

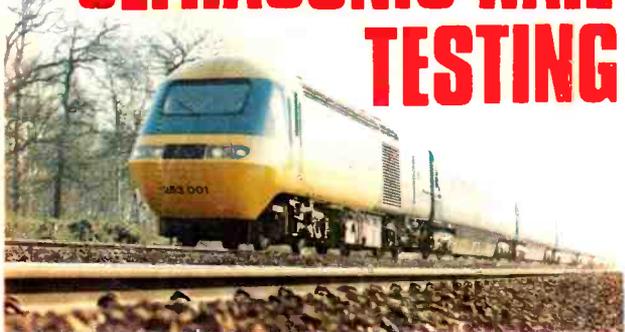
electronics today international

FEBRUARY 1977
35p

INDUCTION BALANCE METAL LOCATOR

**TTL
PINOUT
DATA
SHEET**

ULTRASONIC RAIL TESTING



ELECTRONIC PCB
S49 = TTP



**CAR SCOPING
DISCO MIXER
YAMAHA B-1 REVIEW
BENCH AMP
LED DICE
NOVEL DOORBELL**

COMPUTERS FOR
SMALL COMPANIES

Stirling Sound

QV† MODULES FOR COST-CONSCIOUS CONSTRUCTORS

STIRLING SOUND QV Modules are our own designs manufactured in our own Essex factory. Production standards are carefully controlled and you, the constructor, benefit directly from our many years of experience in meeting demand for components as well as by buying direct from us.

PRE-AMPS & CONTROL MODULES

Unit One

Combined pre-amp with active tone-control circuits. 200mV output for 50mV in. Runs on 10 to 16V supply. Treble ± 15 dB at 10KHz, bass ± 15 dB at 30Hz. Stereo bal., vol., treble & bass controls.

£7.80

SS.100

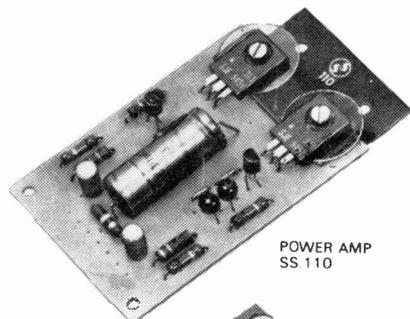
Active tone control, bass & treble

£1.60

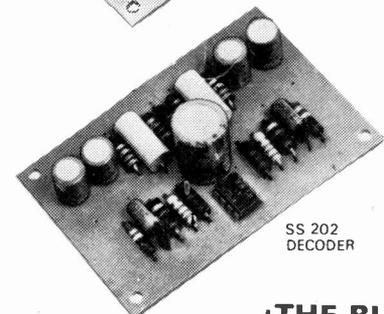
SS.101

Pre-amp for ceramic cartridges, etc., passive tone control circuit shown in data supplied

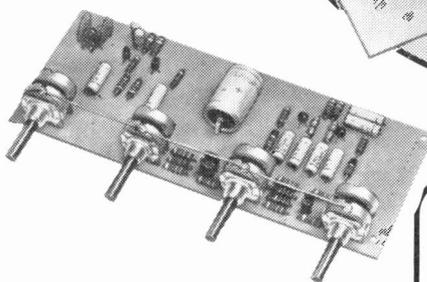
£1.60



POWER AMP
SS.110



SS.202
DECODER



SS.102 STEREO PRE-AMP
R.I.A. corrected for mag p/ups, tape, radio, etc.

£2.65

POWER AMPLIFIERS

SS.103

A 3 watt amplifier using single I.C. type SL 60745 with built-in short circuit protection

£1.75

SS.103-3. Stereo version (2 I.C.s) of above

£3.25

SS.105

5 watts R.M.S. into 4 ohms using 12V supply. Ideal for use in in-car entertainment. Size 89 x 51 x 19mm

£2.25

SS.110

Similar in size and design to SS.105, this QV module delivers 10 watts R.M.S. into 4 ohms using a 24V supply, e.g. SS.324. Of great use in domestic applications

£2.75

SS.120

Using a 34 volt supply, such as SS.334, this amplifier will deliver 20 watts into a 4 ohm load. Same dimensions as above

£3.25

There are suitable Stirling Sound power supplies for all the above.

FM TUNING

SS.201

FM Front End with geared slow motion tuning and A.F.C. facility 88-108MHz

£5.00

SS.202

1 F amp A meter and/or A.F.C. can be connected (size 3" x 2"). For use with SS.201

£2.65

SS.203

Stereo decoder (illustrated). For use with Stirling Sound modules or with any other good mono FM tuning section. A LED beacon can be added (Price 18p) to indicate when a stereo signal is tuned in (3" x 2")

£3.85

†THE BUILT-IN QV FACTOR

means Stirling Sound's guarantee of quality and value which gives you today's best buys all round. That's why you'll do better with QV Modules!

Stirling Sound

A member of the BI-PRE-PAK Group

220-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX SS0 9DF
Phone: Southend (0702) 46344. **PERSONAL CALLERS WELCOME**



SS.140

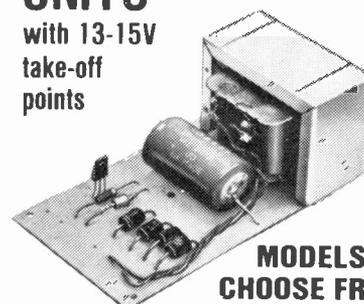
Heavy duty power amplifier giving 40 watts R.M.S. into 4 ohms using 45V. With output capacitor. Good for small diaco or P.A.

