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FEBRUARY 1977

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FEBRUARY 1977 VOL 6 No. 2

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Information

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Type	Quantity 1 £ p	100 £ p	Type	Quantity 1 £ p	100 £ p	Type	Quantity 1 £ p	100 £ p
7400	0.09	0.08	7448	0.70	0.68	74122	0.45	0.42
7401	0.11	0.10	7450	0.12	0.10	74123	0.65	0.62
7402	0.11	0.10	7451	0.12	0.10	74141	0.68	0.65
7403	0.11	0.10	7453	0.12	0.10	74145	0.75	0.72
7404	0.11	0.10	7454	0.12	0.10	74150	1.10	1.05
7405	0.11	0.10	7460	0.12	0.10	74151	0.65	0.60
7406	0.28	0.25	7470	0.24	0.23	74153	0.70	0.68
7407	0.28	0.25	7472	0.20	0.19	74154	1.20	1.10
7408	0.12	0.11	7473	0.26	0.22	74155	0.70	0.68
7409	0.12	0.11	7474	0.24	0.23	74156	0.70	0.68
7410	0.09	0.08	7475	0.44	0.40	74157	0.70	0.68
7411	0.22	0.20	7476	0.26	0.25	74160	0.95	0.85
7412	0.22	0.20	7480	0.45	0.42	74161	0.95	0.85
7413	0.26	0.25	7481	0.90	0.88	74162	0.95	0.85
7416	0.28	0.25	7482	0.75	0.73	74163	0.95	0.85
7417	0.26	0.25	7483	0.88	0.82	74164	1.20	1.10
7420	0.11	0.10	7484	0.85	0.80	74165	1.20	1.10
7422	0.19	0.18	7485	1.10	1.00	74166	1.20	1.10
7423	0.21	0.20	7486	0.28	0.26	74174	1.10	1.00
7425	0.25	0.23	7489	2.70	2.50	74175	0.85	0.82
7426	0.25	0.23	7490	0.38	0.32	74176	1.10	1.00
7427	0.25	0.23	7491	0.65	0.62	74177	1.10	1.00
7428	0.36	0.34	7492	0.43	0.35	74180	1.10	1.00
7430	0.12	0.10	7493	0.38	0.35	74181	1.90	1.80
7432	0.20	0.19	7494	0.70	0.68	74182	0.80	0.78
7433	0.38	0.36	7495	0.60	0.58	74184	1.50	1.40
7437	0.26	0.25	7496	0.70	0.68	74190	1.40	1.30
7438	0.26	0.25	74100	0.95	0.90	74191	1.40	1.30
7440	0.12	0.10	74104	0.40	0.35	74192	1.10	1.00
7441	0.60	0.57	74105	0.30	0.25	74193	1.05	1.00
7442	0.60	0.52	74107	0.30	0.25	74194	1.05	1.00
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7445	0.80	0.75	74118	0.85	0.82	74197	0.90	0.85
7446	0.80	0.75	74119	1.30	1.20	74198	1.90	1.80
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16201 18 Electrolytics 47 uF-10 uF
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AC176K	22p	OC71	9p
AC187K	22p	OC72	14p
AC188	12p	OC81	14p
AC188K	22p	ZTX107	*6p
BC107	6p	ZTX108	*6p
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BC109	6p	ZTX300	*7p
BC118	*10p	ZTX301	*7p
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BC147	*8p	ZTX500	*8p
BC148	*8p	ZTX501	*10p
BC149	*8p	ZTX502	*12p
BC157	*10p	2N696	10p
BC158	*10p	2N697	11p
BC159	*10p	2N706	7p
BC169C	*10p	2N706A	8p
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BC183	*9p	2N2219	15p
BC184	*9p	2N2219A	18p
BC212L&K		2N2221	15p
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BC338	*11p	2N2905	14p
BF115	10p	2N2905A	15p
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BF173	10p	2N2906A	14p
BF194	*9p	2N2907	12p
BF195	*9p	2N2907A	13p
BF196	*12p	2N2926G	*8p
BF197	*12p	2N2926Y	*7p
BF198	*12p	2N3053	14p
BF199	*12p	2N3055	38p
BF257	26p	2N3702	*7p
BF258	29p	2N3703	*7p
BF259	34p	2N3704	*6p
BFX29	18p	2N3705	*6p
BFX84	15p	2N3706	*7p
BFX85	20p	2N3903	*11p
BFX86	20p	2N3904	*11p
BFY50	12p	2N3905	*11p
BFY51	12p	2N3906	*11p
BFY52	12p	2N5172	*9p

DIY PRINTED CIRCUIT KIT

CONTAINS 6 pieces copper laminate, box of etchant powder and measure, tweezers, marker pen, high quality pump drill, Stanley knife & blades, 6in metal rule.
Full easy-to-follow instructions
~~£7.80~~ **£5.50**

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OA47	5p	IN4005	6p
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5 of either **50p**		
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ORP 12	1515	38p
OCP 71 Pack of 5	1520	

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1A/50 PIV	THY 1A/50	18p
1A/400 PIV	THY 1A/400	32p
1A/600 PIV	THY 1A/600	38p
TO66		
5A/50 PIV	THY 5A/50	25p
5A/400 PIV	THY 5A/400	40p
5A/600 PIV	THY 5A/600	50p
TO48		
16A/50 PIV	THY 16A/50	40p
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F.E.T.

2N3819 — 15p

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High quality modules for stereo, mono and other audio equipment.

NEW

PUSH-BUTTON

STEREO FM TUNER

OUR PRICE ONLY

£20.45

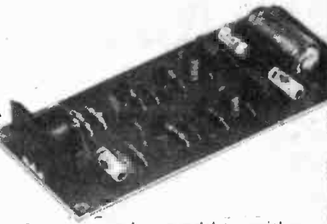
Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T538.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

★ FET Input Stage
★ VARI-CAP diode tuning
★ Switched AFC
★ Multi turn pre-sets
★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

£2.85

VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER

PA 100

OUR PRICE **£13.75**

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

Frequency Response + 1dB 20Hz 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA.

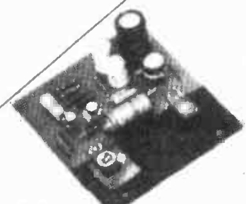
Dimensions 299mm x 89mm 35mm.

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £29.55** plus 85p postage.

TEAK 60 AUDIO KIT:
Comprising: Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 85p postage.

AL-20-30

AUDIO AMPLIFIER MODULES



The AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 5 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.

SPECIFICATION:
- **Harmonic Distortion Po=3 watts f=1KHz 02.5%**
- **Load Impedance 8-16ohm**
- **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po=2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS**

AL20 5w R.M.S. £2.95   AL30 10w R.M.S. £3.25

STEREO 30

COMPLETE AUDIO

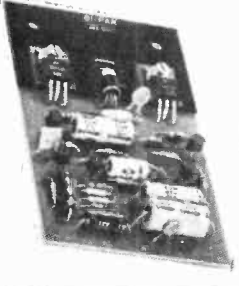
7+7 WATTS R.M.S.

P & P 45p

£16.25

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £5.25 plus 62p p & p.



AL 60

25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£4.35

NEW

PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL 20/30 Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V.5mA. Size 152mm x 84mm x 33mm.

£6.70

PS12

Power supply for **AL20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C. Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.30

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

£3.75

BI-PAK

P.O. BOX 6, WARE, HERTS.

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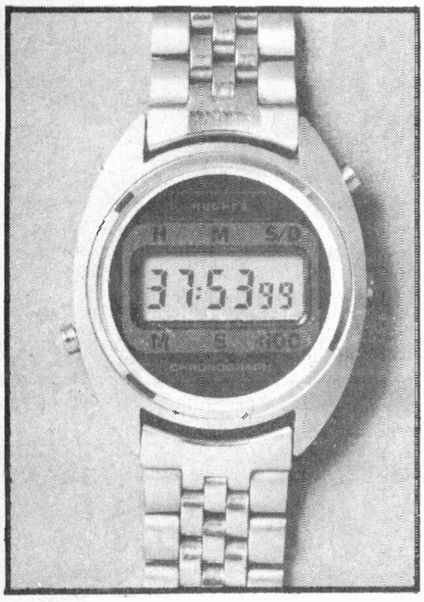
OPEN 9 to 5.30 Mon./Sat. *Tel. 61593*

ANONYMOUS WATCH



A new digital watch module that also functions as a stopwatch has been introduced by Hughes Microelectronics. Measuring 1.15 inches in diameter, the new solid-state module utilizes a 6 digit liquid crystal display. It provides five timekeeping functions - month, date, hour, minute, and second - as well as a stopwatch accurate to one hundredth of a second. A light is also built-in for night time reading.

In the stopwatch mode, the counters can be set to zero and will count in minutes, seconds, hundredths of a second, while in this mode the time can be 'called out' without interrupting the operation of the stopwatch. Similarly, split times can be obtained during counting and the internal counter will continue in operation.

Hughes, which supplies many name-brand and private-label watch companies with modules, does not market a watch to consumers under its own name, and so when this device gets to the shops, it will be called anything *except* Hughes!

Hughes Microelectronics Ltd., Berkeley Square House, London, W1X 6EQ.

CALCULATING SINCLAIR'S ERROR!

We have received several letters from readers concerning our recent survey of scientific calculators.
The letter below is a composite, made up from some of these epistles which makes the points our readers made. The comments are perfectly valid, but it is worth remembering that the CBM and Rockwell machines turn in higher accuracies, regardless of the test applied

Dear sir,
'Cheap scientific Calculators'
Your recent comment on the accuracy of the trig functions of the Sinclair Scientific lead me to check my H.P. 35 which is a ten figure machine.

Following your procedure of taking 45° and then Sin., Cos., Tan., followed by arc Sin., arc Cos., arc Tan., the answer comes out at 45.002° which for accurate survey work would be a significant error.

However I do not feel that this result casts doubt on my H.P. 35, but highlights the problems of working with small angles on the process you adopted involves taking the Cos. of 0.707106° and then the Tan. of 0.01234196°.

With angles of this magnitude the differences are very small and for a high degree of accuracy a very large number of figures has to be used.

What your results show is not the accuracies of the trig. functions of the Sinclair Scientific but the limitations of the restricted number of digits with which the machine computes.

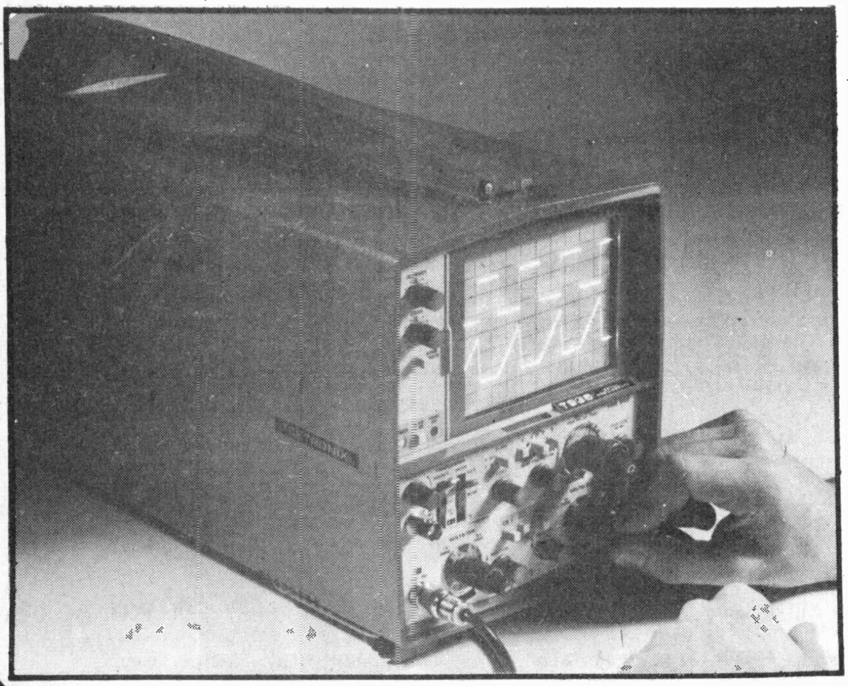
While I have no connection with Sinclairs I feel that you have, to some extent, done them an injustice and in a future edition some word of explanation would not come amiss. Your comments could well have put purchasers off buying a cheap and useful machine.

CEEFAX LEGAL!

The Home Office has recently agreed that approval for the continued transmission of the BBC's CEEFAX service, first authorised in September 1974, should be extended to the end of the current BBC Charter in July 1979, subject to any decisions following the report of the committee on the Future of Broadcasting. At the present time, two separate magazines, each having up to 100 pages, are being transmitted on BBC-1 and BBC-2.

COUNTING LESS IN CMOS

Motorola USA has just hacked 25% off the price of 63 CMOS MSI devices.
This is to heighten competition with low power Schottky TTL chips, which are at present more than holding thier own against the newer technology.
Simple gate prices are not affected.



PLENTY OF SCOPE

The T900 Series of oscilloscopes, from Tektronix U.K. Ltd., is claimed to be engineered to 'reduce the cost of ownership' i.e. make the things cheaper (presumably). Why people can't say what they mean...

Anyway the range includes five models: the T921 and T922 single and dual-trace 15MHz instruments, the T932 and T935 dual-trace 35MHz with single and dual timebases, and the T912 10MHz dual-trace bistable storage oscilloscope. Prices range from about £500 to £1,000 (plus VAT).

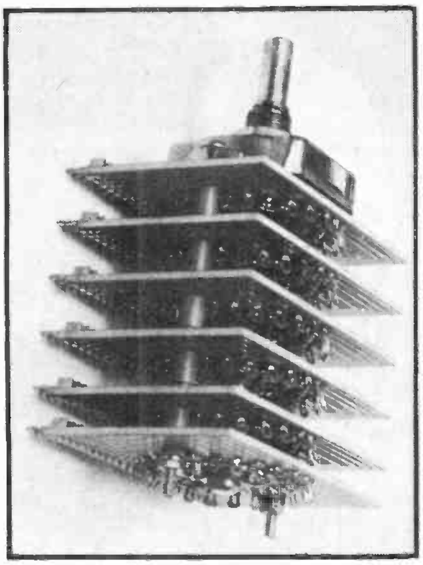
All models have an 8 x 10cm display area, and measure 17.8 x 25.4 x 48.3cm.

The T935 incorporates delayed sweep - signals that reveal insufficient detail on one timebase may be selectively expanded using this feature.

Tektronix U.K. Ltd., Beaverton House, P.O. Box 69, Harpenden, Herts.

SWITCH-OVER

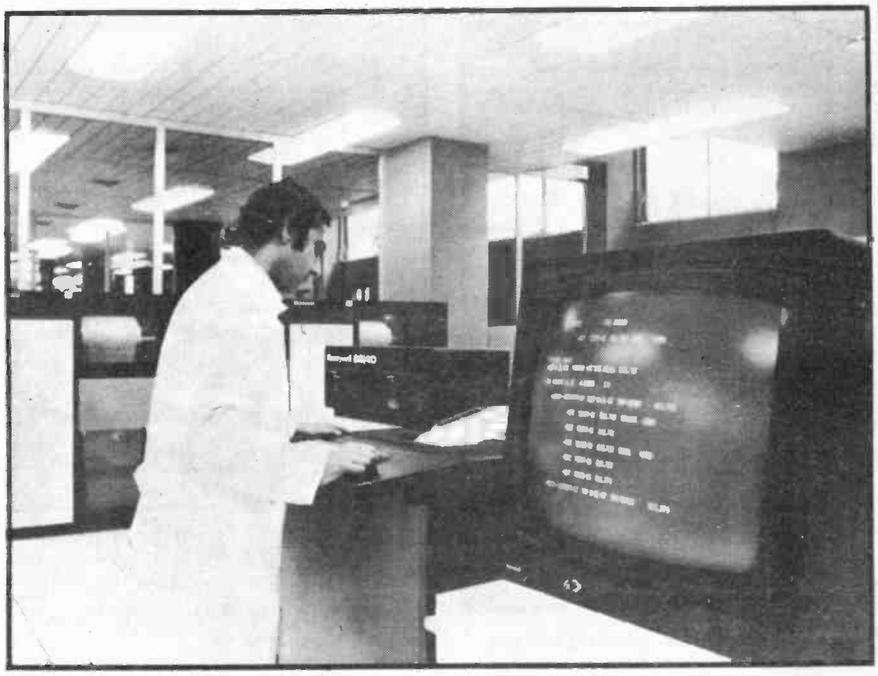
Designed for mounting directly onto the printed circuit board, this compact 24-position rotary switch itself incorporates printed circuit wafers, each containing 24 in-line solder coated pins on 0.1" centres. Switches are



available in break-before-make and make-before-break versions. Contact ratings: 0.5A at 28Vd.c., 0.25A at 110Va.c. The initial control resistance is less than 15 milliohms for all contact types.

Diamond H Controls Ltd., Vulcan Road North, Norwich NR6 6AH.

DRIVING THE ITALIANS MAD? (LEGALLY!)



Photograph shows a dual series 60 Level 66 computer (made at Honeywell's Newhouse Lanarkshire factory) which is now in full operation in Rome speeding the issue of driving licences and car registration cards for the Italian Ministry of Transport.

The computer is a dual Model 66/40 with two Datanet 6600 communications processors for controlling an on-line terminal network between local offices and the central data processing centre in Rome.

Total system value is in excess of £2.5M.

CHEMICAL COAT

A new dual coating tape from Agfa called the Carat, comes in the unusual - nay unique - size of C48. Fe-Cr tapes do offer improvements in some areas, and aimed for this spooling are:

Noise level: 4.5 dB better than iron oxide.

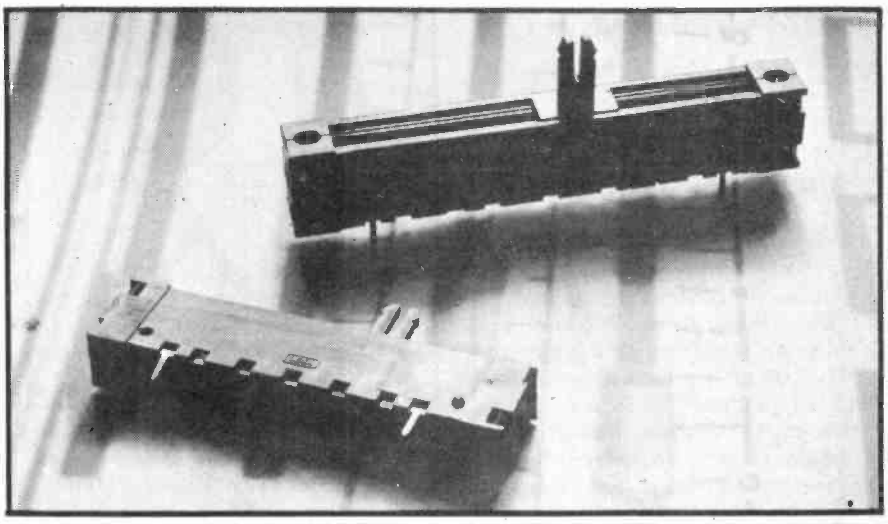
Max. output level: 4 dB better than iron oxide, and 1.5dB better than chromium dioxide.

Dynamic range: 8.5 dB better than iron oxide.

Bias setting should be Fe-Cr really, but in the absence of excellence, record on Fe setting, and replay on CrO_2. Special Mechanics (under licence from you-know-who) are used to aid transport.

Agfa-Gevaert Ltd., 27 Great West Road, Brentford, Middx.

MARKET SLIDE



A comprehensive range of linear - motion slider potentiometers is now available from Distronic Ltd. The Siemart C Series and F Series, including single and tandem slider potentiometers with both 40mm and 58mm travel, and designed for applications in the consumer electronics market, including stereo units, radios, television sets, musical instruments etc..

Metal-screened types are available where the elimination of external interference is important, and tandem types can have earthed metal screening incorporated between the resistive elements to minimise crosstalk between channels. The control spindle is made of insulating material.

Distronic Ltd., 50/51 Burnt Mill, Elizabeth Way, Harlow, Essex.

news digest

A MACHINE TO MARK TIME

Lo and behold - we have a new desk top calculator. Either that or someone has VERY big hands. Perhaps it's a hand-held machine designed to Govt. specifications. It could be useful in any event. The somewhat different facilities (for a desk machine) include two memories, hours minutes seconds arithmetic, Casios fraction operating mode, standard deviation, reciprocal and square root.

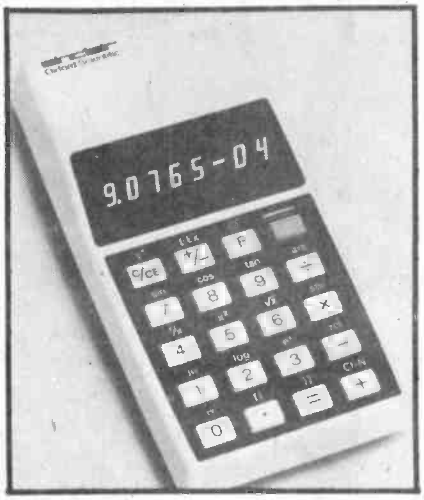
A slide switch is used to select function. Oh yes, the number is 122-F and it has an RRP of £75 around its digital neck.

ABM Ltd., ABM House, Wyfold Road, London S.W.6 6RZ.

AUDIO PHASER P.C.B. CORRECTIONS

The audio phaser PCB contains two drawing errors. The circuit diagram is correct, and projects built up on Veroboard, or some other method should function perfectly. It appears though that layout is fairly critical on this project, and several readers have had problems in this respect.
The errors on the PCB are;
1. One end of RV1 is earthed via a track to IC6. It shouldn't be! Break this track.
2.Top right of the board, the pad which connects R33 to the link has a wire to earth missing.

. . . .AND ONE TO SAVE IT!



The new Oxford Scientific will retail at under £15 plus VAT. In addition to the four normal arithmetic and six trigonometric functions (in degrees and radians), the Oxford Scientific offers logs base$_e$, logs base$_{10}$, antilogs, y^x, memory, two levels of parentheses, sign change, *plus* the four slide-rule functions - x^2, $\sqrt{x}$, $1/x$, and π.

Accuracy is ± one unit in the eighth significant digit on arithmetic and slide-rule functions, and ±2 units on all other functions. The large green eight-digit display shows results in normal or scientific notation.

Sinclair Radionics Ltd., London Road, Huntingdon, Cambs. PE17 4HU

NATIONAL SELL CELLS!

The NSL-312 Cadmium Selenide and NSL-412 Cadmium Sulphide series of photoconductive cells have a 50mW power rating at 25° C, a choice of 7 photocell resistances, and typical dark capacitance figures of between 1.2pF and 4.0pF. Believed to be the smallest photocells currently on the market, they are available in either a TO18 size hermetically sealed package, or as a moisture resistant plastic encapsulated unit.

National semiconductors Ltd., Stamford House, Stamford New Road, Altrincham, Cheshire,WA 141 DR.

Unique full-function 8-digit wrist calculator... available only as a kit.

A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes – take your jacket off, and you're lost!

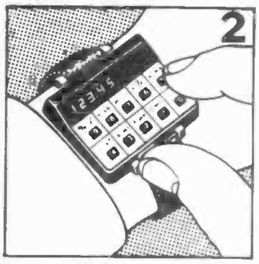
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

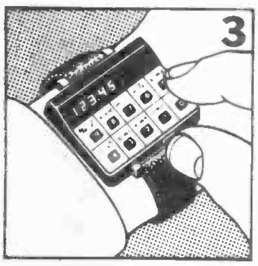
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable £9.95 (plus 8% VAT, P&P). And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, 1/x, x^2; plus a full *5-function memory.*

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.





1. The switch in its normal, central position. With the switch centred, numbers – which make up the vast majority of key-strokes – are tapped in the normal way

2. Hold the switch to the left to use the functions to the left above the keys...

3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free:* we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Contents

Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and is accompanied by full instructions. The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10-day money-back undertaking.

Send the coupon today.

KIT ONLY £9.95 PLUS VAT, P&P

Sinclair Instrument Ltd,
6 Kings Parade, Cambridge,
Cambs., CB2 1SN.
Tel: Cambridge (0223) 311488.

To: Sinclair Instrument Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.

* Please send me . . . (qty) Sinclair Instrument wrist-calculator kits at £9.95 plus 80p VAT plus 25p P&P (Total £11).

* I enclose cheque/PO/money order for £ ....

* Complete as applicable.

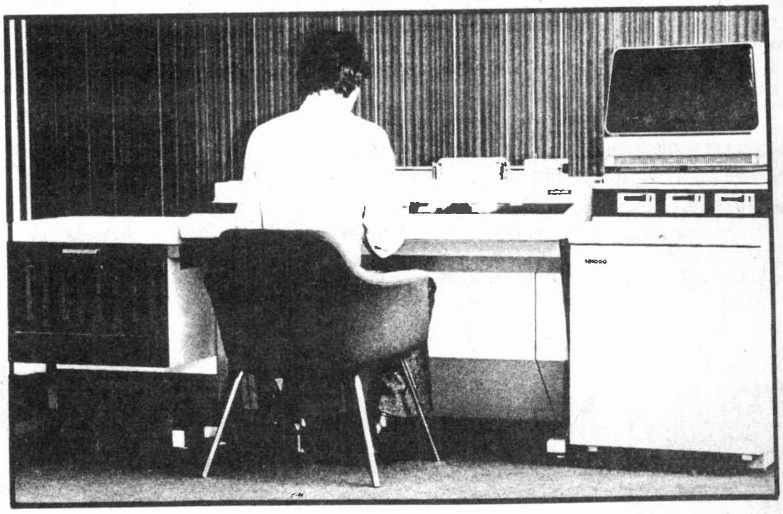
Name ____________________

Address ____________________

(Please print)
I understand that you will refund my money in full if I return the kit undamaged within 10 days of receipt.

ETI/2

COMPUTERS IN SMALL COMPANIES



RON HARRIS EXPLAINS WHY COMPUTERISATION HAS A LOT TO OFFER EVEN THE SMALLEST COMPANY.

DESPITE the panzer-like march of the MPU, there is still a large market for the small computer, and this demand supports a healthy number of companies whose main output consists of such machines. Going back about four years (maybe before MPUs were more than a glint on someone's slide-rule) there were virtually no computers of any respectable capacity to be found in office and small company usage.

It has been in the last three years that smaller firms have begun to put aside the garlic, and take to the dark path of computerisation. A good number of these initiates into the black art are people either 'upgrading', as it were, from micro-systems or genuine first timers.

ADVANTAGES

If you asked someone who has just installed one of these digital tape chewers why they took the fatal step you'd probably be told how much it speeded things up and how easy it was to use. The biggest benefit 'seems' to lie in the order which such a system can bring to all around it.

If a distribution network is involved in the company, stocks may well be reduced — safely — since information as to demand and level is instantly and accurately available.

FINDING THE CORRECT NEEDLE

Once the potential user has recognised the haystack, i.e. the range of office computers now around, the next problem is one of selection. For smaller affairs, less than 25-30 people, and with a price 'ceiling' of around £25,000 (don't faint there in the back row) there are a large, nay vast, number of possibilities. We took a long look at what was available, bearing in mind that any shortlist had to meet certain criteria.

A first-timer is going to want a system that is easy to use (and understand!), can be provided with good back-up, and has the software (programmes) readily available. Other requirements might well be for some types of analyses to be carried out, and/or some statistics provided to aid and abet decision making.

Systems which fit all these criteria might be Adler TA1000; Burroughs L5000, L6000 and L8000; IBM 32; NCR 339; Singer 6800; Philips P350; Nixdorf 820/15 and 820/35; GEC 2050 — to name just a few thousand.

NEEDLE MATCH

In order to show some of the uses and occasions of such a system, we are going to use what is undoubtedly one of the most versatile systems on the market as an example — the Adler TA1000. Launched in 1974, this is quite an 'old boy' in the field now, but remains very high on any short-list you care to draw up. It is relatively cheap — see fig 1 — for what it can do, is flexible in doing it and is selling extremely well!

This particular machine has the advantage over the opposition that it has available a larger number of peripherals than does any of its competitors. These include three cassette drives per system, 20 VDUs per system, magnetic ledger cards, 16 chps (characters-per-second) and 140 chps printers, card reader and tape punch, and floppy disc store,

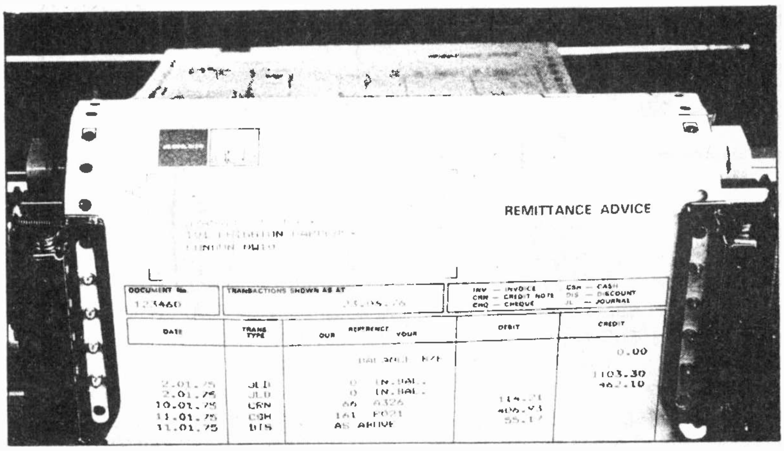
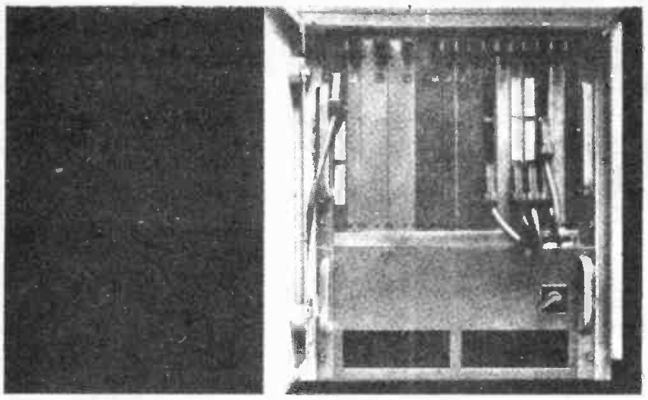
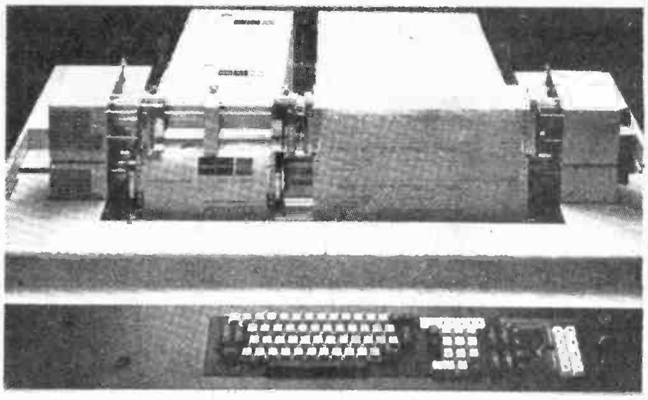


Fig 1. An example of a typical output from a mini-computer line printer In this case the Alder TA 1000 140chs printer

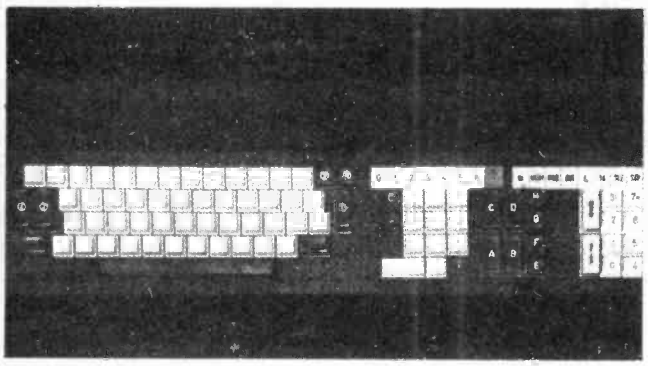
THE ADLER TA 1000 SYSTEM



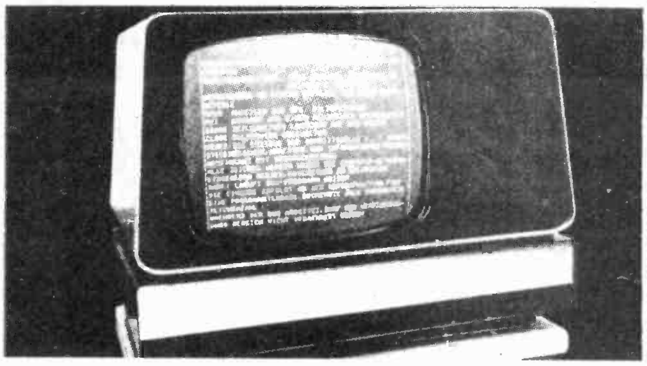
***CPU:—** this is mounted in a standard 10in. rack, and consists of engineers test array an ALU, control memory, user memory, I/O plus power system. The ALU has 16 8-bit (2 byte) index registers, a 16-bit accumulator and uses a 2-byte word length. The CPU is expandable to 64k byte.*



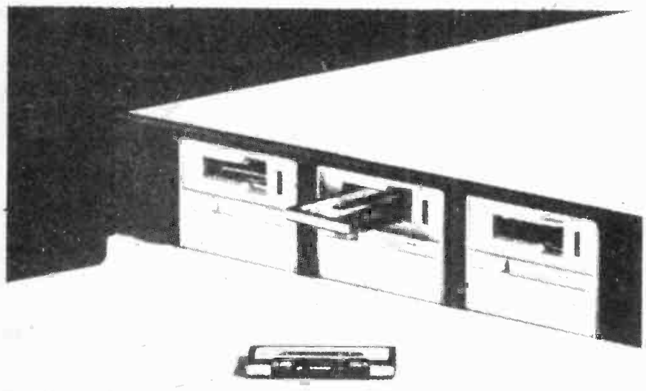
***Fast Printer:—** produced by Triumph-Adler in Germany it possesses a carriage a metre wide, with 276 print positions, and works at 140 chps. It can handle any of a wide range of printing media, from ledger cards to plain ordinary paper. One original and 4 copies are normally provided, although this may be varied.*



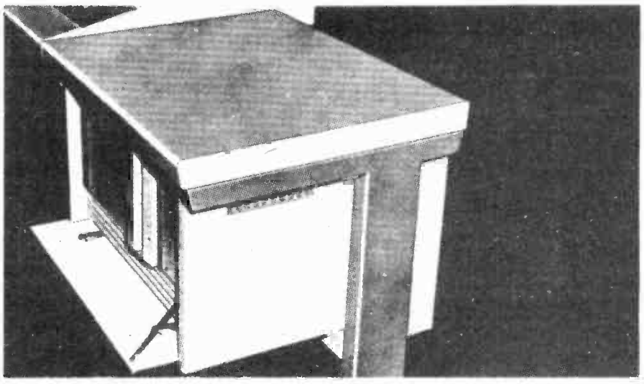
***Keyboard Console:—** consists of a 56-key alpha-numeric system — including a repeat key, and four program definable keys, 14 numeric keys (multiple zero) 16 function keys — 8 interrupt and 8 initialising (both program controlled). The maximum input speed is 100 keystrokes per second, and if you can work at better than this speed you don't need a computer in the first place. We have the usual 64 character set and output is 8-bit parallel (plus parity bit).*



***VDU:—** naturally provided with its own memory system, and up to 20 can be hung onto a single CPU. Cursor control is under program control, and can be placed anywhere on the screen amid the 1056 characters in 22 lines that the machine is capable of displaying in an area of 22.5 x 17 cms. It is of the 'flashing' type, indicating the position being addressed.*



***Cassette Store:—** this enables programs and data files to be accessed easily, under the control of the CPU which can handle three of the beasts. Each tape can carry up to 250K bytes at a density of 31.5 bits/mm. Read/write speed is 70 bytes/sec.*



***Floppy Disc:—** holding 250K bytes on 75 tracks with an average access time of 300 millisecs, this unit considerably extends the capabilities of a TA 1000. The discs themselves are protected by a sealed outer covering during handling so anyone can stack the things in and out.*

maximum four discs per system.

Software: Programming the TA1000 is accomplished in a language called TRIASS — heaven knows what that stands for — which by now, has established itself as a proven medium. All software is produced in a modular basis to meet specific user requirements, although Adler will do a custom design if required, which it rarely seems to be.

They have a system called APEX (Adler Purchase Expense System) which runs on a set-up of TA1000 plus 16K memory, two floppy discs, printer with two feeds and a VDU. This will output such things as batch listings, transaction analysis, creditor balances, turnover reports, file interrogation printouts, etc, and as such meets all our earlier criteria. Maximum volumes of work would seem to be about 1,350 suppliers!

MAKING AN EXAMPLE

This then is a good all-round small business system. By itself it would just sit there, hum a little perhaps or give the occasional interrogative click. Until someone uses it any system is merely so much metal potential.

So let's consider two case histories where this collection of boxes has been made to earn its watts.

CASE NO. 1 — WILLOWVALE ELECTRONICS

Fig 2. The Willowdale machine in situ. From right to left — floppy discs, keyboard and fast printer and VDU.

