ELECTRONICS TODAY

electronics today international

AUGUST 1976

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LOW COST VDU

IT'S BARGAIN MONTH IN ETI

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AMATEUR RADIO BULK BUYING GROUP

Since our inception we have always aimed at giving the following 5 STAR service:
- ★ **All components are brand new to manufacturers' full specifications.**
- ★ **All components carry manufacturer's full guarantee.**
- ★ **Orders normally despatched within 48 hours of receipt.**
- ★ **Full refund offered on any item not in stock.**
- ★ **All prices include V.A.T.**

This service is difficult to match — join the many who now take it for granted.

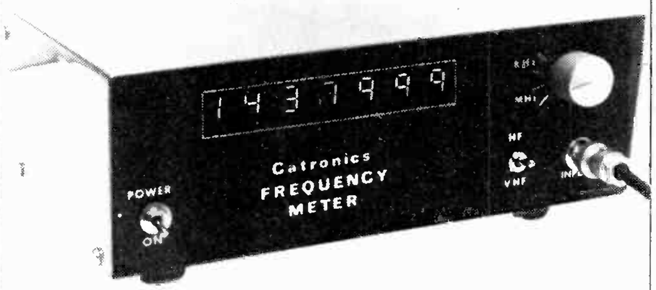
The aims of the Amateur Radio Bulk Buying Group are simple. To help the construction side of the hobby by endeavouring to bring some of the more "difficult-to-get" components to you and to act as agents for some of the leading manufacturers in this country and abroad. All our regular items are brand new from current manufacturers' stock carrying full warranty. Semiconductors are generally from top British and American names such as Motorola, Mullard, National, Plessey and R.C.A., etc. In addition to selling **Jaybeam** VHF aerials, **Microwave Modules** converters, etc. and **Mini-Beam** H.F. aerials we are also the leading U.K. supplier of **Plessey SL600** series i.c.s., **KVG crystal filters** and a wide range of ignition suppression components for car radio use.

CATRONICS is the name of our own designed and produced equipment and specialised kits; Amateur Radio Bulk Buying Group is the name of our Amateur Components Division.

180 MHz DIGITAL FREQUENCY METER

from

Catronics



Enabling frequencies up to over 180 MHz to be read directly. It is now possible to measure frequencies on all bands from 160m. 2m. without any range switching, input level control adjustment or other operation. Additionally a low frequency position may be switched to, enabling audio frequencies and I.F.s to be read directly. This is a 7-digit model with 4-speed time base having gate times of 10S, 1S, 100mS, and 10mS with built-in automatic memory. Reading is displayed for 100mS plus gate time and then changes to display new reading from the integrated circuit memory. This gives a "non-blinking" continuous display even when using long gate times. The display is by long-life seven segment indicators giving a direct frequency reading in four ranges (2 for kHz and 2 for MHz) with automatically positioned decimal point.

The frequency accuracy is determined by a precision 10 MHz master oscillator having a stability of ±2ppm over the normal ambient temperature range.

Power supply is stabilised 240v. input unit, although operation from 12v. battery supply (—ve earth) can be arranged.

The instrument is housed in an attractive two-tone metal cabinet approx. 9in. x 3½in. x 6½in. Write for full specification.

Price only £130 plus £1.50 insured carriage. 25MHz only version also available — model DFM3 — £110.

CRYSTAL CALIBRATION

Catronics model M6 giving outputs at 1 MHz, 200 kHz, 100 kHz, 50 kHz and 25 kHz at the flick of a switch, with harmonics audible up to 2m band. 6 volt supply. Complete PCB module, accurately set to frequency and switch assembly — **£8.90.** Also available — kit of parts for regulator for operation on 9 to 20 volt supplies, **£1.60.**

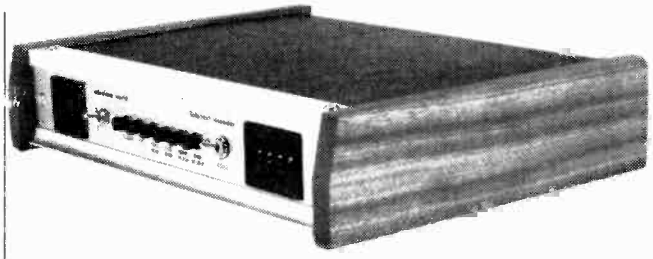
Complete boxed unit with battery — £14.50 plus 50p p&p.

PRINTED CIRCUIT BOARD ETCH RESIST PEN.

Make your own PCBs with a Decon Dalo etch resist pen — **only 85p** from us including full instructions for use.

We also sell Ferrites, Minitron 7-segment indicators, plus a wide range of transistors and i.c.s. including Plessey SL6000 series.

See the above and other new products on our stand at the Radio Communication Exhibition, Alexandra Palace on July 30 — August 1st.



TELETEXT DECODER KIT

CATRONICS Ltd offer the world's first kit for the Home Constructor for decoding and displaying the CEEFAX and ORACLE television information display systems. The design of this decoder is being described in a series of articles being published by 'Wireless World' (from November 1975 issue).

The decoder has all the usual features including full colour characters, Graphics, Newsflash, Sub-Title and Timed Page facilities.

Our kit contains the printed circuit boards and all components necessary to build the complete decoder including power supply and video switching unit. Signal input required is a minimum of 1.0V detected video. The output is approx. 4V of R, G and B drive suitable for driving most types of Colour Television sets, plus a luminance output for black and white sets. The power supply and video switching circuitry are normally installed within the television cabinet and the main decoding, control and memory circuitry are in a separate cabinet (approx. 10½in. x 3in. x 7¾in.) positioned on top of the television. Lower case characters may be added by using an extra add-on printed circuit board unit.

Price of component kit — £104.10
Add On unit for lower case — £13.75
Cabinet and chassis — £13.50
Post & Packing — add £1.50

IGNITION SUPPRESSION COMPONENTS

We have the widest range of suppressors available as follows. Screened Plug Connectors (essential for VHF), straight or angled — **£1.20.** Plug in Distributor Suppressor — **55p.** 1μF Capacitor, available with normal push fit lucar connector, large lucar or fully insulated with wire connections **37p.** 2μF normal or large lucar connector **52p.** 2.5 μF Coax type, **£1.63.** 3μF Capacitor for Lucas ACR alternator, **£1.50.** 3A Chokes, **71p.** 7A Chokes, **£1.00.** Solid Copper Standard Ignition Cable, **7p per ft.** Connectors, **18p for 6.**

VHF COMMUNICATIONS

VHF COMMUNICATIONS, the English language edition of the German publication *UKW-BERICHTE*, is a quarterly amateur radio magazine especially catering for vhf/uhf/shf technology. It is published in spring, summer, autumn and winter.

The current subscription rate is £3.75 post free.

All special components required for the construction of the described equipment, such as printed circuit boards, coil formers, semiconductors and crystals, as well as complete kits, are available for despatch direct from Germany. Many of the printed circuit boards, in addition to a few selected kits, are stocked in the UK. A price list of kits and materials is available — send sae for your copy.

All back issues are available, either post free from Germany (approx. 3 weeks) or can be despatched from UK stock (approx. 3 days) if UK postage is added.

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AUGUST 1976 VOL 5. No. 8

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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.

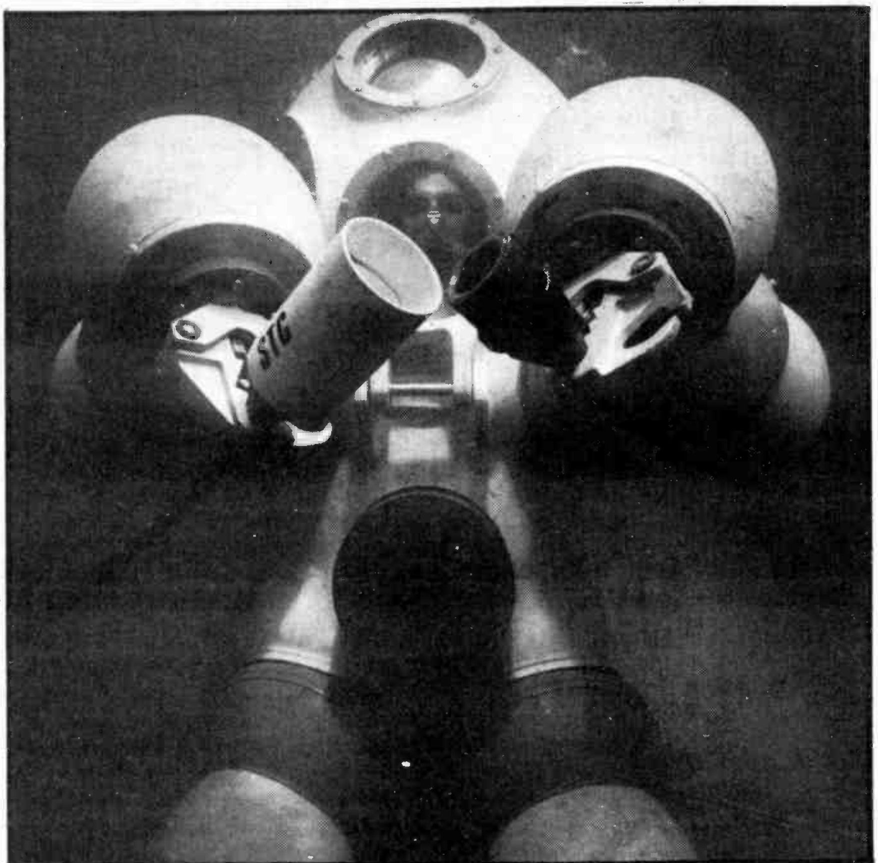
BACK NUMBERS. Back numbers of some issues are available for 40p each, plus 15p postage.

SUBSCRIPTIONS. Great Britain £5.00 per annum. Overseas £5.50 Canada $10.

ELECTRONICS ITS EASY VOL 2 SEE PAGE 37

news digest

THERE MUST BE AN EASIER WAY TO FIX A HI-FI ....



The picture shows the testing of a new STC underwater cable, which is unpluggable whilst live. It can operate at depths where the pressure is in excess of 700 p.s.i. Hence the 'Flash Gordon' repairman suit.

The suit is made by BHB Construction and is worn at the Admiralty Underwater Weapons Division. Finished in finest stainless steel, it is now available complete with matching hernia and free gold lamé truss!

Christian Dior — eat your heart out.

STC Christchurch Way, Greenwich, London SE10 0AG.

SCIENTIFIC PRICE REDUCTION

As a result of increased production and decreased costs, CBM have announced significant price reductions on their line of scientific calculators. These new prices were effective as of June 14th 1976:-

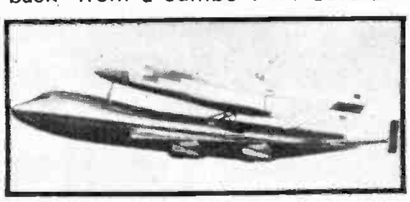
Model	Old Price	New Price
SR4190R	£59.95 inc. VAT	£49.95
SR4148R	£42.50 " "	£36.50
SR1800	£29.95 " "	£24.00
SR7919D	£16.95 " "	£14.50

WRAPPERS FOR CHIPS

Several companies are in the process of producing a calculator 'module', i.e. a complete PCB containing display chip and keying arrangements. These are for the low end of the market, where packages are the determining factor in price. Rockwell will introduce such a module in the US later this month, and National are working on the devices for scientific and financial users.

RIDING HIGH

The next step in America's space programme is the tesing of NASA's space shuttle. Landing tests are to be carried out in mid 1977. Amazingly the machine will be launched 'piggyback' from a Jumbo 747! Several



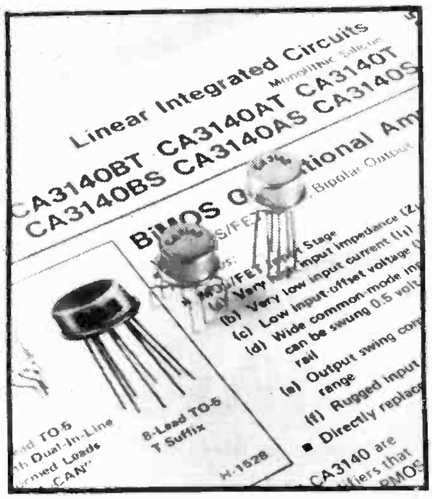
flights will be made to ensure stability before the shuttle is actually released. Trust Americans to build the worlds largest airliner and then carry people *outside* it!

WHAT'S NEW IN THE BOOK WORLD

A couple of new books have come our way in the past month or so, published by Newnes-Butterworths. The *Electronics Engineer's Reference Book (4th ed., edited by L.W.Turner, £25)* is a massive tome, which somehow reminds us of an overgrown pocket diary — it seems to follow a similar format and presentation to the one you probably buy every year. It is very easy when trying to use this book to get side tracked into reading about subjects totally unrelated to your original interest as the format is (for a reference book) fairly readable. However, it always seems to be a characteristic of this type of book that, although it is undoubtedly full of concisely pressented information, it never has *just* the particular piece of information you require. A particular criticism we can level at this book is the almost complete lack of information on digital circuit design, which is counterbalanced by chapters on valves (what are valves?, we hear a younger reader cry), Electronics in Weather Forecasting, Particle Accelerators, etc.. Never mind there's still a lot of good stuff in it.

BI—MOS OP AMP

RCA introduce a new operational amplifier combining different semiconductor technologies in the same device. Known as the CA3140, the operational amplifier uses a technique called BiMOS, combining a p-MOS input stage with a bipolar output stage



having a wide output voltage range.

Data sheets and applications brochures for the CA3140 are available from RCA Solid State — Europe at Sunbury-on-Thames, Middlesex TW16 7HW.

VITAL STATISTICS

The Statistician is a new release from CBM, a 'third generation' scientific calculator which takes a specialised application and 'pre-programmes' this to give greater user convenience than fully programmables, and greater power than earlier scientifics.

The Statistician features many advanced specialist-user functions. It cuts down on operating time by reducing 'setting-up' to an absolute minimum and eliminating programming errors and the need to remember complex input routines. Chi-squared distribution, for example, only needs two inputs for computation, Gaussian only needs one.

Included in the price of £99.95 is a mains adaptor/charger which permits use of the Statistician during recharging. Also provided is a fully comprehensive instruction manual with many

worked examples, a protective carrying pouch, and is guaranteed for 12 months.

Pre-Programmed Functions

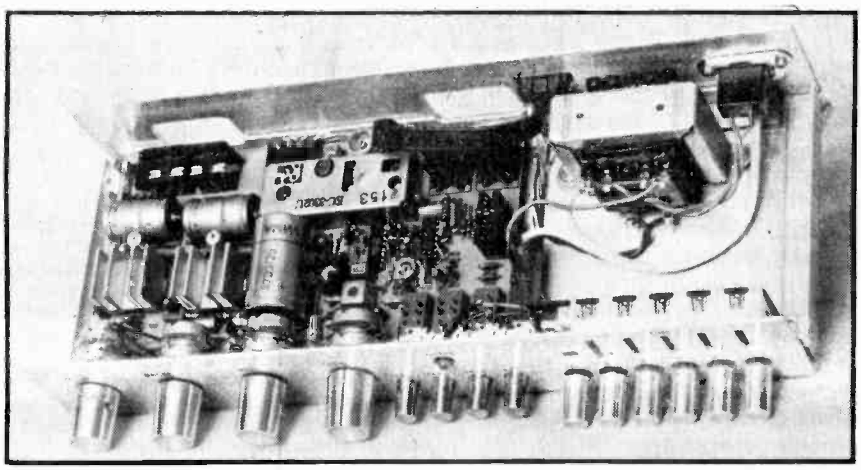
Linear regression, slope, intercept, residual sum of squares, coefficient of correlation, mean of x values, mean of y values, mean and standard deviations, one sample + two sample test statistics, Chi-squared statistic, Chi-squared distribution, hypergeometric distribution, binomial distribution, poisson distribution, F distribution, gaussian probability distribution, t distribution, permutations + combinations.

Basic Mathematical Functions

Eights memories each individually addressable, random numbers, parenthesis, all powers, all roots, square, square root, reciprocal, factorial, gamma function, pi, +/– sign change, exponential entry, x/y exchange, significant number selection, Natural log, Napierian log, e^x, 10^x, sin, cos, tan, sin^{-1}, cos^{-1}, tan^{-1}, degrees/radians conversions, 14 digit display, (10 digit mantissa, 2 digit exponent).

CBM Business Machines Ltd., Industrial Estate, Eaglescliffe, Stockton-on-Tees, Cleveland TS16 0PN.

BOARD DECISION



A fresh approach to audio kits has been shown by Jayen developments. Instead of selling complete parts and instructions, the idea is to provide the PCB's, overprinted, with circuit diagrams and 'shopping lists' of where to purchase components.

First in line is the FM7X7 stereo tuner amplifier with an excellent specification. The photo shows the board built into a prototype chassis. The inclusive price of the PCB's and instructions for this are £3.85 from Jayen Developments, 25 Westgate, Louth, Lincolnshire LN11 9YQ.

JOY STICK TO PLAY WITH

The assembly consists of a self-cenering control lever moving through a square pyramid envelope, meshing via gears with two-gang and single gang potentiometers, One potentiometer may be at maximum travel at 29° from centre, while the other moves

from maximum at one end, through zero at center to maximum. It is expected to be particularly suitable for application in electronic games equipment.

Beckman Instruments Limited, Queensway, Glenrothes, Fife, Scotland.

ETI/HENRY'S COMPETITION WINNER

Winner of the ETI/HENRY'S Sale-of-the-Century Competition in the March issue was H. Thompson of Hawkwell, Essex. Mr. Thompson wins £12.50 but also receives a 90% discount when spending this at Henry's making for a £125 prize. Runners up with £12.50 prizes were:

G. Tanner, Fulbourn, Cambs.
K. Perry, Beckenham, Kent.
A. Kofinas, Sussex University.
S. Brandon, Luton, Beds.
D. Ward, Worthing, Sussex.
G. Rowse, Bexhill, Sussex.

Additional runners-up who had included the 50p price coupon from the Henry's catalogue doubled their prize to were:

R. R. Zick, Wolverhampton,
P. Bolton, King's Lynn, Norfolk.
H. F. Howard, Fishponds, Bristol.
J. G. Brandon, Brentwood, Essex.

The answers were:

A	2n7	F	22k
B	2n7	G	10µ
C	15nF	H	100k
D	15nF	J	15k
E	22k	K	3k3

BRITISH CALCULATORS SAVED

A major threat to Britain's indigenous calculator industry has been removed by some government discussions in the EEC. At present 17.6% duty is charged on all imported displays, and both the companies (CBM and Sinclair) building in Britain rely on supplies outside the market. This is the charge levied on general electronic components rather than on calculator components (9.9%).

This naturally penalised our own industry against US and Japanese competitors. From July 1st all duty on displays will be lifted for a trial period of six months, and this is liable to become permanent.

If some such concession had not been made, the companies would almost certainly moved production overseas.

DISPLAY OF INACCURACY

We've recieved the following letter from 'Metac International' concerning a comment in our 'Electronics It's Easy' article last month. We agree with the comments made in letter, and apologise for letting this slip by us!

The Editor, **8th June, 1976**

Dear Sir,

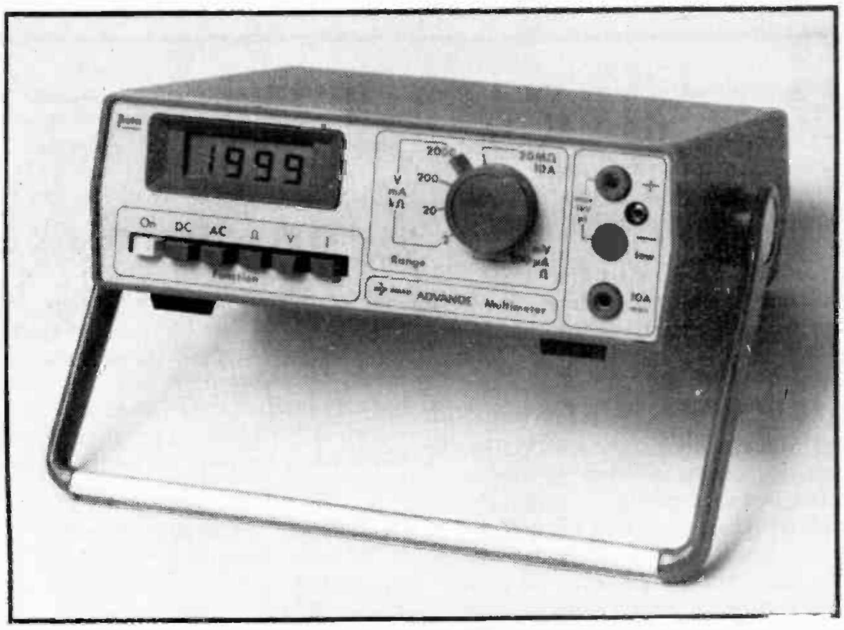
I would like to comment on a statement regarding liquid crystal displays made in the July issue "Electronics It's Easy" article. The section I refer to is on the lifetime of LCD displays which the author claims is 10,000 hours and as short as 1000 hours. These figures I am sure, have been extracted from some very out of data literature and do much to harm the progress of LCD displays in industrial and consumer products.

The very early problems experienced with LCD displays was largely due to impurities in the Liquid Crystal material, also, poor sealing of the glass envelope. With improved techniques, manufacturers such as Thompson-CSF now claim a minimum of 50,000 hours and others claim 100,000 hours. The use of LCD displays is increasing in industry and for military applications. My own company is engaged in development work for LCD displays in cars on behalf of a major car manufacturer.

Our own experience as a supplier of liquid crystal display watches is that the dislay is as reliable as LED displays.

Yours faithfully,
Metac International.

LSI CMOS IC IN LCD DMM



Paris, 10th June....Gould Advance today announced the Beta digital multimeter, a 0.2% accuracy instrument featuring 10A current ranges and optional temperature measurement. Heart of the instrument is a specially designed CMOS chip, produced by Motorola in association with Advance, which includes virtually all the analogue and digital circuitry including on-chip clock and display multiplexing. The resultant low parts count gives benefits in the form of higher reliability and lower cost — £99. The Beta uses a ¼" LCD display (also made by Motorola) to ensure good readability in high ambient light. This also helps with power consumption: up to 600 hours on a set of batteries. Said Tony Grant, Beta Project Manager, at the launching Press Conference, "Beta has not been designed to replace the analogue multimeter, but one comparison may be of interest; when used for measurements on 5V TTL circuitry, the analogue multimeter will typically offer an impedance of 1.67kΩ per£ cost, whereas the Beta offers 222kΩ per £! *Gould Advance Ltd., Roebuck Road, Hainault, Essex.*

I²L DOORBELL

Matsushita Electrics have applied integrated injection logic to a new IC specifically intended for use in doorchimes. The IC produces four possible sounds, and naturally consumes little power.

The circuit consists basically of three oscillators, which can be combined and/or gated for differing times, giving the four seconds.

At the moment it is available only in Japan, but patent rights have been applied for in Britain, America, West Germany, France and Italy.

TI BUY UP MSI

Texas stepped up at an auction in the US recently to sell off Micro Systems International (deceased) hardware. They came away with approx £93,000 of equipment. The haul of loot included four crystal growers, three water polishers, a vapour deposition system (. . . . and a partridge in a pear tree?).

About 600 potential customers turned up at the auction, but there couldn't have been much left.

ERROR REPORT

EXPANDER/COMPRESSOR MAY 1976 ISSUE.

On the track layout C19/C20 is shown as connecting to pin 3 of IC9. The connection should be to pin 1 of that IC the correct detail is shown on the component detail.

OPTICAL COMMUNICATIONS CIRCUITS JUNE 1976 ISSUE.

Transmitter circuit:- R2 should be 6k8 and the 2N3702 has the emitter and collector transposed.

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ACK

ATTRACTIVE 6-DIGIT ALARM CLOCK KIT

With optional CRYSTAL CONTROL for high accuracy and battery back-up (see below). Complete kit including attractive slim case with deep red panel for 6-digit alarm clock with bleep alarm, snooze, automatic intensity control and high brightness display driving. Uses MK50253 IC and Jumbo 0.5" red LEDs. 12 or 24-hour format (easy to add a switch to switch between them). Optional "touch switch" for snooze (extra). Order as "ACK" **£26.80**

Complete kit as above, plus CRYSTAL CONTROL and BATTERY BACK-UP. If mains power is disconnected (through a power cut, accidental switching off or moving clock) the clock will keep perfect time. Accuracy to within a few seconds a month. The extra components, with two PP3 batteries, all fit in the same case. While on back-up, the displays are off to conserve battery life but the alarm remains fully operational. Order as "ACK + XTK + BBK" **£33.58**

SLIM GREEN CLOCK

Complete kit for this attractive 4-digit **Mantlepiece Clock** with bright 0.5" GREEN display. While constructing, select 12 or 24 hour format, flashing or fixed colon. Kit includes miniature transformer. Housed in a new all-white slim case with green perspex front panel. Easy to build. Order as "GCK" **£12.90**
Kit as above, but less case and perspex. Order as 'GMK' **£11.14**

CRYSTAL CONTROL and BATTERY BACK-UP can be incorporated in this clock too. No need to reset your clock each time power is disconnected. For the complete kit including this feature, order as "GCK + XTK + GBBK" **£19.65**

Crystal Controlled 6-Digit CAR CLOCK Kit With Independent Journey Timer

Runs off 12V (car) battery — protected against low voltage drop-out — display comes on with ignition — internal battery back-up allows temporary disconnection. 6 digit timer times journeys up to 24 hours in hours, minutes and seconds — automatic intensity control (essential for car use) — uses 0.5" red LED digits. Same external appearance as our ACK but with 8 push-buttons for setting time, starting, stopping and resetting timer, selecting display to show "time" or "journey time" — all control buttons functional irrespective of display mode selected. Complete kit including case. Order as "CCK" **£39.50**

50 Hz CRYSTAL TIMEBASE KIT

Provides an extremely stable output of one pulse every 20 msec. Uses: Improving accuracy of digital clocks, to within a few seconds a month. If used with a battery back-up circuit also makes clocks power-out or switch-off proof. Replacing 50 Hz signal on battery-powered equipment. Providing film synchronisation. Monitoring or improving turntable speed. Complete kit (PCB dimensions: 64 x 49mm). Order as "XTK" **£6.28**
50Hz CRYSTAL TIMEBASE MODULE: as above, but built and tested and with output preset to within ±5ppm. Order as "671-50" **£9.80**
100 Hz CRYSTAL TIMEBASE MODULE. Use as a pulse generator for any system counting in units of 1/100th sec. High stability, low current consumption (3mA typical). Easily interfaced to TTL (requires 1 transistor — circuit given). 5 to 14V operation (typical). Built and tested and output preset to within ±5ppm. Order as "821-100" **£12.70**

STOPWATCH

Complete kit for stopwatch (as in Dec. ETI): choose 6 digit range from tens of hours to milliseconds. Uses 6 x MAN3M displays. All necessary parts, including case and Manganese batteries **£31.80**
STOPWATCH WITH ONE LATCH: As above, but kit also includes facility to repeatedly freeze the displays with count continuing **£43.23**

Buy it with Access

ADD VAT at 8%. 25p P&P on all orders. Access orders welcomed, by post or phone (see above).
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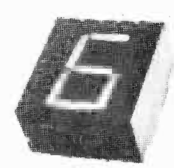
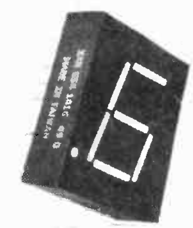


FND500

TIL321, TIL322



XAN652, XAN654

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(B) Medium loss, medium stability e.g. paper, plastic film, high-K ceramic.
(C) Polarised capacitors e.g. electrolytic, tantalum.

MICA CAPACITORS

Mica capacitors have low RF losses right through to UHF and very good capacitance stability. They are suitable for use in RF circuits up to 500 MHz and are recommended for use in oscillators and filters where their stability characteristics are almost unrivalled. Mica capacitors of appropriate size can handle large RF currents and high voltages and are often used in transmitting applications.

Moulded Mica or "Postage Stamp" — the most common form is the "Postage stamp" style, so named because of its size and shape. Often cheaper than real postage stamps and taste better when licked! General purpose mica capacitors have good stability and can be obtained with high voltage and high RF current ratings. They are constructed of layers of foil interleaved with mica (referred to as "stacked mica") or layers of metallized mica. Obtainable in values between 10 pF and 0.1 µF. They may be marked 'M.S.' to indicate Stacked Mica.

Silvered Mica — usually labelled with an S.M. marking, not to be confused with Stacked Mica capacitors. These have very high stability and are recommended for use in oscillators, filters and other critical applications requiring highly stable capacitance. Tolerance is also very good, usually specified to ± 5% but in practice often better. Generally obtainable in values from 4.7 pF to 3300 pF.

Metal-Clad Mica — a square or rectangular-shaped capacitor having a metal clamp holding the stack of interleaved plates of foil and mica. This form of construction has low lead inductance and can handle high RF currents. It is used for dc blocking and bypassing in RF circuits.

Button Mica — named after their shape. Very good RF bypasses. Made in standoff and feedthrough styles. They have very low inductance connections and are used for RF bypass, filter, and tuned circuit applications up to UHF.

The feedthrough style provides a bypassed connection through a chassis while the standoff style provides a direct bypass or bypassed tie point. Obtainable in values between 5 pF and 10 000 pF.

Dipped Mica — this style is encapsulated by dipping in resinous material below atmospheric pressure. They have improved electrical characteristics and higher reliability than moulded types. Obtainable in values from 10 pF to 0.1 µF.

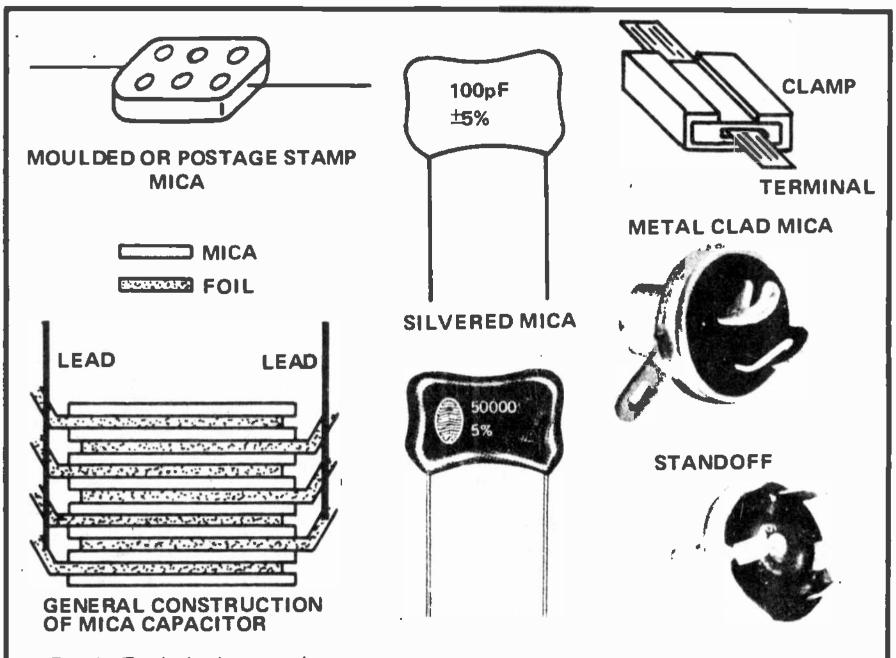


Fig. 1. Typical mica capacitors

CERAMIC CAPACITORS

There are two basic types of ceramic capacitors — low permittivity ("Low-K") and high permittivity ("High-K"). They have widely different characteristics.

Low-K ceramics have low loss and exhibit small, linear changes of capacitance with temperature. They are useful up to 1000 MHz and are made for both low voltage and high voltage applications.

High-K ceramics provide large capacitance values in small space. Their losses are dependent on applied ac and dc fields. They exhibit large, non-linear changes in capacitance against temperature. As a consequence they find application as decoupling and bypass capacitors (discussed later).

Low-K Ceramic Capacitors. Low-K ceramic capacitors are manufactured in a range of temperature characteristics. They are sometimes referred to as "temperature compensating" capacitors as they can be used to compensate for temperature changes in other circuit components. This property is particularly useful in RF oscillators and filters.

The temperature characteristic or coefficient, is quoted in parts per million per °C (ppm/°C), either positive or negative e.g. a capacitor marked 100 pF/P100 will *increase* its capacitance by 100 ppm for each degree centigrade increase in temperature. For a temperature rise of 10°C it will increase its capacitance by 0.1 pF. As a further example, a 1000 pF capacitor

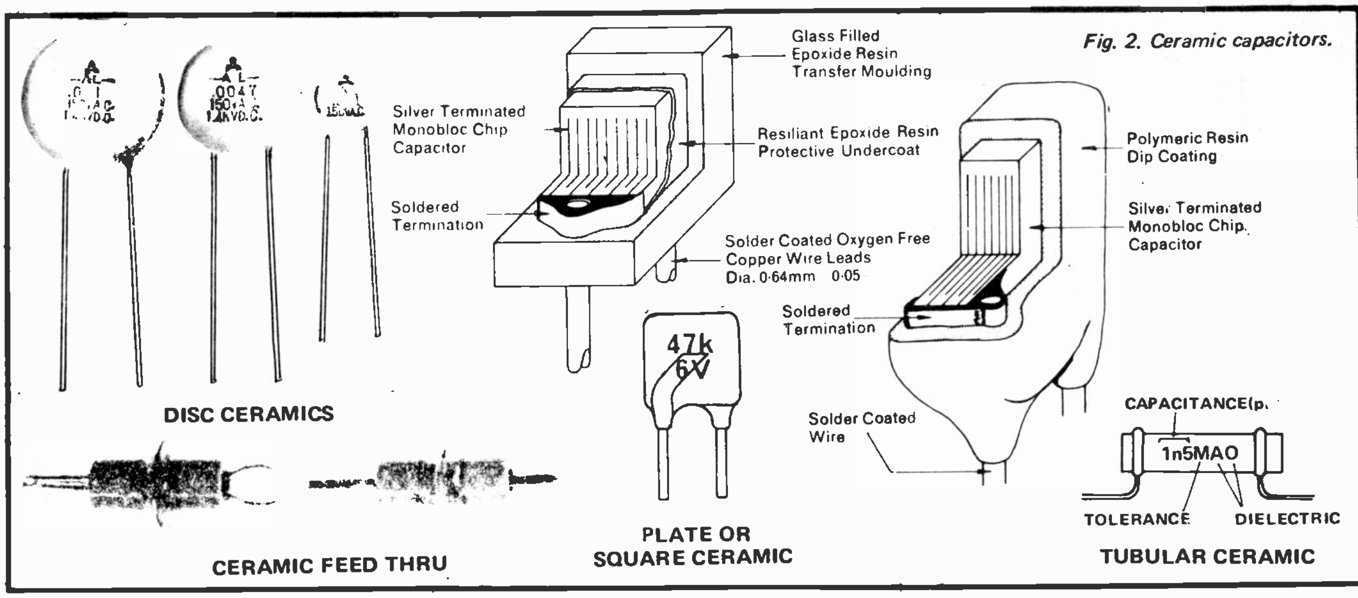


Fig. 2. Ceramic capacitors.

will *decrease* its capacitance by 1500 ppm for each degree centigrade rise in temperature. For a temperature rise of 10°C, its capacitance will drop by 15 pF.

