μF	–	–	–
Flat 80dB gain	–	10μF	10μF	–	–

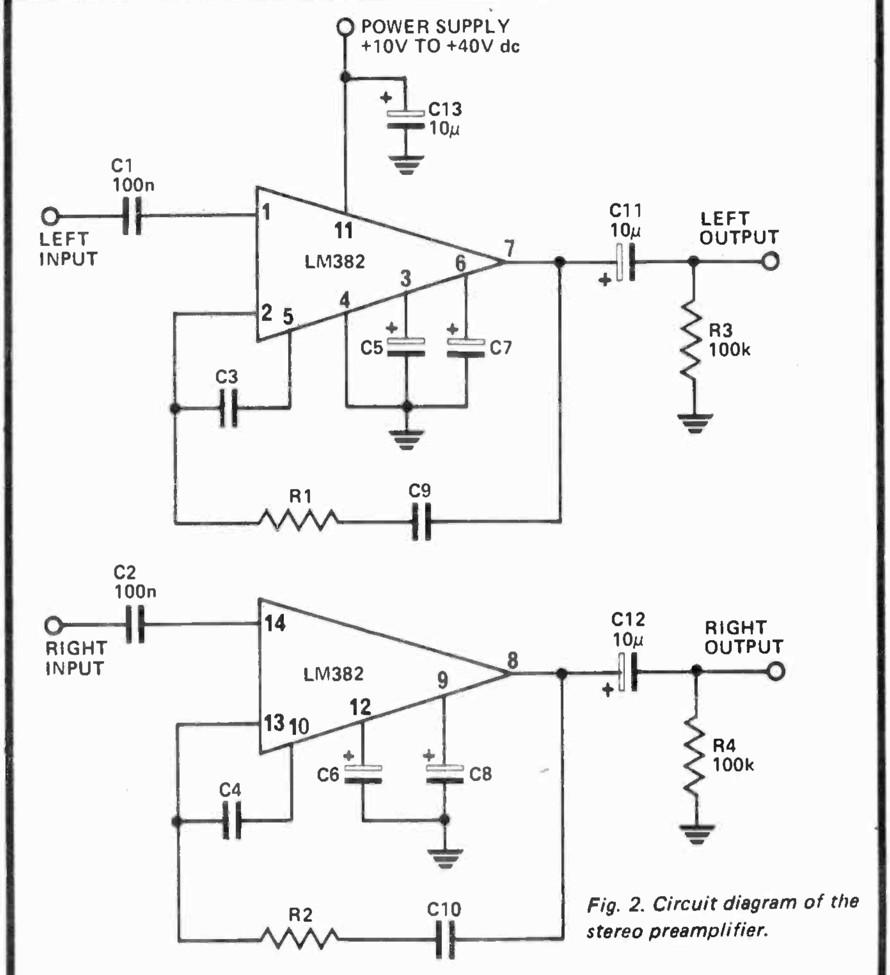


Fig. 2. Circuit diagram of the stereo preamplifier.

WE HAVE HAD MANY REQUESTS for the circuit of a simple preamplifier module suitable for fitting into an existing system. The requirements differed – many people required a module to amplify a magnetic pickup, whilst others wanted a unit that could be used for a tape recorder or microphone.

Whilst these requirements usually require different circuitry, a preamplifier based on the LM382 IC can be made to do any one of these jobs simply by changing a few components around the basic amplifier circuit. As a straight preamplifier the frequency response extends to well beyond 20kHz and gains of 40, 50 and 80dB can be selected by means of simple components changes.

To use the preamplifier for your application select the appropriate component values as deatiled in Table Table 1.

CONSTRUCTION

Strictly speaking a printed circuit board is not necessary and any method, such as Veroboard or Matrixboard, may be used if desired. However, the neatness and ease of construction offered by the use of a proper printed circuit board cannot be matched.

Parts List

Resistors

R1, 2 see table 1
R3, 4 100k ½watt 5%

Capacitors

C1, 2 100nF polyester
C3 – C10 see table 1
C11-C13 10μF 25V electrolytic
Note that C13 should be rated at 50 V for supply voltage above 24V
IC1 integrated circuit LM382
PC board ETI 445
10 PC board pins.

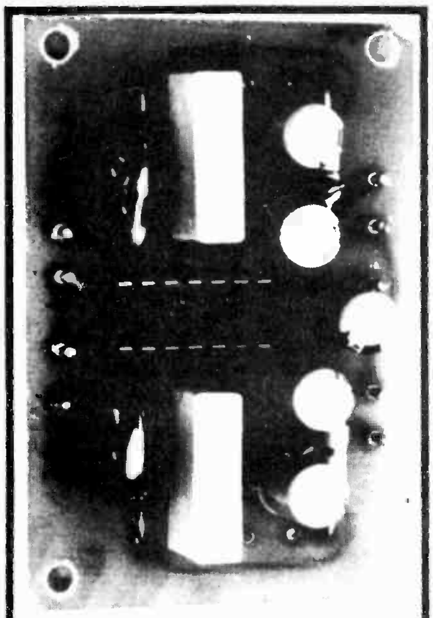
How it works

Not much can be said about how the LM382 works as most of the circuitry is contained within the IC. Most of the frequency-determining components are on the chip - only the capacitors are mounted externally.

The preamplifier may be powered by any dc voltage between 10 and 40 volts the output automatically biased to about +6 volts. Due to this bias the output must be decoupled from the following stages and this done byC11, 12 and R5,4.

The LM382 has the convenient characteristic of rejecting ripple on the supply line by about 100 dB, thus greatly reducing the quality requirement for the power supply.

Thus the power rails of the main amplifier may be used.



Component layout on the PCB.

After determining what components are required from Table 1, assemble the board as shown in the component overlay diagram. The input cables must be shielded as the signals at the input are at very low levels. If trouble with hum pickup is encountered it may be necessary to mount the whole preamplifier in a metal box to shield it. ●

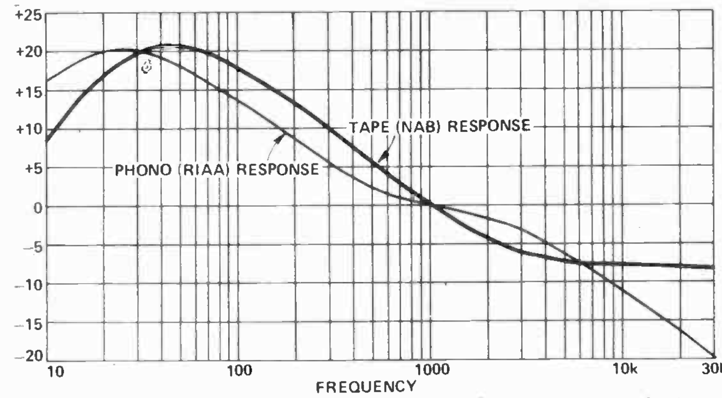


Fig. 1. Frequency response of the NAB and RIAA versions of the preamplifier.

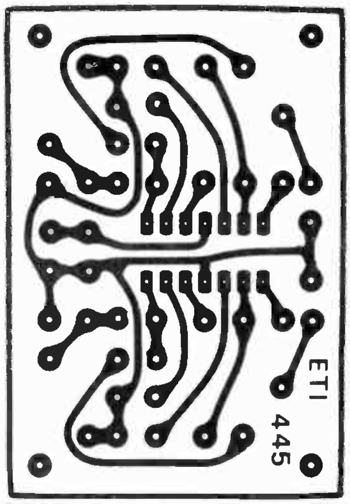


Fig. 3. Printed circuit layout. Full size.

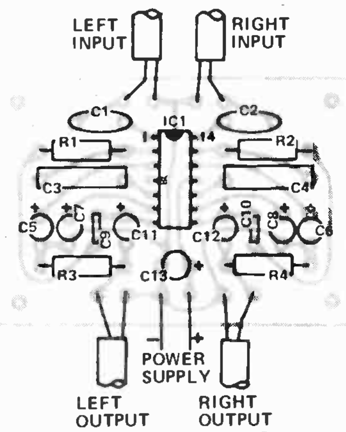


Fig. 4. Component overlay.

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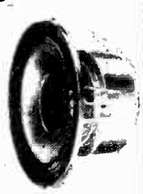

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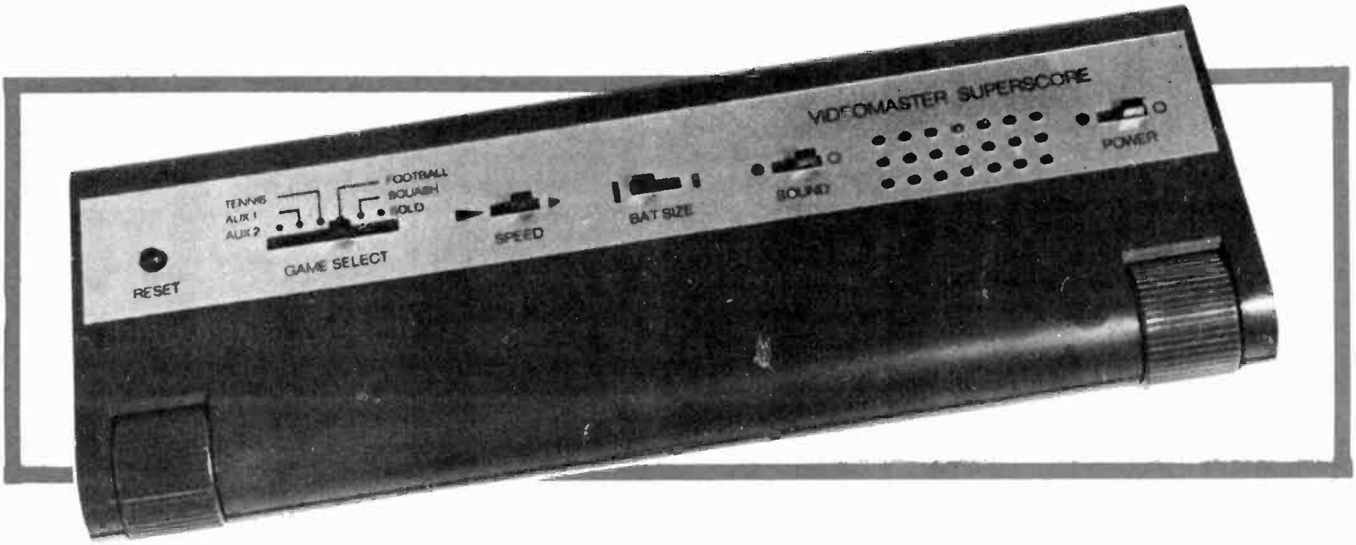
ETI KIT REVIEW

VIDEOMASTER™

Superscore Home TV Game



INTRODUCTION

Up to now the home constructor has had to use dozens, if not hundreds, of TTL or CMOS chips to produce even simple TV games. Now at last a kit is available using just one MOS chip and a few discrete components — the Videomaster Superscore. Not only is the component count low, the game variations are large! The version we constructed had 32 permutations of game and effect, 40 if the auxiliary inputs are used!

We received the first production model of the kit, minus the instruction book! However with the aid of a circuit diagram and some Xerox copies we decided to make it up.

The components were packed in polythene bags, separated into resistors, capacitors, semiconductors, hardware and the games chip itself. Also provided were the case, prebuilt UHF modulator (complete with 6ft of coax fitted with plug) and front panel trim. It seemed that everything apart from tools was present including solder!

The printed circuit board was silkscreen printed with component positions and reference numbers. We soldered in all passive components followed by semiconductors and UHF modulator. After about 2½ hours the chip was taken from its conductive foam home and inserted in the socket on the board. The case was then closed up and screwed together, quite a delicate and fiddley operation.

After batteries had been inserted and the lead plugged into a TV we switched on — wierd noises came forth, it was working!

RAIN STOPPED PLAY

After tuning into the video signal the first problem occurred — a completely unstable picture. The TV would not lock into the games signal without adjustment of the vertical and horizontal hold controls. This meant that we couldn't tune a spare channel to the Video master and switch from BBC1, 2 or ITV to TV game without resetting the controls.

The cause of this was due to the games 2MHz oscillator being slightly out and needed returning. Because we didn't have an instruction manual we hadn't tuned the oscillator coil before closing the case — so we had to take the case apart! To make any adjustment easier we drilled a ¼in hole in the base of the case above the coil, and reclosed the case. This modification meant that we could tune into any set exactly very easily, and adjust for a perfectly stable picture.

ANYONE FOR TENNIS?

We started with a game of Tennis (fig 1) with 1 bat per side on slow speed. Pressing the reset button zeros the on screen score and the ball serves. If the ball hits a side boundary it bounces off at the angle it hit (producing a bounce tone on the internal speaker). The player being served must try and block the ball with his bat, if missed a score is registered and score tone produced, the ball be served again automatically. If the player blocks the ball a hit tone is produced and the ball bounces back at a new angle. This continues until either player scores 15, at this point the ball continues bouncing but the bats do not stop it and the score does not increase.

FOOTBALL

Football is played in the same way as Tennis but the players have a goalkeeper and forward (fig. 2). If attacking the ball goes through the back of your forward and is deflected (electronic kick for good luck) but bounces off the 'front' of defenders. Scoring and game 'referee' is done automatically by the internal logic.

SQUASH AND MORE SQUASH

Squash is played with alternate attempts at hitting the ball — if it's not your turn to hit the ball will go through your player! Both bats are at one end of the screen (fig. 3).

Solo is squash with only 1 bat, you play the machine!

O.K. CORRAL

The two positions marked auxiliary are for 'rifle' attachments which will probably be available early next year. They will turn your TV into a shooting range — with no chance of injuring anyone!

During construction we selected the variable angle option and left the sound permanently on. The printed circuit is designed so that autoserve is permanently connected.

SPECIFICATIONS

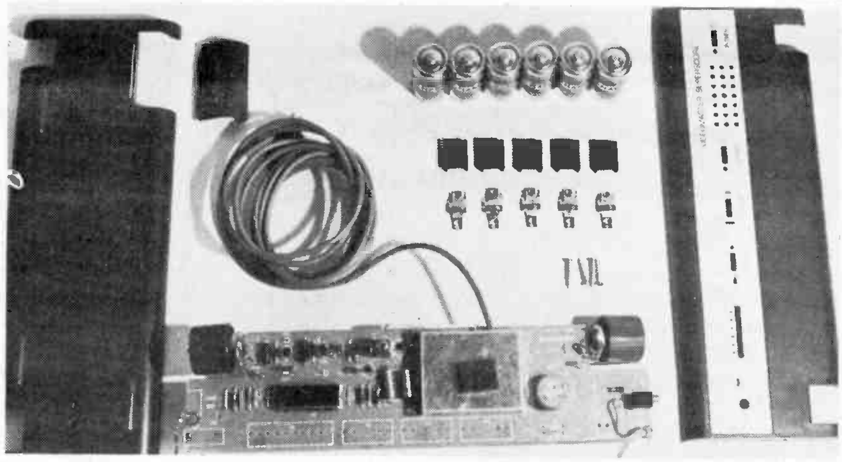
Bat sizes Large 3.56 cm
Small 1.78 cm
On 56 cm screen
Audio output
Hit 32mS 976Hz
Bounce 32mS 488Hz
Score 160mS 1.95KHz
Built-in speaker
Ballspeed
Fast 0.78s
Slow 1.56s
To traverse screen
Rebound angles
$\pm 20^\circ$ or $\pm 20^\circ$ $\pm 40^\circ$
On screen scoring 0-15

Chip used AY-3-8500 + 4 transistors 2 diodes
Battery consumption 65mA.
Output via built in UHF modulator for 625 standard.

Games available

Tennis	Solo
Football	Rifle 1
Squash	Rifle 2

Available from:
Videomaster Ltd, 14/20 Headfort Place, London SW1X 7HN.
£24.95 (inc VAT & P&P) U.K.
£27.10 (inc P&P) Overseas.



POSTSCRIPT

We have just received a copy of the instruction manual. Problems we encountered during construction are covered succinctly, and in general it is a good guide for would-be constructors. Also the production model is now in a black case — our's was a nice shade of brown!

SUMMARY

Suitable for most constructors (apart from a complete beginner) this kit is excellent value for money. Experienced constructors can easily modify it to provide auto or manual serve and remote slider controls (as the thumb controls can become awkward in long games). Only major criticism is the trimming of the 2MHz oscillator, which really needs an extra hole in the base and a plastic trim tool.

Recommended for anyone with lots of spare time or children — it's perfect for Xmas!

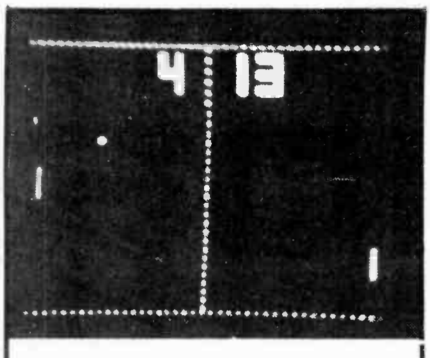


Fig. 1.

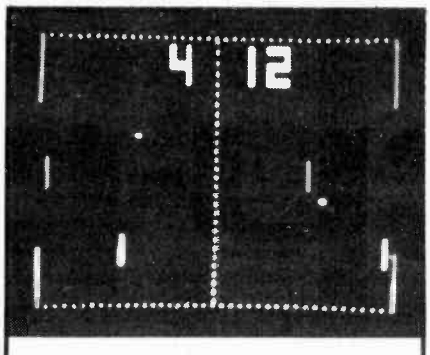


Fig. 2.

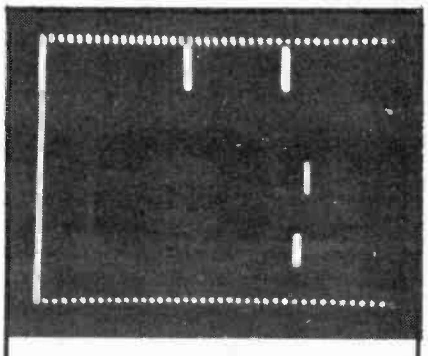
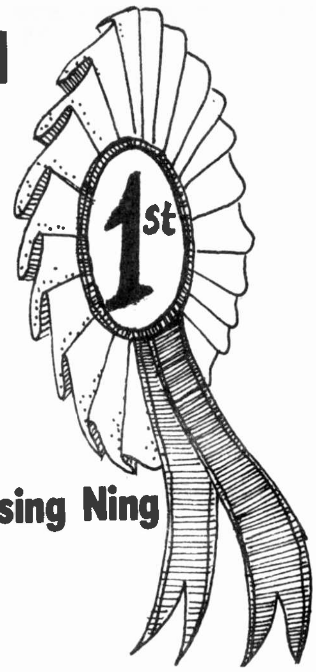


Fig. 3.

ETI—DORAM COMPETITION WINNER

TV PATTERN GENERATOR



By Garsing Ning

FOR ACCURATE COLOUR TV, convergence alignment, the use of a good crossbatch pattern generator is essential. Some of the cheaper, commercially available generators, though capable of producing the required patterns, are often of little use. The reason for this is their inability to generate line and field sync pulses of accurate frequency.

After using such an instrument, one often finds that the perfection achieved on the generator's cross-hatch pattern no longer exists when reverting to "off air" trans-missions. This is due to the frequency-conscious time constants incorporated in the reciver's con-vergence circuitry. The main prob-lem lies in achieving a reasonable degree of accuracy, without the use of expensive crystals, and is over-come in this design in an unusual but effective way.

In order to produce a compact piece of test gear, the PCB's for this device are double sided, though not plated through.Add this to the complexity of the circuitry, and the fact that the modulator is working at UHF, and the result is NOT an ideal first project for beginners. We would reccommend that only experienced constructors tackle this project, but then how many people need a crosshatch generator that badly anyhow?

The chances are that if you want to build this thing it is well within your scope to do so.

Principle of Operation

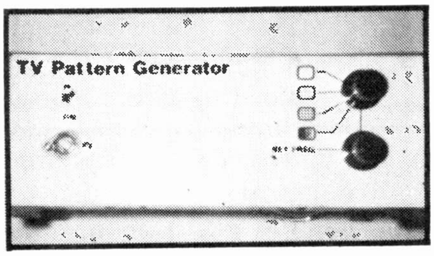
The design of the generator was based on the following spe ification:

i. Accurate Line and Field sync pulse frequency.

ii. A composite video waveform closely resembling that spe-cified by the broadcasting authorities.

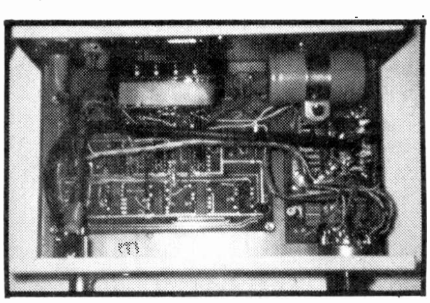
iii. A modulated RF output, suitable for direct connection to the receiver's serial socket.

An adjustable master oscillator of 500kHz is used to produce both line and field sync pulses. A line frequency of 15,625Hz is achieved by dividing this frequency by 32, and a field frequency of 50Hz by a division of 10,000. Because of the direct relationship of these three frequencies, it is only necessary to ensure the accuracy of one of them. For this purpose, a fifth position on the 'Pattern Select' switch is included. When switched to this position a 50Hz. mains frequency hum bar will be displayed on the TV screen. Adjusting the master oscil-lator for a stationary (or almost stationary) display, will ensure the accuracy of both line and field frequencies.



RF Modulator

The modulator oscillates at a frequency somewhere in Band III, a harmonic of which may be selected by the receiver's U.H.F. tuner. The fixed frequency of this oscillator may be adjusted by varying the spacing of L1, or changing the value of C11 as required.



CONSTRUCTIONAL DETAILS

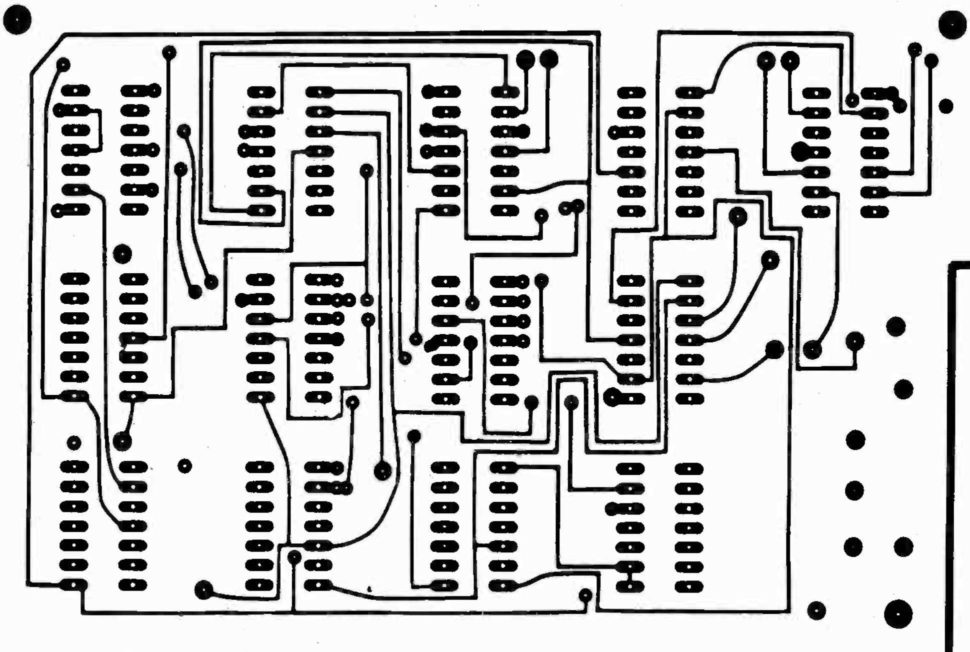
As stated earlier this is not a project for the beginner. The PCB's are complex, and assembly will not be absolutely simple. Through board connections are made by soldering a link of wire at **both** sides of the board, and snipping to length. IC holders **cannot** be used, as many of the leads have to be soldered on the top of the logic board, as well as the underside.

Indeed many through-hole links are made by use of the component leads, and this involves soldering close to the actual component body. Don't linger over such joints contemplating a pint at the Plumbers Arms or anything — else there'll be no crosses hatched on your screen that evening.

Make all the links on the logic board before mounting the IC's, joining each letter to its counterpart. Fit and solder the chips. The flying leads to the other board should now be cut to length (12") and fitted to the logic board.

When assembling the modulator board mount the heatsink and regu-lator first, as it will be obstructed by the capacitors around it else. Next fit the coil and C13, (The holes might need to be enlarged to fit the coil wire supplied.) Mount the rest of the com-ponents, fitting them as close to the ground pane as possible, and taking care when soldering to this via the component leads.

Finally site the PCB's as shown in the photograph — this helps with wiring of the PSU and function selector switch. Interwiring of the boards is fairly straightforward, and if you've gotton this far it should pose no problems now — keep going lad we're almost there! etc — fit yourself an output lead to the coax socket, and that should be that.

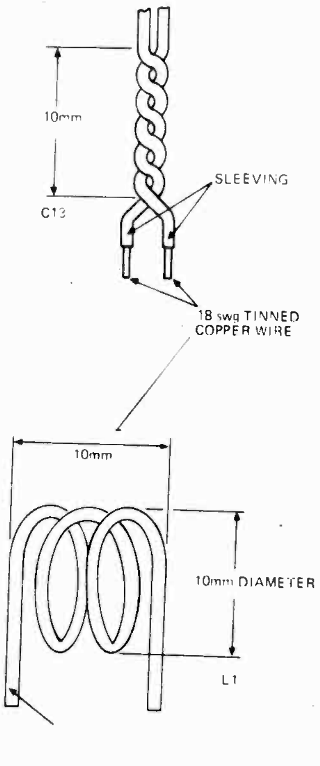


Foil pattern underside logic board.

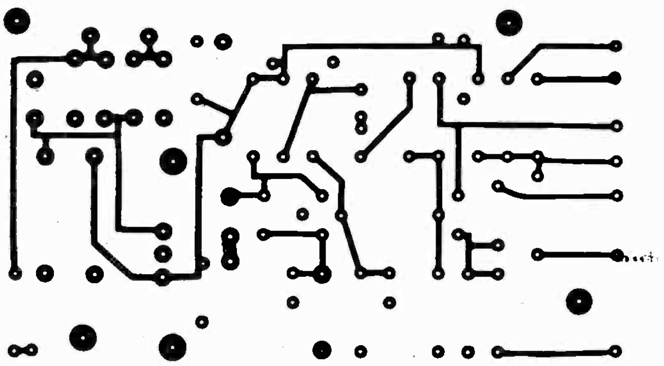
GETTING HOLD OF THE COMPONENTS

Doram Electronics are selling a complete kit of parts.

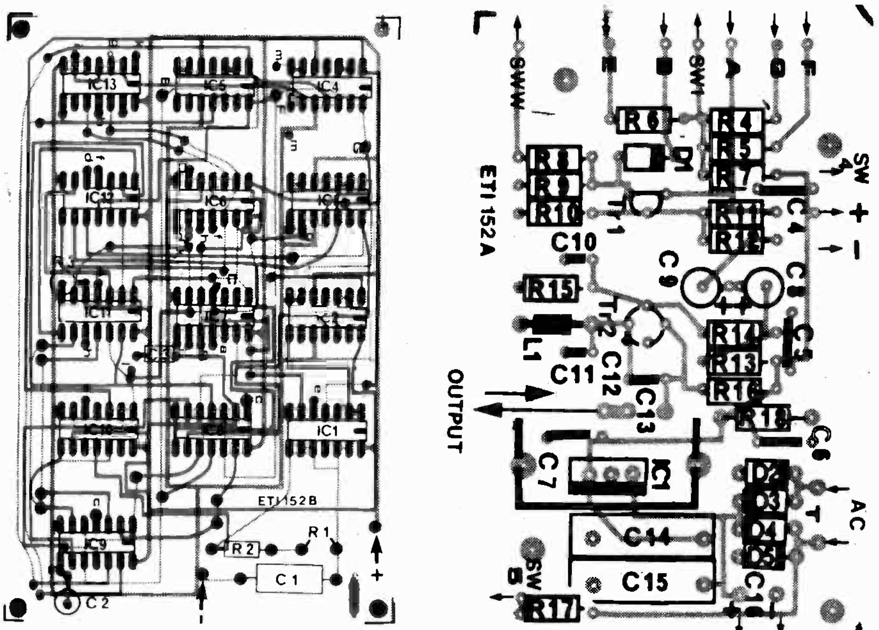
Price £19.77 + VAT



Construction of L1 and C13 — follow exactly.