A nice little success story lies behind this firm — from a £4,000 overdraft (and a van which only went uphill backwards!) to a £1m turnover business is no tale of disaster by anyone's standards. The owner and founder is a man named Peter Bartlett, and it was he who decided to automate his expanding company.

Willowdale supplies components to TV service engineers, and now has three outlets. It has grown up in 11 years, and used to use a simple accounts-only computer system. With the installation of a TA1000 system consisting of CPU, VDU, 140 chps printer with keyboard and four 'floppies' (cost circa £20,000) the whole operation became automated.

Only eight people handle the entire stores and order section of the business — and this for 3,000 customers per month and 5,000 products.

When an order is received a check is made to see if that customer has an account — and if so does he have the money to pay for what he's ordered. This is accomplished via a file interrogation with the result being displayed on the VDU.

If all is well the machine will produce an invoice for that order in such a way that any quantity, or other discounts, are accounted for, and the items are identified with a specific coding to enable the warehousing men to find them easily.

ANY MORE REQUESTS?

When asked to, the system produces stock price list, summary report and stock position together with product analysis. This information provides the means to keep stock levels healthy without being wasteful in terms of cash. Each customer has a file held on them inside the machine, and each transaction is added to this. Statements in each are churned out at specified intervals, so that any black sheep can quickly be detected.

Other reports are made on sales ledgers, individual customer turnover, transaction summary and cash v. area breakdown so that it can be seen how each of the nine reps is faring in his area — even down to how much each product he's selling costs, how well it's doing and the cost to the company to date.

CASE NO. 2 — D. ROSE, WINE RETAILERS

I suppose some of our more cynical readers will find some reasoning behind our choice of component supplier and wine sellers as examples — other than that of being informative cases of computerising a small company. Would it help to deny it?

Be that as it may, our second firm uses a mainly stock control orientated system, comprising CPU printer, VDU and two floppies this time. They have five outlets in London, and the problem for the machine to overcome was one of cash/stock control.

MANAGING THE MANAGERS

Each of the branch managers completes a return form for the day, recording takings, petty cash used, and amount banked. Evidence required to back this are the bank counterfoil and till roll. A list of all deliveries is also produced, coding each brand and product separately.

The cash return and the delivery record is put into the TA1000, and a constant check is kept via the VDU that the correct products are being recorded. The system now produces a batch control file, which is for order and audit purposes, and a record of each branch's activity over an eight-week period.

MASTER AND FILE

The master files are held in product sequences, and the returns in branch sequence, because each is to produce varying reports. Access is no problem with floppies — average time remember to get a file is about half a second. From the master are produced two cash sales analyses, and a cash summary.

For each branch a 'financial performance' is compiled consisting of opening stocks, closing stocks, petty cash usage, cost and selling prices and banked accounts.

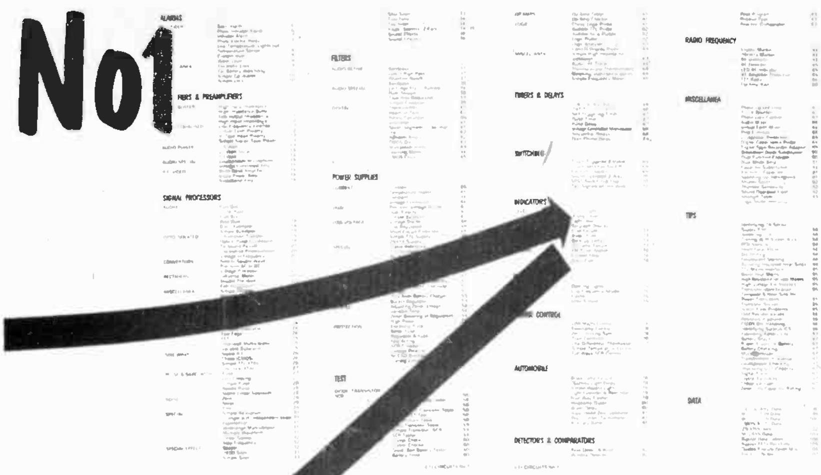
D. Rose's main advantage from their system, according to them, is the speed and accuracy of the computer system's control and reporting. A week's entries for any given branch is entered in under an hour, and a report compiled in less than 20 minutes.

AND SO? . .

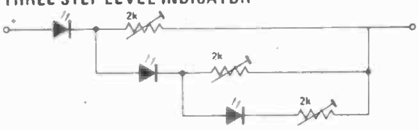
From these two different usages of the same machine comes the same impression — that of order imposed. Willowvale keep track of 5000 products, while D. Rose keeps tight control of five branches.

All this talk of 'reports' and 'checks' and performance listings, etc, might give a hint of Orwellian overtones. But this is just not fair. Office computers don't do anything that wouldn't be done whether they were there or not — they just do it a hell of a lot faster and better.

Our conclusion from compiling this article was that a small business has a lot to gain from a computer system, and very little to lose — except perhaps cash flow problems, overstaffing levels and cumbersome accounting procedures — and no company is too small to wish to be rid of those particular gremlins!



THREE STEP LEVEL INDICATOR



This device makes a very compact and robust level indicator where a meter would be impractical due to lack of space, or not justified due to cost.

Resistor values will depend on type of LED used. In the prototype, the LED's were MV50's and the resistors were 2kΩ ½watt. This gave steps of approx 2V and the current drain with all three LED's on was 5mA. The chain can be extended but current drain increases rapidly and the first LED carries all the current drawn from the supply.

ETI CIRCUITS No. 1 — £1.50 + 20p P&P

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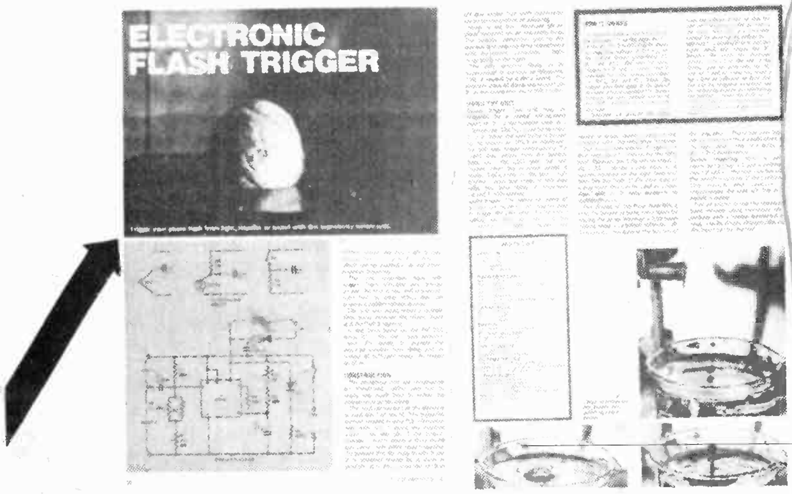
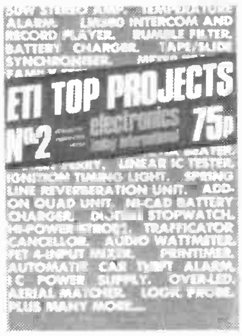


HOW TO ORDER

You can order any of these Special issues from your newsagent or direct from ETI. Postage and packing is 20p for the first, 15p for each subsequent issue (overseas 25p and 20p respectively). Send remittance and order to ETI SPECIALS, 25-27 OXFORD STREET, LONDON W1 1RF.

All payments must be in sterling.

OTHER SPECIALS FROM ETI



TOP PROJECTS No. 2

26 popular projects reprinted from ETI, first published in July 1975. Circuits include 50W stereo amp, Spring Line Reverb Unit, Add-on SQ Decoder, FET 4-Channel Mixer, Rumble Filter, Super-stereo, Audio Wattmeter, Linear IC Tester, Logic Probe, IC Power Supply, Ignition Timing Light, Car Theft Alarm, Battery Charger, High Power Strobe, LM380 Circuits, Temperature Alarm, Tape Slide Synchroniser, Ni-Cad Battery Charger, Digital Stopwatch plus more and several pages of Tech-Tips.

75p + 20p P&P

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Originally published in March 1976, Top Projects No. 3 contains 27 constructional projects including Graphic Equaliser, International 25W Stereo Amp, Simple Stereo, New Sound for your Guitar, Bass Booster, Line Amplifier, Loudness Control, Electronic Ignition, Tacho Timing Light, Car Alarm, Dual-Beam Adaptor, AF Meter, Impedance Meter, Digital Display, Digital Voltmeter, TTL Supertester, Fluorescent Light Dimmer, Radar Intruder Alarm, Light Dimmer, FM Tuner, Colour Organ, Drill Speed Controller plus many more.

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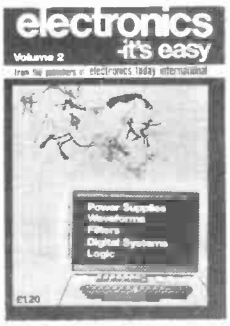

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The "middle-third" of the series introduces the reader to more sophisticated techniques and includes power supplies, waveforms, filters and logic systems.

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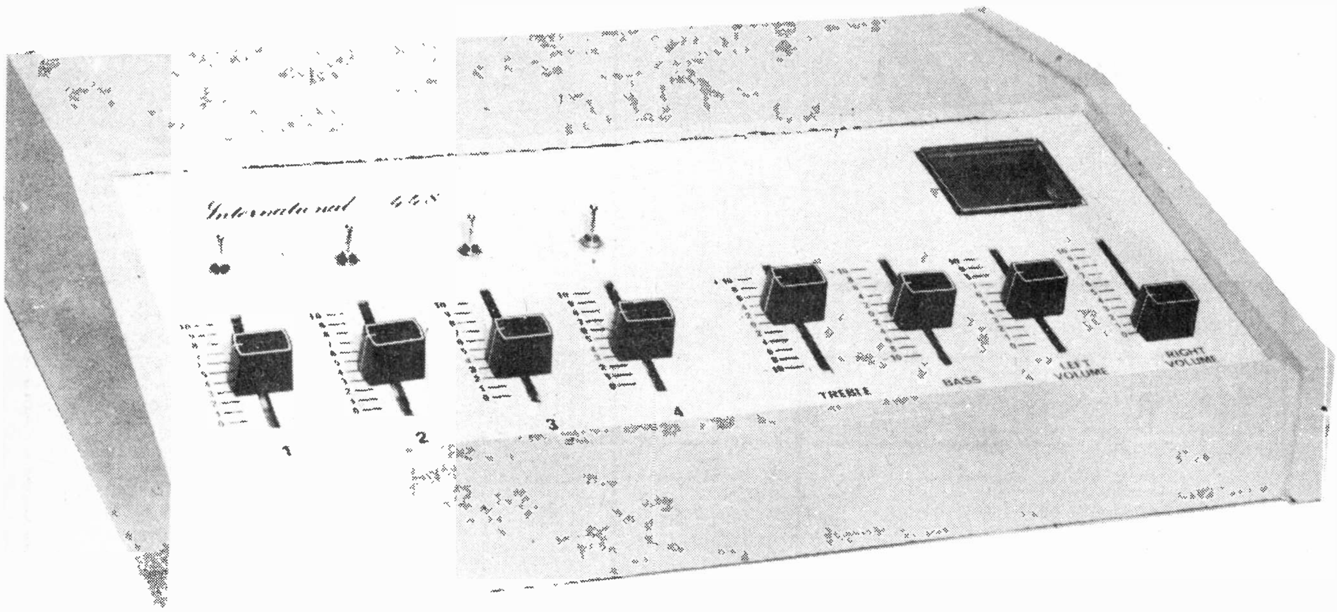
ETI 4600 SYNTHESISER

A complete reprint of our superb synthesiser design, published with Maplin Electronics (who also supply the parts). This reprint will also be of interest to those not specifically wanting to build the unit as the circuitry is highly original and is in fact patented by ETI!

£1.50 + 20p P&P

ETI Project 448/9

DISCO MIXER



This is a general-purpose mixer project that can be tailored by the constructor to meet specific needs. Some of the boards used have been published in previous issues of ETI; in this article we introduce four new ones:

Disco mixer board (448) (with stereo mixing and power supply) mono headphone amplifier (448A) for prefade monitor, balanced microphone preamplifier (449) and stereo VU circuit (449A). Also a simple ceramic cartridge preamp is shown — so simple it can be built on the input sockets!

SPECIFICATION ETI 448

No. of inputs	Nominally 4
No. of outputs	2 main signal outputs 1 headphone amplifier output
Tone controls	Overall bass and treble
Output noise (Mixer stage only)	1 mV (mainly hum)
Maximum output voltage	6 V

Using the boards listed above virtually any audio sources can be mixed by the operator, to provide a stereo signal suitable for driving power amplifiers directly (such as the ETI 413 100 W amps). The mixed signals can also of course be used to feed tape recorders etc. The inputs from turntables, tape recorders, microphones etc must be correctly matched to the inputs of the mixer board. To do this the correct preamplifiers must be selected and constructed.

Our prototype was constructed for use with twin stereo magnetic cartridges, balanced low impedence microphone and stereo cassette recorder. However, the permutations are virtually limitless!

Before beginning construction, decide which preamplifiers you will need (tape recorders do not need any and connect direct to the mixer). Decide what type of sockets you want to use and how many channels you want (although shown as four input the mixer can be expanded by adding extra control pots and mixer resistors).

BALANCED MICROPHONE PREAMPLIFIER

The beauty of this circuit is that it eliminates a costly line transformer! Although designed for 600 ohm input and 40dB gain other impedances and gains can be handled R1 = R4 = input impedance divided by two

R5 = R11 = voltage gain times the value of R3.

The first equation works for impedances up to about 5k. Above this value R2 + R3 must be included in the calculation.

As most people have only one mouth, the output from this circuit can be used to pan the output from stereo by using two 10k resistors or a 20k linear pot with the wiper connected to the output can be used to pan the output from left to right.

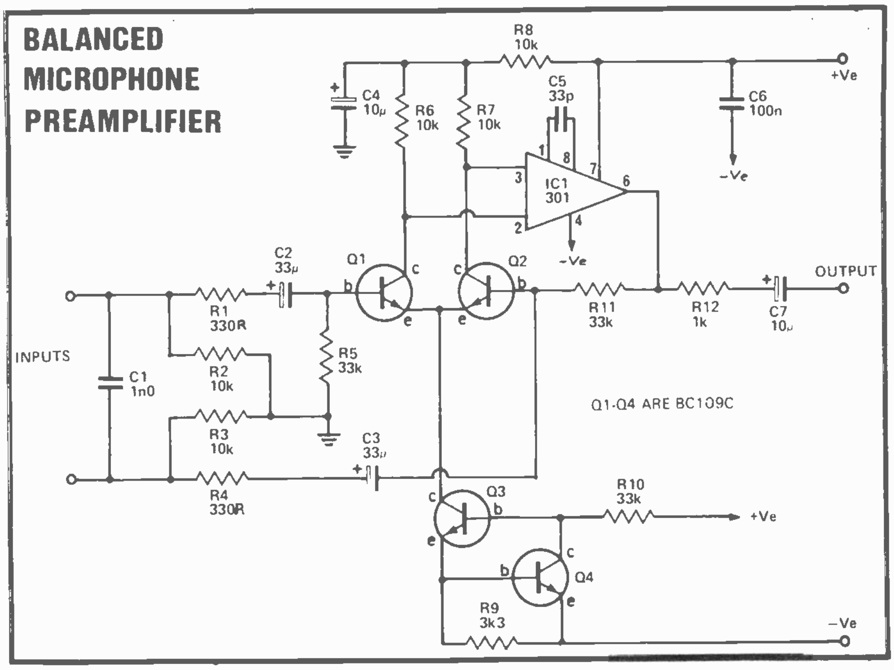
If a high impedance microphone is used ETI 446 (December 76) should be used.

If 446 is used R2 values are as follows: 47K microphone R2 = 4k7 (limiting R2 47k) if used with balanced preamp as input for limiting R2 = 15k.

MIXER AND POWER SUPPLY

Because of the high ripple rejection of the integrated circuits, used in the various modules, the power supply requirements are simple. A straightforward bridge rectifier, large smoothing capacitors with a RF bypass capacitor and we have an adequate power source.

BALANCED MICROPHONE PREAMPLIFIER

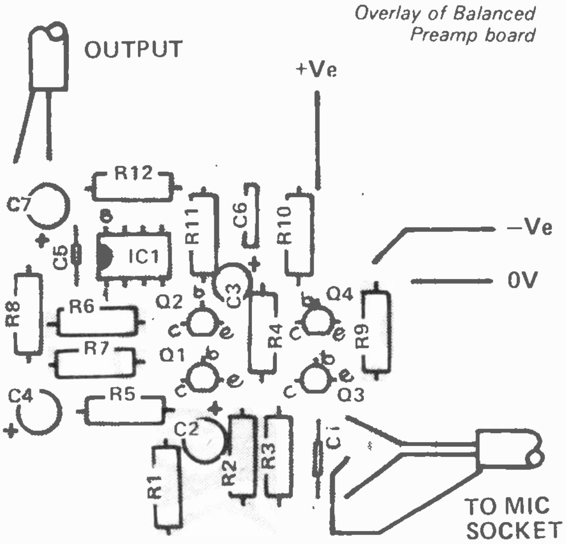


Frequency Response	10 Hz – 20 kHz (<5 V output) +0 −3 dB
Gain	40 dB
Equivalent Input Noise	–123 dB (0.5 µV)
Distortion	0.05% 300 mV – 5 V output 100 Hz – 10 kHz
Max Input Voltage	100 mV
Common Mode Rejection Ratio	60 dB
Maximum Common Mode Signal	3 V

Connection of Cannon plug for microphones

Pin 1	EARTH
Pin 2	BLACK INPUT connect to R1
Pin 3	RED INPUT connect to R4

FOR UNBALANCED INPUT CONNECT PIN 1 AND 2 TOGETHER ON MICROPHONE PLUG.

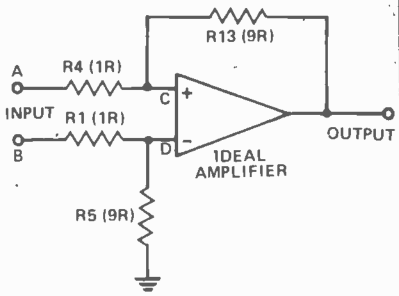


Overlay of Balanced Preamp board

PARTS LIST ETI 449

Resistors all 1 W 5%		Capacitors	
R1	330R	C1	1n0 polyester
R2,3	10k	C2,3	33µ 10v
R4	330R	C4	10µ 16v
R5	33k	C5	33p ceramic
		C6	100n polyester
R6,7,8	10k	C7	10µ 16v
R9	3k3		
R10,11	33k	Q1-Q4	Transistors BC 109C
R12	1k	IC1	LM301A
		PC Board	ETI 449

HOW IT WORKS ETI 449



A "balanced" amplifier or differential amplifier has two separate inputs and only the difference between these inputs is amplified. To explain how this works refer to figure, which is a simplified version of the circuit. To make the maths easier we will reduce the gain to nine by making R1 = R4 = 1 and R5 = R11 = 9. The actual units are not important, only the ratio.

We will start the explanation by looking at the case where point B is at 0V and point A is at +100mV. An ideal amplifier does two things — it does not take any current into the input terminals and it adjusts the output to maintain no voltage difference between the input terminals. We therefore must have 100mV across R4 and consequently a voltage of 900mV across R11 (it has 9 times the resistance and the same current as R4). This gives a gain of nine. The output is therefore —900mV.

In the case when point A is at 0V and point B is at +100mV, point D will be at

$$\left(V_B \times \frac{R5}{R1 + R9}\right) = 90\text{mV}$$

Therefore point C will also be at +90mV. The voltage across R4 will be 90mV and voltage across R1 will be 810mV (9 x 90mV).

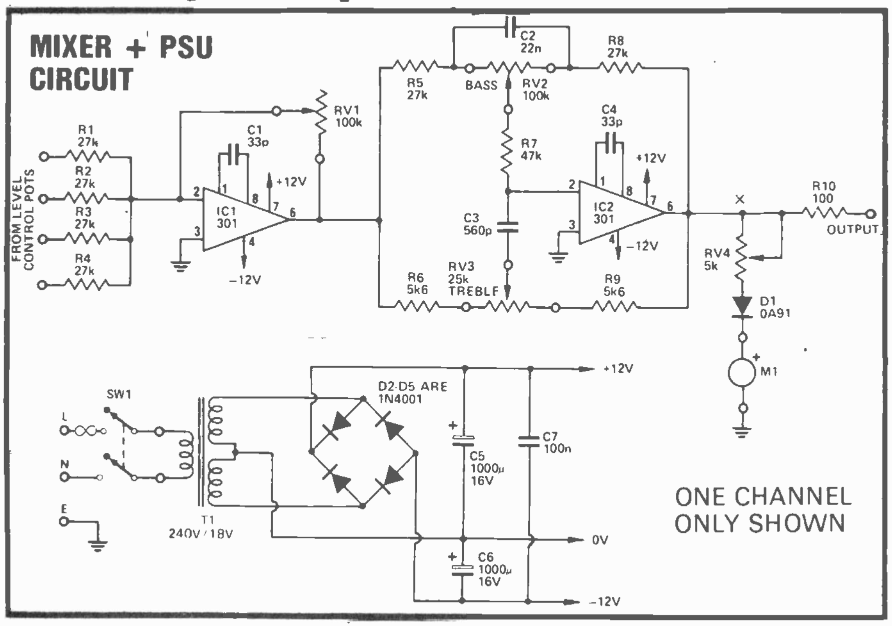
This means the output voltage must be +900mV. This is also a gain of nine. Notice, however, that the polarity (or phase) is different.

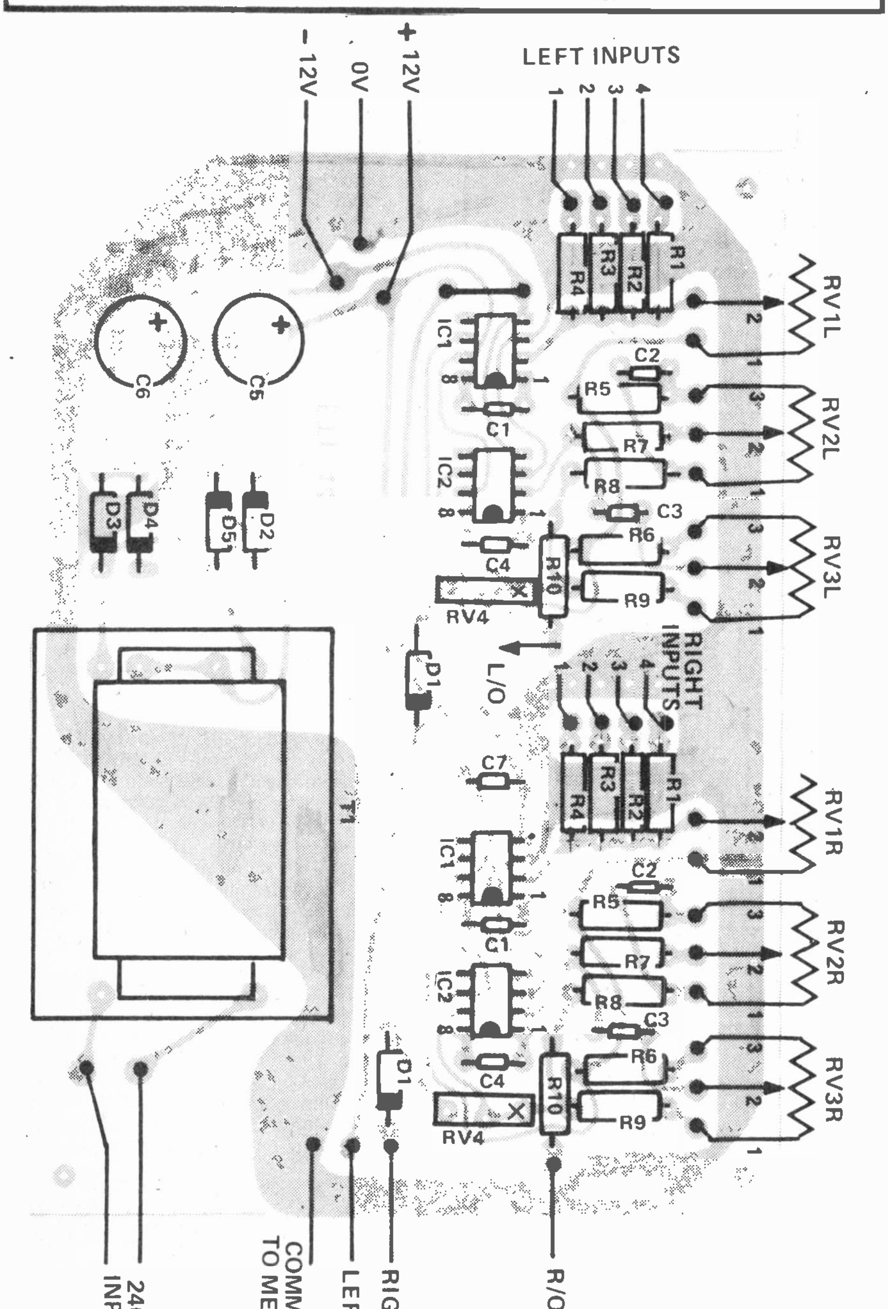
Now suppose both inputs are at, say, +1V, point D will be at +900mV and so will point C. The voltage across R4 is 100mV and R11 900mV. This gives an output voltage of 0V. The common signal is not amplified in any way. If, however, one input (B) is at 1V and the other (A) is at 1.01V the difference is amplified and the output will be —1V.

Getting back to the actual circuit, we have used an LM301A with two low-noise transistors in the front stage. These transistors are supplied with a constant current by Q3 and Q4. A constant current is needed as this allows the inputs to move up and down without changing the voltage across R6 or R7.

The resistors R2 and R3 refer the inputs to 0V but are high enough not to affect the operation in any way.

DISCO MIXER





Overlay of Mixer and Power Supply board

HOW IT WORKS ETI 448

The inputs from the turntables, tape recorders microphones, etc, must be amplified, and if necessary equalized, by a preamplifier before any of the controls can handle them. The output of each of these preamps adjustable, by means of a volume control or fader, before being mixed in IC1. The overall gain of the mixer stage is adjusted by means of RV1. If different preamps have widely differing output voltages the value of R1-R4 can be changed to make them match.

The output of IC1 goes then to the tone control stage, IC2, which normally has a unity gain when the controls are centered. However, this gain is adjustable, with respect to frequency, if the tone controls are not centered. The output of the tone control stage directly drives the main power amplifiers. This output is also rectified by D1 to drive the meter circuitry.

The mixer gives stereo outputs — this is achieved by duplicating the circuitry for the second channel. The exception is the tone controls which are dual gang potentiometers. Note that the volume controls are individual units.

The power supply is simply a full wave rectified supply with a centre tap giving about ±12VDC.

PARTS LIST ETI 448

Resistors all ½w 5%

R1-R5	27k
R6	5k6
R7	47k
R8	27k
R9	5k6
R10	100R

Potentiometers

RV1	100k log single gang slide 45mm
RV4	5k trim

Capacitors

C1	33p ceramic
C2	22n polyester
C3	560p ceramic
C4	33p ceramic

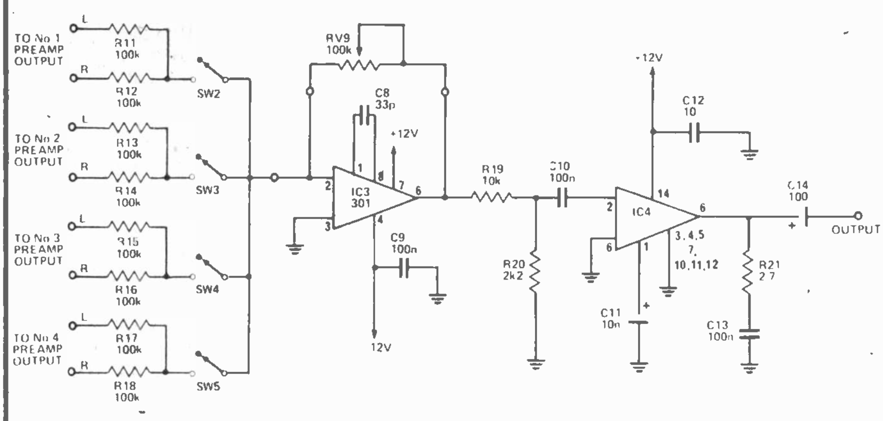
IC1, 2	LM301A
D1	OA91
M1	VU Meter

Two of all the above components are required for stereo operation.

RV2	100k lin dual slide
RV3	25k lin dual slide
RV5-RV8	10k log dual slide
C5, 6	100µ 16V
C7	100n polyester
D2 – D5	IN4001 or similar
Transformer	240V 9-0-9
pc board	ETI 448
Fuseholder	250mA fuse to match
Switch	2 pole 2 position 240 V toggle

*See text

HEADPHONE AMPLIFIER



HOW IT WORKS ETI 448A

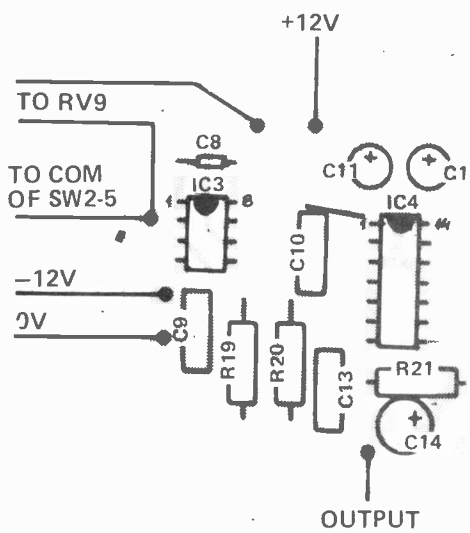
The resistors bridging Left and Right channel outputs are to provide a composite mono signal, without seriously degrading the main mixer stereo separation. The signal is selected by SW2-SW5 and fed to a buffer with variable gain (IC3). The output is then fed to a LM380 power amplifier which drives the monitor headphones.

As with the mixer the input resistors can be increased, to reduce high signals to the level of the other channels.

PARTS LIST – ETI 448A

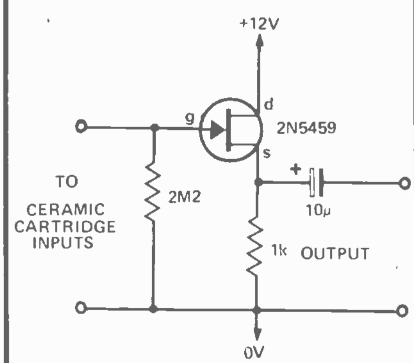
Resistors all ½w 5%

R11-R18	100k
R19	10k
R20	2k2
R21	2.7R
Potentiometer	
RV9	100k log rotary
Capacitors	
C8	33p ceramic
C9, 10	100n polyester
C11, 12	10μ 16 V
C13	100n polyester
C14	100μ 16 V
IC3	LM301A
IC4	LM380
SW2-SW5	single pole toggle
pc board	ETI 448A



Overlay of Headphone board

CERAMIC CARTRIDGE PREAMP



The mixer is a conventional summing amplifier with variable feedback (ie: gain), followed by a Baxandall tone control network.

If input levels are not of the same magnitude, the 27k input resistors can be changed to lower the highest signals increase resister value. Don't reduce below 27k as this will reduce overall sensitivity of the mixer.

The VU circuit can be used, but we recommend the alternative VU board (see VU text).

UNIVERSAL PREAMPLIFIER

Response and gain can be selected from the chart by the components list further details were published in November 76.

HEADPHONE AMPLIFIER

The output from each preamplifier can be switched into this circuit, so that you can cue signals before mixing them into the output. It is suggested that if headphones only are to be used a 100ohm 1 watt resistor be fitted in series with the output. This is to protect your ears and reduce the power dissipation of the LM 380 — otherwise a small heatsink would be required. The volume control can be mounted on the rear of the mixer as it is not adjusted very often.

VU CIRCUIT

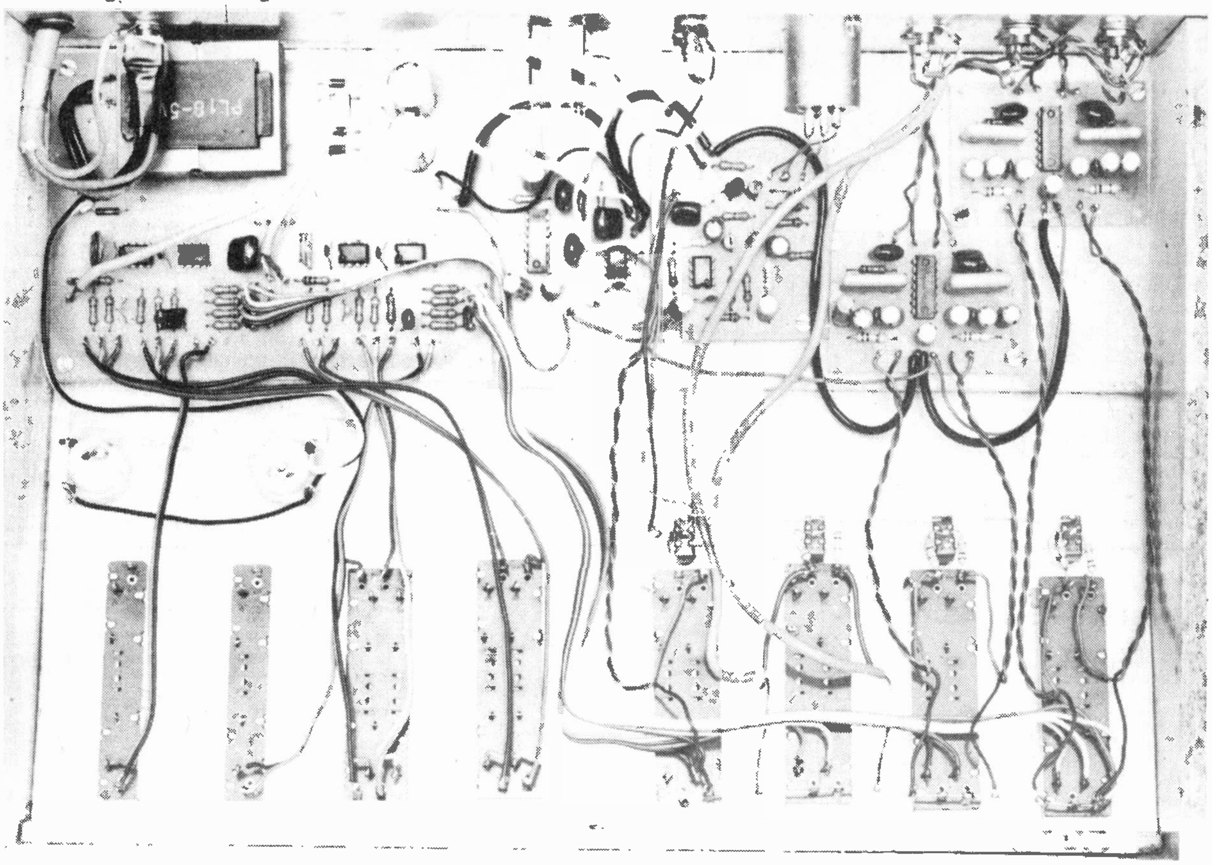
The meter circuit used in the mixer board is very basic — although suitable for some applications — distortion introduced into the output signal is as much as 2% THD.

We strongly recommend the VU board. If used omit RV4 and D1 from the mixer board and connect point X to the input of the VU board. Calibration is by the preset on the VU board, feed a signal through the mixer until the output is just distorting the amplifier, and adjust the preset to indicate +3VU.

CONSTRUCTION

Assemble the boards with the aid of the overlay drawings, for your convenience we have put all the PCB layouts together, on page 22. The photograph on page 21 shows the general layout we used, but this is very flexible, ours was built into a wooden box with metal front and base but a metal box would be more suitable in an electrically noisy environment.

Interboard connections can be worked out from the individual circuits and overlays. All connections should be as short as possible and kept away from the mains wiring. We in fact moved the power switch to the back panel to reduce hum pickup (a metal box, with an aluminium shield around the mains transformer will ensure minimum hum pickup) If this is done unscreened cable can be used internally.



GENERAL PURPOSE PREAMPLIFIER

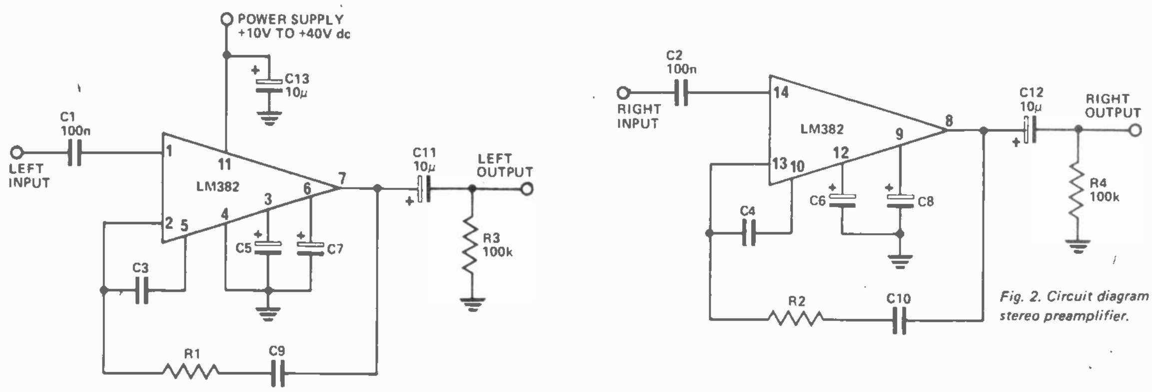


Fig. 2. Circuit diagram of the stereo preamplifier.