Low-K capacitors are also produced having an extremely small temperature characteristic. These are known as NPO ceramics ("Negative-Positive Zero"). Their stability rivals that of silvered mica capacitors.

The graphs in Fig. 3 indicate the range of standard characteristics manufactured. The nominal value of ceramic capacitors is specified at 25°C. It should be noted that the change in capacitance is not strictly linear, having a small curvature, at low temperatures it becomes more negative. The tolerance on the temperature characteristic ranges from ± 30 ppm for NPO capacitors, to ± 1000 ppm for N5600. Below values of 10 pF stray capacitances begin to have a marked effect on the temperature characteristic and the tolerances are widened as shown in Table 1.

The temperature coefficient of silvered mica capacitors is usually about +20 ppm/°C but may be as low as +5 ppm/°C which is somewhat better than NPO ceramics.

Low-K ceramic capacitors are made in disc, square and tubular forms. They are obtainable in a range of working voltages from 50 V to 15 kV. They are useful in RF circuits up to three or four hundred megahertz. Above this frequency, leadless unencapsulated "chip" capacitors are used.

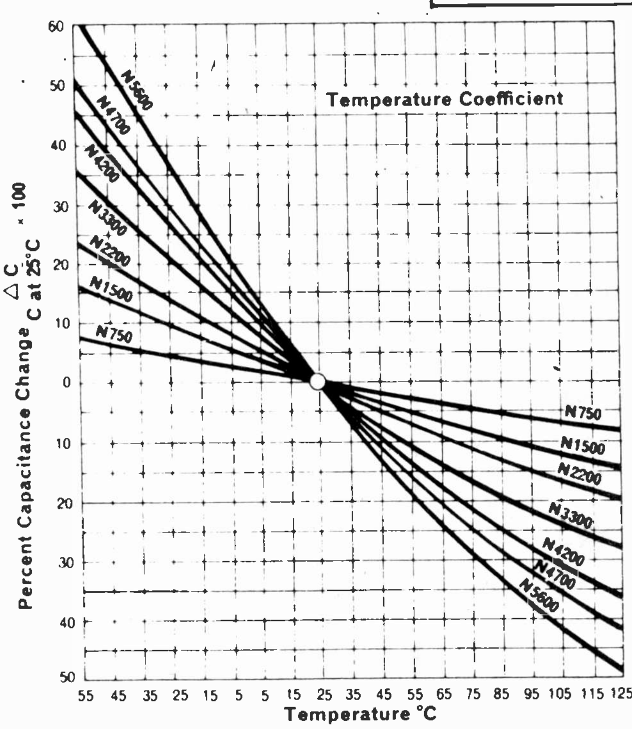
POLYSTRENE CAPACITORS

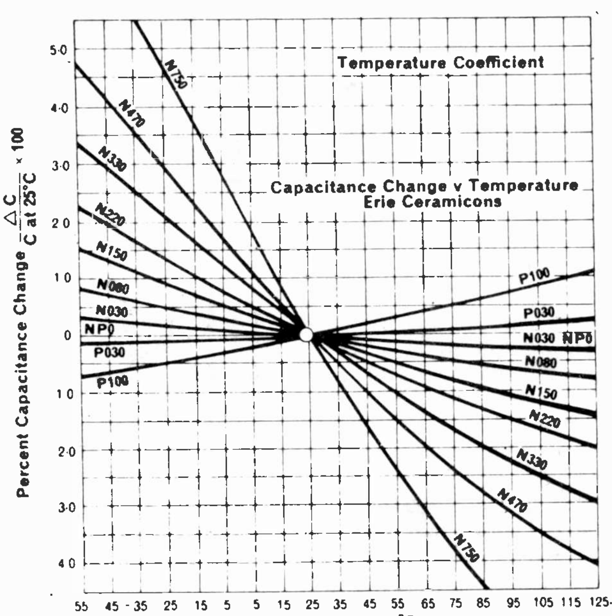
Polystrene capacitors are one type of plastic film capacitor. They are constructed usually by interleaving strips of foil and polystyrene film, the alternate strips of foil being staggered to provide connections. The assembly is then rolled up to form a tubular shaped capacitor. See Fig. 4. They exhibit low loss and good stability and are manufactured in a range of working

TABLE 1

Characteristic	Capacitance range (pF) 0.4-2	2.2-3.9	4.7-10
NPO – N330	± 250 ppm	± 120 ppm	± 60 ppm
N470 – N750	± 250 ppm	± 120 ppm	± 120 ppm
N1500 – N5600	same as 10 pF and over		

Fig 3 Characteristics of ceramic capacitors





FIXED CAPACITORS

	Paper		Polyester		Polycarbonate		Polypropylene		Polystyrene	Ceramic		Mica	Electrolytic		
	metalized	film/foil	metalized	film/foil	metalized	film foil	metalized	film/foil		disc/tube	monolithic		aluminium foil	foil	tantalum solid & wet
Insulation resistance (in megohms)	3×10^3	2×10^4	5×10^4	10^5	5×10^4	10^5	10^5	5×10^4	10^6	10^2	10^4	10^5	← variable →		
Tolerance	10%	5%	5%	5%	5%	2%	5%	2%	0 625%	10%	20%	0.5%	10%	10	5
Temperature range (°C)	−30 to 100	30 to 100	−55 to 125	55 to 125	55 to 125	55 to 125	40 to 85	40 to 100	−40 to 70	−55 to 125	−55 to 125	−55 to 125	−20 to 80	−40 to 125	−40 to 150
Size per CV*	small	large	small	small	small	small	small	small	large	small	small	small	very small	small	
Stability	fair	fair	fair	fair	fair	fair	fair	excellent	excellent	fair	fair	excellent	fair	very good	excellent
Capacitance range (µF unless indicated)	0.01 to 100	0 001 to 100	0 001 to 10	100 pF to 0.01 µF	0.001 to 100	5 pF to 0 01 µF	0 001 to 100	100 pF to 0 47 µF	100 pF to 0 6 µF	5 pF to 1µF	0.001 to 10	5 pF to 0.01 µF	typically 1−22 000	1 −1000	3500 max
Voltage (ac)	250−630	250 −630	63−400	90−160	40- 250	63 160·	250−440	63- 500	−	63−250	−	−	−	−	−
(dc)	500−5000	−	100−1500	160−400	63 1000	100 400	750−1000	100-1500	63- 1000	63−10 000	63−450	63−630	6.3−500	6.3− 300	1−50
Temperature coefficient PPM/°C	300	300	400	400 (non linear)	150	50 to 100	−170	120	150	non linear positive to 1000 neg		100	1500	1000 (non linear)	200−1000
Appr.: resonance MHz	0.1	0 1	0 1	1	0 1	1	0.1	1	1	10	100	1 0	0.05	0 1	0.1

*CV - product of capacitance and voltage

Table 2. Capacitor Comparison Chart.

voltages from 100 volts to 630 volts. They exhibit a small negative temperature characteristic of about 150 ppm/°C and are sometimes used as temperature compensating capacitors. Their main application is in tuned circuits and as coupling capacitors up to about 100 MHz. The higher values (0.01 µF and above) are sometimes used in bypass and decoupling applications.

Polystyrene capacitors are affected by heat, greases and solvents. Care must be taken when using them to keep them away from heat sources (e.g. power resistors). Exercise care when soldering. Flux solvents and other chemical solvents will dissolve the capacitor, with disastrous effects.

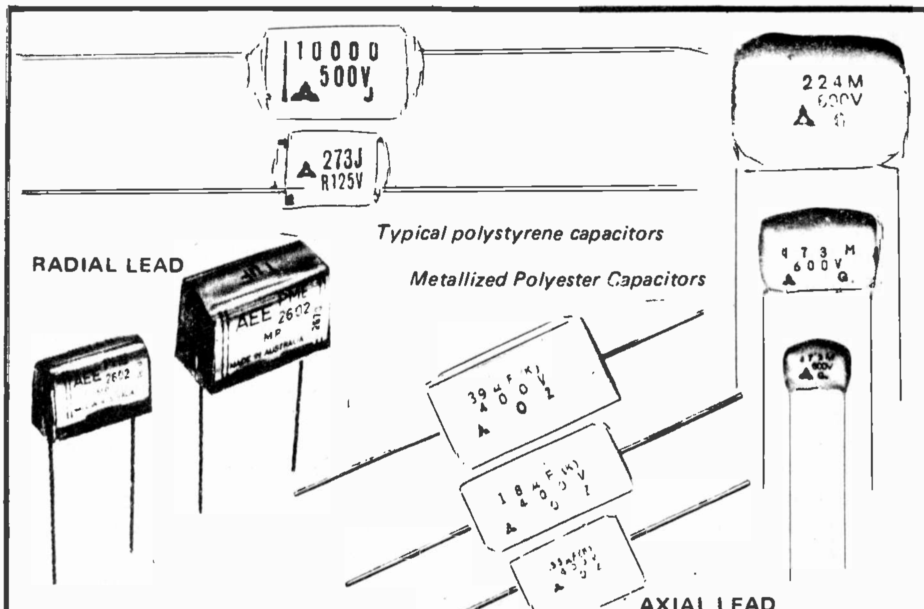


Fig 6 Plastic film capacitors

PAPER CAPACITORS

Paper capacitors are medium loss, medium stability capacitors that were once widely used. They have been largely replaced by plastic film types for most purposes but are unsurpassed in high voltage dc and low frequency ac power applications.

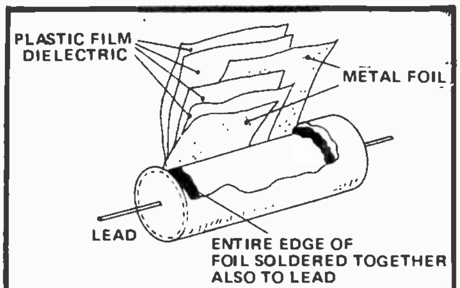
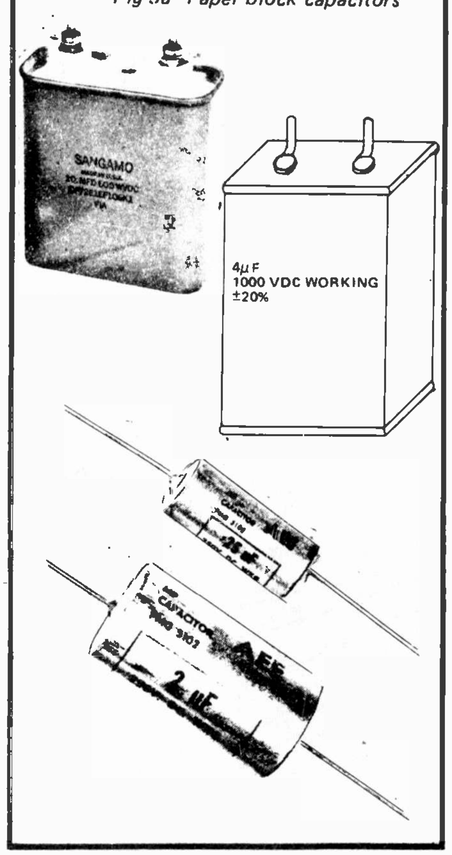


Fig 4 How polystyrene capacitors are made

There are two basic types of construction, the metal foil type and the metallized type. The metal foil type is constructed by winding together interleaved layers of foil and impregnated paper similar to plastic film capacitors, see Fig. 4. This type is best for high voltage and high current applications, a common form being the paper "block" capacitor. See Fig. 5. They are available in voltage ratings up to 4000 V and will withstand considerable charge-discharge currents. The metalized type has the impregnated paper dielectric coated with a thin layer of aluminium or zinc. This form of construction results in a capacitor of relatively smaller physical size.

Fig 5a Paper block capacitors



The paper dielectric is impregnated with another dielectric substance to replace the water content inherent in paper and to prevent the absorption of moisture. A variety of natural oils or waxes, or synthetic chemicals, is used.

Encapsulation of the capacitor assembly is usually by moulding in resin or encasing in hermatically sealed metal cans as is done with block capacitors.

PLASTIC FILM CAPACITORS

Plastic films are widely used in capacitor manufacture due to their high reliability and low cost. They have medium loss and medium stability characteristics except for polystyrene capacitors which have already been discussed. Many types of plastic film are used but these fall into three general groups:— polystyrene, polyester and polycarbonate.

The common form of construction uses strips of aluminium foil interleaved with the plastic film dielectric, alternate layers of foil being staggered to provide lead connections. The assembly is then rolled-up to form a tubular-shaped capacitor. Some types are wound flat to form a flat rectangular-shaped capacitor which enables it to be packed more densely on a printed circuit board. They are referred to as 'flat film' capacitors.

Metallized film construction is also extensively used with plastic film capacitors, resulting in physically small dimensions. These capacitors have largely replaced paper capacitors in most low voltage applications owing to their superior electrical characteristics and considerably smaller size.

Plastic film capacitors are generally encapsulated in a tough, impervious plastic or resin or in a metal case.

The polyester films used are generally of the polyethylene type (Mylar, Melinex etc) or polypropylene, and for most purposes they have similar properties to polycarbonate films. The latter though, has less loss and exhibits less change in capacitance with temperature. Polyester capacitors are available in ratings up to 100 Vdc (or 250 V rms ac), Polycarbonate capacitors are usually only available in ratings up to 400 Vdc.

A comparison of the temperature, loss factor and insulation resistance of various capacitors is given in Figs. 7, 8, and 9.

A small defect, such as a hole, in the dielectric of a capacitor will allow an arc between the electrodes when a sufficiently high voltage is present. In foil capacitors, the arc usually destroys more of the surrounding dielectric, resulting in catastrophic failure — usually a short circuit.

This disadvantage does not occur in metallized capacitors. The heat generated by the arc rapidly vaporizes the electrode section, clearing the short. A very short pulse of current occurs and the voltage across the capacitor drops and then rises again in a few microseconds. Usually, no further damage results. The process is illustrated in Fig. 10.

HIGH-K CERAMIC CAPACITORS

High-K ceramic capacitors provide large values of capacitance in a very small space. Owing to their method of manufacture they have appreciable loss and show large non-linear changes in capacitance with temperature. Primarily for these reasons they largely find application in bypassing and dc blocking. They change capacitance with applied dc and ac voltage, showing a decrease in capacitance with increasing dc voltage which ranges from 14% for the relatively low permittivity high-K ceramics to 80% for the higher permittivity ceramics. Ac voltage effects are the reverse of dc, giving an increase in capacitance with increasing voltage. This may be only 2% for the lower permittivity ceramic or up to 80% with the higher permittivity types.

High-K ceramic capacitors also change capacitance with frequency. The change is primarily dependent on the particular ceramic used, rather than high or low permittivity. They decrease in capacitance with increasing frequency. Most high-K capacitors only show a decrease of 5% between 1 kHz and 10 MHz, but others can drop 20% over the same range. These characteristics are usually of little consequence in most applications. However, care should be exercised in using them as bypass and decoupling capacitors around oscillator circuits. Plastic film capacitors or low-k disc ceramics are to be preferred.

In general, high-K ceramic capacitors have less internal inductance than plastic film or paper capacitors, as well as smaller size and are preferred in bypass applications. Disc or plate style ceramic capacitors are suitable for bypass applications from 10 MHz to 100 MHz. High-K ceramic capacitors are also made in button feedthrough and bypass styles for bypass applications to 1000 MHz. The tubular style is suitable in bypass applications to 50 MHz while the ceramic feedthrough is useful to 500 MHz. See Fig. 2 for illustrations. The large value (1000 pF — 0.47 μF) 'chip' or 'block' style, which has very low lead inductance, is very useful for bypassing in digital circuitry.

ELECTROLYTIC CAPACITORS TOLERANCES

Electrolytic capacitors consist basically of two aluminium foils interleaved with an absorbent paper and wound tightly into a cylinder. Contacts are provided by tabs of aluminium attached to the foils. The winding is impregnated with electrolyte and housed in a suitable container, usually an aluminium can, which is hermetically sealed (Fig. 11).

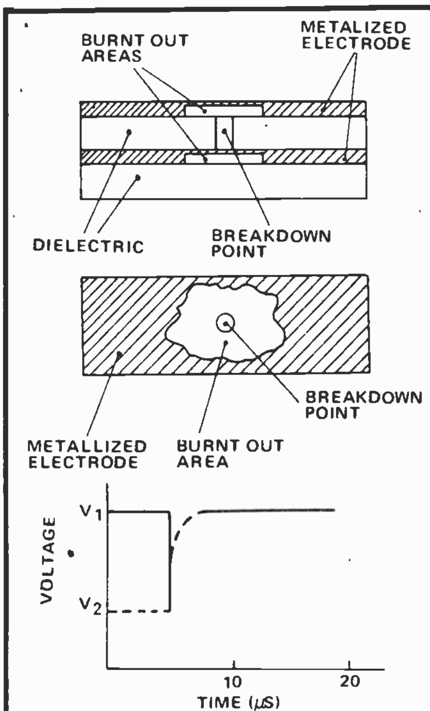


Fig. 10. Process of self healing of a metallized dielectric capacitor. The voltage trace is typical during the process.

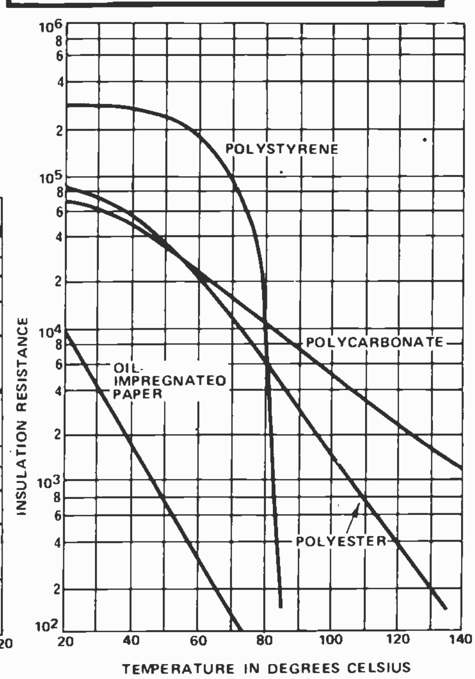


Fig. 9. Temperature versus insulation resistance.

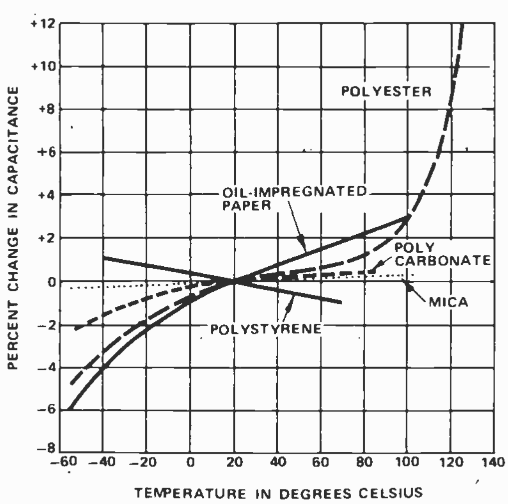


Fig. 7. Temperature versus change in capacitance.

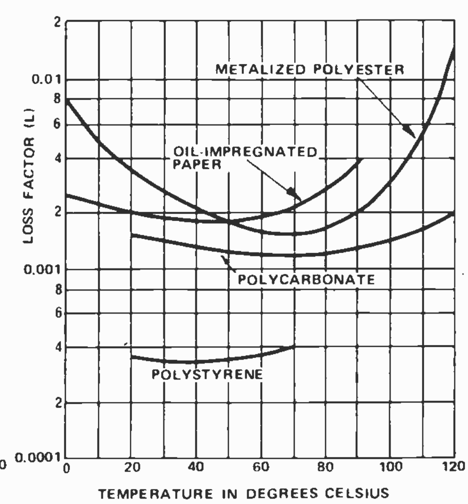


Fig. 8. Temperature versus loss factor.

FIXED CAPACITORS

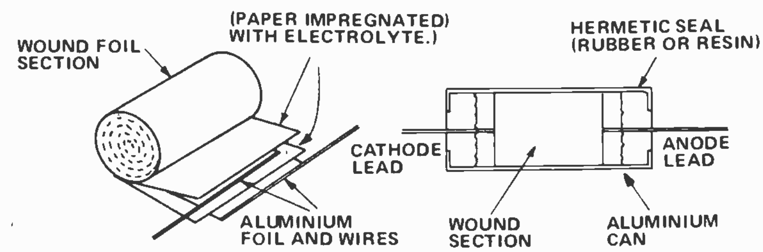


Fig. 11. Construction of typical electrolytic capacitor.

A dielectric layer of aluminium oxide is 'formed' electrolytically on the surface of one aluminium foil which acts as the positive plate, or anode, of the capacitor. The electrolyte serves as the second plate of the capacitor and also to repair any flaws in the oxide film when the electrolyte is polarised. The second foil, usually called the cathode foil, provides contact to the electrolyte. Since this film will have a thin oxide film, due to natural oxidation, it will also possess very high capacitance. The thinness of the oxide films, and their high breakdown potential, is responsible for the very high capictance values per unit volume and high working voltages of electrolytic capacitors.

As a result of their construction, these capacitors are polarised and require the anode terminal to be at a positive potential to the cathode terminal. Most types will only withstand a reverse voltage of 1 V or 2 V for short periods and about 1.5 V peak-to-peak ac without a depolarising voltage.

There are two types of electrolytic capacitor, the plain foil type and the etched foil type. The plain foil construction is described above. The etched foil type is constructed similarly to the plain foil except that the aluminium oxide on the anode and cathode foils has been chemically etched to increase its surface area and permittivity. It results in a capacitor which is physically smaller than a plain foil type of equivalent value but has the disadvantage of not being able to withstand high ac currents, compared with the plain foil type.

Etched foil electrolytics are best used in coupling, dc blocking and bypass applications. Plain foil types are better suited as reservoir capacitors in power supplies.

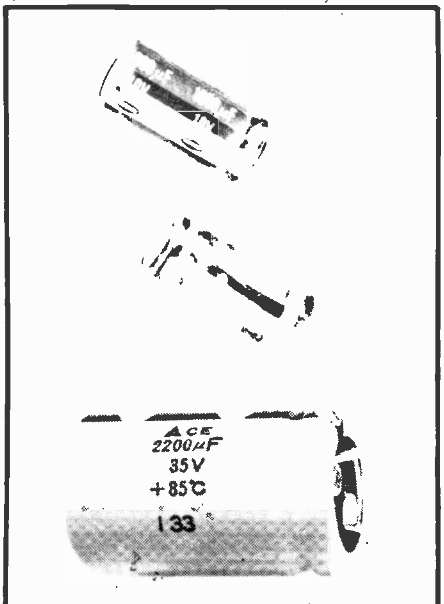


Fig. 12. Electrolytic capacitors.

TOLERANCES

Electrolytic capacitors are usually manufactured to a tolerance of –20 +100% or –50 +100% (they really are!).

The capacitance value and leakage current both increase with temperature. The leakage current increases with applied dc voltage, this increase becoming more rapid at voltages in excess of the rated working value. This can lead to increased heat dissipation in the capacitor which will, in turn, increase the leakage current, leading ultimately to destruction

Most electrolytics are rated to withstand a short voltage surge about 15–20% greater than the rated working voltage. e.g: a capacitor rated at 450 V may be marked 450 VWdc (volts, working, dc), 525 V surge.

Electrolytics can be used below their rated voltage. There may be a slight increase of capacitance with time. Leakage current is usually considerably reduced, resulting in an increased service life.

In manufacture, the internal negative connection may be taken directly to the case or to a tag on the insulated end disc. In this case the capacitor winding is inserted in the case without surrounding insulation so that, even though the negative tag is not directly connected to the case, it is not deliberately insulated from it and leakage current can flow between the case and negative terminal. These capacitors are usually covered in shrunk-on plastic sleeve to insulate the can.

Electrolytic capacitors are made in a range of voltage ratings from 10 V to 600 V.

NON-POLARISED ELECTROLYTICS

These capacitors are constructed using several foils in one winding and connected 'back-to-back'. They are usually larger than polarised capacitors of equivalent value. Since double the foil area than is normally required is used they have increased leakage current. Ac voltage without a dc polarising voltage is permissible, the value depending on ripple current ratings and the frequency.

These capacitors are used as speaker coupling and crossover network capacitors. They are obtainable in values from 1 μF to 100 μF.

TANTALUM CAPACITORS

These capacitors use tantalum oxide as a dielectric. This has a much greater permittivity than aluminium oxide resulting in high value capacitance in relatively small space. Owing to their construction, they are also used as polarised capacitors.

There are three different types of tantalum capacitors, each having different construction. These are the tantalum foil type, the solid tantalum, and the wet-sintered tantalum. The tantalum foil type is similar in construction to electrolytic capacitors but the electrolyte and anode and cathode terminals use different materials.

Solid tantalum capacitors use solid maganese dioxide (which is a semiconductor) as the electrolyte, and a tantalum anode. The cathode connection is formed by coating the electrolyte with graphite and silver. These capacitors may be encapsulated in capacitors may be encapsulated in epoxy resin, polyester sleeve with epoxy seals, or a can with epoxy seals.

Tantalum capacitors are rated at much lower voltages than electrolytic capacitors. Their small size makes them very suitable for use in transistor circuits. Low leakage current and better capacitance stability than electrolytics are two features which make them suitable for timing applications.

Tantalum capacitors are generally available in values between 0.1 μF and 100 μF. Tolerance is usually +50% –20%. Solid tantalum capacitors are available in voltage ratings from 3 V to 100 V. Wet sintered tantalums are available up to 125 V rating and foil tantalums up to 450 V. ●

Next month – all the various capacitor codes etc.

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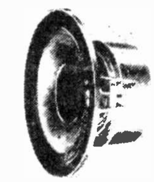

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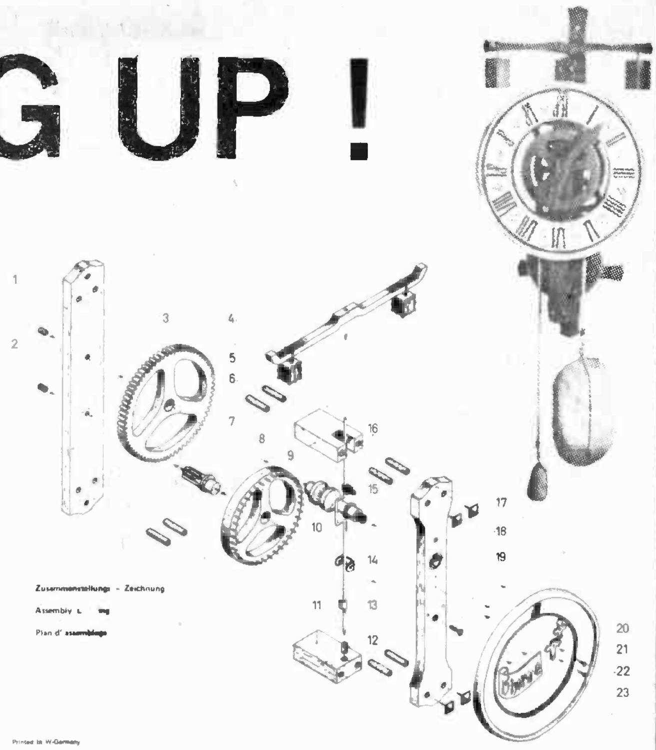

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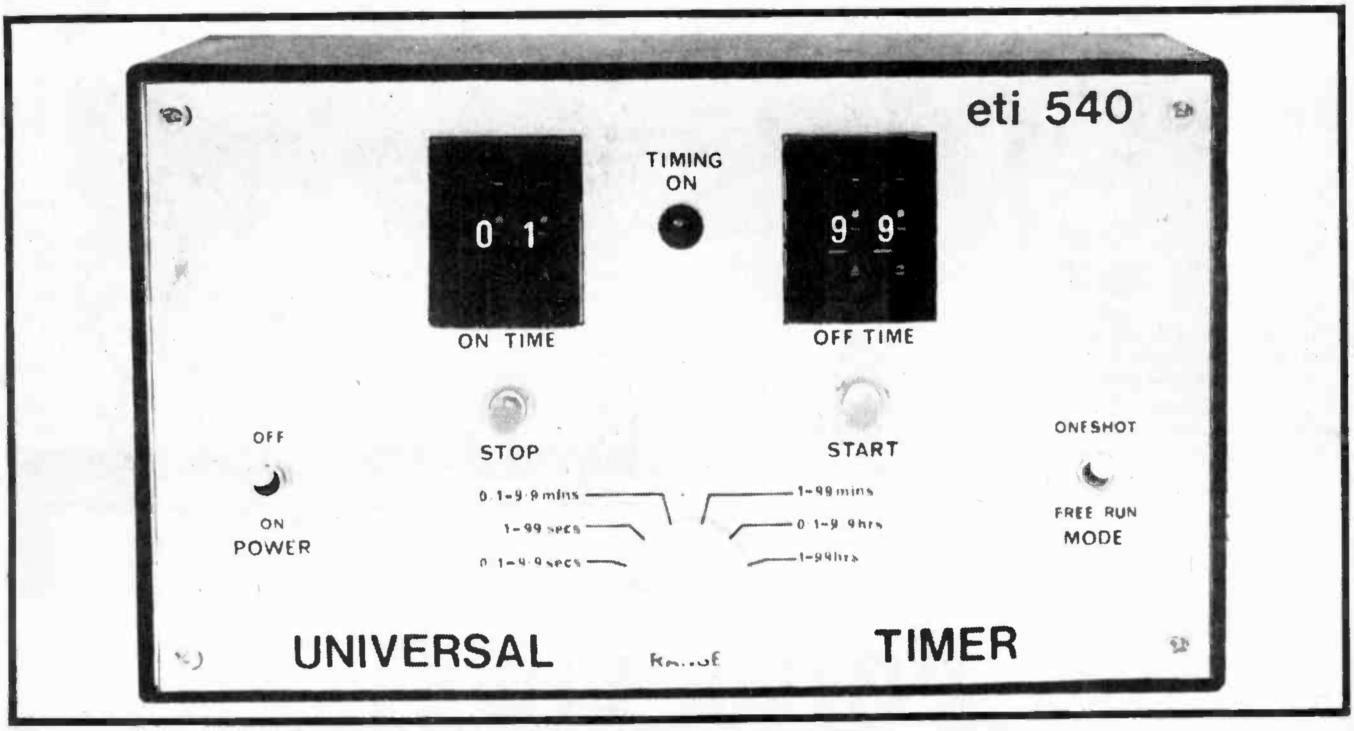
UNIVERSAL TIMER



One tenth of a second to 99 hours. Both on and off times programmable. Manual or automatic operation, resettable at any time.

eti project 540

THE TIMING OF EVENTS and processes is becoming an ever-increasing necessity particularly in applications involving automation.

Unfortunately most timers are either specifically made for a particular application — and difficult to adapt to others — or have restricted timing range, accuracy and facilities.

The ETI Universal Timer described in this project is free of most such constraints. It is extremely flexible, accurate and versatile. Its timing range is from 0.1 seconds to 99 hours. Both 'on' and 'off' times can be programmed (for example 12 hours on and 47 hours off). It can be manually started, stopped, or reset at any time, can be set for automatic cycling or for single cycle operation. It may be triggered by an external source (light, sound or pressure transducer, etc). Finally, as the unit is digital — the 50 Hz mains is used as the reference — timing accuracy is very high indeed, and a manual reset facility enables the timer to be synchronized with local time if so desired.

Clearly not all users will need all the facilities provided — so if the unit is required for a specific permanent use it is a simple matter just to leave out those ICs not required — several variations are described at the end of this project.

CONSTRUCTION

We strongly recommend that this unit be assembled using the printed circuit board shown.

Begin by fitting the links to the board as shown on the component overlay. Note that there are two points labelled 'a' and two points labelled 'b'. Link 'a' to 'a' and 'b' to 'b' using insulated hook-up wire routed on the copper side of the board.

Mount the resistors to the board followed by the diodes, transistors, capacitors and finally the ICs. Take particular care to ensure that all the polarized components are orientated correctly — especially the integrated circuits.

Wires should now be attached to the board for later connection to the front panel switches. We used rainbow cable for the connections to the thumb-wheel switches as this makes the wiring easier and also helps to keep the wiring tidy. Mount the printed-circuit board into the case and mount the power outlet socket. Assemble the switches to the front panel and then interconnect the printed-circuit board, front panel and power socket in accordance with the interconnection diagram.

Finally after wiring the 240 Vac

power circuitry insulate all 240 V terminals with tape to ensure that there is no risk of personal contact when fault finding is required at any later date.

CUSTOMIZING

The unit need not necessarily be built in its complete form and many different modifications are possible to lessen the cost of the unit when it is to be used for one particular application only. The modifications required for a number of specific applications are described.

Specific fixed time — delete selector switches SW3 to SW6, and replace by wiring links from the appropriate outputs of IC4 and IC5 to the inputs of IC6/1 and IC6/2 respectively. The range switch may also be omitted by installing a link between the appropriate output of IC1 to IC3 and pin 13 of IC4.

Single shot operation — connect both inputs of IC6/2 to ground and omit switches SW5 and SW6.

Timing 99 hours or less — omit IC3 and connect inputs of IC7/3 and IC7/4 to ground.

Timing 99 seconds or less — omit IC2, IC3 and IC7.

External triggering — simplest way is a relay contact in parallel with start or stop button.

The main consideration when making any changes is that the logic is CMOS and any unused inputs must be connected to ground or to +12 volts to prevent damage to the IC (which may overheat with unconnected inputs).