£3.95*

TODAY'S BEST VALUE IN POWER SUPPLY UNITS*

ALL AT 8% VAT

with 13-15V take-off points



7 MODELS TO CHOOSE FROM

Compare these guaranteed power packs for power and price. Not only do these excellent power packs stand up unflinchingly to hard work, inclusion of a take-off point (except SS.312) at around 13-15V adds to their usefulness. P/P 50p any model.

SS.312 12V/1A £3.75*

SS.318 18V/1A £4.15*

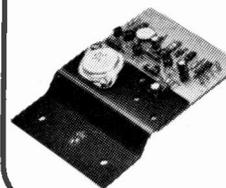
SS.324 24V/1A £4.60*

SS.334 34V/2A £5.20*

SS.345 45V/2A £6.25*

SS.350 50V/2A £6.75*

SS.300. Add-on power supply stabilising unit. Short-circuit protected. Ensures stabilised output variable from 12V/2A to 50V max. at 8A. Ideal for workbench and experimenting. £3.25* (P&P 35p).



SS.310/350 VARIABLE OUTPUT STABILISED SUPPLY

With continuous variable output at 2A from 10 to 50 V.D.C. With built-in protection against shorting and fully adequate heat sink. Guaranteed. Superb value at £11.95*.

WHEN ORDERING

Add 35p to your order for P&P for mail orders. VAT add 12½% to total value of order unless shown* then the rate is 8%. Make cheques, etc., payable to BI-PRE-PAK LTD. Every effort is made to ensure correctness of information at time of going to press. Prices subject to change without notice.

electronics today

international

FEBRUARY 1977*

VOL 6 No. 2

Features

COMPUTERS IN SMALL COMPANIES <i>Mini computers in mini firms — big advantages!</i>	11
ULTRASONIC RAILTRACK TESTING <i>Sounding out the rails Britain runs on</i>	25
YAMAHA B-1 REVIEWED <i>Super-amp with a smooth sound</i>	29
'SCOPE TEST YOUR CAR <i>Putting your vehicle to the silver screen</i>	45
COMPONENTS PART 7 <i>More resistor types explained</i>	54
MICROFILE REPORT <i>Special report from Australia — multiprocessor</i>	59
ELECTRONICS — ITS EASY! PART 36 <i>Series for beginners</i>	62
TECH-TIPS <i>Your ideas and circuits forum</i>	73

Projects

DISCO MIXER <i>Super-comprehensive unit for any use</i>	16
INDUCTION BALANCE METAL LOCATOR <i>The first machine to use this brilliant principle</i>	33
SHORT CIRCUITS: LED DICE	49
TWO-TONE DOORBELL	50
BENCH AMPLIFIER	52

Data Sheet

TTL PINOUTS <i>All those mysterious pins unmasked at last!</i>	41
---	----

News

NEWS DIGEST	6
ELECTRONICS TOMORROW	69

Information

SPECIALS	14
ETI CLOCK OFFER	28
SUBSCRIPTIONS	53
MARCH ETI PREVIEWED	57
BOOK SERVICE	58
TRANSDUCERS IN MEASUREMENT AND CONTROL	72
BINDERS	72
READER SERVICES	82

EDITORIAL AND ADVERTISEMENT OFFICES

25-27 Oxford Street
London W1R 1RF
Telephone 01-434 1781/2

HALVOR W. MOORSHEAD
Editor

LES BELL, G4CFM
RON HARRIS B.Sc
Editorial

TONY ALSTON
Project Development

JIM PERRY
Specials Editor

JULIAN ZINOVIEFF
Production

SANDRA ZAMMIT-MARMARA
Subscriptions

MARGARET HEWITT
Administration

DAVID LAKE (Manager)
BRENDA GOODWIN
Reader Services

ROBERT C. EVANS
Advertisement Manager
Telephone 01-437 5982

INTERNATIONAL EDITIONS

AUSTRALIA: Collyn Rivers
Editorial Director
Steve Braidwood
Assistant Editor

HOLLAND: Anton Kriegsman
Editor-in-chief

CANADA: Peter Priest
Publisher

FRANCE: Denis Jacob
Editor-in-chief

Electronics Today International is normally published on the first Friday of the month prior to the cover date.

PUBLISHED BY
Modmags Ltd.
25-27 Oxford Street, W1R 1RF



DISTRIBUTED BY
Argus Distribution Ltd (British Isles)
Gordon & Gotch Ltd.

PRINTED BY
QB Newspapers Limited, Colchester.

COPYRIGHT: All material is subject to world wide Copyright protection. All reasonable care is taken in the preparation of the magazine to ensure accuracy but ETI cannot be held responsible for it legally. Where errors do occur, a correction will be published as soon as possible afterwards in the magazine.