PARTS LIST — ETI 445

Resistors

R1, 2	see table		
R3, 4	100k	½watt	5%

Capacitors

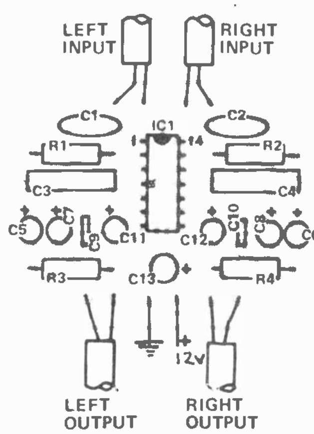
C1, 2	100nF polyester
C3 – C10	see table
C11-C13	10µF 25V
IC1	integrated circuit LM382
PC board	ETI 445

HOW IT WORKS ETI 445

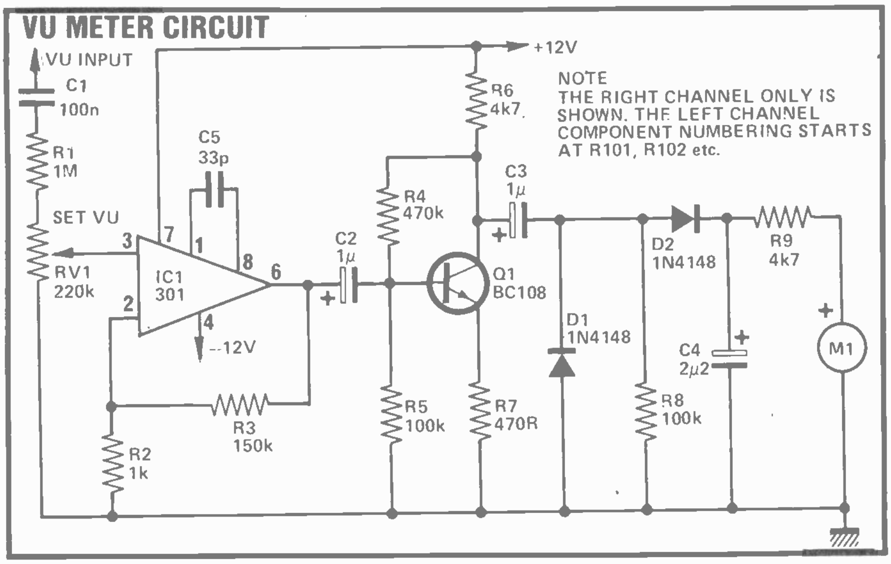
Not much can be said about how the LM382 works as most of the circuitry is contained within the IC. Most of the frequency-determining components are on the chip - only the capacitors are mounted externally.

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

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

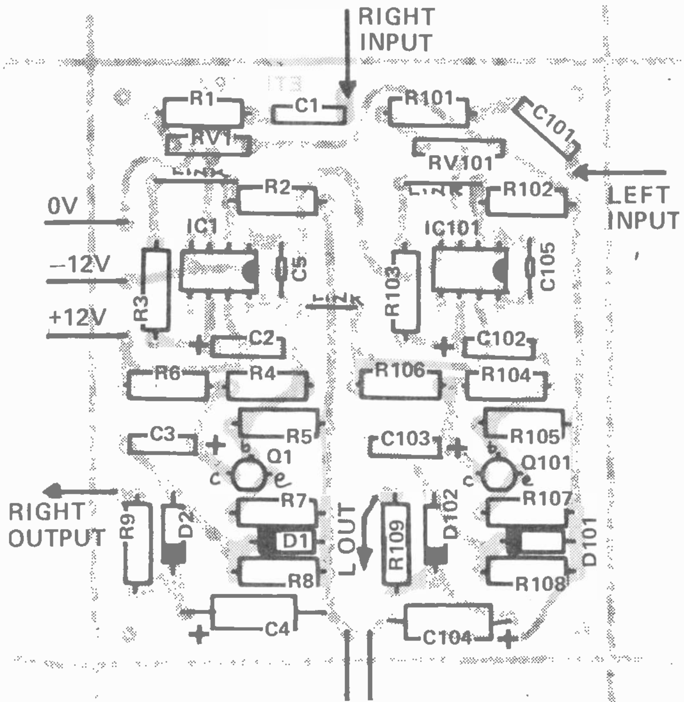


Overlay of General Preamp board



HOW IT WORKS ETI 449A

This VU circuit has an input impedance in the region of 1M and therefore will not load the mixer output by any discernable amount. The IC has a gain of 43dB, the signal is then amplified again by Q1 to get enough level to drive the VU meter. Under no signal conditions the voltage at the junction of D1, D2 falls to OV because of R8. When a negative going signal appears at collector of Q1, C3 will discharge on the negative peak. Difference between negative and positive peaks is transferred through D2 to C4, and hence to the VU meter.



Overlay of VU meter board

PARTS LIST — ETI 449A

Resistors all ¼w 10%

R1	1M
R2	1k
R3	150k
R4	470k
R5,8	100k
R6,9	5k7
R7	470R

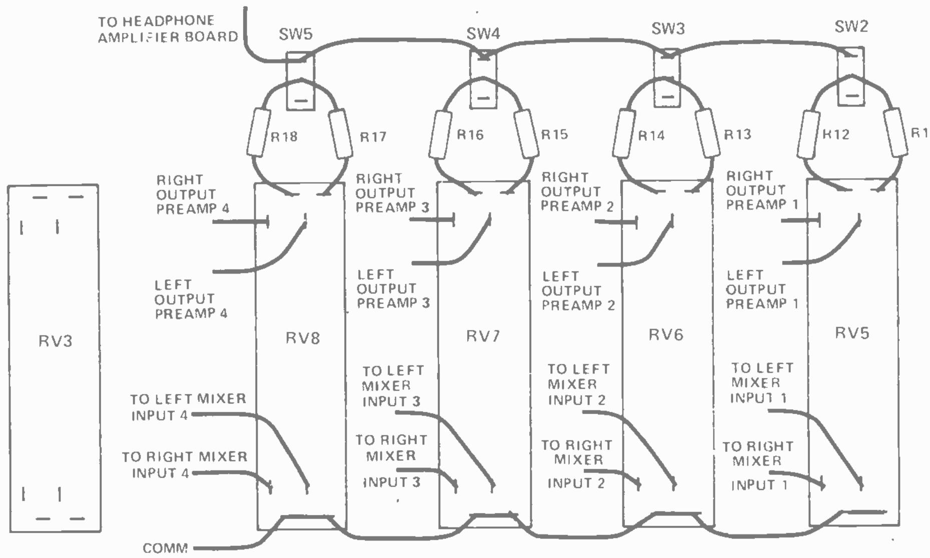
Potentiometers

RV1	220k preset

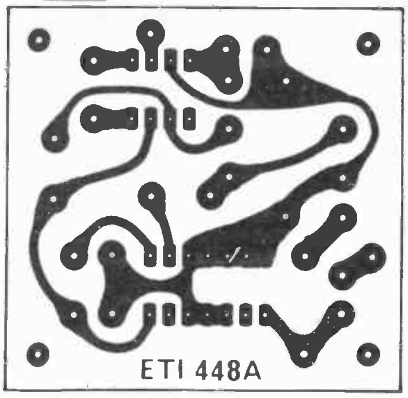
Capacitors

C1	100n polyester
C2,3	1µ 16V
C4	2µ2 16V
C5	33p ceramic
1C1	LM301
Q1	BC108
D1,2	IN4148
M1	VU meter

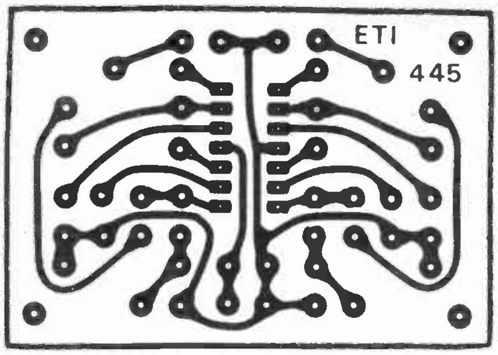
Two of each required for stereo
PC Board ETI 449A



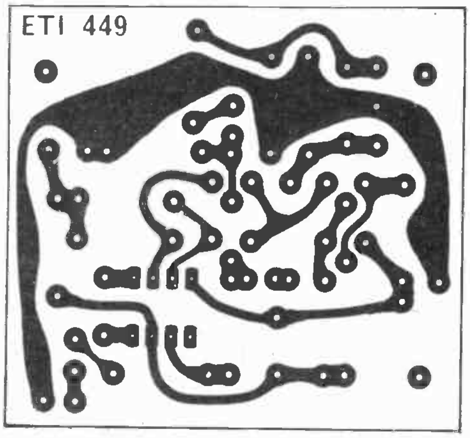
Interconnection diagram of individual volume controls and headphone amplifier selector switches.



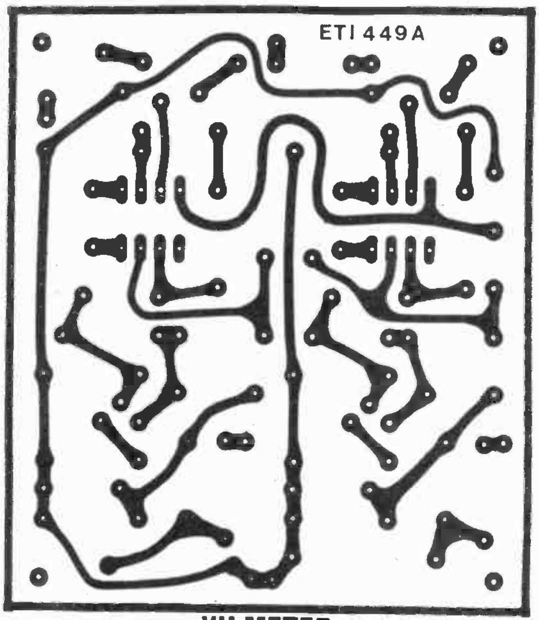
HEADPHONE AMPLIFIER



GENERAL PREAMPLIFIER

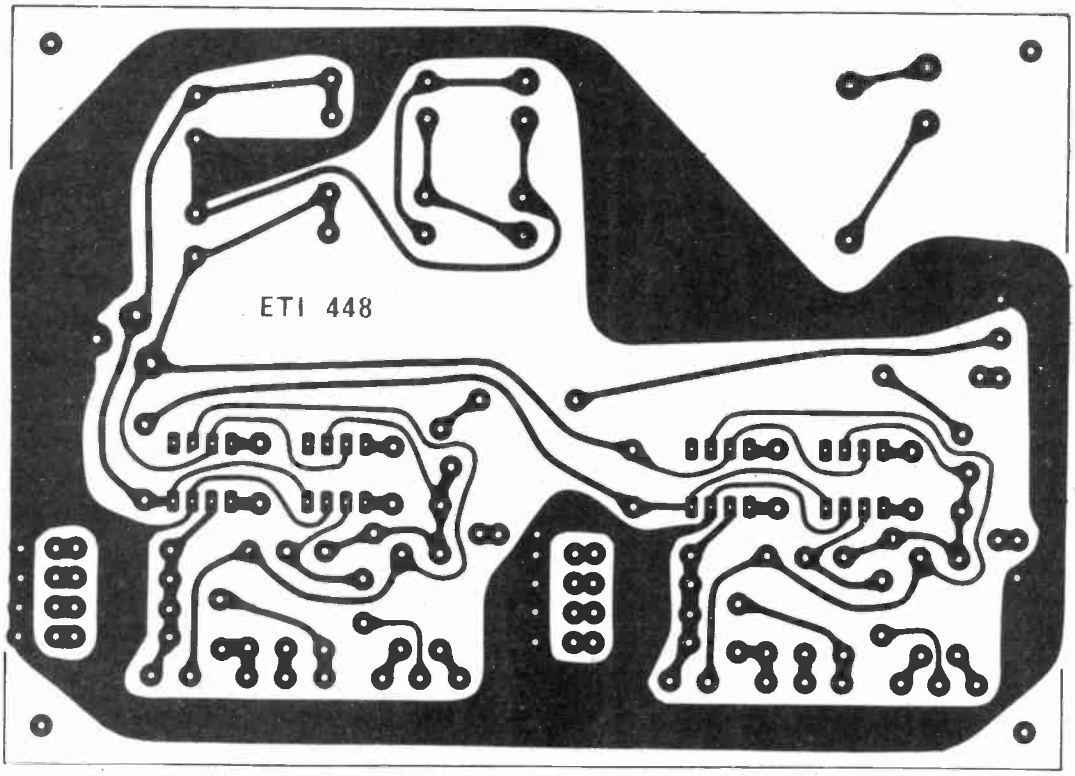


BALANCED PREAMPLIFIER

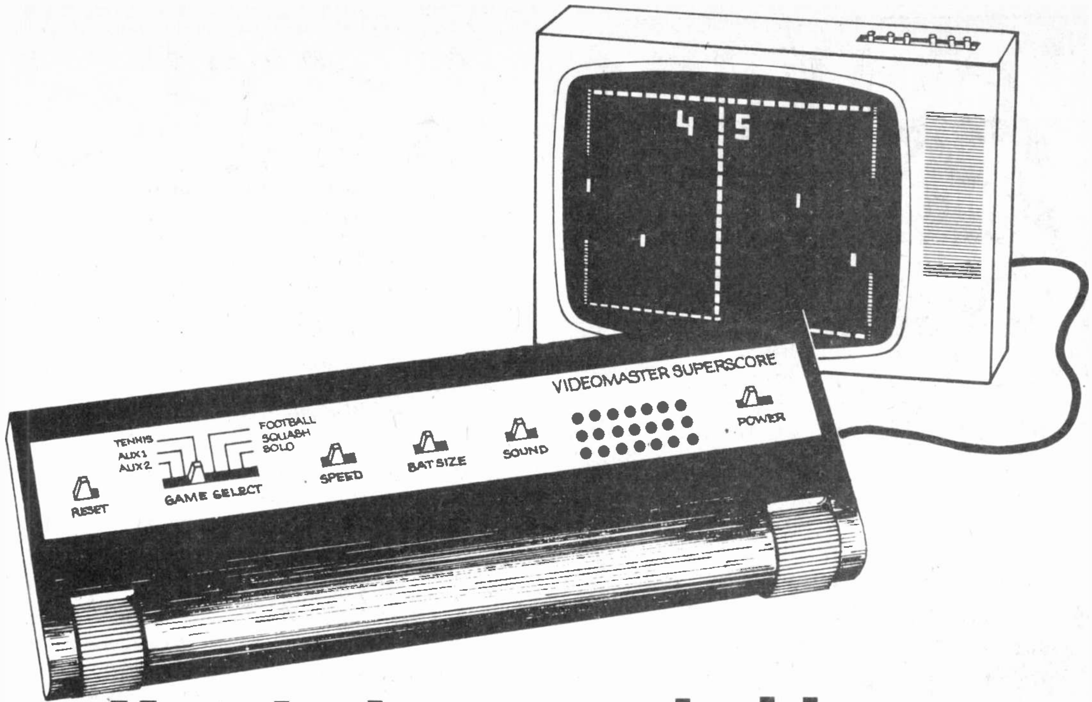


VU METER

COMPONENT OVERLAYS FOR THE DISCO MIXER



MIXER AND POWER SUPPLY


4 5
VIDEOMASTER SUPERSCORE
POWER
SOUND
BAT SIZE
SPEED
FOOTBALL
SQUASH
SOLO
TENNIS
AUX1
AUX2
GAME SELECT
RESET

Sparkrite mk2

Capacitive discharge
electronic ignition kits

* Smoother running
* Instant all-weather starting
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* Up to 20% better fuel consumption

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

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Ready drilled pressed steel case coated in matt black epoxy resin, ready drilled base and heat-sink, top quality 5 year guaranteed transformer and components, cables, coil connectors, printed circuit board, nuts, bolts, silicon grease, full instructions to make the kit negative or positive earth, and 10 page installation instructions.

OPTIONAL EXTRAS
Electronic/conventional ignition switch
Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device, includes: switch connectors, mounting bracket and instructions. Cables excluded. Also available RPM limiting control for dashboard mounting (fitted in case on ready built unit).

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PRICES INCLUDE VAT, POST AND PACKING.

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Quick installation
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	QUANTITY REQD.
Mk. 2 DIY Ass. Kit @ £11.80	
Mk. 2 Ready Built Negative Earth @ £14.97	
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Ignition Changeover switches @ £4.30	
R.P.M. Limit systems in above units @ £2.42	

I enclose cheque/PO's for £ ....

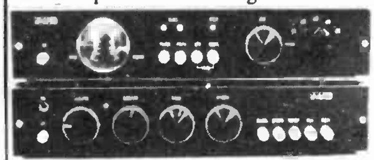
Cheque No.

Send SAE if brochure only required.

AMBIT international (dept 85)

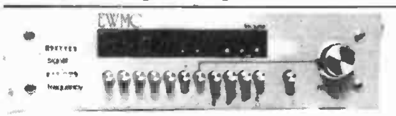
The Dynamic Twosome: Signalmaster/Audiomaster

After long and thorough deliberation, we are proud to announce a new unit from Larsholt - the Audiomaster. As ever, the instructions are designed to lead the unwary- and the inexperienced- through point-to-point steps that culminate in a professionally styled and finished amplifier to complement the Signalmaster FM tuner. Price £79.00



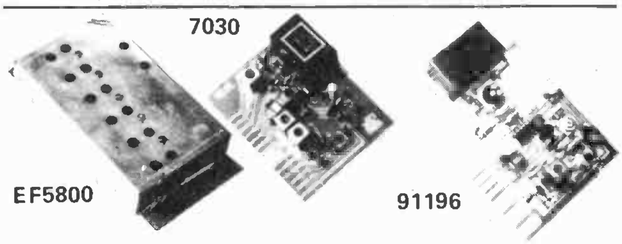
Power: 25+25W RMS
THD: Less than 0.3%
Dynamic range: an exceptional 80dB
(Signalmaster shown on top of the Audiomaster)

The Signalmaster Mk.8 is equally simple to assemble, and results reflect the superb Scandinavian styling and careful electronic engineering. £85.00.



International Mk.2: A choice of tuners for the more experinced constructors.

A chassis, cabinet and front panel designed to be used with a variety of electronics inside. The standard set, with the Larsholt 7253 varicap FM tunerset, plus all necessary parts to complete costs £65.00. Alternative modules for the signal processing stages are available for the more advanced F.M. radio enthusiast/constructor. (EF5800/7030/91196)



7030
EF5800
91196

From left to right, the EF5800 6 circuit varicap FM tunerhead. Two MOS RF stages, both with AGC control, and an ultra stable oscillator. Next the 7030 Linear Phase 10.7MHz IF. Distortion 0.08%, muting, AGC, meter, auto stereo switch outputs. Finally the new 91196 mpx decoder and combined birdy filter. Mono THD 0.05%, stereo sep. 55dB at 1kHz, 42dB at 10kHz - the best decoder module yet.
EF5800.....£14.50 7030.....£10.95 91196.....£12.99 (Built).
Overall performance of the three modules when correctly assembled:- 30dB S/N at 0.85uV input. 60dB at 5uV. THD 0.09%. AFC holds THD below 0.2% over 400kHz if required. AGC effective over a 90dB range. Image rejection -90dB. Noise floor -73dB.

Components: Coils, ICs Filters, etc.

Radio ICs: (and modules)		Coils and filters:-	
CA3089E/HA1137W FM	1.94	AM IFTs TOKO	
CA3090AQ mpx	3.75	YRCS/YHCS types(10mm)	0.30
MC1310/KB4400 mpx	2.20	7MCS types (7mm)	0.30
HA1196 mpx	4.20	FM IFTs:-	
HA1197 AM radio	1.40	KACS/KALS types(10mm)	0.33
TBA120AS FM IF	1.00	94A types (10mm)	0.30
TBA651 AM radio	1.81	AM filters:-	
uA720/CA3123E AM rad	1.40	CFT types ceramic (455)	0.55
LM380N 2W Audio	1.00	CFU type ceramic (470)	0.60
TBA810AS 7W Audio	1.09	SFD470 types (470)	0.75
TCA940 10W Audio	1.80	FM filters:-	
TDA2020 20W Audio	2.99	CFS/SFE ceramic (10.7)	0.50
LM381N stereo preamp	1.81	SFE6MA (TV sound)	0.80
LM3900 Quad amp	0.68	3132 linear phase	2.25
78M12-20-24 volt reg	ea:1.20*	MPX 19&38kHz notch	
NE550A variable reg	0.80*	BLR3107 (4k7 imp)	1.75
TAA550B varicap reg 32v	0.50*	BLR2007 (3k3 imp)	1.75
NE560/2B PLL IC	ea:2.50	23 or 36mH chokes	0.33
NE561B PLL IC	3.50	Tunerheads: (& tunersets)	
NE565A/567V PLL	ea:2.50	EF5600 5 gang varicap	12.80
810k kit for TBA810 amp	2.75	EC3302 3 gang varicap	5.50
2020k kit for 2020 amp	9.35	8319 (Larsholt)	12.00
92310 kit for mpx decoder	5.35	7252 tunerset complete	26.00
7020 kit for 3089 FM IF	6.65	7253 stereo tunerset	26.00
971197 kit for varicap AM radio tuner	9.65	Standard transistors also kept in stock - see lists for further detail and price information.	
7700 built TV sound tuner	27.00		

Terms: Vat extra, 12.5% unless marked *, which is 8%, all complete tuners require £3.00 for packing and carriage. The standard P&P rate remains at 22p per order. Catalogue 40p.
Phone (0277) 216029 (After 3pm please). SAE for free price lists.

Write to: 37a High Street Brentwood, Essex : CM14 4RH

ULTRASONIC RAILTRACK TESTING

A FEW LINES BY RON HARRIS AS TO HOW B.R. KEEPS TRACK OF ITS TRACKS!

Up until 1970 British Rail relied mainly on manual testing of the lines which carry Britain's rail traffic. Hand-held probes were used to 'map' the lines, and show any possible faults.

In 1970 a 'test-car' was tried, using five probes per rail, as shown in fig. 1. In addition to the three shown there, two other probes are 'air-coupled' to the rail from the sides, to detect the fish plate joints holding the rails together.

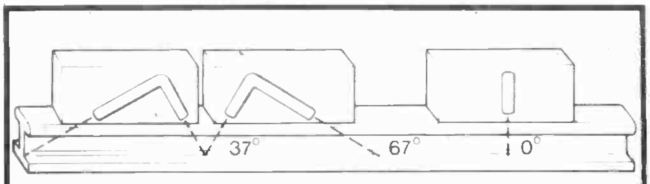


Fig. 1. The layout of the three water-coupled probes on the rail. The air probe is omitted.

The three perspex encapsulated probes are coupled to the rail by water, which is shot onto the track from above. An ultrasonic pulse, a few cycles wide is fired down into the metal by the ceramic transducers, which will then record all returning echoes before the next pulse is transmitted. By judious choice of p.r.f. a continuous 'picture' of the rail beneath the train is possible.

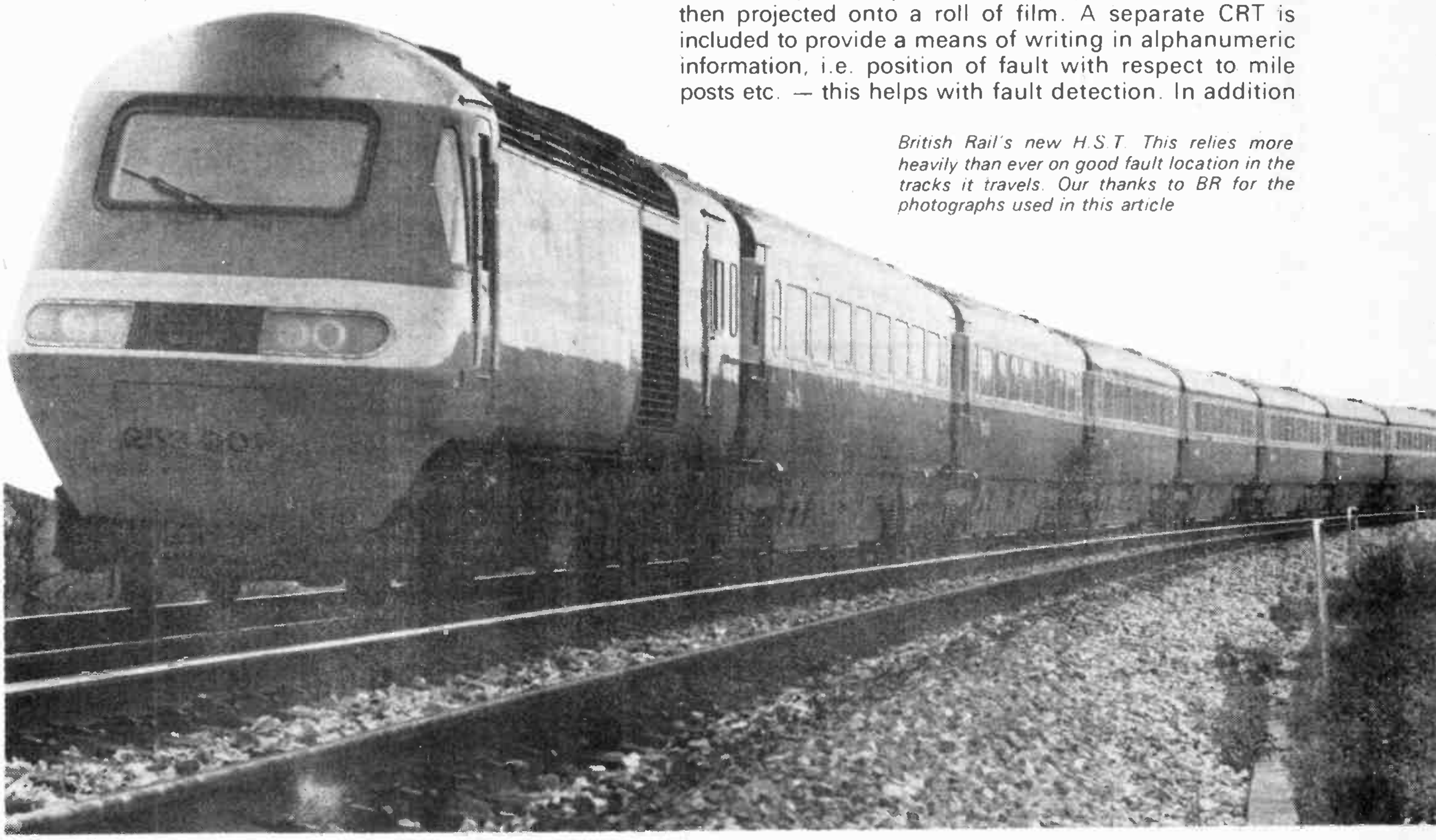
These probes can be clearly seen in fig. 2 fitted to their retractable trolley slung beneath the test vehicle. From 1970 until June 1976, the data from these devices was recorded on film as the vehicle went on its merry way, and was examined later. Since there are some 20,000 miles of track in Britain, and in inspecting 4,000 miles of it this method generated 200 1,000ft reels of film, some sort of speeding of the examination techniques was obviously called for.'

AUTOMATIC FILM CRITICS

An automated system appeals as it would allow the film records to be checked at a speed closer to that at which is it generated, and the cost could be more than that of hiring extra people to check film!

At this point the AERE people down at Harwell became involved to develop an automated inspection and examination system. This was delivered to BR in June — hence the change — and it is this system with which we are mainly concerned here.

The recording equipment (film storage) worked thus: the data from the probes is displayed on CRT and is then projected onto a roll of film. A separate CRT is included to provide a means of writing in alphanumeric information, i.e. position of fault with respect to mile posts etc. — this helps with fault detection. In addition



British Rail's new H.S.T. This relies more heavily than ever on good fault location in the tracks it travels. Our thanks to BR for the photographs used in this article.

ULTRASONIC RAILTRACK TESTING

the exact position of the test-car itself is determined by pulses added to the film every yard, via the 'air' probe channel.

A pattern is thus recorded onto the film, which will have clearly recognisable 'shapes' for a given fault, or given conditions of rail.

The automatic system was designed on the basis

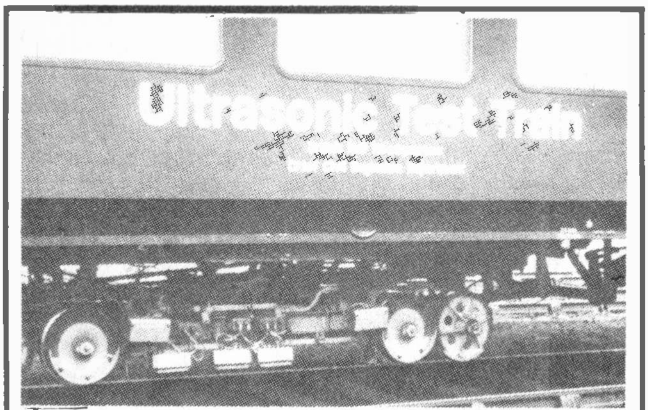


Fig. 2.
The Test-Car itself; the probes can be seen beneath the vehicle on their trolley which is lowered down to the rail when needed.

that it had to be able to evaluate film records without any more effort, on the part of the operator at least — than that required to load the film into the machine.

CRT DOCTOR

Provision has been made to vary the amount of dialogue between man and computer so that any diagnosis by the machine can be modified or cancelled.

In order to translate the information on the film into a meaningful diagnosis, the machine, controlled by a PDP 11, scans the CRT face on which the image is displayed. A reference signal is obtained (it's all done with mirrors!) from the image, and then the film is converted by rectangular mesh scanning into a binary 'image'.

At the same time the reference signal is compared to detect any dirt particles on the CRT face that might produce a false result by being interpreted as a patttern on the film.

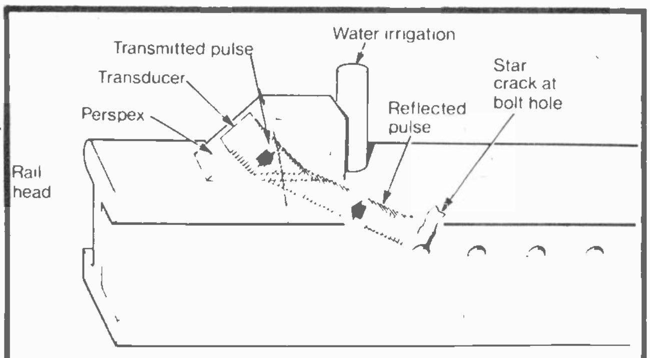


Fig. 3. The method by which the probe is water-coupled to the rails, and the pulse track through the rail.

The scan is stepped along the film, and at each step 1,024 points across the film are sampled for transparency. The points in the film of any boundaries between black and white i.e. positions of pattern, are stored in the memory.

FRAME-UP!

At the end of each frame the data is inspected by the processor, and interpretation takes place within the time interval it takes to advance the film onto the next frame! The routine chosen to analyse any given pattern depends on the outcome of an initial assessment of the data which determines whether one single fault or a complex structure of faults is involved.

ROUTINE PROCEDURE

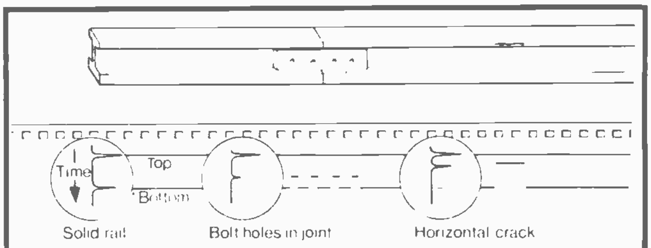


Fig. 4. Typical patterns as seen on oscilloscope readout, and the film record. — From the vertical probe.

Once this is established, the routine needed is selected, and comparison proceeds. Patterns from fishplate joints, which make up the majority of records, are compared to a standard library of shapes on a flexible basis. It would obviously be impossible to match exactly, since each plate will have been put on in a slightly different manner by the man with the hammer.

All diagnosis is attempted on a positive basis. The conditions are going to be anything but laboratory standard, and so just because the echo vanishes from a frame or so of the film, a fault is not automatically assumed. The absence of an echo from the base of the track is, however, used as substantiating evidence if other factors are present.

ALL ABOARD!

The refinement of this system was to place the computer and associated peripherals actually on board the test train.

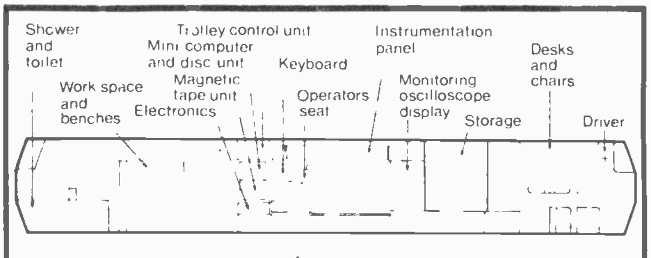


Fig. 5. A floorplan of the complete system when loaded into a rail-car. Perhaps the shower is MPU controlled as well

This fully automated system (figs 5 and 6) is designed to be film-free, with data storage directly into magnetic tape. This results in a saving of 1 mile of film every 100 mile of track. A schematic is shown in fig. 6.

Microprocessors are employed (what else?) to control the filtering and compression of data before passing it to the PDP 11. All the essential information for defect analysis is stored on tape, alongside identification and calibration (i.e. distance) data.

Analysis is carried out by comparing actual patterns (i.e. fig. 7) with stored standards. If a match is not obtained, the system software will ensure that the fault present is identified to a known classification. A report is then printed out to the operator, and in some cases of

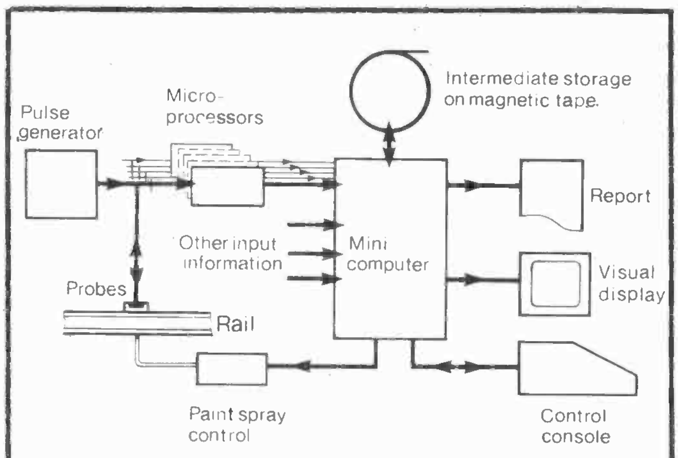


Fig. 6. Block diagram of the Harwell automated system. Note the paint spray for track marking.

obvious defect the recognition is so rapid that before the train passes the fault (moving at 30 mp.h.) the computer will switch on a paint spray and mark the fault location!

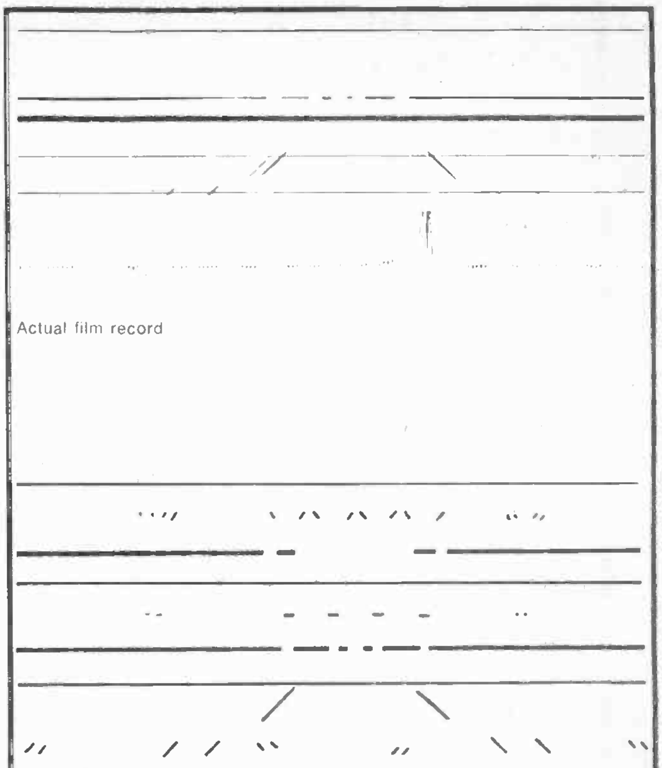
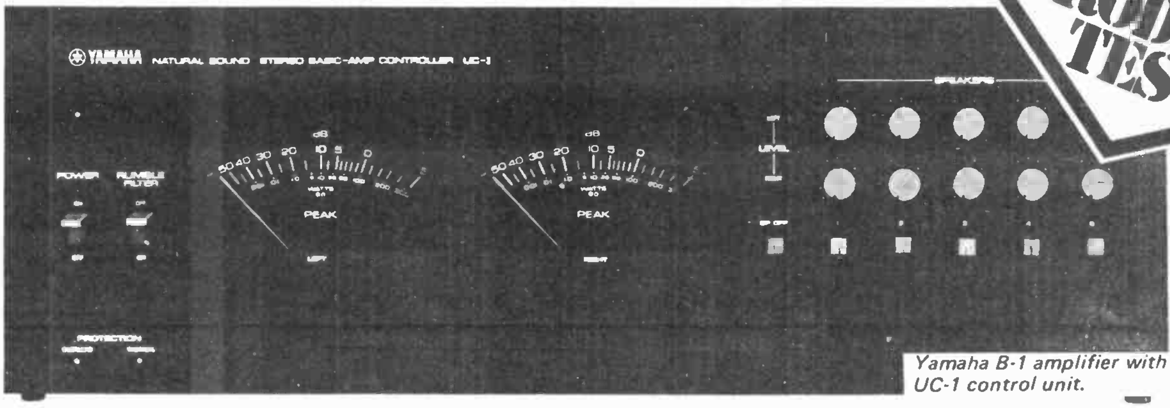


Fig. 7. Idealised against actual film patterns from a single 'fishplate' joint.