SPECIFICATION ETI 540

MODES

Freerun
On/off (note 1)
One shot
Manual override (note 2)

TIMING RANGE

0.1 seconds to 99 hours (note 3)

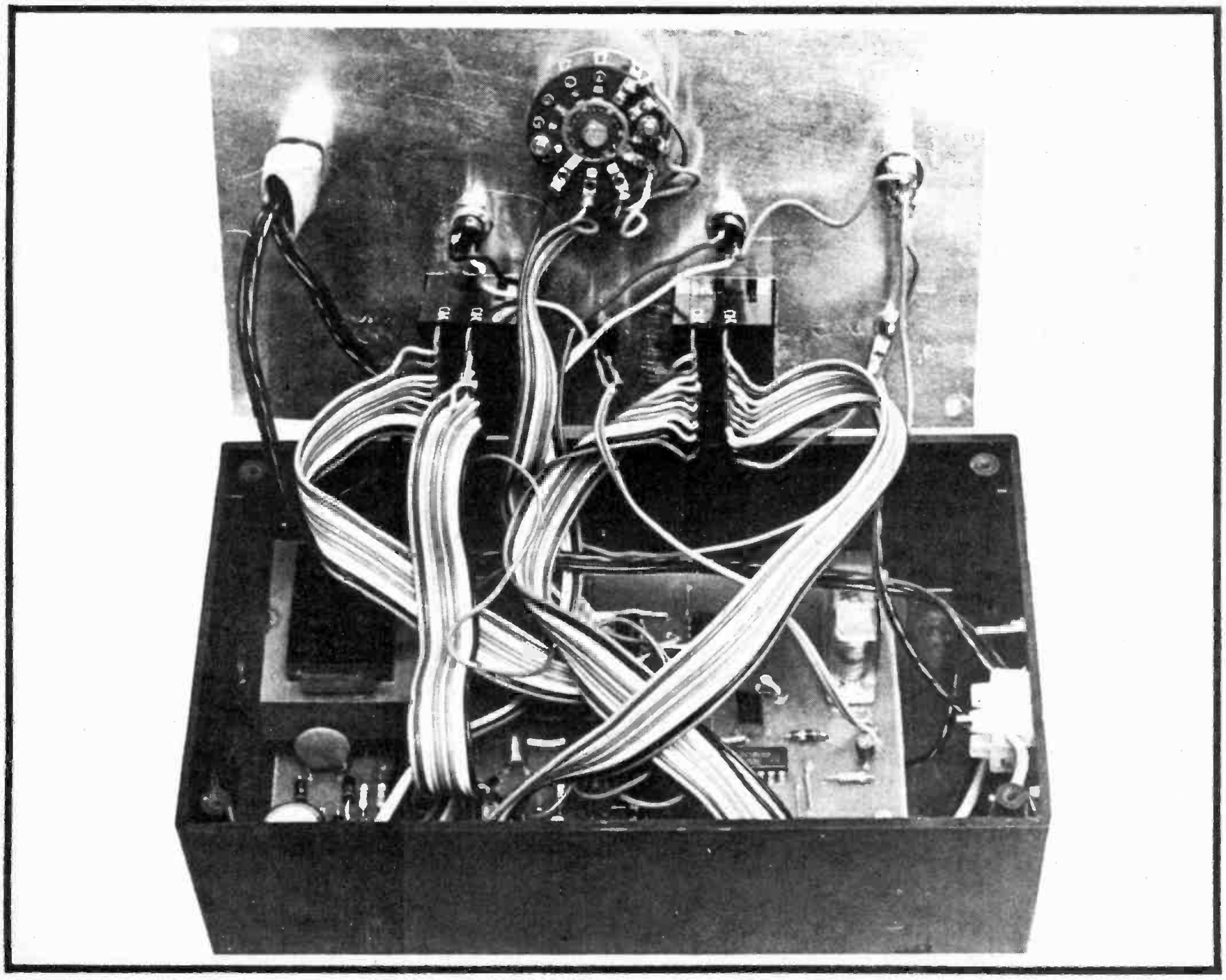
ACCURACY

Mains synchronized

OUTPUT

240 volts ac relay switched

Note 1. Both on and off times are variable independently.
Note 2. Unit may be stopped or started at any time. If the appropriate button is pressed whilst in the same mode the timing is recommenced.
Note 3. Timing is adjustable by a common coarse control which gives ranges having a full scale of 9.9 seconds, 9.9 minutes, 99 minutes, 9.9 hours and 99 hours. Each range is adjustable from 1 to 99 that is one second on and 99 seconds off is possible whereas one second on and two minutes off is not (different coarse range is required).



UNIVERSAL TIMER

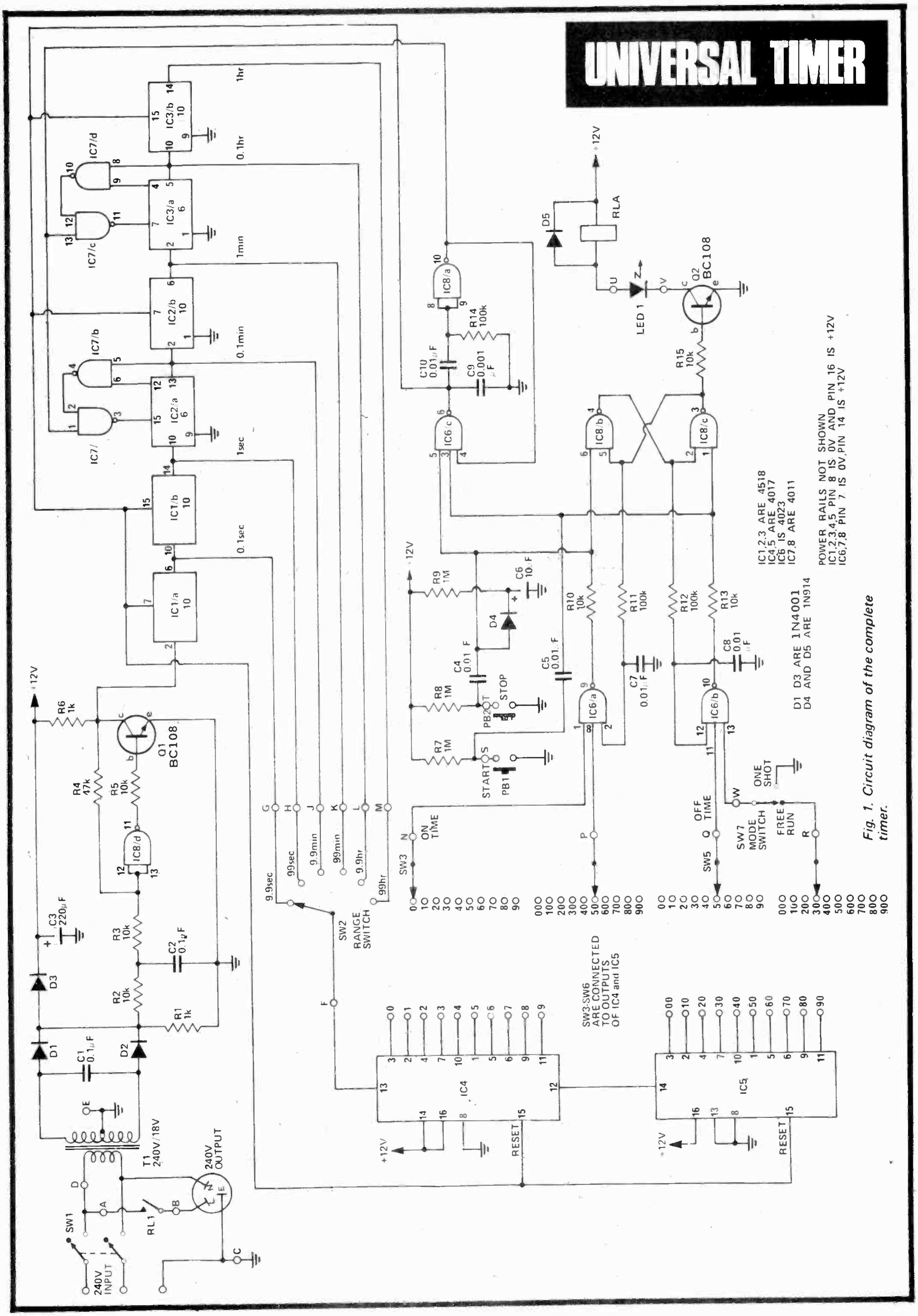


Fig. 1. Circuit diagram of the complete timer.

HOW IT WORKS — ETI 540

The 240 Vac is reduced to 12 Vdc by transformer T1 and diodes D1 to D3. Diode D3 isolates the smoothing capacitor C3 from the rectifiers and therefore 100 Hz ripple appears across R1. This waveform is used for the basic timing reference for the timer. To operate the counting ICs reliably a very fast rise-time waveform is required at the clock input. This is obtained by feeding the 100 Hz to a Schmitt formed by IC8/1 and Q1. Capacitor C2 is included to prevent the control tones superimposed on the mains for the control of hot-water services from upsetting the timing accuracy.

The 100 Hz from the Schmitt trigger is divided by 10 by IC1/1 to give a 10 Hz or 0.1 second output — the first required. Note that due to the low frequencies involved from now on the outputs will be referred to as time periods not as frequencies. A second divide by ten stage is used to give a one second output. A division by six is then performed by IC2/1 with IC7/1 and IC7/2 being used to decode the six count and reset the counter. This gives the one minute (or sixty second) period required. Further divisions of 10,6 and 10 are used to provide the six outputs required to select periods from 0.1 seconds to one hour.

One of these six outputs is selected by the range switch SW2 and is fed to a 4017 IC — the first of a pair of decade counters which have ten decoded outputs. The ten outputs of each IC go high in turn for one clock period each. As the two 4017 ICs are in series, a total division of 100 is obtainable. We have labelled the outputs of IC4 and IC5 as 0 to 9 and 00 to 90 respectively. IC4 is triggered by the clock enable as negative edge triggering is required. The second IC is clocked normally by the carry output from IC4.

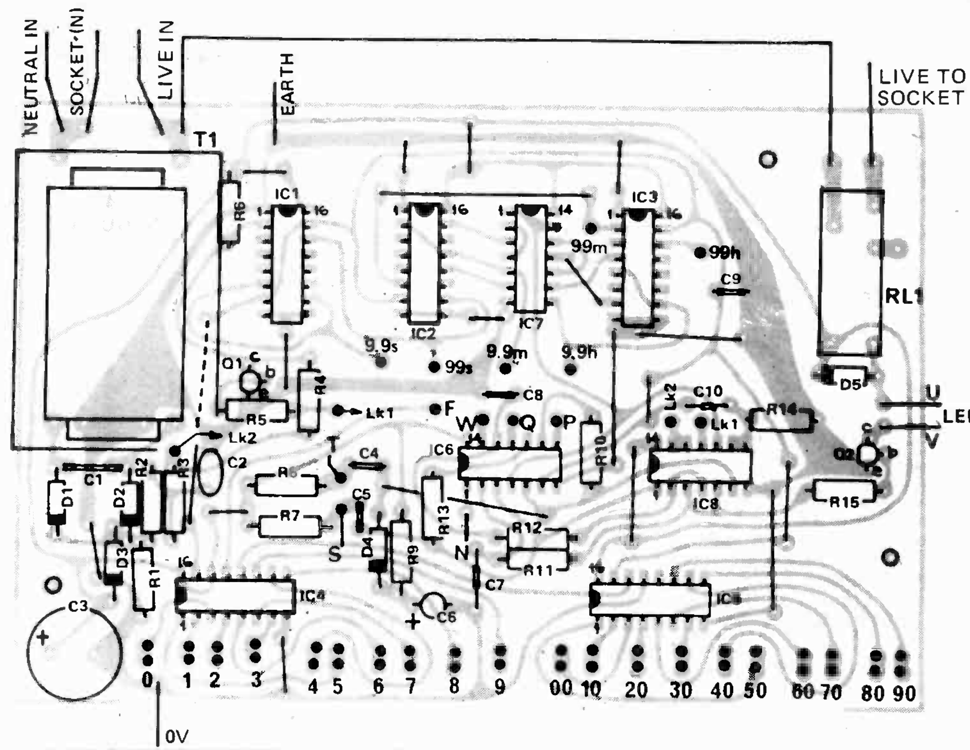
We pause at this point to go straight to the control output which is via a relay RL1, this in turn being controlled by the flip-flop made up of IC8/2 and IC8/3. This flip-flop can be controlled either manually by PB1 (manual on) and PB2 (manual off) or automatically by IC6/1 and IC6/2. To toggle the flip-flop automatically the output of either IC6/1 or IC6/2 must be low and for the output to be low the three inputs must all be high. This occurs only when the number selected by SW3 and SW4 (for IC6/1) and SW5 and SW6 (for IC6/2) is held by the counters IC4 and IC5 and the third input from the flip-flop is used to ensure that the off-time of the relay is controlled only by the off-time selector switches. A small time delay is incorporated in the signal back from the flip-flop to avoid the ambiguity that could arise with equal times.

If the output of either IC6/1 or IC6/2 goes low the monostable formed by IC6/3 and IC6/4 is triggered and its resultant output is used to reset all the counters to zero. This reset also occurs if either of the manual push buttons is pressed. The push buttons are coupled into the logic by capacitors so that only the initial part of the press actuates the logic and there is therefore no dependency on the length of time for which the button is pressed.

The sequence of events is as follows assuming that initially the switches are set for 25 seconds on and 14 seconds off.

On first switch-on C6 ensures that the flip-flop is toggled into the off state and also that the counters are all reset to zero. The control inputs from the flip-flop to IC6/1 and IC6/2 are low and high respectively. Therefore until the flip-flop changes state only IC6/2 can have the three high inputs necessary to provide a low at the output. Meanwhile the counters IC4 and IC5 are counting up at the rate of one count per second. After 14 seconds all three inputs to IC6/2 are high and the output goes low toggling the flip-flop. The monostable is then triggered and all counters are reset to zero. This removes the three high inputs to IC6/2 and the output goes high again. The pulse output of IC6/2 is very narrow and is about a microsecond long. As the flip-flop has now changed state the relay has been closed and IC6/1 has been enabled (control input to pin 2 now high). After 25 seconds all the inputs to IC6/1 are high and the same procedure as before resets the counters and changes the state of the flip-flop.

In the one-shot mode of operation one input of the off timer is grounded and the off time procedure is effectively disabled. The only way that the timer can now start is for the manual start button to be pressed.



PARTS LIST – ETI 540

Resistors				
R1	–	1 k	½ W	5%
R2,3	–	10 k	"	"
R4	–	47 k	"	"
R5	–	10 k	"	"
R6	–	1 k	"	"
R7-R9	–	1 M	"	"
R10	–	10 k	"	"
R11.12	–	100 k	"	"
R13	–	10 k	"	"
R14	–	100 k	"	"
R15	–	10 k	"	"
Capacitors				
C1	–	0.1 μF 50 V disc ceramic		
C2	–	0.1 μF polyester		
C3	–	220 μF 16 V electro		
C4,5	–	0.01 μF polyester		
C6	–	10 μF 16 V electro		
C7,8	–	0.01 μF polyester		
C9	–	0.001 μF "		
C10	–	0.01 μF "		
Diodes				
D1-D3	–	1N4001 or similar		
D4, 5	–	IN914 or similar		
LED 1	–	TIL209 or similar		

Transistors
Q1,Q2 – BC108 or similar

Integrated Circuits

IC1-IC3	–	4518
IC4,5	–	4017
IC6	–	4023
IC7,8	–	4011

Transformer 240 V/18 V CT PL18/5 VA
pc Board ETI 540
Relay, single pole 280 Ω coil 240 V 5A contact

Switches

SW1	double pole toggle switch
SW2	single pole 6 position rotary
SW3-6	single pole 10 position *
SW7	single pole toggle
PB1,2	single pole "make" push buttons

* Thumbwheel switches
– Doram 338–175

Case plastic 196 x 113 x 60 mm
power cord, plug and clamp
3 pin power outlet socket

UNIVERSAL TIMER

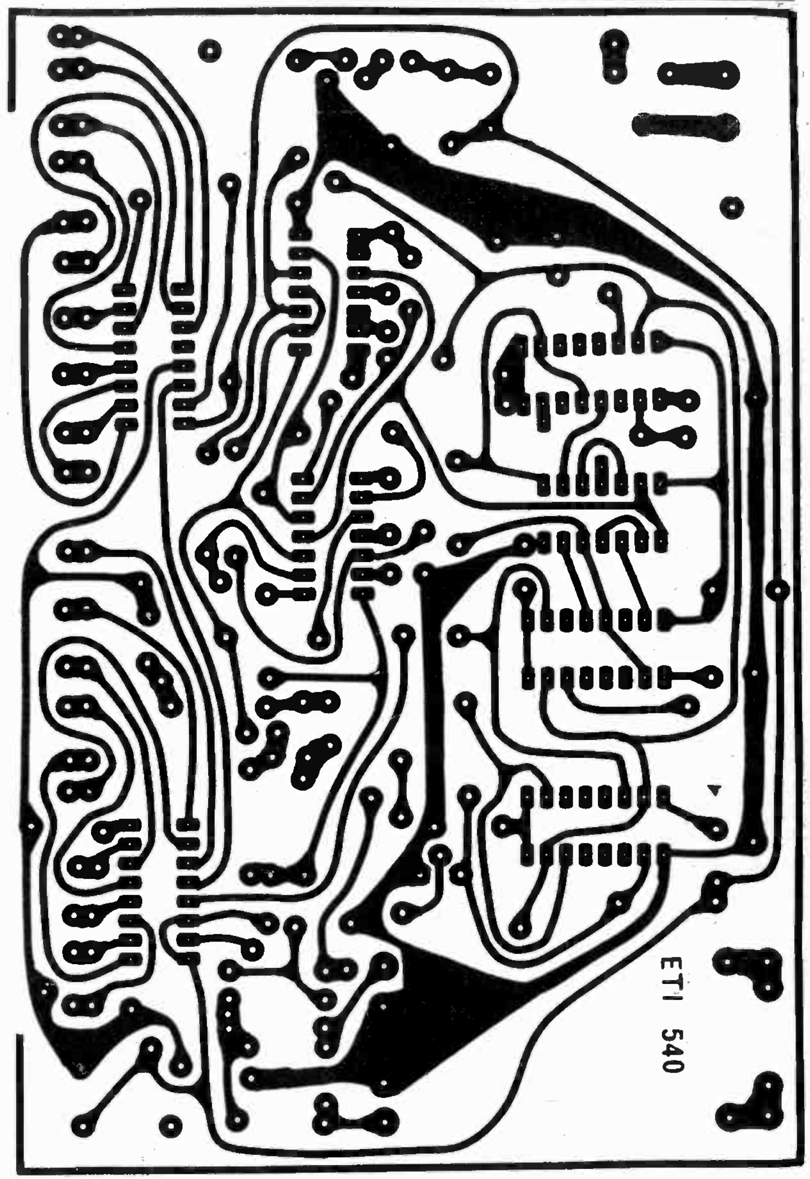


Fig. 4. Printed-Circuit board layout for the timer. Full size 153 x 100 mm.

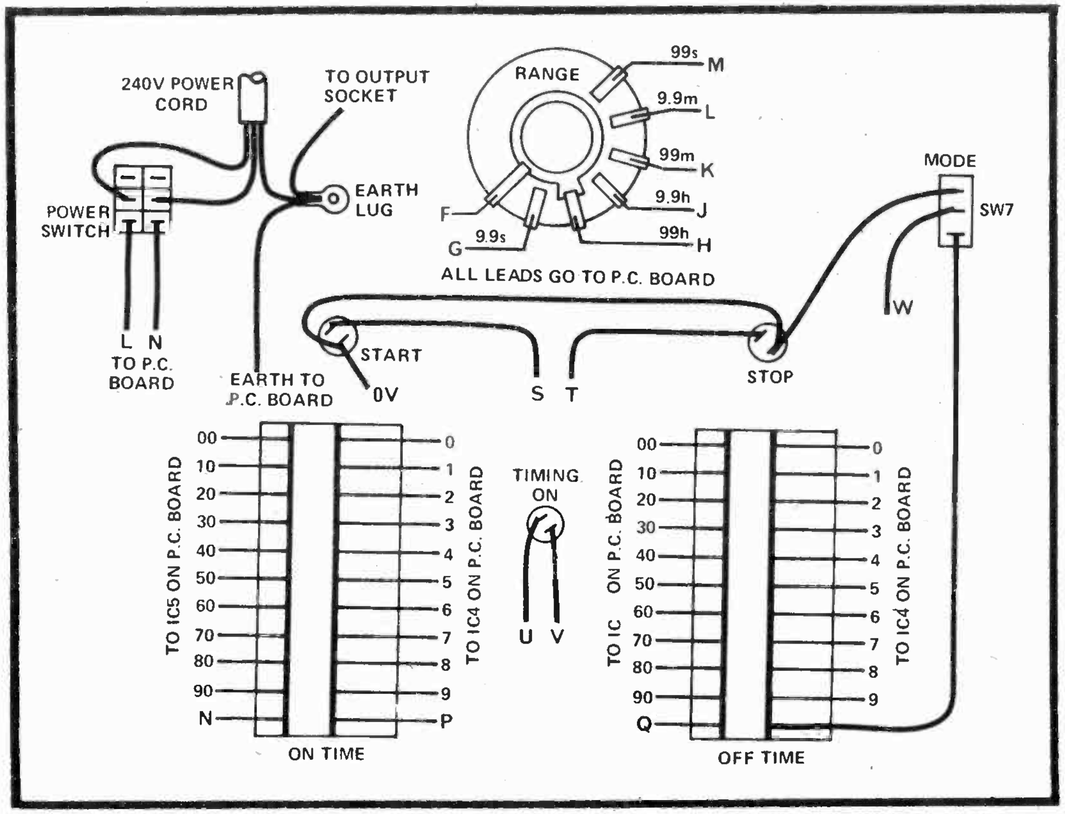


Fig. 3. Interconnection diagram.

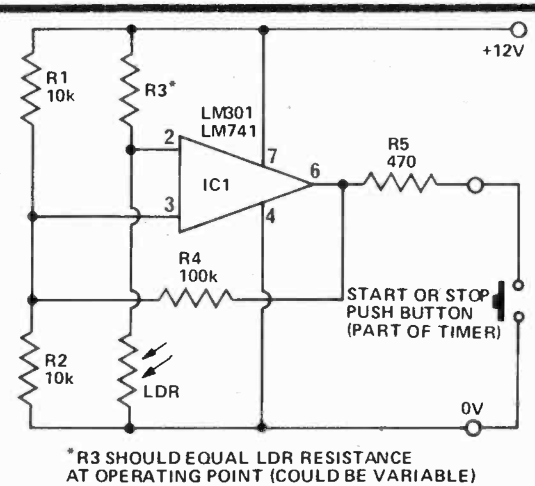
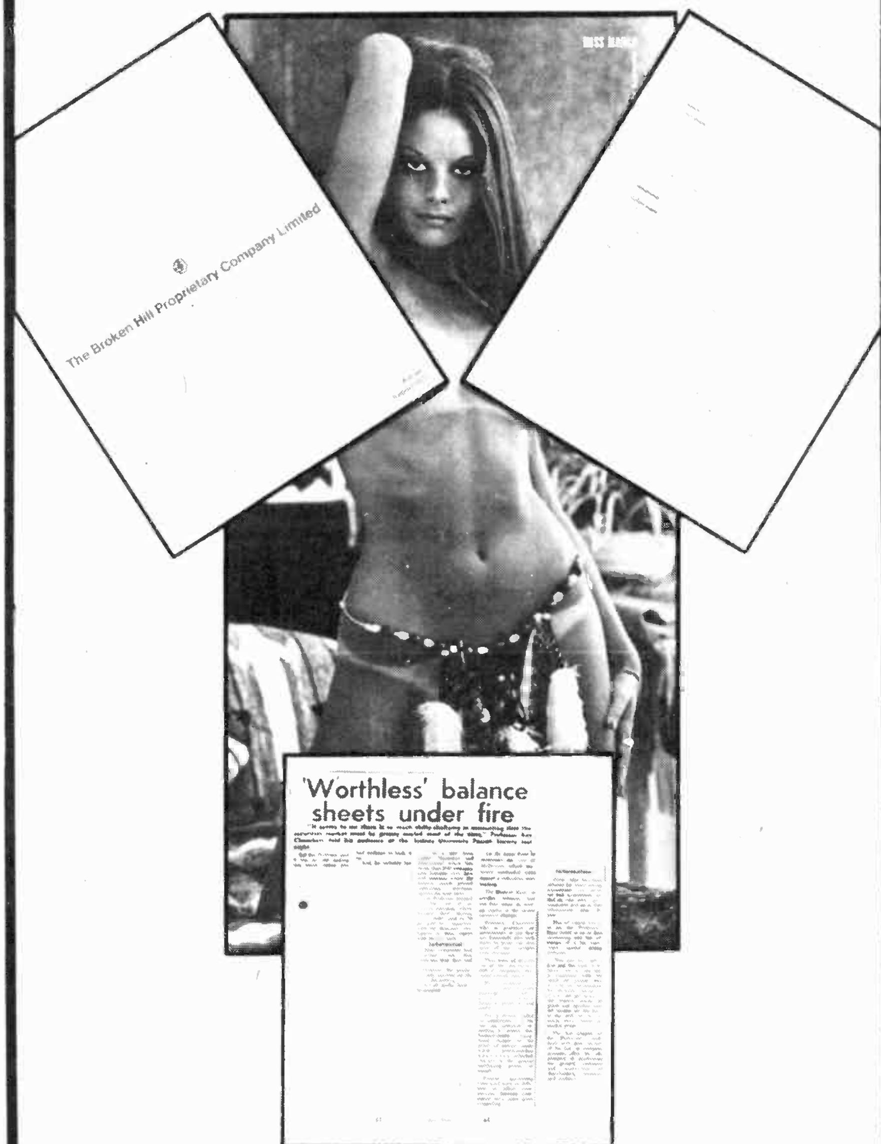


Fig. 6. For triggering timer from a change in light level this circuit will be found suitable.

Measurements

Misunderstandings, misuse, mistakes, mirth and misrepresentation

by Dr. Peter Sydenham



The company balance sheet — what the numbers reveal is interesting but what they hide is vital. (Courtesy John Staunton)

MEASUREMENTS are useful as tools of control of the routine, or as a basis for gaining new knowledge.

Once a particular kind of measurement has been established as necessary, two things can happen. It either remains as is, being adequate for the daily need, or alternatively, constant effort is made to improve it in order to gain the benefits that might accrue from a better determination.

WHAT IS A MEASUREMENT?

To some people measuring implies attaching sophisticated black boxes to a system in order to obtain data about it. Others see the opposite — the use of simple tools such as a ruler to put data to an object. Both are right in a narrow sense. A first basic rule is that *measurement is the comparison of an unknown magnitude of a quantity with an agreed standard declared as the unit, the measure coming forth as the difference expressed in numerical form.*

The most basic number is a binary kind having just two states. The crudest measurement we can thus make is one that provides a yes or no, smaller or larger, up or down, go or no-go, true or false types of answer. Enormous effort can be expended to obtain (or try to obtain) such an answer in many cases. Indeed, it is this kind of measurement that is often the hardest to make. Politicians would give the earth to be able accurately to predict the outcome of an election, social-scientists would be enthralled at the prospects of certainty of success of implemented crime-control measures, geographers seek to know which factors affect what.

As the understanding of a subject is improved — by the use of simple tests giving yes-no type answers — it becomes possible to deploy more and more advanced techniques of hardware and software. The difference between the standard and the unknown (called the measurand) becomes expressible in continuous rather than two-state number terms. For example, the battery in the car will not turn the starter motor because its voltage is *too low* (the two-state situation has been extended by a superlative). Measurement using a voltmeter enables us to say that the battery output is only 6.6 V instead of 12.0 V (the designer's standard requirement now expressed in numbers on a continuous scale).

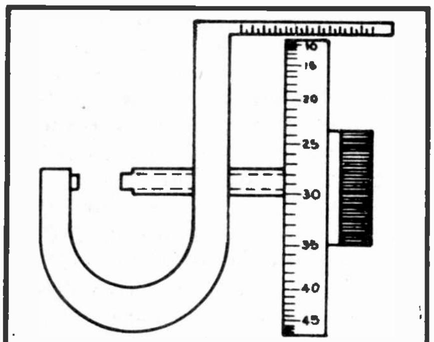


Fig. 2. Adding a huge drum to the dial of a screw micrometer increases its resolution but not necessarily the precision and accuracy of measurements made.

BASIC MEASUREMENT TERMS

Even though we have not yet talked in terms of sophisticated measurements or measuring equipment, the above explanation begins to reveal the need for some definitions of certain facets arising in the intercomparison process. (We need more standards to define standards!)

The misuse and abuse of basic terminology is rife. A first group of terms relates to the description of results provided by the process.

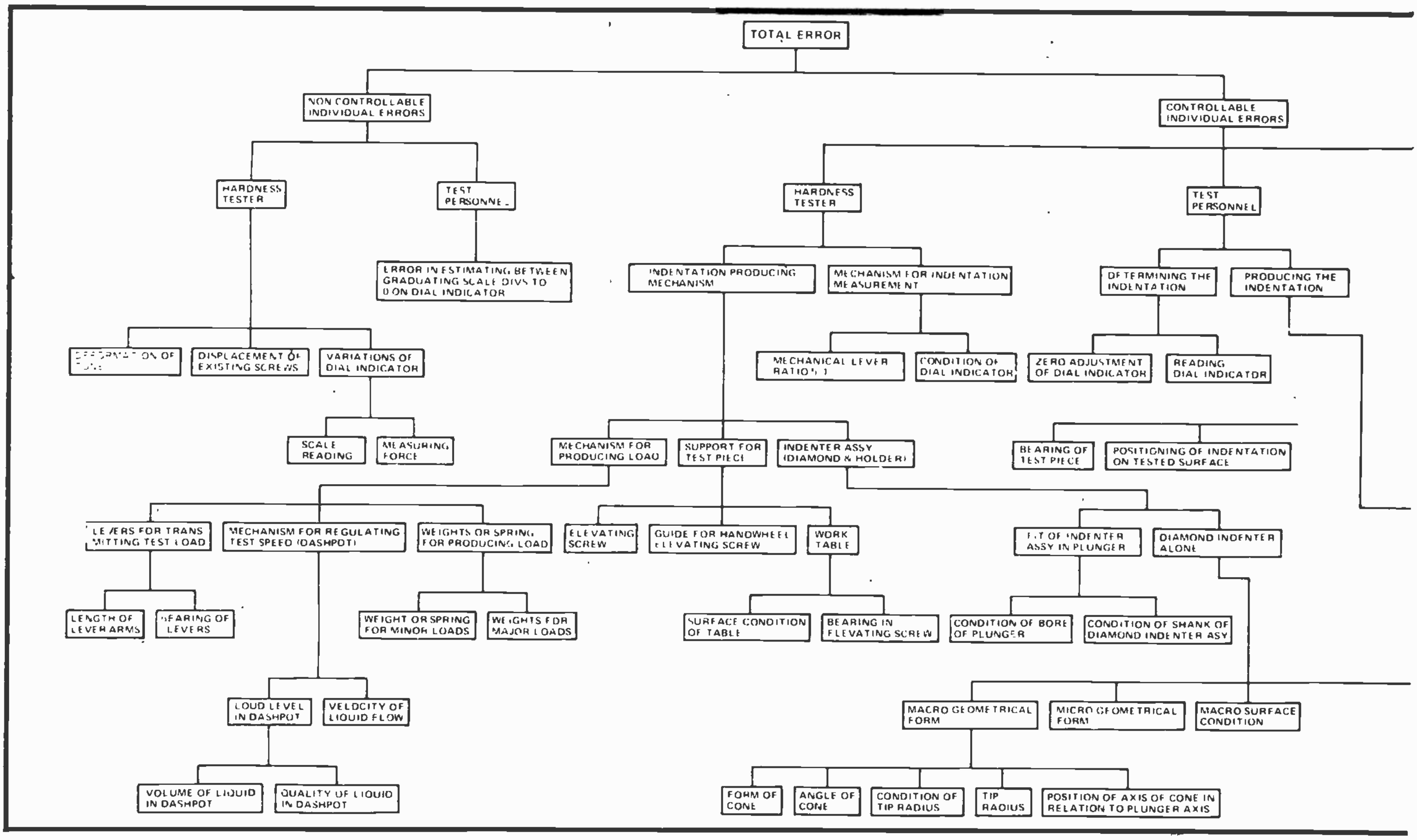
Resolution — at the finest scale available from a particular process of comparison — is the ability to resolve between successive increments in the chosen scale. A person using a mercury-thermometer might be able to resolve, say, 0.1°C intervals, subdividing these intervals into two divisions by eye gives a resolution of 0.05°C. By adding an optical magnifying system (or mechanical gain in, say, a micrometer — as depicted in Fig. 2) which has an inscribed scale at its focal plane, it is possible to raise the resolution 10 times or higher.

The unexperienced, unenlightened measurer will often quote this fact as a measure of how good a device is for measuring with but having resolution may not mean much in reality. It is very much the first basic requirement of comparison, but if it lacks accuracy the answers can be quite wrong. For example, if the optical magnifier on the thermometer has a badly ruled scale or optical distortion each increment will not be equal. Furthermore, the thermometer is supposed to measure temperature but, in fact, pressure of the air or liquid around it will also cause the mercury to rise or fall a little.

Precision — Two men argue as to which is the better rifle-shooter. It is to be settled by a contest on the range. The standard of excellence is to place the shots into the bulls-eye of the target but the game places the contestants sufficiently far back from the target that this is not easy to achieve. If it were, and each man placed all shots in the bulls-eye, the only assessment made would be that both were equally good. This situation lacks resolution to discriminate between them; the range is increased to increase the resolution. Thus emerges an important second rule of measurement — *there must be adequate resolution to a measuring process or little will be learned from the measurement.*

Each fires his group of shots and the two sets are intercompared. The first thing to be seen is that one group lies in a smaller total enclosed area on the target — as shown in Fig. 3a — but (in our chosen case) none is in the bulls-eye. The other shooter, on the other hand, has shots which are contained in a much larger circle, with one actually in the bulls-eye, as shown in Fig. 3b. The argument begins as to who is the better shot. The better shooter is probably the first, not the second, for his precision, that is, his ability to keep on the same spot, is much better than the other person. *Precision then, as the third rule, is the measure of scatter of values obtained in a test.*

In this case the first shooter would



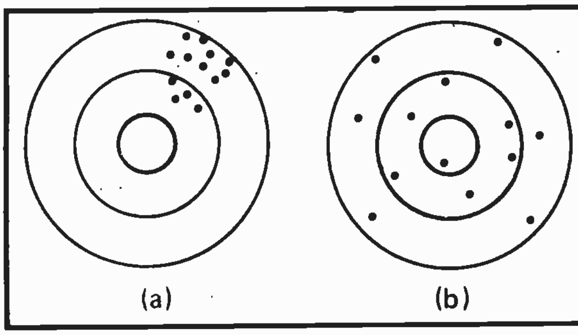


Fig. 3. Rifle-shooting is a good example illustrating the concepts of precision and accuracy.
(a) A precise group of shots that is not as accurate as could be — the mean position is not on the bulls-eye.
(b) An imprecise group which has an accurate mean centred on the bul'-eye.

be able to make a correction to his sight or allow for cross wind in order to move his group over to put more on the bulls-eye than the other person. The less precise shooter could not improve his accuracy. This leads us to what is accuracy in measurement.

Accuracy — In the shooting exercise the aim of each shooter was to reduce the distance between his individual shots and the bulls-eye — which is defined as the standard in this determination. The measurement that gives the closest value to the agreed standard is the most accurate. But in the example above the less precise shooter is, in fact, the most accurate if they decide that the averaged central position of the group is the criteria chosen.

In electrical terms a voltmeter may provide precise values but be very inaccurate due to a bent pointer or an altered value series ballast resistor.

Thus a fourth rule can be seen: *Precision and accuracy are quite different descriptive terms.* These are too often confused. Excellent precision does not imply equally fine accuracy and vice versa. It is always necessary to provide adequate resolution in order to determine the desired fineness of precision and to state the accuracy precisely enough.