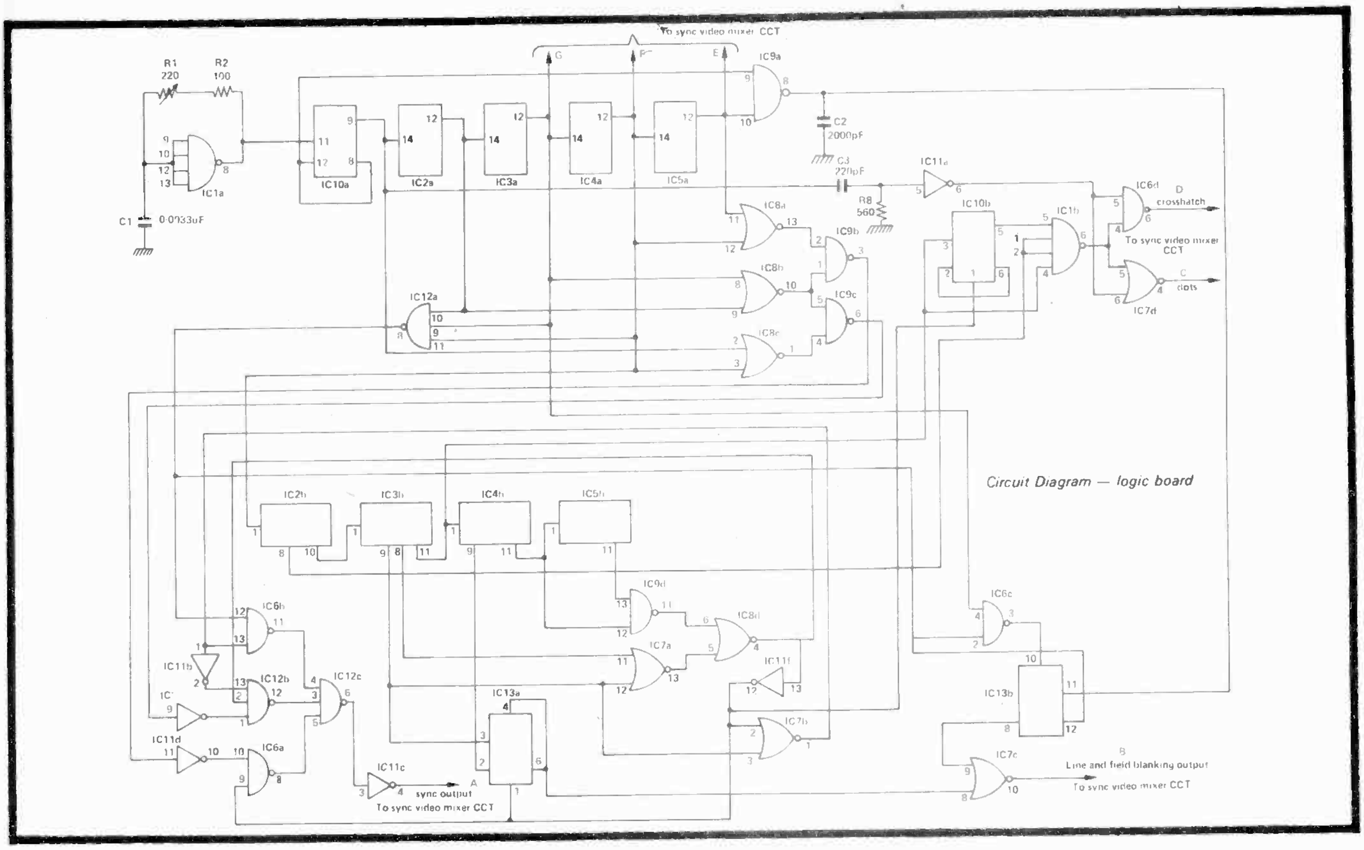
Foil pattern underside modulator board.



Component overlays.

Parts List

Circuit No.	Description	Doram Part No.
IC1	SN7413N	305-541
IC2,3,4,5	SN7490N	305-361
IC6,9	SN7400N	988-102
IC7,8	SN7402N	988-124
IC10,13	SN7474N	305-585
IC11	SN7404N	988-130
IC12	SN7410N	980-495
Q1	BF196	985-535
Q2	AF239	987-109
D1	OA90	271-527
R1	220R Style 'B' Pot.	184-300
R2	220R 0.25W C.F.	131-132
R3	560R o.25W C.F.	131-227
R4	3k 0.5W C.F.	132-602
R5	1k5 0.5W C.F.	132-539
R6 & 7	750R 0.5W C.F.	132-466
R9	56k 0.25W C.F.	131-463
R10	2k7 0.25W 2% M.F.	131-356
R11	15k 0.25W 2% M.F.	131-384
R12,13 & 16	1k 0.25W 2% M.F.	131-255
R17	68k 0.25W 2% M.F.	131-479
R8	1k5 0.5W 2% M.F.	146-538
C1	3300pF 160V	113-358
C2	2200pF 160V	113-342
C3	220pF 160V	113-285
C4-C7	0.1mfd. L.V.	124-178
C8,9	47mfd Electrolytic	985-096
C10,11	5pF "	124-623
C12	2pF "	124-601
C13	(see text)	
L1	(see text)	
S1 1 Pole, 12 Way (Adj. to 5 Way)		327-260
1 Piece 3.75"x11.5" Veroboard 0.1" Matrix		433-826



Circuit Diagram — logic board

How it works

Sync Generation

IC1A is connected as a simple relaxation oscillator and forms the master oscillator. It's output is fed to the five ÷ 2 counters IC10a, IC2a, IC3a, IC4a, and IC5a, to produce a line frequency of 15,625Hz. The output of IC4a is twice this frequency, (31,250Hz) and is fed to the four ÷5 counters IC2b, IC3b, IC4b and IC5b, giving a total division of 625 to produce a field frequency 50Hz. IC8a, IC8b and IC9b effectively NAND the outputs of the four latter ÷ 2 counters to produce line sync pulses of 4μS duration in every 64μS. The outputs of the first four ÷ 2 counters are similarly NANDed by IC8b, IC8c and IC9c to produce equalising pulses of 2μS in every 32μS.

IC12a NANDS the output of IC2a, IC3a and IC4a to produce field sync pulses of 28μS in every 32μS. These three pulse trains are then gated in their correct sequence by IC6b, IC12b and IC6a. For this purpose two timing sequence pulses are generated. The first is of 480μS duration in every 20mS, produced by IC9d, IC7a and IC8d. The second is of 160μS duration in every 20mS starting 160μS after the start of the 480μS pulse, and is generated by IC7b.

Both of these pulses are fed, in their corect phase, to IC6b, IC12b and IC6a to gate the required pulses at the correct times. IC12c effectively ORs the outputs to form a composite mixed sync output at IC11e.

BLANKING

IC9a, IC6c and IC13b generate a 10μS duration in every 64μS pulse, starting 2μS before the line sync pulse to form the front and back porch blanking.

IC13a produces a 1.6mS in every 20mS pulse, starting at the beginning of the equalising pulse period to blank the first 25 lines of each field.

Both of these pulses are combined in IC7c and fed to the mixer stage.

PATTERN GENERATION

The vertical lines of the crosshatch pattern are generated by differentiating the 4μS spaced positive-going edges of IC10a output (C3 and R3), producing approximately 14 visible vertical lines.

IC10b and IC1b generate a 64μS pulse every 1.6mS producing approximately 12 visible horizontal lines per field. (These appear two lines wide due to interlace).

The crossbatch and dot patterns are formed by OR-gating (IC6d) and AND-gating (IC7d) respectively. (Negative Logic).

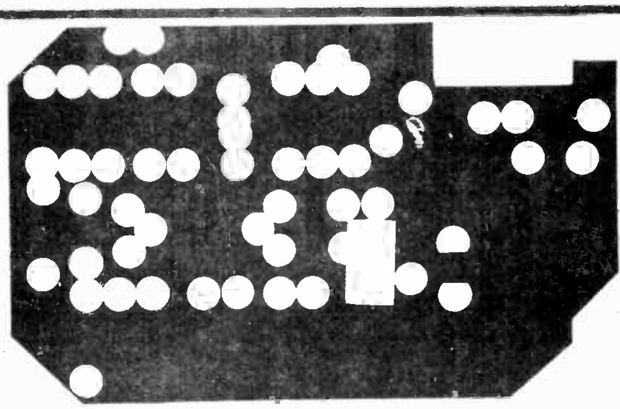
R4, R5 and R6 form a simple D and A converter the output of which produces a staircase waveform by virtue of their binary values.

SYNC VIDEO MIXER

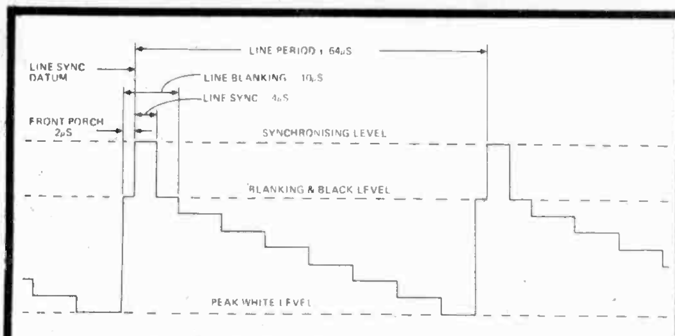
Negative-going sync pulses are fed to the top of the potential divider network R11/R10. During sync the output at R12 is close to zero, and black level produces a voltage of approximately one third of the TTL 'high' output.

Q1 is connected across the top half of the potential divider and is normally biassed off. The application of a positive video voltage at the base of Q1 will turn the transistor on to an extent determined by the video content. This in turn will increase the voltage at the junction of R11/R10 to anything from black level to peak white (a voltage approaching TTL high).

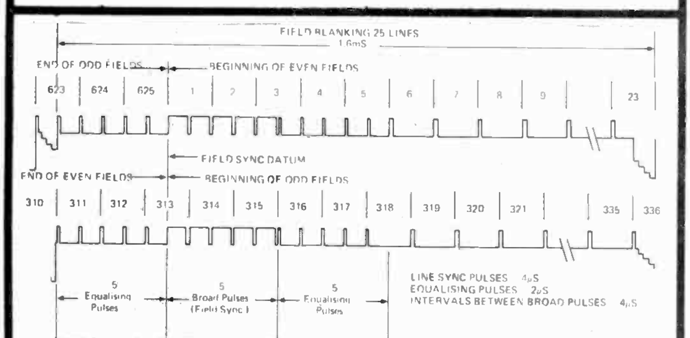
Negative-going blanking pulses are fed to the cathode of D1 which effectively short-circuits the video signal during blanking. C8 and C9 are connected back-to-back to eliminate the need for a large value, non-polarised capacitor, and a.c. couples the composite video signal to the modulator.



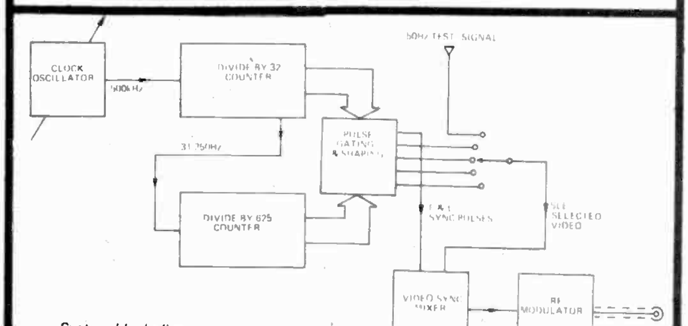
6 Foil pattern — topside modulator board



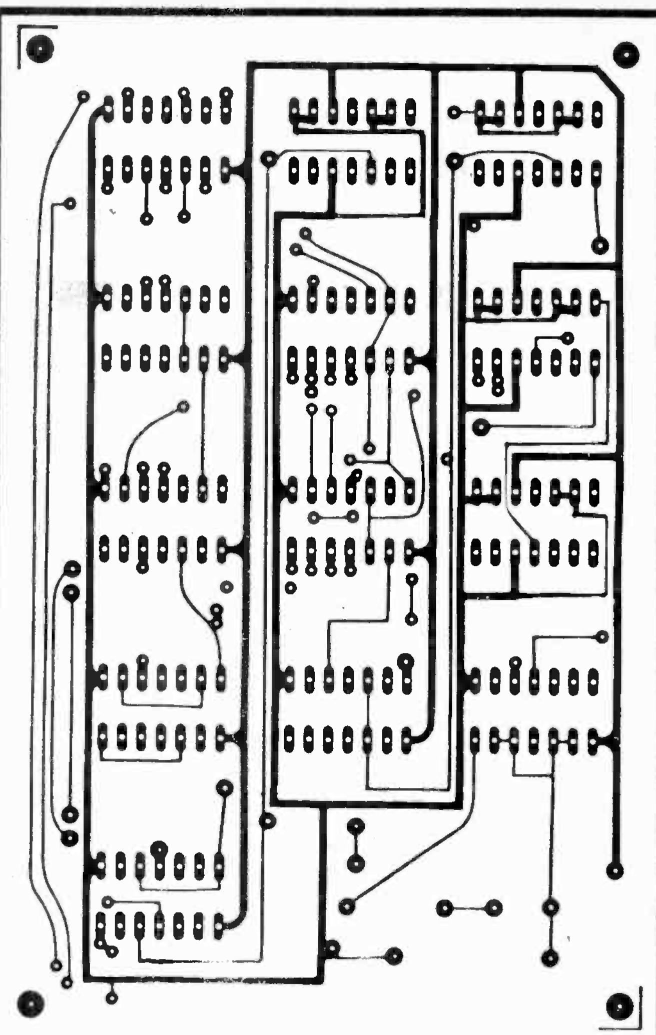
Grey Scale staircase waveform.



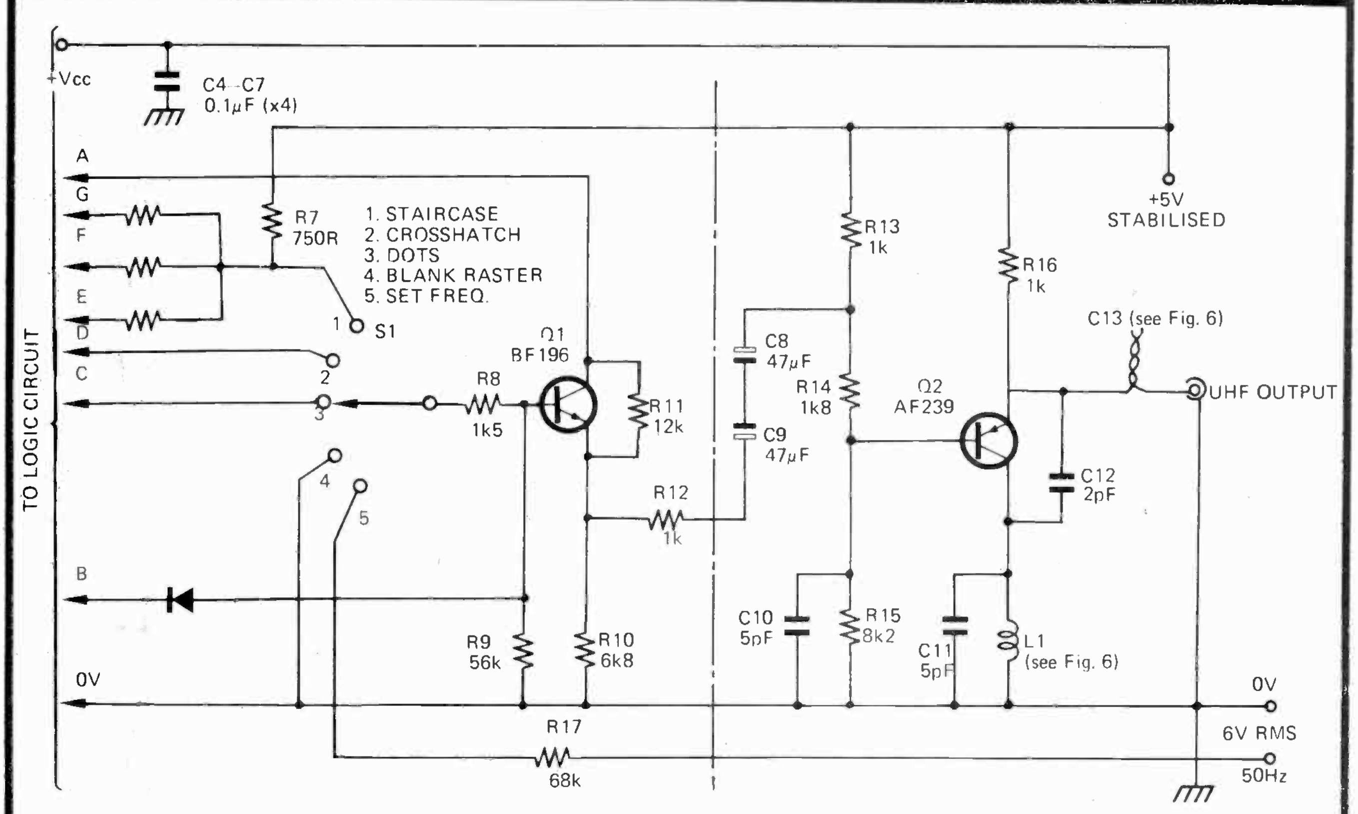
Timing Diagram.



System block diagram.



Foil pattern — top side logic board.



Circuit Diagram — video board

eti microfile

Part 9 Microprofile

THE TOTAL NUMBER of microprocessors available today, counting temperature and speed spec. variations is certainly well over the century. Each of these is different in many ways; in architecture, power requirements, word length or I/O handling, so that the particular application dictates the parameters used in deciding which micro is best. For example, in a portable system where battery power is used, choice is limited to a CMOS micro, such as the Intersil IM6100.

In this survey, we have tried to present the most important characteristics of several of the more popular types, with two aims in mind: firstly, to aid those trying to choose a micro for a specific application, and secondly to show the differences between such apparently similar devices.

We have tried to show the characteristics which would generally be most important to the amateur, e.g. cost, power supplies (unless you like building supplies), and TTL compatibility, all of which bear directly on the pound in your pocket. In addition, the number of instructions and addressing modes give a rough indication of the power of the micro, i.e. the probability of being able to make it do what you want it to do.

Two arguments apply here: it's certainly true that it's not the number of instructions but their effectiveness that counts, but on the other hand, if you haven't got a lot of RAM to play with, those extra instructions can sometimes shorten your program just enough to fit. The classic example is probably hardware multiply, which would otherwise constitute a lengthy subroutine.

The number of registers in the CPU also bears on this; if you have spare registers available it can save you a lot of effort in pushing data around. In addition, some of the spare registers in various chips can be used as Index Registers or do other tricks. We've used a few abbreviations here and there: ACC means accumulator, PC is Program Counter, SP Stack Pointer.

The other devices available in a 'family' of chips can do a lot of the work a CPU would otherwise have to do. For example, a time delay can be implemented in software by making the micro count down from an initial value, but it can't do anything useful at the same time. A programmable timer chip can share the load and let your micro work for its living instead. But watch the cost — if all the time intervals are the same get a 555 — it's cheaper!

The availability of software may also influence one's choice. Assemblers and editors, whilst expensive, can speed up development of programs enormously as well as improving debugging. They also take the element of tedium out of programming — you've solved your problem, you have a flowchart in your mind and know exactly what logical steps to take: and then you have to sit down and convert it all to numbers.

The next stage up the ladder, high level languages like BASIC, virtually let you forget about the constraints of the machine. A program that was written in BASIC for an ICL machine will run equally well on an 8080; if you have the compiler.

Prototyping kits are a way of getting off the ground — they're cheaper than complete, boxed microcomputers with all the support, but more awkward to use and can be a bit idiosyncratic.

INTEL 8080A

The 8080A is the first of the 'industry standard' microprocessors, and consequently Intel have acquired a lot of feedback from users. Consequently, this chip is backed up by a lot of software support, including at least 3 high level languages (at a price!).

Package: 40 pin DIL
Supplies: +5V, −5V, +12V
Technology: NMOS
TTL Compatibility: No
Clock Phases: 2
Word Length: 8 bits
Basic Instruction Set: 88
Addressing Modes: 4
Register Arrangement: PC, SP, 3 pairs of 8 bit registers, 1 pair of temporary registers
Addressing Capabilities: 64k
Interrupt Levels: 1
Special Capabilities: 16 bit handling
Additional Family Devices: 8224 Clock Generator, 8228 System Controller, 8212 Parallel 1/0, 8255 Programmable Peripheral Interface, 8251 Programmable Communications Interface, 8205 1 of 8 Decoder, 8214 Priority Interrupt Controller, 8216 Bus Driver
Available Software: Assembler, Editor, Disk Operating System, and Compilers for: PL/M (Intel), Coral 66 (GEC), Basic (Altair). Also a lot of applications software from Intel and Altair.
Prototyping Kits: SDK80
Prices: 8080A MPU chip £29.40, SDK80 board £247

ZILOG Z80

The Z80 has been designed to get round some of the awkward points of the 8080, and to be considerably more powerful. Certainly the most powerful micro available, it will run programs which have been written for the 8080, and will probably find main application in replacing minicomputers in dedicated systems.

Package: 40 pin DIL
Supplies: +5V
Technology: NMOS
TTL Compatibility: Yes
Clock Phases: 1
Word Length: 8 bits
Basic Instruction Set: 158
Addressing Modes: 11
Register Arrangement: 17 registers — PC, SP, 2 Index Registers, Page Register, Refresh Register, 1 pair 8 bit Accumulators with 8 bit Flag Registers, and 2 sets of 6 General Purpose Registers
Addressing Capabilities: 64k
Interrupt Levels: 3 Maskable modes, 1 non-maskable
Special Capabilities: Dynamic RAM Refresh
Additional Family Devices: Z80 Parallel I/O. Z80 Counter Timer Circuit, Z80 Serial I/O, Z80 Direct Memory Access
Available Software: Assembler, Editor, Disk Operating System, Basic Compiler.
Prototyping Kits: MZ80-MCB (CPU, 4k RAM, PIO, TTY interface, CTC built and tested)

Prices: Z80 CPU £65.00, MZ80-MCB £311.15

FAIRCHILD/MOSTEK F8

The F8 is Fairchild's assault on the micro market, second sourced by Mostek. It is a two-chip set, a CPU and PSU (Program Storage Unit). Unfortunately the PSU contains 1k bytes of mask programmed ROM, but a version containing a monitor program is available.

Package: 40 pin DIL (2 off)
Supplies: +12V, +5V
Technology: NMOS
TTL Compatibility: Yes
Clock Phases: 2
Word Length: 8 bits
Basic Instruction Set: 58
Addressing Modes: 8
Register Arrangement: The 3850 CPU contains Accumulator, Status Register, and 64 bytes of scratch-pad RAM. The 3851 PSU carries the PC, Stack Register, Data Counter, 1k bytes of ROM and a programmable timer.
Addressing Capabilities: 64k
Interrupt Levels: 1 prioritized interrupt on each PSU
Special Abilities: Decimal Arithmetic, 2 I/O ports each on CPU and PSU
Additional Family Devices: 3852/3853 Memory Interfaces, 3854 DMA Controller
Available Software: Resident Assembler
Prototyping Kits: F8 Evaluation Kit
Prices: 3850 CPU £15.10, 3851 PSU £24.65, F8 Evaluation Kit £123

NATIONAL SEMICONDUCTOR SC/MP

SC/MP (for Simple Cost-effective MicroProcessor) is aimed at the controller, rather than the computer, end of the market. It's really intended as a replacement for the 4-bit micros, the advantage of 8 bits being in the handling of ASCII codes.

Package: 40 pin DIL
Supplies: +5V, −12V
Technology: NMOS
TTL Compatibility: Yes
Word Length: 8 bits
Basic Instruction Set: 46
Addressing Modes: 4
Register Arrangement: PC, 3 Pointer Registers, ACC, Extension Register, Status Register.
Addressing Capabilities: 4k (64k with external latch)
Interrupt Levels: 1
Special Capabilities: Serial I/O on-chip
Additional Family Devices: None
Available Software: Cross-assemblers only — no resident software except firmware monitor
Prototyping Kits: Introkit, LCDS
Prices: SC/MP (ISP-8A/500D) £12.50, Introkit £62.50, LCDS £315.

INTERSIL IM6100

The neat thing about the IM6100 is that it runs the same software as the PDP-8/E, possibly the most popular minicomputer around today. This means that it has a very wide range of software available including assemblers and even a calculator-type program. In addition, it is CMOS and so is probably the nearest thing available to a portable computer.

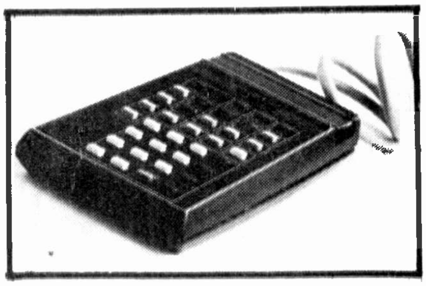
Package: 40 pin DIL
Supplies: +5V
Technology: CMOS
TTL Compatibility: Yes
Clock Phases: 1
Word Length: 12 bits
Basic Instruction Set: 79
Addressing Modes: 3
Register Arrangement: ACC, PC, MQ and TEMP (temporary registers)
Addressing Capabilities: 4k
Interrupt Levels: 1
Special Abilities: Battery Operation
Additional Family Devices: IM6101 Parallel Interface Element, IM6402 UART, also CMOS RAMs
Available Software: Most PDP-8/E software will run on the IM6100
Prototyping Kits: Intercept Junior
Prices: IM6100CCPL £26.46, Intercept Junior £196.39

MOTOROLA M6800

The M6800 family of chips were originally oriented towards data communications — hence the 6860 modem. However, it has found its way into applications as diverse as audio control systems for rock groups. We've talked a lot about it before now and include it here for comparison.

Package: 40 pin DIL
Supplies: +5V
Technology: NMOS
TIL Compatibility?: Yes
Clock Phases: 2
Word Length: 8 bits
Basic Instruction Set: 72
Addressing Modes: 7
Register Arrangement: 2 Accumulators, Condition Codes Register, Index Register, SP, PC
Addressing Capabilities: 64k
Interrupt Levels: 2-maskable and non-maskable
Special Capabilities: Decimal Arithmetic
Additional Family Devices: MC6820 PIA, MC6850 ACIA, MC6880 bus driver, MC6810 128 byte RAM, MC6830 ik byte ROM, MC6852 Serial Synchronous Data Adapter, MC6860 Modem, MC6862 Modem, MPQ6842 Clock Driver
Available Software: Assembler, Editor, Disk Operating System, Basic (Altair)
Prototyping Kits: MEK6800D1 — Family parts and board only
Prices: MC6800L (ceramic) £22.58 + VAT MC6800P (plastic) £20.16 + VAT MEK6800D1 £85.83 (£130 total to complete)

NEWS/PRODUCTS



THE POCKET TELETYPE developed by National Semiconductors is now available from GR Electronics Ltd. It has 36 keys which, with a 'shift' switch, allow entry of a full 64 alphanumeric character ASCII set through a 20mA current loop interface. A 9-digit alphanumeric LED display is used. *GR Electronics Ltd., 80 Church Road, Newport, Gwent.*

'Introduction to Minicomputers and Microprocessors' is the title of a course being given at the *Polytechnic of Central London, 115 New Cavendish St., London W1* on Wednesday evenings at 6.30pm. This 22 week course will cost you about £9, for which you get lectures by Dr. G.R. Burke, plus a bit of 'hands on' experience. For registration contact the 'registry' or Dr. Burke at the above address, or phone 01-486 5811.

The first national computer show for Stateside hobbyists, Personal Computing '76, was apparently a great success, with around 5000 attending. Amongst over 100 companies exhibiting were IBM, DEC and National Semiconductor. Apparently, DEC (Digital Equipment Co.) had a 132 page 'direct sales catalogue for do-it-yourself computer equipment purchases'. Don't know if it's available in this country....