YAMAHA B-1

ETI PRODUCT TEST



Yamaha B-1 amplifier with UC-1 control unit.

VERTICAL FET POWER AMPLIFIER

PRODUCES OVER 200W PER CHANNEL — AND IT'S CLEANER SOUNDING THAN VALVES

CONVENTIONAL POWER OUTPUT transistors produce a fairly high level of distortion as a result the non-linearity of their transfer characteristics. In fact transistor manufacturers have been searching for many years for a solid state device which would have characteristics more nearly equivalent to the hitherto ubiquitous valve.

Professor J. Nishizawa's development of the field effect transistor provided the break-through that had long been sought. The characteristics of these FET s, when compared with the conventional bipolar transistor, are firstly the elimination of carrier storage effects, reducing switching or notch distortion when used in Class AB or B power stages, and extremely rapid rise and decay times. High order harmonic distortion is dramatically reduced because of the squareness of the transfer characteristics and the power drive requirements are extremely low.

Unlike bipolar transistors, when the temperature rises the quiescent current decreases and so the big bugbear of bipolar transistors, thermal runaway, is very conveniently avoided. When placed in a power output stage of a power amplifier this provides the opportunity to develop extremely low open loop distortion and, in theory, almost the ultimate in power amplification characteristics.

The B-1 Power Amplifier is a braggart's delight! It's bigger, heavier, more powerful (within limits) and has better performance than any other power amplifier in its class that we have ever tested. It also has many most valuable features that are not commonly encountered.

The B-1 unit is a big ventilated black box on which are mounted a power ON/OFF switch, two speaker level controls and three LED s indicating the operation of the overload protection, the state of the thermal overlaod protection and power ON/OFF.

These controls are set in an anodised aluminium panel which is readily removeable to enable it to be interchanged with a Basic Amp Controller UC-1 which includes two large peak level meters with the unusually wide dynamic range of −50 dB to +5 dB. These are also calibrated in terms of watts into an 8 ohm load; i.e., a range of up to 0.01 W to 300 W. This unit allows the connection of any one or more of up to five pairs of stereo speakers each with its own pair of individual pre-set level controls, the load terminals for which already exist on the rear panel of the main amplifier.

PROTECTION RACKET

Main amplifier features include completely separate power supplies for left and right channels and a third power supply for the relay control functions. These are activated via a relay from the front panel power switch such that when the power is switched on the speaker protection muting circuit operates to disconnect the speaker loads until the amplifier voltage conditions have stabilised.

There are two separate protection circuits whose operation is indicated on the front panel. These are, firstly, thermal protection — designed to cut off the power supply if there is any danger in any circuit elements rising to a temperature exceeding 100°C: simultaneously, the speaker protection circuit will be activated cutting off the sound. This circuit is self re-setting when the internal temperature returns to a safe level. A second protection circuit operates on overloads resulting from three distinct conditions. Firstly, the speakers are disconnected if a dc level exceeding ±2 volts is detected at the out output terminals. Secondly, the muting circuit already mentioned is activated immediately following power turn-on to eliminate loudspeaker thumps and thirdly, the power supply is disconnected whenever an abnormal voltage or current is detected in the output

YAMAHA B1
VERTICAL FET POWER AMPLIFIER

circuitry. This provides amongst other things protection against short circuits on the output or loads of less than 4 ohm impedance. This feature may preclude the amplifier being used with some 4 ohm speakers – the impedance of which falls to well below 4 ohms at some frequencies.

A rumble filter with a 12 dB per octave filter (below 10 Hz) protects the loudspeakers from low frequency transients. The control switch for this filter is at the back of the unit.

MEASURED PERFORMANCE

Our past experience with Yamaha products has been that the manufacturer's specification is generally bettered. The Yamaha B-1 was no exception. It has a frequency response which was +0 –0.4 dB from 10 Hz to 122 kHz, a straight line on a level recorder. The manufacturer's power ratings were easily exceeded, both with 8 ohm and 4 ohm loads, being 210 watts into an 8 ohm and 220 watts into 4 ohm with both channels driven. The power bandwidth was 5 Hz to 50 kHz – precisely as stated by the manufacturer.

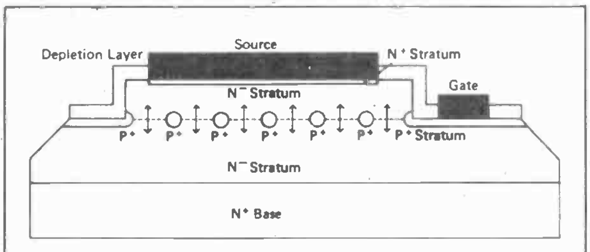
Distortion is very low indeed – over most of the frequency and power output range the unit introduced no

MEASURED PERFORMANCE OF YAMAHA B-1 POWER AMPLIFIER – SERIAL NO. 2869

Frequency Response:	–0.4 dB at 10 Hz and 122 kHz			
	–3.0 dB at 2.3 Hz and 122 kHz*			
Power at Clipping Point:	210 watts (8 Ω 1 kHz)			
(Both channels driven)	222 watts (4 Ω 1 kHz)			
Power Bandwidth:	5 Hz:	144 W	8 Ω	0.13% THD
	50 kHz:	105 W	8 Ω	0.3% THD
Total Harmonic Distortion:			100 Hz	0.03%
(Both channels driven)	100 W	8 Ω	1 kHz	<<0.01%
			6.3 kHz	0.07%
			100 Hz	<0.03%
	1 W	8 Ω	1 kHz	<0.03%
			6.3 kHz	0.04%
Noise:	–99 dB re max. power i.e. 0.46 mV			
	–106 dB (A) " "			
Hum	–126 dB " "			
Sensitivity:	60 mV input gives 1 watt (8Ω)			
Input Impedance:	92 kΩ at 1 kHz			
Output Impedance:	0.08 Ω at 1 kHz			

*Max measurable frequency with test gear used.

YAMAHA VERTICAL FET CONSTRUCTION

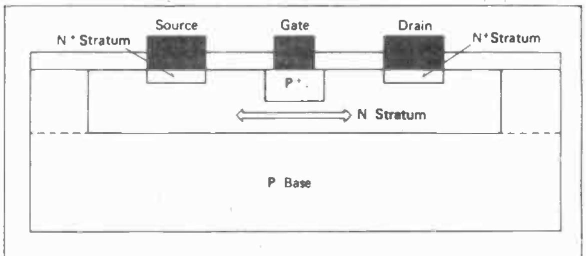


Arrows show current flow direction

As the vertical FET illustration below shows, the source, gate and drain are aligned vertically, permitting much higher power capacity. Each element of the mesh is, in effect, equivalent to an independent FET; a single Yamaha vertical FET contains tens of thousands of such elements.

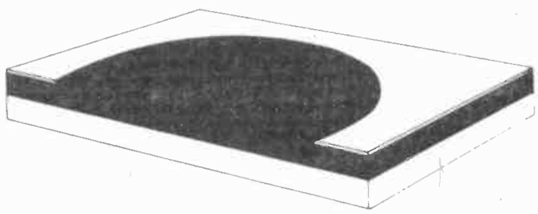
The mesh itself measures 5-10μ across. To assure highest possible drain-source and drain-gate breakdown voltage, impurity concentration is reduced to a level far below any previous semiconductors, through a special epitaxial layer formation method.

Conventional FET Construction



Arrow shows current flow direction

Yamaha Vertical FET Mesh Configuration



increase in distortion beyond the inherent distortion of our measuring system.

Yamaha conservatively state that at one watt output, the distortion at 1 kHz is 0.03%—and 0.04% at 20 kHz. Our findings indicated that under those conditions the distortion was respectively less than 0.02% and less than 0.03% respectively. At 100 W output the distortion was very much less than 0.01% (being typically less than 0.005%) and at 6.3 kHz it was a precise 0.07%.

Until recently it was generally believed that ultra-low distortion levels were irrelevant.

Nevertheless there is increasing evidence that basic design improvements such as those incorporated in the Yamaha B-1 amplifier result in audible improvements — even though these improvements are not necessarily measurable by standard steady-state test methods.

Noise was found to be −99 dB with respect to maximum output or, if you prefer it, less than half a millivolt at the output terminals. Hum was an extraordinarily low −126 dB with respect to maximum power output.

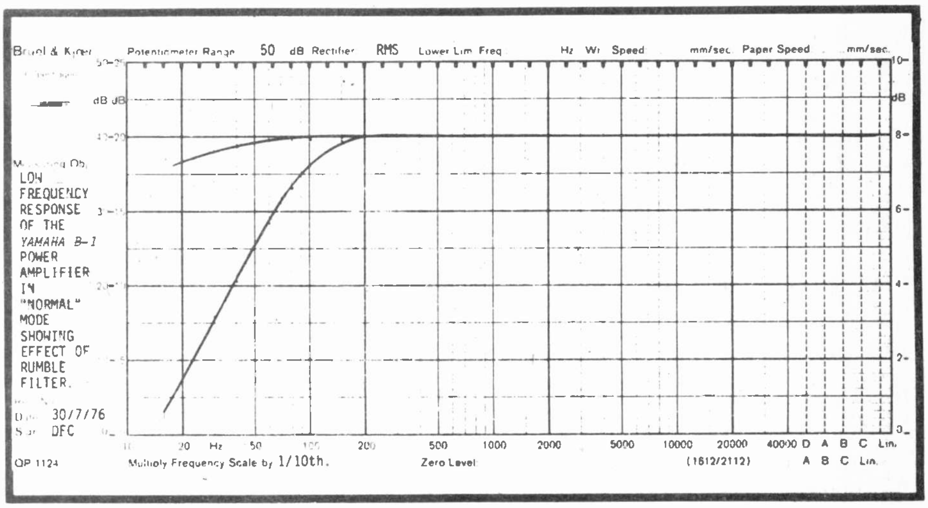
SUMMARY

As hard as we tried we could in no way fault the performance of this unit, except lamely to say that when we picked it up we found it too heavy!

Currently research shows that amplifiers offering higher linearity with lower levels of inverse feedback offer very good transient performance.

We think, but cannot prove, that the subjective performance of this unit is better than other amplifiers using conventional bipolar transistors but must honestly say that we have not positively proven it so, on the basis of instrumental measurements.

Let it suffice to say that our subjective evaluation leads us to believe that the performance that this amplifier produced was the cleanest that we believe we have ever heard up to this time.



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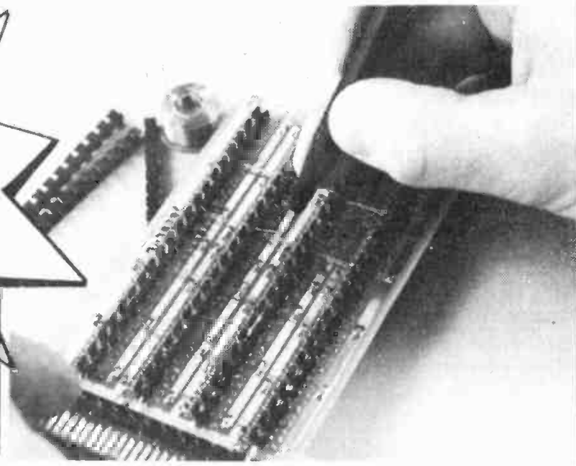

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INDUCTION BALANCE METAL DETECTOR

A really sensitive design operating on a different principle from that of other published circuits. This Induction Balance circuit will really sniff out those buried coins and other items of interest at great depths depending on the size of the object.

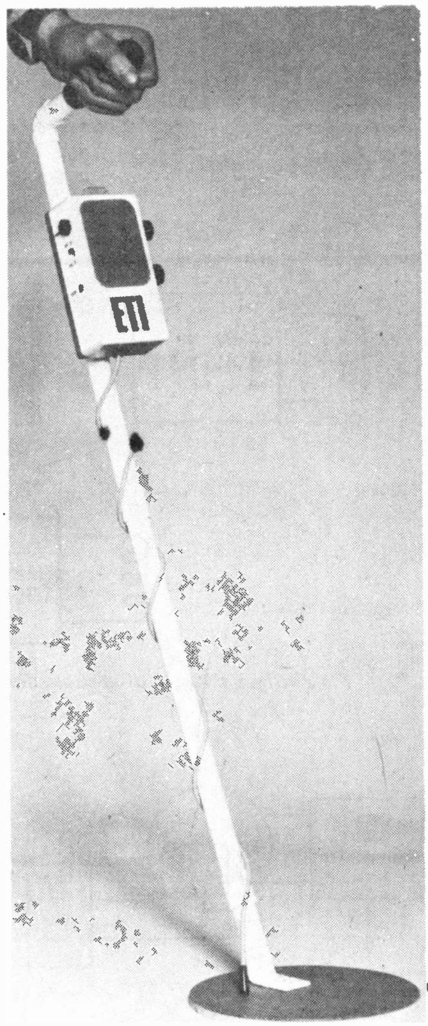
"*ANOTHER* METAL LOCATOR," some of you will say. Yes and no. Several designs have been published in the hobby electronics magazines; some good, some downright lousy but they have invariably been Beat Frequency Oscillator (BFO) types. There's nothing wrong with this principle — they are at least easy to build and simple to set up. The design described here works on a very different principle, that of induction balance (IB). This is also known as the TR principle (Transmit-Receive).

All metal locators have to work within a certain frequency band to comply with regulations and a licence is necessary to operate them. This costs £1.20 for five years and is available from the Ministry of Posts and Telecommunications, Waterloo Bridge House, Waterloo Road, London S.E.1.

First a word of warning. The electronic circuitry of this project is straightforward and should present no difficulty even to the beginner. However, successful operation depends almost entirely upon the construction of the search head and its coils. This part accounts for three-quarters of the effort. Great care, neatness and patience is necessary and a sensitive 'scope, though not absolutely essential, is very useful. It has to be stated categorically that sloppy construction of the coil will (not may) invalidate the entire operation.

IB VERSUS BFO

The usual circuit for a metal locator is shown in Fig. 2a. A search coil, usually 6in or so in diameter is connected in the circuit to oscillate at



between 100-150kHz. A second internal oscillator operating on the same frequency is included and a tiny part of each signal is taken to a mixer and a beat note is produced. When the search coil is brought near metal, the inductance of the coil is changed slightly, altering the frequency and thus the tone of the note. A note is produced continually and metal is identified by a frequency change in the audio note.

The IB principal uses two coils arranged in such a way that there is virtually no inductive pick-up between the two. A modulated signal is fed into one. When metal is brought near, the electromagnetic field is disturbed and the receiver coil picks up an appreciably higher signal.

However, it is impractical for there to be no pickup — the two coils are after all laid on top of each other. Also our ears are poor at identifying changes in audio level. The circuit is therefore arranged so that the signal is gated and is set up so that only the minutest part of the signal is heard when no metal is present. When the coil is near metal, only a minute change in level becomes an enormous change in volume.

BFO detectors are not as sensitive at IB types and have to be fitted with a Faraday screen (beware of those which aren't — they're practically useless) to reduce capacitive effects on the coil. They are however, slightly better than IB types when it comes to indentifying exactly where the metal is buried — they can pin-point more easily.

Our detector is extremely sensitive — in fact a bit too sensitive for some applications! For this reason we've included a high-low sensitivity switch. You may ask why low sensitivity is useful. As a crude example, take a coin lying on a wooden floor: on maximum sensitivity the detector will pick up the nails, etc., and give the same

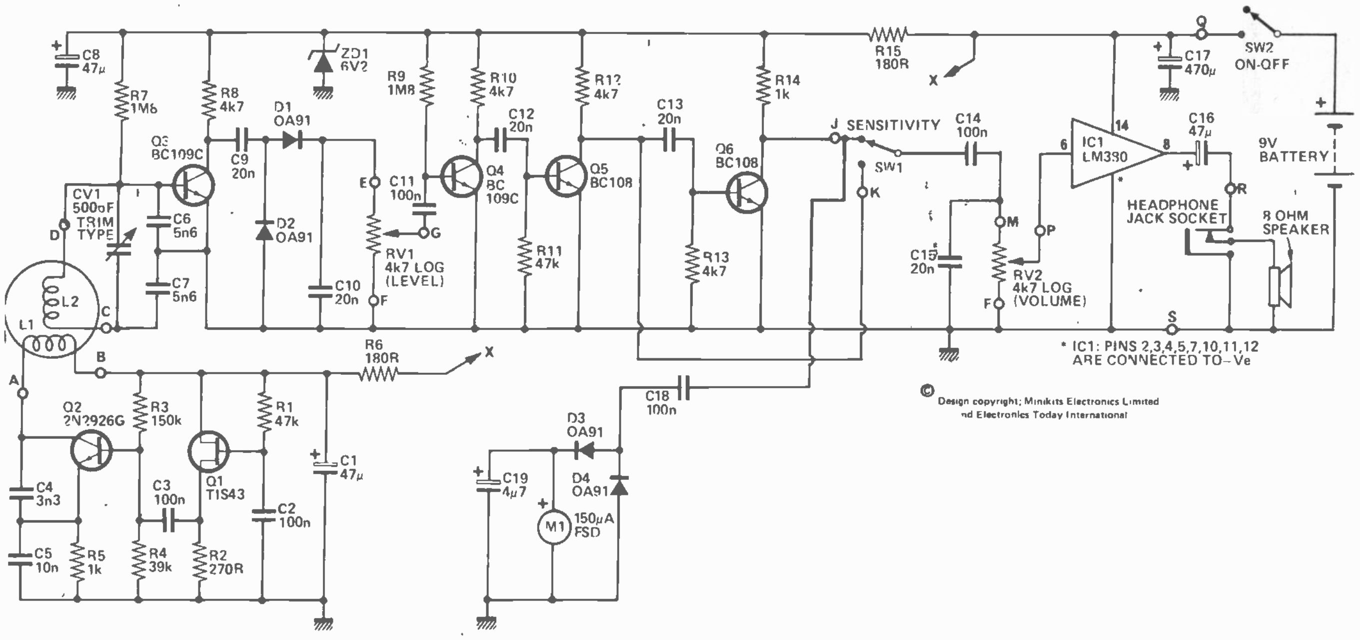


Fig. 1 Complete circuit of the metal locator. Note that though the electronics is simple using very common parts, the whole operation depends on the coils Li and L2 which must be arranged so that there is minimal inductive coupling between the two. Note also that the leads from the circuit board to the search head must be individually screened and earthed at PCB.

readings as for the coin, making it difficult to find.

Treasure hunting is an art and the dual sensitivity may only be appreciated after trials.

Table 1 gives the distances at which various objects can be detected. These are static readings and only give an indication of range. If you are unimpressed with this performance you should bear two things in mind: first compare this with any other claims (ours are excellent and honest) and secondly bear in mind how difficult it is to dig a hole over 1ft of ground every time you get a reading. Try it — it's hard work!

COMPONENT CHOICE

The injunction Q1 is *not* the normal 2N2646; we found several examples of these erratic in their level — we are talking about tiniest fractions of one per cent which would normally not matter, but it *does* in this circuit. Even some examples of the TIS43 did not work well — see the note in How it Works. Secondly Q2 is deliberately a plastic type. Metal canned transistors usually have the collector connected to the case and due to the nature of the circuit we noted a very small change in signal level due to capacitive effects when metal can types were used.

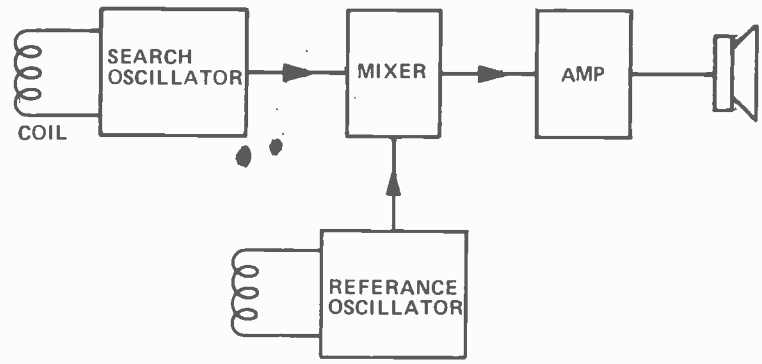


Fig.2a Block diagram of the common BFO type metal locator.

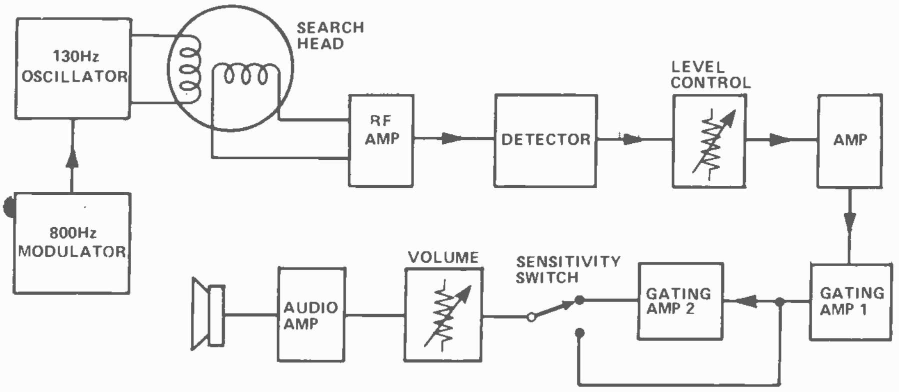


Fig2b Block diagram of our IB design.

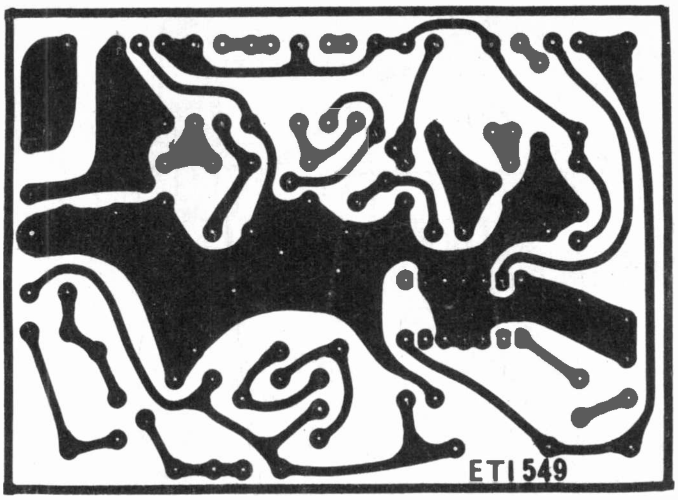


Fig.3 The PCB pattern. Most components other than the meter circuitry is built on this.

HOW IT WORKS — ETI 549

Q1, Q2 and associated components form the transmitter section of the circuit. Q1 is a unijunction which operates as a relaxation oscillator, the audio note produced being determined by R1 and C1. The specified components give a tone of roughly 800Hz. R1 can lie in the range 33k to 100k if a different audio frequency is desired.

Q2 is connected as a Colpitt's oscillator working at a nominal 130kHz; this signal is heavily modulated by C3 feeding to the base of Q2. In fact the oscillator produces bursts of r.f. at 800Hz. L1 in the search head is the transmitter coil.

L2 is arranged in the search head in such a way that the minimum possible signal from L1 is induced into it (but see notes on setting up). On all the prototypes we made we reduced this to about 20mV peak-to-peak in L2. L2 is tuned by C6 and C7 and peaked by CV1 and feeds to the base of Q3, a high gain amplifier. This signal (which is still modulated r.f.) is detected by D1, D2 providing the bias for D1. The r.f. is eliminated by C10 and connects to the level control RV1.

The signal is further amplified by Q4 which has no d.c. bias connected to the base. In no-signal conditions this will be turned off totally and will only conduct when the peaks of the 800Hz exceed about 0.6V across R11. Only the signal above this level is amplified.

On low sensitivity these peaks are connected to the volume control RV2 (any stray r.f. or very sharp peaks being smoothed by C15) and fed to the IC amplifier and so to the speaker.

The high sensitivity stage Q6 is connected at all times and introduces another gating stage serving the same purpose as the earlier stage of Q5. This emphasises the change in level in L2 even more dramatically. Note that RV1 has to be set differently for high and low sensitivity settings of SW1.

Whichever setting is chosen for SW1, RV1 is set so that a signal can just be heard. In practice it will be found that between no-signal and moderate-signal there is a setting for RV1 where a 'crackle' can be heard. Odd peaks of the 800Hz find their way through but they do not come through as a tone. This is the correct setting for RV1.

The stage Q6 also feeds the meter circuit. Due to the nature of the pulses this need only be very simple.

Since we are detecting really minute changes in level it is important that the supply voltage in the early stages of the receiver are stabilised, for this reason ZD1 is included to hold the supply steady independent of battery voltage (which will fall on high output due to the current drawn by IC1).

It is also important that the supply voltage to Q1 and Q2 does not feed any signal through to the receiver. If trouble is experienced (we didn't get any) a separate 9V battery could be used to supply this stage.

IC1 is being well underused so a heatsink is unnecessary.

Battery consumption is fairly high on signal conditions — between 60mA and 80mA on various prototypes but this will only be for very short periods and is thus acceptable. A more modest 20mA or so is normal at the 'crackling' setting.

Stereo headphones are used and are connected in series to present 16 ohms to IC1 reducing current consumption.

Selection of Q1 and Q2

We found that Q1 and to a lesser extent Q2 required careful selection. Q1 should be chosen for the minimum possible 'crackle' — so that the transition from no-signal to hearing the 800Hz is as definite as possible. Some transistors for Q1 and Q2 can produce higher odds peaks than others.

We have specified Q3 and Q4 types as BC109C (highest gain group) for although lower gain transistors worked for us, they left little reserve of level on RV1 and really low gain types may not work at all.

RV1 is the critical control and should be a high quality type — it will be found that if has to be set very carefully for proper operation.

The choice of an LM380 may seem surprising as only a small part of its power can be utilised with battery operation. It is however inexpensive and widely available unlike the alternatives (note it does not require d.c. blocking at the input).

Output is connected for an 8ohm speaker and to headphones. Stereo types are the most common and the wiring of the jack socket is such that the two sections are connected in series presenting a 16ohm load (this reduces current consumption from the battery).

CONSTRUCTION: CONTROL BOX

The majority of the components are mounted on the PCB shown in Fig. 3. Component overlay and the additional wiring is shown in Fig. 4.

Exceptional care should be taken to mount all components firmly to the board. The trimmer capacitor CVI is mounted at right-angles to the board, its tags being bent over and soldered firmly to the copper pads. This enables it to be trimmed with the box closed. A plastic trimming tool should be used if possible. Poor connections or dubious solder joints may be acceptable in some circuits — not in this one. Take care to mount the transistors, diodes and electrolytic capacitors the right way around.

The PCB is fitted into the control box by means of long screws and pillars. The control box has to be drilled to take the speaker, the pots, switches, headphone jack and the cable from the search head.

THE HANDLE ASSEMBLY

The handle is made totally from standard parts. The general construction can be seen in Fig. 5. This is made from Marley 22mm cold water plumbing available from many plumbing shops. The hand grip is that for a bicycle — also easily available and a perfect fit onto the plastic pipe. A right-angled elbow and two sleeve connectors are specified. The elbow should be glued firmly and one end of each of the connectors should be glued also.

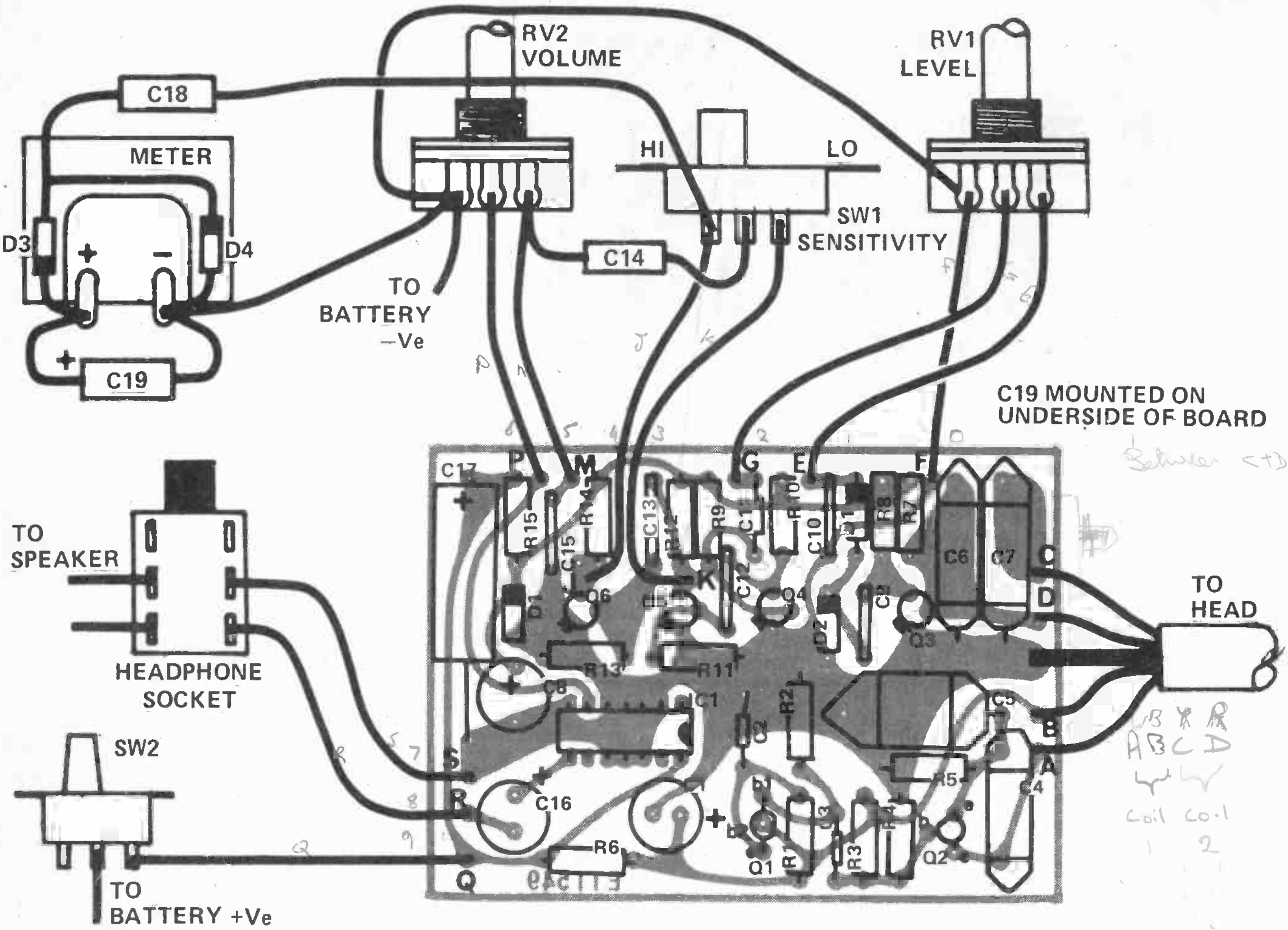


Fig. 4. The component overlay and wiring diagram to other parts of the circuit not on the PCB.

PARTS LIST — ETI 549

Resistors

R1	47k	¼W, 5%
R2	270R	¼W, 5%
R3	150k	¼W, 5%
R4	39k	¼W, 5%
R5, 14	1k	¼W, 5%
R6, 15	180R	¼W, 5%
R7, 9	1M8	¼W, 5%
R8, 10,11,12,13	4k7	¼W, 5%

Potentiometers

RV1	4k7	log rotary
RV2	4k7	log rotary

Capacitors

C1,8,16	47μF 16V electrolytic
C2,3,11,14,18	100nF ceramic etc.
C4	3n3 polystyrene 5%
C5	10n polystyrene 5%
C6,7	5 n 6 polystyrene 5%
C9,10,12,13,15	20n ceramic etc.
C17	470μF 16V electroytic
CV1	4μ7 16V electrolyric
C19	500p trimmer

(Note 1n = 1000pF

Semiconductors

Q1	TIS43	Unijunction
Q2	2N2926	— see text
Q3, 4	BC109C	
Q5, Q6	BC108	
IC1	LM380	14 pin DIL
D1, 2, 3, 4	OA91	
ZD1	6.2 volt 400m W Zener diode	

MISCELLANEOUS

SW1 SW2, 2 pole, 2 way slide switches
Stereo jack socket
Miniature (2¼in etc) 8ohm loudspeaker
L1, L2 — See text and drawings
Vero box (65-2520J)
PCB Board, ETI 549
4 core, individually screened cable, 1.5 metres
Battery clip (PP6)
Battery, PP6
Wood and laminate for search head
2 Control knobs, 2BA Nylon Nut Bolt
M1 Signal level meter, 150μA movement
Marley 22mm Cold Water Plumbing (see text)
Bicycle Grip

The reason for the connector near the base is to facilitate easy removal of the head and the control box for testing and initial setting up.

The control box is held to the handle by means of two pipe clips — again available from plumber's merchants.

The connection to the search head is by means of a 4½in length of tubing which has to be modified. Put 1½in of this tube into boiling water for about half a minute to soften the plastic, take it out and quickly clamp it into a vice to flatten half the length,

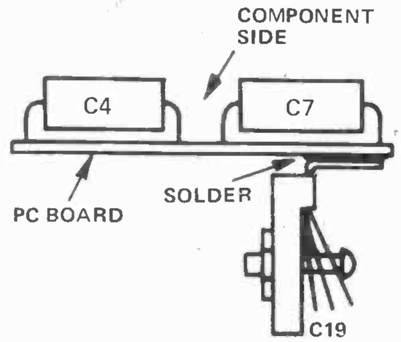
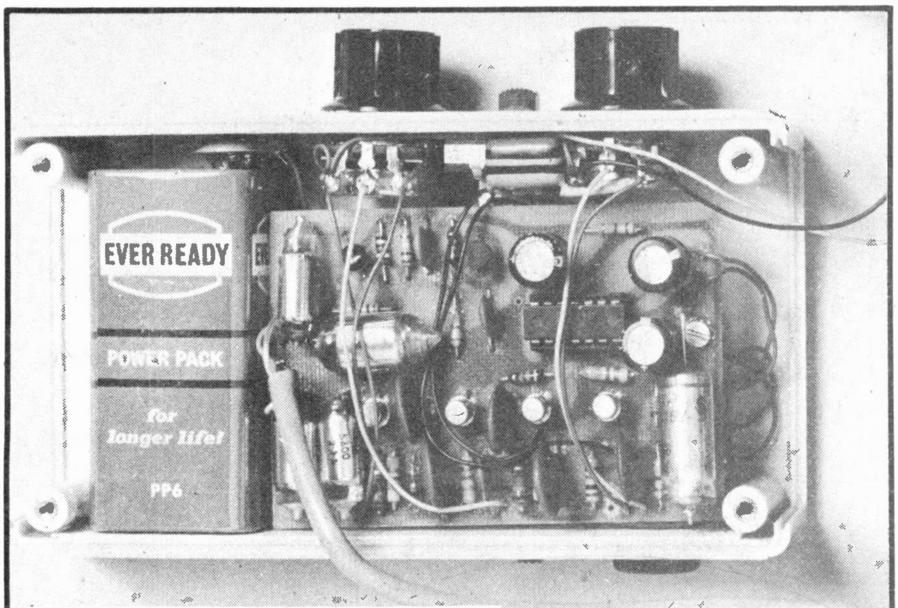


Diagram showing C19 mounted on copper side of P C Board



Internal photograph of metal locator control box.