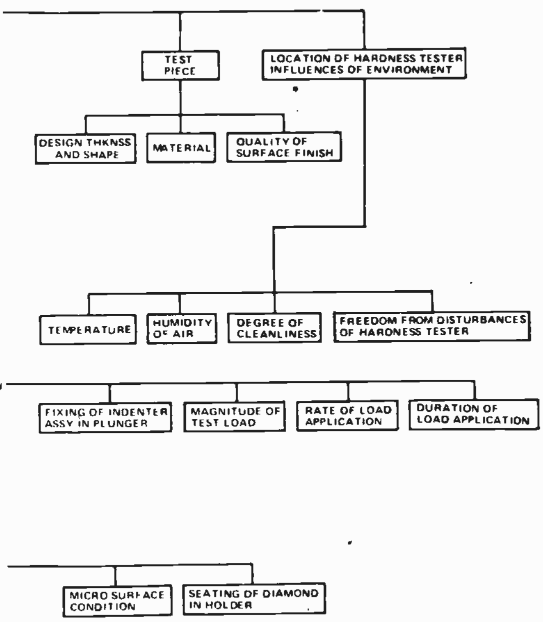


Fig. 4. Personal errors involved in using a simple technique of pressing a point into a surface to measure its hardness.

TYPES OF ERRORS

The numerical value between the standard value and the measurand is termed the measurement error. Error magnitudes may affect the degree of precision and the accuracy obtained. They arise from many different sources, ranging from clearly identifiable processes, to never-identified mechanisms. Ideally, the measurer desires to eliminate all errors but the fact of life is that the closer we investigate a process in order to improve its resolution, precision and accuracy, the more errors loom up. Numerous sources of error can be identified with even the simplest of processes. Several years ago a study was made of the make-up of total error of a simple measurement (in principle at least) involving the pressing of a hardened point into a surface to measure its relative hardness by the degree of penetration — the Rockwell-C hardness test in this case. Something close to 40 sources of error were identified (as shown in Fig. 4).

There are three main classes of error into which similar errors can be typified. Each has to be eliminated, reduced or lived with in different ways. A fifth rule of measurement is that *errors limit the usefulness of a measurement* and need to be reduced to tolerable levels.

Systematic errors — these are the derivations of values that always occur in the same way, and for which a corrective value can be applied to get the right value once the magnitude of the error is known. The rifle shooter resets his sights, the bent pointer is straightened. Or, the voltage reading can be corrected by adding the difference due to a bent pointer, or multiplied by a constant to make up for a wrong value series ballast resistor. It is, however, not necessary to know what *causes* the systematic error, only what its rules of occurrence are so that it can be allowed for.

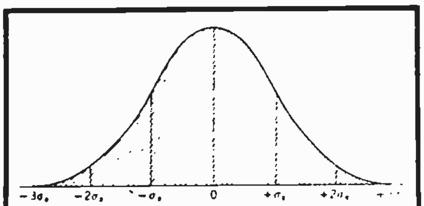


Fig. 5. Gaussian or top-hat distribution of random error.

Random errors — In strong contrast are errors that appear as the name implies, with random amplitude and sign. It is by definition impossible to predict what the random error will be on an individual value basis — the best that can be done is to place a level of probability of such and such a value arising at a certain time. In other words, seen as a group rather than a single occurrence of errors, it is possible to be reasonably certain about the value of such parameters as the *mean value* of the group and the *spread* of the group, but never the facts about the individual until it has occurred.

Random values follow statistical laws for collections of events. The most common occurrence of random error is with the so-called Gaussian distribution (also called top-hat or normal distribution). This form of error has a symmetrical profile for the plot of probability of occurrence of a value versus value changing as shown in Fig. 7. The peakiness of the curve is a measure of the spread of values and from the mathematical laws of this type or error it is possible to define a term that expresses the peakiness — the standard deviation (or s.d. or δ). In practical terms a s.d. of 1 means the limits $\pm 1\delta$ contain 68 per cent of values, $\pm 2\delta$ limits contain 95 per cent and $\pm 3\delta$ limits contain 99.7 per cent. If the chance of a value occurring is 50 per cent within a given limit and 50 per cent outside this limit then the probable error — has a value of 0.67δ.

It is conventional practice to quote the random error of a process in terms of the standard deviation as this conveys the tightness of the random error in the measurement situation.

A trap that exists, however, is that not all random processes are Gaussian in distribution. Nuclear radiation particle occurrence, for instance, has a lop-sided distribution (Poisson) and another quite different set of mathematical formulae describes the chance of occurrence of values. In the majority of cases Gaussian statistics apply — white noise for example in electronic circuits.

Personal errors — To be correct these

Measurements

reduce to random or systematic causes of error, but by treating them as a specific group the deleterious effects of human observation are emphasised. There are numerous sources of personal error. The individual making the measurement may view a scale line at a different angle to another person thus introducing parallex error, the way of driving an adjustment screw dial may be different to another — moving from the opposite direction to the mark or at a different speed could introduce slightly differing values from one observer from another. In surveying practice it is quite normal for the theodolite or level operator to repeat the observation from the opposite direction. This reduces systematic errors of calibration by differential cancellation, thus reducing the personal error.

TRACEABILITY

We saw above how a standard must be created as the sole legitimate value of the unit, and how a measurement was made by comparing the unknown against this.

If the standard varies, then so does the measurement value. In the case of physical standards such as length, mass and time it is possible to provide some defined physical apparatus that acts as the standard. In some disciplines this is not so easy. Biological experiments use a control group — a group of test subjects that do not undergo the test given to the test group — as the temporary standard. In economic studies even the concept of a control group is hard to create, for we cannot ask half the country's population to stay the same economically and isolated at the same time as the other half have their financial situation altered. We would probably learn more about economic procedures if we could!

Whatever the standard it must be adequately constant for a long enough duration and be usable. For physical standards the demand for use is so great that it is necessary to have a sole fundamental standard controlling many working standards in each country, these controlling, in turn, the field standards used by individual laboratories. These control the value of the unit actually used in practice. Thus we can have as many as five or six steps between the fundamental standard and the working instrument. Each stage loses some accuracy so international standards must be maintained in the highest state possible by a national laboratory devoted to this task — the National Measurement Laboratory in Australia, the National Physical Laboratory in Britain, the National Bureau of Standards in the USA, etc.

Clearly if this tree of standards were not strictly controlled any individual unpoliced link could upset the sequence. The process of traceability is used to ensure that a measurement (at least with high-performance instrumentation) is traceable right through to the fundamental standard with the loss in accuracy being designed at each level. This concept is vital to the maintenance of standards in practical use.

MIRTH

Looking back in time, man's measurement endeavours include some highly amusing methods of producing standards. One early standard of length for the inch was 'three barleycorns, round and dry'. Another standard of length was prescribed by taking the first 16 men as they came out of church, making them stand with their left feet end to end — this gave a standard 'rod'. Not quite as bad as it may seem for at least a vaguely reproducible average was obtained. But the last man out defined the foot! In 1800, in Germany, there were 112 different size standards used to define just one common unit of length.

A peculiarity still with us today, concerns the gallon — the US gallon being smaller than the British Imperial gallon. In fact the US gallon is the earlier British gallon — the Pilgrim Fathers used the then-smaller Imperial gallon when they emigrated to the Americas in the 15th century. The Americans retained the original standard (more or less) but the British one was subsequently re-defined.

A 14th century treatise related an English penny — called Sterling — as the same weight as 32 grains of wheat. Thus in a very round-about way 20 pence make an ounce, 12 ounces a pound, eight pounds make a gallon of wine and eight gallons make a bushel of London.

Today some of our basic standards are still based on physical apparatus that is subject to damage or change. The standard (prototype as it is called) kilogram is still a piece of metal held in Paris. Most standards, however, can now be reproduced from a stated description of an apparatus which can be used to replicate the standard to within extraordinarily fine limits. Length for instance is defined as so many wavelengths of radiation from a Krypton discharge lamp.

Some extraordinary anomalies in measurement occur in every-day life — the most frequent being of a kind that imply an accuracy that does not exist.

A recent advertisement for a certain make of car — one that would be expected to be more careful over advertisements, says: "The car responds as quick as adrenalin". This is an entirely meaningless expression. It states nothing of substance. The same advertisement states that the car is "20 per cent safer than the safest car on the road". How do we measure safety in quantitative number terms? It is also said to have "precise rack and pinion steering" — let's hope so! And later: "Every one of its over 5000 parts is the result of adaption and re-adaption of . . . s" pioneering safety programme. It is very doubtful if every single one has been such — if so the designers need sacking for never getting there first-time in their design. Finally, "you need greater reserves of power to outdistance danger" — what a meaningless jumble of measurement statements! ●

- A recipe in a recent issue of an Australian magazine dutifully translated 'take 5 oz of flour' as 'take 141.75 grams' and half a pint of milk as '.354 litres'.
- Motoring magazines frequently quote standing quarter mile (or 400 metre) acceleration runs to three decimal places of one second. Yet one overseas magazine to my certain knowledge measures the required distance simply by a member of the staff pacing it out!
- A 'hundred thousand ton' ship was recently described in a daily paper as displacing '101,606.44 kilograms' — leaving aside that this contained an error of several orders of magnitude — the conversion implied that the original displacement was known almost exactly.
- After hearing that an aircraft was 'one minute late' I'm still trying to determine at precisely which point in its journey that an aircraft officially 'arrives'.
- Until very recently the altitude record for aircraft (and balloons) was recorded to two decimal places of a metre. Yet the actual height recorder was an aneroid instrument with an accuracy at best of plus or minus 0.1 per cent — thus the actual recorded height would not have been known to within 50 to 100 metres!
- A British millionaire was recently described as being worth $1.612 million dollars!

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1A/600PIV	30p
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5A/400PIV	40p
5A/600PIV	50p
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AC142K	18p	BF259	20p
OC71	09p	BFX29	18p
BC107	06p	BFX84	15p
BC108	06p	BFY50	15p
BC109	06p	BFY51	15p
★BC1[illegible]	08p	BFY52	15p
★BC148	08p	2N696	10p
★BC149	09p	2N697	11p
★BC157	11p	2N698	11p
★BC158	10p	2N706	06p
★BC159	10p	2N708	08p
★BC169C	07p	2N1613	15p
★BC170	05p	2N1711	15p
★BC171	05p	2N2219A	15p
★BC172	05p	2N2369	12p
BC178	12p	2N2369A	12p
★BC182	10p	2N2905A	13p
★BC182L	10p	★2N2926g	09p
★BC183	10p	★2N2926y	08p
★BC183L	10p	★2N29260	08p
★BC184	11p	2N3053	15p
★BC184L	11p	2N3055	36p
★BC212	10p	★2N3702	08p
★BC212L	10p	★2N3703	08p
★BC213	10p	★2N3704	09p
★BC213L	10p	★2N3705	08p
★BC214	11p	★2N3706	08p
★BC214L	11p	★2N3903	08p
BC327	12p	★2N3904	08p
BC328	12p	★2N3905	09p
BC337	11p	★2N3906	09p
BC338	11p	★2N4058	08p
BD116	50p	★2N4060	09p
BF167	10p	★2N5172	09p
BF173	10p	★ZTX300	05p
★BF194	09p	★ZTX500	08p
★BF195	09p	★ZTX107	05p
★BF196	10p	★ZTX108	05p
★BF197	10p	★ZTX109	05p
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OA81	5p	IN4004	4p
OA91	5p	IN4005	4½p
OA200/		IN4006	5p
BAX13	5p	IN4007	6p
OA202/			
BAX16	5p	**3 AMP**	
IN914	4p	IN5400	11p
IN4148	4p	IN5401	12p
IS44	4p	IN5402	13p
IS920	5p	IN5403	14p
IS923	5p	IN5404	15p
IS970	5p	IN5405	16p
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RTVC CASSETTE REVIEW

WE MUST ADMIT to some initial scepticism on first encountering this deck. The price puts it well down into those murky regions known as the 'junk jungle', an area notorious for huge discounts and spectacular failures.

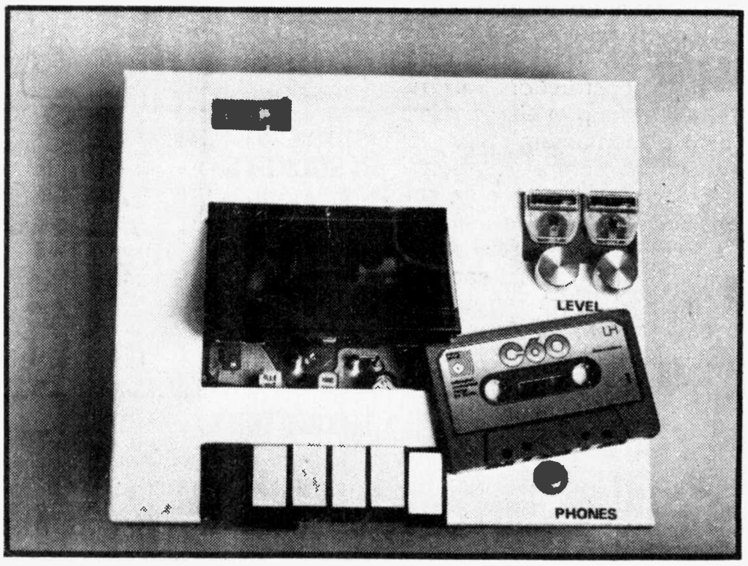
However, RTVC are well known for the reliability of their goods, the best known perhaps being the car radio the 'Tourist'. The company thus has to contend with people's wary attitudes at these price levels, and are paying for being somewhat of an exception to a rule. It was thus with a great deal of interest we approached the cassette unit supplied to us.

Looking over the manufacturer's specification the unit would seem to be suited to the budget audio market, and we were given no reason to quibble with the spec during our dealings with the machine, except to say it is a little vague and if detailed closer could only benefit RTVC.

KITTED OUT

On arrival the kit consists of a main assembly, PSU board, mains transformer and assorted components, i.e. level meters, rotary level controls and knobs, input (DIN) and headphone socket, mains switch and knob. Wire and the few attendant resistors are also provided.

The instruction sheet included is comprehensive enough to show a suggested layout, and offer some sound advice on boxing up the player. (Ours went into the inevitable aluminium box from the equally inevitable H. L. Smiths!). RTVC's layouts are very sensible and should be followed by all but the genius class amonst you! Wiring diagrams are given, as are photographs of the inter connections. Sections cover 'Housing', 'Connections', 'Setting Up' and 'Trouble shooting'.



HOUSE CONNECTIONS

Wiring up the kit entails only connecting the main (pre-assembled) circuit board to the ancillaries. After mounting the transport and the PCB's, the wiring is undertaken, and the order used in the instruction sheet is best followed. Each connection is dealt with, and the steps are sufficiently clear to circumnavigate most problems. If the description of what you've got to do sounds reasonable to you, then probably you'd find building the kit simple enough. As kits go this is a pretty simple example to construct. The complications arise in the setting up.

COMPROMISING POSITIONS

As is to be expected, the alignment and bias adjustments, if left to the home constructor, have to be a compromise. While it is hard to approve of these procedures, it is harder to suggest any other way of carrying out the adjustments at a price compatible with the kit! RTVC have at least been ingenious in solving the equations. Let us hope people involved in construction are faithful to the execution of the instructions.

When setting up the deck to RTVC's instructions, choose yourself a brand of tape, align and bias for this brand, AND THEN STICK

MANUFACTURER'S SPECIFICATION

Frequency Response:	50-12k Hz
Output Level:	>0.5V
Input Levels:	—65dB 10k
	—47dB 100k (DIN)
Tape Speed:	4.8 cms^{-1} (1⅞ ips)
Bias Frequency:	57kHz
Price:	£29.25

TO IT. This will ensure maximum performance. If you do have to change the tape, it would be best to re-align and re-bias the machine, although improvements may be marginal.

With reference to this procedure, we would take odds with RTVC over their recommendation to use a pre-recorded cassette for the purpose. These are notorious in their variation, and provide at best questionable high frequency accuracy. It would be better to use a tape recorded by a friend from disc or FM radio (MCPS licensed we hope!).

SHOOTING TROUBLES

A nice touch is the inclusion of a small listing of possible faults and their causes. Most fault conditions will arise from constructional errors, and careful checking of all work is a must before contacting any kit company with a complaint. Better still get someone else to give the wiring the once-over for you.

We encountered no real problems with building our sample, although the metalwork required is a little 'fiddly' and will soak up a fair bit of patience and time to get it right.

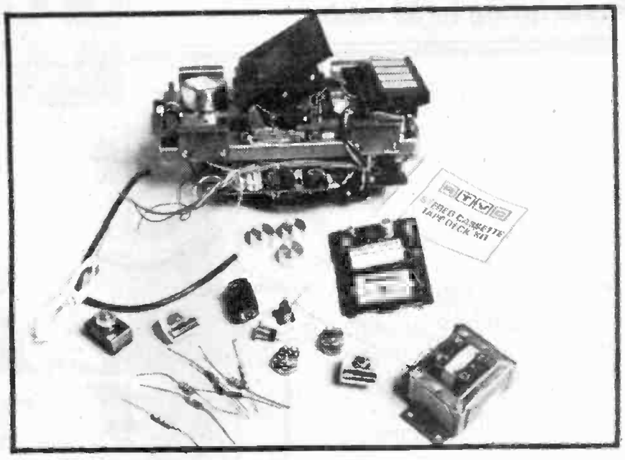
SAMPLED DELIGHTS

As we said earlier building up the unit posed us no problems, and it took us about 2 hours to wire up the unit, and several times longer to carry out the metalwork!! We followed RTVC's setting up, using a BASF C60 cassette as an example of a 'typical' tape.

There is one error in that instruction sheet – Fig. 7. – the 'fast fwd' and 'stop' switches have become transposed on the diagram. Not a major mistake, but a little confusing nonetheless. The setting up procedure was indeed a compromise – no doubt better results could be obtained using a calibrated test tape and lab equipment, however time prevented us from attempting this ourselves.

Using RTVC's methods, the results obtained were certainly fair value for money. A very audible hiss was naturally present, as was a certain amount of 'wow'. Not a machine to record piano concertos! The alignment position proved highly critical and the screw is best secured once the best spot is found.

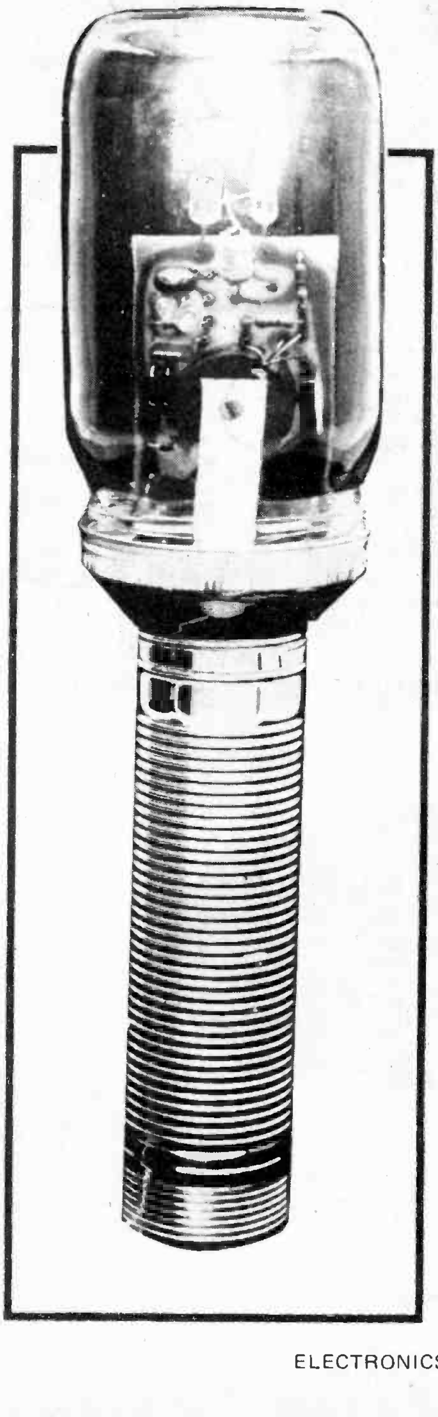
Overall not a bad attempt at low cost cassette audio, and would probably make a starting point for someone who can wave a soldering iron in the correct direction. ●



High Power Beacon

Truly portable battery-operated unit generates immensely bright flashes about fifty times a minute for up to 20 hours.

ETI project 240



A COMPLETELY PORTABLE emergency flash unit has many applications — particularly as a rescue aid when boating or hiking in isolated areas.

For such purposes it is essential that the unit be self-contained, compact and light in weight. It must above all produce a brilliant powerful flash that will attract attention over long distances, yet be capable of operating for at least eight hours from a couple of torch batteries.

The two requirements of high power and battery economy preclude the use of incandescent globes. However a xenon flash tube is capable of producing about fifty 0.6 joule flashes per minute for 20 hours or so if energised — via suitable circuitry — from a pair of alkaline "D" cells.

CONSTRUCTION

This may take any number of suitable forms. One approach is shown in the drawings and photos in this feature. No doubt readers will be able to construct individual housings to suit their own requirements.

Our unit was based on a metal-cased torch powered by two "D" cells. We discarded the torch globe and reflector but retained the switch mechanism. Regardless of the form of housing, construction should be based on the printed circuit board shown. All components should be mounted on the board as shown in the overlay drawing taking care that the diode, SCR, power transistor and pulse transformer are the correct way round.

The trigger lead of the pulse transformer is connected to a spiral of copper wire wound around the body of the flash tube to ensure reliable triggering. The inverter transformer is mounted to the board with a 4 BA or similar screw. This also secures the special bracket that contacts the positive terminal of the battery. This bracket is made from a piece of 18 gauge aluminium as shown in the side view diagram. The brass strip in the torch housing which normally makes contact with the reflector is soldered to the large pad provided for this purpose. This connection, as well as forming the negative battery connection, also holds the board down into the torch body.

We discarded the torch glass and the threaded flange which retains the glass, trimmed back the torch housing a little with tin snips, and then soldered the lid of a jam jar to the torch housing. The jar lid had previously had a hole cut through it to allow the electronics to protrude through into the jar. The jar should be kept over the unit whenever it is being operated as some parts of the circuit are at 400 volts or so and a nasty shock could be received.

The capacitor used for CI is not rated at 300 V but has been found to be entirely suitable for such intermittent pulse operation. A capacitor rated at the full voltage would not only be much bigger and much more expensive, but would not add anything in the way of reliability.

PARTS LIST – ETI 240

Resistors				
R1,2*	–	220	½W	5%
R3,4	–	2M2	"	"
R5	–	10 k	"	"
Capacitors				
C1	–	10 μF	250 V polyester	
C2	–	0.1 μF	200 V	
Transistor				
Q1	–	TIP 3055		
Diode				
D1	1N4008			
SCR1	C106D			

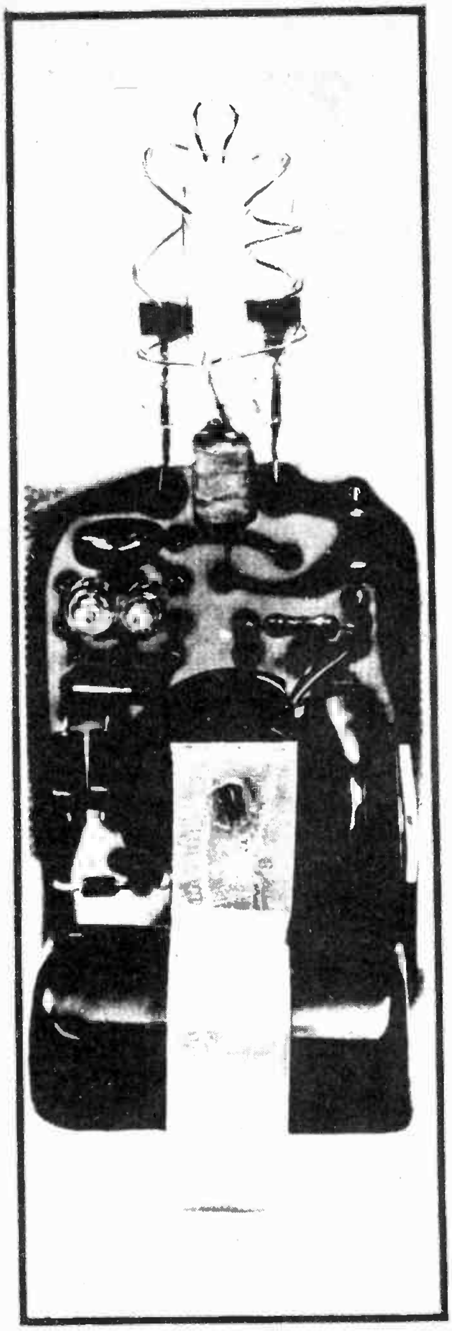
Transformer
T1 See Table 1
T2 See Table 1

LP1, LP2, Neon Lamps NE2 (75 v)
LP3 Flash Tube (see Table 1)

PC Board ETI 240

Torch, Battery etc.

* For 6v operation change R1 to 470 ohm.



HOW IT WORKS – ETI 240

The flash tube requires about 300 to 350 volts to supply the flash energy, and about 4000 volts to trigger it into conduction. The 300 volts is generated from a three-volt battery supply via a blocking oscillator. The oscillator works as follows.

On switch-on the transistor Q1 is biased on by R1 and R2 and a small voltage is generated across the primary of transformer T1. Due to the action of the transformer a voltage is induced in the feedback winding of the transformer which turns on Q1 hard. The current in the primary therefore increases sharply until the transformer core-material saturates. At this time normal transformer action stops, the feedback voltage disappears and the transistor turns off. The polarity of the voltage on the primary reverses and the energy stored in the core must be dissipated. In effect the energy is dumped into capacitor C1 via the diode D1 causing C1 to change to the 300 volts or so required. If the capacitor was not present the voltage on the collector of the transistor would be high (60 volts or more) and the secondary voltage would be well over 1000 volts. Therefore it is essential that the oscillator never be run without the load connected. It is also essential that the polarity of the windings be correct as marked on the circuit diagram (PS for primary start etc).

When the energy in the core has been dumped into C1 the transistor turns on again and the cycle is repeated. The repetition rate depends on the voltage across C1 but is typically within the range 8 to 15 kHz.

When the voltage across C1 reaches 300 to 350 volts the voltage across the scr is about 150 volts and at this point the two neon lamps conduct thus triggering the 'SCR. The SCR now discharges C2 via the primary of the pulse transformer thus generating a pulse of about 4000 volts amplitude on the secondary. The pulse is applied to the trigger electrode of the xenon tube causing it to strike. The flash tube then discharges capacitor C1 in about 10 microseconds giving a very intense and high-speed flash of light. The peak current in the flash tube is about 350 amps.

The SCR turns off automatically due to ringing of the pulse transformer and the low amount of current available through R3.

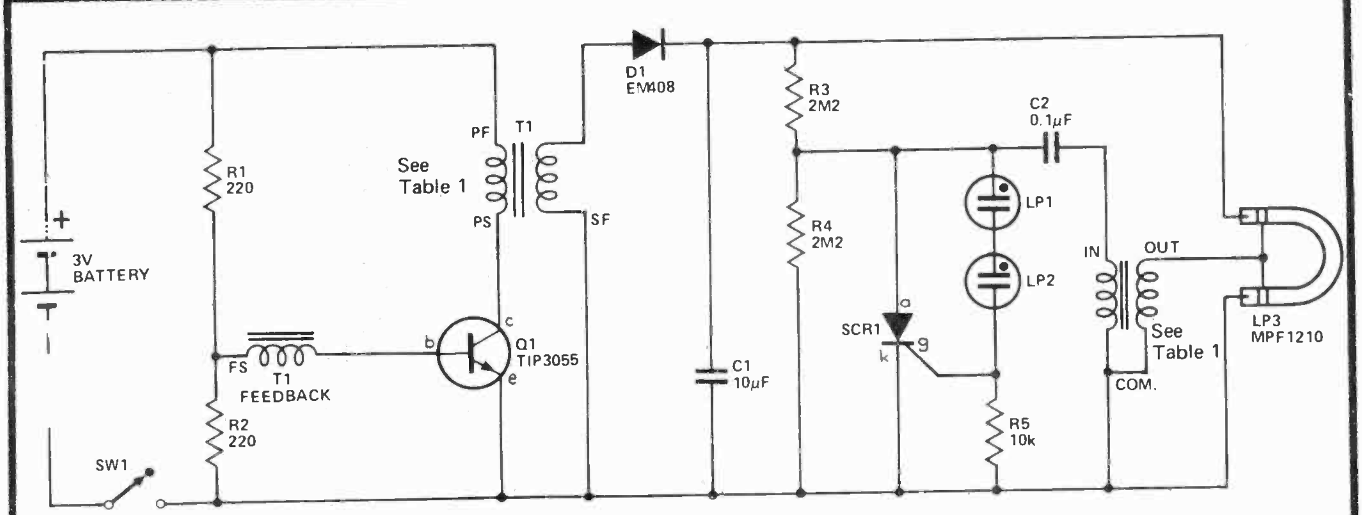


Fig. 1. Circuit diagram of the portable emergency flash.

High Power Beacon

TABLE 1

Winding details transformer T1.

CORE	FX2240 (2 halves) plus single section bobbin to suit
SECONDARY (wound first)	see below
PRIMARY	4 turns 0.5 mm wire (or two 0.315 mm in parallel)
FEEDBACK	4 turns 0.315 mm wire

Mark the start of all windings clearly as polarity is important. Add a layer of Sellotape over the secondary for insulation.
Note that for six volt operation primary should be wound with eight turns of 0.315 mm.

With Philips 126048 or MPF1210 the TR-4KN trigger transformer should be used, but with the Tandy 272 1145 the secondary of T1 should be reduced to 110 turns and the matching trigger transformer 272 1146 used.

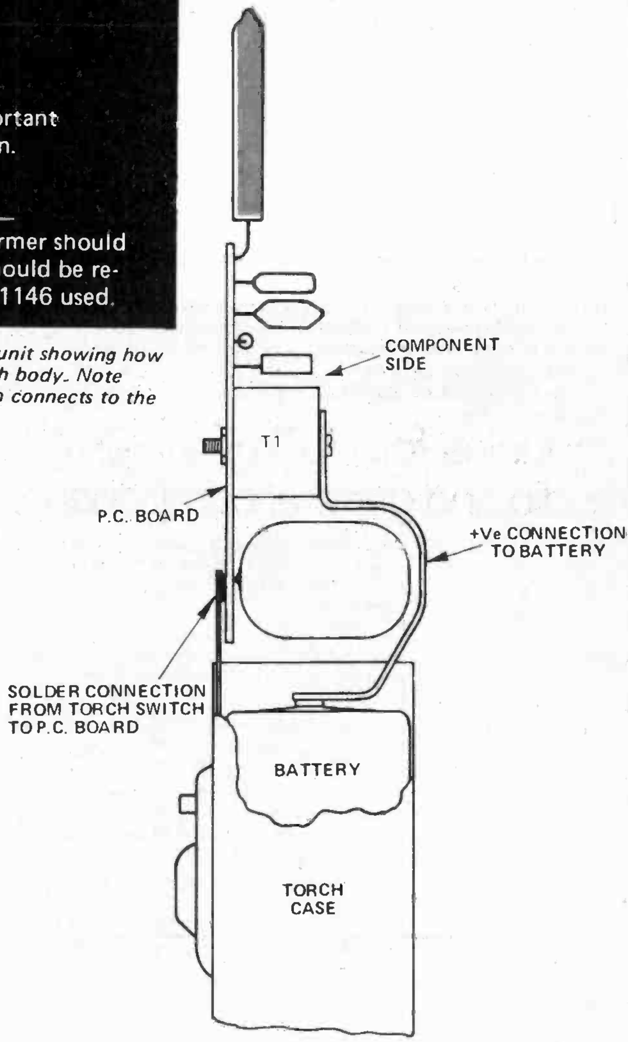


Fig. 3. Side view of the flash unit showing how board is secured into the torch body. Note particularly the bracket which connects to the battery positive terminal.

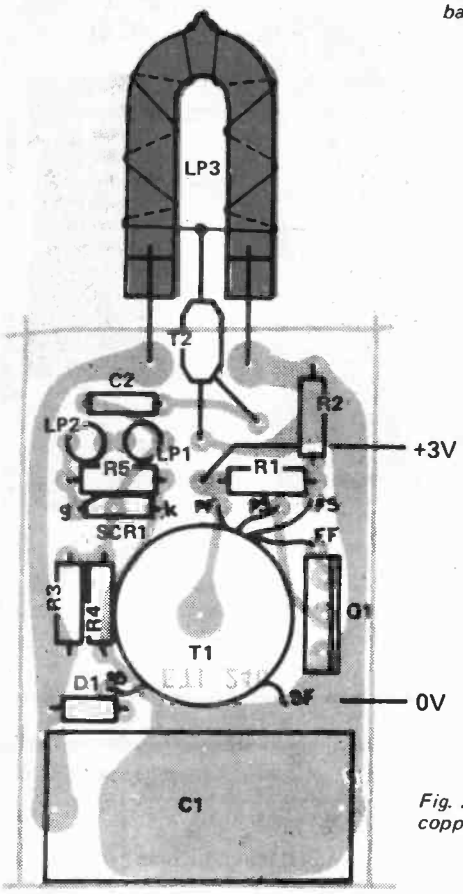


Fig. 2. Component overlay. Note copper wire spiral around flash tube.

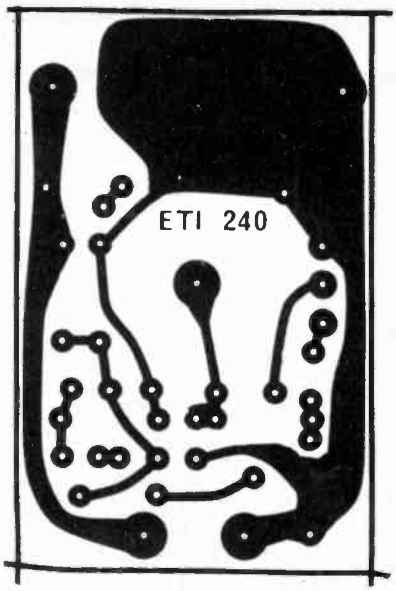


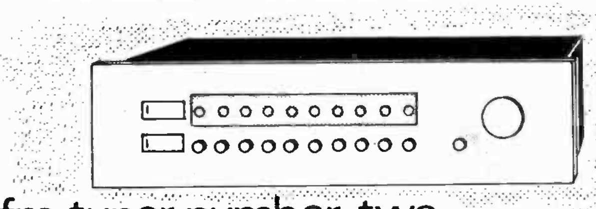
Fig. 4. Printed-circuit layout for the flash. Full size 73 x 47 mm.

SPECIFICATION ETI 240

INPUT	
Voltage	3 volts (nominal)
Current	400 to 450 mA at 3 volts
Power	1.25 watts
OUTPUT POWER	0.6 joules/flash
FLASH RATE	1.2 seconds per flash typical
EXPECTED BATTERY LIFE (2 D size cells)	
Alkaline	20 hours
Normal	8 hours
Nickel cadmium	10 hours

ambit international

WIRELESS SPECIALISTS



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NEW	92310	The MC1310 mpx decoder, with twin audio preamps, and BLR3107 ultrasonic block filter. kit £5.35 built £6.65
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TDA2020	2.99	NE567	2.50*	p = PN P type	

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HEADPHONE RADIO

WHILST IT MIGHT BE argued by some of our readers (and our competitors!) that this project is merely a cheap trick to boost sales by giving us an attractive (well isn't it?) cover, we think that the 251 headphones radio stands on its own merits as a good but simple project. It was designed simply because it seemed like a fun project which readers would enjoy building, and it was also a good trick to boost sales by giving us an attractive cover. (You bought it, didn't you?)