Shugart Associates have unveiled a new 5¼" square minifloppy disk aimed squarely at the hobby computer market and likely to hit it right between the eyes. A capacity of 110k bytes at 125kbit/s data transfer rate make it a very attractive proposition. The drive is 3¼" x 5¾" x 8" and consumes just 15 watts.

We regret that, owing to circumstances beyond our control, we have been forced to delay publication of the constructional details of System 68.

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200	0.27*	0.35	0.45	0.40	0.58	0.60	0.60	0.68	1.14
400	0.30*	0.40	0.50	0.45	0.87	0.88	0.88	0.98	1.40
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7420	0.16
7427	0.27
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7437	0.27
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7442	0.65
7445	0.85
7447	0.81
7448	0.75
7447A	0.95
7470	0.30
7472	0.25
7473	0.30
7474	0.32
7475	0.47
7476	0.32
7482	0.75
7485	1.30
7486	0.32
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7492	0.57
7493	0.45
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74107	0.35
74121	0.34
74122	0.47
74141	0.78
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AC141	0.18	BC160	0.32	BD238	0.60*	BU126	1.60*	OC44	0.12	2N2926R	0.10*
AC141K	0.28	BC161	0.38	BD184	1.20	BU204	1.60*	OC45	0.10	2N29260	0.09*
AC142	0.18	BC168B	0.09*	BDY20	0.80	BU208	2.60*	OC70	0.10	2N2926Y	0.09*
AC142K	0.28	BC182	0.11*	BDY38	0.60	BY206	0.15	OC71	0.10	2N2926G	0.10*
AC176	0.16	BC182L	0.11*	BDY60	0.60	BY207	0.20*	OC72	0.22	2N3053	0.15
AC176K	0.25	BC183	0.10*	BDY61	0.65	BYX36—		OC84	0.14	2N3054	0.40
AC187	0.18	BC183L	0.10*	BDY62	0.55	300	0.12*	SC40A	0.73	2N3055	0.50
AC187K	0.25	BC184	0.11*	BDY93	2.72	600	0.15*	SC40B	0.81	2N3440	0.56
AC188	0.18	BC184L	0.11*	BDY94	2.34	900	0.18*	SC40D	0.98	2N3442	1.20
AC188K	0.25	BC207B	0.12*	BDY95	2.14	1200	0.21*	SC40F	0.65	2N3525	0.50
AD140	0.50	BC212	0.11*	BDY96	4.83	BYX38—		SC41A	0.65	2N3570	0.80
AD142	0.50	BC213	0.12*	BDY97	4.12	300	0.50	SC41B	0.70	2N3702	0.10*
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AF116	0.20	BC327	0.18*	BF244	0.17*	C106A	0.40	TIP41A	0.68	2N3771	1.60
AF117	0.20	BC328	0.16*	BF257	0.30*	C106B	0.45	TIP42A	0.72	2N3772	1.60
AF118	0.50	BC337	0.17*	BF258	0.35	C106D	0.50	IN2069	0.14	2N3773	2.10
AF139	0.35	BC338	0.17*	BF337	0.32	C106F	0.35	IN2070	0.16	2N3819	0.28*
AF239	0.37	BCY30	0.55	BFW60	0.17*	CRS1 05	0.25	IN4001	0.04*	2N3904	0.16*
AU103	1.30*	BCY31	0.55	BFX29	0.26	CRS1 10	0.25	IN4002	0.05*	2N3906	0.11*
AU106	1.70*	BCY32	0.60	BFX30	0.30	CRS1 20	0.35	IN4003	0.06*	2N4124	0.14
AU113	1.60*	BCY33	0.55	BFX84	0.23	CRS1 40	0.40	IN4004	0.07*	2N4290	0.12
BC107	0.09	BCY34	0.55	BFX85	0.25	CRS1 60	0.65	IN4005	0.08*	2N4348	1.20
BC107B	0.09	BCY38	0.50	BFX88	0.20	CRS3 05	0.34	IN4006	0.09*	2N4870	0.35*
BC108	0.09	BCY39	1.15	BFY50	0.20			IN4007	0.10*	2N4871	0.35*
BC109	0.09	BCY70	0.12	BFY51	0.18	CRS3 10	0.45	2N696	0.14	2N4919	0.70*
BC109C	0.12	BCY71	0.18	BFY52	0.19	CRS3 20	0.50	2N697	0.12	2N4920	0.50*
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BC142	0.23	BD135	0.36	BSX19	0.16	MJ490	0.90	2N1132	0.16	2N5062	0.27*
BC143	0.23	BD136	0.39	BSX20	0.18	MJ491	1.15	2N1304	0.20	2N5064	0.30*
BC144	0.30	BD137	0.40	BSX21	0.20	MJE340	0.40*	2N1305	0.20	2N5496	0.65
BC147	0.09*	BD138	0.48	BSY95A	0.12	MJE371	0.60	2N1711	0.18		
BC148	0.09*	BD139	0.58	BT106	1.00	MJE520	0.45	2N2102	0.44		
BC149	0.09*	BD181	0.86	BT107	1.60	MJE521	0.55	2N2369	0.14		
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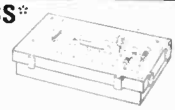

S-DeC £2.24. T-DeC £4.05. u-DeCA £4.45. u-DeCB £7.85. IC carriers with sockets 16 dil £2.21. 10TO5 £1.95.

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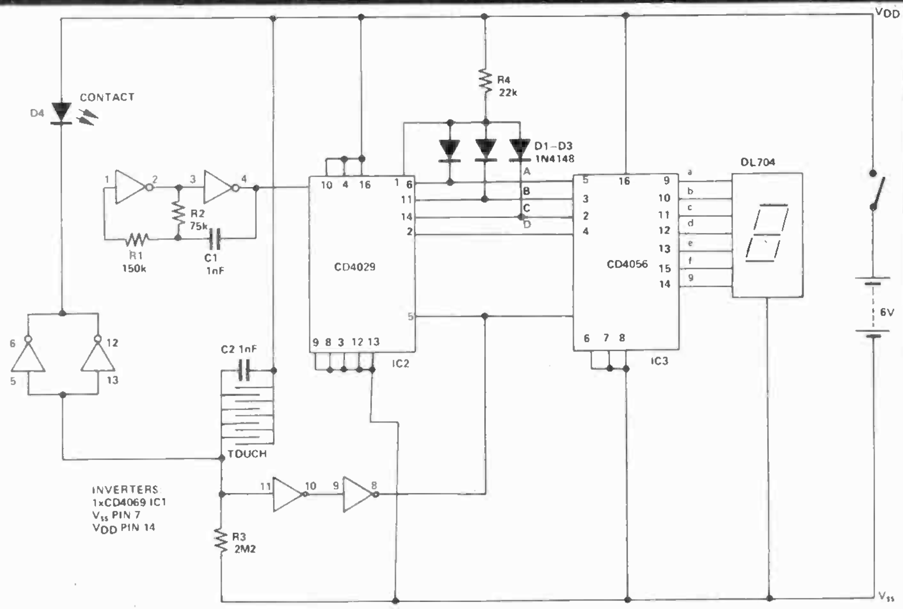
tech-tips SPECIAL

CMOS ELECTRONIC DIE



This circuit gives a readout of a random number on a 7-segment LED display. As shown, it will generate a number from 1 to 6 as does an ordinary cubic die. However the 4029 can be made to reset on another BCD number (one greater than the higest number required) by changing teh arrangement of the diode AND gate. by changing the logic level on the preset pin (Q1:4, Q2:12, Q3:13 and Q4:3), the counter will reset to the pre-programmed number. If these features are not to be used (i.e. count is 0–9) pin 1 on IC2 should be taken to V_{SS}.

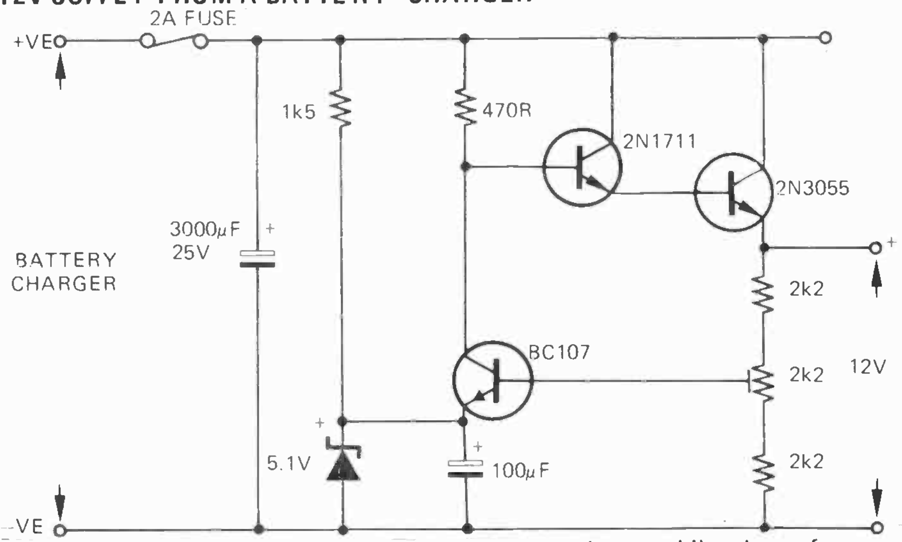
Alphabetical symbols (L,H,P and A) will be produced on the display if pin 9 of IC2 is taken to V_{DD} causing the counter to produce the binary numbers from 10–15 as well.

A finger on the touch plate causes pins 5 and 1 on ICs 2 and 3 to go high, stopping the counter and enabling the latch in IC3. When the finger is removed the number is stored in the latch and the counter restarted.

If a common anode display (DL707) is used instead of the DL704, taking pin 6 of IC3 to V_{DD} will invert all its outputs, suitable for a common anode device.

The touch switch may be replaced by a single pole push to make if required, otherwise it is a small veroboard cutoff with alternate strips wired together.

12V SUPPLY FROM A BATTERY CHARGER

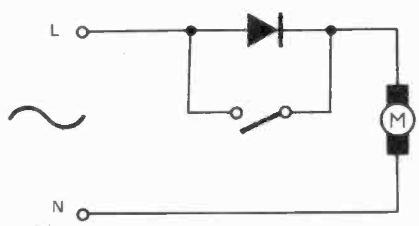


This 12V regulator unit was designed to enable bench testing of mobile equipment (radios, tapes, C–D units, etc,) using a battery charger, thus avoiding the expense of a complete bench supply and the inconvenience of a car battery.

The charger output is smoothed by the 3000mfd capacitor. The BC107 is a comparator, sampling part of the output voltage while the reference zener holds the emitter at approximately 5V (4.7V or 5.6V zeners could be used). The 2N1711 supplies the necessary current gain to drive the 2N3055 series regulator.

A heatsink of at least 16 sq.ins. should be provided for the 2N3055 but the 2N1711 will run cool without a heatsink.

ONE SPEED – TWO SPEED



Series wound 'universal' electric motors are widely used in domestic appliciances such as electric drills, sewing machines, food mixers, etc. and are usually designed as single speed devices.

Two speed operation can be achieved by switching in a diode in series with the motor. This results in a 20% speed reduction. The switch and diode can be fitted externally into a 13A socket outlet box.

SUBSTITUTE FOR BREAKDOWN DIODE

Experimenters may have tried the circuit of Fig.1. as a substitute for a diac. Due to the high V_{cbo} of modern silicon planar transistors, the configuration will snap into conduction only when 20–30V are reached. In addition, the breakdown voltage is ill-defined, varying from sample to sample.

However if the transistors are used in the inverted mode, as shown in Fig. 2, the breakdown voltage now depends upon the V_{cbo} of the transistors used, which is confined to a narrow range for a given transistor type.

Experimental circuits have conducted at voltages from 2 to 6V, depending upon transistor type and quality.

Fig. 3 shows two typical applications. Doubtless other uses like time-base and delay circuits can be conceived.

Note that the circuit can be triggered at either base with an appropriate current pulse.

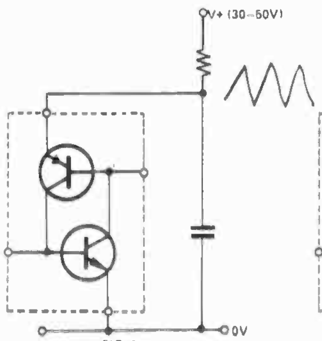


FIG. 1

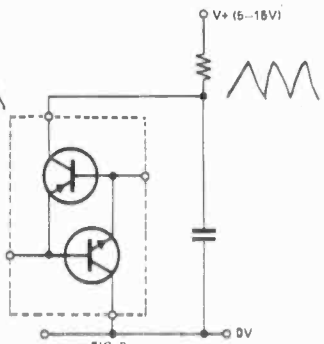


FIG. 2.

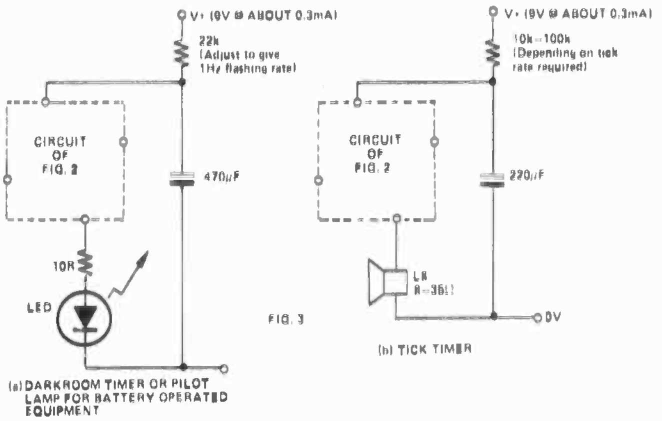
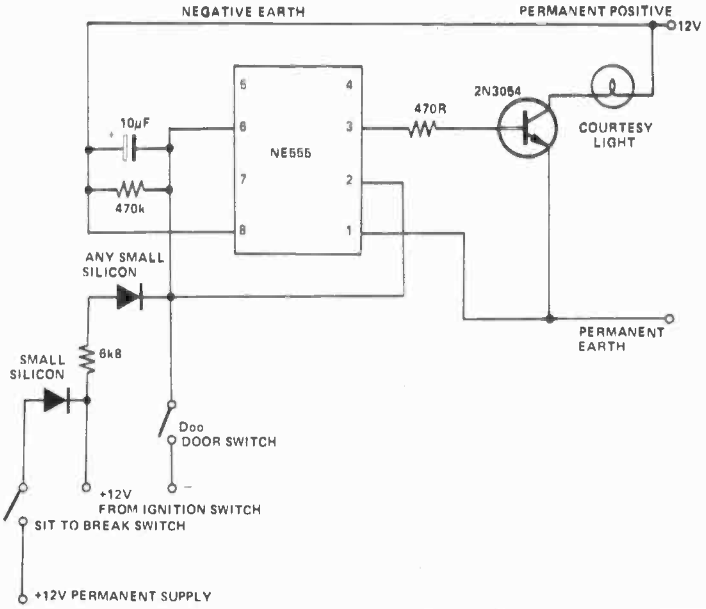


FIG. 3

COURTESY LIGHT DELAY

There are two problems with courtesy light delay switches, the first is that having the courtesy light stay on in a dark car park albeit only for a few seconds, can attract unwanted attention when you are leaving the car. The other problem is that most delay switches are set for about 10 seconds, which is too long when you wish to drive off straight away and is too short if you wish to go into the glove compartment or perhaps put on gloves.

This circuit defeats both these problems, the light stays on for a maximum of 1 minute or goes out as soon as the ignition is turned on. Though a switch mounted under the seat which is fitted so the switch breaks when you set on it, the light goes out as soon as you leave the car.



ECONOMY 'LINE-O-LIGHT' DECODER

The decoder works in the following fashion: one NAND gate of IC2 (a 7413) is wired as a clock pulse generator, running at approximately 10kHz. These pulses are used to clock IC4, a 7490 4-bit BCD counter, which in turn drives a 7441 BCD-to-one of ten decoder. The line of ten LEDs is arranged with the anodes linked together and coupled 50 +5V via TR1. The ten LED cathodes can be pulled down to 0V by the 7442 outputs. Thus, if TR1 is turned on, the counter will scan through 0-9 and the LEDs will turn on in sequence. If the clock frequency is high enough, all ten LEDs will appear to be on all the time.

In Fig. 1, the second half of IC2 is used to detect when the counter outputs are at 9, and this signal is used to trigger the 555 timer, IC1, which is connected as a monostable. The output of the mono drives the base of TR1. Thus, every time IC4 reaches 9, IC1 will fire and switch the LED array on.

The voltage input to the decoder, Vin, is fed to the control voltage input of IC1, altering the threshold at which the internal comparators of the 555 will switch. This in turn decides (in conjunction with the values of R3 and

LINE-O-LIGHT cont.

C2) the length of pulse available at the mono output. IC1 is, in effect, used as a pulse-width modulator.

Fig. 2 shows the relative timing of the clock, 555 trigger and 555 output waveforms, together with the 'ON' times of the individual LEDs.

If the value of Vin is such that the 555 pulse length is approximately equal to nine clock pulses, then TR1 will be on almost continuously and the LEDs will all appear to be on. As Vin is reduced, TR1 ON time will become less than nine clock pulses; consequently, the +ve supply to the LEDs will be removed at the same point in every count cycle. This will have the effect of 'shortening' the row of illuminated LEDs. Because the mono pulse length does not decrease in definate steps of one clock pulse, the row of LEDs will decrease in length by the highest gradually dimming, then the next highest, etc. — a rather pleasing effect.

Some experimenting with the value of C2 may be required to achieve a realistic rane for Vin, and to prevent the mono pulse length being greater than ten clock pulses at maximum Vin.

The values for C1, R3 and C2 given are those used in the prototype.

FIG. 1.

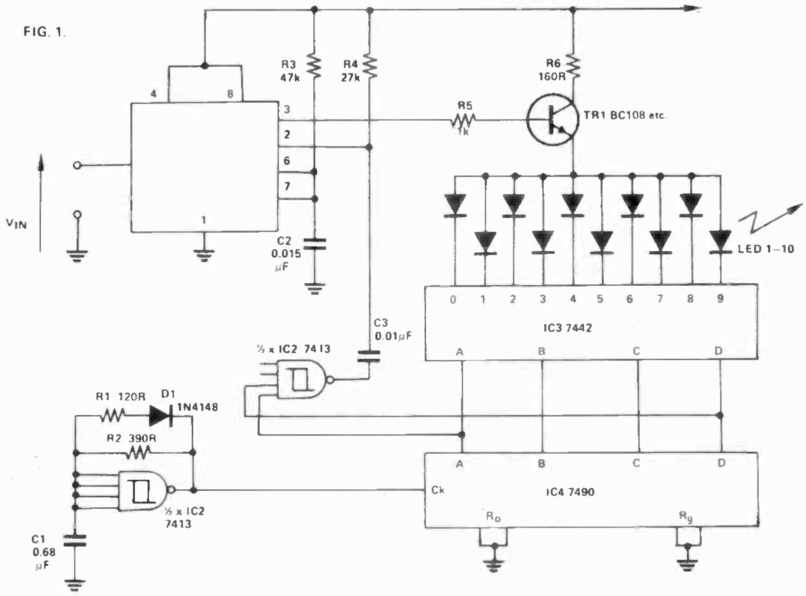
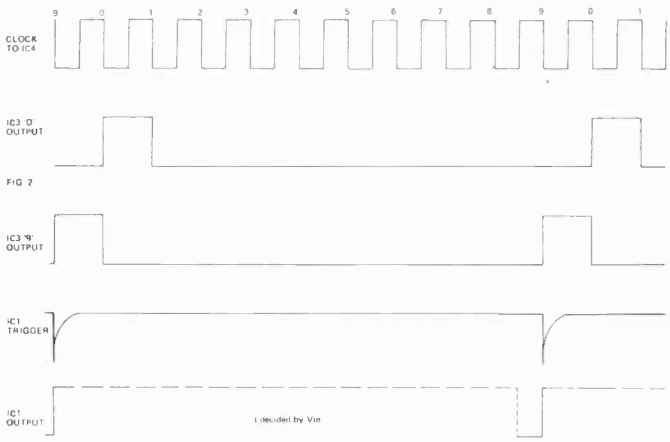


FIG 2

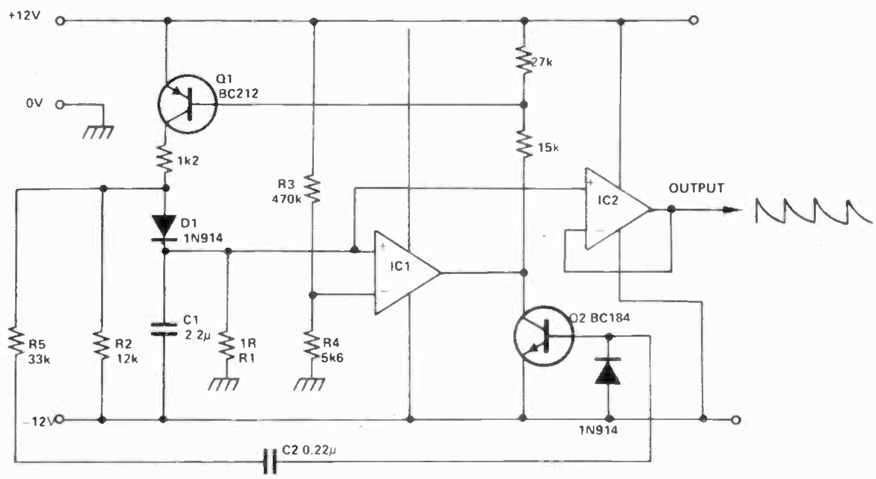


EXPONENTIAL WAVEFORM GENERATOR

This circuit produces a waveform that decays exponentially from a set voltage to near-zero, and then rapidly resets to re-start the cycle.

Initially C1 is charged to +12V, and Q1, Q2 are both off. The timing capacitor there discharges slowly through R1, the exponentially decaying voltage appearing at low impedance at the output of unity-gain buffer IC2. R2 prevents the leakage current from Q1 affecting the discharge as D1 is reverse-biased. When the voltage on C1 reaches a value just above zero that is set by R3, R4, the open-collector O/P of IC1 goes low, turning on Q1 and rapidly recharging C1. IC1 of course reverts to its original state almost at once, but the recharge mode is prolonged for several milliseconds by the positive feedback loop through R5, C2 and Q2, to ensure C1 charges fully. After this time C2 is also fully charged, and Q2 turns off, turning off Q1, and allowing the slow discharge of C1 to begin again.

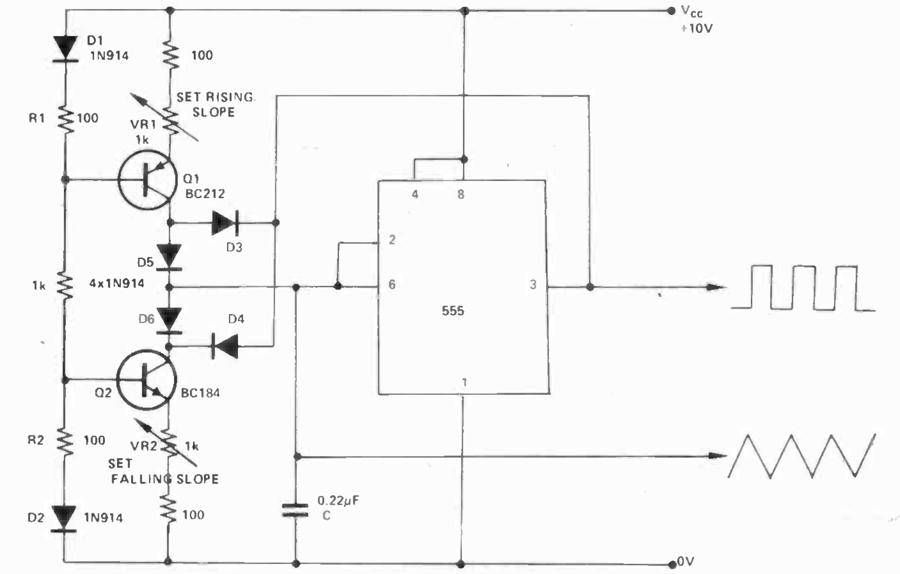
With the component values shown, each cycle lasts about ten seconds.



IC1 — An open-collector O/P comparator, eg LM339. IC2 — 741 or similar.

tech-tips SPECIAL

TRIANGLE GENERATOR WITH INDEPENDENT SLOPE SETTING

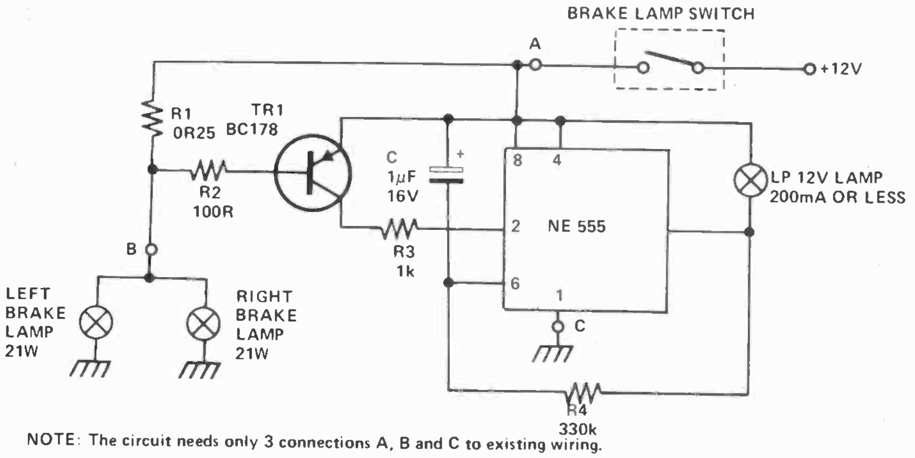


This free-running oscillator circuit generates a triangle waveform, the rising and falling slopes of which may be set by completely independent controls. Simultaneously the 555 output (pin 3) provides a rectangular waveform at low impedance that is synchronised with the triangle waveform.

Assuming the 555 output is low, the output of constant-current source Q1 is shorted to earth via diode D3, and diode D5 is reverse biased. During this time current source Q2 linearly discharges the timing capacitor C through D6, D4 being reverse biased. Eventually the voltage on C falls to $1/3V_{CC}$ (set by the internal potential divider that biases the two comparators in the 555) and the 555 output goes high. Now the output of Q2 is shorted away from the timing capacitor, and Q1 is allowd to linearly charge it up; when the capacitor voltage reaches $2/3V_{CC}$ the 555 output goes low again, and the cycle repeats.

The biasing networks R1D1 and R2D2 compensate for the changes in V_{CC}.

BRAKE LAMP FAILURE INDICATOR



NOTE: The circuit needs only 3 connections A, B and C to existing wiring.

Here is yet another application for the NE555 timer.

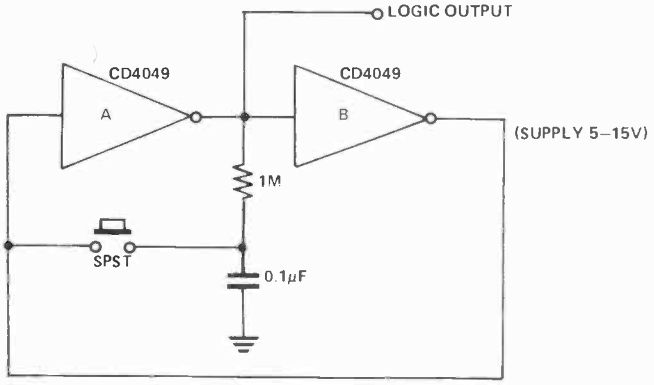
If both brake lamps are working the lamp LP lights but if one or both are open circuit the lamp will flash at 2Hz, alerting the driver.

When both lamps are good the current through R1 turns on TR1 preventing C from charging, and keeping pins 2 and 6 at rail potential. Under these circumstances pin 3 is low and LP is on, however if one or both lamps are faulty TR is not turned on and the NE555 time oscillates freely at 2Hz, flashing LP.

R1 is calculated on the basis of two 21W brake lamps (42W total). If a different total wattage is used, use the formula:

R1=10.5/P where P is the total wattage of two lamps.