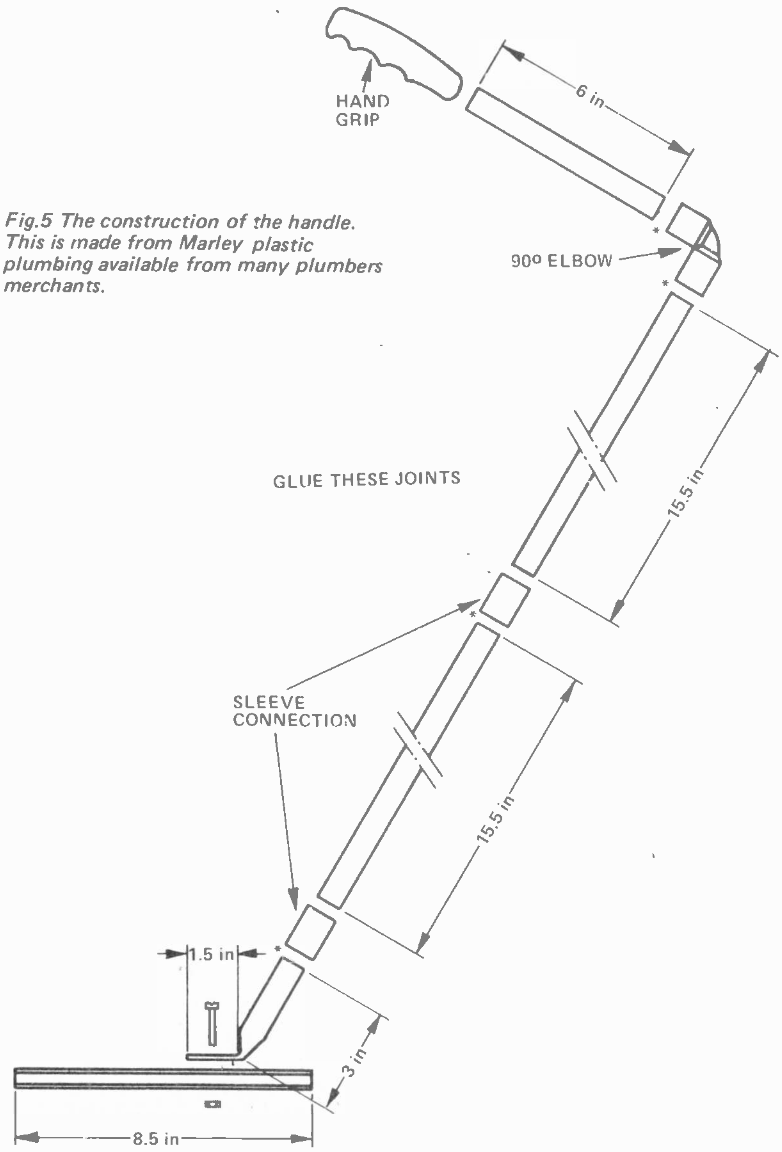


Fig.5 The construction of the handle. This is made from Marley plastic plumbing available from many plumbers merchants.

at the same time bending the flat to about 45° This will now lie across the top of the search head and is glued into position and held by a single 2BA nylon nut and bolt through the top of the search head.

THE COIL

Remember this is the key to the whole operation. The casing of the coil is not so critical but the layout is.

It is best first to make the 6mm plywood circle to the dimensions shown in Fig. 5. A circle of thinner plywood or hardboard is then firmly clued onto this — it's fairly easy to cut this after glueing. Use good quality ply and a modern wood glue to make this.

This now forms a dish into which the coils are fitted. The plastic connector to the handle should be fitted at this stage.

You'll now have to find something cylindrical with a diameter of near enough 140mm (5½in). A coil will then have to be made of 40 turns of 32 s.w.g. enamelled copper wire. The wire should be wound close together and kept well bunched and taped to keep it together when removed from the former. Two such coils are required: both are identical.

One of the coils is then fitted into the 'dish' and spot clued in six or eight places using quick setting epoxy resin: see photogaraph of the approximate shape.

L2 is then fitted into place, again spot gluing it *not* in the area that it overlaps L1. The cable connecting the coil to the circuit is then fed through a hole drilled in the dish and connected to the four ends. These should be directly wired and glued in place, obviously taking care that they don't short. The cable must be a four-wire type with individual screens — the screens are left unconnected at the search head.

You will now need the built up control box and preferrably a 'scope. The transmit circuit is connected to L1. The signal induced into L2 is monitored; at first this may be very high but by manipulating L2, bending it in shape, etc., the level will be seen to fall to a very low level. When a very low level is reached, spot glue L2 until only a small part is left for bending.

Ensure that when you are doing this that you are as far away from any metal as possible but that any metal used to mount the handle to the head is in place. Small amounts of metal are acceptable as long as they are taken into account whilst setting up.

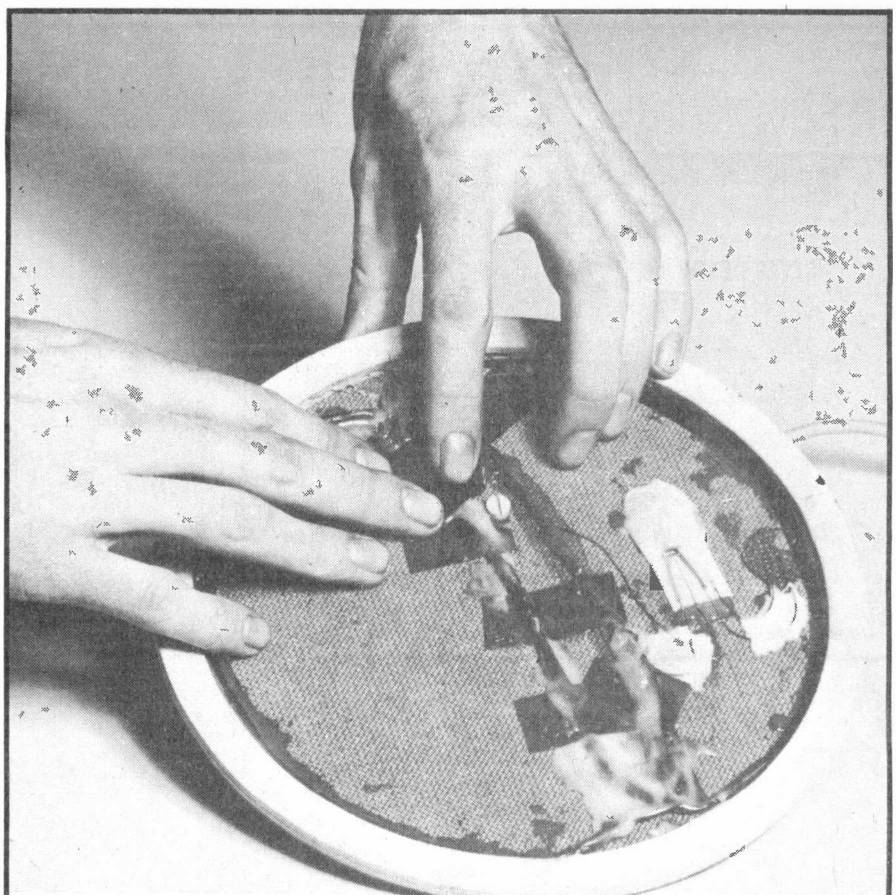
Now connect up the remainder of the circuit and set RV1 so that it is *just* passing through a signal to the speaker. Bring a piece of metal near the coil and the signal should rise. If it falls in level (i.e. the crackling disappears) the coil has to be adjusted until metal brings about a rise with no initial falling. CVI should be adjusted for maximum signal, this has to be done in conjunction with RV1.

Monitoring this on a scope may mean that the induced signal is not at its absolute minimum: this doesn't matter too much. Now add more spot gluing points to L2.

You should now try the metal locator in operation. If RV1 is being operated entirely at the lower end of its track, making setting difficult, you can select a lower gain transistor such as a BC108 for Q4.

When you are quite certain that no more manipulation of the coils will improve the performance, mix up plenty of epoxy resin and smother both coils, making certain that you don't move them relative to each other.

The base plate can then be fitted to enclose the coil, this should be glued in place.



Photograph showing coil being adjusted.

USING THE METAL LOCATOR

You will find that finding buried metal is rather *too* easy. 95% will be junk — silver paper being a curse. The search head should be panned slowly over the surface taking care to overlap each sweep: the sensitive area is somewhat less than the diameter of the coil.

This type of locator will also pick up some materials which are not metal — especially coke and it is also not at its best in wet grass.

Think very carefully about where you want to search: this is more important than actually looking. The area you can cover thoroughly is very, very small, but is far more successful than nipping all over the place. As an example of how much better a thorough search is, we thoroughly tried on 25 square feet of common ground (5ft x 5ft); we found over 120 items but a quick search initially had revealed only two!

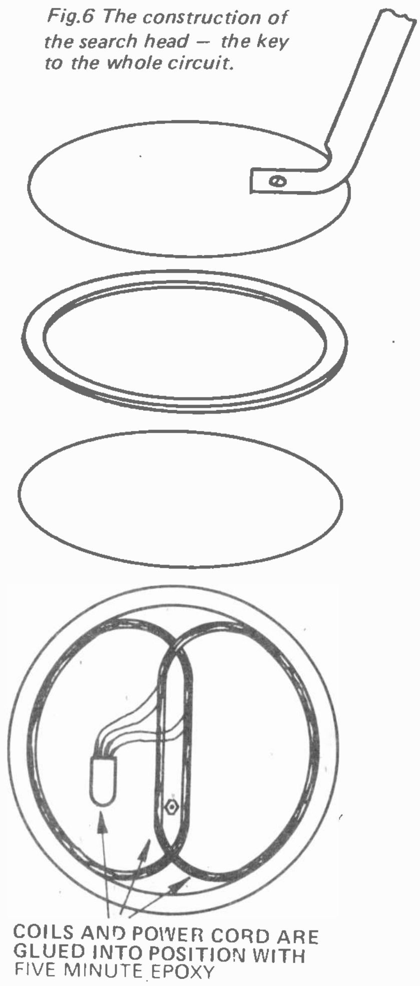
Treasure hunting is growing in popularity and those who do it seriously have adopted a code; essentially this asks you to respect other people's property, to fill in the holes you dig and to report any interesting finds to museums. And do get a licence — it must be the best bargain available at 25p a year (rather £1,20 for five years).

TABLE 1

OBJECT	HIGH SENS	LOW SENS
2p COIN	8"	6"
BEER CAN	17"	14"
6" SQUARE COPPER	22"	16"
6" STEEL RULER	12"	9"
MANS GOLD RING	8"	6"

Table showing sensitivity of the metal locator in free air. (Buried objects can usually be detected at greater depths.)

Fig.6 The construction of the search head — the key to the whole circuit.



METER CIRCUIT

Since the circuit is basically sensing a change in audio level, a meter circuit can be incorporated. For the very first indication from the 'crackle' (see later) to heavy crackle your ears are likely to be more sensitive than the meter but thereafter it will come into its own.

This part of the circuit is optional and the components are not included on the board. ●

Please fill in the coupon on page 9.

'Scope test your car

How to use your 'scope to check out a car's carburetion and ignition systems.

AUTOMOBILE ENGINE TUNING IS A grossly misused and misunderstood operation. To many it implies some esoteric knowledge or ability — of listening to an engine and somehow deducing that the ignition must be advanced — or the mixture strength richened a bit on the front carburettor.

In reality it consists almost entirely of ensuring that ignition and carburetion is adjusted to the vehicle manufacturer's specifications.

No more — no less.

But to do this it is virtually essential to use at least some basic instrumentation; a dwell meter, a tachometer, a good exhaust gas analyser — and preferably an ignition analyser.

Many car enthusiasts have at least a tacho/dwell meter — but few have access to an ignition analyser for such devices are costly indeed. Nevertheless if a few limitations are accepted virtually *any* standard oscilloscope can be used as an ignition analyser simply by making a couple of very simple capacitive probes — which can be as simple as clothes pegs and a few square inches of aluminium foil.

An ignition analyser displays waveforms from the primary or secondary side of the vehicle's ignition system. Surprisingly perhaps, this waveform provides information not only about the ignition system in general but also about carburetion, and a number of mechanical conditions.

The analyser can do this because the voltage required to fire a petrol/air mixture in an engine is affected by many different variables including air/fuel ratio, cylinder compression, ignition timing, ignition polarity, spark plug gap and condition etc, etc.

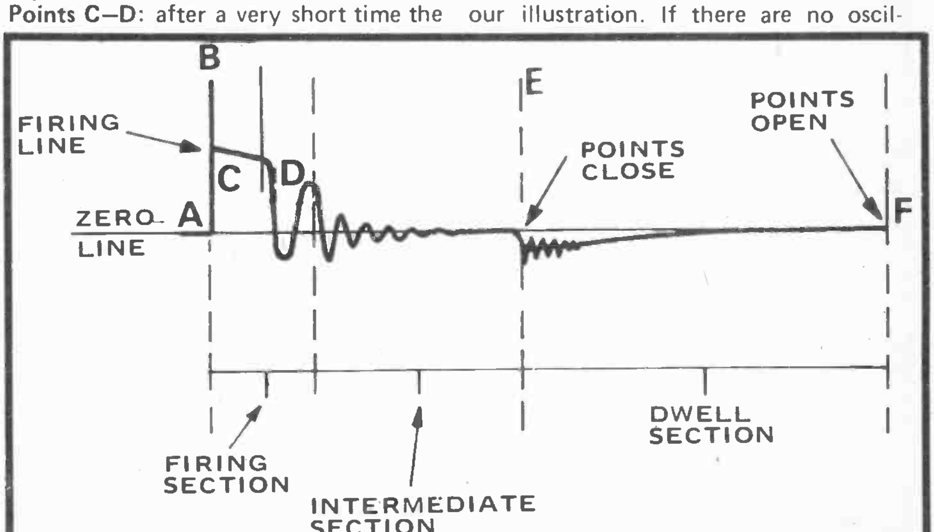
THE SECONDARY WAVEFORM

The simple waveform shown at the beginning of this article is a typical secondary waveform that is derived from the secondary (or high voltage) side of the ignition system. This waveform is the one most commonly used since phenomena occuring in the primary side of the system will be reflected through the coil windings and appear in the secondary pattern.

Point A: is the instant at which the contact points open thus causing the magnetic field to collapse through the coil's primary winding. A very high voltage is thus generated in the secondary winding and this continues to rise — until a spark jumps across the distributor rotor gap and the spark plug gap (point B). The voltage at which this occurs is known as the 'ionization' or the 'firing' voltage and may be anywhere between 5 kV and 15 kV depending on the factors outlined above.

Points C–D: after a very short time the voltage drops substantially but the arc is maintained (point C). The subsequent section from point C to point D is known as the spark line and when viewed on a 'scope the amount by which this line slopes away from the horizontal is directly related to resistance in the plug and coil ht leads (ignition suppression). A slope of 30° or so is OK — if it's more than that then it's worth checking lead resistance with an ohmeter. The total resistance between the centre terminal of the coil and the centre electrode of the plug should not exceed about 20 k assuming the rotor gap is shorted out of course! Actual resistance is not critical but anything more than 30 k may cause problems. Resistance over 50 k almost certainly will.

Point D: the section immediately following the end of the spark line (point D) should be a series of diminishing oscillations. These should appear as our illustration. If there are no oscil-



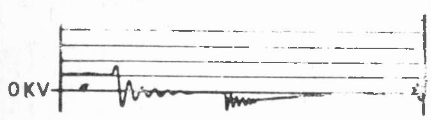
'Scope test your car

lations — or just or or two — then it's a safe bet that there's a shorted turn in the coil. It may not have broken down completely yet but it's a safe bet it shortly will. (See also below).

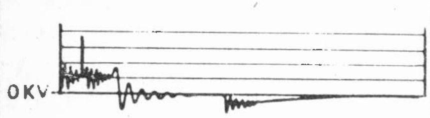
Point E: is where the contact breaker points close. It is essential that there is a gap between the last oscillation of the preceding section and point E for otherwise the diminishing coil energy will be fed into the now closed points thus preventing the coil re-building its magnetic field for the next cycle of ignition.

A great deal may be learnt by studying point E carefully, point misalignment, point bounce, burnt points etc may be spotted at this part of the waveform. The correct waveform at point E should be a short downward line followed by six or so diminishing oscillations.

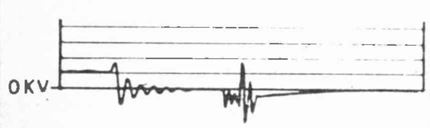
CONTACT POINT INDICATIONS



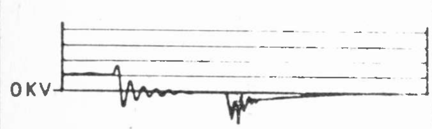
Unusual point opening signal (note hash extreme right of picture) burnt or arcing points.



Spike on spark line. Point arcing caused by faulty capacitor.



Points bouncing probably caused by weak closing spring.



Points misaligned — or dirty.

Point F: magnetic energy will now build up in the coil until Point F. This is in effect the same point as our previous point A but in the next firing sequence. The section from points E to F is known as the dwell section and should occupy roughly the proportion of the total, waveform as shown in our main drawing. Dwell is adjusted by varying the contact breaker gap and should be set using a dwell meter.

SPECIFIC INDICATIONS

Firing waveforms should be observed with the engine warm and running at about 1000 rpm — that is about 400 rpm higher than normal tickover speed.

Check each section of each firing sequence slowly and carefully. The various figures shown in this article indicate how specific faults will show up.

FIRING LINE

All firing lines should be of roughly equal height. If any plug is 10-15% or more higher than the rest, connect a jumper lead to earth and short out at the plug terminal. If the firing line now decreases the fault lies within that cylinder — either a faulty plug or unusually weak mixture (probably caused by a leaking inlet manifold gasket). If the firing line does *not* decrease there is a partial open circuit in the associated plug lead or that lead is not making firm contact with the connector within the distributor cap.

If the firing lines are unequal on a multi-carburettored engine check to see if the lines which are higher correspond to those cylinders fed by one common carburettor. If so it is probable that the mixture from the carburettors is unbalanced. A further but less common fault that may be spotted this way is an eccentric distributor cap — the gap between rotor and distributor contacts being wider on one side than the other.

At some time during the check 'snap' the throttle wide open momentarily, meanwhile watching the firing lines. They should all rise by about the same amount. If one or more lines rise substantially higher than the others then there is an open circuit plug lead or resistor, a wide plug gap or badly deteriorated plug electrode.

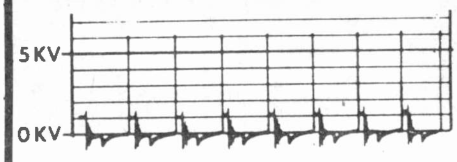
One or more lines staying lower than normal indicates spark plug breakdown or insulation breakdown in the circuit concerned.

COIL OUTPUT AND INSULATION TEST

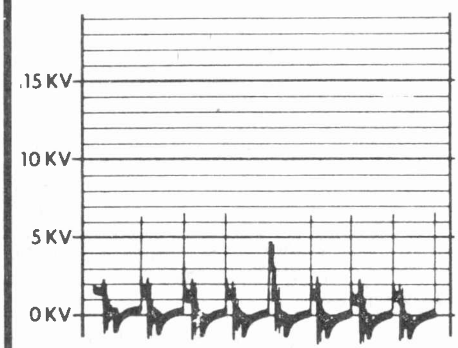
While the engine is running disconnect a plug lead and observe the firing pattern for that cylinder. The firing line should rise to about two to three times its previous level (to about 20 kV) and should extend below the base line by about half the upward distance.

If the firing line is short or intermittent — or if the lower section does not appear — then there is an insulation breakdown in the distributor cap, plug leads, rotor or coil.

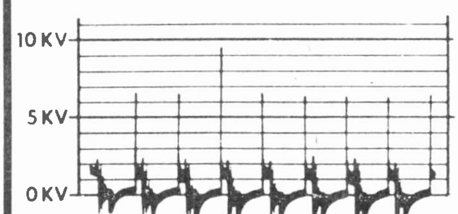
SNAP THROTTLE INDICATIONS



All lines should rise but remain even.



One line breaks up. Insulation break down — probably spark plug fouling. Extreme cases will show similar signal under normal steady running.



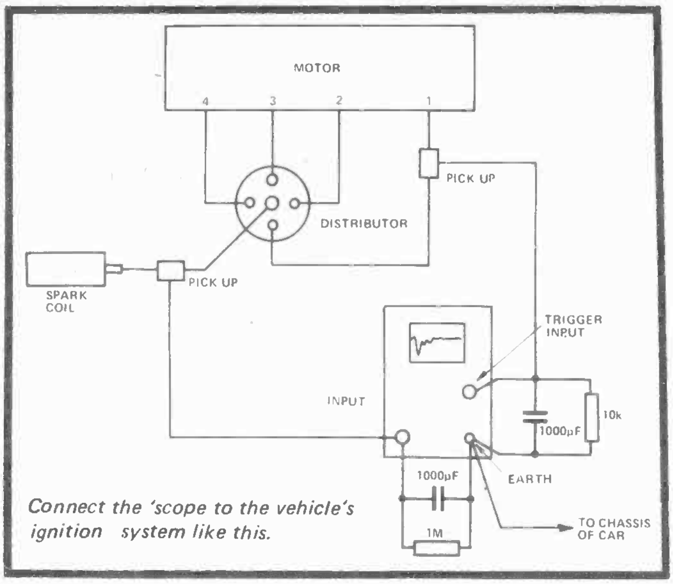
One line rises above rest. Wide plug gap, partial break in suppression resistor, plug lead etc.

COIL AND CAPACITOR

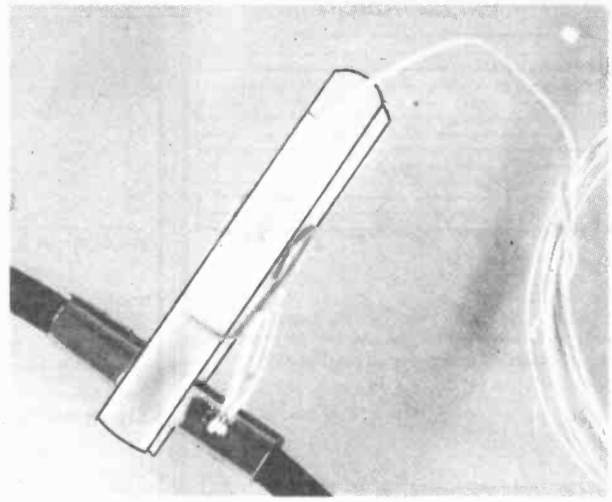
A series of diminishing oscillations should be observed at point D in the waveform. If these do not appear, or are truncated, there is either a shorted or crossed turn in the coil — or the capacitor is breaking down.

BREAKER POINTS

Point E on the main waveform. The drawings accompanying this article show various fault indications. Note however that faulty point action may also show up at the point opening position (A). Check breaker point action with the engine running at all speeds. Weak or incorrect breaker



Connect the 'scope to the vehicle's ignition system like this.



A simple pick-off can be made by glueing short lengths of split metal tube to a clothes peg.

A motor vehicle's ignition system produces output voltages varying from 3kV to 20kV or more. These high voltages must be reduced to a workable level before coupling into an oscilloscope.

The simplest way of doing this is via a resistive voltage divider - however a capacitive divider will work equally well (we are dealing with ac signals) and is simpler to connect.

We can make one of the capacitors by wrapping a piece of Alfoil - about 50mm long - around the required lead and connecting this foil to the scope. A more professional approach is to glue a short length of split tube to a clothes-peg - as shown in the accompanying photograph. This will have a capacitance of about 1pF - not much but ample for the massive signals we are sampling.

A second capacitor of about 1000pF should be connected as shown. The capacitive divider thus formed divides the input signal by about 1000:1 thus reducing the input signal to a workable 3 - 20 volts. A 1M resistor should be connected across the 1000pF capacitor to provide a dc load.

The technique in use: Place the 1pF capacitor over the main lead from the coil to the distributor and connect it to the 'Y' input of the scope.

If the scope has a trigger input, this may be used to lock in the ignition signal. Just make up a second capacitive pick-up and place this around number 1 plug lead. Once again use a 1000pF capacitor as a divider but bridge this capacitor with a 10k resistor - not 1M as previously.

Start the motor and adjust the 'Y' gain and timebase frequency to give four (or six or eight) complete firing sequences across the screen. The first complete pattern will be number 1 cylinder and the rest will follow in the engine firing order.

All waveforms may be superimposed by expanding the trace and triggering via the X input.

If the scope does not have a trigger input, synchronization is slightly harder to achieve. Number 1 cylinder may be identified simply by shorting out that cylinder momentarily.

When the scope is connected as described above, the ignition waveform will appear inverted relative to that seen on a commercially produced ignition analyser - and the waveforms shown in this article. It is surprisingly easy to adapt to an inverted picture, however, if this is found to be a problem, it can be remedied simply by coupling the signals into the scope via a simple 1:1 transformer. Details will vary from one scope to another but all that is basically needed is two coils of wire taped together. It may be necessary to reduce the 1000pF capacitor/s to 470pF. Just connect the secondary to give the correct picture.

If possible, arrange to calibrate the scope's vertical axis so that the magnitude of the signals may be measured. This is best done simply by taking average indications from several vehicles and 'calibrating' by transferring data from the graphs in this article. The result may not be accurate, but only a rough guide is required.

springs will cause the points to bounce — and this is readily seen on the scope pattern.

COIL

With very few exceptions — notably on some Citroens — the high voltage side of a vehicle's ignition system is designed to have positive earth — *regardless of overall vehicle battery polarity.*

The reason for this is that electrons are emitted more readily from a hot surface than a cold one so as a spark plug centre electrode always runs hundreds of degrees hotter than the side electrode the ignition system is devised so that a negative potential is applied to the centre electrode.

If this polarity is reversed, the plug will require an extra 5 kV or more to fire it — and that voltage may not be available from the coil under heavy load — or when running at light throttle at high speed (remember a weak mixture needs a higher voltage to ignite it than a rich one).

If you are checking polarity on a specialist ignition analyser then the polarity is correct if the pattern is as shown in the illustrations in this article. If you are checking it with a standard scope (with no inverting device) then the pattern should be upside down if polarity is correct. (See inset for full explanation).

Polarity is corrected simply by reversing the coil terminals. (Incorrect polarity is usually caused by a mechanic replacing a coil intended for a negative earth vehicle with a coil meant for a positive earth vehicle — or vice-versa. It may also, but less probably, be caused by an incorrectly manufactured coil, or less likely, by the vehicle's polarity being accidentally reversed by the battery being connected the wrong way round).

MIXTURE STRENGTH

This section is intended for the lucky man who has access to an exhaust gas analyser and tachometer as well as a scope.

If cylinder compression pressures are identical, plugs in good order and evenly gapped, and plug leads and distributor in good order — then any significant difference in firing line heights will almost certainly be caused by differing mixture strength from one cylinder to another.

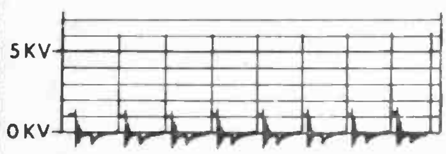
The voltage required to fire a rich mixture is substantially less than for a weak mixture: for instance a 12:1 ratio may need 3 to 4 kV — whilst a 15:1 ratio may need 7 to 9 kV (typically). Thus even quite small differences in mixture strengths will be reflected quite dramatically in firing line height.

The only accurate way to adjust mixture strength is as follows:

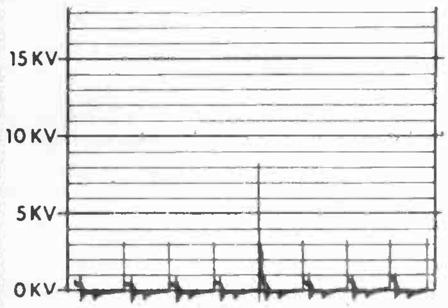
Connect a tachometer to the engine and adjust slow running to 1000 rpm. *Without looking at the gas analyser* adjust mixture strengths so as to produce the highest tickover speed whilst maintaining the firing lines at an even height. If necessary reduce the tickover speed to keep it around 1000

FIRING LINE INDICATIONS

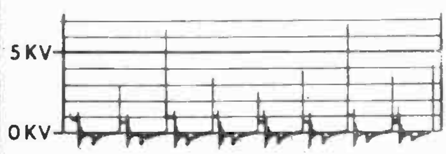
Normal pattern:
Note that the firing line for cyl. 1 appears at the extreme end of the trace. The remaining cylinders then appear in engine firing sequence.



Firing lines even but high:
Excess plug gaps, rotor gap, break in coil ht lead, mixture too lean ignition retarded.



Firing line high on ONE cylinder:
Break in plug lead, broken electrode in spark plug. To test short plug — if line drops, problem is within cylinder.



Firing lines uneven:
Break in plug leads, worn plugs, burnt distributor cap contacts, uneven air/fuel mixture.

rpm. Finally richen the mixture a shade until tickover speed drops by about 50 rpm.

Then *and only then* — look at the gas analyser. You should now have a reading somewhere between 14:1 and 15:1. If you haven't then there's something wrong with the carburetion system — an air leak in the induction manifold: incorrect float chamber level: blocked slow running jet or *something.* ●

SHORT CIRCUITS

NEW SERIES

This new series will describe straightforward projects but they are not necessarily simple in their operation or aimed at the beginner. We plan to carry between two and four such projects each month.

LED DICE

THIS SIMPLE DICE PROJECT IS based on a CMOS (Complementary Metal-Oxide Semiconductor) integrated circuit counter which is stepped by the output of a 555 timer integrated circuit connected to run as an oscillator at approximately 6500 Hz.

When the button on the unit is pressed the 555 oscillates and the kHz 6.51 pulses which it generates at pin 3 are fed to the input of IC2 (pin 14). The integrated circuit, IC2 is a decade counter in which each of the count states (0 to 9) are brought out to separate pins. By connecting the seventh count output (pin 5) back to the reset input (pin 15) the counter is made to reset after every sixth count. The six count states of the IC which are used are each connected to a light-emitting diode (LED). As the IC counts it will switch on each of the six light emitting diodes in turn. Whilst the button is pressed the LEDs will be switched at a rate of 6.5 kHz and thus all LEDs will appear to be on due to the limited frequency response of the human eye.

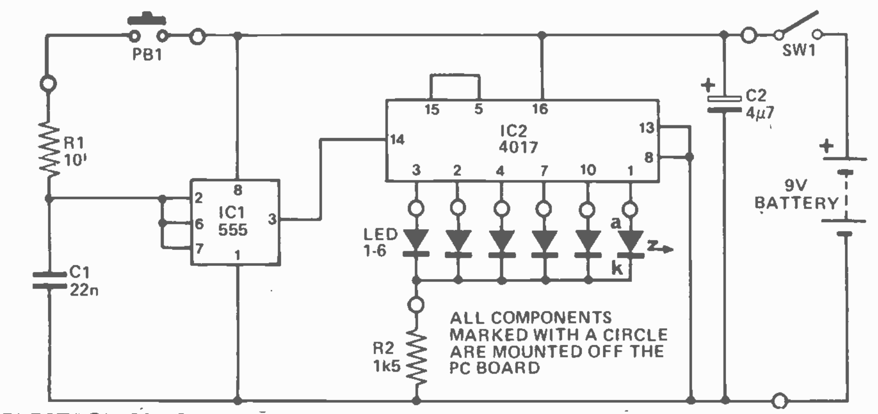
When the button is released the oscillator stops counting leaving one only of the LEDs alight. As the IC cycles through its six states the LEDs will each be on for the same interval. Thus the probability of being on when the button in released is the same for each LED. The LEDs may therfore be numbered from one to six and the device can then be used as a dice.

CONSTRUCTION

Whilst CMOS devices are fairly rugged in-circuit they are liable to be damaged by static discharges when handled out of circuit. For this reason they are supplied in either conducive foam, aluminium foil or specially-coated plastic containers which short all the pins together for protection. The CMOS should only be removed from its protective packing when you are ready to insert the device into the board. All other components should be mounted to the board first and the CMOS inserted last of all. Handle the pins of the device as little as possible and solder in place quickly and cleanly with a light-weight soldering iron.

The integrated circuits are marked by a small notch or dot at one end of the body. When inserting the IC make sure that this mark is aligned with the orientation mark provided on the component overlay. Make sure also that the electrolytic capacitor C2 in inserted with the correct polarity.

The light-emitting diodes will have their cathode terminals (k) marked in some way. Usually this is



How it works

The output of IC1 is connected to the clock input of IC2 and every time there is a pulse from IC1 the output of IC2 which was high, will go low and the next output will go high (providing that the reset input is low). Thus the "high" shifts through the ten outputs of IC2 in sequence at the same rate as the input pulses from IC1. The sequence of ten outputs recycles whilst there are input pulses.

However a dice has only six surfaces so we require IC2 to count to six, rather than to ten. This is easily performed by connecting the seventh output of the IC back to the reset input. Now when the counter is clocked from output six to output seven, seven goes high and resets the counter. Once the counter resets the high is removed from output seven and the counter, back at output one, is free to count again. The time taken to do this is only about 100 nanoseconds (0.000 000 1 sec).

The outputs one to six of IC2 are each connected to the anode of an LED. The cathodes of the LEDs are all connected in parallel, via a common current-limiting resistor, to 0 volts.

For checking purposes the action may be slowed down by putting a high value resistor across the terminals of the push button (even just the finger across the terminals will do). This will cause the oscillator to run at a low speed so that the changing of the LEDs can be seen.

by means of a small flat on the plastic body of the component adjacent to the cathode lead or the cathode lead many be shorter than the other. Make sure that the leds are inserted the correct polarity — if any LED fails to light when the button is pressed it is most likely that it is the wrong way round.

The dice project may be assembled using the Veroboard layout as given or using the printed-circuit board alternative. If Veroboard is used the tracks must be cut in the positions indicated with a small drill bit. The components are then assembled to the respective board with the appropriate overlay. ●

Parts List

RESISTORS

R1	10K	
R2	1K5	
All ½W 5%		

SEMICONDUCTORS

IC1	555 resistors	
IC2	4017 CMOS	
LED 1,2,3,4,5,6		TIL 209 or similar

MISCELLANEOUS

PP3 battery
PP3 battery clip
Board spacers
Nuts, bolts, etc.

CAPACITORS

C1	22n	ceramic or similar
C2	4u7	16V electrolytic

SWITCH

P.B.1	=	push to make type
SW1	=	single pole / Off-On rocker

CASE

ABS	M2	Doram

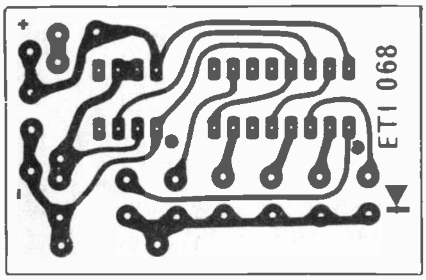


Fig. 2. Printed-circuit board layout for the LED dice. Full size 55mm x 35mm.

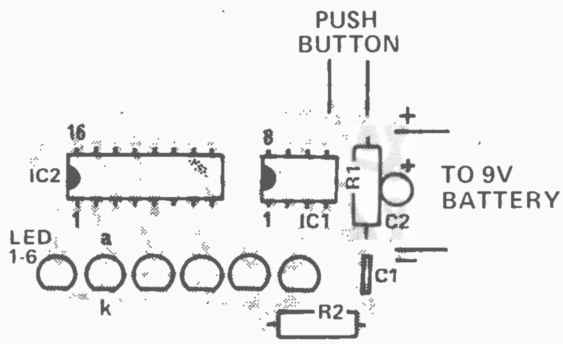
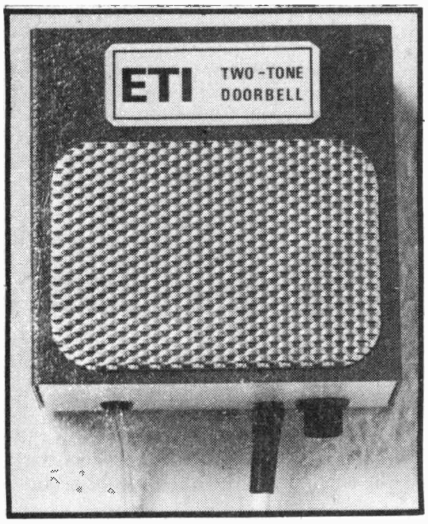


Fig. 3. How the components are mounted to the printed-circuit board.

TWO-TONE DOORBELL



THIS ELECTRONIC DOORBELL IS based on the 555 integrated circuit. The device is widely used in many types of timers and as a simple oscillator. In this project both operations are used. When the button is pressed the 555 oscillates at one frequency (tone), when the button is released the tone changes and the IC continues to produce this second tone for a predetermined period. Thus by pressing the control button once a two-tone doorbell sound is produced by the speaker driven directly from the integrated circuit.

CONSTRUCTION

Assemble the components as shown in the component overlay diagram. Note that in this diagram the copper tracks are shown dotted as they are on the opposite side of the board from the components and therefore cannot be seen.