With summer upon us already people have taken up such worthwhile pursuits as sunbathing, walking in the park, or slaving over a hot soldering iron conjuring up projects like this one. It is only natural, in this solid state age, to grasp for one's personal pocket radio as one exits into the summer sunshine, in order to do whatever it is one intends to do, to music. The trouble is, a lot of people believe that transistor radios are unnatural devices, especially when efficiently radiating a watt or so into the air around their earhole.

SPOT THE . . .

This project then, is dedicated to those electronic ecologists who regard noise as pollution and who, in order that their fellow men (and women!) shall not suffer are willing to walk about looking completely loony with this contraption on their heads. On, then to the project itself.

In the interests of keeping the cost down, and the designer sane, it was decided not to include facilities for FM stereo reception in the 251. Consequently, the circuit is (ridiculously?) simple, using our old friend the ZN414, and we were going to use another well-known chip, the MFC4000B for audio output except that it's gone the way of all silicon, and so we used what the man in the shop gave us instead, an MC1306P. This is quite a nice little device which will deliver ½ a watt for around 3mV input. Great, we said, and off we went, with a hey-ho, the ZN414 and the MC1306P, to buy a pair of headphones. We got ours from the local branch of a large photographic/hi-fi chain, called D'x'ns, and very cheap they were too. The assistant couldn't understand why we didn't want to buy the model XYZ1001¾s with volume and tone controls plus built-in cocktail cabinet and binoculars, but we explained that we were mad electronics enthusiasts with journalistic aspirations, so he stopped the sales talk and humoured us.

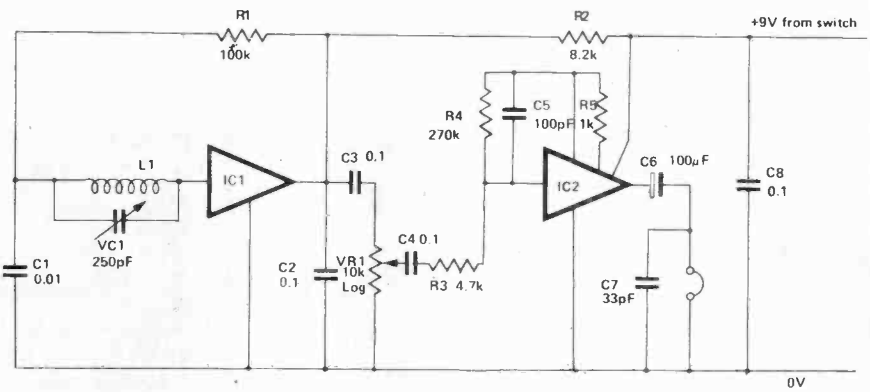


Fig. 1. Circuit diagram.

Virtually any pair of 'orrible 'eadphones will do, and obviously the size will vary enormously so that we have only given a generalized PCB layout as the PCB may have to be smaller or larger to suit your phones.

CONSTRUCTION

Construction is straightforward, with virtually all components mounting on the board except for the loudspeakers, on-off switch, and the 9V battery which we mounted together in the other earpiece. This meant that we had to replace the cable in the headband, with a three-core type, to carry +9V, speaker connection and earth/common. The speakers were wired in series since we didn't know how the MC1306P would like a 4 ohm load and didn't want to find out the hard way! Of course, if you want to try it . . .

The ZN414 is a 3-terminal TRF radio which suffers from one major bugbear: instability. If R2 is too low it will take off like a bat out of *&%+, whistling as it goes. If you do have a problem with instability, try increasing R2, and this may cure it. On the other hand, if you have a particularly docile 414, it could need just that little extra bit of oomph that a 6.8k for R2 might give it.

Apart from that, the only piece of advice is don't wear the things in public or you'll have a lot of explaining to do! Incidentally, these things are great for doing that old trick of getting people to put them on and then . . .

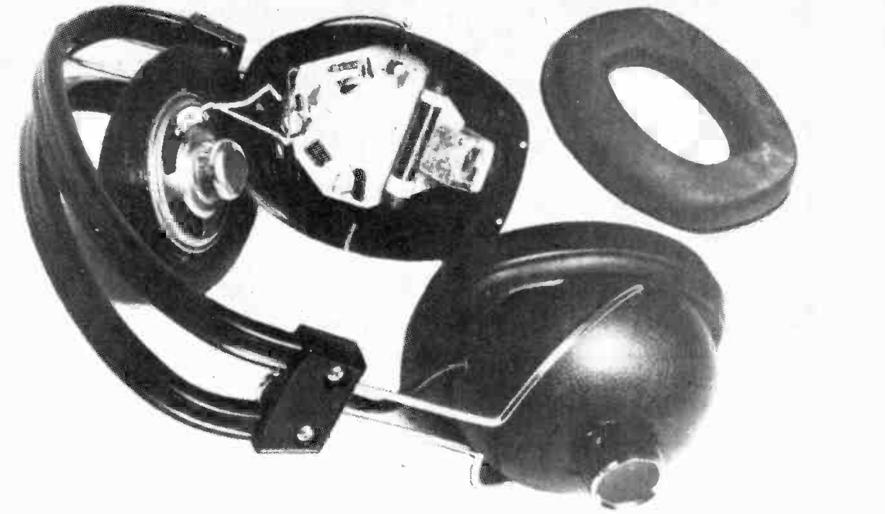
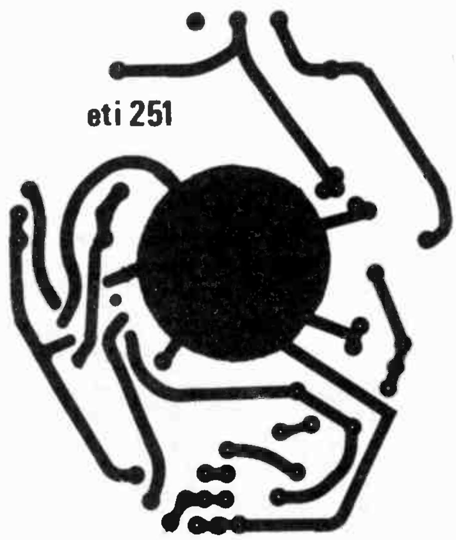


Fig. 2. Printed circuit board (full size),



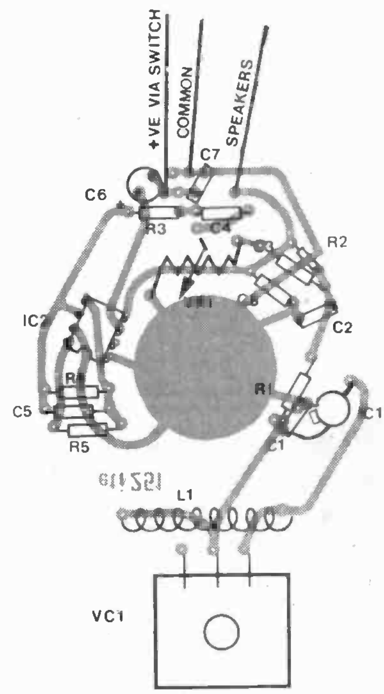


Fig. 3. Component overlay.

PARTS LIST – ETI 251

R1	100k
R2	8.2k
R3	4.7k
R4	270k
R5	1k
VR1	10k log
C1	0.01pF
C2	0.1pF
C3	0.1pF
C4	0.1pF
C5	100pF
C6	100μF
C7	33pF
C8	0.1pF
IC1	ZN414
IC2	MC1306P

L1 80 turns close-wound 32swg enamelled wire on 42 x 9mm ferrite rod
VC1 250pF (Home Radio type TP4 is suitable)
PCB ETI 251 Knobs, switch, 9V battery (PP3), etc..

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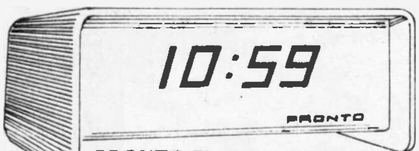

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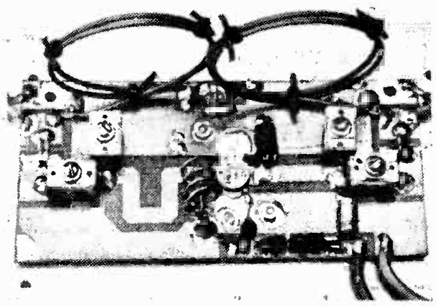
100W — yes, one hundred watts per channel disco unit with all the facilities you'd expect from an ETI design — voice-operated fader and excellent monitor facilities. Constructional details in the September issue of ETI.

CMOS-TO-MAINS

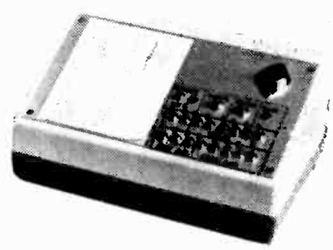
George Hanslip delves into the interface between the high power world of mains and the low power world of CMOS. The use of CMOS for power control via TRIACs is thoroughly discussed, and practical circuits given.

TWO METRE POWER AMP



Based on the Motorola 2N6084 VHF power transistor, this project for the up-to-date radio amateur gives over 40 watts output at 145MHz. Solid state switching gives simple construction, low cost and a thumping mobile signal. See it at the RSGB exhibition, Alexandra Palace 30th-31st July and 1st August.

ETI 560 VDU



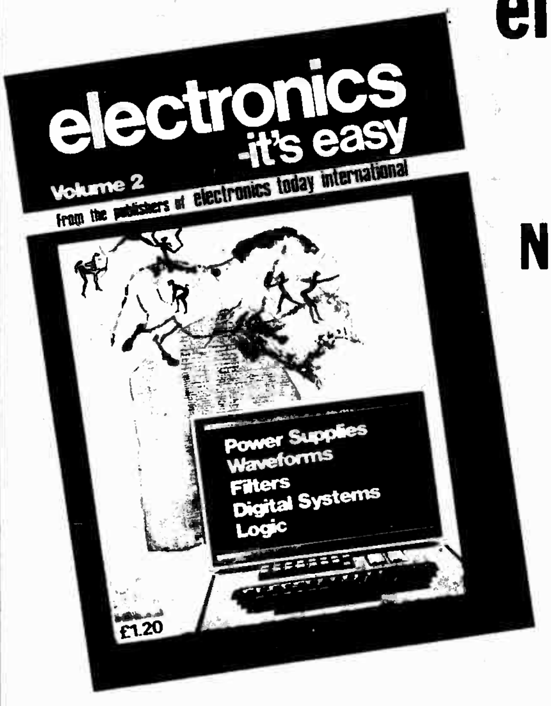
Full constructional details will be given next month for this low-cost video display unit. Primarily intended for microcomputer input/output, it can also be used for paging systems or to display scores for electronic games. Use your imagination; the ETI 560 makes it possible!

PCB KIT OFFER

NORMAL PRICE: £9.00

ETI OFFER PRICE: £5.95

The kit, put together by Decon, comprises a Seno GS System PCB kit, a Dalo pen, 10 strips of dry transfer PCB markers and two Seno Polifix polishing blocks. Today's advertised price is £9.00 but using the coupon in next month's issue will enable you to get this for £5.95.



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SEE ADVERTISEMENT ON PAGE 49

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SEE ADVERT PAGE 41

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NEW

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AS ADVERTISED PAGE 33

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BC214	.10	MJE340	.43	SN76013N	1.30
BC237	.11	MJE370	.55	SN76023N	1.30
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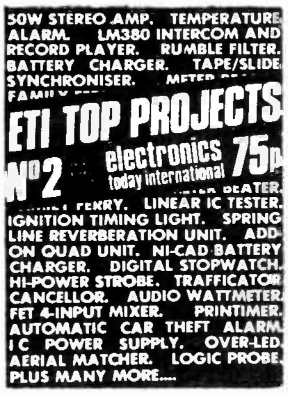
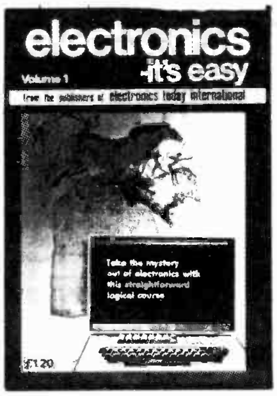
To: ETI Specials, ETI Magazine, 36 Ebury Street, London SW1W 0LW.
POSTAGE AND PACKING is 15p for the first, 10p for subsequent (overseas 20p and 15p).



Projects Book Two – contains 26 popular projects from the pages of ETI, first published July 1975 75p + 15p p&p.



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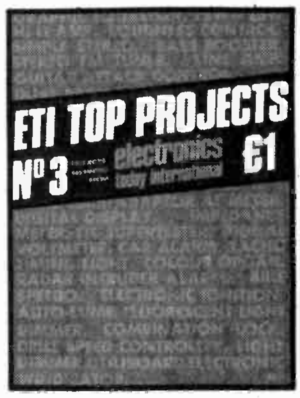

Project Book Three – contains 27 popular projects from the pages of ETI, first published March 1976 £1.00 + 15p p&p.

WANT TO WORK FOR ETI?

We have two editorial staff vacancies at ETI. No, no one has left us: these are both new positions and we reckon that ETI readers are likely to fill these. These jobs are not being advertised elsewhere, at least at this stage. Both positions are full-time and permanent.

We are one of the fastest growing magazines in Britain in *any* field and to maintain our growth rate and to improve our magazine further we are looking for people to fill the positions described below. Oh, by the way, we genuinely have no objections to female applicants (some ETI staff members actually like girls).

1. Technician

We want someone who likes — and is very good at — building projects. The person would be working largely in our workshop, building and checking prototypes of projects.

A high standard of layout and craftsmanship is necessary and the job may be of interest to someone currently working as a prototype wireman in industry. Some mechanical skill in metalwork and even woodwork would be very useful. Ability to design p.c.b. layout is also highly desirable.

Some electronics knowledge is necessary but we are not looking to this person so much to initiate projects but to bring to fruition the ideas and projects of the editorial team. The successful applicant will be working without supervision for most of the time. Salary is negotiable.

2. Specials Editor

This position carries a variety of responsibilities but the prime one will be production of projects books and other specials. The other responsibilities? Well we don't want to say too much as our competitors read ETI avidly and it's a bit early to make some plans public.

The job will involve working methodically alone for long periods. Essential qualifications are (a) interest in electronics as a hobby, (b) high level of intelligence and common sense, (c) ability to work to a laid-down plan and to a schedule. Some knowledge of book or magazine production would be an advantage but is not an essential qualification for the right applicant. Salary is negotiable.

Working for ETI: The successful applicants will be working with a small but very enthusiastic team. The total staff of ETI, when these positions are filled, will be 11. ETI is published by Modmags Ltd which is independent of all other British groups but has strong international ties.

Applications must be made in writing with all relevant details and must reach us by Monday, 19th July. They should be sent to:

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2N718A	0.28	2N3639	0.27	40362	0.45	BC119	0.29	BCY33	0.96	BFS21A	2.30	MJ490	1.05	TIP29A	0.49
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2N914	0.22	2N3702	0.12	40389	0.46	BC125	0.16	BCY38	1.00	BFS61	0.27	MJ2955	1.00	TIP31A	0.62
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2N1303	0.19	2N3708	0.14	40409	0.52	BC137	0.17	BCY70	0.17	BFX87	0.28	MJE2955	1.20	TIP41A	0.79
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2N1309	0.47	2N3714	1.38	406D2	0.61	BC148	0.09	BD123	0.82	BFY53	0.26	MPSA05	0.25	TIP33c	1.45
2N1671	1.54	2N3715	1.50	40603	0.58	BC149	0.11	BD124	1.20	BFY90	1.37	MPSA06	0.31	TIP34c	2.60
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2N1671B	1.85	2N3771	2.20	40636	1.10	BC154	0.18	BD132	0.50	BSX20	0.28	MPSA55	0.25	TIP42c	1.60
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2N2219	0.42	2N3810	0.37	AC153	0.35	BC169C	0.15	BD530	0.80	CA3052	1.62	NE560	4.48	ZTX501	0.13
2N2219A	0.52	2N3820	0.29	AC153K	0.40	BC170	0.15	BDY20	1.05	CA3046	0.70	NE561	4.48	ZTX502	0.18
2N2220	0.25	2N3823	0.58	AC154	0.25	BC171	0.16	BF115	0.29	CA3048	2.11	NE565A	4.48	ZTX530	0.23
2N2221	0.18	2N3904	0.19	AC176	0.41	BC172	0.12	BF117	0.55	CA3089E	1.96	OC28	1.48	ZTX531	0.22
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2N2369A	0.22	2N4059	0.15	AD143	0.68	BC182L	0.12	BF153	0.25	LM380	0.98	OC72	0.25		
2N2369	0.22	2N4060	0.15	AD149	0.74	BC183	0.12	BF154	0.16	LM381	2.07	OC81	0.25		
2N2646	0.55	2N4061	0.15	AD150	0.63	BC183L	0.12	BF159	0.27	LM702C	0.75	OC83	0.24		
2N2647	0.98	2N4062	0.15	AD161	0.69	BC184	0.13	BF160	0.23	LM741CAN	0.38	ORP12	0.60		
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Snipe nose box joint 4" long	£2.40
Desoldering tool	£4.50

P.C. MARKER PEN DALO 33PC 0.87. **ZENER DIODES** 400MW 0.11, 1W 0.17, 2.5W 0.35. **IC SOCKETS** 8DIL 0.12, 14DIL 0.14, 16DIL 0.16. **RESISTORS** ¼W 0.02 (100 per value 0.013), ½W 0.03 (100 per value 0.02). **SCORPIO CAR IGNITION KIT £12.95. BOX £1.80 TRANSFORMERS £3.75 IMF** 440 VAC **£1.50 BOARD 0.95 JUMBO 7-SEGMENT DISPLAYS £2.00. DL** 707 **£1.75. MINITRON £1.50. LEDs** RED YELLOW GREEN .2in. dia. **0.24.**

SEE MARSHALL'S FOR CMOS

CD4000	.18	CD4018	.88	CD4042	.70
CD4001	.18	CD4019	.52	CD4043	.83
CD4002	.18	CD4020	.98	CD4044	.77
CD4006	.99	CD4021	.88	CD4045	1.30
CD4007	.18	CD4022	.85	CD4046	1.20
CD4008	.82	CD4023	.18	CD4047	95
CD4009	.52	CD4024	.72	CD4049	.45
CD4010	.52	CD4025	.19	CD4050	.45
CD4011	.18	CD4027	.43	CD4510	1.25
CD4012	.18	CD4028	.83	CD4511	1.94
CD4013	.45	CD4029	1.06	CD4516	1.25
CD4014	.89	CD4030	.52	CD4518	1.87
CD4015	.89	CD4031	.98	CD4520	1.87
CD4016	.45	CD4037	.88	CD4553	4.07
CD4017	.88	CD4041	.70		

Veroboard

	Copper		Plain	
	0.1	0.15	0.1	0.15
	£p	£p	£p	£p
2.5x3¾in	36	29	22	17
2.5x5in	44	40	—	19
3¾x3¾in	44	40	—	—
3¾x5in	49	54	32	32
3¾ x 17in	1.73	1.44	1.00	1.92
PINSx36	30	30		
x200	1.16	1.16		

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SN7401	0.16	SN7412	0.22	SN7438	0.28	SN7454	0.16	SN7483	0.82	SN74100	1.10	SN74153	0.68	SN74175	0.70
SN7402	0.16	SN7413	0.28	SN7440	0.16	SN7460	0.16	SN7484	0.95	SN74107	0.30	SN74154	1.20	SN74176	1.14
SN7403	0.16	SN7416	0.28	SN7441	0.68	SN7470	0.29	SN7485	1.00	SN74118	0.85	SN74155	0.78	SN74180	1.10
SN7404	0.19	SN7417	0.28	SN7442	0.65	SN7472	0.21	SN7486	0.29	SN74119	1.75	SN74157	0.76	SN74181	1.95
SN7405	0.19	SN7420	0.16	SN7445	0.78	SN7473	0.31	SN7490	0.42	SN74121	0.32	SN74160	0.88	SN74190	1.86
SN7406	0.36	SN7423	0.23	SN7446	0.84	SN7474	0.31	SN7491	0.75	SN74122	0.42	SN74161	0.88	SN74191	1.86
SN7407	0.36	SN7425	0.23	SN7447	0.80	SN7475	0.45	SN7492	0.45	SN74123	0.65	SN74162	0.88	SN74192	1.15
SN7408	0.19	SN7427	0.23	SN7448	0.90	SN7476	0.30	SN7493	0.45	SN74141	0.75	SN74163	0.88	SN74193	1.15
SN7409	0.18	SN7430	0.15	SN7450	0.16	SN7480	0.42	SN7494	0.75	SN74145	0.72	SN74164	1.60	SN74196	1.60
SN7410	0.16	SN7432	0.22	SN7451	0.16	SN7481	1.00	SN7495	0.68	SN74150	1.20	SN74165	1.60	SN74197	1.58
												SN74167	3.30	SN74198	1.80
														SN74199	1.80

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Linear or Log

	Single	Double
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Rotary Switched	55p	—
Sliders	45p	75p

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Presets Horizontal or Vertical
1W 8p 3W 10p

DIN PLUGS — 18p
DIN CHASSIS SOCKETS — 11p
3-pin, 4-pin, 5-pin 180°, 5-pin 240°, 6-pin speaker, 7-pin.

LINE SOCKETS 18p each
3 pin, 5 pin 180°, speaker plugs.

PHONO PLUGS (screw top). Red, White, Black, Green or Yellow — 12p.
LINE PLUGS (same colours) — 12p.
PHONO CHASSIS SOCKETS: Single 7p, Double 10p, 3-way 12p, 6-way 28p, 8-way 40p.

JACK PLUGS & SOCKETS

¼" mono plastic plugs	18p
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¼" mono line socket	25p
¼" plastic switch socket	18p
¼" stereo plastic plug	26p
¼" stereo chrome plug	50p
¼" stereo plastic line socket	40p
¼" stereo chrome line socket	30p
¼" stereo plastic switched socket	26p
3.5mm plug	16p
3.5mm socket	8p
3.5mm line socket	16p
2.5mm plug	16p
2.5mm socket	8p

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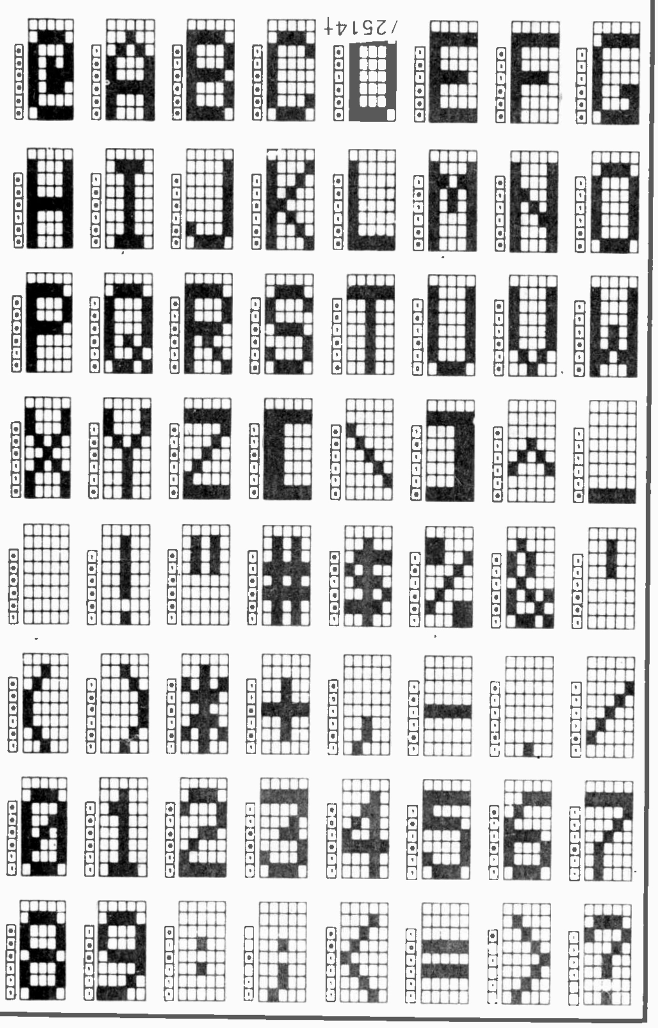
ALL PRODUCTS FULLY GUARANTEED TO MANUFACTURERS SPECIFICATIONS

ETI DATA SHEET

2513 CHARACTER GENERATOR

SIGNETICS

ASCII CHARACTER FONT



The Signetics 2513 is a high speed 2560-bit Static ROM available in 64×7×5, 64×8×5, and 512×5 versions. The product uses +5V, −5V and −12V power supplies, 5V TTL level input signals and Tri-State-Outputs for direct, low cost interfacing with TTL, DTL and MOS.

The use of Silicon Gate Low Threshold Process allows the design and production of higher functional density and operating speed.

All inputs of the 2513 can be driven directly by standard bipolar integrated circuits (TTL, DTL, etc). The data output buffers are capable of sinking a minimum of 1.6 mA, sufficient to drive one standard TTL load.

The 2513 is available from Catronics Ltd, 39 Pound Street, Carshalton, Surrey, at a price of £9.62 inc VAT plus 20p p&p.

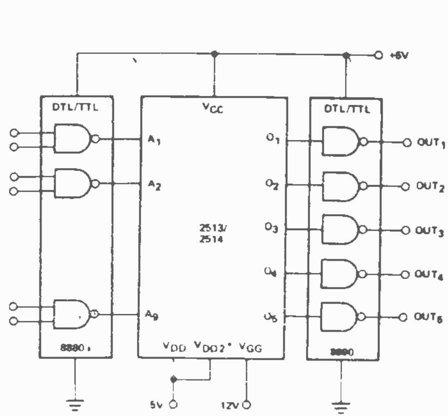
MAXIMUM GUARANTEED RATINGS

CHARACTERISTICS	MAX
Input Load Current	500 nA
Output Leakage Current	1000 nA
V_{DD} Power Supply Current	18 mA
V_{GG} Power Supply Current	10 mA
Input Logic "0"	1.05 V
Input Logic "1"	5.3 V
Character Access Time	600 ns
Access Time (A_4 - A_9)	600 ns
Row Access Time (A_1 - A_3)	500 ns

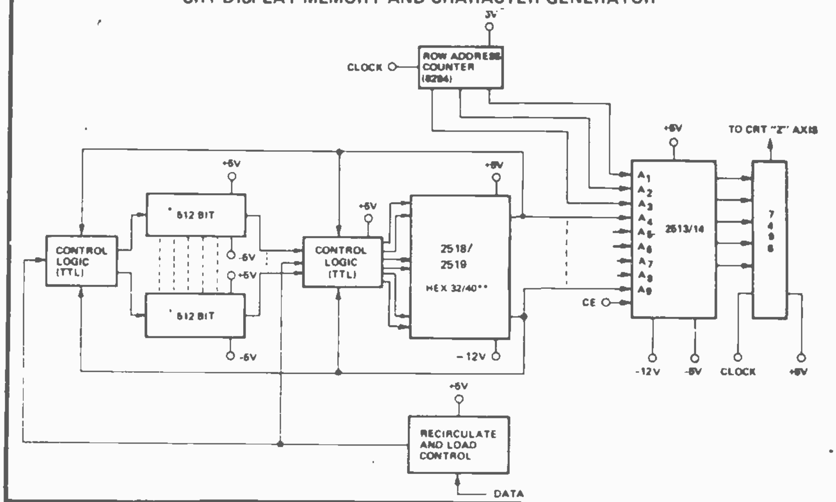
NOTE

V_{DD} = -5V ±5%;
V_{CC} = 5V (8)
T_A = 25°C;
V_{GG} = -12V ±5%;

DTL/TTL INTERFACING



CRT DISPLAY MEMORY AND CHARACTER GENERATOR



The TAD100 is a silicon integrated circuit primarily intended for a.m. receivers. The circuit incorporates the mixer, oscillator, i.f. amplifier, a.g.c. and audio pre-amplifier stages. The audio output transistors are not included so that different output power stages may be added to suit individual receiver requirements. The circuit incorporates a diode clamp to stabilise the oscillator voltage.

As a service to ETI readers, Marshalls Ltd of 42 Cricklewood Broadway, London NW2 3ET are offering the TAD 100 and the filters at a special price of £1.50 exclusive of V.A.T.

QUICK REFERENCE DATA

Supply voltage (nom.)	6.0	9.0	V
Receiver audio output power	0.7	1.5	W
Total receiver current drain (quiescent)	15	23	mA
Typical sensitivity (r.f. input voltage at pin 1 for 10mV a.f. at detector load)	6	4	μV
Typical a.g.c. range (change in r.f. input voltage for 10dB change in audio output)	59	62	dB
Typical signal-to-noise ratio (for signal level of 20μV at input)	25	24	dB
Distortion (over most of dynamic range)		<2	%
Operating ambient temperature range	−10 to +55		°C

Refer to Fig 1.

COMPONENT VALUES

V_{CC}	6.0	9 0	9 0	V
P_{out}	0.7	1 0	1 5	W
R_L	4.0	8.0	5 0	Ω
R_{10}	18	27	27	kΩ
R_{11}	68	150	150	Ω
R_{12}	390	680	390	Ω
R_{13}	VA1040	VA1040	VA1034	
R_{16}	3.9	15	15	kΩ
R_{17}	4 7	10	10	kΩ
R_{18}	27	100	120	Ω
C_{16}	320	200	200	μF
	6 4	10	10	V
C_{22}	640	200	400	μF
	6.4	10	10	V
C_{23}	800	320	640	μF
	4.0	6.4	6 4	V
C_{24}	.125	32	32	μF
	4.0	4 0	4.0	V

RECEIVER SPECIFICATION

	Typ.	
A.F. driver saturation voltage at I_C=30mA	0.82	V
at I_C=1.0mA	—	V
R.F./I.F. sensitivity (R.F. input voltage at 1MHz 30% modulation 400Hz measured at pin 1 for 10mV a.f. at detector load)	4.0	μV
Voltage at detector load for 100μV r.f. at mixer base (pin 1)	50	mV
A.G.C. range (change in r.f. input voltage for 10dB change in audio range)	62	dB
Signal-to-noise ratio for r.f. input voltage=20μV at 1MHz	24	dB
Signal-to-noise ratio for r.f. input voltage=1mV at 1MHz	40	dB
Percentage distortion ($V_{A.F.}$ =10mV, $V_{in (R.F.)}$ modulated 30% at 400Hz)	4	%
Total receiver current drain (excepting the output pair TR1-TR2)	20	mA

NOTES

'1'

TR1-AC187, TR2-AC188. Tuning Gang Mullard type AC0049 (C_3, C_5) with 300pF padding capacitor (C_{11}) on oscillator section C_1, C_7 are part of the i.f. filter. C_6, C_{10} are trimmers on the tuning gang.

'2'

Oscillator coil specification

Tuned winding 100 turns	3 × 46s.w.g wavewound with bunched conductor wire on 0.2in former with ferrite core and frame Q_0=150
Coupling winding 10 turns	
Feedback winding [illegible] turns	

ABSOLUTE MAXIMUM RATINGS

Maximum voltage pin 6	12	V
Maximum voltage pin 2 or pin 9	9	V
Maximum current pin 6 peak	30	mA
average	20	mA
P_{tot} — Max total dissipation at T_{amb} =55 C	150	mW

Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.

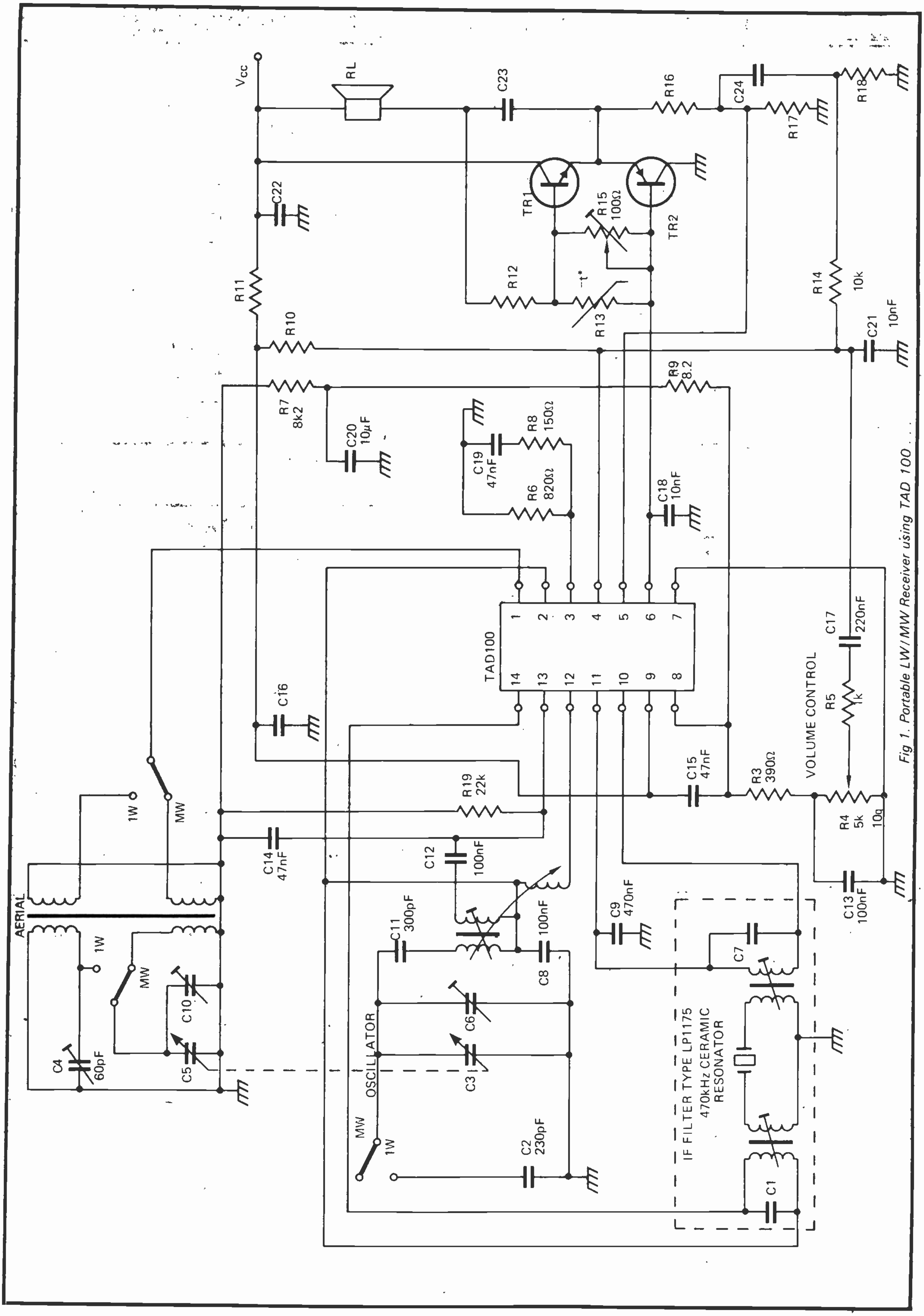


Fig 1. Portable LW/MW Receiver using TAD 100

SOUND LIGHT FLASH TRIGGER

ETI project 514B

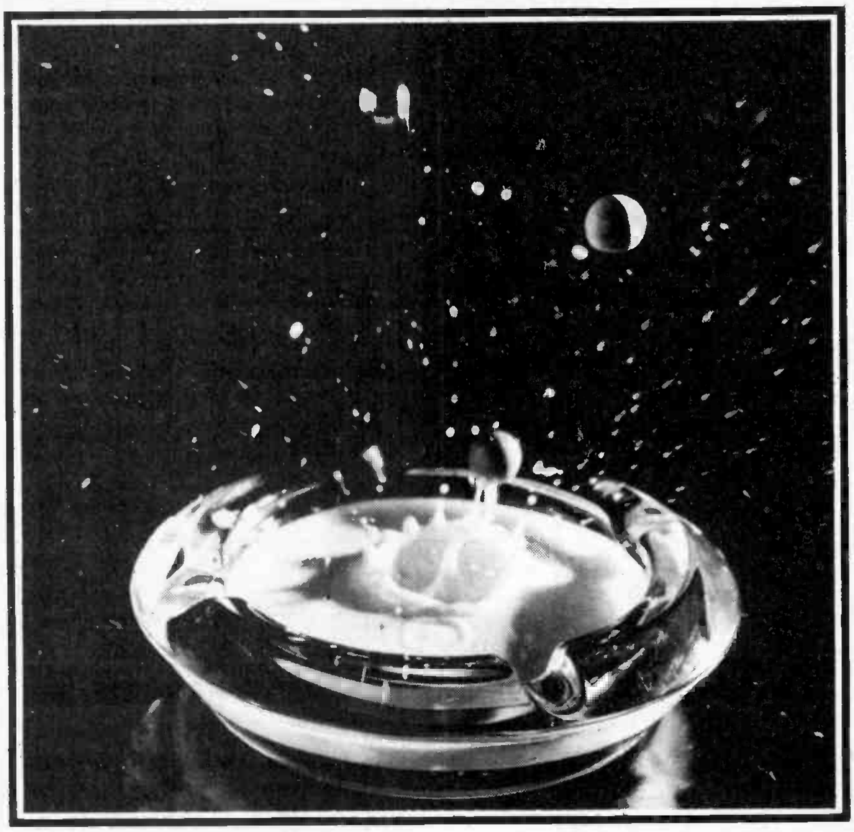
This flash trigger sets off any standard electronic flash unit a predetermined and adjustable time after a specific change in light or sound has occurred.