SPST SWITCH FLIP FLOP



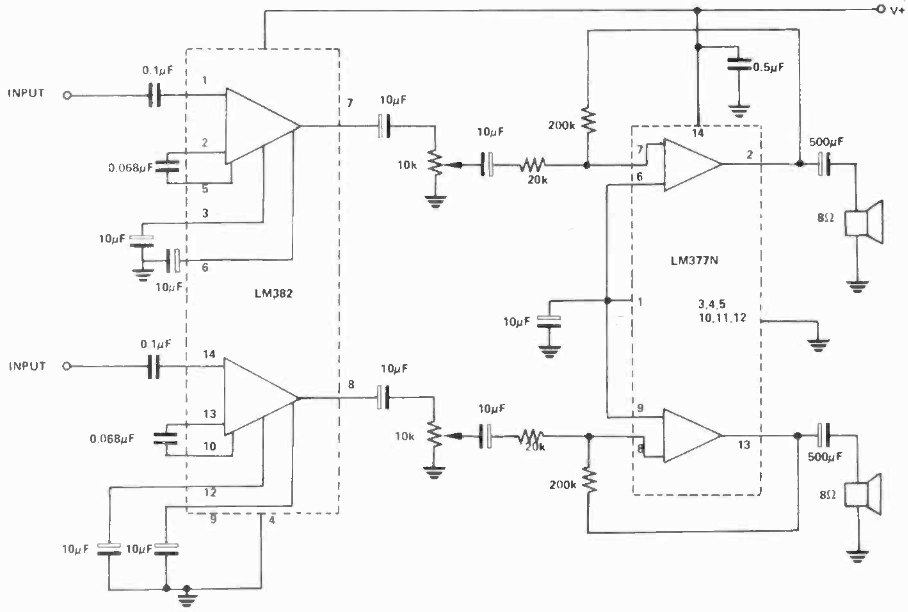
The circuit gives latching on-off action with a single SPST switch, utilizing the high input impedance property of CMOS logic.

It can be seen that C will go to the logic state opposite to that existing at the input to inverter A. On closing the contact, the input to inverter A is taken to the opposite logic state momentarily and the latch flips.

The RC time constant of about 100 milliseconds provides sufficient protection from switch bounce yet gives quick recovery for the next operation. The output may drive other logic gates or external loads through buffer circuits.

SIMPLE STEREO TAPE PLAYER

The circuit shown employs the National Semiconductor LM382 low noise dual preamplifier and the LM377 dual 2W power amplifier as a complete stereo tape player circuit providing the normal NAB equalization characteristic. The number of components employed is much smaller than in conventional circuits. The power supply voltage should be in the range 10V to 26V, but no special precautions are required to remove hum from the supply line, since the LM382 provides 120dB hum rejection and the LM377 80dB rejection.

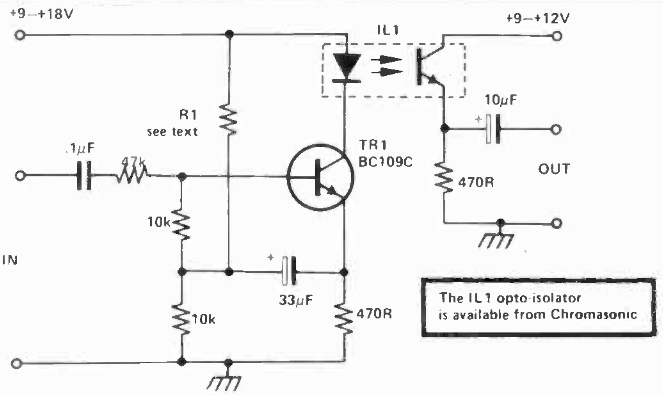


LOW COST TELEVISION SOUND PICKOFF

The idea behind this circuit is the fact that in many modern TV set the sound IF and detector stages are up to Hi-Fi standard but the output stage and loudspeaker are not, so it makes sense to extract the signal before the output stage can distort it.

This circuit uses a cheap opto-isolator to couple the sound from the output of the sound detector of a television to a Hi-Fi system. The signal from the detector is buffered and amplified by TR1 and fed to the LED in the opto-isolator. This modulates the light emitted and this is detcted by the phototransistor in the opto-isolator.

There is no electrical connection between the two halves of the circuit and the isolator can withstand a voltage of 2.5kV between its input and output.



The power for the input side is taken from the television, a supply of about 6mA at any voltage between 9 and 18V will do, and to 36V if a BC107C is used for TR1. (R1 should be chosen to give a voltage of about 3V at the base of TR1).

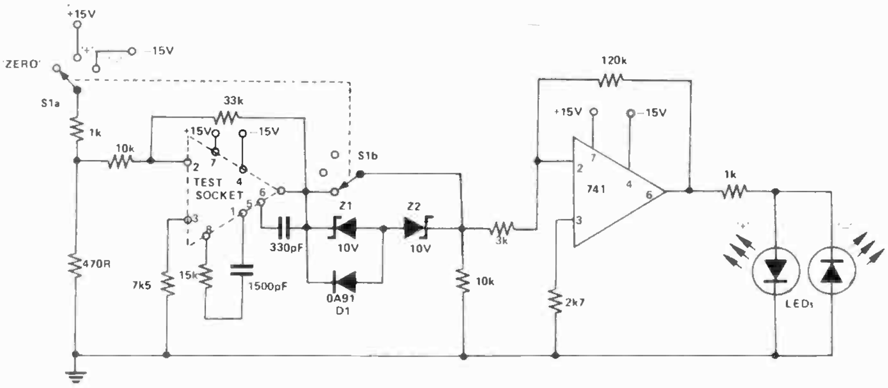
If the TV uses a transistor IF strip, the power can normally be taken from it, otherwise a dropping resistor and zener can be used to take the power from the HT supply. The entire unit can be built for around £2.

OP–AMP TESTER

The design illustrated is intended for 709, 741 and similar amplifiers which can use ±15V rails, and ±15V *must* be used with the component values shown. For checking amplifiers such as the CA 3130 as well, the rails would have to be dropped to ±8V and Z1 and Z2 reduced accordingly.

Circuit operation is as follows: with S1 in the 'zero' position neither LED should be on, and one LED on indicates excessive offset, both LEDs on oscillation.

In the other two positions S1 the LEDs can only light if the output of the amplifier on test exceeds the zener voltage. A good amplifier should light the LED corresponding to the position of S1.



D1 is a Ge diode (low voltage drop) which helps to allow for the unequal output drive of 741s by reducing the forward voltage drop across Z1.

S1 can be replaced by two toggle or push-button switches if more convenient.

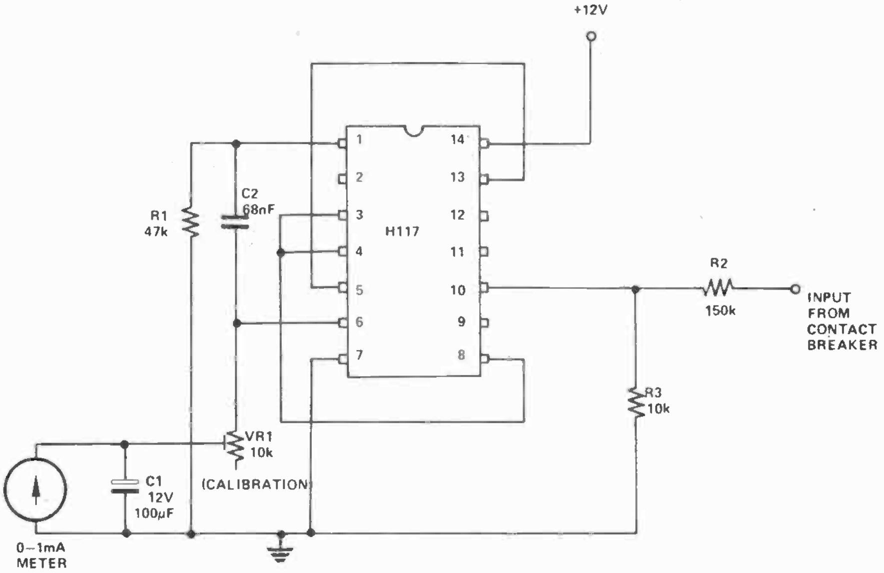
tech-tips SPECIAL

HLL REV COUNTER

The electrical systems of vehicles contain a great deal of noise, this being generated at the contacts by the dynamo and the petrol pump, etc. The circuit shows how a simple rev. counter can be made for a positive earth vehicle. using the H117 dual-in-line 14 pin HLL (High Level Logic) monostable device.

The positive voltage peaks produced each time the contacts open are about 150 to 300V in amplitude. The input attenuator R2 – R3 reduces this to about 10 – 20V before it is applied to pin 10 of the H117. The pulse is inverted and appears at pin 8; this negative pulse is fed to both inputs of the AND gate at pins 3 and 4 and triggers the monostable circuit.

Each time the monostable is triggered, a pulse of current passes through the meter. The mean current through the meter is therefore proportional to the rate of opening of the contacts and hence to the revolution rate of the engine. The meter is calibrated before it is fitted in the vehicle by using a signal generator which can provide square waves of amplitude about 20V.



This waveform should be applied directly between pin 10 and ground and *not* through R2.

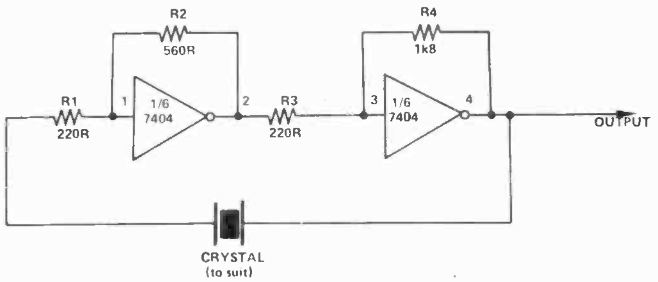
In order to obtain the 3000 rev/min mark *for a four cylinder car,* one must appreciate that the cam shaft rotates at 1500 rev/min and the contacts open 6000 times per minute or 100 times per second. Thus a 100Hz waveform will produce the same meter reading as one obtains at 3000 rev/min. In the case of a six cylinder car, however, a 150Hz waveform would produce the same meter deflection as would be obtained at 3000 rev/min. The potentiometer VR1 is adjusted until the meter reads the correct amount on the scale.

A SIMPLE TTL CRYSTAL OSCILLATOR

This is possibly the simplest and cheapest crystal oscillator it is possible to make, comprising one third of a 7404, four resistors and a crystal. It was originally designed for a battery operated timer.

The two inverters are biased into their linear regions by R1 to R4, and the crystal provides the feedback. Oscillation can only occur at the crystals fundamental frequency.

Note that the oscillation occurs

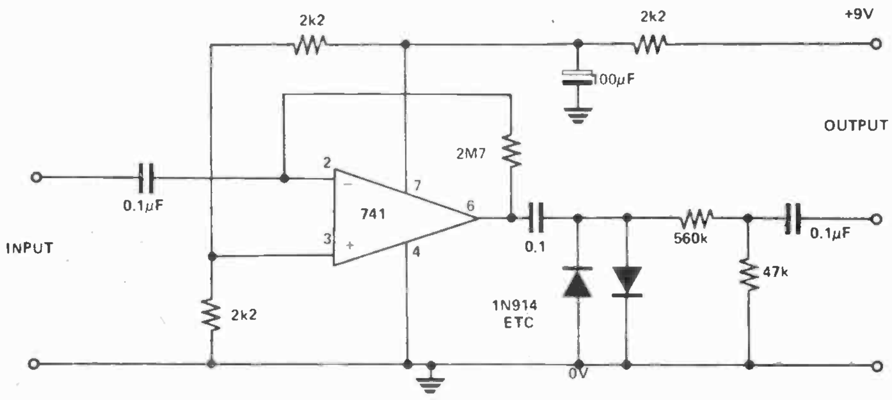


at fundamental frequency, whereas many crystals (particularly higher frequency ones) are stamped with the overtone frequencies. These will operate at the fundamental and not the marked value.

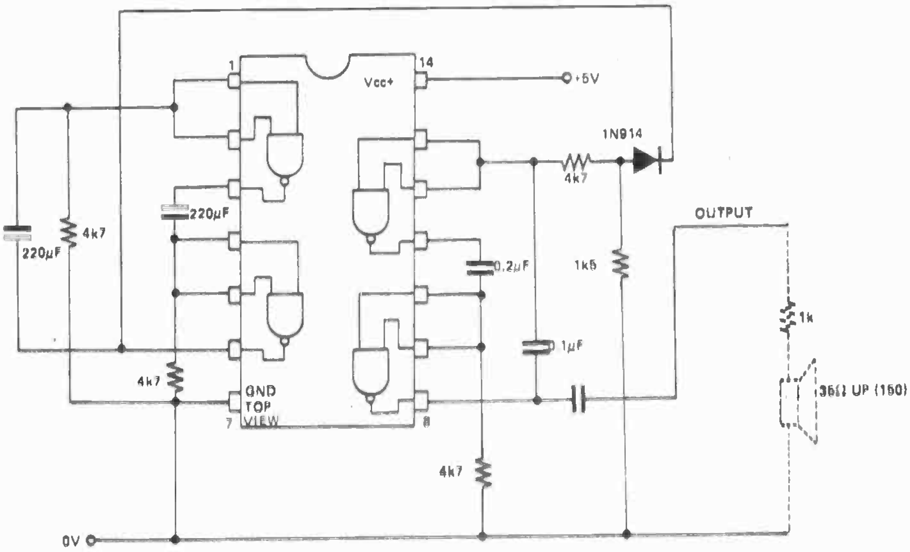
Trimming capacitors for fine adjustment can be added if required.

GUITAR FUZZ

The 741 has a maximum gain of 20,000, but the circuit is so designed that the IC's gain is 2,700,000 which then distorts the output. This distortion gives the fuzz effect. The two diodes clip the output to drop the level, also lowered by the potential divider. This circuit also sustains the notes, due to clipping, giving a totally new sound.



7400 SIREN

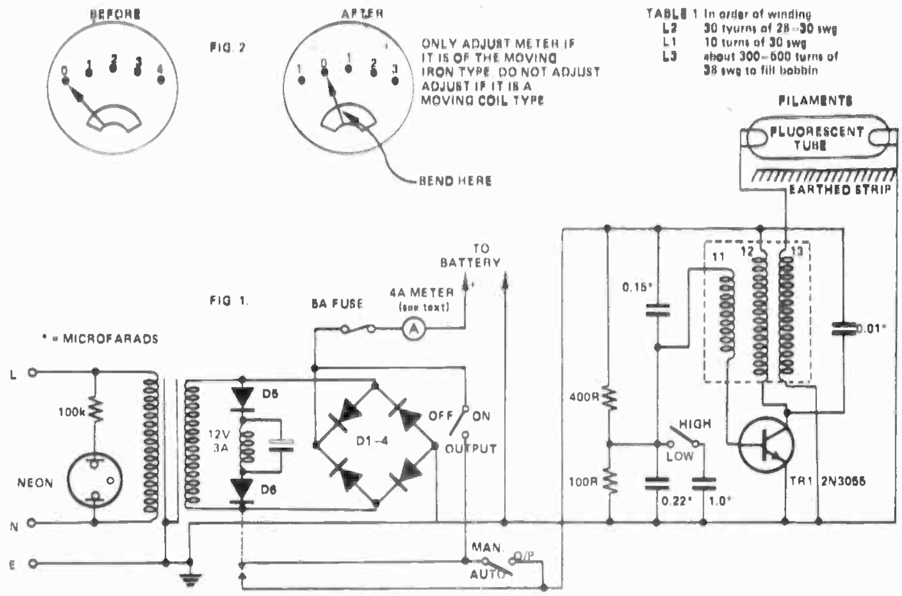


The circuit uses the NAND gates as Hex invertors. Two of these are used for the oscillator, and two as the control. If the two tone speed needs to be altered, the 220µF capacitors can be changed (larger for slower operation).

When the control oscillator output is at logic "0" it effectively shorts out the 1k5 resistor, giving a low note. When the control oscillator output goes to logic "1" the diode blocks the output. So the "1" condition gives high note, (as if the control oscillator was disconnected).

If the frequency of the oscillator is to be changed, the capacitors can be varied and the value of R1 can be increased. To change frequency range between the two notes alter the 1k5 resistor. (Note, this changes the oscillator frequency altogether). DTL-946s could be used instead of the 7400s but they give a higher pitched note.

DUAL FUNCTION CHARGER



The charger is quite straightforward; the 13V AC from the transformer is rectified by the power diodes (D1-4) and then goes through the 5A fuse and then goes through a 5A fuse and 4A ammeter to the clips on the battery (it may be better to use lead clips if the clips are to be used for long periods, as steel ones tend to corrode).

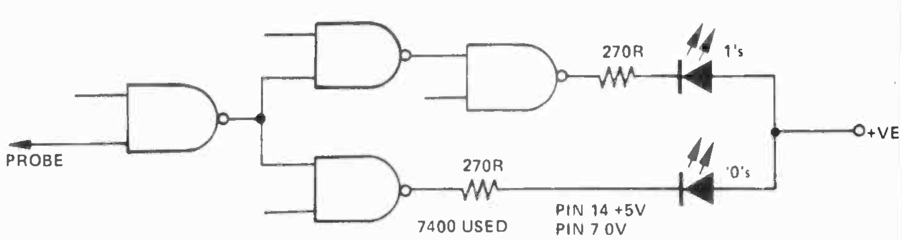
However, this 13V is also ½ wave rectified by D5-6 which are connected to a 9V relay (a capacitor may be connected across the relay to smooth out the supply). Most of the time the relay will hold in the contacts and break the circuit – normally closed contacts are used here. But when the power is disconnected (during a power failure) the contacts connect the supply to the inverter and the indicator lights.

(The meter can be made to measure the current drawn by the inverter from the battery by bending the needle slightly as in Fig. 2).

The inverter section is a simple positive feedback oscillator with frequency dependent on the value of C1 and the inductance of T1. This is wound as in Table 1 onto a Mullard LA5 or LA7 pot core. R1, 2 make a voltage divider for the biasing of C2, 3. With C3 in circuit the inverter in fact becomes more efficient, but has a lower output. Using a 2N3055 enables the inverter to be modified to give higher output and also guards against thermal runaway when used for long periods. A heatsink is advisable.

The frequency of the oscillator should be kept as high as possible as the fluorescent light gives out 20 per cent more light if operated at a frequency above 10kHz. The circuit is designed to operate a 12 inch 8W tube but can probably be made to produce up to 30W.

LOGIC PROBE WHICH DISPLAYS 1's & 0's



The logic probe automatically goes to logic 1 when not in use and uses the power supply of the circuit under test.

LOOK WHATS INSIDE

AUDIO

SWEET SIXTEEN
Sweet music from a simple design
WAA WAA
Exotic sound from your guitar
AUDIO LEVEL METER
Solid state led display
EXPANDER-COMPRESSOR
Puts back what the studios took out

MOTORIST

ANTI-THEFT ALARM
Make sure your car stays where you leave it!
AUTO AMP
5W for your radio or cassette
HEADLIGHT REMINDER
Don't get caught with a flat battery
SOLID STATE FLASHER
Unaffected by load or voltage fluctuations

PHOTOGRAPHER

EXPOSURE METER
Perfect photographs made easier
PHOTO TIMER
Accurate circuit with elapsed time indication

TEST GEAR

DUAL TRACKING POWER SUPPLY
Programmable laboratory standard circuit
SIMPLE CMOS TESTER
Sorts out the good, the bad and the ugly!
AUDIO MILLIVOLTMETER
Sensitive instrument for noise and signal measurement
THERMOCOUPLE METER
Remote sensing of several points

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INTRUDER ALARM
CMOS circuit for reliability
TOUCH SWITCH
Safe ac line operation
PUSH BUTTON DIMMER
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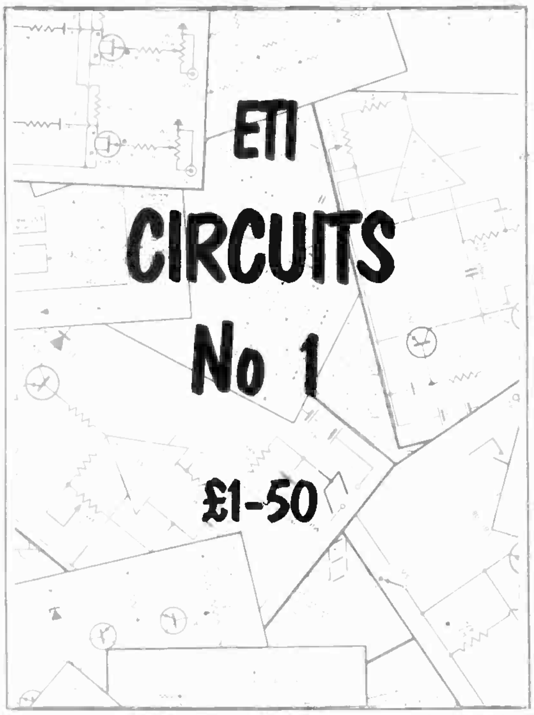

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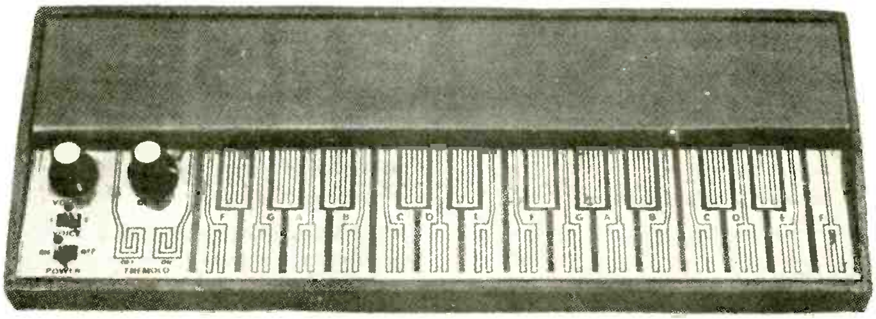
What to look for in the December issue: On sale Nov 5th

LOOK NO KEYS OR STYLUS! THE ETI TOUCH ORGAN



Something constructive for Xmas! An easy to assemble touch-keyboard electronic organ. All the components (keyboard as well!) are on one PCB, and the instrument has two voices, and a full two-octave range with touch controlled tremolo. Just the thing to keep someone happy — and drive someone else mad! Think of all those people you don't like — and give one to their kids!!

7-Segment Display Data sheet special

A new departure for Data Sheet this month, a step into the luminous world of 7-segment displays. There are many many types around, and we'll be burning the midnight filament to sort them out, so that you can be sure which is ideal for your particular display system.

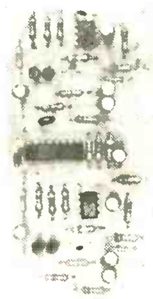
HEART-RATE MONITOR

An ingenious machine to see exactly how upset you really are! With no electrical connection to the body, the unit reads out heart-rate on a clear display. Ideal for use either by athletes or the bio-feedback experimenter.

How long can it last?

The continually rising sales have allowed us to keep the price at 30p — well below that of our competitors. We're proud of this and readers must forgive us for reminding them!

AUDIO LIMITER



The ETI Expander/Compressor (May 76) has proved very popular, but we have had requests for a simpler limiter circuit. So, you asked for this — here it is. A simpler circuit — a limiter — which can be used as limiter, automatic volume control, or even a voltage controlled amplifier.

ELECTRONICS: 2000AD

A new series by Dr Peter Sydenham which attempts to forecast what will be happening in the world of electronics in the year 2000. This first part is a look at how accurate forecasters have been before, and what are the chances for a successful future for looking into the future!

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ETI DATA SHEET

SL 600 SERIES **PLESSEY**

SL 610C 611C 612C — RF/IF AMPLIFIERS

ELECTRICAL CHARACTERISTICS

Characteristic	Circuit	Value Typ.	Units	Test Conditions
Voltage gain	SL610C	20	dB	30MHz Source = 25Ω
	SL611C	26	dB	30MHz Load R≥ 500Ω
	SL612C	34	dB	1.75MHz Load C≤ 5pF
Cut-off frequency (−3dB) (See Fig. 9)	SL610C	140	MHz	Source = 25Ω
	SL611C	100	MHz	Load R≥ 500Ω
	SL612C	15	MHz	Load C≤ 5pF
Noise Figure	SL610C	4	dB	Source = 300Ω, f = 30MHz
	SL611C	4	dB	Source = 300Ω, f = 30MHz
	SL612C	3	dB	Source = 800Ω, f = 1.75MHz
Max. input signal (1% cross modulation) No AGC applied	SL610C	100	mVrms	Load 150Ω, f = 10MHz
	SL611C	50	mVrms	Load 150Ω, f = 10MHz
	SL612C	20	mVrms	Load 1.2kΩ, f = 1.75MHz
Max. input signal (1% cross modulation) Full AGC applied	SL610C	250	mVrms	f = 10MHz
	SL611C	250	mVrms	f = 10MHz
	SL612C	250	mVrms	f = 1.75MHz
AGC range (See Fig 10)	SL610C	50	dB	
	SL611C	50	dB	
	SL612C	70	dB	
AGC current	SL610C	0.15	mA	AGC Voltage = 5.1V
	SL611C	0.15	mA	
	SL612C	0.15	mA	
Quiescent current consumption	SL610C	15	mA	Output open circuit
	SL611C	15	mA	
	SL612C	3.3	mA	
Change of voltage* gain with temperature	All types	±1	dB	−55°C to +125°C
Change of AGC range* with temperature	All types	±2	dB	−55°C to +125°C

*from nominal

OPERATING NOTES

The SL610C, SL611C and SL612C are normally used with pins 5 and 6 strapped. A slight improvement in noise figure, and an increase in the LF input impedance may be obtained by making the necessary AC connection via the earthy end of an input tuned circuit in the conventional manner.

It is evident that if an inductive element having inductance L1 and parallel resistance R1 is connected across the input, oscillation will occur if R_{in} is negative at the resonant frequency of C_{in} and L1, and R1 is higher than R_{in}.

Similarly, if a capacitor C1 in series with a resistance R2 is connected across the output oscillation will occur if, at the resonant frequency of L_{out} and C1, R_{out} has a negative resistance greater than the positive resistance R2. Where the input may be inductive, therefore, it may be shunted by a resistor and where the load may be capacitive 47Ω should be placed in series with the output.

These devices may be used with supplies up to +9V with increased dissipation.

The AGC characteristics shown in Fig. 8 vary somewhat with temperature: a preset potentiometer should not, therefore, be used to set the gain of either of these circuits if gain stability is required.

Test conditions: Supply voltage = 6V
Temperature = +25°C (unless otherwise stated)
Pins 5 and 6 strapped together
AGC not applied unless specified.

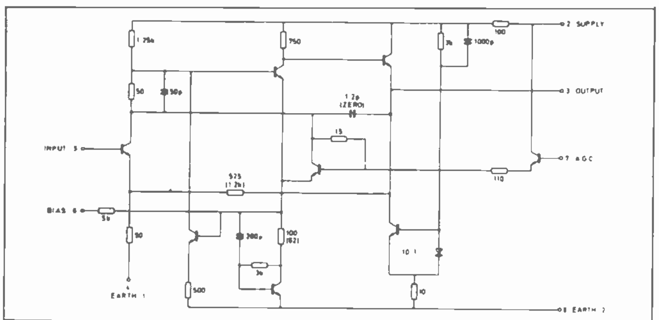


Fig. 1 Circuit diagram of SL610C and SL611C (Component values in parentheses refer to SL611C)

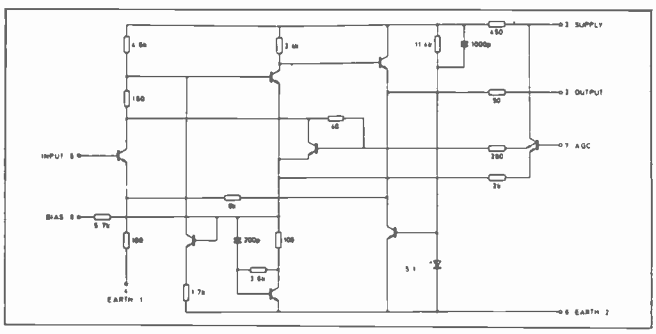


Fig. 2 Circuit diagram of SL612C

SL 620C SL 621C — AGC GENERATORS

ELECTRICAL CHARACTERISTICS

Characteristic	Circuit	Typ.	Units
Input for 0.65V dc output	SL620C	70	mVrms
Input for 1.5V dc output	SL620C	87	mVrms
Input for 2.2V dc output	SL621C	7.0	mVrms
Input for 4.6V dc output	SL621C	11.0	mVrms
*Fast rise time, t_1	Both	20	ms
*Fast decay time, t_2	Both	200	ms
*Slow rise time, t_3	Both	200	msec
Input 3 dB point	Both	10	kHz

Maximum fade rate*	SL620C	0.22	V/s
	SL621C	0.45	V/s
*Hold collapse time, t_4	Both	200	ms
*Hold time, t_5	Both	1.0	s
A.C. ripple on output	Both	12	mVp-p
Maximum output voltage	SL620C		V
	SL621C		V
Quiescent current consumption	Both	3.1	mA
Surge current	Both	30	mA
Input resistance	SL620C	1.4	kΩ
	SL621C	500	Ω
Output resistance	SL620C	40	Ω
	SL621C	70	Ω

OPERATING NOTES

The SL621C consists of an input AF amplifier TR1 – TR4 (3dB point: 10KHz) coupled to a DC output amplifier, TR16 – TR19, by means of a voltage back-off circuit, TR5 and two detectors, TR14 and TR15, having short and long rise and fall time constants respectively.