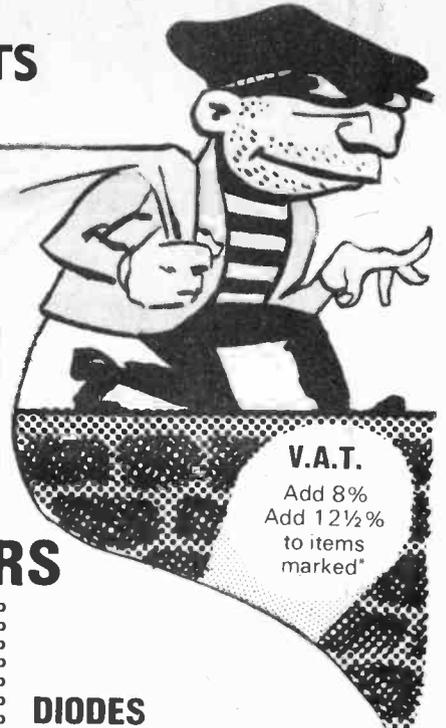
BI-PAK

SEMICONDUCTORS

PO BOX 6
WARE HERTS

POSTAGE & PACKING
Please add 25p. Overseas
add extra for airmail
Minimum order
£1.00

SECOND GREAT WINTER SALE!



V.A.T.
Add 8%
Add 12½%
to items
marked*

74 SERIES TTL ICs

Type	Quantity		Type	Quantity		Type	Quantity	
	1	100		1	100		1	100
	£p	£p		£p	£p		£p	£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
7443	0.95	0.90	74110	0.48	0.45	74195	0.80	0.75
7444	0.95	0.90	74111	0.75	0.72	74196	0.90	0.85
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
7447	0.70	0.68	74121	0.28	0.26	74199	1.80	1.70

Devices may be mixed to qualify for quantity price. Data is available for the above series of I.C.'s in booklet form price 35p

LINEAR ICs

TBA 800	*75p
741P 8 pin DIL	*18p
72474 14 pin DIL	*36p
748P 8 pin DIL	*25p
NE555 Timer	*38p
NE556 Dual Timer	*78p

I.C. SOCKETS

Order No	
BPS 8 8 pin 1611	9p
BPS 14 14 pin 1612	10p
BPS 16 16 pin 1613	11p

TRIACS

Order No	
2A/400T05 TR12A/400	50p
10A/400 Plastic TR110A/400P	80p

CAPACITOR PAKS

16201 18 Electrolytics 47 uF-10 uF
16202 18 Electrolytics 10 uF-100 uF
16203 18 Electrolytics 100 uF-680 uF

BUY ONE OF EACH
Special Price £1.20* the 3

16160 24 Ceramic Caps 22 pf-82pf
16161 24 Ceramic Caps 100pf-390pf
16162 24 Ceramic Caps 470pf-3300pf
16163 21 Ceramic Caps 4700pf-0.047pf

BUY ONE OF EACH
Special Price £1.60* the 4

RESISTOR PAKS

16213 1/8th 100 ohm-820 ohm
16214 1/8th 1K-8.2K
16215 1/8th 10K-8.2K
16216 1/8th 100K-1M

BUY ONE OF EACH
Special Price £1.60* the 4

TRANSISTORS

AC128	10p	BFY53	12p
AC153K	18p	OC44	12p
AC176	19p	OC45	12p
AC176K	22p	OC71	9p
AC187K	22p	OC72	14p
AC188	12p	OC81	14p
AC188K	22p	ZTX107	*6p
BC107	6p	ZTX108	*6p
BC108	6p	ZTX109	*6p
BC109	6p	ZTX300	*7p
BC118	*10p	ZTX301	*7p
BC154	*16p	ZTX302	*9p
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
BC170	*6p	2N708	8p
BC171	*6p	2N1631	15p
BC172	*6p	2N1711	15p
BC177	12p	2N1893	18p
BC178	12p	2N2217	18p
BC179	12p	2N2218	15p
BC182L&K	*9p	2N2218A	18p
BC183	*9p	2N2219	15p
BC184	*9p	2N2219A	18p
BC212L&K	10p	2N2221	15p
	*10p	2N2221A	16p
BC213	*10p	2N2222	15p
BC214	*10p	2N2222A	16p
BC251	*6p	2N2369	12p
BC327	*12p	2N2369A	12p
BC328	*12p	2N2904	14p
BC337	*11p	2N2904A	15p
BC338	*11p	2N2905	14p
BF115	10p	2N2905A	15p
BF167	10p	2N2906	12p
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
3FX84	15p	2N3706	*7p
BFX85	20p	2N3903	*11p
BFX86	20p	2N3904	*11p
BFY50	12p	2N3905	*11p
BFY51	12p	2N3906	*11p
BFY52	12p	2N5172	*9p

DIODES

OA47	5p	IN4005	6p
OA81	5p	IN4006	7p
OA85	6p	IN4007	8p
OA91	5p	IN5400	11p
OA200/BAX 13	5p	IN5401	12p
OA202/BAX16	5p	IN5402	13p
IN914	4p	IN5403	14p
IN4148	4p	IN5404	15p
IN4001	3p	IN5405	16p
IN4002	4p	IN5406	17p
IN4003	5p	IN5407	18p
IN4004	6p	IN5408	20p