DURING the past few years we have received many requests to publish full constructional details of a light and sound operated photographic flash trigger that would be cheap to build, versatile in use and small enough to slip into the pocket or camera bag.

So here it is . . . it can be triggered by any sudden change in light or sound to photograph any related transient phenomena. It has innumerable applications in specialised photography, science and industry.

The device will set off any standard electronic flash unit a pre-determined time (adjustable between five milli-seconds and 200 milli-seconds) after a sudden change in ambient light or sound. The magnitude of the change required to trigger the unit is also adjustable.

The light triggering facility enables the trigger unit to be used as a slave flash.



CONSTRUCTION

Solder all components on to the printed circuit board — with the exception of the LDR and potentiometers RV1 and RV2. Ensure that capacitors C1 and C3 are correctly orientated — see overlay drawing.

Solder short lengths of tinned copper wire on to the potentiometer terminals — insert ends into the pc board and locate as shown.

Don't solder the leads through until the final position of the potentiometers relative to the rest of the assembly has been established.

When assembling the potentiometers on to the front panel space the potentiometers away from the panel by two washers on each potentiometer.

Locate the LDR so that the light sensitive grid is lined up with the hole in the front panel of the unit.

Finally mount the switch and microphone socket on to the front panel and wire them to the pc board and battery clip as shown in the component overlay.

A synchronisation extension flash lead must be purchased to suit the camera in use. Remove the unused connector from the end of the lead and solder the lead to the board as shown in the overlay.

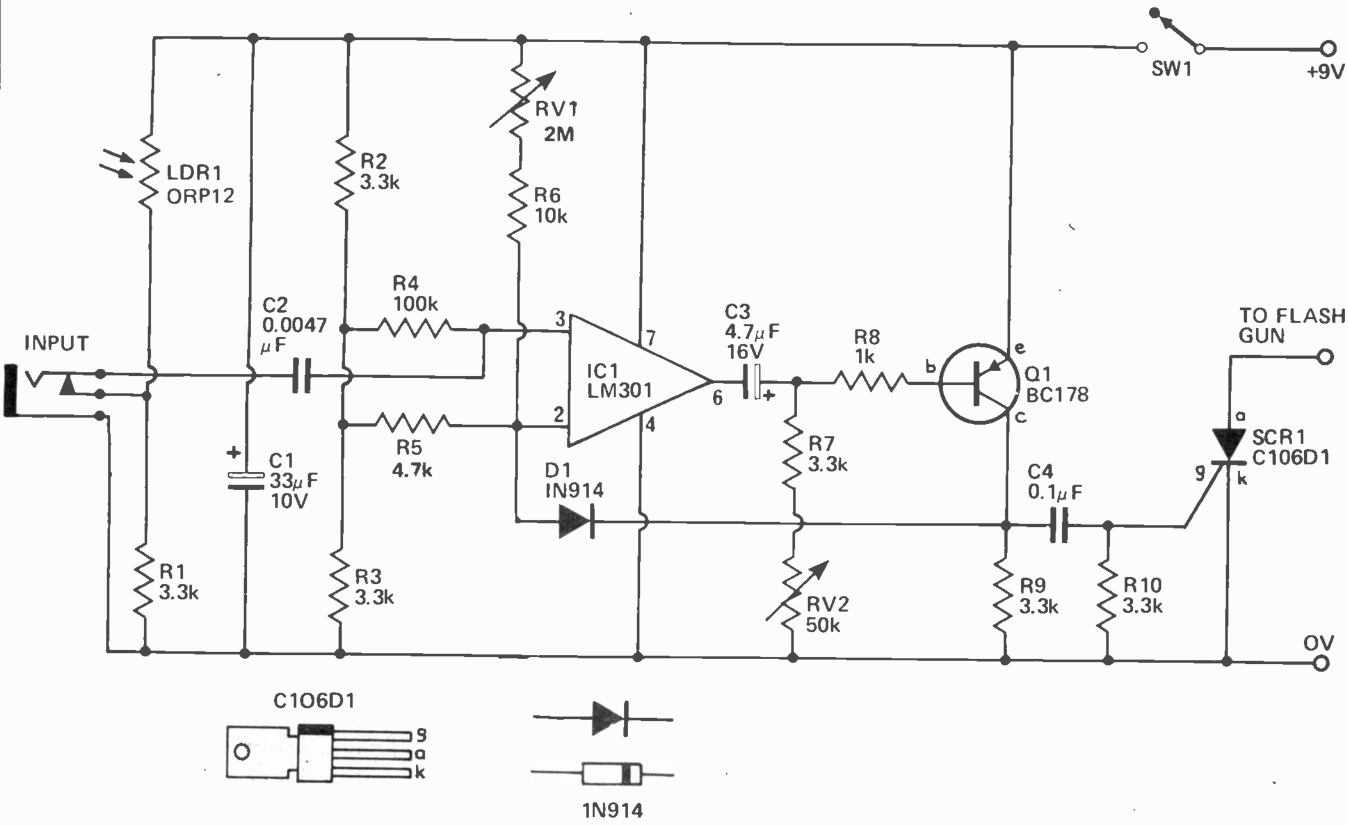
OPERATION

To use the unit in the sound operated mode simply plug the microphone into the socket provided and connect the unit's flash lead to the camera.

Switch on SW1 and adjust RV1 so that the flash is not triggered by ambient noise, but will be triggered by the event to be recorded — ie gun firing, hands clapping, glass breaking, etc.

In most circumstances the stop action photography must be done in a dark room with the camera shutter open, or if only black and white film is used — using a red safelight.

Assume for example that you wanted to photograph a bottle at the instant it is broken by a stone from a catapult. The equipment, catapult and bottle are set up initially in the light and tested to confirm correct function and sequence.



Circuit diagram of complete unit.

PARTS LIST ETI 514B

Resistors

R1	–	3.3 k	5%	¼ W
R2	–	3.3 k	"	"
R3	–	3.3 k	"	"
R4	–	100 k	"	"
R5	–	4.7 k	"	"
R6	–	10 k	"	"
R7	–	3.3 k	"	"
R8	–	1 k	"	"
R9	–	3.3 k	"	"
R10	–	3.3 k	"	"

Potentiometers

RV1	–	2 M log rotary
RV2	–	50 k lin "

Capacitors

C1	–	33 μF 10 V electro
C2	–	0.0047 μF polyester
C3	–	4.7 μF 16 V electro
C4	–	0.1 μF polyester

Seniconductors

Q1	–	transistor BC178 or similar
D1	–	diode IN914 or similar
IC1	–	integrated circuit LM301
SCR1	–	SCR C106 D1

Miscellaneous

LDR1	–	ORP12
PCB	–	ETI 514B
SW1	–	switch spst

3.5 mm phone jack
plastic box, flash cord, microphone, battery and battery clip.

HOW IT WORKS

Basically the microphone triggers the IC monostable circuit which subsequently triggers an SCR, and hence the flash, after a time delay. This delay is adjustable — by varying a monostable on-time — from 5 milliseconds to 200 milliseconds.

Integrated circuit IC1 is an LM301A. This is a dc differential amplifier with a high gain — typically 25 000. The output swing of the IC with a 9 volt dc supply is of the order of 6 volts, and this is obtained with an input swing of only 24 microvolts. This makes the IC ideally suited for use as a comparator and is the mode of operation utilised in our circuit.

Due to the very high gain and the relatively large output signals normally encountered, the IC is almost always either fully cut off or fully saturated. The linear region is very narrow and is not utilized in this circuit.

The two inputs of the IC (pins 2 and 3) would be at the same potential were it not for the bias current supplied through RV1. This raises the voltage at pin 2 of the IC by 10 mV or more above pin 3 depending on the setting of RV1. The IC will therefore normally be fully saturated and the output voltage will be low.

Transistor Q1 is normally held on by the current through RV2, and its collector is high.

When an audio signal from the microphone produces at pin 3 a level exceeding that set on pin 2 by RV1, the IC will rapidly change state and its output will go high.

The front edge of this transition turns off Q1 via C3. The collector of Q1 will fall, D1 becomes forward biased and pulls down pin 2 to about one volt — the IC output is maintained in its high state.

After a time — determined by the time constant of C3 and RV2 — Q1 turns on again allowing the IC to revert to its normal low output.

The output signal from Q1 is differentiated by C4 and R10. The positive pulse which occurs at the end of the delay period, triggers the SCR and fires the flash.

When the microphone is pulled out LDR1 and R1 are placed in circuit. When the light falling on the LDR suddenly increases, the resistance of the LDR falls and the voltage across R1 increases. This increase is passed via C2 to pin 3 of the IC triggering it if it is above that on pin 2.

SOUND LIGHT FLASH TRIGGER

A test film is then shot using an arbitrary setting of the delay in the now darkened room. This is done by opening the shutter, firing the catapult and then closing the shutter before turning on the lights. (Although shooting a bottle in the dark may seem difficult — with a little practice it is surprisingly easy. But do wear eye protection).

A run through the test film will show whether the chosen delay was correct. If too short, the bulb or bottle will be photographed before actually breaking up — if too late the action will have progressed further than needed or wanted.

Further pictures should then be taken, varying the time delay to bracket the actual delay that is now estimated as correct. With a little experience you'll be able to estimate the required delay accurately.

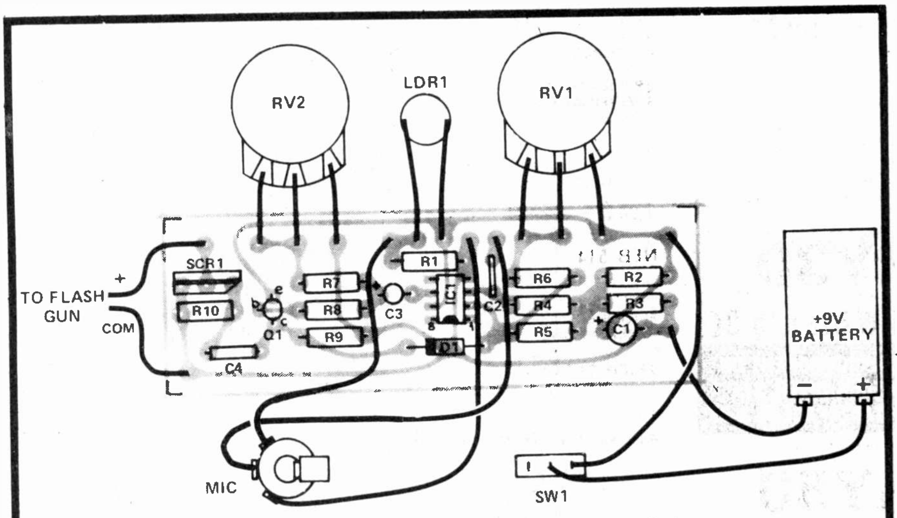
(Don't forget to get in a good supply of bottles).

As the flash duration is typically 1000-2000th sec, high speed action can be frozen as our lead picture shows.

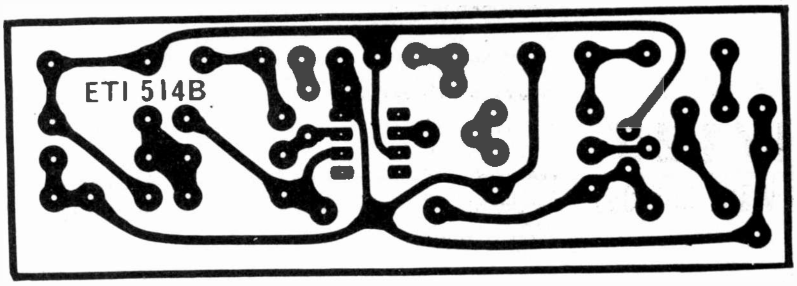
SLAVE LABOUR

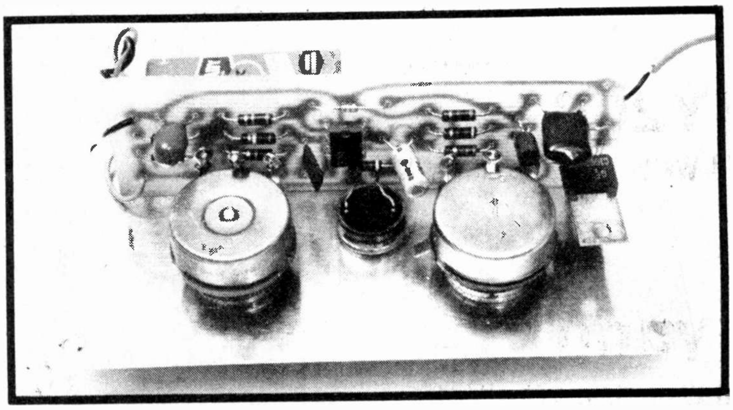
To use the unit as a slave flash simply unplug the microphone. This automatically places the built-in light sensor in circuit — adjust the sensitivity so that the unit is triggered out by the master flash when it is operated. In this particular application the delay should be set to minimum for use as a slave flash.

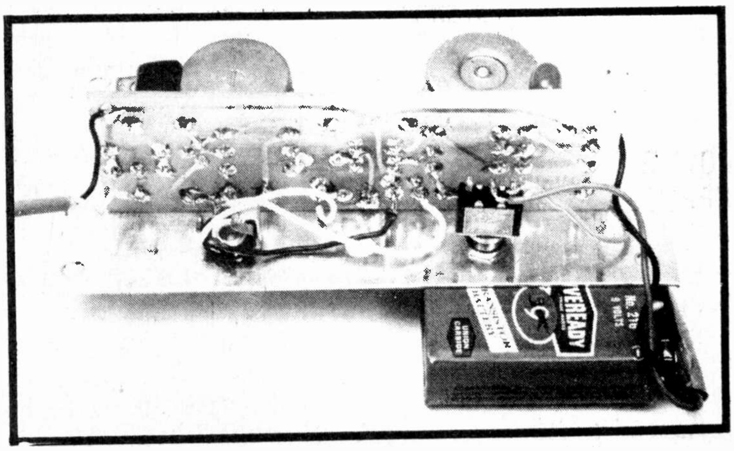
Or some delay may be used to obtain a time sequence exposure. Note that the minimum delay is 5ms and hence the unit cannot be used as a slave flash for extremely fast action without a double exposure occuring. ●

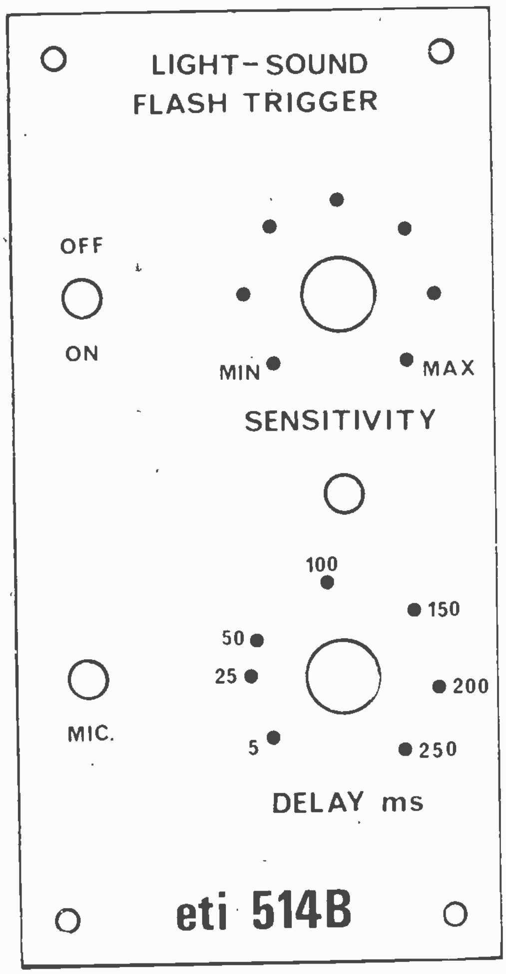


Follow this diagram to mount components and for interconnections.









15—240 Watts!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally; the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

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

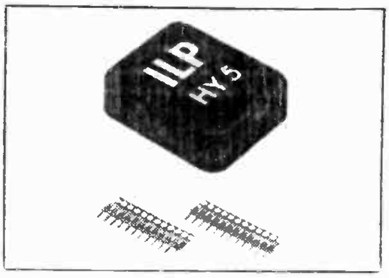
OUTPUTS Tape 100mV Main output 500mV R.M.S.

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

THIS COMPONENT ON SPECIAL OFFER: SEE DETAILS PAGE 38 & 39

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

Price £4.75 + 59p VAT P&P free.

Available June '76

HY50
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

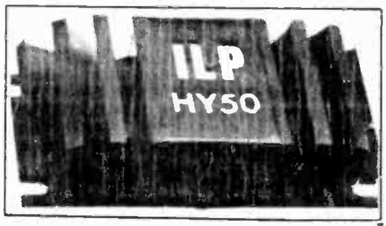
SPECIFICATIONS: INPUT SENSITIVITY 500mV

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

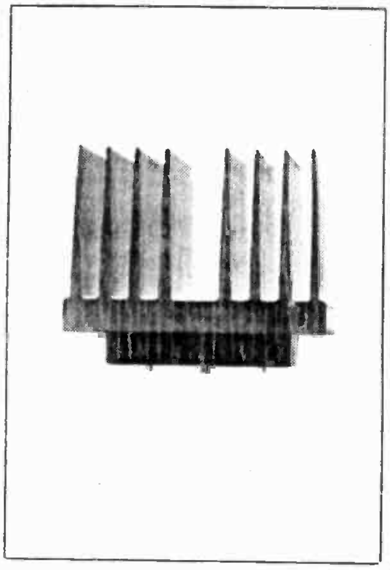
INPUT SENSITIVITY 500mV

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

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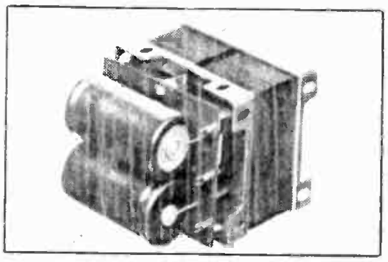

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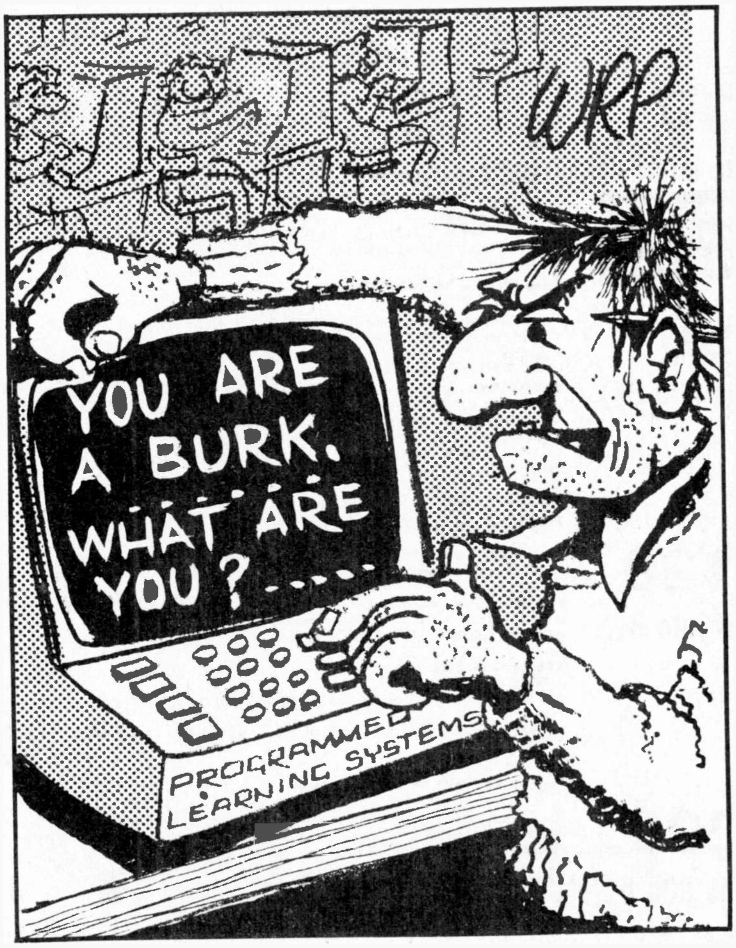
PART 6; MPUS 4 U

OVER THE PAST FEW MONTHS, a goodly proportion of our readers have been going through a general 'finding out' phase, and we've done our bit like a good informative electronics mag should do, to the extent of pushing microprocessors for what has seemed like no apparent reason. We've been through all the stuff about what a micro is, and what it does, and how it does it — all good stuff but a bit *theoretical,* wouldn't you say?

So what happens if you want to do something *practical* with microprocessors? At the moment, the answer is sadly, very little unless you have a fair amount of the crinkly green stuff (£800 for a teletype, etc, etc . . .). The amateur constructor is fascinated by this new device which could provide him with months of interest and enjoyment (that's what the hobby's about, right?) yet he can't quite get there because, no matter how cheap the chip is, there's a lot of expensive hardware got to go with it. Right?



WRONG

The main objection for the amateur is the cost of a teletype — but a teletype is not necessary for microprocessor system input/output. This is especially true of micro systems for amateurs. The microprocessor system can interface to just about anything from a single LED up. What places the teletype constraint is the monitor program, which is written with the professional user in mind, who of course, already has a spare teletype.

If we accept that a special purpose interface for low cost I/O, with a special purpose monitor program to drive it is possible (why not?), we can design a special low cost microcomputer system. Following a good systems engineering plan to go about this, we start by setting out the requirements the system must meet, i.e. what do we want it to do?

If experience in the USA is anything to go by, a great many users want a MPU so they can take up computer programming as a hobby. There is no doubt in the author's mind that programming will catch on, as people realise the potential for electronic games (moon landing, Mastermind etc), complex calculations or even just the challenge of getting a program to run. After the initial capital investment on your computer, it's cheap, useful and fun.

Beyond mathematical type programming, it is virtually impossible to predict just what people will want to do; they may want to interface to anything from a rat maze to an FM tuner. One obvious possibility, which has already been tagged for consideration at ETI, is to interface to a Teletext/Viewdata receiver. In short, a very general purpose interface is required.

PROGRAM I/O

So far, we have postulated two types of I/O: a) through a terminal for programming and b) general purpose. Type a) will be required by everyone writing and developing programs. Let's look closer. The amateur does not have to share time on his computer terminal so he does not need hard copy, i.e. reams of paper to take away and analyse. He could write and amend his programs while sitting at the terminal with no threat of interruption.

The program in memory takes the form of pairs of hexadecimal digits, one pair to each byte of memory. Hence to load a program, the only characters required are the hex digits 0-9 and A-F, together with a key which will store each step in memory. Also required is a key to specify the address in memory one is working at, and a key to commence program execution at a specified address. A desirable feature is a key which would let one examine the contents of a memory location for program review. That is really the bare essentials for input to the system, so let's look at output.

7-SEG DISPLAY

In *Microfile 4 (June 1976)* while discussing the ROL instruction we postulated one method of driving a 7 segment display. If programmable calculators can communicate through displays of this kind, why not a basically similar MPU system? The 7 segment display can, in fact, be used to display all the Hex characters (admittedly, it's a mixture of upper and lower case) — try it yourself.

Readers who are familiar with minicomputers such as the ubiquitous DEC PDP8 will see a certain similarity to a regular front panel — except that this pseudo front panel works in a slightly different way, is to a slightly greater extent 'human engineered,' (binary brains, again!), and uses virtually no special hardware. The key to the system lies in a special ROM-stored control program which runs the whole system.

SYSTEM

OK — now we have a basic, low cost I/O system; what about the rest of the system? The keynote here, for the amateur, is *modularity*. Buy the bits you need, to start with, but that should not make expanding your system difficult, nor should you have to buy bits you don't need.

With this in mind, it seems that splitting the system into functional blocks, on sensible sized boards is a good idea, with all connections at one end so that the boards can easily be linked. The CPU board, for example, should carry the system clock, MPU and buffering to drive other boards, and a good size for this is 100 x 160 mm (Eurocard size) as a card frame can then be used to hold the boards, with connectors at the rear carrying the bus signals.

OPTIONS

The system described so far is basic, but can be used for simple program development. The main problem is the tedium involved in keying in a program each time you want to use it. To get round this, some form of non-volatile storage is required, and perhaps the commonest form of this medium around today is cassette tape. A small board which will convert logic information to audio tones and vice versa could be coupled to an ordinary cassette recorder and programs or data stored for later use.

Another possible addition to the system is a low cost VDU such as the ETI 560 which is described elsewhere in this issue. This would permit the display of a full range of alpha numeric and special characters, thereby allowing prompts, full display of equations, etc.

PROGRAMME DEVELOPMENT

Writing programs for the simple display system can be done only in machine language, i.e. by entering the op codes of instructions directly into memory through the keyboard and then commencing execution at the first program location. Although this is slightly tedious, routines could be implemented in ROM to assist in program editing, by, for instance, re-packing memory. Another point is that output and input decoder routines could be available to the user's programs to permit input and output of data during runtime, for example.

Further developments could include the development of subroutines for multiple precision decimal addition, subtraction, etc, which could all be brought together in the form of a programmable calculator.

High-level languages are a possibility, with a VDU on the system, but the writing of assemblers and compilers is a time consuming task which most amateurs would not care to tackle, though no doubt someone will view it as a challenge to their programming ability and have a go. It's a bit like mountain climbing, really!

It will come as no surprise to many of our readers that we have been working on a system broadly similar to that described, here at ETI. We call it *System 68*, and have designed it expressly as a low cost, expandable system for the amateur. We have a number of applications programs (games etc.) under development so that there are no shortage of applications for the system, but obviously we'd like to know if you have any interesting ideas for using such a system, or any particular facility which we may have overlooked. Fortunately, the big advantage of designing with micros is that major improvements can be incorporated into the system at a late stage at virtually zero cost. Anyway, let's hear your ideas. Remember, it's coming your way in ETI!

INTEL NEWS

Intel have just published the sixth edition of Intel News, a house magazine which is of interest to all engineers who are working with microcomputers or memory systems.

The publication contains a number of useful articles on such topics as refreshing dynamic RAMs in microcomputer systems, interfacing with keyboards and displays, the use of CCD memories and a novel method of producing neatly laid out programme listings. The centre pages give details of Intel's recently announced SBC-80/10 single board OEM computer and an 8-bit computer kit known as the SDK-80.

Intel Corporation (UK) Ltd., Broadfield House, 4 Between Towns Road, Cowley, Oxford OX4 3NB.

4K RAMs are dynamic devices, i.e. the information is stored as charge on capacitors which will leak away if not refreshed, so that the low order (row) address lines must be cycled periodically to prevent the stored information being lost. Intel have introduced three refresh controllers which contain all the necessary logic for this purpose. The 3222 is a refresh controller for 22-pin 4K RAMs such as the 2107A and B families. It contains a refresh timer, which is controlled by a simple RC network, and is complete with all control and I/O circuitry. Refresh can be automatic or under the control of a refresh request input line. There is also a second version of the device, the 8222, which is intended for use with the microprocessor-oriented 8107A or B 4K RAMs.

microfile

The 3232 refresh controller is intended for 16-pin multiplexed address RAMs, such as the 4K 2104, and can be used in a conventional or burst refresh mode. This device is fully compatible with 16K RAMs (when they become available).

The new SDK-80 Microcomputer Prototyping kit contains all the LSI chips, crystal, IC sockets, PCB, connectors, auxiliary components, etc., to build an 8-bit microcomputer around the new 8080A MPU, 8228 system controller and 8224 clock generator. The kit has 256 bytes of RAM, 2K bytes of PROM (including 1K of system monitor), a programmable serial communications I/O port and 24 other programmable I/O lines.

The system monitor enables the user to enter, run and check out a program, alter memory locations, examine registers etc.

Other devices announced by Intel include a special microcomputer programmable interface chip for driving keyboards and displays (the 4269) and a 256Kbit memory board designed to store video images of 512 elements by 512 lines (in-477). The 4269 will interface the 4040 MPU with a wide variety of input devices such as encoded and non-encoded keyboards and switches and will also drive alphanumeric, numeric or on/off displays, including seven-segment LEDs or Burroughs Self-scan and Panaplex displays.

Intel Corporation (UK) Ltd., Broadfield House, 4 Between Towns Road, Cowley, Oxford OX4 3NB.

ALTAIR IN UK

The Altair range of microcomputer kits and peripherals which are extremely successful in the USA, are now available in the UK from the exclusive distributor, *Compelec Electronics Ltd. 310 Kilburn High Road, London NW6.* The Altair 8800 system based on the Intel 8080 is available for £396. This includes documentation, assembly instructions, power supply, front panel components including switches and LEDs, all parts for the CPU board, card frame and box. A kit for the Motorola 6800 is also available at £290.

Comprehensive software, including a BASIC interpreter, an extended BASIC interpreter, and a BASIC disc-based operating system is available to users. The first convention of Altair users was held in Albuquerque in March this year, and 700 people attended, many carrying their computers, to swop notes and take part in "software contests".

National Semiconductor are now in volume production of 4K RAMS in the series MM5270, 5271; MM5280, 5281 and MM5275. All utilise n-channel silicon-gate MOS, and employ single transistor cells to increase packing density and reduce cost-per-chip. Of particular interest is the MM5270, the industry's first 18-pin 4K RAM, which uses a unique concept that National call TRI–SHARE™. In this system a single lead serves three functions:- (1) data read and write control, (2) logical selection of the RAM chip when operating in a system and (3) to enable an on-chip voltage regulator that is used with the output logic, Hence the TRI–SHARE™ feature, combined with TRI–STATE™ common input and output leads, eliminates four separate pins and allows almost twice the number of 4K devices on a PCB.

National Semiconductor UK Ltd., 19 Goldington Road, Bedford MK40 3LF.

NEW SEMICONDUCTOR LOGIC TECHNOLOGY

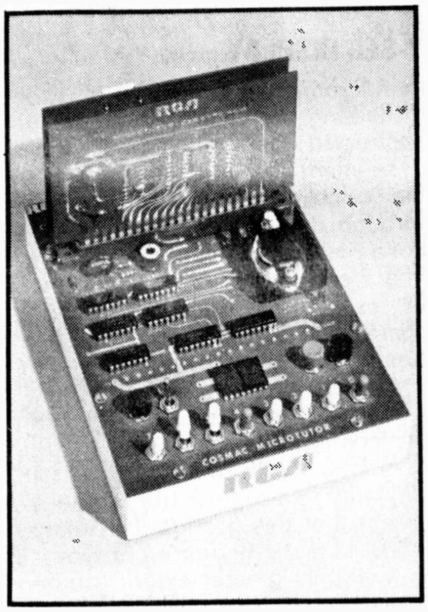
A new semiconductor technology — closed COS/MOS logic or C²L — is used in the latest microprocessor circuits from RCA Solid State. The first products using the C²L technique, which offers increased speed and packing density, are the CDP1802 single-chip 8-bit, 40-pin microprocessor and four of the associated family of memory and input/output circuits.

In conjunction with the self-aligned silicon-gate process used by RCA, C²L significantly increases device speed and packing density by a factor of 3. It differs from RCA's standard COS/MOS (complementary symmetry metal-oxide-semiconductor) technology in that it permits a common source structure, so that seperate source connections are not needed for each transistor in the integrated circuit. In a C²L device, a gate electrode essentially forms a closed circle, providing the necessary gate terminations and eliminating the need for guard-bands. Even without guard-bands, C²L can still be used over the full COS/MOS voltage range.

RCA Solid State, Sunbury-on-Thames, Middlesex.

RCA MICRO KITS

The CDP 18S011 COSMAC Microtutor is a microcomputer based on the CDP 1800 series of microprocessors with 256 bytes of random-access memory. Outputs are registered on a 2-digit hexadecimal display and a set of eight switches is provided for manual inputs. The Microtutor is intended primarily as a minimum-cost experimental/educational microprocessor system, and is accompanied by a manual written in simple language designed for people with only a basic electronics background.



Microcomputer concepts are demonstrated by sample programs which are simple to load and run on the Microtutor. All system signals can be directly observed, and an external option socket allows users to add their own circuits, typical examples being suggested in the manual. The Microtutor may also be used for prototyping COSMAC systems in applications which do not justify the use of more sophisticated programming aids.

The CDP 18S002 Stand-Alone Microkit is an enhanced version of the basic CDP 18S001 Microkit, and provides a vehicle for software support as well as a hardware prototyping environment. The additional features include expanded random-access memory capacity (4 kbyte); a modified terminal interface (providing tape reader control), a memory bank select card (for building the memory up to the full complement of 64 kbyte using 4 kbyte randam-access memory cards) and expanded debugging hardware and 'firmware'.

RCA Solid State—Europe, Sunbury-on-Thames, Middlesex TW16 7HW.