The detected audio signal at the input will rapidly establish an AGC level, via TR14, in time t_1 (see Fig. 2). Meanwhile the long time constant detector output will rise and after t_3 will control the output because this detector is the more sensitive.

If signals exist at the SL621C input which are greater than approximately 4mV rms they will actuate the trigger circuit TR6 – TR8 whose output pulses will provide a discharge current for C2 via TR10, TR13.

By this means the voltage on C2 can decay at a maximum rate, which corresponds to a rise in receiver gain of 20 dB/s. Therefore the AGC system will smoothly follow.

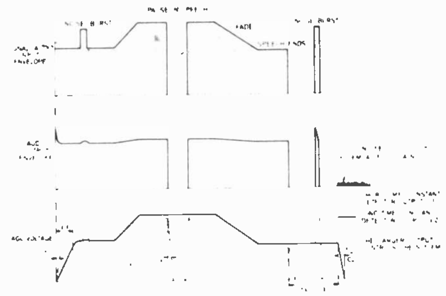


Fig. 2 Dynamic response of a system controlled by SL620C or SL621C AGC generator

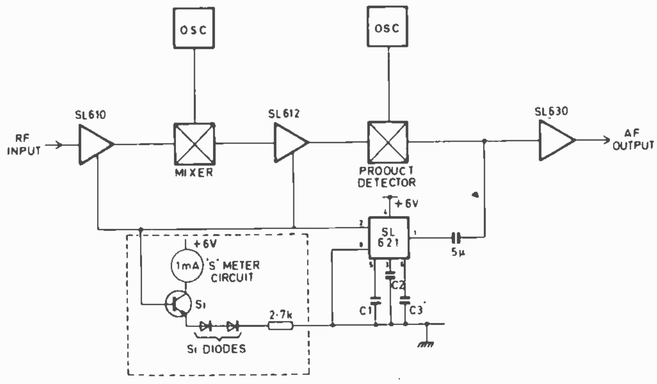


Fig. 3 SL621C used to control SSB receiver

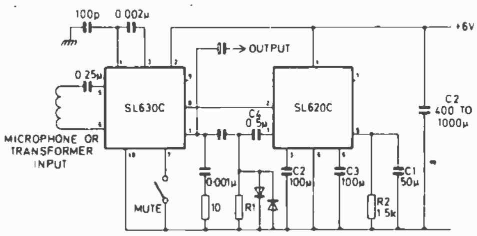


Fig. 4 SL620C used to control SL630C audio amplifier

signals which are fading at this rate or slower. However, should the receiver input signals fade faster than this, or disappear completely as during pauses in speech, then the input to the AGC generator will drop below the 4mV rms threshold and the trigger will cease to operate. As C2 then has no discharge path, it will hold its charge (and hence the output AGC level) at the last attained value. The output of the short time constant detector will drop to zero in time t_2 after the disappearance of the signal.

The trigger pulses also charge C3 via TR9, so holding off TR12 via TR11. When the trigger pulses cease, C3 discharges and after t_5 turns on TR12. Capacitor C2 is discharged rapidly (in time t_4) via TR12 and so full receiver gain is restored. The hold time, t_5 is approximately one second with C3 = 100μF. If signals reappear during t_5, then C3 will re-charge and normal operation will continue. The C3 re-charge time is made long enough to prevent prolongation of the hold time by noise pulses.

Fig. 2 shows how a noise burst superimposed on speech will initiate rapid AGC action via the short time constant detector while the long time constant detector effectively remembers the pre-noise AGC level.

The various time constants quoted are for C1 = 50μF and C2 = C3 = 100μF. These time constants may be altered by varying the appropriate capacitors.

An input coupling capacitor is required. This should normally be 0.33μF for an SL621C and about 1μF for an SL620C.

Fig. 2 shows how the SL621C may be connected into a typical SSB receiver.

Fig. 3 shows how the SL620C is used to control the gain of the SL630C audio amplifier. The operation of the SL620C is exactly the same as that of the SL621C and the diagram showing the dynamic response of the closed loop system, Fig. 1, is equally applicable to the SL630C/SL620C combination. Again, the time constants may be altered by varying the capacitor values.

The supply must either have a source resistance of less than 2Ω at LF or be decoupled by at least 500μF so that it is not affected by the current surge resulting from a sudden input on pin 1. The devices may be used with a supply of up to +9V.

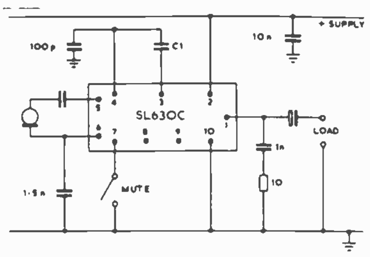
In a receiver for both AM and SSB using an SL623C detector/Carrier AGC generator, the AGC outputs of the SL621C and SL623C may be connected together provided that no audio reaches the SL621C input while the SL623C is controlling the system.

AGC lines may require some RF decoupling but the total capacitance on the output of an SL620 or SL621 should not exceed 15000pF or the impulse suppression will suffer.

SL 630C — HEADPHONE AMPLIFIER

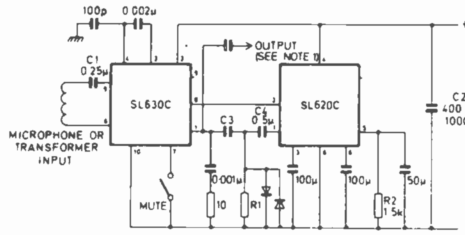
ELECTRICAL CHARACTERISTICS

Characteristic	Value Typ.	Units	Test Conditions
Differential input voltage gain	40	dB	Input 1mVrms
Single ended input voltage gain	46	dB	Input 1mVrms
Maximum output voltage	1.2	Vrms	6V supply
	2.8	Vrms	12V supply
Maximum output power			0.5% distortion
Quiescent current		mA	6V supply
		mA	12V supply
Differential input impedance	2.0	kΩ	
Single ended input impedance	1.0	kΩ	
Output impedance	1.5	Ω	
Gain control range (See Fig. 5)	100	dB	
Maximum input (with gain reduced)	50	mVrms	10% distortion
Short circuit output current	110	mA	Irrespective of supply

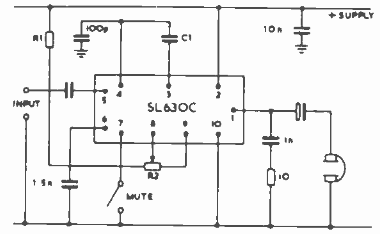


SL630C used as a microphone amplifier

SL630C used with a balanced input on pins 5 and 6. If the load resistance increases with frequency it is necessary to stabilize the output circuitry. This is accomplished with 10Ω in series with 1nF connected between pin 1 and earth. The earth return to pin 10 must not share any common leads, particularly with the input. Decoupling pins 2 and 6 should follow normal engineering practice.



SL630C used with SL620C to achieve automatic gain control



SL630C used as a headphone amplifier

To apply a g c., an SL620C should be used as shown in the circuit of Fig 4 This will give effective gain control with a low audio-frequency cut-off of 200 Hz and a control response of approximately 20 ms.

To preserve low-frequency stability and prevent motor-boating, C4 should not exceed the value given and, whilst R1 should not exceed 300Ω, the time constant C3R1 must not be greater than 800 µs

R2 is non-essential, but is useful if the input is likely to contain a large component below 300 Hz

C2 should be used if the power supply has a source impedance of more than a few ohms or is connected by long wires

The system should not be tested with sinewave inputs below 300Hz as such signals can give rise to delay effects not produced by speech waveforms.

SL 623C — AM DET./AGC AMP/SSB

ELECTRICAL CHARACTERISTICS

Characteristic	Value Typ.	Units	Test Conditions
SSB Audio Output	30	mV rms	Signal Input 20mV rms @ 1.748 MHz. Ref. Signal Input 100mV rms @ 1.750 MHz
AM Audio Output	55	mV rms	Signal Input 125mV rms @ 1.75 MHz. Modulated to 80% @ 1 kHz.
Quiescent Current Consumption	9	mA	Output open circuit
Max. operating frequency	30	MHz	
Change of SSB audio output with temperature +85°C	−0.5	dB	Signal Input 20mV rms @ 1.784 MHz. Ref. signal input 100mV rms @ 1.75 MHz.
−40°C	+0.5	dB	
Change of AM audio output with temperature +85°C	−0.25	dB	Signal Input 125mV rms @ 1.75 MHz Modulated to 80% @ 1 kHz.
−40°C	−0.25	dB	

The SL623C is a silicon integrated circuit combining the functions of low level, low distortion AM detector and AGC generator with SSB demodulator. It is designed specially for use in SSB/AM receivers in conjunction with SL610C, SL611C and SL612C RF and IF amplifiers. It is complementary to the SL621C SSB AGC generator.

The AGC voltage is generated directly from the detected carrier signal and is independent of the depth of modulation used. Its response is fast enough to follow the most rapidly fading signals. When used in a receiver comprising one SL610C and one SL612C amplifier, the SL623C will maintain the output within a 5 dB range for a 90 dB range of receiver input signal.

The AM detector, which will work with a carrier level down to 100 mV, contributes negligible distortion up to 90% modulation. The SSB demodulator is of single balanced form. The SL623C is designed to operate at intermediate frequencies up to 30MHz. In addition it functions at frequencies up to 120MHz with some degradation in detection efficiencies. The encapsulation is a 10 lead TO-5 package and the device is designed to operate from a 6 volt supply, over a temperature range of −55°C to +125°C

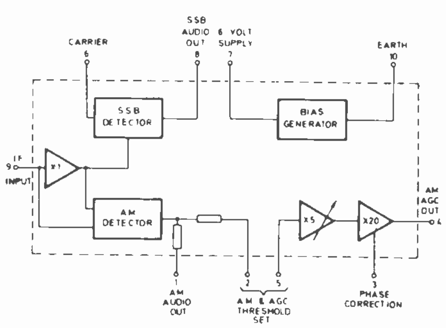


Fig. 1 Block Diagram

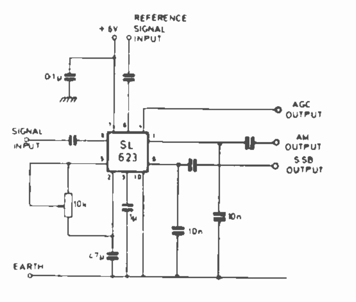
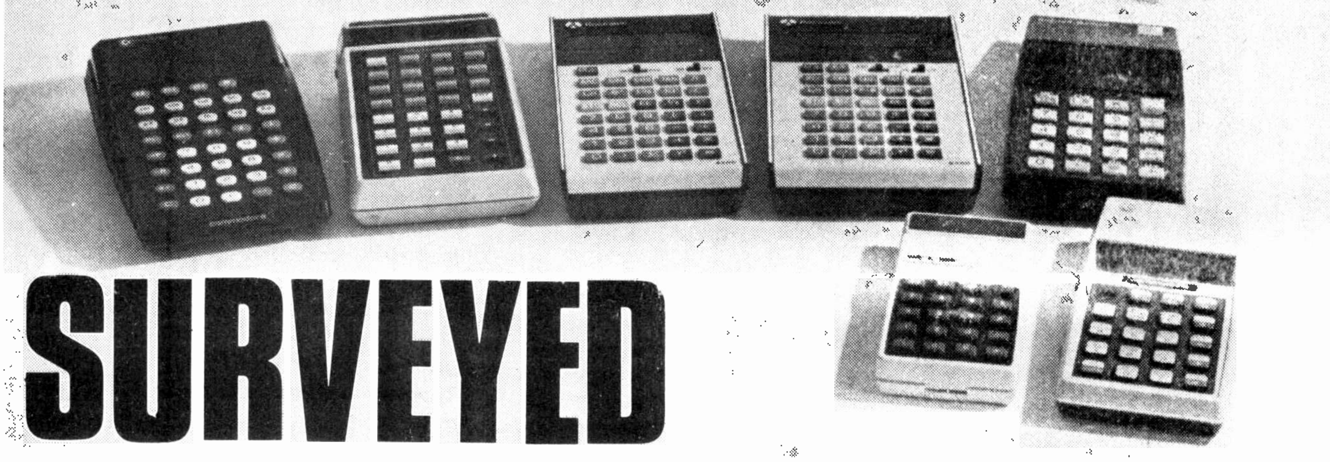


Fig. 2 Typical circuit using the SL623C as signal detector and AGC generator.

SEVEN RIVAL MACHINES PUT TO THE TEST — IN GREAT DETAIL . . . .

£10-20 SCIENTIFICS SURVEYED



THE IDEA FOR THIS survey was spawned in the entrance hall to one of those huge 'electrical office' shops. You know the kind, the carpet rustle's affectionately around your knees as you walk in, and your eyes are blinded by the reflections from the bright steel wallracks and the salesmen's chromium teeth.

Along the stretching-into-infinity shelves lie every possible denomination of machine, from the angels harp tuner (digital) to the Gestapo Mk IV hydraulic thumb screws (sure to break the ice at parties!) Our eyes wandered lovingly over the Kenweed Food Destroyer — guaranteed to mash anything and everything (dead or alive) into a tasteless, featureless, odourless pulp. Complete with 10 megaton coffee grinder. At last we reached the calculators. This is what we came for.

OBJECTIVE IN SIGHT

On special offer is the BMC 45Z maxi-calculator. Intrigued by the kilo-button case, we picked up the instruction manual-volume one, first supplement, and read:

"Complete with 152 fully addressable and potty trained memories, this programmable marvel comes to you with quadruple function keys and its own 2MV anti-theft alarm. (New! 21 digit code to remember!)."

Naturally the thing gives you an I.Q. test on purchase, and will refuse to work unless you score at least 250. Price? Mortgages available on request.

REALISM RETURNS

Somewhere amid these monuments to Man's incomprehension of Man are hidden away the budget (<£1,000) range of calculators, the ones people actually buy to *use*! A simple four function machine these days will rarely set you back more than £8, and by a little judicious pushing aside of RRP you can obtain memory and percentage facilities for even less than this.

Complex scientifics seem to begin at around £10 discount these days, and work their way (all to 10 decimal places with two digit exponent of course) towards that mythical brain destroyer mentioned above. At present the dizzy heights for portable machinery seems to lie amid the H.P. programmables and their rivals — admittedly few.

An increasingly popular pasture appears to be the £10-£20 field, and so it was here we decided to take a closer look at some of the boxes vying for your funds. In the past surveys of calculators, or indeed most other things, have attempted to include every machine within reach, be it manufactured in Balham or on the outer moons of Jupiter.

FIELD DEFINITION

Inevitably this results in a cross-indexed table of features and models. With such wide coverage it is impractical to test run every one, and so no clues as to how the beass were tamed, how they 'felt' to use can be included. Such things as whether the buttons are so close only a stick insect can operate them, but so stiff it takes 20 tons p.s.i. to do so, get lost in translation.

So gathering up our stick insects and courage we decided to be different. This time we'd take only a small number of the most popular calculators and put them through the same tests together. In this way a comparison of vices and virtues can be arrived at more readily, and should be of more use to those considering lashing out the hard-earned lucre on one of these worthy items.

ASSESSING . . .

Machines we included from National, Rockwell, Sinclair and CBM. We know there are many, many more, but this seemed a representative sample if not a complete population.

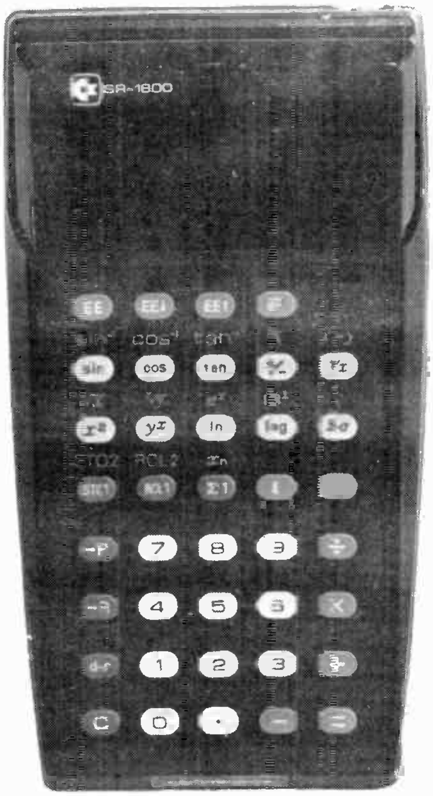
Each calculator is given consideration on the same criteria, and good and bad points are noted. We have attempted to draw no comparative conclusions, we'll leave that task to you and just hope we've provided enough information to make it easy.

. . . ACCURACY

It is difficult to give a definitive accuracy test for a pocket machine. What we did was to attempt to assess the accuracy of the trigonometric section of the calculators. To do this we keyed in 45°, or 0.8 rads, and then took sin, cos, tan, arcton, arcos, and arsin. We should now be back at 45° with a perfect machine.

Percentage errors are given for each machine. A word on pricing. We took the limits rather loosely, and worked in actual *selling* price, often a lot lower than RRP in these days of the dreaded discount.

CBM SR 1800



85 mm wide x 155 mm long x 40 mm deep

FEATURES:- sin, $\sin^{-1}$, x^2, $\sqrt{x}$, $\log_e$, R → P, $\frac{1}{x}$, EE↑, cos, $\cos^{-1}$, $\sqrt[x]{y}$, y^x, $\log_{10}$, d → r, x ↔ y, EE↓, tan, $\tan^{-1}$, e^x, 10^x, parentheses, memory, $\bar{x}$ and σ, EE, π.

DISPLAY:- Large, pleasant green colour.

INSTRUCTION MAN:- Well provided with examples, and layed out in a logical and clear manner. The text is slightly patronising though, and we wish they wouldn't refer to the 1800 as the mini-computer! A good manual nonetheless.

CASE STYLING:- Display visible over a wide area — can be used on a desk. Fitted with rubber feet, so it doesn't leap away whenever a key is pushed. Keys well spaced, with a light springy touch. No 'click' action.

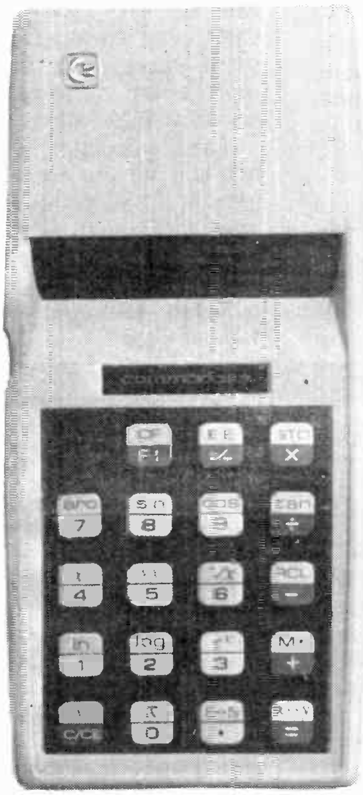
TRIG ACCURACY:- Degrees:- 0.00238% error
Radians:- no error detected.

THINGS WE LIKED:- Good feel to the buttons: can be used with rechargeable battery pack: sensible range of functions: good styling.

THINGS WE DIDN'T:- The display was un-readable under a 2000W green spotlight! — Otherwise absolutely nothing!

R.R.P. £24.00 **DISCOUNT PRICE £18.50**

CBM SR7919



65 mm wide x 135 mm long x 25 mm deep

FEATURES:- sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$ x^2, $\sqrt{x}$, $\frac{1}{x}$, $\log_e$ $\log_{10}$, e^x, π, y^x, memory, x ↔ y, 8 ↔ 5 (see text) EE.

DISPLAY:- Small, magnified, beneath wired red filter. Red naturally.

INSTRUCTION MAN:- Not so much a manual, more a way of folding up a sheet of paper! A small but clear pamphlet is provided, which covers all the machines functions and how to use them. It is well written and perfectly adequate for the job. A handy reference point since it is feasible to keep this in the pouch with the machine.

CASE STYLING:- CBM have avoided having too many keys on too small a space by making EVERY key double function. This can slow down operations, but once used to it should pose no problems. The case is solid and easy to hold in the hand. Just as well since the damn thing did a highland reel all over the desk when we tried to use it there!

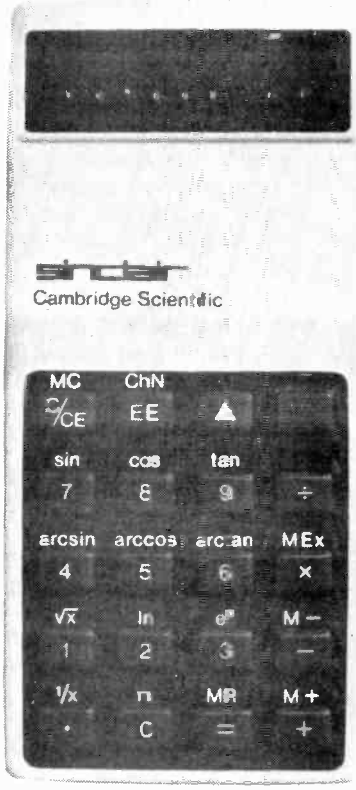
TRIG. ACCURACY:- Degrees:- 0.039% error.

THINGS WE LIKED:- Sensible size, and good action to the keys. The 8 ↔ 5 key which displays all the 8 digits the machine works in, rather than the 5 it usually shows in scientific notation. Excellent value for money.

THINGS WE DIDN'T:- Unavoidable we know, but all those double function keys unnerved us.

R.R.P. £14.50 **DISCOUNT PRICE £11.50**

SINCLAIR SCIENTIFIC



50 mm wide x 110 mm long x 15 mm deep

FEATURES:- sin, cos, tan, $\sin^{-1}$, $\tan^{-1}$, $\frac{1}{x}$, $\sqrt{x}$, π, $\log_e$, e^x, memory.

DISPLAY:- Tiny (magnified) red.

INSTRUCTION MAN:- O.K. We give up. Please Sinclair, why make the book the same size as the calculator? As a result the print is minute, and the information not presented in a way that the (excellent) content deserves. A useful production all the same. I wonder if they'll try to put it on a postage stamp next time?

CASE STYLING:- Definitively pocket sized! As a result we have crowded keys, and very limited viewing angle on the display. Not for desk use, – it slides all over the place. Click action keys, but they are so stiff and so close that this negates the advantage. Perhaps the style has aged a little in comparison with its peers.

TRIG. ACCURACY:- Degrees:- 33.3% (Thirty three point three) error.
Radians:- 0.005% error.
Degree error abominable!

THINGS WE LIKED:- True algebraic e.g. 12x(.3)=36

THINGS WE DIDN'T:- Size, key spacing and stiffness, display, trig accuracy. The fact it doesn't work out trig function for angles greater than 90° is a little annoying!

DISCOUNT PRICE £12.95

SINCLAIR OXFORD 300

75 mm wide x 115 mm long x 30 mm deep

FEATURES:- As Cambridge Scientific.

DISPLAY:- Large, sensibly angled and green in colour.

INSTRUCTION MAN:- Apart from the introduction this is identical to the book on the Cambridge, not surprising since the insides are the same as well! The larger page size helps the presentation.

CASE STYLING:- Very good as a small desk-top machine Large angle of display visibility, good stability and well spaced keys. If anything these were a little too positive, and tended to slow down operation.

TRIG. ACCURACY:- Degrees:- 33.3% error. No further comments.
Radians:- .025% error.

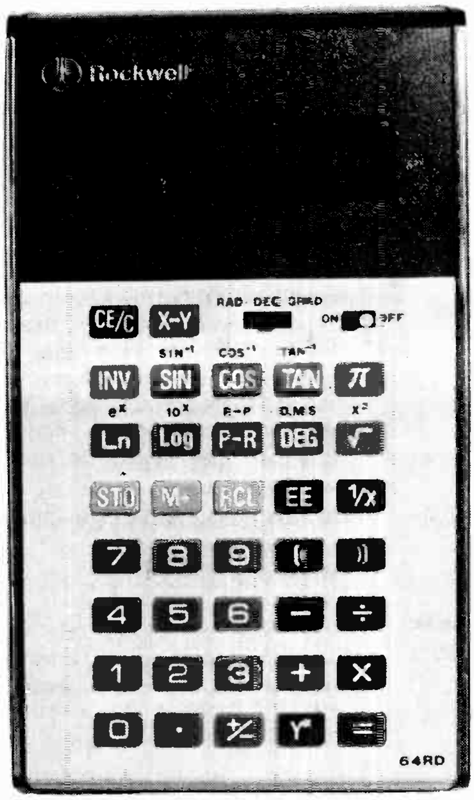
THINGS WE LIKED:- As on the Scientific, the 'function in use' and error indicators, and the overall style. Very good value for money, and ergonomically sound as a desk-top.

THINGS WE DIDN'T:- That terrible trig accuracy,in degrees. Work in radians if possible.

DISCOUNT PRICE £14.95

ROCKWELL 64RD

90 mm wide x 155 mm long x 25 mm deep



FEATURES:- sin, sin^{-1}, x^2, $\sqrt{x}$, log_e, R → P, $\frac{1}{x}$, cos, cos^{-1}, $\sqrt[x]{y}$, y^x, log_{10}, rads → deg → grad, x ↔ y, tan, tan^{-1}, e^x, 10^x, parentheses, memory, EE, π.

DISPLAY:- Large, green in colour.

INSTRUCTION MAN:- A multi-lingual brew, which tends to lose a little in detail as a result. The examples are not as clear as they might be. Useful, but not as good as the machine!

CASE STYLING:- Very nice key action, although a little too close together for our personal taste. The clear button seemed somehow out of the way up in the top left-hand corner. Excellent display viewing angle-good for desk use (fitted with rubber feet). Nicely styled overall.

TRIG. ACCURACY:- Degrees:- 0.7% error
Radians:- 0.028% error
Grad:- 2.384% error

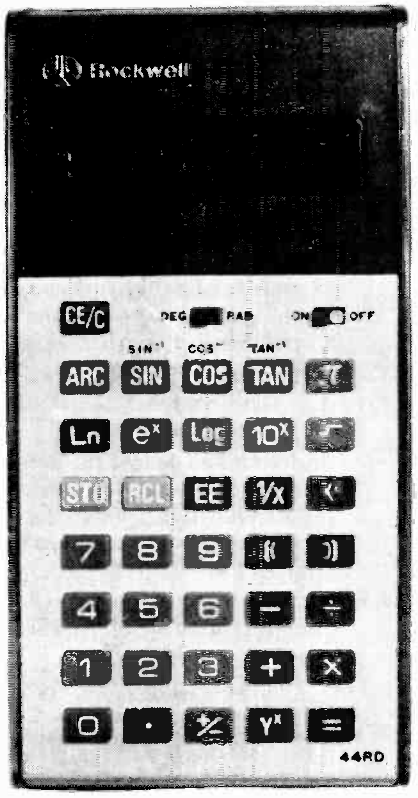
THINGS WE LIKED:- The styling and the feel of the keys. Also the good display visibility.

THINGS WE DIDN'T:- Those closely packed keys, and the conversion error when working in grads. Misplaced y^x and clear keys.