VOLTAGE REGULATORS

MVR 7815	85p
MVR 7812	85p
MVR 7815	85p

OPTOELECTRONICS

L.E.D. DISPLAYS	Order No	Price
DL 707 0.3"	1510	0.70
DL 747 0.6"	1511	1.50
L.E.D.'s		
TIL 209 RED 125"	1501	
FLV 117 RED 2"	1504	
5 of either 50p		
PHOTO DEVICES		
ORP 12	1515	38p
OCF 71 Pack of 5	1520	

THYRISTORS

T05	Order No	
1A/50 PIV	THY 1A/50	18p
1A/400 PIV	THY 1A/400	32p
1A/600 PIV	THY 1A/600	38p
T066		
5A/50 PIV	THY 5A/50	25p
5A/400 PIV	THY 5A/400	40p
5A/600 PIV	THY 5A/600	50p
T048		
16A/50 PIV	THY 16A/50	40p
16A/400 PIV	THY 16A/400	60p

UNIUNCTION

UT46/TIS 43	18p
-------------	-----

F.E.T.

2N3819	15p
--------	-----

ORDERING

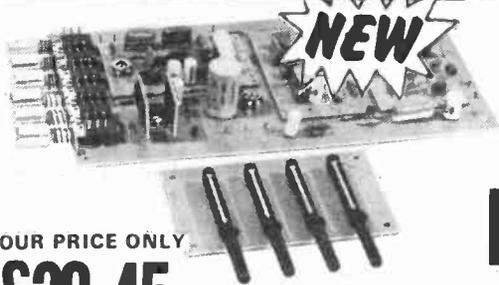
PLEASE WORD YOUR
ORDERS EXACTLY AS
PRINTED NOT FORGET-
TING TO INCLUDE OUR
PART NUMBER

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

PCB MARKER PENS 50p

BI-PAK

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



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.

PUSH-BUTTON STEREO FM TUNER

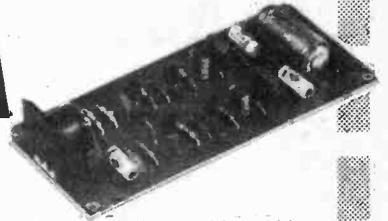
- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

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



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.

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 16 3/4" x 11 1/2" x 3 3/4", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 85p postage.

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 with 1dB from 20Hz to 20KHz.
Supply - 20-35V at 20mA
Dimensions
299mm x 89mm
35mm.

SPECIFICATION:

- Harmonic Distortion $P_o = 3$ watts $f = 1$ KHz **02.5%**
- Load Impedance **8-16ohm**
- Frequency response ± 3 dB $P_o = 2$ watts **50Hz-25KHz**
- Sensitivity for Rated O/P - $V_s = 25v$, $R_L = 8ohm$ $f = 1$ KHz **75mV.RMS**

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

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.

**VAT
ADD
12 1/2%**

POSTAGE & PACKING

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

STEREO 30 COMPLETE AUDIO

7+7 WATTS
R.M.S.



£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

Frequency Response 20Hz-20KHz (-3dB). Bass and Treble range 12dB. Input Impedance 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. **OUR PRICE £1.30**
Transformer T538 **£2.30**

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

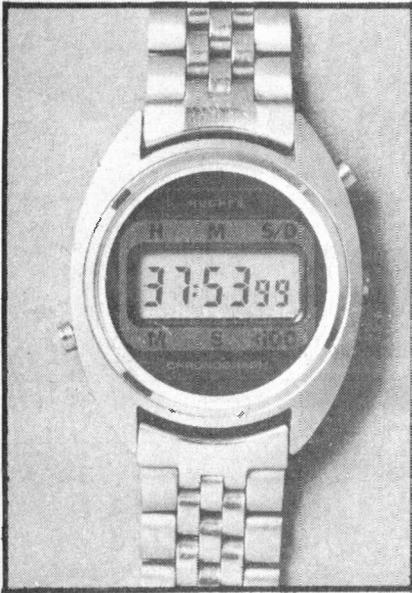
£3.75

BI-PAK

P.O. BOX 6,
WARE,
HERTS.

SHOP AT 18 BALDOCK ST., WARE, HERTS
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.

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 their own against the newer technology.

Simple gate prices are not affected.

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.;

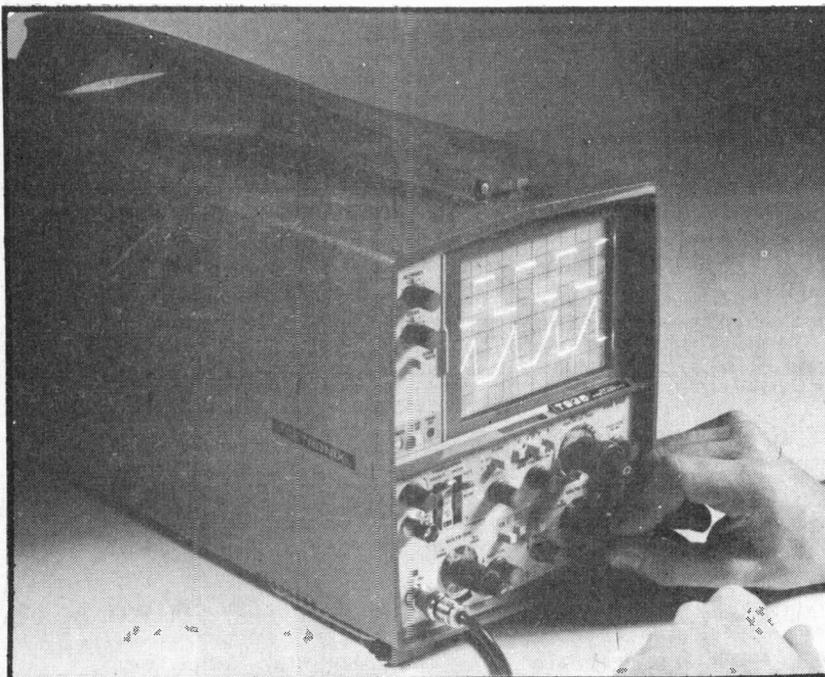
Following your procedure of taking 45 o and then Sin., Cos., Tan., followed by arc Sin., arc Cos., arc Tan., the answer comes out at 45.002 o which for accurate survey work would be a significant error.;