'HANDS ON' MPU LEARNING MODULE

The new TI μP Learning Module, designed to provide a simplified and effective method of gaining 'hands on' experience of microprocessor operations has recently been introduced by

Mogul Electronics Ltd. This hand held, 6½" x 5¼" x 1¾" module operates from rechargeable batteries and incorporates a 4-bit static parallel processor, is manually programmed, has VLED bus monitors, push button manual clock and contains a 40 pin socket for expansion. Also provided with this LCM 1001 module is a fully comprehensive, copiously illustrated instruction manual covering basic and advanced concepts of microprocessors.

Commencing with an introduction to Digital Machines, the manual moves through the areas of Microprocessor Operation, Data Handling, Loading and Read-out of Registers and concludes with illustrations and examples of Binary Multiplication, Division, BCD Adder and Test and Branch Operations with each stage being linked to a 'hands on' example utilising the Learning Module. The TI µP, together with the Instruction Manual and Battery Charger is available from Mogul Electronics Ltd. at £98, thereby providing a fast, low-cost method of understanding microprocessors.

Mogul Electronics Ltd. 123-124 The Stow, Harlow, Essex.

TAKING THE NAME IN VAIN!

Now available from the Engineering Division of The Exchange Telegraph Company Ltd. (EXTEL), the DTC Micro-File combines a microcomputer, a dual flexible disc drive, and a basic 8k characters of random-access-memory (expandable to 56k) in a compact table top unit. The design concept of Micro-File is such that any RS-232 compatible data terminal can be transformed into a powerful stand-alone business system, file storage system or intelligent terminal.

Programming Micro-File is simplified by the availability of a BASIC compiler. The system incorporates a powerful text editor, allowing an operator to create, modify and erase data files or application programs. When combined with a high print quality terminal such as the DTC 300 (also available from EXTEL), Micro-File can be used as an extremely versatile word processing system. An automatic letter writter program is already available with Micro-File.

An important software feature offered to Micro-File users is a BASIC assembler which enables users to write their own program in this widely used language. The BASIC assembler makes the machine ideal for carrying out a variety of business-oriented programs, and the cost of Micro-File is low enough to be justified for in-house use — an important asset for small business computer users.

Micro-File configurations start at £2800 (plus VAT) and a typical system using the BASIC assembler costs about £3700 (plus VAT).

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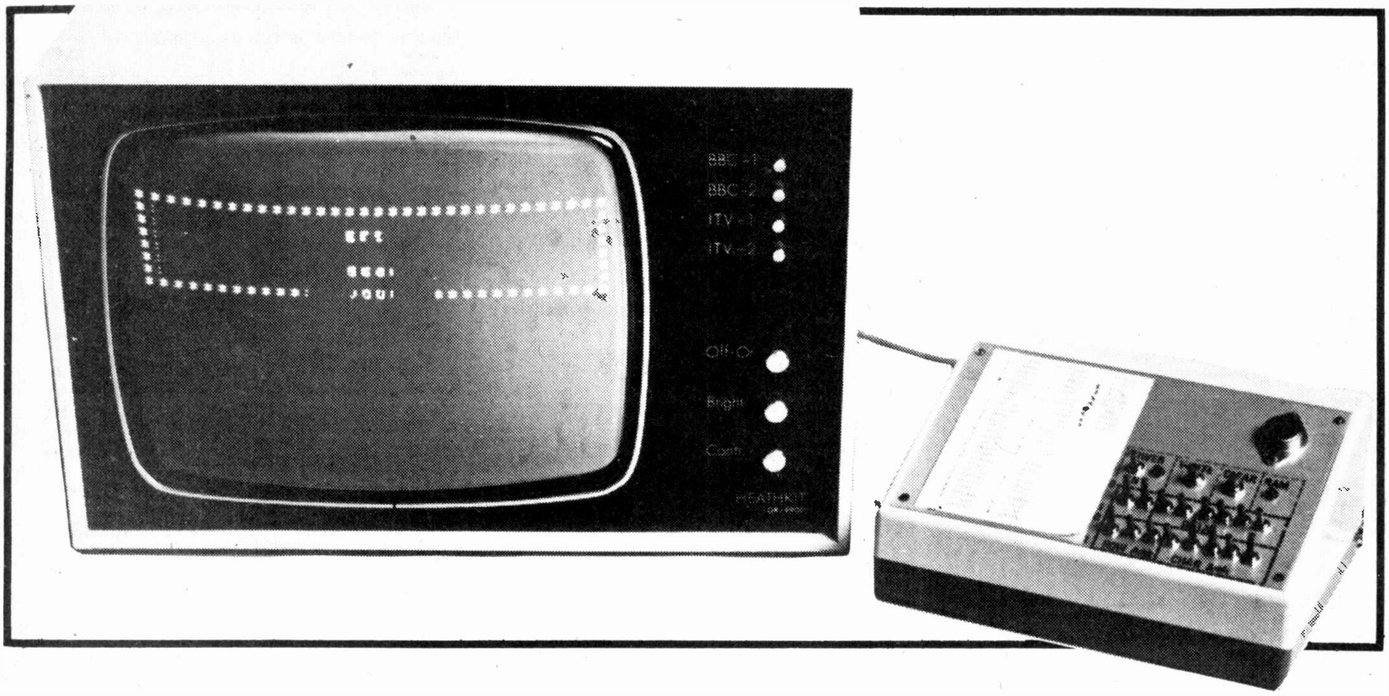
LOW COST VDU

ETI project 560



NO-FRILLS DESIGN IDEAL FOR MPU

Part 1: Introduction

A LOT OF YOU MAY now be used to seeing electronic character generaton on a TV screen in TV games, Teletext and Viewdata, computer terminals, sports timings, etc. The 560 is a basic video character generation system which can be used for the above applications but is designed to be used as a VDU input/output peripheral for a microprocessor or for sub-titles or messages in a closed circuit TV system or studio. The basic system to be described next month will allow for several modifications and options but in its basic form will cost under £50 to build.

The VDU will display a total of 64 different characters in any of 256 positions set out as eight lines each containing 32 character spaces. It can be expanded to display either 8, 16 or 24 rows of 32 or 40 characters, and graphics and two-tone or flashing options can be added later.

Input to the system is via three sets of inputs — data, address and control, these can be generated from switches, MPU or from a keyboard controller.

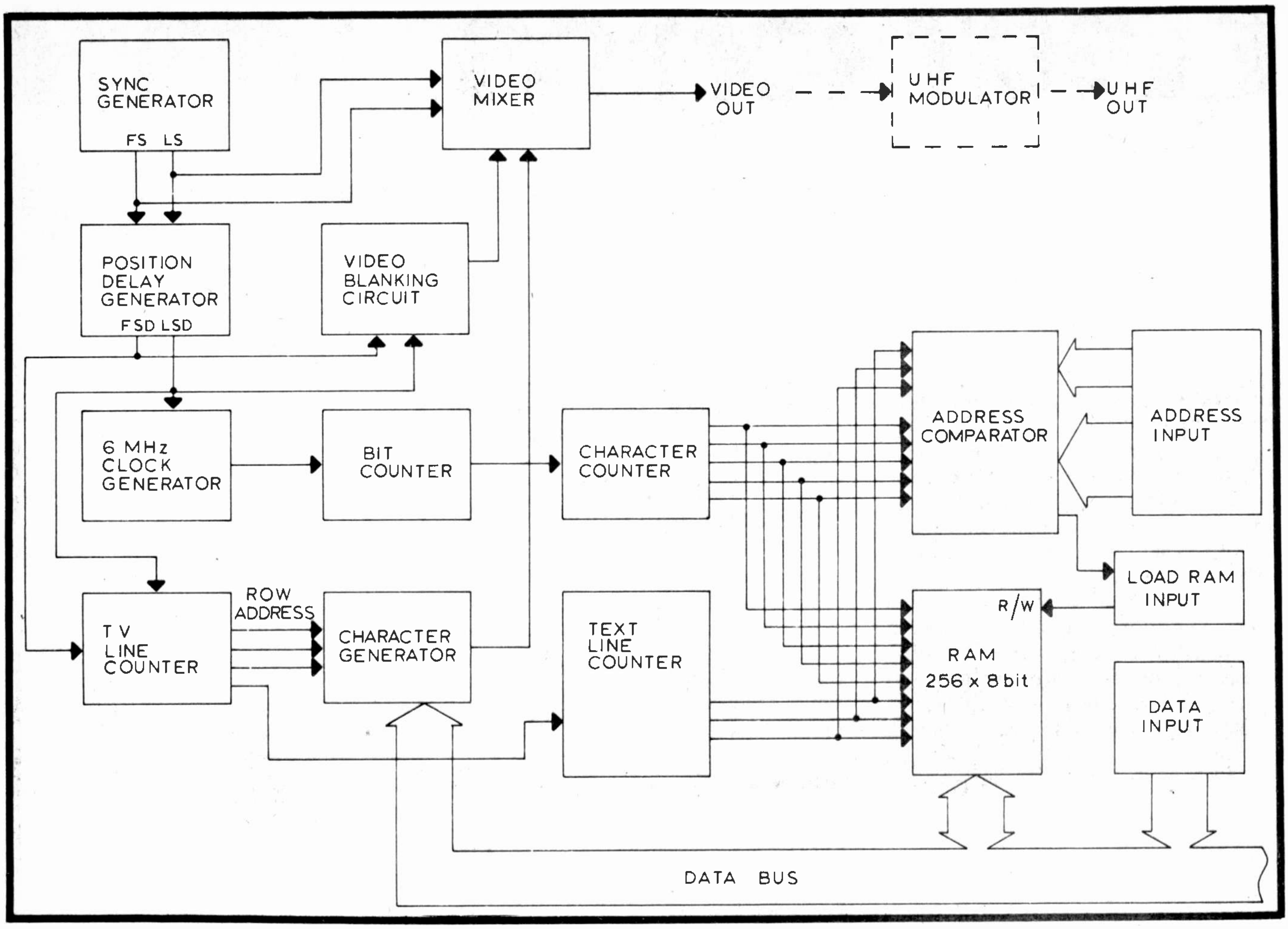
DESIGN REQUIREMENTS

The character style usually used in this type of application is the 5x7 dot matrix where 35 dots are arranged as seven horizontal rows of five dots, and the pattern of illuminated dots defines a character. This information is supplied by a character generator ROM which outputs the status of the dots in each row on five outputs while a simple BCD 0-7 address defines which row is to be output (row 0 is always blank). On a TV screen the smallest characters can be obtained when one TV scan line is equivalent to one character row, if we allow for a space between each line of character on rows 1-7. With just over 300 scan lines on a TV screen this gives us a maximum of 30 character lines and as the RAMs give us units of eight rows our maximum is therefore 24 character rows.

To get the verticals of our characters in ratio to the horizontals we must split up each TV line into just over 300 dots, again if we use a 7490 counter we need 320 dots (for 32 spaces) in just under one TV line. Each TV line is 64μS, so that allowing for flyback time and a border at each side we have to generate 320 dots in approx 50μS, ie at about 160nS intervals or 6.4MHz.

SYSTEM DESCRIPTION

Figure 1 shows the system block diagram in its simplest form. The sync signals for the TV are generated as field sync (FS) and line sync (LS) and a mixed sync which is passed to the video mixer stage. FS occurs off the screen to the top and thus we have to define a time after FS when we want the display to start. To do this a monostable is triggered by FS



and its trailing edge is used to start the vertical display. This signal is called FSD and a similar signal LSD is derived from LS. These signals define our top and left-hand borders and are fed to the blanking circuit so that no video can be output during these periods. LSD is also used to synchronise the 6MHz clock so that the character dots all start at the same distance from the side of the screen. LS is used as a row counter input with 0-7 outputs to the character generator and a once per line output to the text line counter. The 6MHz signal is input to a bit counter and from there to the character generator and character counter. Data is input to the character generator from the RAM which is continuously addressed by the character and row counter outputs so that the data for each character is output as that character display position is addressed.

Data is input to the system by setting up the address of the required display position and comparing this address to the outputs from the character and row counters. When both addresses are the same an equal output is generated which may be used to transfer the data on the data bus into the RAM by enabling the WRITE input of the RAM. The data is thus written into the RAM and will be displayed on the next cycle.

The output from the video mixer can be fed directly into the video input of any receiver or can be modulated to enable it to be fed in via a UHF aerial socket.

APPLICATIONS

On the basic system the input of data, address and controls is done with switches and push buttons which can be replaced with any TTL compatible inputs. The obvious application is to use the 560 as an I/O device connected to an MPU with the input being presented either from a PIA or by direct addressing with the data on the MPU data bus, the VDU RAM can be read by the MPU and thus a program can be written in the VDU and then executed by the MPU.

If the input is fed from a slow speed counter then this counter can be controlled by a cursor counter control connected to a full keyboard which would allow for much faster input to screenriter than from switches. A faster I/O method would be to use a cassette recorder to carry the input information; this data could be recorded on one track of a stereo machine with the bit clock on the other track. The data could be loaded onto the cassette or read from it by a simple interface in the form of a complete 256 characters, rows of 32 characters preceded by a row address character or as a unique character address and data.

If used as a subtitle unit the sync signals would have to be derived from the rest of the CCTV system, here the unit could be used to put video sub-titles onto a video recording or could be used 'live' with input from a cassette recorder triggered by a manual signal.

If correct switching or TRI-STATE units are used for input then data for different parts of the screen can be derived from different units. For instance it would be possible to construct the unit so that the first characters in the first row were always loaded from a digital clock chip such as an MM5318.

CONSTRUCTION

Full constructional details of the basic unit will be given next month together with complete component list. The finished unit is self contained with its own power supply and an I/O socket at the rear for connection to MPU or other equipment.

Concluded next month..............

ELECTRONICS —it's easy! PART 30

Code converters and display systems.

IT IS both necessary and convenient to transfer data between sub units of a digital system, by means of some kind of code. We have seen in the previous section how counting stages are sometimes arranged to count in BCD (Binary Coded Decimal), and how this form of code must then be 'converted' into another form that is suitable for the particular kind of display device used. Thus codes and code converters are of great importance in digital instrumentation.

In this section we will not discuss codes like ASCII, Baudot, Excess 3 etc, which are computer and communication codes, but restrict ourselves to those codes and converters which are concerned with counting and display.

BINARY TO BCD CONVERSION AND VICE VERSA

To convert binary to BCD a common method is to set a binary counter — see Fig. 3 — to the desired number either by direct counting upward from zero, or by transferring the value across from another stage with a parallel converter. Clock pulses are then fed into both this binary counter, now set to count back down to zero, and to an up-counting BCD counter. A detector senses when the binary counter reaches the 0000 state upon which any further changes in the count state of both units are inhibited. The BCD equivalent of the binary number is now held in the BCD counter.

At this point the BCD number is cleared into a store or is available for any other system need, the binary counter is reloaded and the process repeated to convert the next number from binary to BCD.

The reverse, BCD to binary, is accomplished in the same manner except this time the roles are reversed as shown in Fig. 4. The BCD counter is set to the desired number, the clock, when enabled, clocks the BCD counter down to zero and at the same time the binary counter upward. When the BCD counter reaches zero state its outputs logically inhibit the clock input to both counters. The process is repeated for each new number after clearing and resetting the two counters to the correct starting conditions.

This serial method is fairly slow and a much faster method is to use logic gates in a parallel arrangement. The parallel method works well for BCD to decimal and other cases but requires innumerable connections when set to convert decimal or BCD back to binary. It is little used in this reverse mode.

BINARY CODED DECIMAL TO DECIMAL AND OTHERS

Each BCD stage stores its decimal number as some form of binary code using four bits. The 1-2-4-8 weighting is the most usual form used but other codes such as the 'excess three' and the 'Aiken' variations, are also used. Thus, each of the digit values 0 to 9 (in decimal) is represented by four

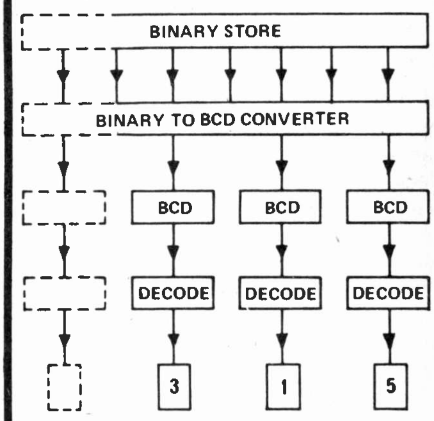
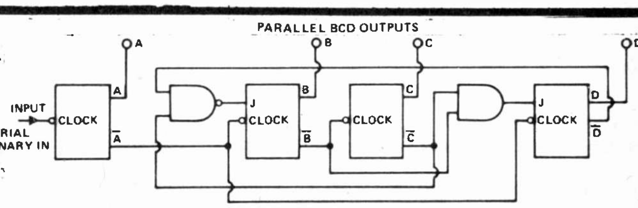


Fig. 1. Basic arrangement of binary to BCD converter and display decoders.

Fig.2. An asynchronous BCD counter provides a parallel BCD coded output which corresponds to the number of pulses fed to the input.



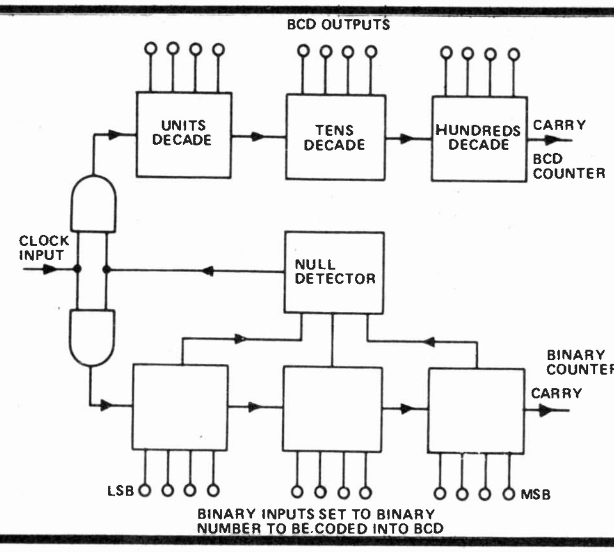


Fig. 3. System required to convert a binary number to its BCD equivalent.

lines, each having a '0' or a '1' state. This is demonstrated by studying the truth table for equivalent BCD and decimal states given in Fig. 5.

When the output must finally appear as decimal indication, it is necessary to energise the display or character printer segments appropriately. Displays, such as the neon tube or the columnar style — see previous part — require one output for each of the 0 — 9 numbers. From the truth-table of Fig. 5 it can be seen that to energise, say, a decimal '4' output we must set up a logic gate that provides an output when the BCD state is 0100. For '8' we need a BCD state of 1000. It is not possible to totally economise by using only '1', as the logical indications for this leads to ambiguities between numbers. On the other hand there is no need to arrange for all code sequences and bit combinations as that introduces redundancies using up extra unnecessary gates.

By careful design, and the use of inverters to invert '0' to '1's, it is possible to find a minimum number of AND gates and interconnections that will produce the 10 decimal states (0 to 9) as distinct outputs from the four-line (A B C D) outputs of the BCD stage. One such scheme is given in Fig. 6. Thus, by the use of logic gates alone we can provide a parallel code conversion from BCD to decimal.

Getting from BCD to a format suitable to drive a seven-segment display requires more gates, see Fig. 7, but the technique is basically the same. A decoder suited for the BCD to decimal requirement of a neon tube is quite unsuited to drive a seven-segment display. As both these and other conversions are in great demand they are available as simple ICs. Further, in some options the decoding logic is integrated onto the same chip as the BCD counter stage.

In practice the need to understand the internal operation of the decoder arrangement rarely arises, for the ICs are clearly marked with the connections to be made — it is just a case of making correct connections between the counter-stage chip, the decoder chip, and the display.

THE NEED FOR DISPLAY DRIVER STAGES

The power levels available from decoder stages are rarely adequate for direct drive of display units. A buffer stage which raises the power level is normally required. Again, these are generally incorporated into the decoder IC stage. Such integrated units are known as decoder/drivers. Different displays, even of the same format, require differing power needs so it is important to select decoder/driver stages suited to the display being used.

The buffer stage of a decoder/driver obtains current (or voltage gain) by the use of a transistor stage such as a Darlington pair or an emitter-follower circuit. A method recommended for driving seven-segment fluorescent displays is shown in Fig. 8 — these displays require high voltage drives.

Sometimes the need arises to drive displays from special-purpose one-off decoding circuits. In such cases a suitable driver stage is obtained by using standard IC inverter chips. (Discussed in Part 25).

THE ASSEMBLED BASIC COUNTER WITH DISPLAY

An illustration of the actual construction of a complete counting stage is to be found inside the digital clock shown in Fig. 9a. The display — neon tubes in this case — is arranged to appear where required by using end-connected tubes which plug into the main printed-circuit board as shown in Fig. 9b. Immediately behind each neon tube is the decoder/driver IC which, in turn, is driven by the counter IC located behind that again. On the circuit diagram these appear as

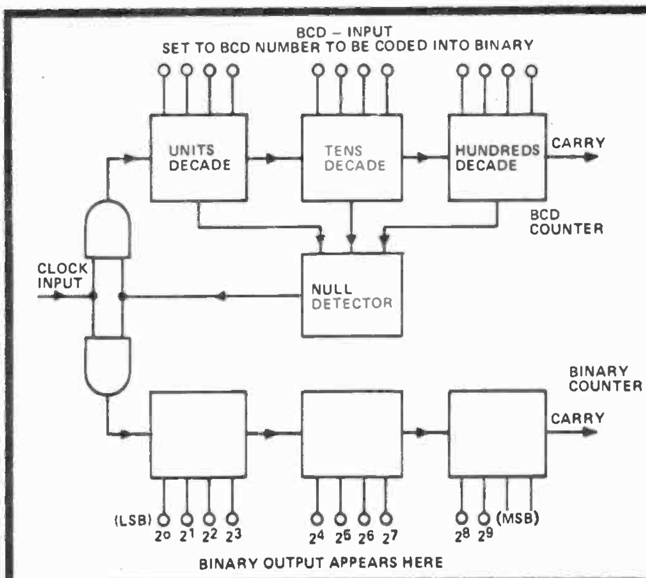


Fig. 4. To convert a BCD number to its binary equivalent the same circuit as Fig. 3. is used but the BCD number is now the one pre-loaded.

B.C.D. Inputs				Outputs										Decimal equivalent	
A	B	C	D	0	1	2	3	4	5	6	7	8	9		
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	Valid state of encoding
1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
0	1	0	0	0	0	1	0	0	0	0	0	0	0	2	
1	1	0	0	0	0	0	1	0	0	0	0	0	0	3	
0	0	1	0	0	0	0	0	1	0	0	0	0	0	4	
1	0	1	0	0	0	C	0	0	1	0	0	0	0	5	
0	1	1	0	0	0	0	0	0	0	1	0	0	0	6	
1	1	1	0	0	0	0	0	0	0	0	1	0	0	7	
0	0	0	1	0	0	0	0	0	0	0	0	1	0	8	
1	0	0	1	0	0	0	0	0	0	0	0	0	1	9	
0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	Illegal states that should not occur with BCD code.
1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	
0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	
1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	
0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	

Fig.5. Truth table relating four-line BCD with its decimal equivalents.

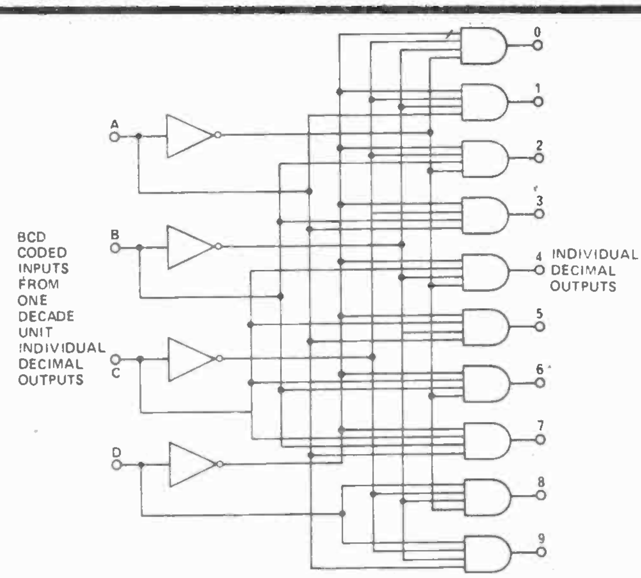


Fig. 6. Logic arrangement for decoding BCD units into one-of-ten outputs.

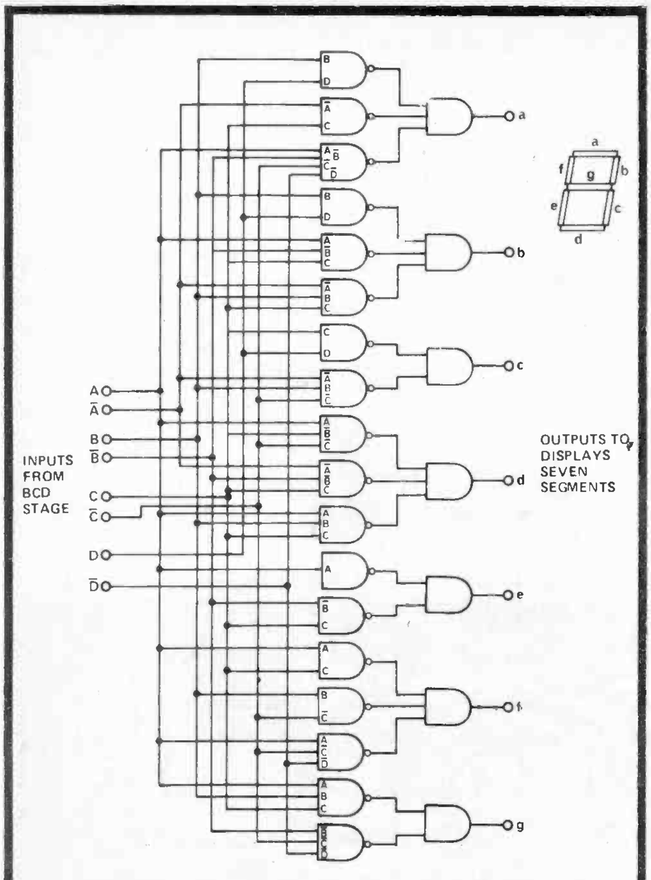


Fig. 7. Logic for converting BCD to seven-segment display format.

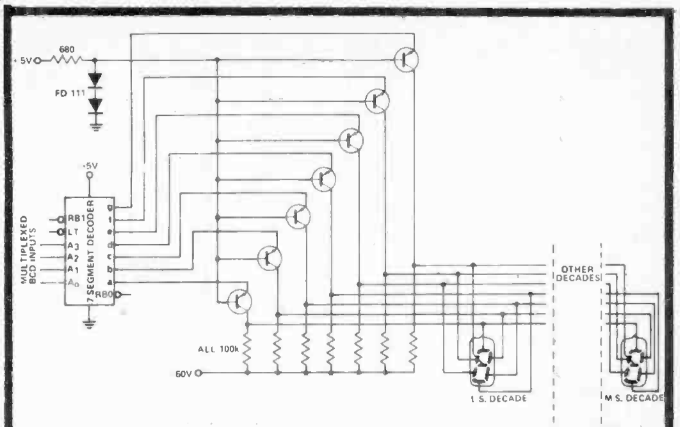


Fig. 8. How buffer transistors are used to obtain increased drive for fluorescent displays (seven-segment format).

shown in Fig. 9c and on the component overlay of the PC board as in Fig. 9d.

The Texas Instruments TIL 306 LSI is an example of an IC unit that incorporates the counter, decoder, driver, and display in one package. No doubt this will be the trend as it provides reduced assembly costs and smaller packaging. It should not be unrealistic to expect complete single-IC, multi-stage counter units to be in general use before long.

LATCHES

Direct coupling of the display to the counter stage results in a continuously changing display value. If the input is sufficiently dynamic it is awkward, if not impossible, to read values. Addition of a latch overcomes this by sampling and storing the count to be displayed for fixed intervals whilst the counter continues to cycle.

This is achieved using a memory stage between the counter and the decoder/driver stage as shown in Fig. 10. This system, the digital end of a digital voltmeter, displays a steady value for a short period by transferring the instantaneous value of the divider stage (the counter) into a buffer-store stage. The transfer or updating process is initiated by a common display timing line which is actuated at appropriate intervals. Such latches are invariably placed between the counter and decoder stages.

Internally a latch is a bi-stable designed specifically for the purpose of storing and transferring the value of a digital bit. Integrated circuit units provide four such latches in a dual-in-line package – see Fig. 11, thus allowing the four line data from a BCD counter to be sampled and stored by a single IC.

DECIMAL POINT

Facilities are usually provided in all displays to enable an input to energise a left-hand or right-hand point at each digit position. Obviously specific

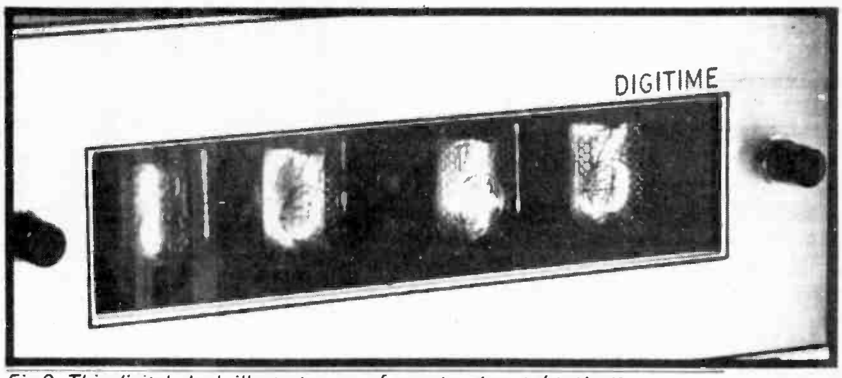


Fig.9. This digital clock illustrates use of counter stage subsystems.
(a) The frontal appearance of the Nixie display.

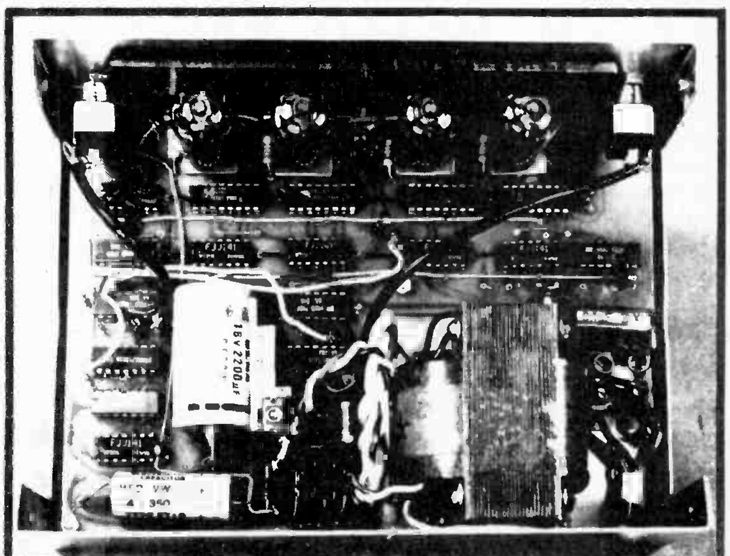


Fig. 9 (b). Top view of component assembly.

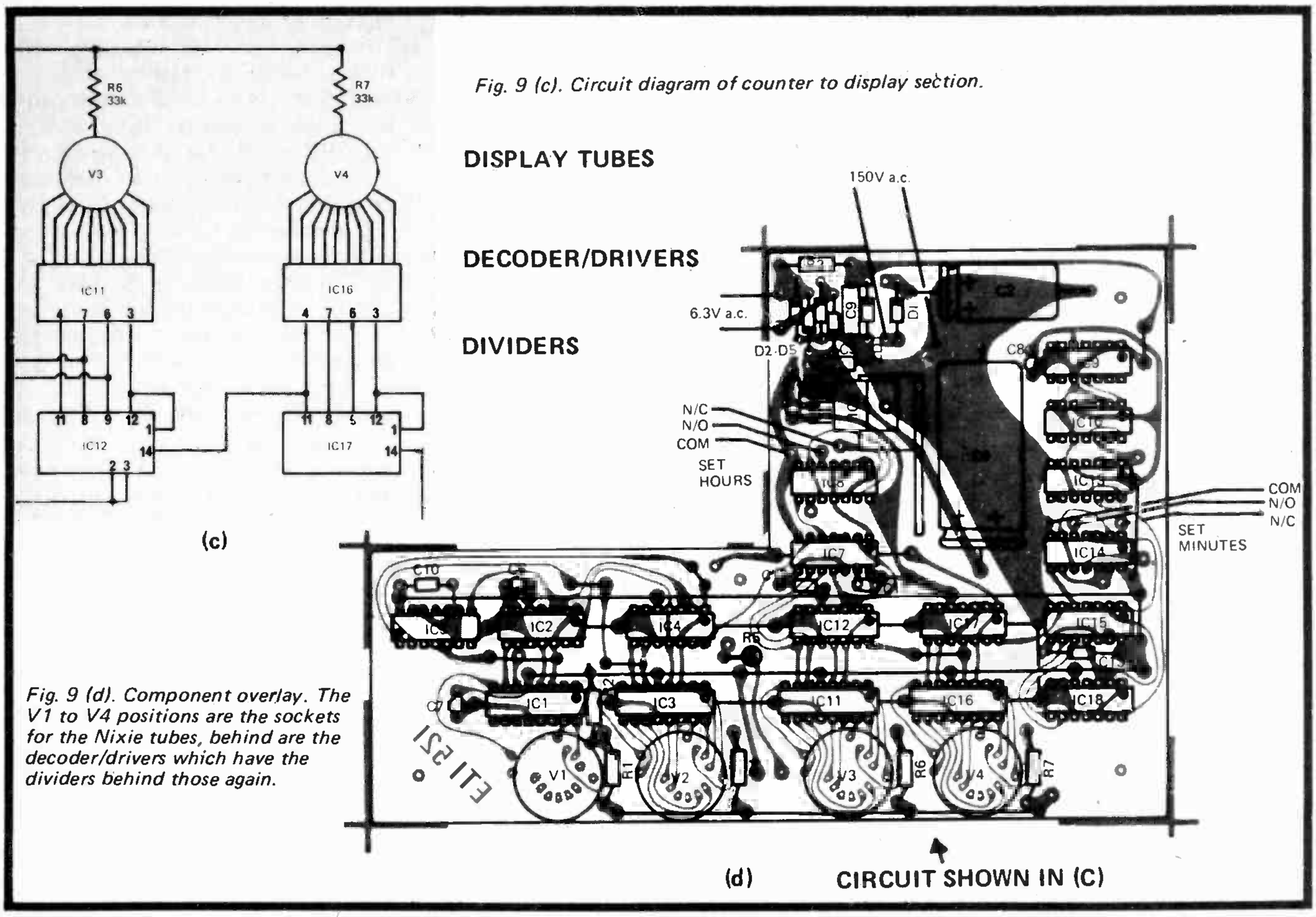


Fig. 9 (c). Circuit diagram of counter to display section.

Fig. 9 (d). Component overlay. The V1 to V4 positions are the sockets for the Nixie tubes, behind are the decoder/drivers which have the dividers behind those again.