R.R.P. £29.95 **DISCOUNT PRICE £19.80**

ROCKWELL 44RD

75 mm wide x 155 mm long x 25 mm deep



FEATURES:- sin, cos, tan, sin^{-1}, cos^{-1}, tan^{-1}, π, e^x, log_e, log_{10}, 10^x, $\sqrt{x}$, x^2, $\frac{1}{x}$, memory, y^x.

DISPLAY:- As 64RD

INSTRUCTION MAN:- Written to the same standard as the manual for the 64RD. For this machine this makes it very adequate indeed. A little more detail could have been included we feel, but no real complaints.

CASE STYLING:- Virtually identical to its big brother, except that the case is smaller so the keys look even more cramped! In fact they're not, so don't worry. Once again good for desk use, and easy to hold in the hand being slimmer than most. All 64RD comments apply!

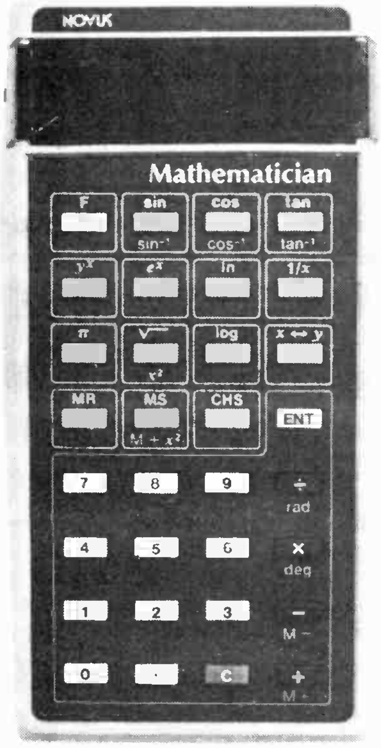
TRIG. ACCURACY:- Degrees:- 1.546% error.
Radians:- No error detected.
Different algorithims to 64RD.

THINGS WE LIKED:- Good size for hand use, and very good value.

THINGS WE DIDN'T:- Those lost y^x and clear keys, and once again the stick insect key spacing.

R.R.P. £19.95 **DISCOUNT PRICE £15.00**

NOVUS 4510



75 mm wide x 145 mm long x 30 mm deep

FEATURES:- sin, cos, tan, sin^{-1}, tan^{-1}, y^x, $\log_e$, $\log_{10}$, $\frac{1}{x}$, π, x^2, $\sqrt{x}$, $x \leftrightarrow y$, memory, $M + x^2$, $d \rightarrow r$.

DISPLAY:- Small, magnified National display-red.

INSTRUCTION MAN:- An excellent example this of all a manual should be. Well presented, comprehensive instructions with good clear examples. A useful bonus is the explanation of RPN included as an appendix. Ten out of ten.

CASE STYLING:- In a word — bulky. The case is large but light, giving the machine a perculiar 'hollow' feel. A fairly good viewing angle means it could be put to desk use if needs must. The buttons are very small, but are well spaced. The 'feel' of the buttons though is very 'springy' and frankly disconcerting.

TRIG. ACCURACY:- Degrees:- 1.63% error.
No radians mode.

THINGS WE LIKED:- Battery saving display turn-off after no keys have been pressed for 35 secs.

THINGS WE DIDN'T:- The 'hollow' feel of the machine, and the buttons. One major drawback is the lack of ability to work in scientific notation. This limited the machine to numbers smaller than 99,999,999! Not good therefore for scientific use.

DISCOUNT PRICE £14.60

SURVEY SUMMARY

CBM SR 1800: — Very good manual. Excellent value for money. Good large display with good viewing angle. Incredible trig accuracy. Good for either desk or hand use. Good well spaced keys with good sound action. Rechargeable punch available.

CBM SR 7919: — Very good value for money. Small display not vertically readable. Good hand held machine and good instruction pamphlet. All keys are double function, and have a good feel to them.

NATIONAL 4510: — Excellent instruction manual. Poor case and key construction. Cannot work in scientific notation. Good viewing angle to display.

ROCKWELL 44RD: — Very good value for money: sensible size, good display, cramped keys once again, but with a good operational feel to them. Adequate instruction manual.

ROCKWELL 64RD: — Superbly styled. Good for desk use. Large display with large visibility angle. Keys very close together. Clear key in odd position. Good key action, nice solid feel to it as a whole.

SINCLAIR OXFORD 300: — Good display — intended as desk-top machine — good large keys, with solid click action. Trig accuracy atrocious in degrees mode makes a better desk calculator than it does a hand-held machine.

SINCLAIR SCIENTIFIC: — Although introduced some time ago it is still the smallest — genuine pocket size — and suffers because of this in respect of key spacing, display etc. A well written manual — pity they've made it the size they have.

VARIABLE CAPACITORS

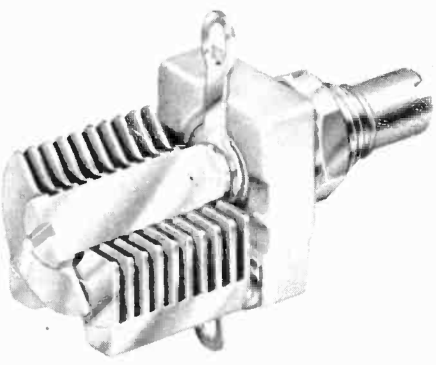
part 4

Our series on passive components has already presented valuable reference data on fixed capacitors. In this part we look at the range of variable capacitors available and where to use them.

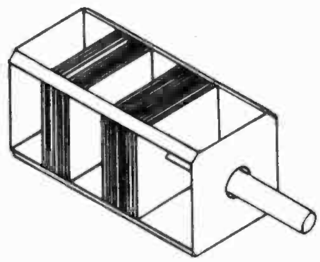
VARIABLE CAPACITORS CAN BE divided into two basic groups: continuously variable types, generally called tuning capacitors, and preset types, generally called trimmers.

Tuning capacitors have a set of fixed plates and a set of moving plates that mesh with the fixed plates. The position of the moving plates with respect to the fixed plates determines the capacitance. Capacitance is maximum when the plates are fully meshed. The dielectric may be air, mica or plastic film. Various tuning capacitors are shown in Fig. 1. Most tuning capacitors have air as the dielectric. Miniature tuning capacitors such as those used in portable transistor radios, have a plastic film dielectric. As this has a greater permittivity than air, a considerable reduction in size is achieved. Precision tuning capacitors such as those used in instruments and communications receivers have precision ball-race bearings at each end of the shaft and a heavy, rigid frame to provide stability and reset accuracy.

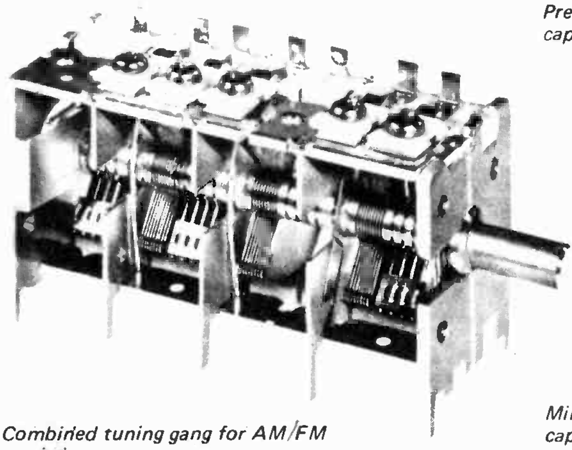
Fig 1. Different types of variable capacitor used where the circuit requires continual readjustment.



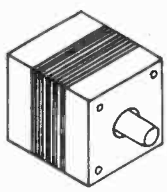
Low capacitance, single section air dielectric variable capacitor.



Precision, high stability, tuning capacitor.



Combined tuning gang for AM/FM receiver.



Miniature, film dielectric tuning capacitor from portable transistor receiver.

Tuning capacitors are available in various sizes and values for different applications. Those for receiver applications generally have small, closely-spaced plates, several units being "ganged" together in one frame so that several circuits may be tuned simultaneously. Two and three gang capacitors are quite common. The plates are often semi-circular or specially shaped to produce the desired tuning scale or "law". This is done to obtain linear or logarithmic dial calibrations for example.

There are four basic tuning characteristics.

Linear Capacitance For each degree of rotation there is an equal change in capacitance. For example, a capacitor may change by 2 pF for each degree of rotation. This produces a square-law dial scale.

Linear Frequency Each degree of rotation causes an equal change in frequency. This produces a linear dial scale. This characterisation is very useful in tuners and communication receivers.

Log Frequency Each degree of rotation produces a constant percentage change in frequency, e.g. a 1% change in frequency for each degree of rotation. This produces a logarithmic dial scale which is sometimes seen on AM tuners and broadcast receivers. It is often used in measuring instruments and signal generators.

Square Law The variation in capacitance is proportional to the square of the angle of rotation. This is also used in measuring instruments. Typical dial calibrations and capacitor tuning law curves are shown in Fig. 2.

Multiple-gang capacitors are commonly used in superhet receivers, particularly AM and FM broadcast receivers, where the RF, mixer and oscillator circuits are ganged to tune a range of frequencies. Usually, each section of a gang covers the same capacitance range and has the same tuning law. As the oscillator circuit covers a different frequency range from the RF and mixer, one section of a gang may have less plates and thus a different capacitance range or a slightly different tuning law. This is done so that the oscillator can correctly "track" the RF and mixer circuit with an almost constant frequency difference (the intermediate frequency).

Maximum and minimum capacitance values used for tuning the AM broadcast band and in general coverage HF receivers are:—

3 – 120 pF
10 – 240 pF
4 – 250 pF
6 – 340 pF
10 – 365 pF
11 – 415 pF

For the 88-108 MHz FM broadcast band, common values are:—

0.9 – 19 pF
1 – 22 pF
2 – 32 pF
7 – 40 pF

Some gangs may have each section fitted with trimmers so that the effect of stray capacitance may be compensated for and to provide alignment for the high frequency end of the tuning range.

Tuning capacitors for use in transmitters usually have large, widely-spaced plates to withstand high voltages, and special connections to reduce inductance and to conduct high RF currents. Semi-circular plates are commonly used. For push-pull tuned circuits, requiring two sets of fixed plates and common moving plates, 'butterfly' capacitors are used. See Fig. 3. The construction permits 90° rotation only. 'Split-Stator' capacitors are also used in this application: these have two sets of semi-circular rotor plates on opposite sides of a common shaft and two sets of stator plates with separate connections. These turn a full 180°.

TRIMMERS

Trimming capacitors are available in a wide variety of constructions and adjustment methods. The most common dielectrics are air, mica and ceramic, although glass and quartz are also used for their superior temperature stability. A representative selection is illustrated in Fig. 3.

Vane Trimmers These trimmers have solid metal plates that may be silver-soldered to a rigid frame or the plates and frame milled from a single piece of specially shaped metal. The latter have better mechanical and electrical stability. The capacitor assembly is usually fixed to a ceramic mounting plate. This type of trimmer is usually more costly than other types but has superior electrical characteristics. Vane trimmers are available in a wide variety of values and sizes, with breakdown voltage ratings from 100 V to 1500 V, depending on the air gap between the fixed and moving plates. Butterfly and split-stator types can also be obtained.

Concentric or 'Beehive' Trimmers The fixed and moving plates of these trimmers are constructed from short sections of different diameter aluminium cylinders, nested inside each other and mounted concentrically around a central shaft. The diameters of the moving plates are such that they mesh between the fixed plates with a small air gap. The central shaft is threaded and a hexagonal boss on top of the moving plates enables capacitance to be adjusted by using a simple plastic tool. These trimmers are cheap and have a wide variety of applications. They are made in several values, the most common being 3-30 pF and 5-60 pF. Their breakdown voltage is usually above 250 V, although it is not *recommended* that they be operated at high voltages. The threaded centre shaft imparts a vernier action which makes adjustment easy and accurate.

Compression Trimmers These consist of several thin plates of springy metal interleaved with a mica or plastic film

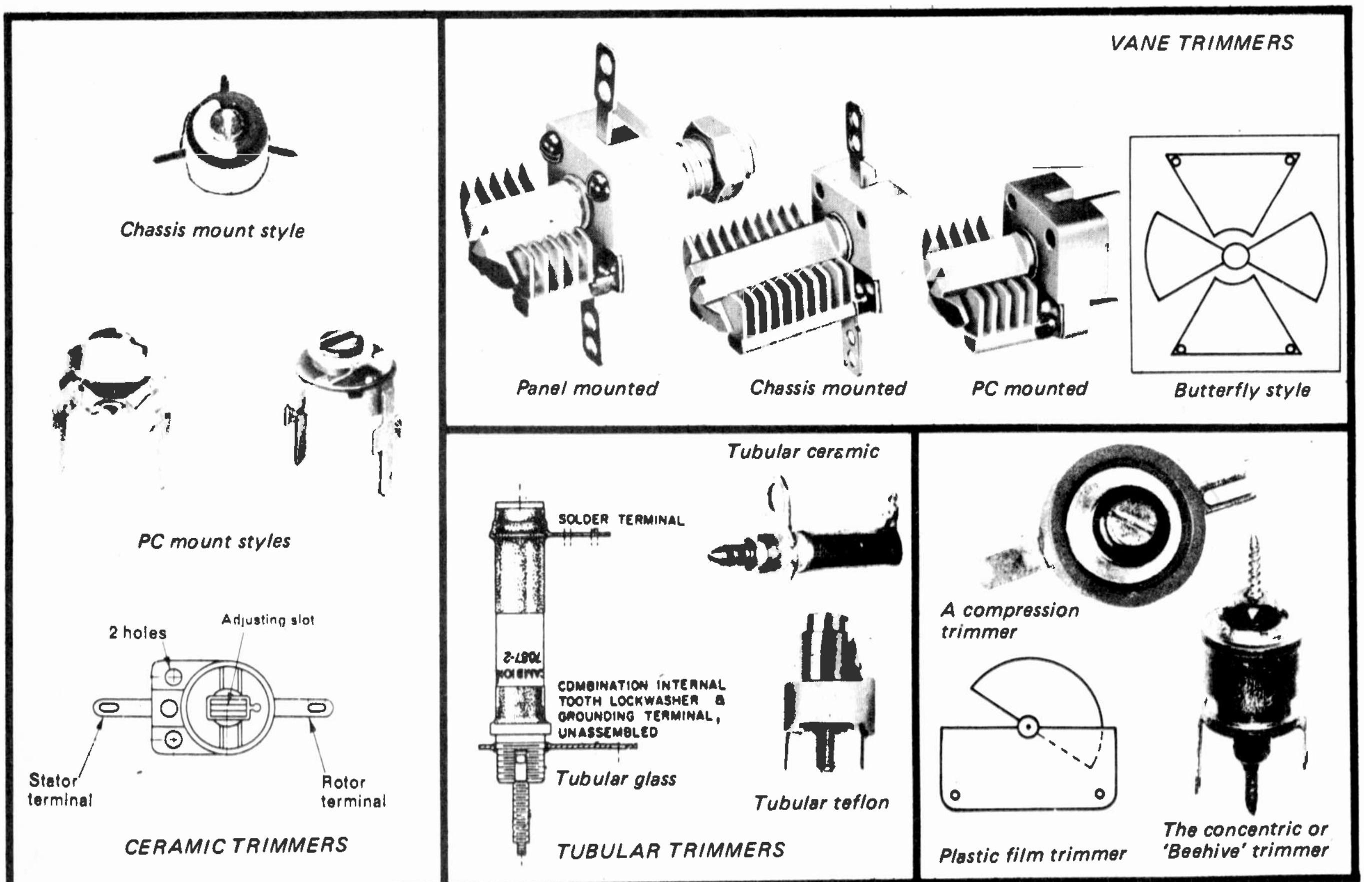


Fig. 3. Different types of trimmers. These are used when the circuit requires adjustment in setting-up but not in everyday use.

VARIABLE CAPACITORS

dielectric. An insulated screw is passed through the centre of the plates and threaded into a phenolic, plastic or ceramic mounting compressing the springy plates. The further the screw is turned in, the more compression is applied to the plates, thus increasing the capacitance. Trimmers of this type are usually quite inexpensive. Their stability is not very good but is nevertheless adequate for many applications, but they drift appreciably with time necessitating frequent realignment.

Mica compression trimmers are generally constructed on a ceramic mount. They have the best characteristics of all the compression trimmers and find application in solid state transmitters as they can withstand appreciable RF currents. Some types are manufactured especially for this application. The other styles having a phenolic or plastic mount are used mostly in receiver or non-critical instrument applications.

Compression trimmers are capable of quite a wide adjustment range — an advantage over other trimmers, although the adjustment may be coarse and quite non-linear. Typical minimum and maximum values are:—

2 – 25 pF
3 – 30 pF
2.5 – 40 pF
3 – 55 pF
10 – 80 pF
30 – 150 pF
20 – 220 pF

Compression trimmers have a large, and not really predictable temperature co-efficient that varies appreciably over their range. Their breakdown voltage is in the order of 100 V to 300 V.

Plastic Film Trimmers. These are constructed in a way similar to vane trimmers and generally have semi-circular fixed and moving plates with a plastic film dielectric. Consequently they are smaller in size for similar values. These trimmers are relatively inexpensive and are a good alternative to air dielectric trimmers. They generally have a negative temperature coefficient of about 200 ppm/°C (decrease capacitance with increasing temperature). They are generally manufactured for p.c. board mounting although chassis-mounting styles are available. Typical minimum and maximum values are:—

1 – 5 pF
1.8 – 10 pF
2 – 18 pF
1.5 – 20 pF
4 – 40 pF
5 – 60 pF
7 – 100 pF

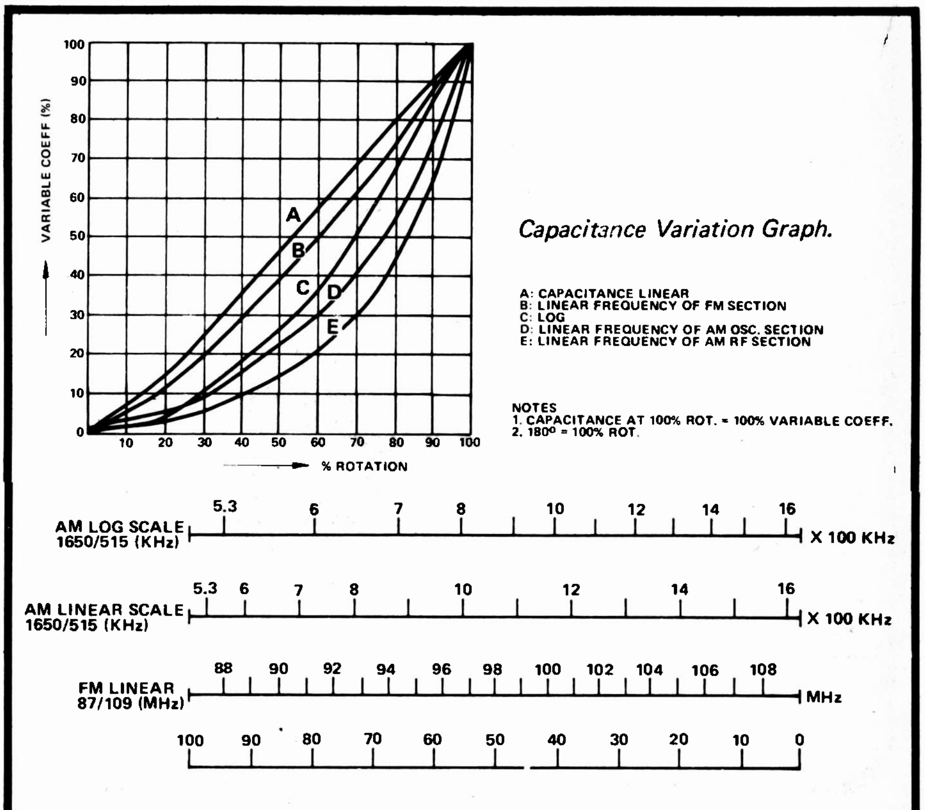


Fig. 2. The standard dial formats.

Film dielectric trimmers generally have a breakdown voltage of 100 V.

Ceramic Trimmers. These consist of a ceramic body with a semi-circular metal film deposited on it as the fixed plate. The moving plate is a ceramic disc with a semi-circular film (the same size as the fixed plate) deposited on it, and pivoted over the fixed plate by a metal screw which is soldered to the metal film. The screw passes through a nut in the ceramic body, the moving plate connection being made to this nut.

Ceramic trimmers are available having a variety of temperature characteristics ranging from P 100 to N 500, the more common values having negative temperature coefficients. Typical maximum and minimum values and temperature coefficients are:—

2 – 4 pF/P100
3 – 9 pF/N033 or N075*
3 – 12 pF/N 470
4 – 20 pF/N 470 or N 750*
7 – 35 pF/N 1500
10 – 60 pF/N 1500

* Characteristic depends on size, the subminiature ones having the smaller coefficient. Ceramic trimmers are obtainable in pc board or chassis mounting styles and may be operated at voltages of at least 200 V or greater.

Tubular Trimmers. Tubular trimmers are also known as 'piston' trimmers. They consist of a tube of dielectric material which has a metal band or metal film around one end forming the fixed plate and a threaded metal cap on the other, through which passes a screw; this latter assembly forms the moving plate. The dielectric material may be ceramic, glass, PTFE (Teflon), polypropylene or quartz. Tubular trimmers are very stable but are used only in VHF/UHF receiver applications (i.e. TV tuners, VHF converters as their particular construction limits the maximum capacitance obtainable. However, ceramic, glass and quartz types can withstand considerable RF currents and voltages, so find some applications in transmitters. Typical working voltages are 250 Vdc to 600 Vdc. Tubular trimmers with a plastic dielectric are generally cheapest, the more costly styles being ceramic, glass and quartz. Typical maximum and minimum values are:—

0.25 – 1.5 pF
0.7 – 3 pF
0.8 – 8.5 pF
1.8 – 10 pF
0.8 – 12 pF
0.8 – 23 pF
0.8 – 38 pF
2 – 60 pF

Both printed circuit and chassis mounting styles are available. ●

100W DISCO

PART THREE

ETI project 458

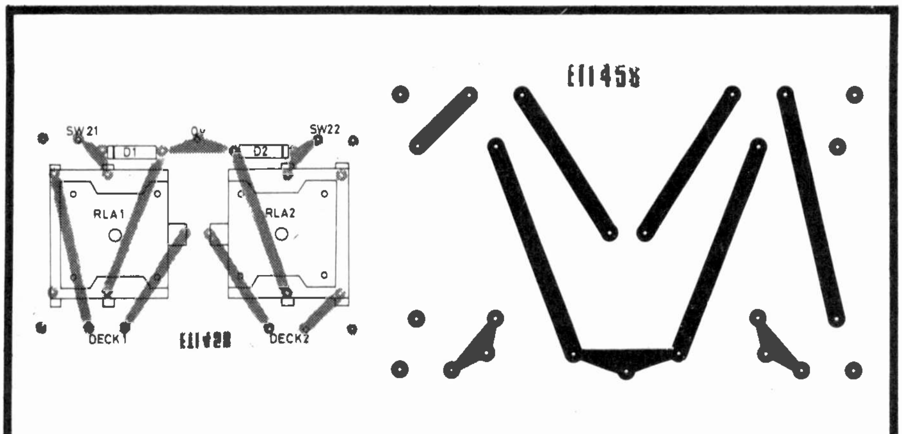
THIS LIGHT MODULATOR is a high quality unit having three output channels, each capable of driving loads in excess of 1kW, 750W with spotlamps, or 100W when fitted within the console. The unit includes an automatic gain control so that continual readjustment of the sensitivity controls is not necessary and after initial adjustment will operate correctly with inputs from 100mW-100W! However, manual control is provided, and may be selected if desired. Individual sensitivity controls are provided so that trigger levels may be set individually for each channel.

The crossover frequencies for the channels are at approximately 550Hz and 3kHz, and the filters have a very sharp roll-off outside the pass band. The triggering is designed to occur just after the instantaneous a.c. mains voltage crosses the OV point so that radio frequency interference is virtually eliminated.

L.E.D.'s are provided which light in unison with the lamps, and thus it is possible to check from the console that the individual sensitivity controls are at their most favourable settings. The circuit is arranged such that if a bulb goes open circuit the L.E.D. associated with that channel lights continuously, providing immediate indication of the failure.

SETTING-UP

Turn VR2, 3 and 4 fully clockwise, VR1 to "off" (auto) and feed in a music signal (about 1W) which contains all frequencies — all the lamps will flash. Adjust VR5 fully clockwise (minimum resistance). If the lights do not flash disconnect the mains and reverse the connections to the primary of T4. Re-connect the mains and turn VR5 anti-clockwise until one or more of the lamps ceases to flash altogether. Now turn VR5 clockwise again very slowly until all the lamps operate. All the thyristors should now be firing at the correct point. To obtain the most pleasing effect the channel controls VR2, 3 and 4 can be adjusted.



Layout and pattern for the remote start board

CONSTRUCTION

Fit the components to the circuit board as shown. The wiring of the components on the front panel associated with this board is shown. Connect the OV from the p.c.b. to the earth link between the two main power supply capacitors C1, C2. Run a wire from the O/P of FSI on each 100W Amp Board to pin LM1 and pin LM2 for the other channel. The transformer should be bolted to the p.c.b. using 4BA×¼in. bolts and nuts. Twist together the pair of wires to each L.E.D. and insulate the leads of the L.E.D.'s.

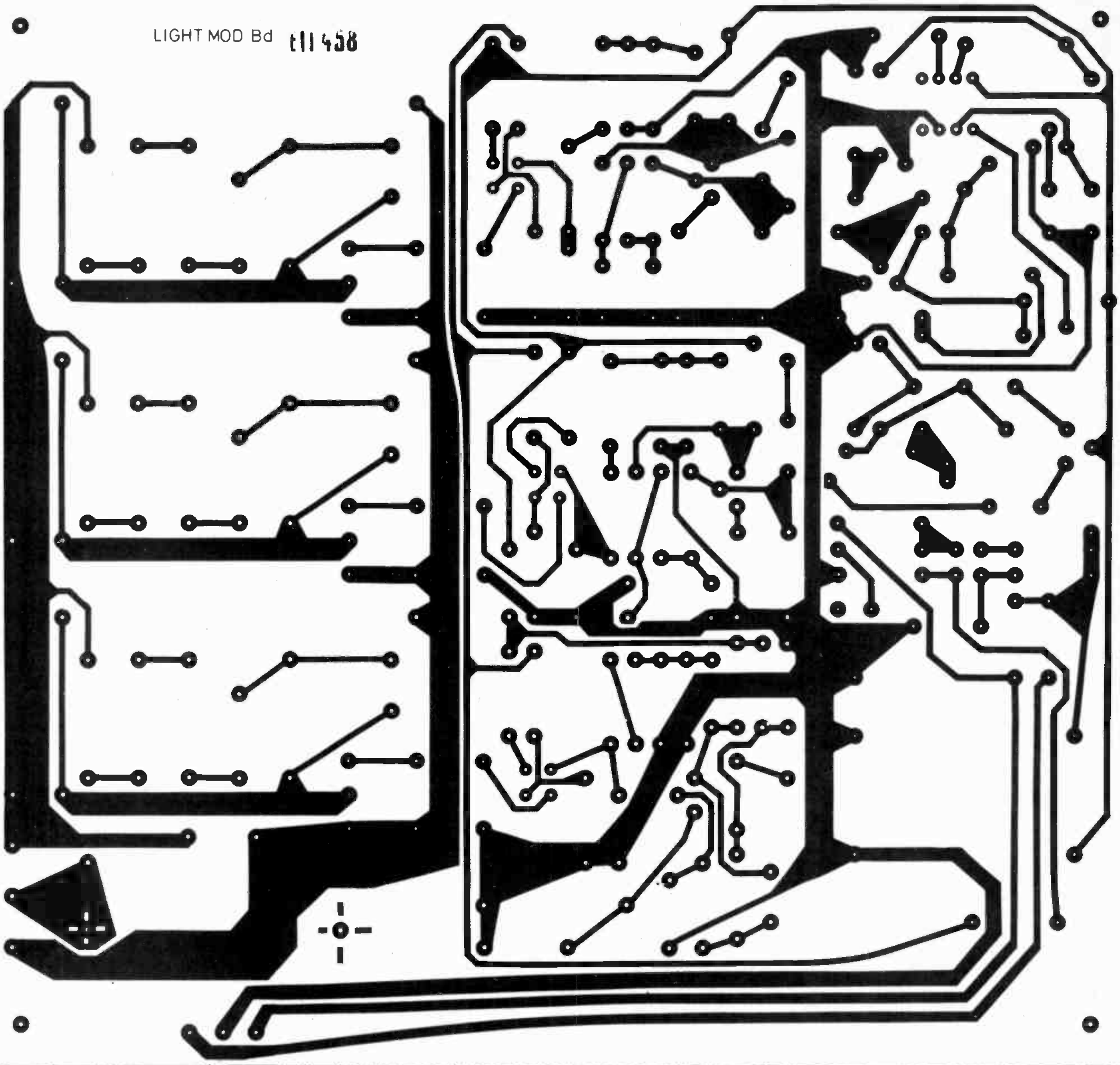
DECKS MOTOR SWITCHING BOARD

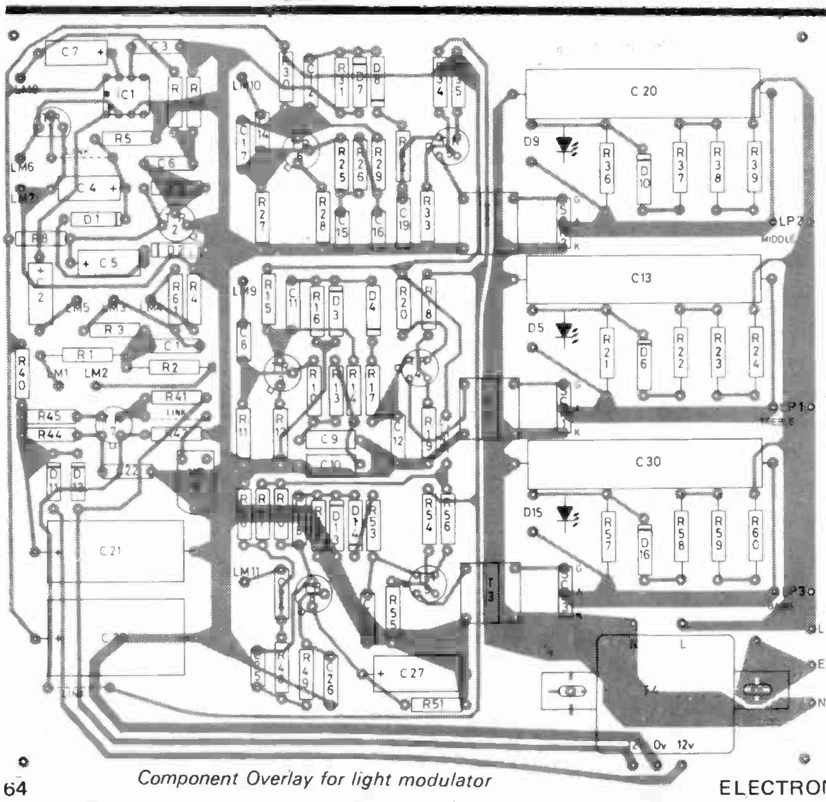
Fit the diodes, relays and wiring pins to the board as shown.