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 o and then the Tan. of 0.01234196 o.

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.;



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).

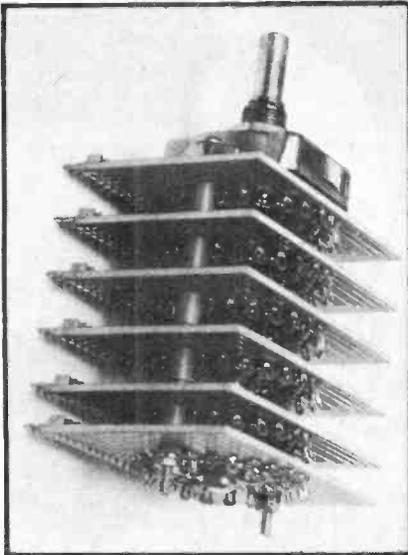
All models have an 8 x 10cm display area, and measure 17.8 x 25.4 x 48.3cm.

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 24 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 110V.a.c. The initial control resistance is less than 15 milliohms for all contact types.

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

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.



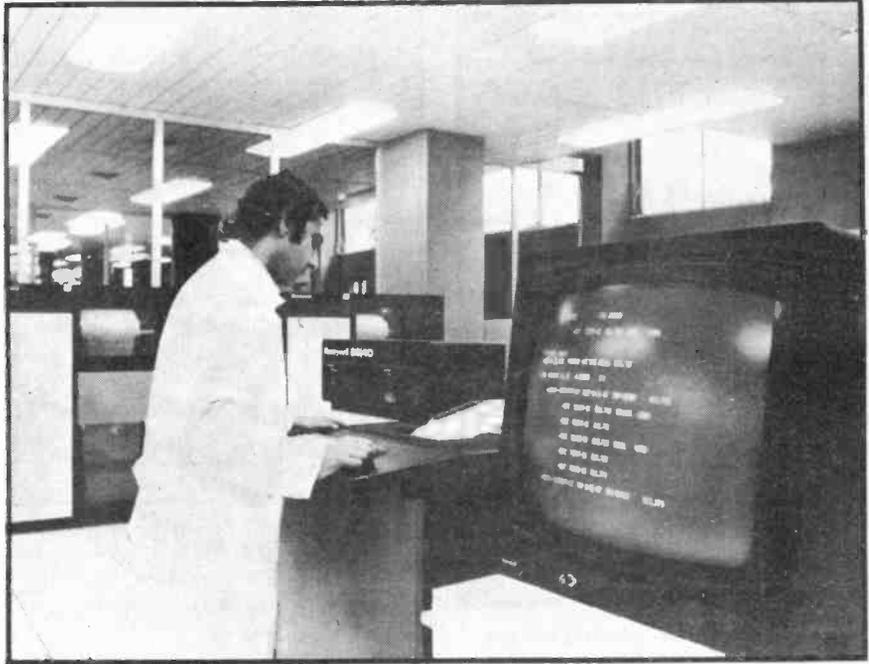
Max. output level: 4 dB better than iron oxide, and 1.5dB better than chromium dioxide.

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 CrO₂. Special Mechanics (under licence from you-know-who) are used to aid transport.

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

DRIVING THE ITALIANS MAD? (LEGALLY!)

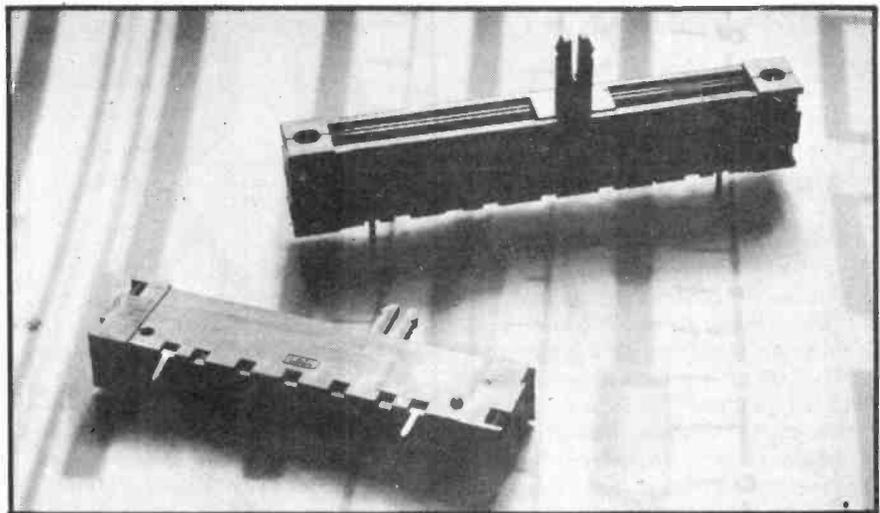


Photograph shows a dual series 60 Level 66 computer (made at Honeywell's Newhouse Lanarkshire factory) which is now in full operation in Rome speeding the issue of driving licences and car registration cards for the Italian Ministry of Transport.