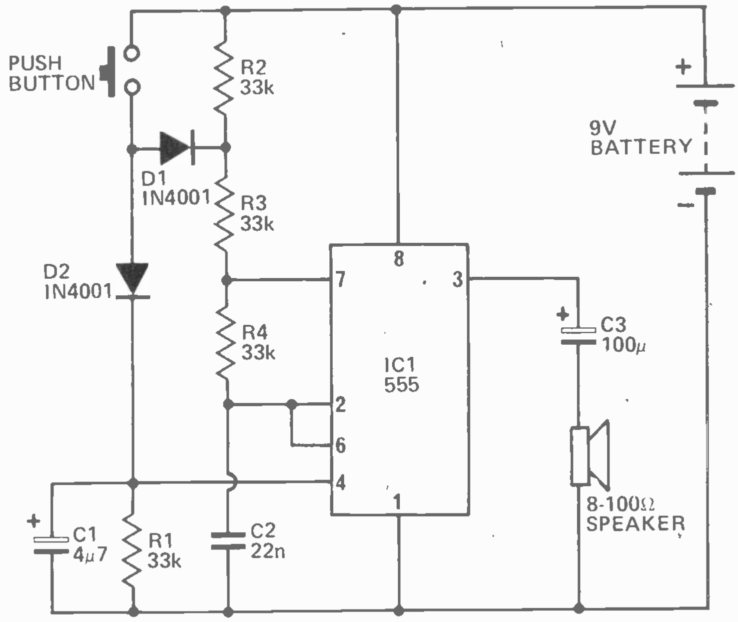
The integrated circuit, diodes, and the electrolytic capacitors, must be mounted the correct way round. The overlay shows the distinguishing marks on each component, and the component must be placed so that the marks on the component are the same way as on the overlay diagram.

How it works

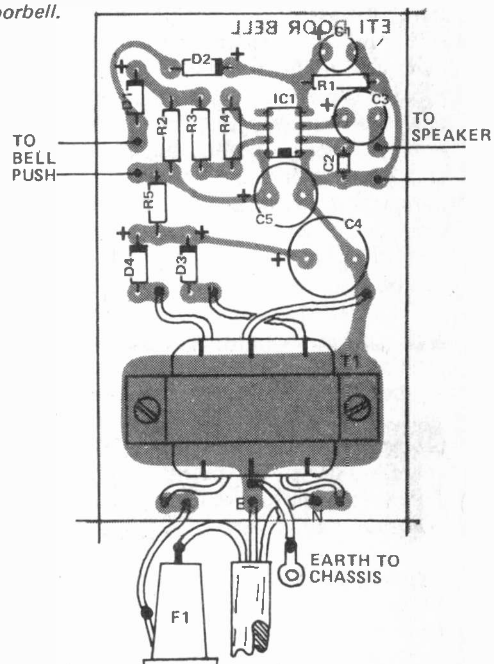
Operation of the doorbell may be described as follows: The capacitor C2 initially charges towards plus nine volts via resistors R2, 3 and 4. However, the top of the capacitor is connected to both pin 2 and pin 6 of the 555 timer IC. Hence when the voltage on the capacitor reaches 6 volts both comparators will be above threshold and the output of the 555 at pin 3 will go low and the internal transistor will switch on, shorting pin 7 to ground. However pin 7 is connected to the junction of R3 and R4 and C2 will therefore now be discharged via R4. When the voltage on C2 falls below 3 volts the output will go high again, the transistor will turn off, and C2 will commence charging again via R2, 3 and 4. This sequence continues thus producing a triangular waveform across C2 and a pulse train at pin 3. The pulse train output from pin 3 is coupled to the loudspeaker via C3 which prevents the dc component of the voltage from reaching the speaker.

The triangular waveform is produced by C2 charging from 3 to 6 volts and then discharging from 6V to 3V.

If a different pitch tone is required R2, 3, 4 or C2 may be altered in value.



Circuit diagram of the two-tone doorbell.



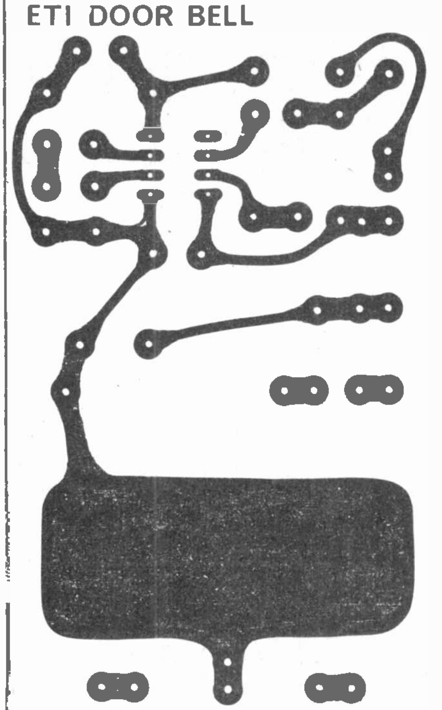
Overlay for Doorbell

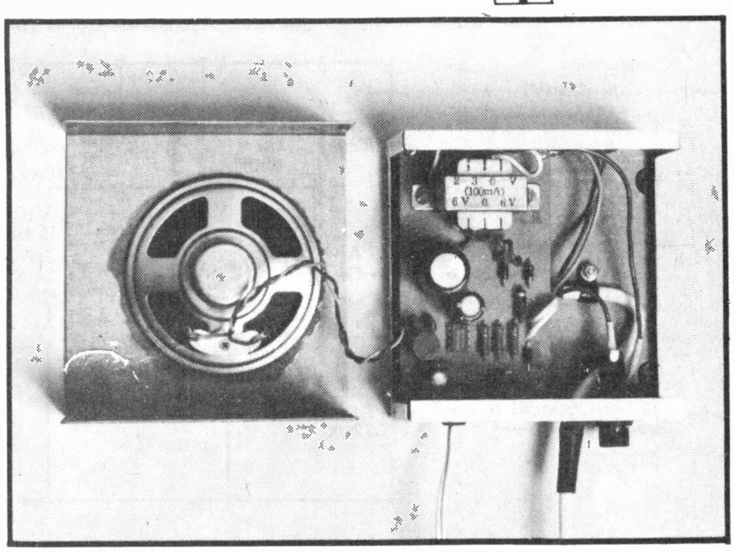
Parts List

CAPACITORS		
C1	4u7	16V electrolytic
C2	22n	ceramic or similar
C3	100u	16V electrolytic
C4	1000u	16V electrolytic
C5	470u	10V electrolytic
SWITCH		
P.B.1	Bell push type	
CASE		
Samos S2		Doram
SPEAKER		
LS1	2½" 8Ω type.	

RESISTORS	
R1, R2, R3, R4,	33K
R5	22R
All at ½W 5%	
SEMICONDUCTORS	
IC1	555 timer
D1, D2, D3, D4	IN4001
TRANSFORMER	
T1 240V - 6/0/6	100mA
MISCELLANEOUS	
F1 fuse holder	250mA fuse
3-core mains flex	
2-core bell flex	
Panel gromet	
4 board spacers	
Nuts, bolts, etc.	

ETI DOOR BELL





Internal [illegible] of Doorbell

BENCH AMP

How it works

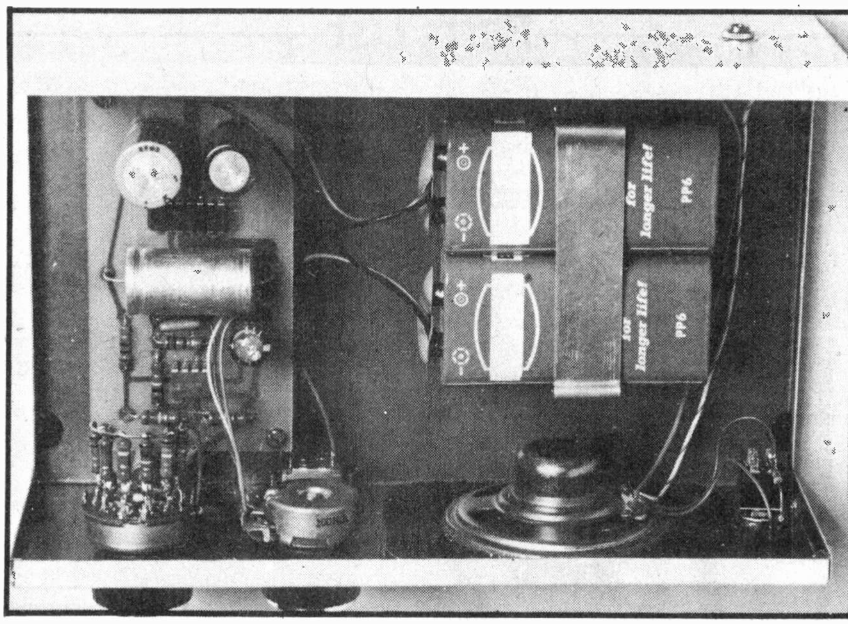
The gain of IC1 is set by the ratio R9/R1 - 6 Resistors R1 - 6 vary this from ≈20 to ≈0.5. Thus to produce 100mV across RV1, inputs from 5mV to 200mV are required. R7 and R8 bias the non-inverting input to 4.5V and R10 is included to protect the chip. Since D.C. gain of the circuit is unity, the output will set at +4.5V D.C., providing maximum swing capability. To minimize output offset due to bias current, the value of R7 and R8 in parallel should be approxinately the same value at R9. Bear this in mind if you intend to alter the supply voltage.

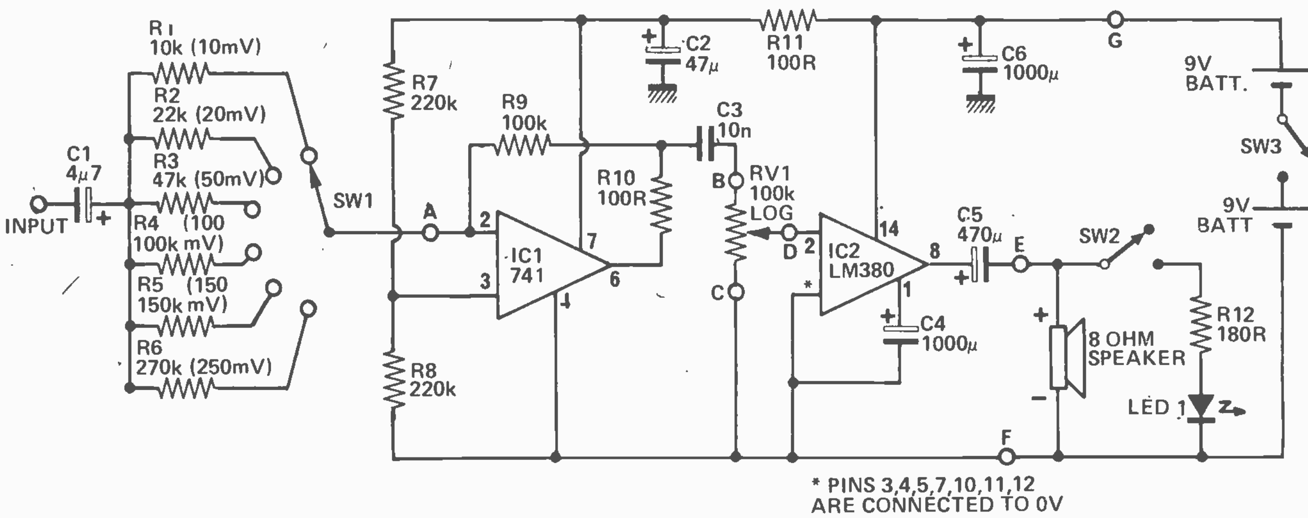
R11 and C2 provide decoupling for the 741 rail, as C6 does for the LM380. This capacitor can be increased in value to advantage with a supply not entirely stable. If another value of impedance speaker is employed, R12 will have to be altered to maintain the conditions.

THE AMPLIFIER TO BE described here differs in one major respect to most others - it can be used as an accurate millivoltmeter! One of the most awkward things to measure in a lab is an audio signal of less than a volt. Specialist meters are expensive, and rarely justifiable for an amateur: hence this project. This provides at least an 'order of magnitude' reading, and in most cases an accurate value can be assigned to the signal.

The circuit is basically an audio pre- and power amplifier combination, with switchable preamp gain. Depending on which sensitivity is selected, the gain of the 741 is so adjusted as to produce the specified input to drive the LM380 to the point of clipping. This voltage in turn is just sufficient to cause the LED to light.

To measure an A.C. signal, turn the volume control to maximum, and apply the input to the socket and work down from the lowest sensitivity until LED just comes on. The value of the input is now indicated by the switch. We tried several 380s and several dozen LEDs to see if our results were repeatable: they were. In all cases we were within 10% of the value of the signal!

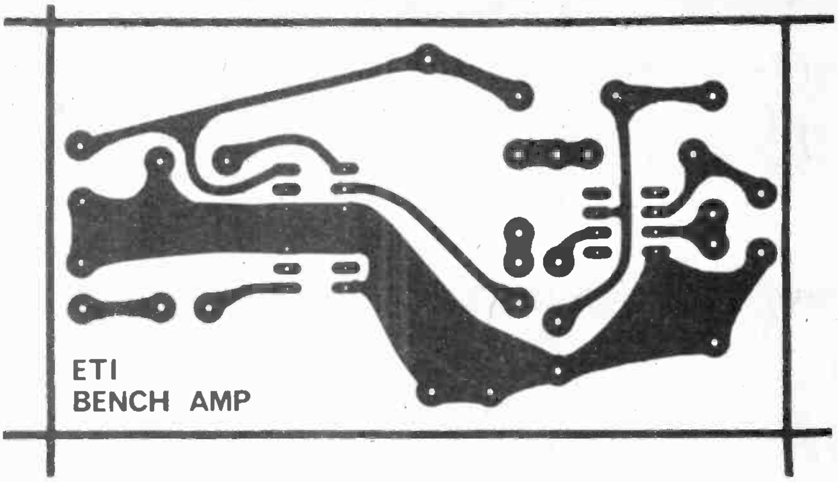




Circuit diagram of the Bench Amp

Construction is not critical, but a metal box is a good idea to help screen the amplifier from extraneous radiations etc. Ours came from Doram, and very nice they were too. Battery power was chosen so as to leave as much bench supply free as possible.

Further sensitivities can be easily added by using a larger switch with more poles, and adding the appropriate resistors. The quality of the circuit is good enough to feed an external loudspeaker, and a socket is provided to enable this to be accomplished. ●



Parts List

RESISTORS

R1	10K	
R2	22K	
R3	47K	
R4,9	100K	
R5	150K	
R6	270K	
R7,8	220K	
R10,11	100R	
R12	180R	

All ½W 5%

POTENTIOMETER

RV1 100K Log rotary

SEMICONDUCTORS

IC1	741 op-amp	
IC2	LM380 power amp	
LED1	0.2" type	

MISCELLANEOUS

Phono socket
Nuts, bolts, etc.
3.5mm jack socket

CAPACITORS

C1	4u7	16V electrolytic
C2	47u	16V electrolytic
C3	10n	ceramic or similar
C4	1000u	16V electrolytic
C5	470u	16V electrolytic
C6	1000u	25V electrolytic

SWITCHES

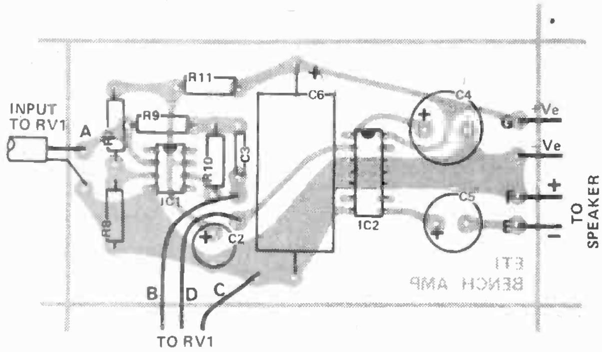
SW1	1 pole 6-way rotary	
SW2	single pole / Off-On toggle	
SW3	single pole / Off-On rocker	

CASE

Samos S7 — Doram

SPEAKER

LS1 2¼" 8Ω type



Component overlay for the Bench Amp

FILM RESISTORS

PART 7

Previous articles in our Components Series have dealt with resistors and capacitors. This article looks at carbon-film resistors and their properties in circuit

FILM RESISTORS ARE MANUfactured by forming a deposit of an appropriate resistive material, usually carbon, carbon-boron or some metallic oxide, on a ceramic former, usually a tube or rod. A helical groove is then cut in the film coating. The groove forms the resistive coating into a long continuous path resulting in a compact resistor that can have a value up to 100 megohms. Terminations are made in a variety of ways. Metal end caps may be forced over the ends of the ceramic rod, contacting the deposited film. Leads are attached to the caps by soldering or spot-welding. In some types, the ends of the coated ceramic rod are metallized and leads are wrapped around the metallized portions and soldered. The component is then coated in a suitable lacquer for protection.

Typical construction of a film resistor is illustrated in Figure 1.

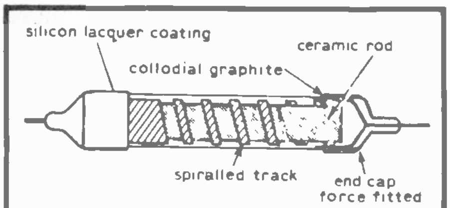


Fig. 1. Typical construction of a film resistor.

Thick-film resistors are a special type of film resistor. They are generally constructed by depositing the resistive material on a ceramic or aluminium-oxide substrate. A portion of the film coating is then removed, according to a predetermined pattern, to provide a long resistive path between the resistor terminals. Typical construction of one style of thick-film resistor is illustrated in Figure 2. This style is obtainable as a 'fusible' resistor. When overloaded, the substrate cracks, ensuring an open circuit which reduces the possibility of further circuit damage, physical or electronic. These thick-film resistors occupy a minimum of space on a printed circuit board and can dissipate considerable power owing to their large surface area and high hot-spot temperature (150°C).

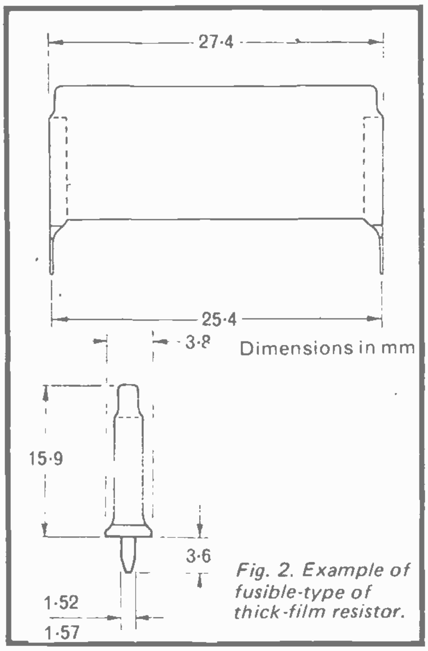


Fig. 2. Example of fusible-type of thick-film resistor.

Thick film resistors are also made in appropriate groupings on a small substrate and encapsulated in a standard DIL IC package. Certain values of resistance are standard in digital circuitry and this style is used in such applications (for example, as the 'weighting' resistor network in a digital-to-analogue converter). Another application is for 'pull-up' resistors for open-collector logic gates.

Thin film resistors are constructed in a similar fashion but on a considerably smaller scale. They are primarily used in IC manufacture. Some thin film resistor networks are available in standard DIL integrated circuit packages and these find application in digital circuitry.

There are four basic types of film resistor:–

(a) Carbon Film
(b) Metal Film
(c) Metal Oxide Film
(d) Metal Glaze (Cermet)

CARBON FILM RESISTORS

These resistors are manufactured by a 'cracking' or pyrolytic process where a hydrocarbon vapour at high temperature is decomposed onto a special ceramic rod, producing a thin carbon film on the surface. These are sometimes referred to as 'deposited-carbon' film resistors. Some types use a boron-carbon film; a boron containing gas is introduced during the cracking process. This results in a resistor that has a superior temperature coefficient over a limited range of values than the plain carbon film type.

Terminations may consist of metal end-caps forced over the ends of the element, and then axial or radial leads are attached. Some manufacturers metallize the ends of the element and solder leads to them. Sometimes a combination of the two techniques is used to improve reliability.

Protection for the element is provided in a number of ways. Numerous layers of varnish may be applied followed by a final paint coating. Some modern types are completely sealed in a silicone resin base which is impervious to moisture as well as providing excellent mechanical and thermal protection.

TABLE 1. General Characteristics of Carbon Composition Resistors

Rated Wattage @ 40°C	Rated Wattage @ 70°C	Max. Working Voltage Commercial	Max. Working Voltage Mil.	Max. Operating (= hot-spot) Temperature Commercial	Max. Operating (= hot-spot) Temperature Mil.	Critical Resistance Commercial	Critical Resistance Mil.	Uninsulated Types Length	Uninsulated Types Diameter	Insulated Types Length	Insulated Types Diameter	Typical Resistance Range
	0.125	500	150		150	2 M	180 k			3 7 mm	1.6 mm	4.7 Ω – 1 M
0.5	0.25	700	250	107	130	3M9	250 k	6.4 mm	2 3 mm	9.5 mm	2.4 mm	2.2 Ω – 10 M
0.75	0.35	1000	–	107	130	2M7	–	10.8 mm	4 1 mm	9 5 mm	4.8 mm	10 Ω – 4M7
1	0.5	1000	350	107	130	1M8	250 k	10 mm	3.5 mm	11 7 mm	5.8 mm	2.2 Ω – 100 M
2	1	1000	500	107	130	1 M	250 k	18 mm	6 mm	19 1 mm	6.4 mm	10 Ω – 1 M
	2	1000	500	107	130	470 k	120 k	29.8 mm	7 7 mm	35 mm	8 mm	10 Ω – 1 M

(1) Rated Wattage assumes voltage limit not exceeded
(2) Max. Working Voltage assumes wattage rating not exceeded.
(3) Max. Operating Temperature is that due to ambient temperature plus temp rise due to power dissipation. No power can be dissipated by a resistor if the ambient temperature equals the hot-spot temperature. The hot-spot temperature for commpercially-rated carbon composition resistors is usually between 105 and 110°C.
(4) Sizes given are body sizes for axial-lead types.

Other types may be encased in a plastic moulding or sealed in a ceramic or glass tube. The varnished types afford the least protection against mechanical damage (through handling etc) and moisture.

The voltage coefficient of carbon film resistors is very much less than that of carbon composition types, being usually less than 100 ppm/V and this rarely needs to be considered.

GETTING HEATED

Carbon film resistors exhibit temperature characteristics which are superior to composition resistors, but not as good as metal film or wirewound types. Nevertheless, the temperature coefficient of carbon film resistors is quite acceptable for a wide variety of applications. Only those applications requiring a very good temperature characteristic warrant the use of the other, usually more expensive, film resistors.

–400 ppm/°C for values over 100k. The variation of TC with resistance value and the spread that might be expected is illustrated in Figure 4.

The TC of carbon film resistors is also dependant on the wattage rating due to the thickness of the carbon film used in its construction.

GROWING OLD

All resistors change their value permanently with age and use. Carbon composition resistors are the worst in this regard and may be expected to change as much as 20% Film and wirewound resistors are considerably better. Carbon film resistors have a stability of better than 1% which is usually more than adequate for all but the most stringent applications.

The high frequency characteristic of carbon film resistors is one of its advantages. Coated types are somewhat

NOISES

The noise generated by carbon film resistors is a function of the applied voltage, the thickness of the film and the length of the spiral track. Consequently, the lower value, higher wattage units generate the least noise. For values below 10k it is typically between .08 and .5 μV/V, and for values between 10k and 100k it may be as low as 0.2 μV/V and up to 1.0 μV/V. For values above 100k, the noise ranges from 0.5 μV/V to 1.5 μV/V.

DERATE, DERATE

There are several power derating curves for carbon film resistors, dependant on size and construction. Miniature coated types have a hot-spot temperature of 120–125°C and are derated from 40°C to half their wattage rating, at 70°C, then derated to zero dissipation at the hot-spot temperature. This results in a 'dogs-leg' derating graph

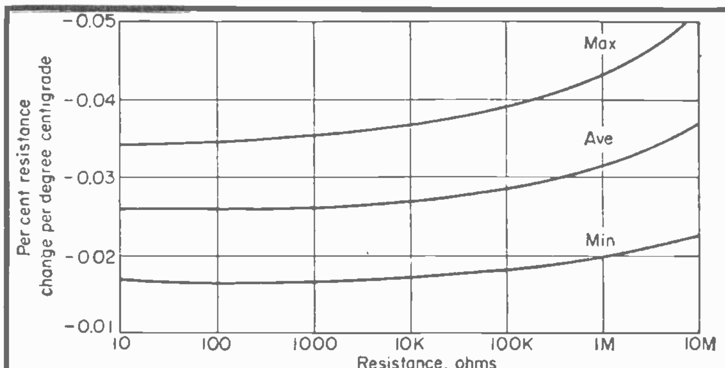


Fig. 3. Typical temperature-coefficient spread for deposited-carbon resistors.

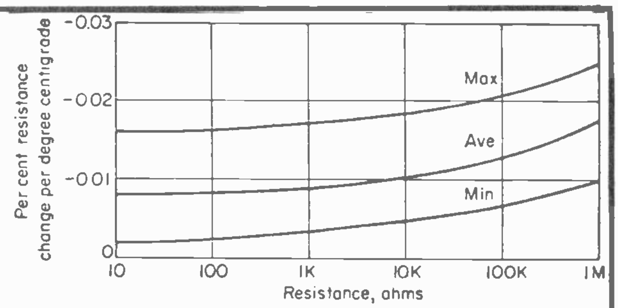


Fig. 4. Typical temperature-coefficient spread for boron-carbon resistors.

As mentioned just previously, the temperature coefficient of boron-carbon film resistors is somewhat better than the deposited-carbon types. The latter may have a temperature coefficient between +350 and –550 ppm/°C for values under 100k, and between +350 and –800 ppm/°C for values under 100k. Generally though, the TC will be negative. The variation of TC with resistance value and the sort of 'spread' that can be expected for a particular batch of components is illustrated in Figure 3 for deposited carbon resistors. The temperature coefficient of boron-carbon resistors is typically between +100 and –200 ppm/°C for values under 100k, and between –50 and

better than equivalent moulded or encased units. Generally speaking, the apparent value of the resistor decreases at high frequencies. Values below 1k will maintain their resistive value well beyond 500 MHz. Even relatively high values will not show a decrease of more than 10% until well into the VHF region. This is illustrated for typical coated ½W deposited-carbon film resistors in Figure 5.

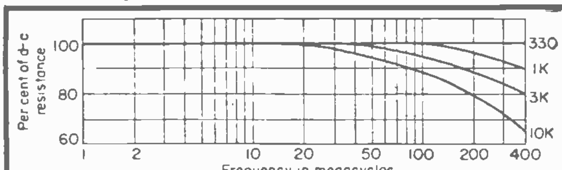


Fig. 5. Approximate frequency characteristics for ½-watt deposited-carbon resistor.

as shown in Figure 6. This mainly applies to the miniature 0.25W and 0.33 W types which have body dimensions typically 6-7mm long and about 2.5mm diameter. Moulded style units are usually derated from 70°C and have a hot-spot temperature of 130°C, according to the derating curve shown in Figure 7. Some types have a much higher hot-spot temperature, being constructed on a special ceramic rod and coated with a silicone resin compound which have superior heat dissipating properties. These types have a hot-spot temperature of around 165°C and are derated from 70°C, as illustrated in Figure 8. It is best to check the manufacturer's literature if the power derating characteristics are needed. Special 'carbon-alloy' types have a hot-spot temperature of 200°C but are not commonly used.

Carbon film resistors are available in ratings from 0.1W to 2W and in values that range from 10 ohms to 15M for

TABLE 2. General Characteristics of Carbon Film Resistors

Rated Wattage @ 70°C	Max. Working Voltage	Max. Operating Temp.	Critical Resistance	Typical Sizes		Typical Resistance Ranges	
				Length	Diameter	Deposited Carbon	Boron-Carbon
0.125	250 V	130/165°C	250 k	7 mm	2.3 mm	10 Ω – 1 M	50 Ω – 100 k
0.250	300 V	130/165°C	360 k	10 mm	2.3 mm	10 Ω – 2 M	20 Ω – 100 k
0.33 (0.5 @ 40°)	300 V	125°C	360 k	9 mm	3 mm	2.2 Ω – 5M1	
0.5	350 V	130°C	250 k	12 mm	4 mm	4.7 Ω – 5M1	10 Ω – 100 k
0.5	350 V	165°C	250 k	15 mm	4 mm	10 Ω – 7M5	
0.75	350 V	165°C	160 k	14 mm	6 mm	10 Ω – 7M5	
1.0	500 V	130°C	250 k	14 mm	4.8 mm	2.2 Ω – 10 M	20 Ω – 240 k
1.0	500 V	165°C	250 k	24.6 mm	7.2 mm	10 Ω – 15 M	
1.25	600 V	165°C	270 k	22 mm	9 mm	10 Ω – 15 M	
2.0	750 V	130°C	270 k	55 mm	7.5 mm	10 Ω – 20 M	30 Ω – 1 M
2.0	750 V	165°C	270 k	32 mm	9 mm	10 Ω – 15 M	

(1) Rated Wattage assumes voltage limit not exceeded.
(2) Max. Working Voltage assumes wattage rating not exceeded.
(3) Max. Operating Temperature is equal to hot-spot temperature.
(4) Sizes given are body sizes for axial-lead types.
(5) Coated types and silicone resin coated types only considered.

FILM RESISTORS

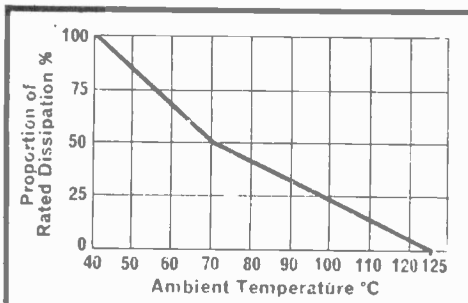


Fig. 6. Derating curve for miniature moulded carbon-film resistors.

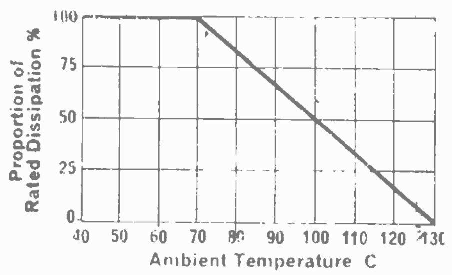


Fig. 7. Derating curve for coated carbon-film resistors.

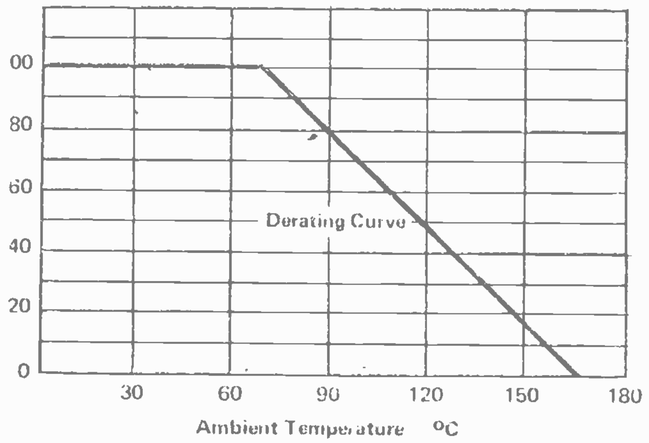


Fig. 8. Power derating curve for specially constructed carbon film resistors.

commonly available units and up to 100M on special order. They are manufactured to tolerances of ± 0.5% (E192 series), ± 1% (E96 series), ± 2% (E48 series) and ± 5% (E 24 series).

Carbon film resistors will withstand a short-term overload of twice to 2.5 times the rated maximum working voltage. Failure is more common in the high value resistors. Irregularities in the spiral track and extremely thin film contribute to the failure of the component. The resistor may burst into flame when it fails due to a prolonged overload.

HIGH PRAISE INDEED

The execellent stability and low cost of carbon film resistors, along with other desirable features such as low noise, small TC and good high frequency characteristics have contributed to their increasing use in a wide range of electronic applications. The general characteristics of carbon film resistors is given in Table 2.

electronics today international

What to look for in the Febuary issue: on sale Jan 7th

DON'T BE DONE!

The modern home has on average about £5,000 worth of removable valuables — colour TV, stereo system, carpets, money — you name it, a burglar will steal it. Not only is the financial risk high, the emotional disturbance can be tragic. No home is exempt from petty or even major theft. We can't promise to turn your home into Fort Knox — but a strong castle is a very good English tradition! Lots of articles have been published with alarm circuits — but we will tell you how to work out what you need — and just as importantly how to install a system properly. Also non-electronic security has its role — we will cover this as well. Remember hundreds of people every day have it happen to them — it can't happen to you though — or can it?

This project is based on a brand new Ferranti IC which does away with the need for separate A→D and D→A convertors in an instrument of this type.

Emphasis has been placed on ease of construction and on setting up, so that this three-and-a-half digit DVM is quickly built and aligned. Basic range is ±2V, and a simple switched attenuator extends this as you like. Resolution is 1mV when correctly set up.

This project is a good way to upgrade your workbench at a cost of around £30!

SHORT CIRCUITS:

BIOFEEDBACK

Biofeedback is the art of controlling your body by knowing exactly what it's doing! Put like that it sounds simple. But it isn't. Your brain generates several sets of 'waves', all at different frequency, and all with totally different meanings and functions. Yoga may be an old-fashioned idea — but biofeedback is a modern method achieving those aims — instantly! Or so its advocates claim. Make up your own mind in next month's ETI.

Temperature Alarm:— an ingeniously simple circuit to sound an audible warning (or trip a relay) when a preset temperature is exceeded or fallen below. Will work superbly as a deep-freeze alarm, process temperature controller, etc., etc.

Drill Speed Controller:— makes those tricky jobs seem easy, and extends the usage of *any* power drill.

Function Injector:— we refuse to call this a 'signal' injector, simply because these are usually sine or square wave only. Well ours does both and triangular functions as well, and is packed in a compact hand-held box to make life easier when you're crawling around inside that amplifier you've been meaning to fix for ages.

TECHNICAL BOOKS FROM ETI

CALCULATORS

99 WAYS TO KNOW AND USE YOUR ELECTRONIC CALCULATOR
L. Frenzel — £4.50

SCIENTIFIC ANALYSIS ON YOUR POCKET CALCULATOR
Smith — £8.25

COMPUTERS AND MICROPROCESSORS

COMPUTER CIRCUITS AND HOW THEY WORK
B. Wells — £1.80
Become acquainted with the various parts of a computer and its technology

COMPUTER TECHNICIANS HANDBOOK
B. Ward — £3.25
This giant volume compares to a 1,000 hour course on computer mechanics

DIGITAL ELECTRONIC CIRCUITS AND SYSTEMS
N. M. Morris — £2.60
The ideal book for the enthusiast confused by logic and digital techniques

MICROPROCESSORS
L. Altman — £11.75
Gives a general overview of the technology design ideas and practical application

MICROPROCESSORS
D. C. McGlynn — £8.00
Technology Architecture and Applications. This introduction provides a clear explanation of this important new device

MICROPROCESSORS AND MICROCOMPUTERS
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Describes the application programming and interfacing techniques common to all microprocessors

ELECTRONICS

ACTIVE FILTER COOKBOOK
D. Lancaster — £9.95
Everything you need to know to build and use active filters

ELECTRONIC ENGINEERS REFERENCE BOOK — 4th EDITION
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A completely new and up-to-date reference book for all engineers and students

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DESIGNING WITH TTL INTEGRATED CIRCUITS
Texas Instruments — £8.95
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ELECTRONIC MEASUREMENTS SIMPLIFIED
C. Hallmark — £2.10
Covers just about every conceivable test or measurement you will need

ELECTRONICS POCKET BOOK
P. McGoldrick — £4.15

ELECTRONICS AND PHOTOGRAPHY
R. Brown — £2.20
Practical circuit projects devoted to photography

ESSENTIAL FORMULAE FOR ELECTRICAL AND ELECTRONIC ENGINEERS
N. M. Morris — £1.20
Handy reference book, includes a section on S1 units, resistor colour codes and preferred values

FIRE AND THEFT SECURITY SYSTEMS
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HOW TO READ ELECTRONIC CIRCUIT DIAGRAMS
B. Brown — £1.85
Everything you need to know from basic circuit components to integrated circuits

HOW TO BUILD PROXIMITY DETECTORS AND METAL LOCATORS
J. Shields — £3.25
A practical do-it-yourself book

HOW TO USE IC CIRCUIT LOGIC ELEMENTS
J. Streater — £3.25
Helps those unfamiliar with digital logic circuits

INTEGRATED ELECTRONICS
J. Millman — £7.60
Using an IC approach the text leads the reader step by step from semiconductor physics to devices models circuits and systems

IC OP-AMP COOKBOOK
W. Jung — £8.75
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MULTI PROCESSOR

A CHANGE IN STYLE THIS MONTH — A REPORT FROM OUR AUSTRALIAN EDITION ON AN INTERESTING USE OF THE MPU IN THEIR PART OF THE WORLD.