Fix the p.c.b. to the underside of the motor board between the two decks making quite certain that the circuit board does not foul the top of the transformer or any other component which is mounted on the baseboard. This is most important since the chassis of the relay will be live when in use. Drill two ¼in. holes in the front pane such that one hole is ¾in. from one end of the cross-fade control slot (and in line with it) and the other hole is ¾in. from the other end of that slot, and fit SW21 and SW22.

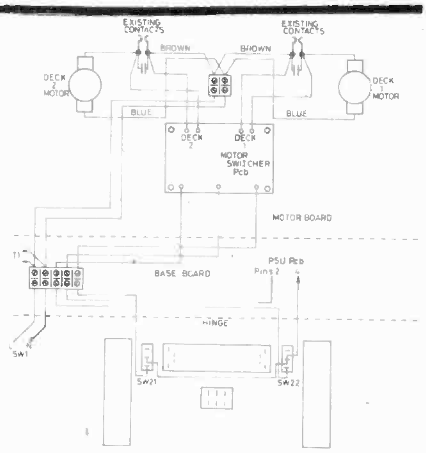
On both decks; before fixing the platter on the BDS80 turntable, remove the two screws securing the paxolin cover on the motor switch which is next to the motor (taking care that you don't lose the nylon nut which holds one of the screws tight, and is on the other side of the chassis) and connect wires to the tags inside the switch as shown

This will enable the deck

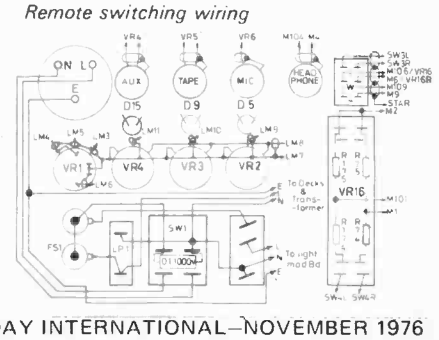




Component Overlay for light modulator



Remote switching wiring



How it works

A full wave rectified supply is provided by T4, D11, D12, C21 and R40, and is fully smoothed by C23. The mixed stereo signals are applied to an automatic gain control (IC1). When VR1 is fully anti-clockwise its switch contacts are open and the gain of IC1 is controlled by its own output.

TR1 is an emitter follower which couples the high impedance control voltage into pin 2 of IC1. When VR1 is turned clockwise SW1 closes and pin 2 of IC1 is connected to OV thus fixing the gain of IC1 at maximum. R4 is short circuited and the sensitivity of the unit is now completely under the control of VR1. Since the amplitude of the high frequencies is usually much less than the bass frequencies, C1 has been added to boost these frequencies.

The components around TR3 form a high pass filter for the high frequency channel; those around TR6 a band-pass filter for the mid range channel; and those around TR8 a low pass filter for the bass. The subsequent circuitry is identical for each channel, and so, considering the treble:— the output from the filter is rectified by D3 and D4 and used to charge C12. This voltage appears across the anode (a) and cathode (k) of a programmable unijunction transistor TR4, which presents a very high impedance until a trigger pulse is applied to the cathode gate (kg).

This is produced as follows: A d.c. voltage flows through R44 and charges C22. This remains charged until the unrectified (instantaneous) voltage from T4 reaches the trigger valve for TR7.

TR7 switches on very quickly causing C22 to discharge through R43 and produce a very short duration pulse used to trigger TR4, 5 and 9.

VR5 is provided so that the timing of the trigger pulse may be adjusted to coincide with the a.c. mains on the bulbs just crossing over into its positive phase. Thus a trigger pulse is applied to the cathode gate (kg) of TR4 by TR7 at the instant when the a.c. mains voltage is about +10V. This pulse causes TR4 to turn on and C12 to discharge through the primary of T1. A pulse appears on the secondary. This fires SCR1 as the voltage exceeds the threshold point, thus lighting LP1.

The L.E.D., D5, also lights. D6 prevents current flowing through the resistor chain to the L.E.D. when the mains voltage is in its negative phase. If a bulb goes open circuit the a.c. mains is coupled through C13 to the L.E.D. which lights continuously.

Parts List

LIGHT MODULATOR

R1, 2	1k5 ½w std res	ICI	MC3340
R3	6k8 ½w std res	TR1	2N3905
R4	22DR ¼w min res	TR2, 3, 6, 8	BC108
R5	330k ¼w min res	TR4, 5, 7, 9	BRY39A
R6, 7, 17, 32, 53	22k ¼w min res	SCR1, 2, 3	BT109
R8	3k3 ¼w min res	D1, 2	OA 91
R9	560K ¼w min res	D3, 4, 7, 8, 13, 14	1N 4148
R10, 11, 13, 14, 16, 25,		D5, 9, 15	LED RED
26, 27, 29, 31, 47, 52,	100k ¼w min res	D6, 10, 16	1N4004
R12,	22R ¼w min res	D11, 12	1N 4001
R15, 30, 50	6k8 ¼w min res		
R18, 19, 33, 34, 46, 48,	10k ¼w min res	TR1, 2, 3	Pulse Transformer 1:1
49, 54, 55,	220k ¼w min res	TR4	Sub Min Transformer 12V
R20, 35, 44, 45, 56	2k2 ¼w min res		
R21, 36, 57			
R 22, 23, 24, 37, 38, 39,	8k2 1w res		
58, 59, 60	39R min res		
R28	120R ½w std res		
R40	270k min res		
R41	33k min res		
R43, 51	1k min res		
R50	8k2 ¼w min res		
R61			
VR1	SW Pot Log 5k		
VR2, 3, 4	Pot Log 100k		
VR5	Horiz S-min preset 100k		
R53	22k		
C1	Polyester .033µF		
C2	Axial 1uF 63V		
C3	Polystyrene 470pF		
C4	Axial 4.7µF 63V		
C5, 7	Axial 10µF 25V		
C6, 11, 18, 22, 24, 26,	Polyester .1 µF		
28	Mylar .001 µF		
C8, 25	Polystyrene 680 pF		
C9, 10	Polyester .047 µF		
C12, 19, 29	Mixed D 047 at 300V		
C13, 20, 30	AC.		
C14, 15, 16	Ceramic 3900pF		
C17	Polystyrene 100pF		
C21	Axial 470µF 25V		
C23	Axial 1000µF 16V		
C27	Axial 150µF 6.3V		

Misc., 3 x BC Lampholders 3 x Coloured Spot Lamps (Red, Amber, Green Blue, Clear or Violet).
1x Light Modulator PCB Veropins

MOTOR SWITCHER

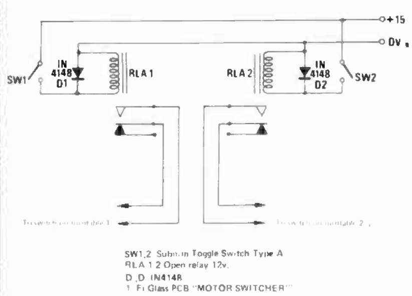
RLA1, 2, OPEN RELAY 12V
D1, 2 1N4148.
SW21, 22, Sub. Min Toggle spot (Type A)
Misc. 1 x P.c.b. "Motor Switcher" Veropins.

MISC PARTS FOR FINISHING DISCO.

2 "Flexilamps" Flexible operating lamps
2 Turntables BDS80 BSR/McDonald
2 Cartridges Sonotone 9TAHC
2 Illuminating Kits for Panel Meters
1 Microphone Eletret type 50K impedence
1 Mic. Stand Gooseneck Type 21"
1 Bracket for Gooseneck Mic. Stand
2 Transformer Mounting Plates.
1 Front Panel Fully Drilled and Printed
1 Cabinet complete with lid, all covered in hard-wearing Vinyl cloth. Motor board finished in white laminate.

REMOTE SWITCHING OF TURNTABLE

[Headphone amp. power supply]

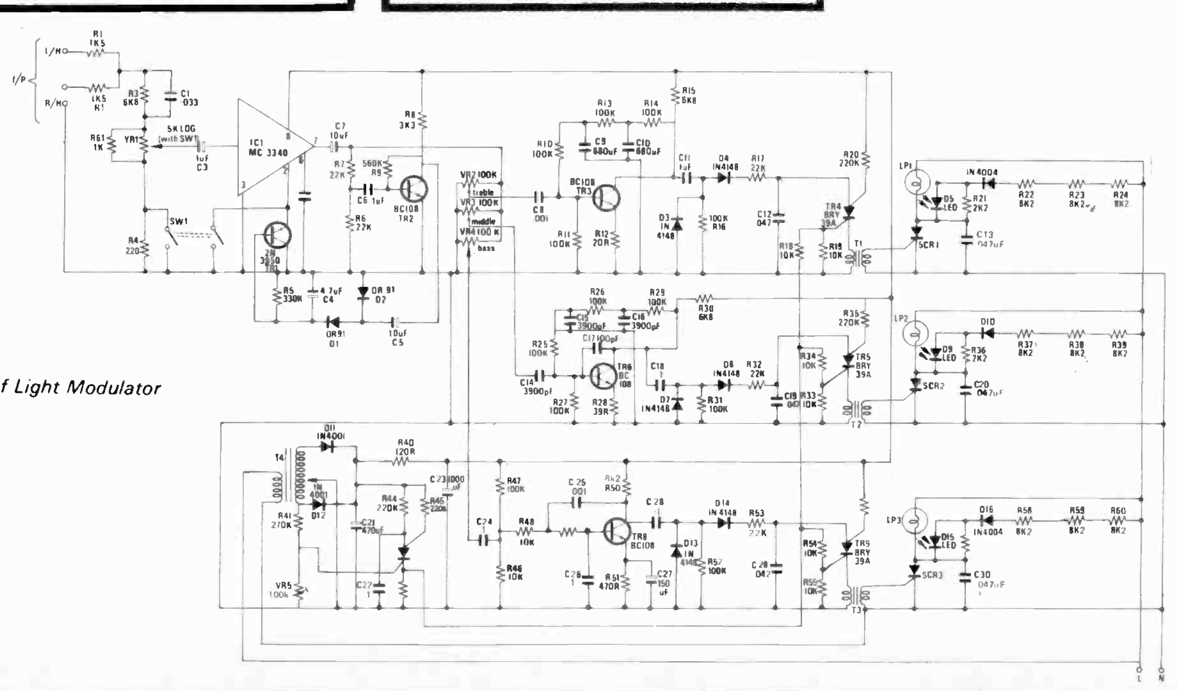


motors to be turned on and off from the console when the switch on the decks is at "stop". Whilst this method of switching is being used gently release the tone-arm from its latch and leave it released.

FINAL DETAILS

Fit and wire up the flexible operating lights and the VU meter lights as shown

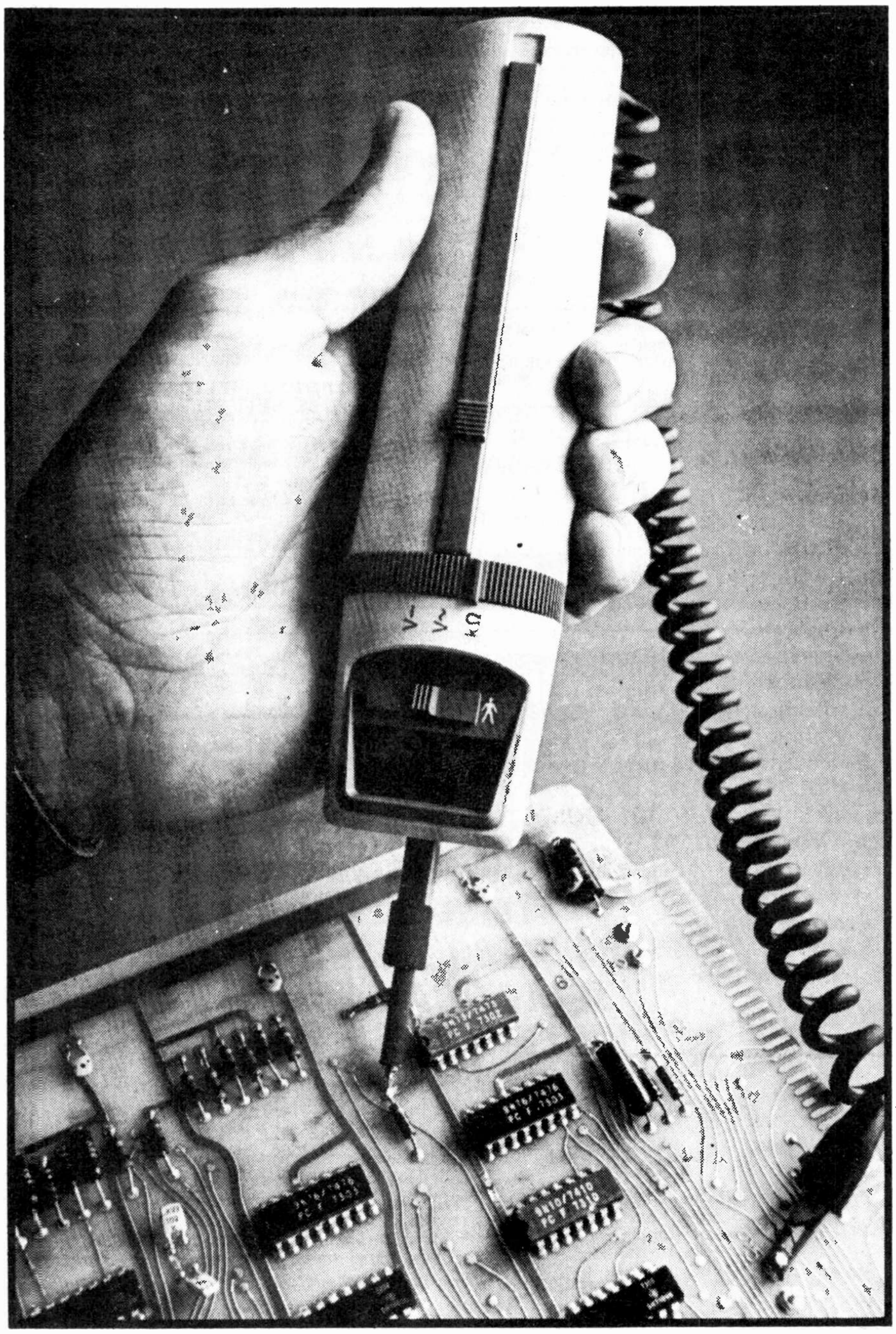
Ready-made cabinets complete with lid and carrying handle are available from Maplin, overall dimensions (excluding lid) are 36×24×9½ins. To make sorting out the components you will need easier Maplin have made available a schedule which lists everything required — right down to the last nut and bolt!



Circuit of Light Modulator

ELECTRONICS —it's easy! PART 33

Digital instruments and test equipment



IN THE previous two sections we discussed the basic building blocks of digital systems. We are now in a position to study how these blocks are assembled into specific types of general-purpose instruments and test equipment.

Digital instruments may be defined as those in which the major proportion of the circuitry is digital rather than analogue. The circuitry of such instruments is seldom all digital, as few of the natural processes we require to measure are in digital form (a notable exception is counting — a digital procedure). Hence the digital instruments that are used to measure real-world variables usually have an analogue-to-digital converter at the input. However there are many modern instruments designed to 'see' into logic circuitry — such instruments (having direct digital inputs) are truly digital.

Many test procedures could be implemented using solely analogue circuit techniques. However, there now exists a definite trend to replace analogue techniques with much more complex, but cheaper, digital equivalents.

Digital measuring equipments range in size and complexity from the simple panel meter for measuring voltage, current or resistance, through medium complexity, portable and highly-flexible digital instrument systems, to large automatic testing plants, Fig. Fig. 1 which operate on commands of in-built computers.

Today, many testing instruments (even quite small units) possess self-testing facilities, in-built diagnostic ability and other advanced capabilities such as the automatic readjustment of the circuit under test to bring it within quoted specifications.

SOME HISTORY OF DIGITAL INSTRUMENT DEVELOPMENT

We have seen that most analogue signals can be converted to a digital equivalent. This concept first found serious economic application in computational systems.

In the early days of digital systems even simple equipment had to be built using large numbers of thermionic valves and electro-mechanical relays. In the early 1940's the power requirements and the sheer bulk of such systems severely restricted the application of digital techniques to computers. Hence the early uses of digital systems in testing and evaluation first appeared in applications where portability was not required.

The need for an adequately-fast training simulator for aircraft pilots led to the development of the 'Whirlwind 1' computer by MIT in 1946. This evolved from work previously done on the use of digital techniques in the fire control of guns.

Digital voltmeters first appeared in the mid fifties and at least two companies, Non Linear Systems and Schumberger, lay claim to being first in the field. In the period 1955 to 1960 new skills, developed in the manufacture of computers, were used to build smaller cheaper and more effective instruments thus commencing the swing from analogue to digital instrumention. The introduction of transistors enabled large-scale digital process control to be realised — Texaco Refinery at Port Arthur, 1959, was the first. They also allowed portable digital instrumentation to be made.

In the early 1960's integrated-circuits were conceived. The cost and space savings gained with their use removed any doubt that digital techniques were not competitive with traditional analogue methods.

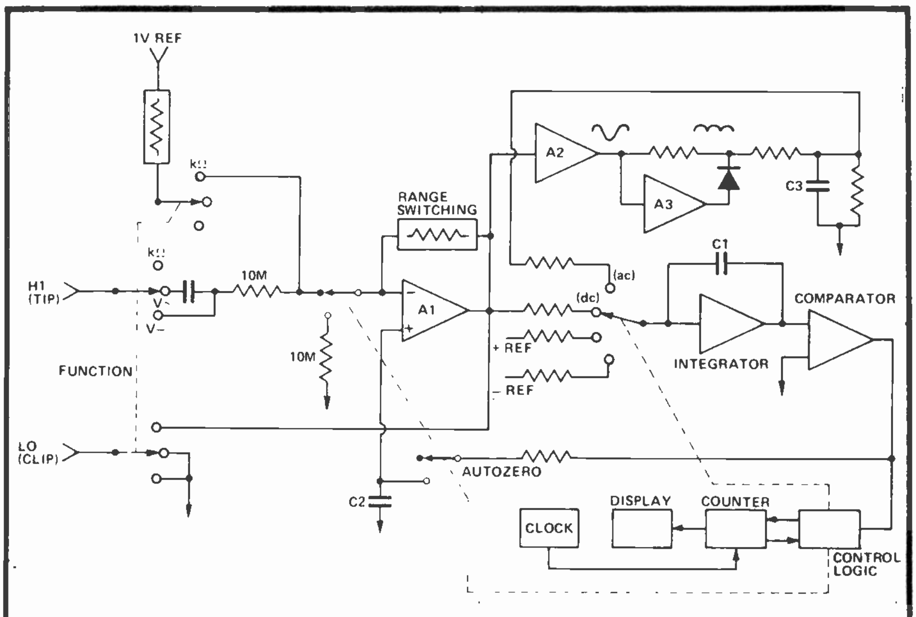


Fig. 1. Schematic of HP 970 A digital multimeter.

THE DIGITAL MULTI-FUNCTION METER

We have already dealt with the basic sub-systems used to form most digital instruments. They usually comprise various assemblages of digital displays, A/D and D/A converters, counters, registers, gates and sources of precise frequency signals.

A digital multi-meter, for instance, consists of analogue input, function and range selection stages which feed an A/D converter; this drives the digital readout form of display. They are marketed in a wide range of forms — from the nest compact fixed purpose units in which modules are interchangeable to suit the very wide range of possibilities that the common power supply and digital readout allow. Functions offered (by choice of appropriate modules) may include more than the traditional multi-meter measurements. Frequency measurement, timing, counting, totalising, and ratio measurement may all be offered. Readout of any physical variable is possible provided a sensor exists that may be correctly interfaced with the digital end of the measurement system.

The simplified block diagram of the very compact H.P. 970A a hand-held digital multimeter, is given in Fig. 2 The circuits are of analogue form until the comparator stage after which digital signals are used. This unit uses the dual-slope integration method to convert from analogue to digital. Most of the circuitry is manufactured on just two custom-made monolithic IC chips — Fig. 3a shows an assembly with 40 flip-flops, 19 MOSFET switches and some 3500 bits of ROM (read only memory); Fig 6b shows the chip which carries the bulk of the linear circuits used.

Multimeter measurements of alternating current or voltage are only meaningful if the waveform is sinusoidal. If the waveform is complex it is necessary to use an oscilloscope to gain knowledge of the ratio of peak to average or rms as measured by the multimeter. There are instruments available which incorporate the multimeter and CRO functions within the one case. Such an instrument is the Tektronix type 213 unit as illustrated in Fig. 4. This instrument displays either the waveform or the scan-generated multimeter measurement as required.

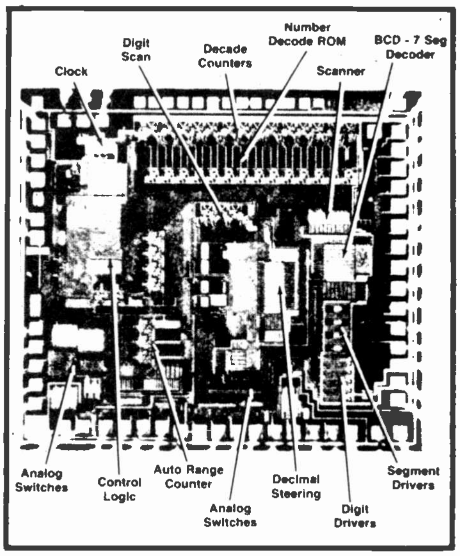


Fig. 3. Digital instrument circuits are often manufactured as custom-built chips.
(a) Digital chip of HP 970A is just 3.9 by 4.3 mm in size.

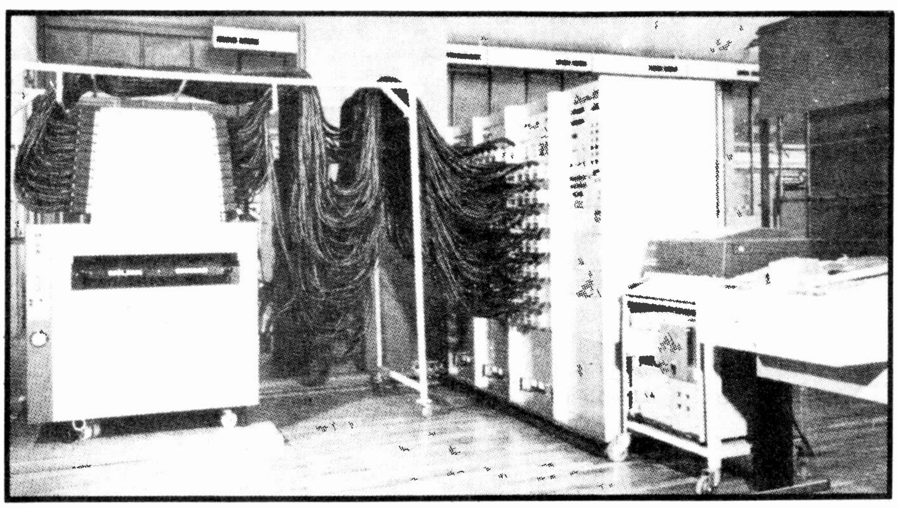


Fig. 2. Automatic Wiring Tester VD30, by Siemens — it handles 12,000 connections.

COUNTER–BASED DIGITAL INSTRUMENTS

Combining a display with a suitably gated counter and timing system provides the ability to count events; totalize and indicate elapsed time;

ELECTRONICS–it's easy!

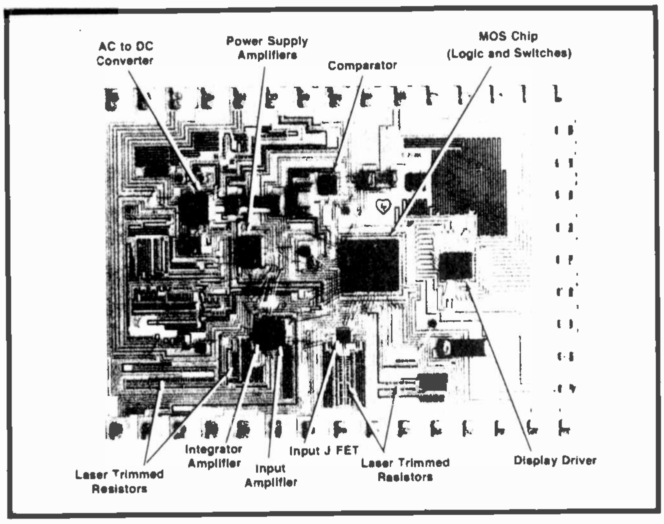


Fig. 3(b). Thin-film hybrid of HP 970A carries much of the analogue circuit on its 28 x 38 mm substrate.