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.

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.

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 \pm 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.

BUILD THE

TREASURE TRACER MK III

METAL LOCATOR



AS SEEN ON BBC-1 & BBC-2 TV

- Genuine 5 silicon transistor circuit, does not need a transistor radio to operate.
- Incorporates unique varicap tuning for extra stability.
- Search head fitted with Faraday screen to eliminate capacitive effects.
- Loudspeaker or earphone operation (both supplied).
- Britain's best selling metal locator kit. 4,000 already sold.
- Kit can be built in two hours using only soldering iron, screwdriver, pliers and side-cutters.
- Excellent sensitivity and stability.
- Kit absolutely complete including drilled, tinned, fibreglass p.c. board with components siting printed on.
- Complete after sales service.
- Weighs only 22oz; handle knocks down to 17" for transport.

Send stamped, self-addressed envelope for literature.

Complete kit with pre-built search coil **£14.75**
Plus £1.00 P&P
Plus £1.18 VAT (8%)

Built, tested and Guaranteed **£19.75**
Plus £1.00 P&P
Plus £1.58 VAT (8%)

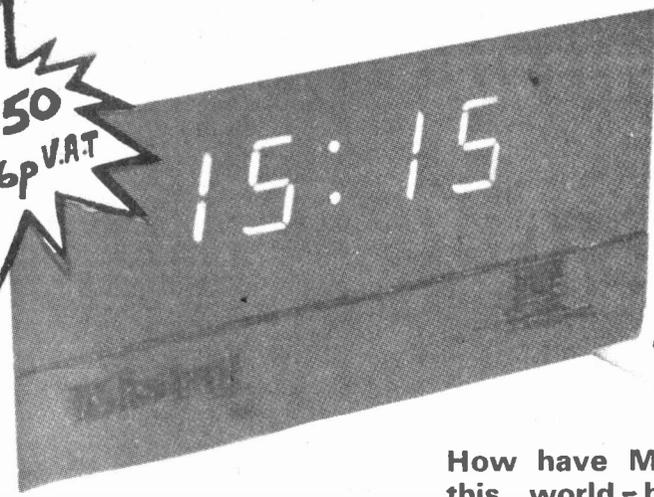
MINIKITS ELECTRONICS,
6d Cleveland Road, South Woodford,
LONDON E18 2AN
(Mail order only)

START THE NEW YEAR WITH A GREAT BARGAIN!

From **Metac**

BUILD YOUR OWN DIGITAL CLOCK
 COMPLETE KIT OF COMPONENTS
 WITH EASY TO FOLLOW INSTRUCTIONS

£9.50
 + 76p V.A.T.



- SILENT
- 1/2" DIGITS
- GREEN DISPLAY
- PULSATING COLON
- ATTRACTIVE CASE
- 12/24 HOUR READOUT

**WE COULDN'T WAIT TO TELL YOU!
 WE'VE DONE IT AGAIN!**

Bringing together FUTABA of Japan and GENERAL INSTRUMENT CORP. of America to produce this attractive digital clock offered to you in easy to build kit form at a new low, low price. The kit is complete even to the attractive plastic case which is ready drilled, and can be assembled in around one hour using the easy to follow instructions.

How have METAC managed to offer this world-beating high-technology clock at such a low price? Well, if you haven't already guessed, METAC is, of course, part of an established electronics manufacturing company ELECTRONIC SERVICES AND PRODUCTS, who are manufacturers of electronic instrumentation and well-known for the ESP range of electronic capacitance meters.

Our engineers are not only experts in digital instrumentation but have been involved in digital clock design possibly longer than anyone else in the United Kingdom.

STOP PRESS

BRITAIN'S TOP SELLING DIGITAL ELECTRONIC CLOCK NOW AVAILABLE



Recommended Retail Price *17 95

OUR PRICE £13.95
 Inc VAT

In choice of orange planar gas or soft green fluorescent digit displays Green model has 24-hour readout Orange model has 12-hour readout and AM/PM indicator Both models have flashing second indicator 24-hour bleeper alarm 5-minute repeater mains failure indicator 5" across x 3 1/2" deep Attractive white case Thousands sold Please state choice

This form should also be used for our watch advertisement on page 39 of this issue.

To METAC INTERNATIONAL, 67 High Street, Daventry, Northants. Tel. 03272 76545.

Please supply the following:—

Name

Address

I enclose cheque/Postal Order/Money Order
 I wish to pay by Barclay Card/Access and my number is

Signature

Mail Order Customers. Trade enquiries welcome

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!

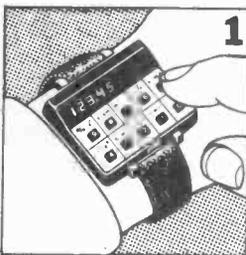
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

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.