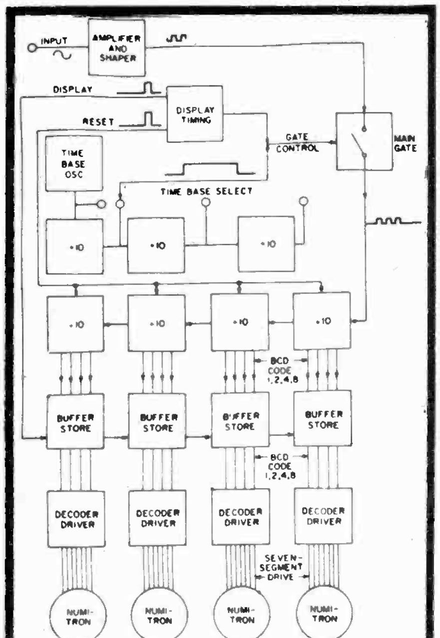


Fig. 10. Buffer stores are used to latch the display causing it to remain steady for selected periods. (circuit shown is a counter/timer using RCA incandescent displays).

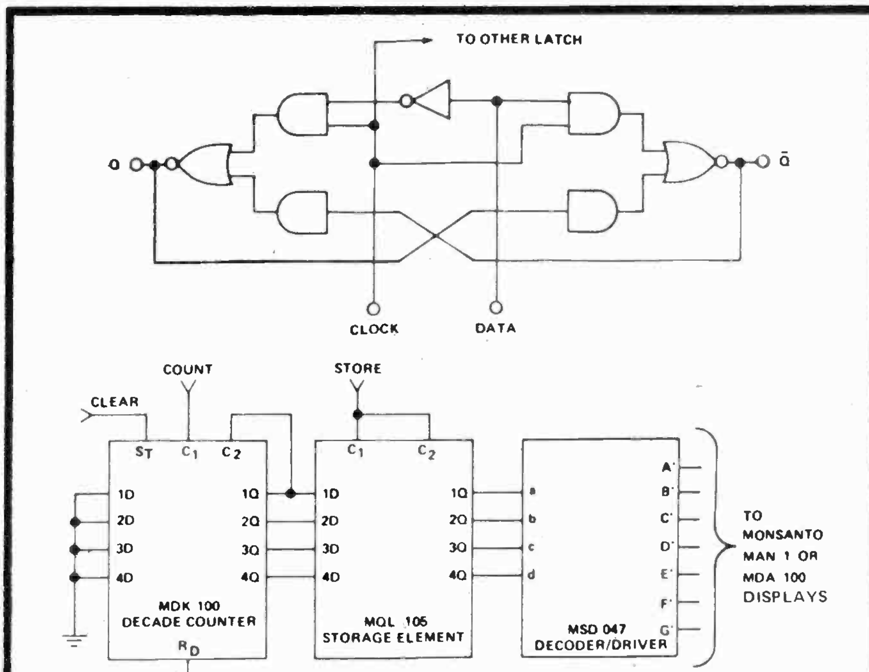


Fig. 11. Schematic (a) and pin connections (b) of counter, latch decoder system using the Monsanto MQL 105 four-bit bistable latch.

circuitry is required to energise just one of the total available in a multi-digit display in order to present the correct decimal number. The simplest arrangement is when the range switch of, say, a multi-range digital voltmeter decides the point to use. In autoranging voltmeters (etc) and in many calculators, solid-state switching is used to select the correct point position.

Further Reading:

"Solid State Alphanumeric Display Decoder/Driver Circuitry" — Hewlett Packard application note 931 gives details of scanning methods used with 7 x 5 displays.

"Mullard TTL Integrated Circuits — Applications" includes a chapter devoted to various kinds of code converter gating layouts. ●

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

WHAT A SCAMP!

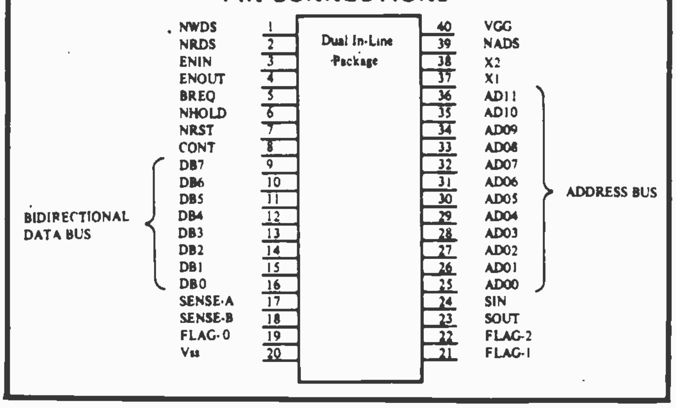
National Semiconductors have been in the MPU market for some time with their PACE and IMP systems which are both designed for use in major computer sized machines. Now they have introduced SC/MP in the smaller MPU market, an 8 bit CPU in a single 40 pin package at a low price and with the usual NS technological back-up. SC/MP is intended for use in general-purpose applications where the cost per function is the most important factor as SC/MP is slower than the F8 and 6800 CPUs. For most applications the speed is not an important factor as the MPU is used to replace TTL type logic circuitry which would be too complex to build or require too much power for the required function. SC/MP includes a variety of useful functions that are not even provided by other MPU systems, like self-contained timing circuitry, 16 bit (65K) addressing capability, serial or parallel data transfer and common memory/peripheral instructions. These built-in features are combined with the low unit-cost make SC/MP the ideal answer to many applications which could not previously have been considered.

All input and output pins are TTL compatible and are also TRI-STATE which means that in addition to logic '0' and Logic '1' there is a third state of the outputs where the output will follow the status of any other TRI-STATE output connected in parallel with the first without t amage to either output driver. This is similar to Wire ORing TTL outputs using the open collector gates except that in the latter a logic '1' on either (or any) parallel output will produce a logic '1' on the wire ORed line, with the TRI-STATE outputs the output is in a high impedance state until it is enabled thus one may choose logically which of the paralleled outputs is to be enabled and put data onto the common bus.

IN-OUT or IN-OUT

The 40 pin pin-out of the SC/MP CPU chip is shown as fig 1. The functions of these pins working from pin 1 are as follows.

PIN CONNECTIONS



NWDS is an output to indicatae to peripherals that CPU data is now valid, ie WRITE.

NRDS is an input which allows data from the data bus into the CPU, ie READ.

ENIN, ENOUT, BREQ are controls used in multiple CPU systems to denote which CPU chip has access to the address and data busses.

NHOLD this input causes the I/O address and data busses to lock in their present state until NHOLD input goes high, this can be used for slow I/O devices such as humans.

NRST reset input, when this is set low or on CPU power-on the internal registers are all initialised and the program pointer points at location Hex 0001.

CONT this input is similar to NHOLD except that the CPU is halted before fetching the next instruction whereas NHOLD stops it halfway through an instruction.

DB 0-7 Parallel I/O bus to/from ROMs, RAMS, I/O units, etc.

SENSE-A this is an external interupt signal which can be sampled by the CPU or can be used to cause immediate transfer to an interupt program, and is usually used by I/O devices to indicate that they wish to access the CPU.

SENSE-B this input is similar to SENSE-A except that it will not cause immediate transfer to another program as it has to be sampled by the CPU program. It could be used with SENSE-A to indicate a particular type of interupt.

FLAG 0-2 These are output indicators to indicate to other units user designated states of the CPU or other peripherals. For instance they could be used as acknowledgment indicators in peripheral handshake routines to indicate to the peripheral that its interrupt request has been noticed by the CPU.

SIN, SOUT are serial I/O pins. An instruction will cause a data bit at SIN to be transferred to an internal register or from the register to SOUT, this is used for example in teletype I/O or other VDU, CASSETTE, or KEYBD I/O routines.

ADAO-11 This is a 12 bit address bus which can directly access any location within a 4K 'page' it can be used in conjunction with the data bus to access any location within the 65K maximum for the CPU.

X1-X2 These are the timing pins which can have a 1MHz crystal on a 500pF capacitor connected across them,. the crystal is only used where accuracy of instruction times is required, ie if an accurate DELAY is required.

NADS This is one of the most important pins on the whole device, its basic function is to denote to any I/O or memory unit that a valid address is available on the address bus. If it is used to latch the data bus as well then the data bus has non-data information on it at NADS time.

This information is a four bit 'page' number to denote which of the 16 possible 4K pages is required (in a basic 4K system this address will always be 0000 and thus need not be latched). The other four bits of the data bus at NADS time shows the status of four flags R-FLAG shows whether input or output is to take place, I-FLAG shows whether data or instruction is being accessed, D-FLAG shows that a DELAY in in operation and H-FLAG can be used with the CONT input to enable a programmed halt.

Vss-VGG Nominal 12 volt supply.

WE HAVE 'LIFT-OFF'

Perhaps your car is not quite capable of 'lift-off' but it may well have ignition problems, so why not solve the problems with SC/MP? Fig 2 shows a very complex and relatively expensive application for SC/MP which may find application in racing engines fitted to cars, boats, planes, etc. An analogue multiplexer samples various signals from transducers in significant parts of the engine and passes these to the CPU via an A/D converter. The selection of transducer input and output selection is done via a latch connected to the data bus. The system may well be expensive as a straightforward electronic ignition system but remember that with all that information available to it*the CPU would also be able to give outputs of RPM, MPG, general engine efficiency, etc., and still have enough time and core to control lights, heating, warning lamps, etc. In fact a car built around a SC/MP might be a very interesting proposition.

At a recent exhibition NS had a Scalextric racing car set run from a microprocessor which was not a SC/MP but could well have been according to NS engineers. The idea was for one car controlled by a human to race against another car controlled by the MPU, similarly one can imagine a very complex train layout being controlled by a SC/MP system—in its spare time of course after looking after the rest of the household heating and cooking and helping junior with his homework. Anybody got a nice N guage layout they want to sell?

Price of the SC/MP CPU chip is only £12.50; an evaluation kit at £50 and a pseudo-TTY kit also at about £50. Available from NS distributors or Bywood starting July/August.

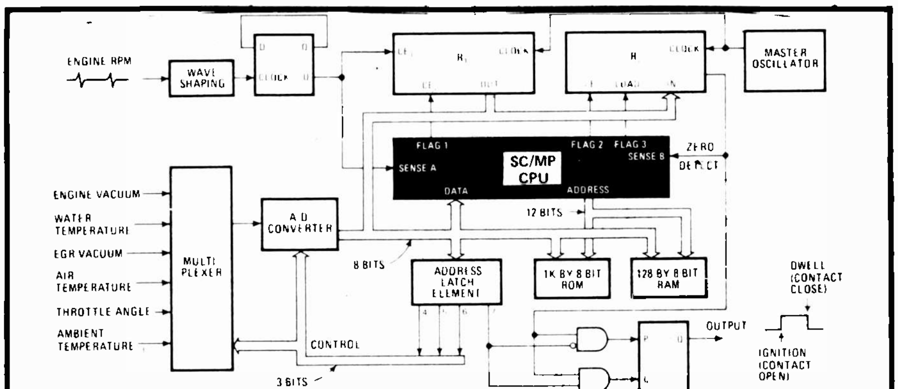


Fig. 2. Revving up. SC/MP can generate ignition dwell timing angles based on engine parameters as inputs. The external registers, R1 and R2, allow the system to handle high engine speeds by sampling engine conditions every other cycle.

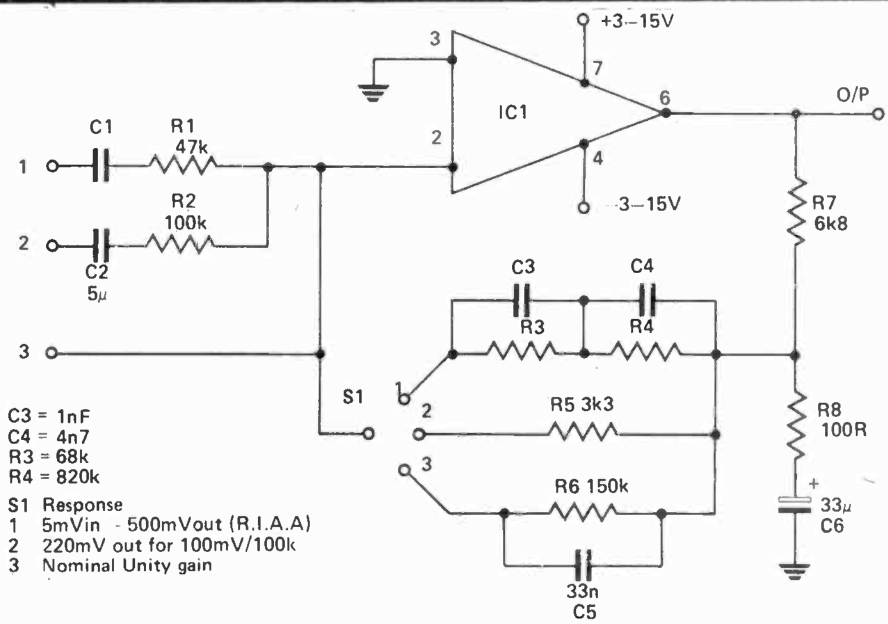
tech-tips

VIRTUAL EARTH PREAMP

This circuit caters properly for both magnetic and ceramic pickup cartridges and features an auxillary input with a flat response.

A 741 op amp is used in the inverting mode as a virtual earth amplifier. In order to maintain a reasonable closed loop gain the feedback is tapped from the junction of R7 and R8.

Advantage is taken of the low impedance summing point to directly connect the various inputs reducing the complexity of the switching arrangements. Of particular interest is the equalisation for ceramic cartridges employed. It is based on the charge amplifier principle. R6 in parallel with C5 introduces a −3dB cut at 40Hz and C1 performs the same cut at 40Hz and C1 performs the same function at the magnetic P.U. input. C6 provides a further attenuation at this frequency providing, a steep cut rumble filter with a −6dB point at 40Hz.



NOVEL VOICE FADER

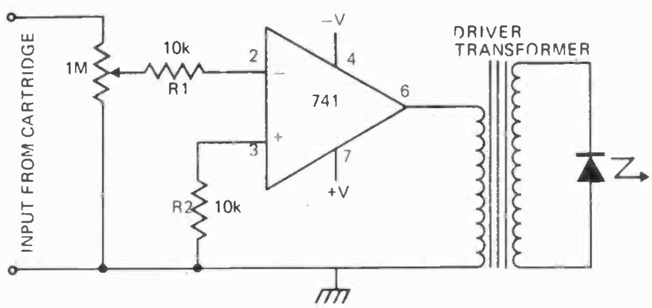
A cheap and effective alternative to cueing disco decks by PFL with headphones can be made by using LEDs to give a visual indication of the audio signal using this circuit.

R2 is used to ground the non-inverting input. The 1M pot and inverting input are used to ensure negligible output drain on the cartridge.

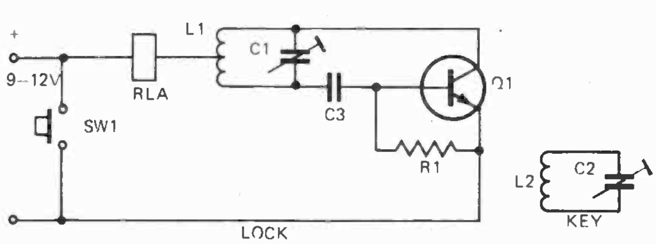
The ourpur of the 741 drives into the low impedance winding of an ordinary subminiature driver transformer. The secondary of this gives sufficient drive voltage to light the LED.

As the current drain for the whole circuit is small it can be supplied either from the main dual-voltage supply lines of the existing equipment or alternatively two PP3s. (Should last for several months).

The 1M pot is set to give no signal at the LED when the pick-up is on the lead-in track of the record.



SIMPLE ELECTRONIC LOCK



Operation is very simple, when the key is brought near the lock, providing L1—C1 have the same resonant frequency as L2—C2, the reed relay will open as the key absorbs energy from the lock. After each operation of the lock, it should be reset by a short press on the reset button.

Setting up is best done with a resistor in place of the relay with a voltmeter across it, making the operating range of the circuit more apparent.

PARTS LIST

Q1	BC108
C1/C2	250pF trimmers
C3	1000pF ceramic
L1/L2	80 turns 34swg on 3/8" diameter ferrite (L1 is tapped at 40 turns)
R1	27k
RLA	Reed relay resistance around 5k
SW1	Push-to-make switch

P.S. Found that ETI's TIC-TAC radio could be used as key!

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

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 36 Ebury Street, London SW1W 0LW.

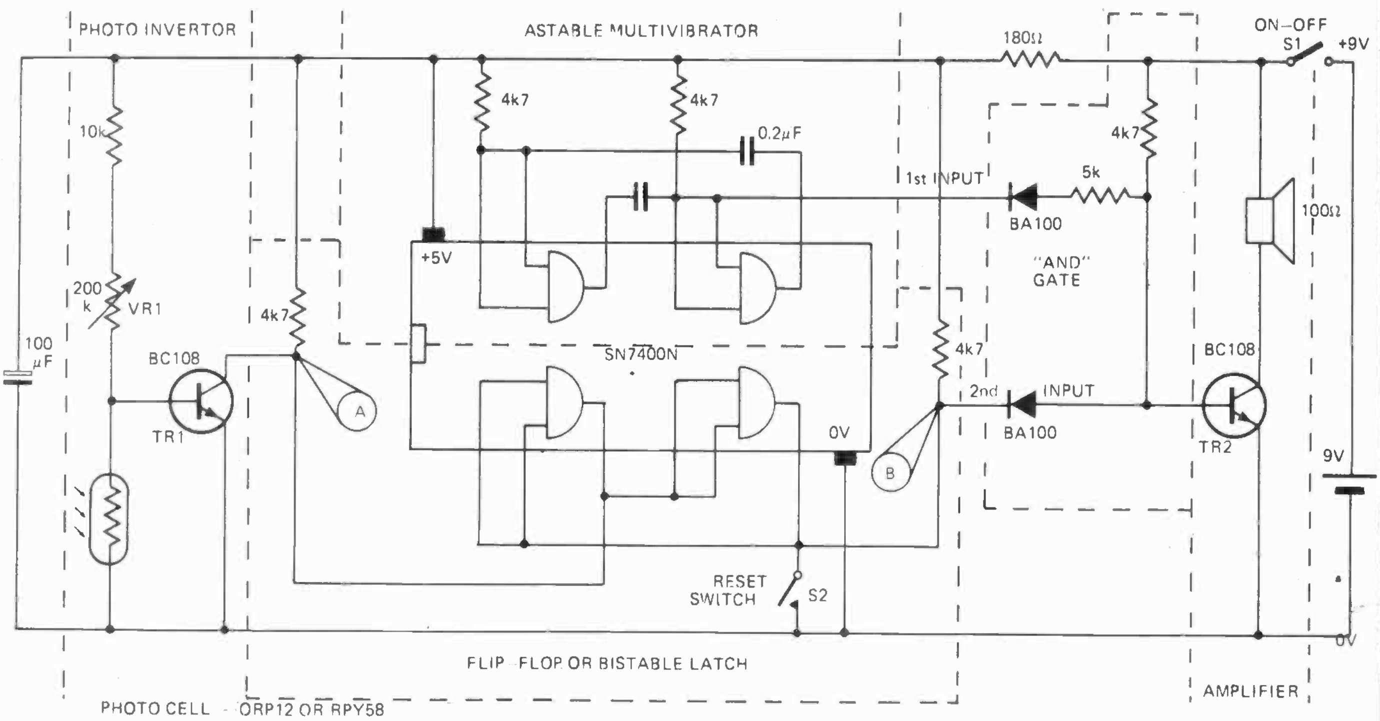
PHOTO INTRUDER ALARM

Designed so that when an object obscures the light following on a photocell an alarm is triggered.

The circuit is reset on depression of the reset switch. IC's (SN7400) has been used for the astable multivibration and bistable latch instead of using transistors, making the finished circuit smaller and neater to build.

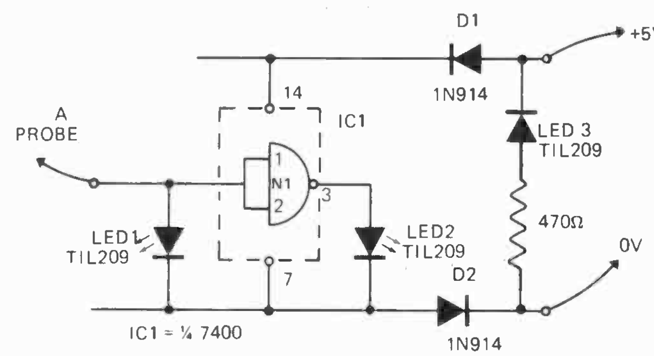
The circuit operates as follows. When the light on the photo cell fractionally decreases, the voltage on the collector of TR1 falls (point A). This triggers the bistable latch so that the voltage at B rises from 0V to +5V. Point B is the second input of a simple diode "AND" gate. An astable multivibrator (composed of the other two NAND gates of the IC) generates a square wave which is fed to the first input of the "AND" gate. This waveform is generated continually but does not appear at the output of the gate as long as the second input is held at 0V. When the second input rises to +5V the square wave appears across the emitter-base function of TR2 which drives the amplified tone into the speaker. To reset, the object in front of the cell is removed and the reset switch pressed.

To gain the maximum sensitivity VR1 is turned to its maximum. The reset switch is then pressed if the alarm is sounding. The tone should disappear. Now VR1 is slowly decreased until the alarm operates. VR1 is then increased very slightly until the alarm stops by pressing S2. The circuit is now at its maximum sensitivity for the given light level.



CHEAP LOGIC PROBE

When point A is at '1', LED1 is on indicating the 'Hi' state. When point A is at '0', output of N1 is '1', so LED2 is on indicating the 'Lo' state. Diodes D1 and D2 protect the circuit should it be wrongly connected to the supply, LED3 coming on to indicate wrong polarity.

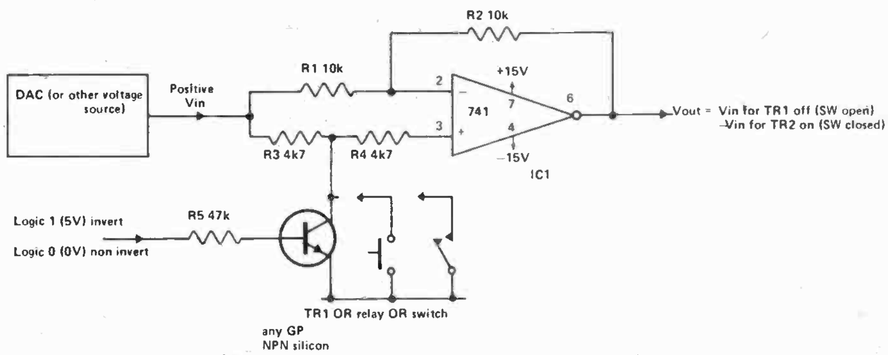


tech-tips

DUAL MODE AMP

This circuit was designed for use as the output of a relatively low accuracy (2%) Digital to Analog Converter (DAC). The DAC was required to have a bi-directional output, i.e. both positive and negative. It is quite expensive to provide this normally, so the simple invert/non invert amplifier was used.

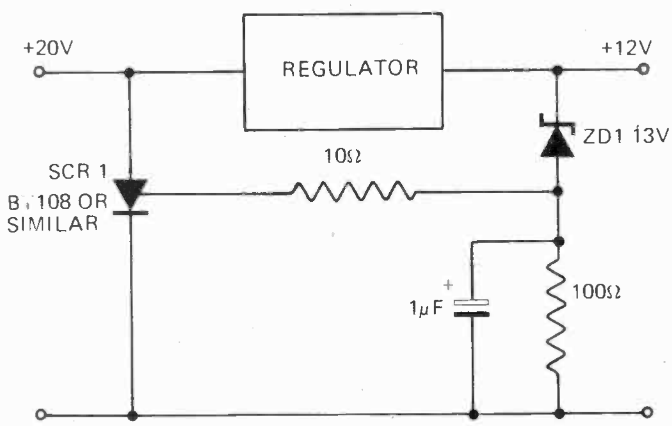
With TR1 turned off the Operational Amplifier IC1 acts as a voltage follower because its inverting and non inverting inputs are at the same potential. In this sense the amplifier has unity gain and little offset. The only errors are caused by the amplifier offset (a few millivolts) which will appear at the output, and the voltage caused by the input currents flowing



through R1 and R3/4.

With TR1 turned on, the non-inverting input of the Op Amp is connected to 0V via R4, and the amplifier now behaves as a conventional unity gain inverting amplifier. The performance in this mode is not as good. The saturation voltage at TR2 collector (typically 0.2V) will appear at the output subtracted from Vin. This limits the performance of the circuit to relatively low accuracy applications. It is possible to switch in a bias offset, but the complexity of this will usually be matched by having a bi-directional DAC.

FAST ACTING PSU PROTECTION



When using a regulated PSU to reduce a supply voltage there is always the danger that component failure in the PSU might lead to a severe overvoltage condition across the load. If the load is a circuit using ICs they can be permanently damaged under such conditions.

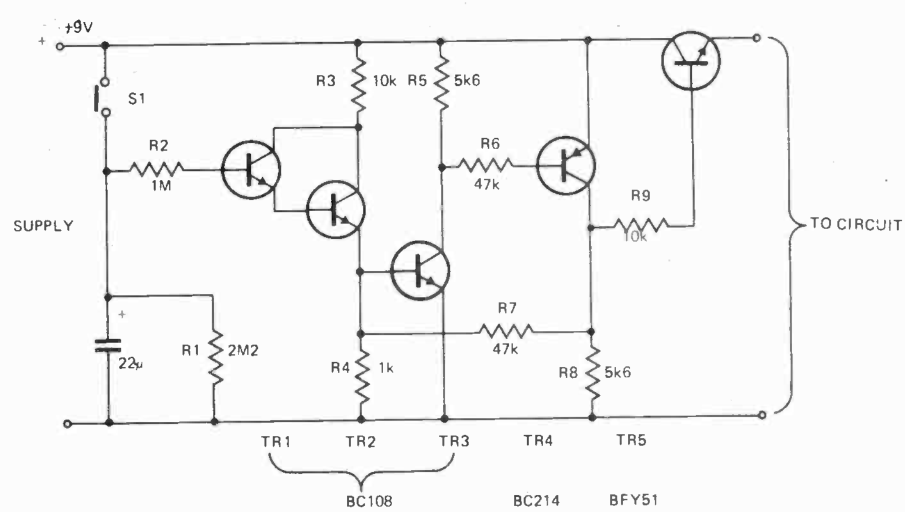
A fuse prevents excess current from flowing in a circuit but would generally be too slow to cope with overvoltage situations. The circuit shown is designed to protect the load under overvoltage conditions. Component values given are for a 20V supply with regulated output at 12V. The zener diode can be changed according to whatever voltage is to be the maximum.

If the voltage at the regulator output rises to 13V or above, the zener diode breaks down and triggers the thyristor which shorts out the supply line and blows the main fuse.

A TIMER WITH ZERO STANDBY CURRENT DRAIN

Most timer circuits draw current in both 'on' and 'off' states. For many applications this is no drawback, but for some purposes a timer is required which can remain in 'standby' indefinitely without drawing any supply current. The prototype is used with a toy siren similar to one in a previous "Tech-Tips" features, since young children delight in leaving such devices running indefinitely and a timed cut-out work wonders for parents' mental health! — but more practical uses would include delayed light switches for garages, communal areas in flats, etc, and 'sleep switches' to turn off radios used to lull one to sleep, where it could easily be built into the set.

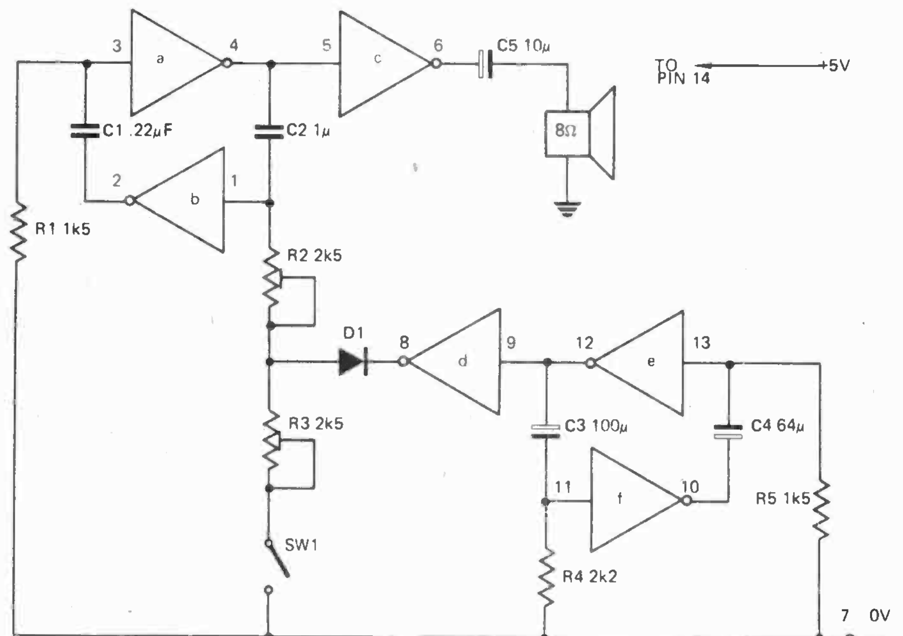
In operation all transistors are 'off'



until push-switch S1 is operated momentarily, charging C1, after which the darlington pair TR1 and TR2 start to conduct. A voltage then appears across R4, and this used to operate the switch proper, TR3 and TR4. These two transistors are used in a positive feedback arrangement to give a sharp switching action as the voltage across C1 gradually falls below a threshold value. Some of the collector voltage from TR4 is fed back to TR3 base through R7 and helps hold it switched on; as TR3 starts to switch off so TR4 turns off and this holding current falls, causing a sharp regenerative switching action to take place. TR5 is driven from TR4 collector and handles the supply current to the circuit being switched. R1 ensures C1 fully discharges since as long as any charge remains TR1 and TR2 continue to pass a small current (1mA).

The time depends on the value of C1 and R1, as shown around 2—3 minutes is obtained, but delays up to ½ hour or so should be easily obtainable with larger values of capacitor. Substituting a pot for R1 would provide some measure of control. C1 should for preference be a tantalum or low-leakage type. Almost any small silicon transistors should work, but germanium types are not recommended as their leakage currents might cause problems.

TWO TONE OSCILLATOR

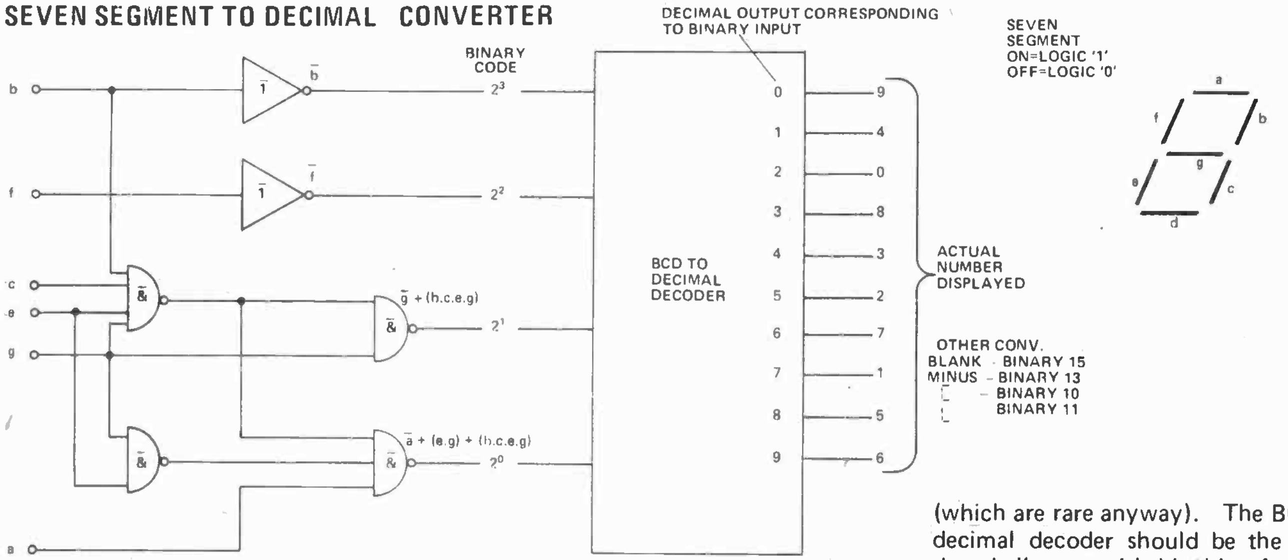


ALL GATES = SN7404 SW1 OPEN = ONE TONE SW1 CLOSED = TWO TONE
D1 = ANY GENERAL PURPOSE DIODE eg. 1N4001

This simple circuit uses only 1 SN7404 IC and can either generate an altering two tone signal or a pulsed single tone, either of the two tones can be varied and the circuit will drive a loudspeaker or a crystal earpiece.

In the circuit gates 'A' and 'B' generate an AF signal, the frequency of which depends on the resistance of the two inputs to earth (Pins 1 and 3). Gates 'F' and 'E' switch at a lower frequency (typically .5Hz) and their o/p is fed to gate 'D'. Whenever pin 8 is at logic '0', D1 is forward biased and the effective resistance to earth from pin 1 is R2 plus the resistance of D1 and the invertor 'D'. Whenever pin 8 goes to logic '1', D1 is reverse biased and the effective resistance to earth from pin 1 changes to that of R2 + R3 therefore the AF output frequency changes, when the circuit is switching a high and low tone alternately, R2 sets the frequency of the high tone and R3 that of the low tone, when the circuit isgiving a single frequency (i.e. SW1 open) then the o/p frequency is set by R2.

SEVEN SEGMENT TO DECIMAL CONVERTER



Note that the output from the gates is not 'straight' BCD so the outputs from the BCD to decimal decoder are transposed. It will convert 6's and 9's with or without the top and bottom bars respectively but not 'hooked' 7's (which are rare anyway). The BCD to decimal decoder should be the 'fully decoded' type with blanking for BCD inputs over 9 since a blank is encoded as binary 15, hence a 74141 instead of 7441. Some other conversions which result from this circuit are shown.

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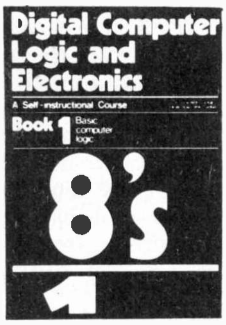

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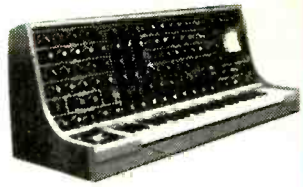

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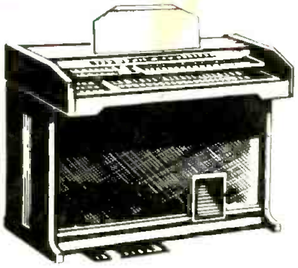

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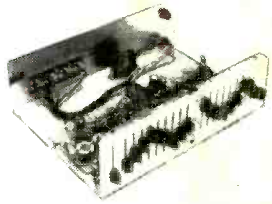

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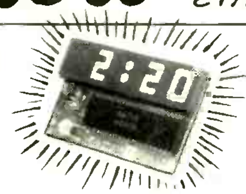

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