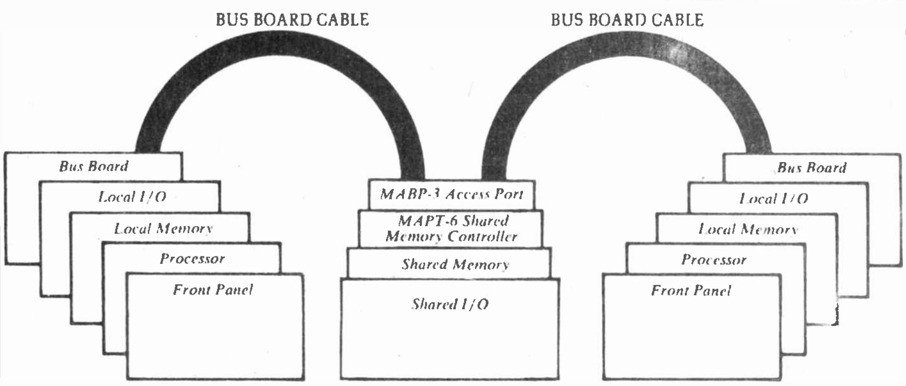
THE LATEST DEVELOPMENTS IN microprocessor systems are in using two or more processors with shared memory. We know of one American microcomputer manufacturer offering a 'shared memory' board but surprisingly we discovered a couple of people working with dual processors over in Australia. Information Electronics in Canberra sell a terminal using two processors (one to handle the screen and keyboard and one to handle the line) and in Sydney we discovered a guy who has developed a general-purpose dual-processor computer soon to be available from Fairlight Instruments Ltd. This computer was designed by one of Australia's leading microcomputer consultants, Tony Furse, and we went out to visit him to see what his system could do.

The world's best music synthesiser?

The dual-processor computer was originally developed to control an electronic music synthesiser. But surely *one* microprocessor would be enough, especially when current synthesisers don't have any sort of digital control? But wait 'til you hear what the machine can do — there's a polyphonic keyboard, eight 'instruments' can be synthesised at one time, there's a VDU screen which can be used to graphically display all sorts of information to the operator, there's up to eight terminals which can be used to synthesise sounds using programs in the firmware of the machine (for example, key in 80 80 80 80 80 80 . . . and watch the VDU display. You get a sine wave of amplitude 80 (I've no idea what units) followed by its 1st harmonic at the same amplitude, then the 2nd, 3rd, 4th ... at the prescribed amplitudes. As you watch the synthesis of the waveform you hear the sound out of the speakers). Obviously it would take a complete article to describe the system but you can see it is pretty complicated — too complicated for one microprocessor to handle with the response demanded by musicians in a live performance.

So dual processors take over where single processors leave off?

No, even in a simple application (capable of single-processor control) there are advantages offered by the dual-processor



MULTIPROCESSORS AND SHARED MEMORY

The IMSAI multiprocessor system uses a different concept to that of the Qasar system described in the text, it is a method of interconnecting two or more of the IMSAI 8080 computers so that they share memory. Not only do you have two processors but you have two of everything else, plus the extra boards in the centre of the diagram. Each 8080 processor has its own memory, which may be anything up to 64K minus the amount of shared memory. The Shared Memory Access Port and Shared Memory Controller boards available can link up to six computers.

What advantages of the dual processor?
Put simply there are three advantages:

1. Speed due to one processor being optimised for dealing with the outside world.

2. Programs are simpler because interrupts (servicing the outside world) which normally divert the processor temporarily can be handled by one processor optimised for this task, enabling the other to be expert at number-crunching. The second processor is more organised because it doesn't have to worry about things coming in from the outside world. Its data is pre-processed by the first processor and arranged in an optimal way for the second processor. The two processors are more than twice as good as one (it is something like four times as fast as a single processor for some jobs).

3. Debugging and testing. Testing of a program can be made quite simple because you can make the program go round and round without doing any output. You don't have to worry about output routines because you can use the debugging firmware package in the second processor to read the data tables that the first one uses.

Normally (with a single processor) if you are trying a program and nothing comes out you don't know if it's your output routine or what.

With a dual-processor system you can use the second processor to change the numbers in the program being run by the first processor. Then you can see the effect immediately.

Would the advantages of using two processors be similar to the advantages of using a 16-bit processor rather than an 8-bit type?

No. Two eight-bit processors don't provide a simple substitute for a 16-bit processor if it's 16-bit arithmetic or logic you want, provided of course that your choice of 16-bit processor is such that it does a 16-bit operation in the same time as an 8-bit processor does a similar 8-bit operation. It turns out however that many 16-bit microprocessors are quite a bit slower than the 6800, in fact this difference can

MULTIPROCESSOR

be such that one 6800 even though it must execute upwards of twice as many instructions for a given 16-bit function still produces the 16-bit result faster.

One other problem one encounters regularly is a need for 24-bit arithmetic. To give the one part in a million precision needed in these applications to the 8-bit processor this problem is merely a matter of triple precision arithmetic, but to the 16-bit processor one would usually be tempted to go to 32-bit precision to avoid programming complication. However this may be very wasteful of memory space if arrays of 32-bit data must be maintained. Once again this 8-bit processor tends to win against the current 16-bit opposition, this time on two counts: speed for a given operation and memory efficiency.

One other interesting aspect of the 8-bit versus 16-bit debate is the fact that generally a large part of all information to or from the outside world is in 8-bit bytes. Some 16-bit microprocessors are quite ugly when it comes to processing bytes and text and unfortunately byte processing constitutes something like 60% to 80% of the programme of human engineered interactive systems.

Can the two processors communicate?
On the computer there is an interface which enables the two processors to interrupt each other, but this doesn't happen often: only when there is a whole table of new data.

The processors have a second way of talking to each other – through memory locations. Periodically they can look up certain "mailbox" locations to see if any flags have been left there by the other processor.

Another advantage is that you can run an editor and an assembler simultaneously. Two completely independent programs can be run simultaneously.

Interface

Having the second processor means you can have peripheral interfaces that are a lot less sophisticated.

One could use most of the resources or the second processor in avoiding complicated hardware to interface to various peripheral devices, this technique, often termed "bit banging", uses the processor to control various individual input and output bit patterns normally controlled by external gates, flip flops, one shots etc. For example, a floppy disk normally needs around 60 to 150 TTL ICs for its microcomputer interface using up 50% of the processing resources of the second processor and providing a serial synchronous communications adaptor chip and several other TTL MSI chips. One gains a floppy disk interface which is controlled by software operating the second processor. The cost in hardware terms is possibly as little as 25% of the cost of the alternative, not to mention the extra flexibility gained.

If you take out the second processor chip, you have a port capable of gulping information out of the memory at a million bytes a second. And this has continuous access.

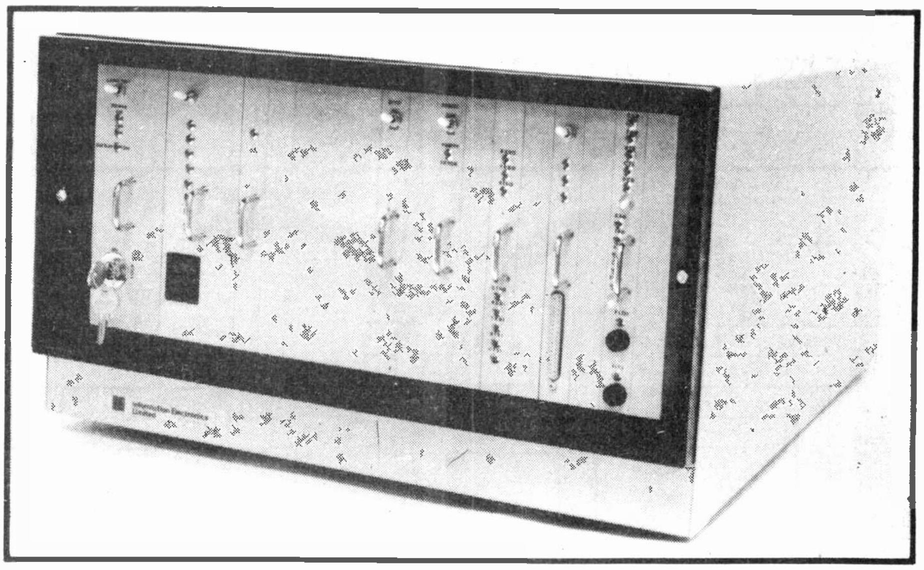
How do you keep the processors from colliding?
They are never operating at the same instant, they run out of phase. The memory is twice as fast as either of them needs: one processor does its cycle and before it gets round to doing the next the other processor has been in. With the 6800 all the activity occurs within half of the cycle so these devices are particularly suited to interleaving.

Is the dual processor only for people who know about microprocessors already, or does it offer advantages to the beginner?
The advantage for the guy who doesn't know so much about microprocessors is that he doesn't have to diddle about with input-output routines to try out programs. Once he knows the two processors behave identically he can load his program under the control of one with the other switched off, then he can start it running which immediately takes all the time of that first processor. Then he can use the second processor to get at the program while it is running. He can change numbers and things and see the immediate effects.

Quite often normal single processor debugging techniques make it very difficult to debug programs in which time critical closed loop control of some device or peripheral is a feature; in such programs data is read from the device processed and new control information is then output in order to keep the device under control. Use of program breakpoints or instruction tracing results in interference with the integrity or the control loop and of course under such circumstances the data gained in this manner may at best be misleading.

Use of the second processor in such applications allows inspection and modification of data without any interference to the loop integrity and of course allows far more effective debugging since loop overload recovery and other exotic s may be simply tested.

In practice, if you're handling a lot of peripherals, you use one processor to deal with the outside world (8 terminals, a graphics display, disc storage, etc in the case of the synthesiser). This is then the peripheral controller processor. It queues up work for itself to do and then does it. The other processor is free to get on with the business of crunching numbers and handling its very high-priority tasks.



The IE 180 microprocessor system from Information Electronics is aimed at the data communications and process control markets. It is based on the Intel 8080 processor but can incorporate two other processors, one for fast functions like moving memory blocks and one for doing complex scientific calculations.

The company also uses the multiprocessor concept in a Visual Display Unit, the IE 139. Two Intel 8080s are used as follows: One microprocessor is dedicated to line handling and communication, permitting line data rates up to 9600 baud. The second microprocessor controls the display functions and manipulation of data within the unit. The microprocessors have access to a common central dual port memory and interprocessor buffer thus making their actions time-independent. In addition, each microprocessor can address up to 4K of Read Only Memory for the firmware control program.

ELECTRONICS —it's easy!

PART 36

Digital computer systems — peripherals, stores and microprocessors.

ALL COMPUTING SYSTEMS HAVE a Central Processing Unit, (discussed previously) and a number of pieces of external equipment associated with them. Such additional units, known as peripherals are necessary to handle the flow of information between the outside world and the Central Processing Unit (CPU).

The range of peripherals available today is extensive. Basically the design aims are to provide interfaces between the human or automatic plant user and the computing system which are the easiest to use, the cheapest to implement and which have the means to transfer data as fast as is desired.

At present — though this will undoubtedly change in the future — we are unable to communicate with the computer by the same means that we communicate with each other — that is by direct speech and vision. Peripherals, are by necessity of our technological and economic limitations still very much compromises to the ideal, except in applications where the computer interfaces to hardware plant, such as in process control, when interface problems are easier to solve as such systems communicate by the same signal formats.

CARD AND TAPE PUNCHES AND READERS

In order to make good use of the high speed of electronic computing circuits, the input and output functions should ideally be capable of transferring the data at a comparable speed. Rarely has this ideal been realised. The throughput rate of peripherals has been speeded up enormously since the first EDP system but, similarly, the rate of computation has been increased.

Because of this shortcoming, data (in human operator use) is first prepared by hand onto a medium that can feed into the EDP system at rates far exceeding the operator's ability. It is then stored in the machine ready for access when the CPU needs it.

The earliest form of input/output medium used punched holes made in a pile of paper cards or a continuous tape. We inherited these from a 17th century weaving machine via the Hollerith census sorter. Figure 1 shows the commonly used Hollerith coded punched card. The holes are punched out in a code that represents the alphanumeric symbols shown above each row. Figure 2 is a section of punched tape: these are available with 5,6,7 and 8 hole positions across the tape width. (The smaller hole is for the timing drive sprocket). Tape readers are built to read code from a specific width tape: that is, a 5-hole tape could not be used on an 8-hole system. Tapes and cards which are to be used extensively can be made in more durable materials such as oiled paper, Mylar and aluminium-Mylar.

The holes in cards are produced by mechanical punches. These comprise a punching head by which the appropriate holes are made for each character in response to a typewriter keyboard-input. Keyboard layouts are based on the familiar office typewriter. Extra keys are added for computer applications to enable a greater range of control by the operator. Such additions vary widely.

Tape can be punched automatically whilst the teleprinter type of terminal, is used as a typewriter. Where the tape is generated as part of an automatic process - as in a data logger, a smaller punch unit is used which incorporates punch drivers activated by control signals - no keyboard is needed.

Card and tape readers consist of a transport mechanism that passes the medium across reading heads. Recognition of a code represented by holes is accomplished by mechanical fingers making direct electrical contact (in the slower readers) or by solid-state optical sensing using LED lamps and photo-diode arrays set to sense the passage of light through a hole position. Some method of synchronising the code position with the data values is essential.

Cards can be punched by an operator at rates between 250-500 per hour. They are often checked on a verifier machine that determines if the card is punched in the same way as the check operator keys the code a second time. They can, by contrast, be machine read or sorted, at 200-1000 cards per minute depending upon the complexity of the task.

Tape punching is confined to similarly slow rates of production at the operator stage of preparation. When the punch is machine operated, punching rates can rise to 150 characters per second. The speed at which punched tapes can be read varies from very slow, using

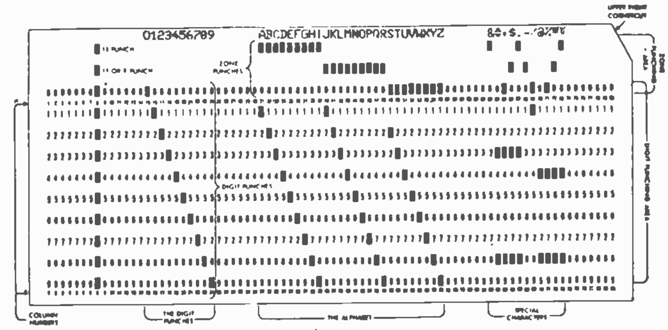


Fig 1 Standard Hollerith Code used for punched cards

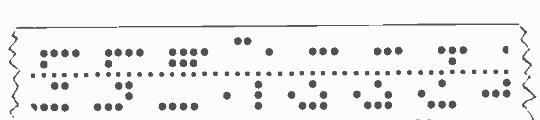


Fig. 2. Section of 8-hole punched tape. Two rows on the wider side of the central sprocket holes are not used in this data.

mechanical sensing up to 600 characters per second or more with high-performance optical equipment.

A considerable amount of electronic logic and drive circuitry is needed to operate a punch unit. Figure 3 is the block diagram of a reader using brushes to sense the presence of holes. Input commands to the punch would emanate from the control unit of the EDP system.

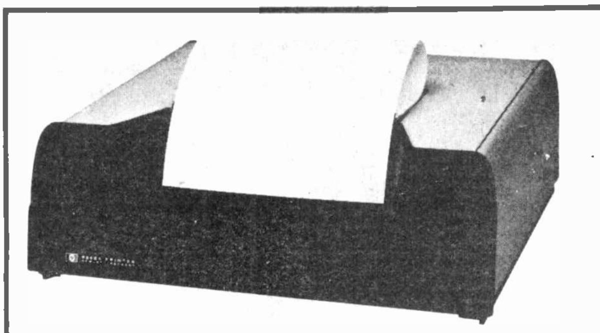


Fig.5. This Hewlett Packard 2607A desk-top line printer provides hard copy output (with 6 copies) at 200 lines per minute.

MAGNETIC TAPE INPUT/OUTPUT UNITS

Cards and paper tape store information about commands to the EDP system (the programme) and hold the numerical data to be manipulated. They are, therefore, a form of permanent data storage. They suffice (in the form described above) as a data store when the data quantity is not great. A recent trend, which has speeded up data transfer and reduced the bulk needed to store the programme and data, makes use of magnetic tape in cassette form. The compact unit shown in Fig.4 can transfer data at 6000 bits per second at a density of 30 bits per millimetre of tape. (Total capacity on a cassette – five million bits). These can also be used as additional memory in the system.

PRINTERS

Teletype units are able to provide hard copy printout but due to the slow printout resulting from letter by letter operation they are not used as the main alpha-numeric output of an extensive EDP system. They can print-out at only 10 characters per second or so.

The line printer was evolved to speed up this form of output. It prints all the characters of a complete line simultaneously. Line lengths are typically 132 characters and the faster models can print lines at rates exceeding 1000 lines per minute. (For which an outlay of £25,000 is required!)

Printing mechanism vary considerably, ranging from development of the fundamental typewriter method, to devices that print each character from a 5 x 7 matrix of dots. Line printers were originally bulky units. Today desktop, typewriter size units, are in common use (Fig.5)

Printers can be programmed via the EDP system to provide any format required – periodic reports, invoices, records, data lists, software record. A crude form of graphical display can also be produced using the position in a line as one ordinate and the lines as the other.

When computers are used for automatic pagination the printer can be one that produces print-type direct.

GRAPHIC DISPLAY – PLOTTERS

Many computational tasks ideally require a graphical display of output information, not a long list of numbers. Plotters may be of x-y type or y-t type.

The x-y type of plotter is arranged so that the graph paper is held stationary and the pen is capable of being driven both vertically (y axis) and horizontally (x axis).

The y-t plotter has a roll of graph paper which is driven at a constant (and usually adjustable– speed; the pen can be driven in one axis only (y axis). Hence the y-t plotter basically plots a single variable against time. Plotters made specifically for computer operation will be provided with the interface facility that enables direct connection to the EDP system. (Normal plotters require an extensive amount of extra equipment to make them compatible).

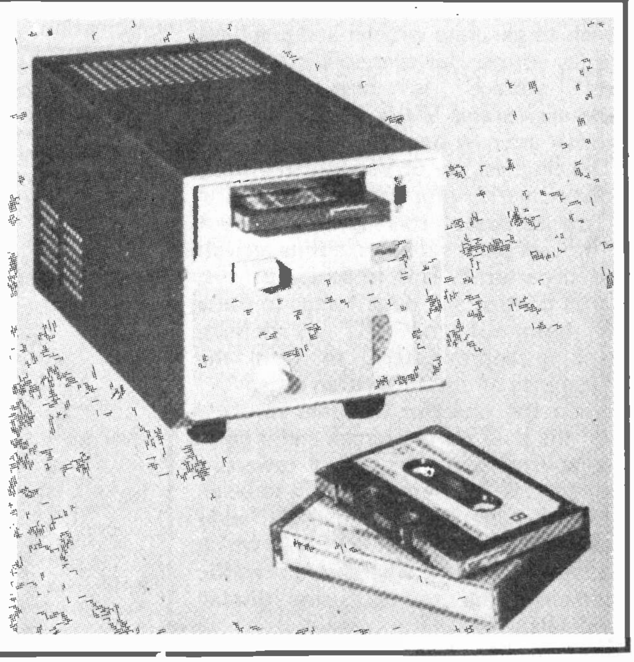
Computer controlled plotting of x-y format has the ability to be scaled on demand and to generate alpha-numeric legends on the plot. It is an easy matter to replicate the plot – the programme is run again.

Plotters may be of the analogue drive kind (a later part discusses plotters in detail) but due to the nature of digital processing the result may still have a quantized appearance if the resolution is not sufficiently small. Alternatively the axes may be driven with stepping motors – such machines are called incremental plotters.

Flat-bed style of x-y plotters are available which can handle paper of all sizes – from a few centimetres square to size of a wall. A medium-size computer controlled flat-bed plotter is shown in Fig.6

Line drawing rates are limited by inherent electro-mechanical response to around 0.4 m/s in small plotters. The very large machines, when under tight control, are usually capable of around 0.1 m/s translation rates when working

Fig.4 Cassette form of magnetic tape is finding greater application as a standard EDP and computing caculator peripheral.



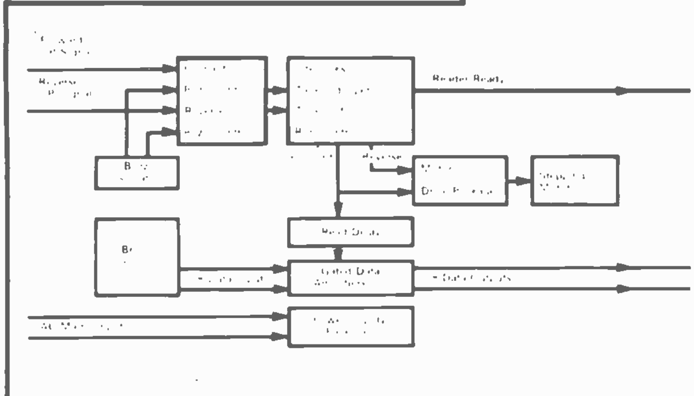


Fig.3 Block diagram of early model Data Dynamics low-speed tape reader (30 c.p.s.).

ELECTRONICS–it's easy!

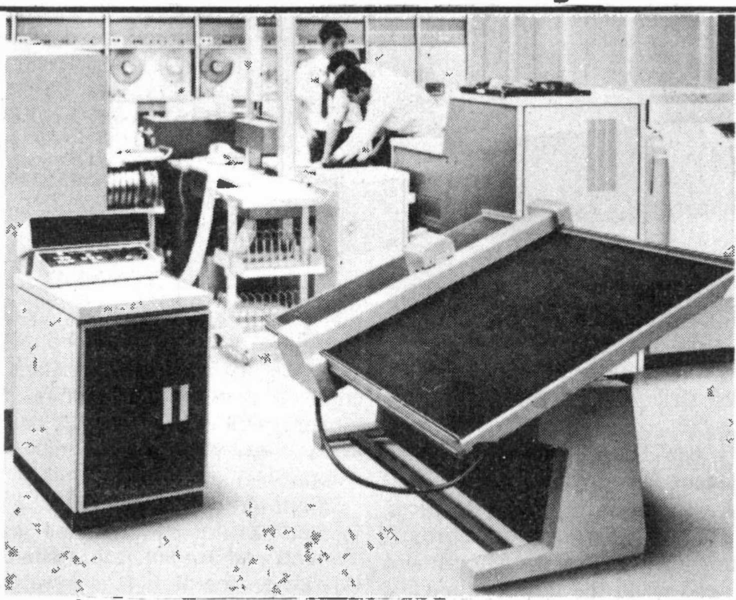


Fig.6. Series 500 automatic drafting system by Gerber Scientific.

to precisions of 25 μm.

Some y-t plotters incorporate bi-directional drive for the t axis (the paper drive) enabling very long lengths of paper to be driven back and forth along the roll in order to produce an x-y form of plot from a y-t format machine.

GRAPHIC DISPLAY – VISUAL MONITORS

Many applications require rapid call-up of data that is presented in a way that can be easily read by the operator. It may be quite unimportant to receive it as hardcopy. The cathode ray tube (television) type of display was an obvious choice. Such displays are known as visual display units, VDU for short.

Originally, visual display units were very limited because of the need for a considerable amount of storage with which to generate written and graphical display forms. However solid-state mass data storage is now relatively inexpensive and VDUs in one form or another are now standard peripherals.

The simplest use of VDUs is to display alpha-numeric information — a section of the software programme, a readout of process plant variables, airline arrivals and departures. This is achieved using digital control and data storage to cause the beam of the CRT to deflect, blanking appropriately, to form the appearance of a static written page.

When the operator becomes involved with the data on the screen and is given the ability to manipulate it toward a desired task the terminal is said to be an interactive graphic terminal. An early example of this is given in Fig.7 which depicts a system whereby air traffic controllers are trained using display terminals.

Once it had been realised how the VDU could be used to produce line drawings designers sought ways to 'draw' on the screen. The result was the 'light-pen'. The operator holds a special stylus on the screen of the CRT. Closed loop controls cause the spot to lock onto movements of the stylus. If the trace path is to be retained, the x, y and intensity coordinates values are fed into the digital memory. Once a line is drawn it can be retained and regenerated in this way. Other operations enable the operator tc automatically erase sections of line, straighten lines and smooth curves by computer processing. The complete drawing can then be permanently recorded as hard copy on a plotter or as a data set. Interactive methods have saved an enormous amount of time in tasks such as deciding the extremes of a motor-car wheel movement during the many combinations of springing and steering positions within the wheel arch.

Today's graphic terminals are extremely versatile. Completely self-contained units which incorporate a built-in processor are in common use. A recent release is shown in Fig.8

Improvements in the storage-tubes used to hold the displays of a CRT system have been coupled with the power of modern computing to provide display terminals that have half-tone photographic quality presentation. Figure 9 shows the quality (after our recopying) obtainable. The images shown are entirely reconstructed on the VDU from digital, not analogue data. Colour displays are also coming into use adding yet more dimensions to the interaction available to the operator.

A recent project of the Australian National University gives some idea of the use of the interactive VDU. In the Department of Engineering Physics a team of research workers have developed a colour display terminal that can call-up the data recorded by the ERTS satellite. The computing system has in its memory file copies of the original ERTS data. Using the graphic terminal the operator can select which form of photograph — IR, false colour, etc., to study. He can then rapidly zoom into a particular area using a joystick control expanding the spatial scale as the search becomes concentrated. Other control includes enabling the colours to be digitized into level zones and to be complimented.

INSTRUMENTATION INTERFACES

When the digital computer has to manipulate measurement and control data from analogue processes, the system must be provided with the appropriate A to D and D to A converters, and the multiplexing arrangement which forms the data logger.

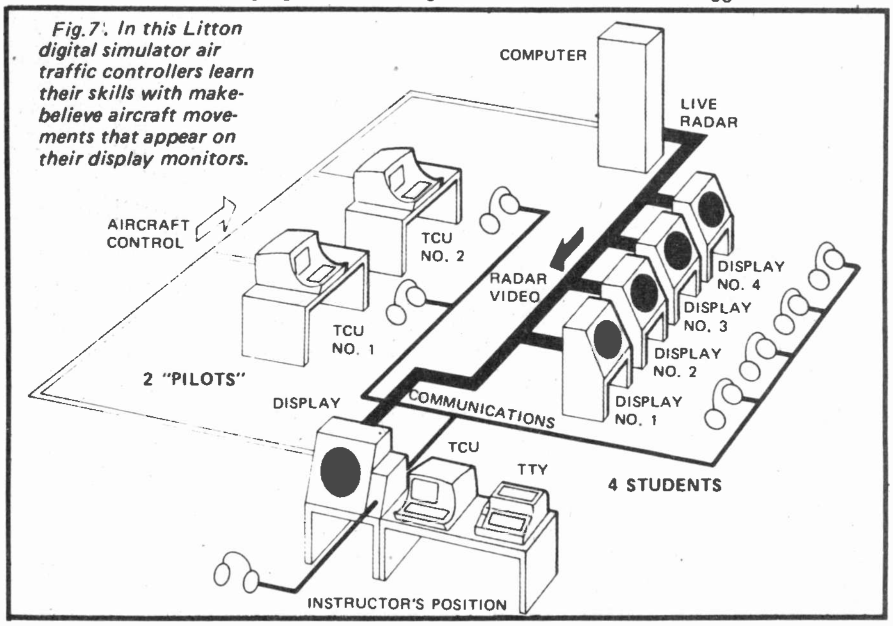


Fig.7. In this Litton digital simulator air traffic controllers learn their skills with make-believe aircraft movements that appear on their display monitors.

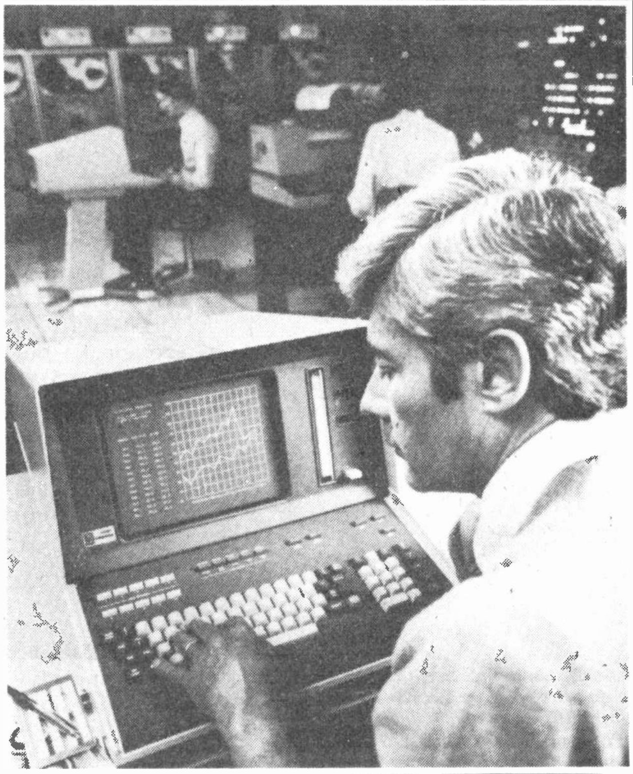


Fig.8 . Interactive graphic units often now incorporate their own processing and memory to form an off-line self-contained unit — 4051 Tektronix BASIC graphic computing system.

MODEMS AND OTHER LINKS

When computer data has to be transmitted over considerable distances it becomes expedient to use telephone lines or microwave links. Units interfacing computers over telephone lines have become known as MODEMS (a word built by combining Modulator and Demodulator).

MISCELLANEOUS PERIPHERALS

New methods for communicating with the power of an EDP system continue to be devised in an endeavour to overcome the interface difficulty humans have with electronic machines. We are still a long way from the stage where we need only casually to talk to the machine. Steps are, however, in progress toward this aim with research into spoken word and written word recognition. Neural research into brain waves may one day be coupled with electronic hard ware to provide direct thought links.

Work at Warwick University has resulted in computer - controlled production of braille maps for the blind. Automatic mapping and language translation are other areas where positive progress is being made into very complex human communication processes.

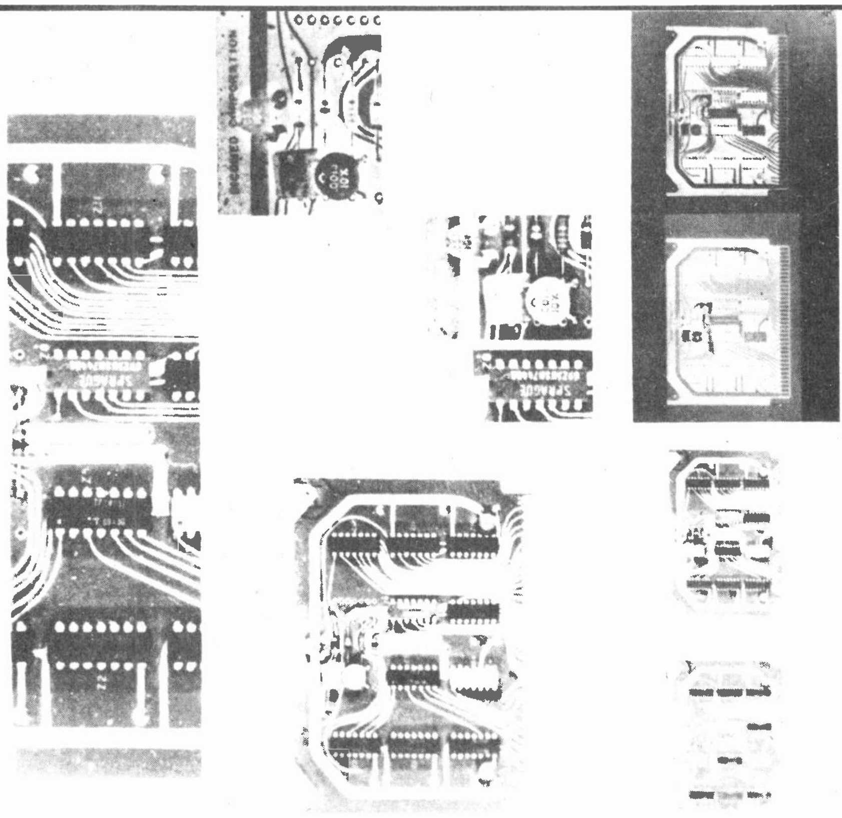


Fig.9 This multiple image presentation is photographed from the screen of DICOMED digital image display unit.

STORAGE

Inside a CPU and external to it will be found a memory of some kind. This is used to store the vast quantities of coded data needed to perform the various tasks.

Memory within the CPU is characterised by the need for high speed access to any data bit needed. The requirement on capacity is less stringent. Memory external to the CPU will, by the necessity of machine organisation, be a little slower to access but it will usually need much greater storage capacity.

CPU MEMORY

Core - storage is needed in the CPU to hold important programme instructions and to act as a temporary home for data generated in the course of a manipulation.

There are many options open to the designer but the storage method that has emerged as the optimum for CPU storage is magnetic core storage — known simply as the core store. (This situation will, however, soon change, the preference going to solid-state methods). Magnetic core storage makes use of the fact that magnetically hard materials, such as ferrite, will swing remanent magnetism polarity from one state to the other with the passage of a quite widely toleranced current through a wire passed through the core — see Fig.10a To make a practical core store it is necessary that any chosen core can be switched on demand. If a second wire is passed through the loop this can be used to prevent or enhance the magnetic switching action by the passage of the current.

A core store comprises a plane of ferrites arranged in a grid as shown in Fig. 10b Two half-current units appearing in the same direction in a core will switch that core but no other. Thus two lines will select a unique core in the plane as the place to store or readout one bit.

To read out the values it is necessary to interrogate the selected core using input signals in the write wires that will, if switching takes place, induce currents in an additional readout wire. As this process can destroy the data on the core

ELECTRONICS—it's easy!

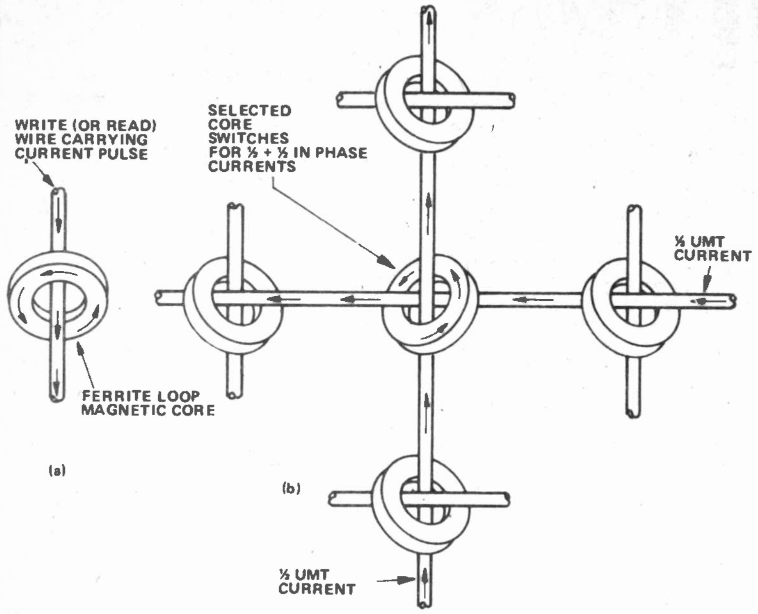


Fig.10. (a) When a large enough write current passes in one direction through the ferrite core the core becomes magnetised in one polarity. It thus records a bit.
Fig.10 (b) A second wire is added to act as an inhibitor or enhance line.
Fig.10 (c) Finishing touches being added to a Philips 3-D core store. (20 planes of 64 x 64 cores, one X wire, one Y wire, read and inhibit wires).

a test means may be provided to rewrite it again ready for reuse. Figure 10c shows a stacked core-plane. Ferrite cores are typically 0.1 mm overall. Planes are either stacked one on the other or mounted flat on a printed circuit board to provide a memory unit. The capacity of core storage varies from thousands to millions of bits. Core-store is more usually quoted in word capacity, words being of 32-60 bit length. The terminology is to refer to capacity as, for example, 32 k of 16 bit words. (This is often incorrectly written as 32 K — the lower case k should always be used as this is the *only* correct abbreviation for '1000'). Core storage can be cycled in 100 ns (typically) with some systems taking only 10 ns. The disadvantages of core are the relatively high cost resulting from the labour intensive production method and the comparatively large space needed.

DELAY LINES

Another reasonably fast storage system makes use of the delay-line concept. It is the property of materials, such as mercury, to pass only waves of acoustic energy at a given rate of propagation. Early computers used mercury delay lines in which the acoustic equivalent of a binary word was sent down a tube of mercury to emerge at a later time at the other end. Whilst in transit the word was in storage. The method (if used at all in a computer today) would now be implemented using solid wires or clocked - on registers. It has the severe shortcomings of low storage capacity.