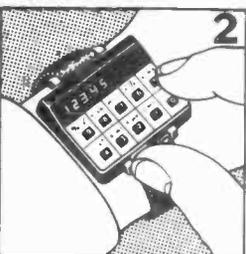
How to make 10 keys do the work of 27

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

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.

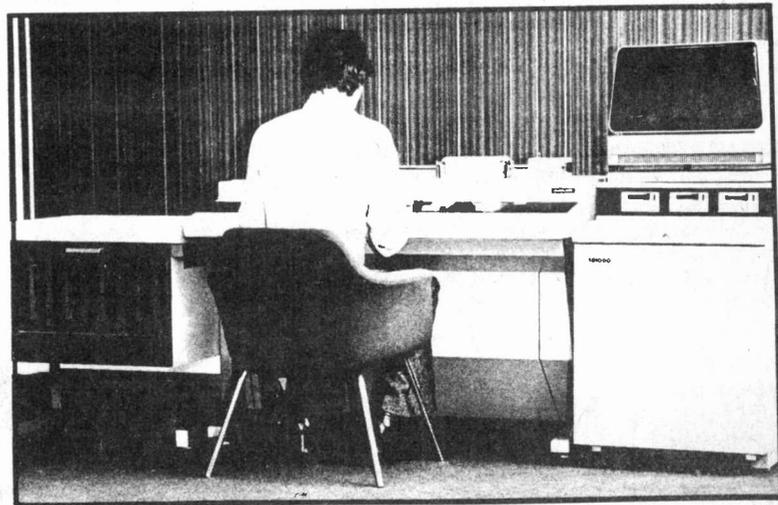
FINDING THE CORRECT NEEDLE

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.

COMPUTERS IN SMALL COMPANIES



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

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

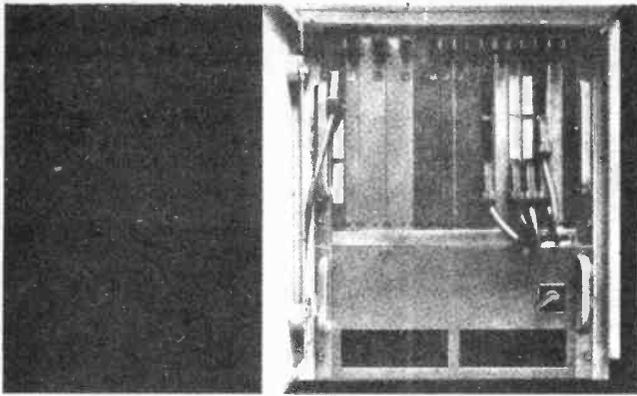
do, is flexible in doing it and is selling extremely well!

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.

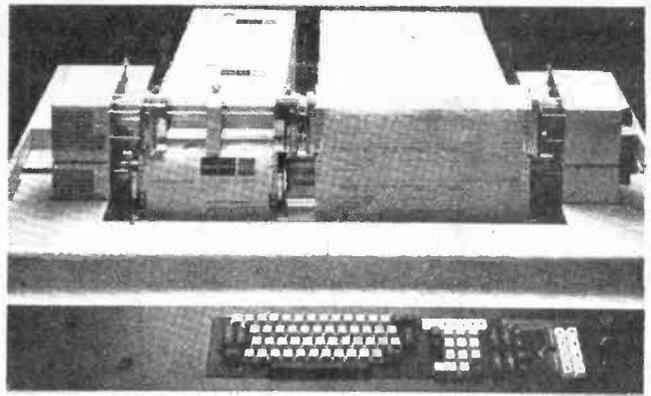
DOCUMENT NO.	TRANSACTIONS SHOWN AS AT	INV. CHG.	INVOICE CREDIT	CHQ. CREDIT	CASH ACCOUNT
12-1460	12-1460				
DATE	TRANS. TYPE	OUR	REPRESENT YOUR	DEBIT	CREDIT
					00.00
02-01-75	JR D	0	IN. BAL.		1103.30
02-01-75	JR D	0	IN. BAL.		462.10
10-01-75	LRN	676	6326		
11-01-75	CRH	161	8001		
11-01-75	BTN	0	ACTIVE		