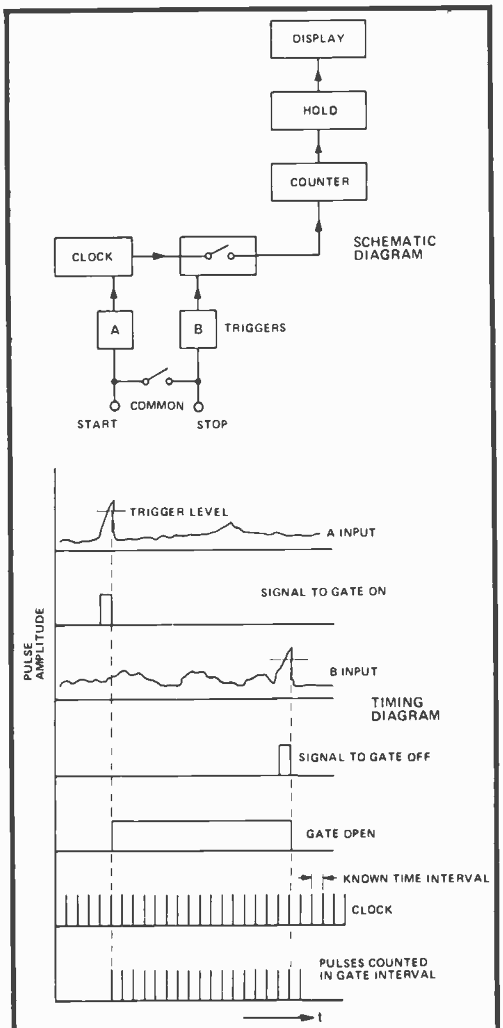


Fig. 6. Addition of a clock to the totalizer yields time-interval measurement with this configuration.

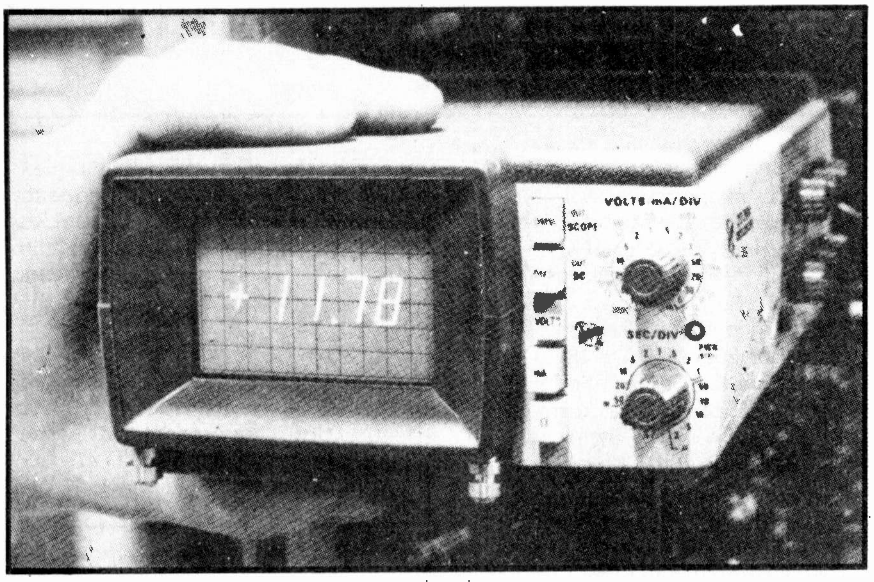


Fig. 4. The digital multimeter function is combined with a C.R.O. facility in the Tektronix 213 unit.

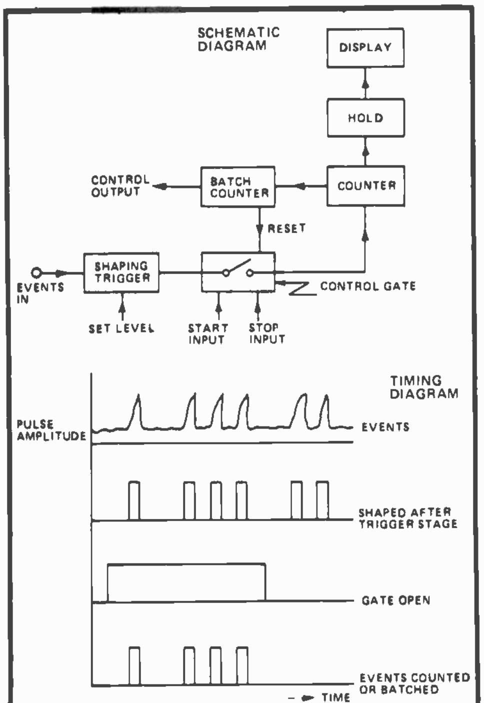


Fig. 5. Schematic diagram of totalizing and batching use of counter with display.

determine frequency and period of periodic waveforms or provide a time-clock. In these options little analogue circuitry is involved, the unit either generating its own digital signals (a clock) or operating on input signals that are already in digital form.

We have dealt with the internal operation of counters in Parts 24 and 25: here we expand their use by studying the various modes of operation possible with a basic counter.

TOTALIZING AND BATCHING

This is the simplest use of a counter. Events to be counted (for example packages on a conveyor belt may intercept an optical link, thus causing an electrical pulse to be generated each time the beam is broken). These pulses enter the counter, (Fig. 5) and are shaped into clearly recognisable counting pulses. Whether or not an event is counted is decided by the condition of the input gate which can be opened or closed on electronic command. In many applications the gate is quite simple, but its design can be a major problem when very fast signals are to be totalized to high-accuracy.

A batching counter goes a little further in that it counts to a predetermined value. When this is reached it provides an output command to the process being batched (for example, tins being counted into cartons) which causes some change in the process. At the same time, if the process is repetitive, the counter is reset to the starting value ready to count the next batch. It is sometimes more convenient to count downward from the number required, operating the batch command at the zero value. More complicated batching systems may have a stored program that sets each batch sequence to varying count values.

TIME INTERVAL MEASUREMENT

It is possible to measure the time-interval between two events by feeding pulses of known time separation into the input of the counter, as shown in Fig. 6, where a clock drives the counter. An example is the timing of a race. The gate is opened at the starting signal and stopped at the end. Counts accumulated represent the time interval. Obviously there is an advantage in choosing a pulse repetition rate that suits the units of time being used. The choice of clock frequency therefore depends on the resolution needed. For example, to measure one second with a resolution of 1 in 10^6 a pulse frequency of 1 MHz is needed to gain 1 μs discrimination.

In some applications a common gate — control input is suitable — where the on and off event reproduces the same situation such as in period measurement of a sine-wave signal. Often, however, two separate input channels are needed so that each can have the specific pulse conditioning needed by different signal sources. Race timing, for example, might initiate the count on the sound of the starter gun and stop it on the signal from a pressure-pad sensor.

Because many triggering signals are ill-defined in time, most counter/timers have input stages that trigger at preset adjustable levels — Schmidtt triggers or comparators are used. This enables the operator to discriminate the events to be counted from relatively noisy backgrounds that have a lower peak value — see later. Another reason for selective-level triggering is to allow the counter to operate at different points on a waveform — a sinewave input can be used to produce pulses of varying widths in this way. The counter output may also be used to trigger an event so as to provide automatic timing sequences, this being similar in priniciple to batch counting.

PERIOD OF REPETITIVE SIGNAL

The time interval measurement arrangement also enables the period of a wave-form to be measured. The most basic procedure is to gate the clock into the counter for the interval between the same trigger level of successive waveforms. The precision can be greatly improved by extending the gate-open time to 10, 100, 1000, or 10 000 periods, dividing the count by the appropriate divisor (which means a mere shift of the decimal point if decimal multiples are used). This is referred to as multiple-period measurement, it gives greater precision but at the expense of greatly increased time for each measurement.

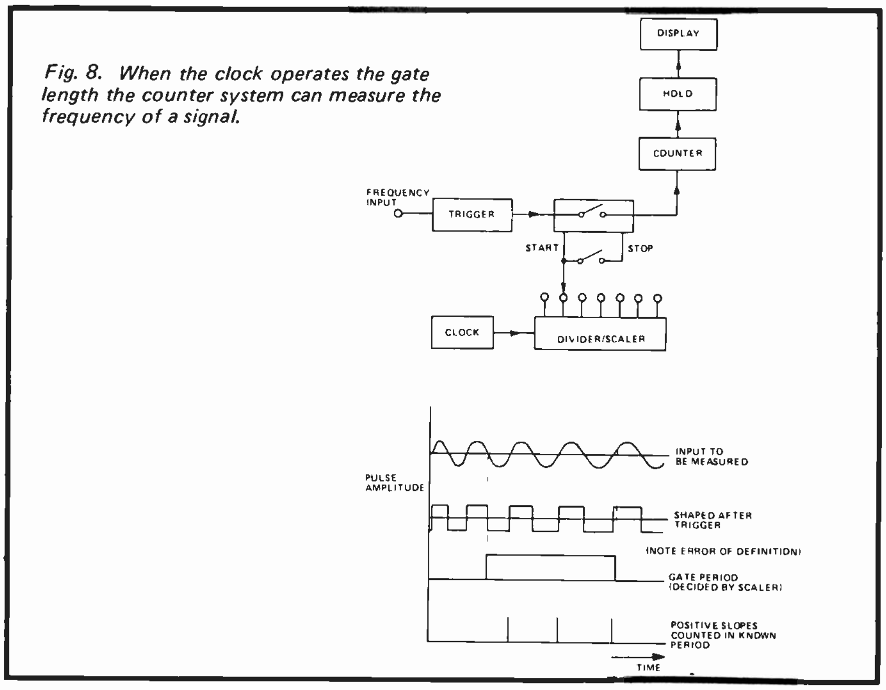


Fig. 8. When the clock operates the gate length the counter system can measure the frequency of a signal.

PULSE WIDTH

A special case of period measurement occurs when the width of a pulse is to be determined. If the pulse had a perfect square response profile the on and off gating points would always give an accurate answer because the triggering transitions would occur precisely on the rise and fall of the pulse. Trigger-level would not affect the interval measured. Practical pulses, however, will not be perfect, the edges having definite rise and fall times. In this case the trigger-level becomes critical in width determination, as is depicted in Fig. 7. Counters usually provide a slope selection control. This decides whether the trigger operates on the positive or negative slope, that is, a or b slopes respectively (Fig. 7)

PHASE DIFFERENCE

Two identical waveforms can be regarded as two separate inputs for the start-stop inputs. If both trigger at the same point on each waveform (preferably at the zero-crossing to gain maximum precision) the ratio of the time-interval between the two crossings to the period of the waveform is the phase shift in terms of a fraction of one cycle.

FREQUENCY MEASUREMENT

The frequency of a repetitive signal is defined as the number of cycles (events) per unit time. A digital frequency meter, therefore, can be made with controlled gate-on period of precisely known time interval. In other words, it is the same combination as the interval timer (i.e. oscillator counter with display, gate control and precision) but with the difference that the clock now controls the gate (not the counter) through a precision divider that scales the basic clock frequency down to obtain the gate duration needed. Gate periods range from 1 μs to 1 s. A simplified schematic is given in Fig. 8. The input signal is often sinusoidal; the input stage shapes this into a square wave to enhance individual cycle detection by the counter.

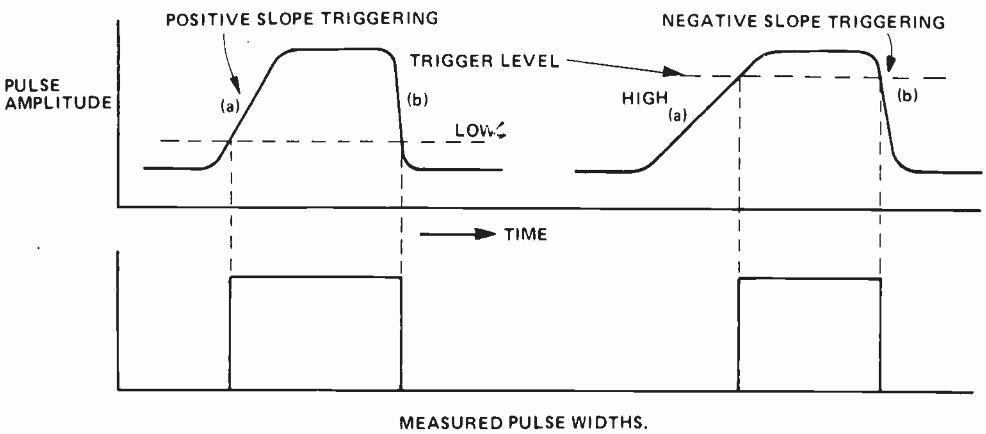


Fig. 7. Trigger level must be considered in pulse width measurement to obtain the parameter required.

ELECTRONICS–it's easy!

NOISE ERROR REDUCTION

The above descriptions give the basic operating modes of the various counter/time/frequency-meter combinations. In practice a number of refinements may be incorporated to obtain better practical performance.

Noise can be reduced by incorporating a fixed amount of backlash in the trigger circuit; this produces what is called the trigger window. On the way up the trigger level is at a higher level than on the way down.

Provided the noise added to the signal has an amplitude smaller than the window width, the counter will only trigger once on the way up and once on the way down. This method works well for high frequency measurements where the noise is usually a small percent of the signal plus-noise signal amplitude.

Low frequency measurements can often involve interference sources that produce rapid spike transients. One simple method of reducing this is to use filters. Advanced designs contain filter systems that reject all frequencies higher than that being tested, the appropriate filter being automatically selected by the counter itself after it has made a determination of the frequency of the signal.

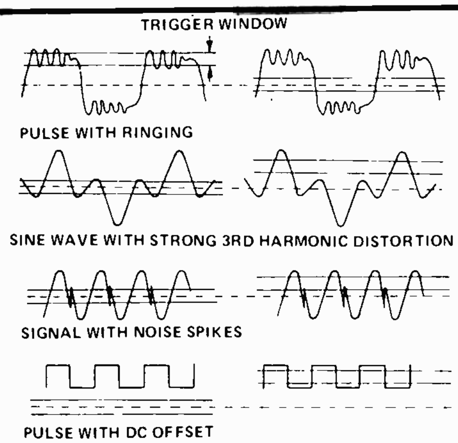


Fig. 9. Trigger height for the window must be chosen to suit the wave shape.

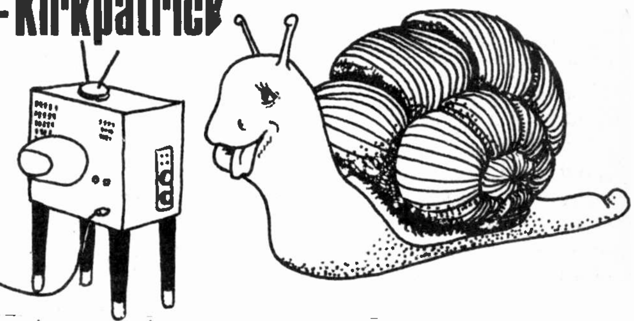
A recent approach to the noise problem is to set up a time-window (as opposed to the trigger height window) that, once the counter gate is on, inhibits the off-state chance until after a time just shorter than the expected interval. This is known as trigger masking. It is very useful in eliminating contact-bounce retriggers.

Before using a counter/timer on an unknown waveform it is, where feasible, good practice to study the waveshape on an oscilloscope in order to decide the best strategy for trigger-level and height-window width settings. Figure 9 illustrates the differences between window level settings on various waveshapes.

As the readout is in digital form it is necessary to hold the display at the determined value for a period long enough to allow the value to be read. Some units incorporate a control that gives the operator a choice of hold time.●

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick



THE GREAT TELETEXT RACE

DUMP A WHOLE LOAD OF GARDEN SNAILS at one end of the room and a large juicy marrow plant at the other end and eventually you have a snail race. Do this in the same room as representatives from the BBC, IBA, Post Office, BREMA, Texas Instruments and a few other "interested" parties and most of your snails will get trodden on as people stride up and down the room putting forward their various arguments and counterclaims. The great wealth of decoders for Teletext which we had all expected and had been promised by the beginning of this year has not been forthcoming due to changes in specifications to include new codes and to allow for Viewdata. Now there is a new delaying tactic coming up.

The people down at Mullard Research in Redhill obviously read ETI or also come up with clever but obvious ideas. The standard form of Teletext decoder can be split into a decoder, storage and display. Looking at something like the 560 VDU one can see that a VDU also requires decoding from the MPU or whatever, storage of data and display circuitry. A Viewdata terminal requires a basic Teletext storage and display system plus a keyboard and telephone modem. Put all of this lot together and add about £100 worth of microprocessor and you have the makings of a very useful device, add a cassette recorder and a software library and you have an extremely useful device.

Mullard Research Laboratories have developed a prototype MPU based home information terminal that could eventually lead to the programmable house. Called Micterm 2 the prototype terminal expands the memory available to Teletext and Viewdata users by adding a conventional cassette recorder which can record 360 Teletext pages on one C60 tape by recording at 120 characters per second (I thought that CUTS was 300 bps). Micterm 2 connects a MC6800 microprocessor to a PROM, 4 page RAM and TV display circuitry. Also interconnected are the Teletext and cassette modem inputs, and the telephone and keyboard interfaces.

Oh dear, back to the drawing board again I suppose.

"AND AT THE FIRST TURN IT'S SPECTRUM IN THE LEAD."

Yes, the race is still being run; some snails have not given up yet. There are two snails pulling away from the pack and beginning to show promise in the consumer race. Catronics have a couple of decoder kits (or ready built) based on mainly TTL logic, these give colour or B/W characters in uppercase only or upper and lower case formats. The interconnections and trimming is not easy, nor is the building and checking but it is probably worth it in the end. To convert a colour set would cost less than £200 even if you bought the built version and paid an engineer to fix it.

The second snail is also developing a Viewdata and MPU/games unit for release in the future but at present is proud to announce its Teletext decoder. Spectrum Laboratories Ltd have decided that whilst most of the snails are still discussing the manufacture of decoders, they are able to offer immediate delivery. Termed the Spectrum Telefax Decoder, the unit includes all standard features for receiving Ceefax and Oracle while providing optional facilities for decoding the PO Viewdata service. Control is from a very slim hand held keypad which can be hard-wired to the TV or can be supplied optionally to work ultrasonically. Page number is continuously displayed at the top left of the information page and the unit includes Roll and a time display which can optionally be overlaid on top of the TV program (special version). Priced at approximately £300 the Spectrum Telefax Decoder may be built in to TV receivers with sufficient room or may be used externally. In order to maintain low cost and high performance the decoder is intended for hard-wiring into a receiver and Spectrum are able to advise and supply the necessary circuitry information for conversion of most TV receivers.

With Spectrum's obviously larger market it looks as if they are in the lead to be the first major suppliers of Teletext decoders, but is it worth buying one yet or waiting for the next generation in a few months time?

A NEW FORM OF TAPE READER

Visaud is a new way of using our friend the C60 cassette, this time in education. If you imagine a standard C60 cassette opened up at one end and extended at that end by about 6 inches then you have the basis of this rather clever (patented) idea. The extension loops the magnetic tape around a detour of about 12 inches, 3 inches of which can be seen travelling right to left through a small window cut in the plastic extension. The part which can be seen is the back (non magnetic) side of the tape and on this is written a text in a special pen or white Lettraset. The text which is passing through this window can be read at the same time that its audio counterpart is passing over the playback head, thus the tape can be read and listened to at the same time. This system is ideal for youngsters just starting to read, children or adults with a reading problem or even for students of a foreign language or even shorthand. The simplicity of this technique underlines the thought that the great technological advances being made at present can lead to stupid solutions to problems.

Just after I had seen the Visaud system I was discussing a problem with someone who wanted to use a similar cassette with an audio and a digital track. The Audio track would be the spoken word as before but the digital track would contain the same word in digital form to be reproduced as a travelling character string on a VDU. The first solution can be made in small volumes for less than £50 including the recorder, the second solution would cost about £200 for each playback unit plus a similar figure for each recording unit. Both give the same end result, a string of written and spoken words, but the first solution is a non-electronic solution. Next time you decide to design or build a new project have a quick check that modern electronics gives the best solution — some of Marconi's ideas are still being used in their crudest form today.

MINI-FLOPPY ANSWER?

Last month we described the problem of direct-access storage systems using discs and the requirement in the amateur market for a cheap system. Now a company in the USA have announced miniaturised versions of the popular floppy-disc systems for applications that are at present dominated by cassette tape units. Shugart Associates of Sunnyvale, California will start to ship their SA400 "Mini-floppy," SA104 "Mini-diskette" and SA440 "Mini-streaker" later this month. These controllers are expected to triple the present market for floppy disc systems because of the $250 price tag for large volumes. The Minifloppy controller is about half the size and half the cost of a standard floppy controller and gives one-third of the capacity which would be sufficient for most applications. Applications for such miniaturised systems would include word processing, mini and microcomputer program storage, intelligent calculators and terminals and the emerging microcomputer hobby market.

REFERENCES:

Mullard Research Labs, Redhill, Surrey.

Catronics, Wallington Square, Wallington, Surrey. 01-669 6700.

Spectrum Labs Ltd, 32 Royal Ave, London SW3. 01-730 1801.

Visaud, 29 Bar Lane, Stapleford, Cambs. ●

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TRANSFORMERS — All 240V 50HZ inputs
Type A 17-0-17V 250 MA; 7.5-0-7.5V 250MA 0-20V 5Amps; 0-4V 5 Amps 0-1-1.5V 5 Amps **£2 ea.** P&P £1.25
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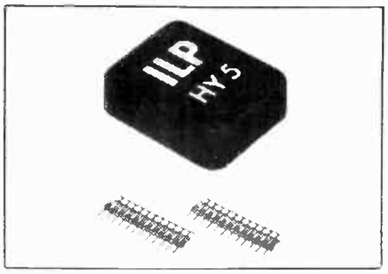
APPLICATIONS: Hi-Fi – Mixers – Disco – Guitar and Organ – Public address

SPECIFICATIONS:

INPUTS Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV Auxiliary 3-100mV input impedance 47kΩ at 1kHz
OUTPUTS Tape 100mV Main output 500mV R M S
ACTIVE TONE CONTROLS Treble ± 12dB at 10kHz Bass ± at 100Hz
DISTORTION 0 1% at 1kHz Signal Noise Ratio 68dB
OVERLOAD 38dB on Magnetic Pick-up SUPPLY VOLTAGE ± 16 50V

Price £4.75 + 59p VAT P&P free.



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I L P it features a virtually indestructible I C with short circuit and thermal protection The kit consists of I C heatsink P C board 4 resistors 6 capacitors mounting kit together with easy to follow construction and operating instructions This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available

FEATURES: Complete Kit – Low Distortion – Short Open and Thermal Protection – Easy to Build

APPLICATIONS: Updating audio equipment – Guitar practice amplifier – Test amplifier – audio oscillator

SPECIFICATIONS

OUTPUT POWER 15W R M S into 8Ω DISTORTION 0 1% at 15W
INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz -3dB
SUPPLY VOLTAGE ± 18V

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25 Watts into 8Ω

The HY50 leads I L P s total integration approach to power amplifier design The amplifier features an integral heatsink together with the simplicity of no external components During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World

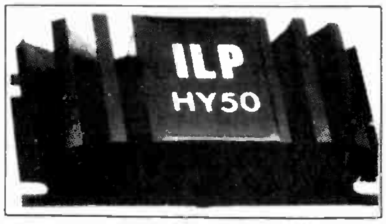
FEATURES: Low Distortion – Integral Heatsink – Only five connections – 7 Amp output transistors – No external components

APPLICATIONS: Medium Power Hi Fi systems – Low power disco – Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV

OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4 16Ω DISTORTION 0 04% at 25W at 1kHz
SIGNAL NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz -3dB
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm

Price £6.20 + 77p VAT P&P free.



HY120
60 Watts into 8Ω

The HY120 is the baby of I L P s new high power range designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design

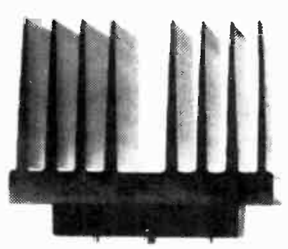
FEATURES: Very low distortion – Integral heatsink – Load line protection – Thermal protection – Five connections – No external components

APPLICATIONS: Hi-Fi – High quality disco – Public address – Monitor amplifier – Guitar and organ

SPECIFICATIONS

INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4 16Ω DISTORTION 0 04% at 60W at 1kHz
SIGNAL NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz -3dB SUPPLY VOLTAGE ± 35V
SIZE 114 50 85mm

Price £14.40 + £1.16 VAT P&P free.



HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance

FEATURES: Thermal shutdown – Very low distortion – Load line protection – Integral heatsink – No external components

APPLICATIONS: Hi-Fi – Disco – Monitor – Power slave – Industrial – Public Address

SPECIFICATIONS

INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4 16Ω DISTORTION 0 05% at 100W at 1kHz
SIGNAL NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz 3dB SUPPLY VOLTAGE ± 45V
SIZE 114 100 85mm

Price £21.20 + £1.70 VAT P&P free.

HY400
240 Watts into 4Ω

The HY400 is I L P s Big Daddy of the range producing 240W into 4Ω It has been designed for high power disco or public address applications If the amplifier is to be used at continuous high power levels a cooling fan is recommended The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module

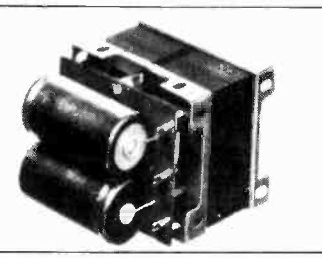
FEATURES: Thermal shutdown – Very low distortion – Load line protection – No external components

APPLICATIONS: Public address – Disco – Power slave – Industrial

SPECIFICATIONS

OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4 16Ω DISTORTION 0 1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV SIZE 114x100x85mm

Price £29.25 + £2.34 VAT P&P free.



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news digest

POST HASTE PCB KIT

Compstock, the Basildon—based distributors, announces its own PCB lab kit, comprising an etching system, an abrasive block for cleaning and degreasing metal surfaces, etch-resist transfer symbols, and etch-resist marker pens

to prepare the PCB. Major difference from existing systems is that the etchant is supplied in pellet form to which is added a bottle of buffer solution. Compstock claim that this system is safer to send by post. Price £8.25 inc. VAT & P and P. Compstock Ltd., 42—44 Bowlers Craft, Basildon, Essex.

BRIGHT IDEA

Hitachi will be marketing sets later this year which incorporate colour picture tubes twice as bright as current types. A high potential is set up between mask and screen and the guns fire almost twice as many electrons as before.

BULBS FOR TUBES

A fluorescent lamp that will replace ordinary electric lights but will use only a third of the power and will last for up to ten years is being developed in America. The common construction of a fluorescent lamp is a long tube with a phosphor coating on the mercury vapour. The phosphor emits visible light when hit by UV photons, which are emitted by the electrically-excited mercury atoms.

The electrical discharge is initiated and controlled by starters and ballasts.

To fit the starting and controlling electrics for the discharge into a small package would not be possible, so the inventor of the new globe has taken another approach. He uses radio-frequency excitation, produced by a transistoried circuit in the base of the globe and radiated by a coil in the centre.

GENERATING POLES?

New from Poland come two Function Generators which are imported by Electronic Brokers Limited, London NW1.

Model G430 provides a source of sine and square-wave signals across the frequency range 1Hz to 1MHz, in six

switchable sub-ranges, continuously variable from 0 to 10V.

Distortion is less than 0.03% in the range from 100Hz to 20kHz, 0.1% from 20Hz to 100kHz, and 1% in the range from 1Hz to 1MHz. Rise time of square wave is less than 50n sec.

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BC147/8/9	10p
BC157/8/9	11p
BC167/8/9	11p
BC169C	12p
BC177/8/9	17p
BC182/3/4L	11p
BC186/7	30p
BC212/3/4L	12p
BCY70/71/72	13p
BF194/5	12p
BF196/7	14p
BFY50/51	16p
BFX29	30p
BFX84	24p
BSX19/20	16p
OC71	10p
2N706	10p
2N1711	20p
2N2219	20p
2N2904/5/6/7	16p
2N2904/5/6A	18p
2N2926(R)	7p
2N2926(G)	12p

2N3053	15p
2N3054	45p
2N3055	41p
2N3702/3/4	12p
2N3903/4/5/6	16p
2N2646	35p
TIS43UJT	25p
MPF102	40p
2N3819	25p
2N3823	30p
IN914	3p
IN4001	5p
IN4002/3	6p
IN4004/5	7p
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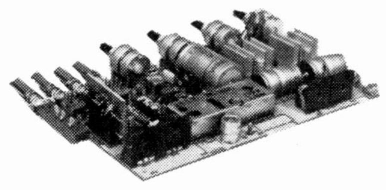

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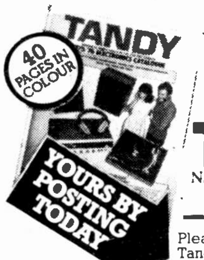

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