SOLID-STATE

Although core storage still forms part of many computer installations the current trend is clearly toward the use of a solid state circuitry which stores bits in register style flip-flop systems. Read only memories (ROM), content addressable memories (CAM), random access memories (RAM), and Programmable ROM memories (CAM), random access memories (RAM), and Programmable ROM devices (PROM) are available as IC chips with typical arrays downward from 512 eight bit words — that is 4096 bits on a single IC chip. Figure 11 shows just one of a huge range of alternatives — 1024-bit read-only memory. Memories such as this exhibit a typical delay from address to output of 36 ns. Chips such as these are also available ready mounted as memory cards with as much as 65 536, 16-bit word capacity. ●

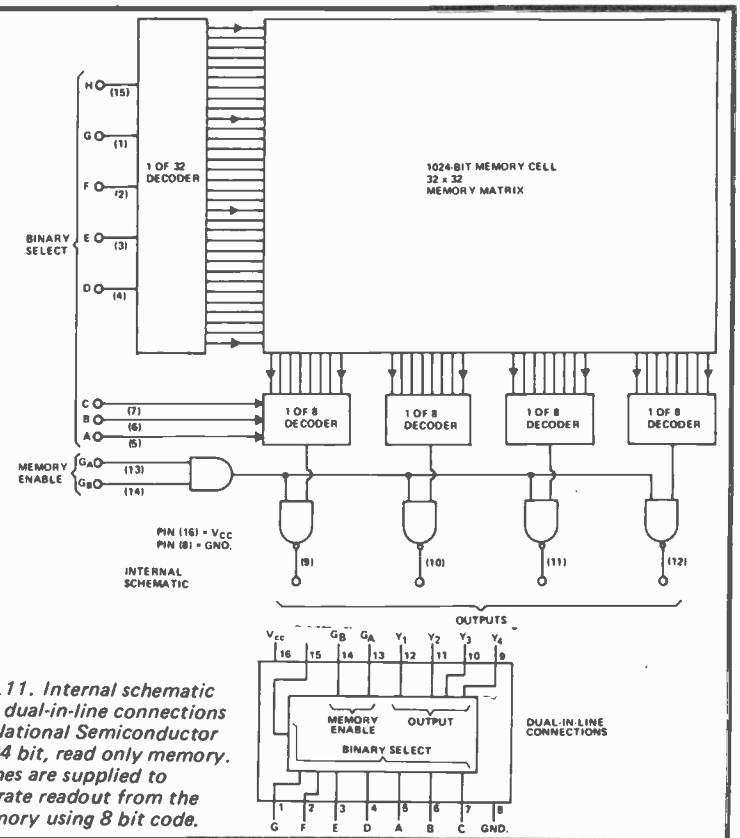


Fig.11. Internal schematic and dual-in-line connections of National Semiconductor 1024 bit, read only memory. 8 lines are supplied to operate readout from the memory using 8 bit code.

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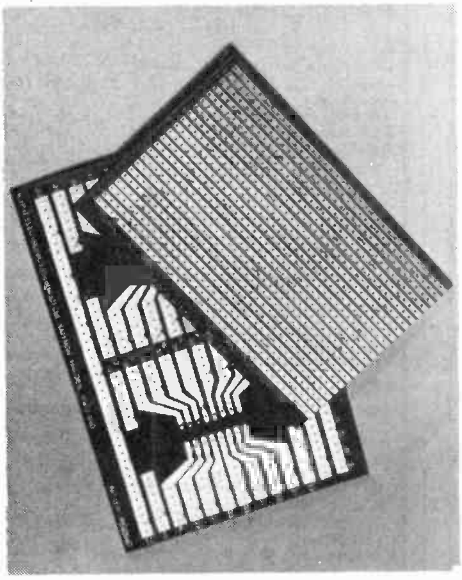

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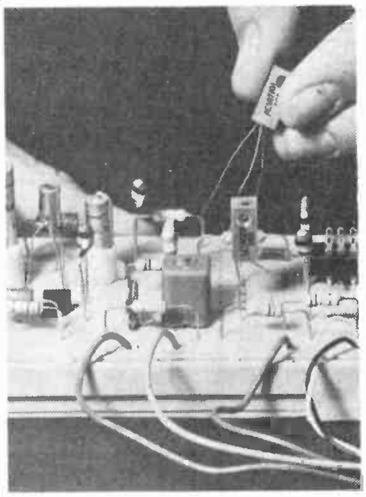
Take an S-DeC, take a small stock of components. Plug components into S-DeC, no soldering, make a radio receiver, light operated switch, 3 stage amplifier. When circuit is made unplug components and use them again to make a morse practice oscillator, LC oscillator, binary counter and any other discrete circuitry. See Practical Wireless for new series of S-DeC projects. S-DeC + step by step instructions to build above projects and 3 more + which components to use + free control panel for mounting switches, lamps etc. + free Blob Board. S-DeC only £1.98 + 37p (VAT + post) send only £2.35.



T-DeC

If you are using IC's to build circuits use T-DeC for 1 chip circuits and U-DeC A for 2 chip circuits. Draw circuit on graph paper, plug IC into Adaptor and plug into DeC. No soldering, no bent leads, no wasted IC chip. Lines on DeC show contact rails, plug discrete components in. Cross overs, connections are made using different coloured leads. Circuit completed and working unplug components and use for next circuit. No soldering, no damage to components. Use your DeC and small stock of components over and over again. T-DeC send £4.30. U-DeC "A" send £4.60. Adaptor send £2.30.

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ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

THE Computer User's Tape System (CUTS) has long been proposed as the ideal system for recording digital data on cassette tape units for the amateur using standard cassettes. CUTS you may remember relies on two different tone transmissions to differentiate between logical 'I's and logical 'O's, the two tones being 2400Hz and 1200Hz. The encoding and decoding circuits are built around the requirement for 4 cycles of 1200Hz to define logical 'O' or 8 cycles of 2400Hz to define logical 'I', thus setting bit transfer rate at 300Hz. With 11 data bits per byte (8 data, 1 start and two stop bits) the character transfer rate comes down to under 30 characters per second. Quite a few encoding and decoding circuits have been proposed, but these have the problem that your decoding circuit may have to decode data encoded by completely different circuits if cassette interchange of programs, etc is to be done using this system. CUTS is not a self-clocking system and thus needs the same master oscillator frequency to be used by both encoder and decoder. The decoder has to allow for tape errors such as dropout and wow and flutter and phase correction has to be included.

TONING UP

This can be a tone decoder set at approximately the master oscillator frequency or a multiple of it (say 4800Hz) and phase locked by a derivation of the incoming tone. An alternative with a fast MPU is to serially read the 2400 or 1200Hz directly into the MPU and to cycle round a sampling loop during each input phase change. The number of times through the loop is counted and an average worked out for a 2400Hz phase change. This average can then be compared to each actual count and used to define whether the current phase change is about the same as the average (thus 2400Hz) or about double the average (thus 1200Hz).

The average for a logical '1' is used both because it is the faster of the two and also because CUTS defines that logical '1's must be transmitted between each block of data and that the start bit is therefore a logical 'O'.

This type of system for decoding CUTS can be used at any input speed because the MPU will automatically compensate for minor or major changes in input frequency. This system is thus self-clocking because it can extract a sampling period from the incoming data frequency without knowing what that frequency is supposed to be. There are many other forms of self-clocking system which could be used for tape (or audio phone) data transfer.

Possibly the simplest system available at low cost is to use a stereo tape unit and to record data on one track and the sampling pulse on the other track. Wow and flutter errors will be low, because the fault will be common to both tracks but the system cannot be used for single line date transmission unless you want to try using stereo encoders and decoders.

TEXT ON TELLIES

Teletext uses a bit rate of 6MHz to transmit a 40 character data line during each of its two television lines. The data is encoded as Non Return to Zero (NRZ), which means that the data is transmitted as true high or low levels. This is decoded by generating a clock from a set of 101010 transitions, and relying on a reverberating oscillator which is 'kicked' into oscillation by the incoming data pulses.

This works until the oscillator dies away or gets out of phase because of lack of transitions if a long string of '1's or 'O's is transmitted (as few as 10 bits without change can cause trouble). The next logical step is to use a phase change to indicate a data bit. Looking at the NRZ-Mark system each logical '1' will cause a change in the signal phase and a logical 'O' will leave the signal unchanged —

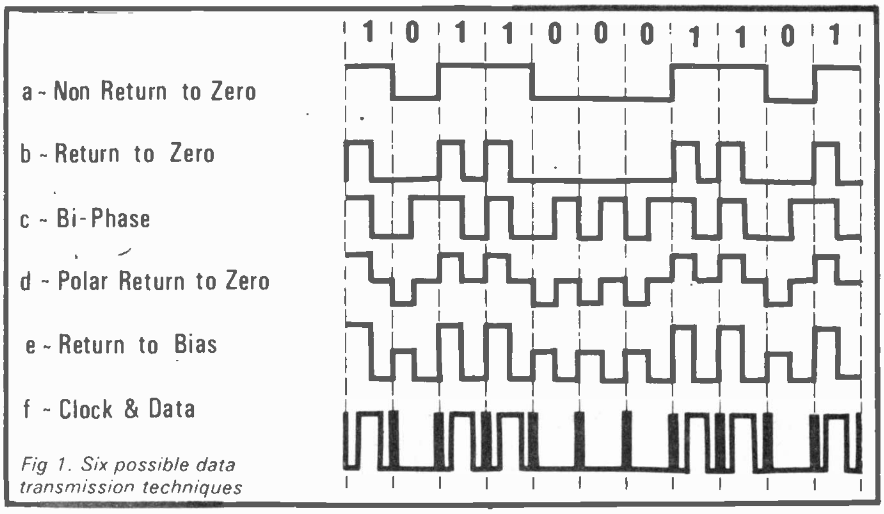

Fig 1. Six possible data transmission techniques

by John Miller-Kirkpatrick

these are reversed for the NRZ-Space system. Again this system can quickly end up with errors if bit changes are not frequent enough.

HALF A CLOCK

Using a bit transmission time of half of the clock period means that each clock period will contain a signal transition. This is shown most easily by the RZ system where the first half of each clock period is sampled for the data and the second part of the clock is always logical '0'. This system will only give errors if a string of '0's is transmitted. With the Bi-Phase systems the change in phase is used as the clock generator and as the data identifier, a HIGH to LOW level change identifies a bit '1' and a low to high as a bit '0'. The clock period must be set or calculated by examining a string of '1's as with CUTS and extracting a clock period, one transition change per clock period indicates a change in bit data but two transitions indicate no change.

ONE WIRE OR TWO?

All of the above systems require that one wire in a two wire connector is at a common ground, in a lot of cases this will not be possible because of an intermediate audio conversion. Thus we should consider decoding from an unbalanced pair of wires where there is no common reference level between transmitter and receiver.

An alternative approach is to use a bias level of signal and recognise variations from this bias as data bits. Two variations are shown one using positive and negative changes from the bias voltage and the other showing two levels of positive voltage from a common ground.

A further technique puts out a regular short clock pulse followed by a wider data pulse for logic '1' or no pulse for logic '0'. This last system is suggested by National Semiconductors on an application note for interfacing SC/MP to a cassette recorder. For a copy of this application note (AN163) contact N.S. at 19 Goldington Rd, Bedford.

POSSIBILITIES

Having considered all of the above possibilities we are left with the problems that could be caused by spikes causing spurious data transitions at the transmitter, at the receiver or in between. In a self clocking system these can be overcome by filtering either with a C/R or a digital monostable, but if the system is to work at any rate then the C/R or monostable would have to be modified for different data rates and this requires a feedback averaging system. This in turn could be done by an MPU using mathematical averaging and sampling with much more efficient results than any form of C/R averaging. Whichever of the transmission techniques is used we have to extract probable data and probable clock pulses and feed these into our MPU as two bits in parallel via some form of latch or input port. Any transitions in the data are compared with a calculated average and thus transitions much shorter than the average can be ignored as noise.

SLOW SCAMPERING

As SC/MP is one of the slower MPUs any system used by SC/MP could be easily used by a faster MPU. SC/MP performs one machine cycle in 2uS with each instruction taking about 10 cycles to complete. Thus instructions are performed at about 50KHz (1MHz being the MPU crystal frequency). If we assume a maximum transmission frequency of about 2500Hz to be available on audio cassettes (or the telephone- then our MPU can perform about 20 instructions between each input data cycle. Without trying it I would guess that 20 instructions is about the minimum required to sample several times and calculate an average clock period. Without stop and start bits a 2500Hz bit rate ends up as about 300 bytes per second data transfer rate, ie about 10 times faster than CUTS.

BLOCK WRITING

Regardless of the transmission format or rate the data must be finally used and we have tied up our MPU so that it is continuously sampling the input but never being able to do anything with the data. It is for this reason that data is usually transmitted in blocks with an inter-record gap during which the processor can process the data. With tape I/O a block might be 1K bytes which would take about 30 seconds to read or write using CUTS. The MPU can now be instructed to read or write 1024 bytes at a time using a 1K byte RAM as intermediate storage. The data in the RAM can be read or written by the MPU at leisure during an inter-record gap, if necessary the tape transport can be stopped during this gap but allowing a space for the tape to reach recording speed and if necessary rephase the clock at each restart of the machine.

Typically an inter-record gap on cassette would be a couple of seconds (CUTS specifies 5 seconds) and thus a record of less than a few seconds would cause tape wastage in a lot of inter-record gaps. Alternatively we might specify that every block must be 1024 bytes and not allow for shorter records physically but test the RAM for an end of record marker. This means that tape could now be wasted by 'filler' data that is not to be processed, somewhere between these two alternatives is the compromise standardisation of blocking factors which can be used by any MPU or even by non-MPU systems.

CUTS IN STANDARDS

American amateurs (mainly with 8080 systems it seems) have evolved CUTS as a standard interchange system. In this country there is no standard because of the relatively small number of amateur users, the British Amateur Computer Club have about 500 members of which about 50 have MPU systems and about 20 have large mainframe systems. With the advent of non-TTY MPU systems (such as ETI's SYSTEM 68 and Bywood's SCRUMPI) the low cost MPU is now a feasible proposition for more people with the result that program and data interchange is going to happen more often.

Now is the time that a UK standard for amateur data interchange has to be set up and that standard must take all of the points in this article and others into consideration. To my knowledge the BACC is the only body in existence in the UK attempting to unite amateur computer and MPU users but they have no definite views on the use of CUTS or any other recording system nor any views on block sizes, etc. If you have any ideas or opinions on these subjects or if you know of any other user groups why not contact us at ETI or write to the BACC.

Membership of the BACC costs £1 per April to April year, you get a good newsletter as well as organised talks and visits, a worthwhile investment as an addition to any MPU system. For further details send a SAE to Mike Lord, 7 Dordells, Basildon, Essex.

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- Size & weight: 60x160x405mm, 1,7 kg

This type of mixer is at 2 channels, namely channel 1 and 2, supplied with a compensating-amplifier for MD (Magneto Dynamic) pick-up elements. The third input is suitable for connection of a dynamic or capacitor (electret) microphone. The fourth input is suitable for a tuner, tapepart or crystal p.u. with an output level of 0,1-1V.

MP-2002 MD STEREO MIXER
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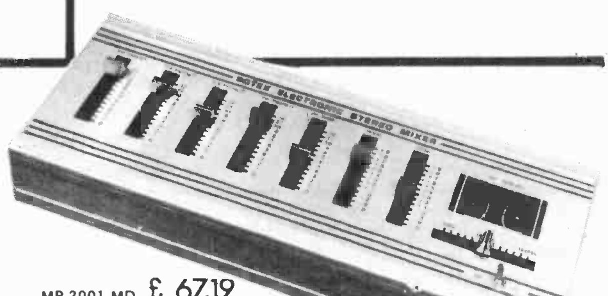
A second type from the ROTEX mixer series like the MP-2001, but incl. adapted microphone with swan-neck, fadingslide control and front monitor. Connection for headphone, of which the volume can be separately adjusted by means of slide control.



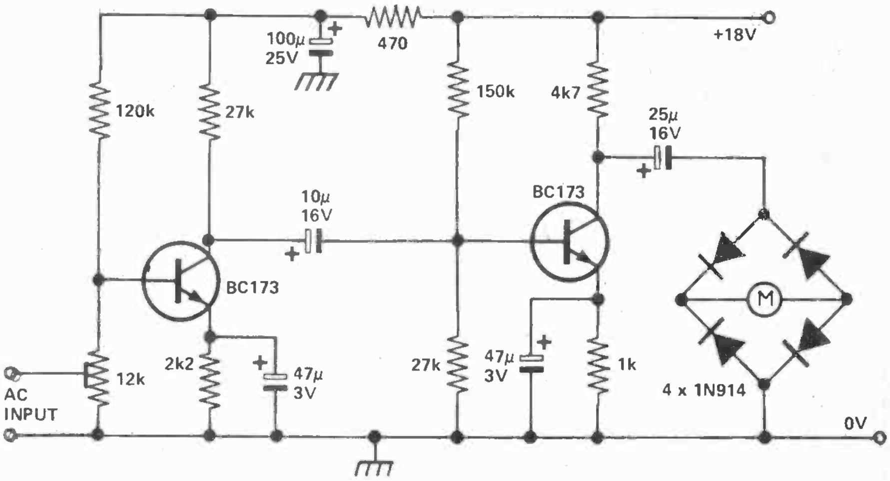
MP-2001 MD £ 67.19

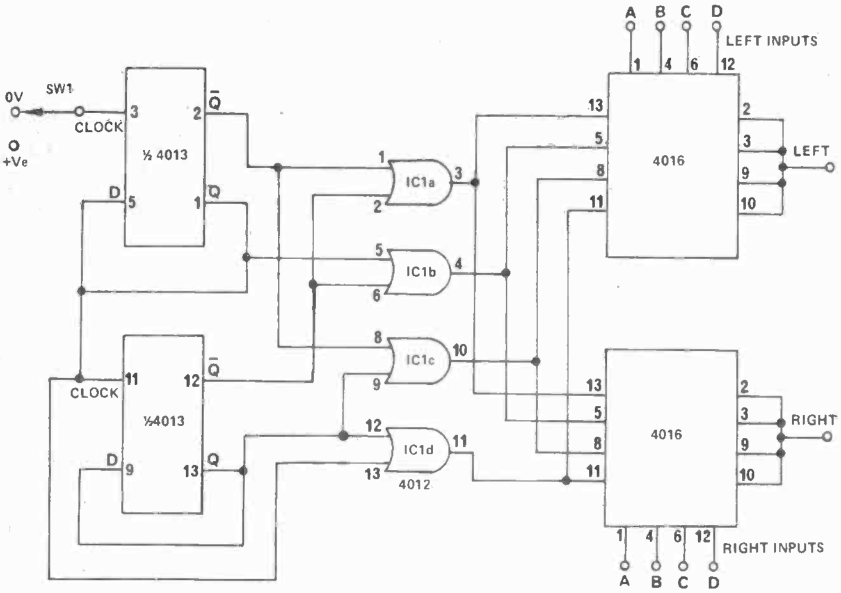
MP-2002 MD £ 93.39

tech-tips

RECORDING LEVEL METER

The circuit shows a two-stage voltage amplifier driving a recording level meter. The AC signal input is amplified, rectified, and the resultant DC voltage shown on the meter. The circuit can be used with a tape-recorder or audio mixer and should be fed from a point early in the pre-amp. Current consumption in a no-signal state is 2.8mA. The 12K preset gives a variation in sensitivity. The meter can be any general purpose type.





SINGLE POINT STEREO INPUT SELECTOR

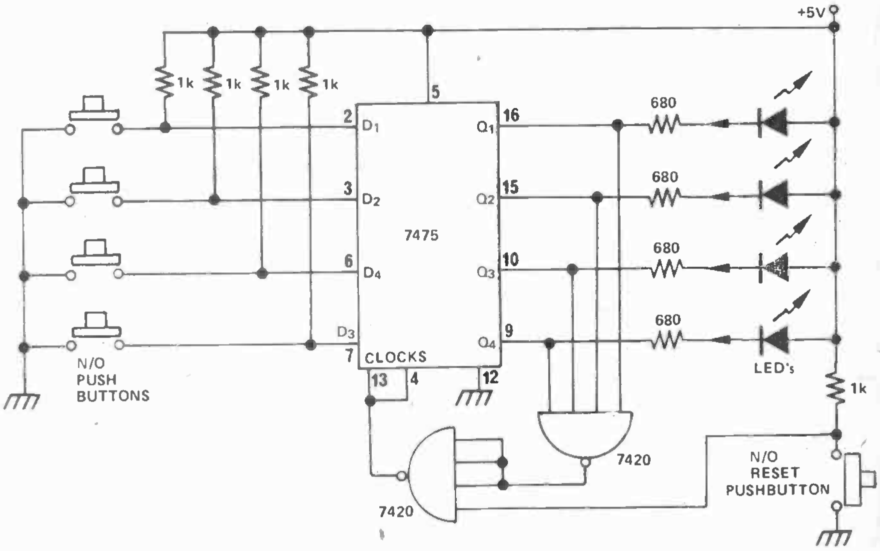
Four differant inputs can be switched through by the continual pressing of SW1.

IC1 is a dual 'D' type flip flop. The Q outputs are connected to the D inputs so that the clock inputs are divided by two. The two flip flops are connected in series, giving a two-stage binary counter.

IC2 is a quad AND gate. This is used to decode the four states of the counter. The outputs are used to control the quad switches at IC3 and IC4 (4016AE).

WINDICATOR

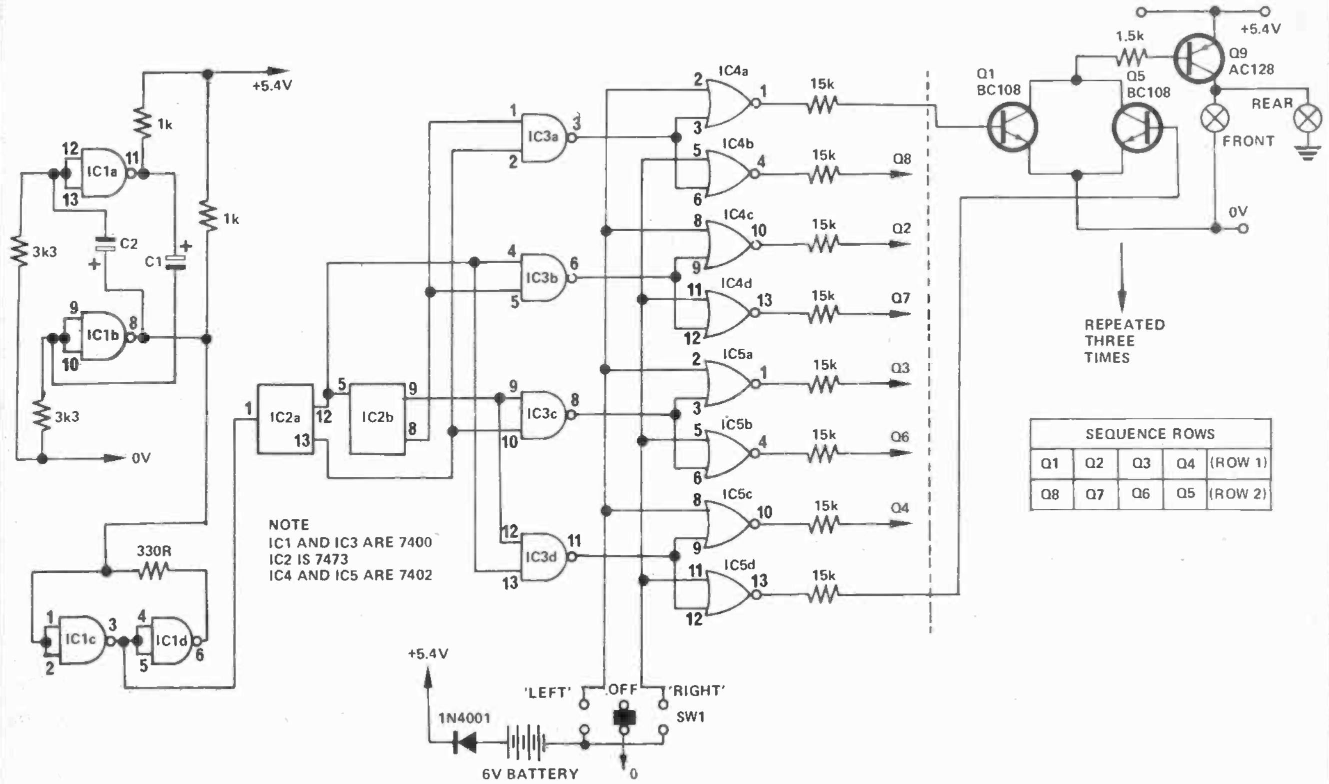
With two TTL ICs and a handful of other components, a circuit can be constructed that will indicate which of four buttons was pressed first, as well as lock out all other entries. It is thus suitable for quizzes, games of Snap and the like. The appearance of a logic 0 at one of the Q outputs, lights the appropriate LED and locks out other entries by taking the clock input low. The TTL outputs are capable of sinking 10 TTL loads or 16mA. Running the LEDs at 5mA leaves adequate margin to sink the 1 load of the 7420 gate.



tech-tips

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.

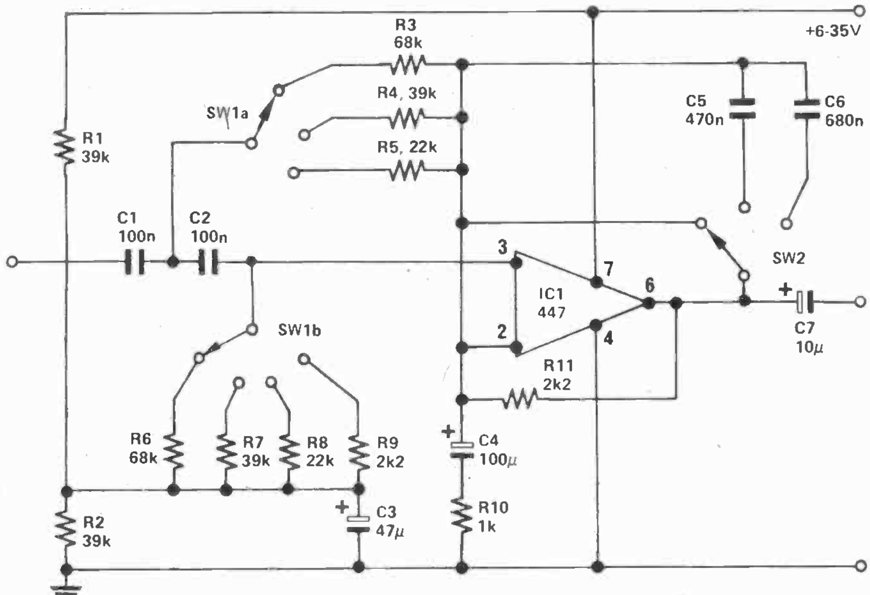


SEQUENCE ROWS				
Q1	Q2	Q3	Q4	(ROW 1)
Q8	Q7	Q6	Q5	(ROW 2)

NOVEL INDICATORS

Since a bicycle has no effective width, normal indicator lamps placed on each side do not give a clear indication of direction when seen from a distance, especially at night.

The circuit shown is a four stage ring counter which sequentially drives four yellow lamps giving an impression of movement i.e. towards the left or right. Lamp sequencing rate can be altered by changing C1 and C2. (50uF was found to be about right). Oscillator pulses are shaped by schmitt trigger IC1b. The decoding and output gating are performed by ICs 3, 4, and 5. Driver transistors Q1 to Q8 can be any low current, medium gain NPN silicon.



SW1	−3dB
1	25Hz
2	40Hz
3	80Hz
4	FLAT

SW2	+3dB
1	Flat
2	150Hz
3	100Hz

SWITCHABLE RUMBLE FILTER

The circuit shown provides a cut-off at 25, 40, or 80Hz. C1 and C2 in conjunction with R3 - 9, form second order Butterworth filters with 12db/octave roll-off below the turnover frequency.

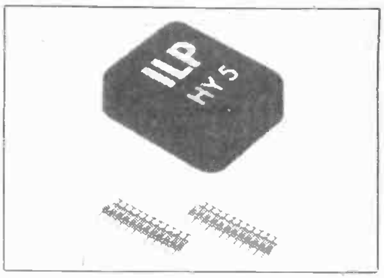
Unlike most designs, the feedback is taken from the inverting input. In practise this works well once the signal at this point follows exactly that at the non-inverting input.

A useful feature is the deep bass boost provided by the feedback loop proper.

S2 in position 3 gives a +3db point at 100Hz whilst position 2 provides a +3db point at 150Hz. A supply 6-35V DC at 10mA is required.

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

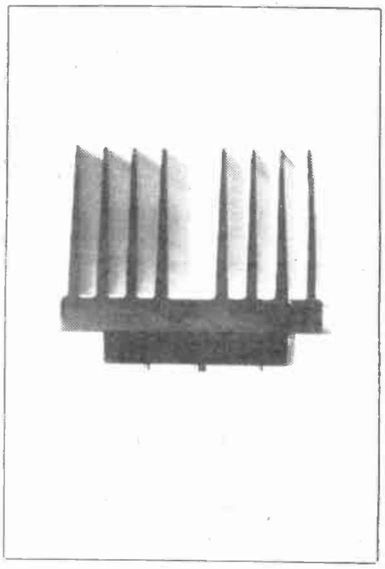
The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier 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.

We apologise sincerely to ETI readers for recent problems and delays affecting the supply of HY30. All outstanding orders have now been dealt with and we are confident we can maintain our usual standard of service.

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 in 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

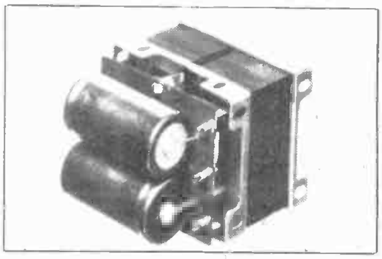


The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.
FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five 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 1 kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz — 3 dB SUPPLY VOLTAGE ± 35V
SIZE 114x50x85mm
Price £14.40 + £1.16 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral Heatsink — No external components
APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address
SPECIFICATIONS:
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
SIZE 114.100.85mm
Price £21.20 + £1.70 VAT P&P free.

HY400
240 Watts into 4Ω



The JY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown — Very low distormion — Load line protection — No external components
APPLICATIONS: Public address — Disco — Power slave — Industrial
SPECIFICATIONS:
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1 kHz
SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV SIZE 114 x 100 x 85mm
Price £29.25 + £2.34 VAT P&P free.

POWER SUPPLIES

PSU35 suitable for two HY30's **£4.75** plus 59p VAT P P free
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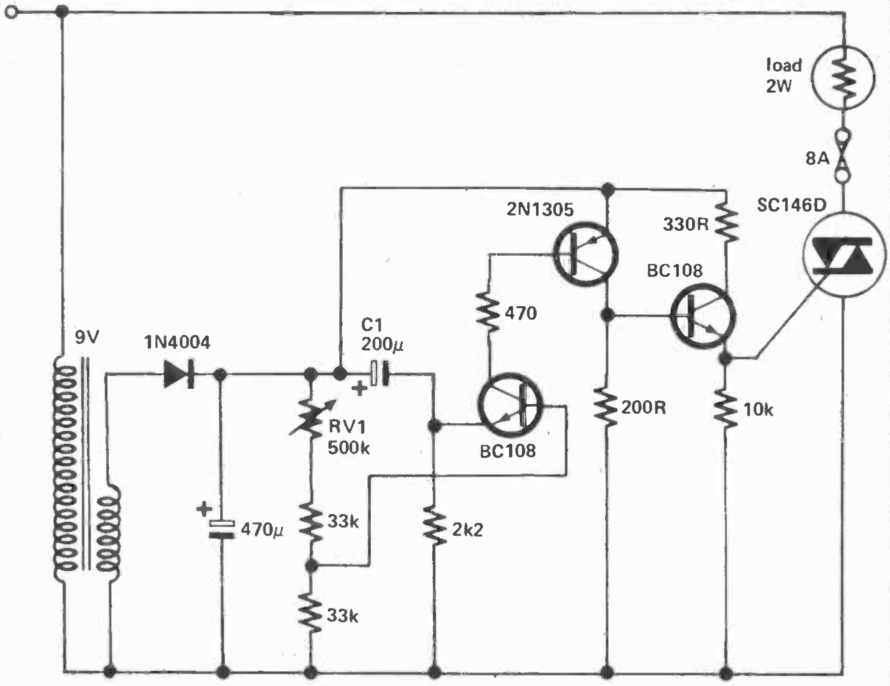
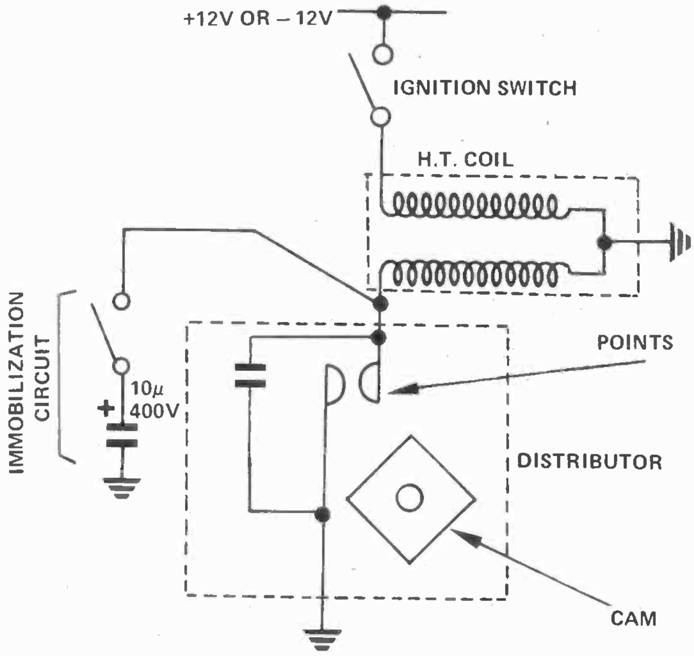
tech-tips



TRIAC LAMP FLASHER

The circuit is a relatively simple triac lamp flasher, probably of most interest to those in the disco business. The flasher will handle a load of up to 2kW with a variable flash rate of about 20/200 flashes per minute, achieved by altering the value of RV1.

C1, the timing capacitor, can be experimented with to obtain the most satisfactory results. Even though little power is dissipated in the triac (15W on full load), it should be mounted on a heatsink.



AUTOMOBILE IMMOBILIZATION

In order to discourage theft of an automobile, many people incorporate a 'secret' switch to break the ignition circuit (usually in series with the key switch). This system is very easily by-passed using 'jumper' leads.

A more effective method of immobilisation is shown in Fig.1, also using a 'secret' switch. A 10uF/400V capacitor is switched across the points preventing the ignition being started; at the same time this prevents the use of 'jumper' leads.

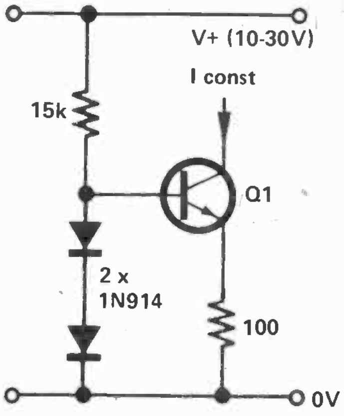


Fig. 1

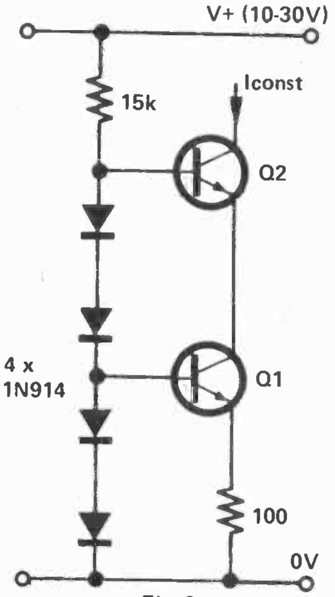


Fig. 2

DRIFT FREE CURRENT SOURCE

The conventional type of constant-current source, as shown in Fig.1, will drift in output current immediately after switch-on. This is because of the voltage drop across Q1, causing a significant amount of power to be dissipated in the transistor, heating it and its Vbe. Hence the output current slowly increases after switch-on, typically reaching a stable value about two minutes later. In tests the current increased by about 4% for a small signal transistor dissipating 100mW.

This effect is greatly reduced by the configuration shown in Fig.2, which fixes the voltage across Q1 at a very low level by virtue of the common-base transistor Q2. The main voltage drop occurs across Q2, leaving about 600mV across Q1, this being set up by the two extra diodes in the bias chain, (D1, D2) which fix the emitter potential of Q2.

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Type E 3V 1 Amp. **25p** ea. P&P 50p.
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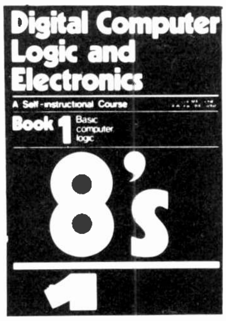

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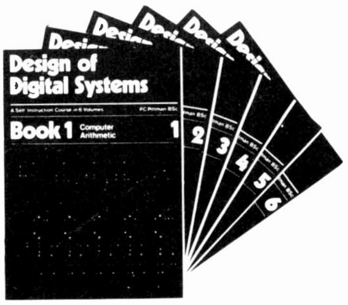

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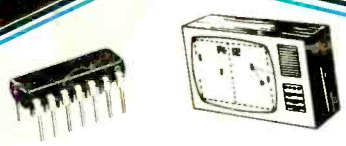

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