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

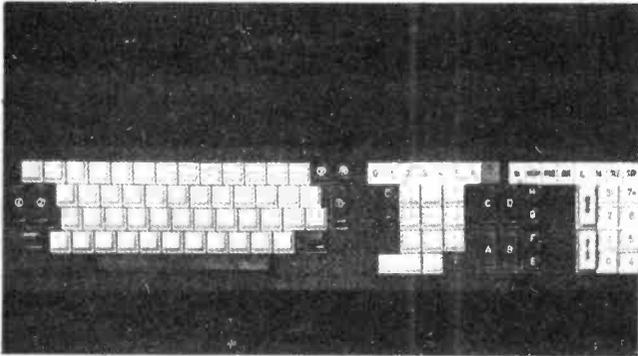
THE ADLER TA 1000 SYSTEM



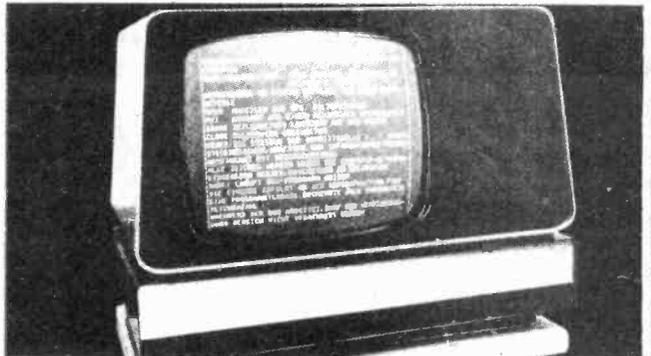
CPU:— this is mounted in a standard 10in. rack, and consists of engineers test array an ALU, control memory, user memory, I/O plus power system. The ALU has 16 8-bit (2 byte) index registers, a 16-bit accumulator and uses a 2-byte word length. The CPU is expandable to 64k byte.



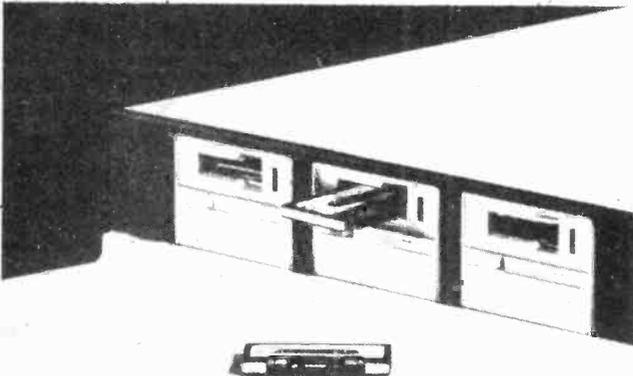
Fast Printer:— produced by Triumph-Adler in Germany it possesses a carriage a metre wide, with 276 print positions, and works at 140 chps. It can handle any of a wide range of printing media, from ledger cards to plain ordinary paper. One original and 4 copies are normally provided, although this may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



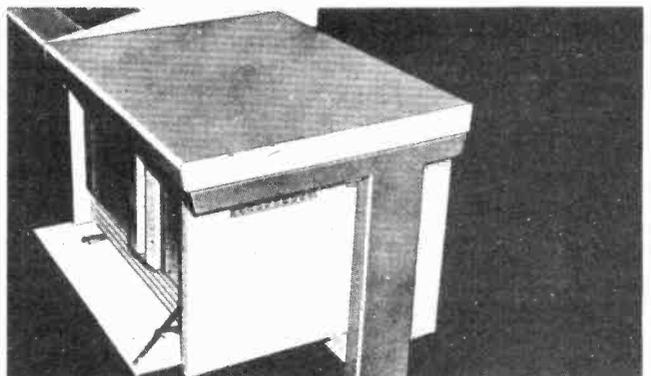
Keyboard Console:— consists of a 56-key alpha-numeric system — including a repeat key, and four program definable keys, 14 numeric keys (multiple zero) 16 function keys — 8 interrupt and 8 initialising (both program controlled). The maximum input speed is 100 keystrokes per second, and if you can work 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 millisecons, 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 — WILLOWDALE 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? . .

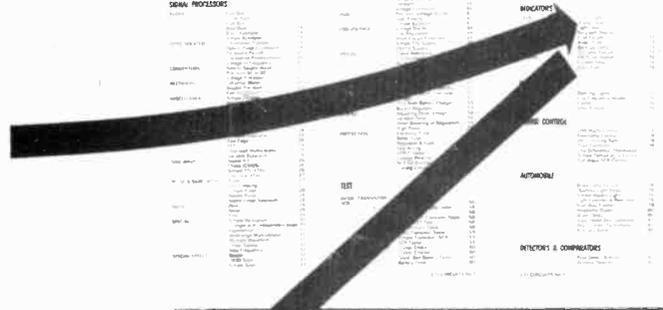
From these two different usages of the same machine comes the same impression — that of order imposed. Willowdale keep track of 5000 products, while D. Rose keeps tight control of five branches.

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!

No1

ALARMS	50W STEREO AMP	TEMPERATURE ALARM	LINEAR INTERCOM AND RECORD PLAYER	BUMBLE FILTER	BATTERY CHARGER	TAPE SLIDE SYNCHRONISER	APPROXIMATELY 75p
TEST & MEASUREMENT	LINEAR IC TESTER	IGNITION TIMING LIGHT	SPRING LINE REVERBERATION UNIT	ADD-ON QUAD UNIT	NI-CAD BATTERY CHARGER	DIGITAL STOPWATCH	75p
POWER SUPPLIES	TRAFICATOR CANCELLOR	AUDIO WATTMETER	FET 4-INPUT MIXER	PERFORMER	AUTOMATIC CAR TYRE ALARM	IC POWER SUPPLY	OVER-LED
DIAGNOSIS	AERIAL MATCHER	LOOK PROBE	PLUS MANY MORE...				



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 1/2watt. 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

TOP PROJECTS No. 4 — £1.00 + 20p P&P

ELECTRONIC FLASH TRIGGER

Trigger your flash from light, suitable for use with the conventional camera.

DESCRIPTION: This is a simple and reliable circuit which will trigger a camera flash from a light source. It consists of a light sensitive transistor which is biased to conduct when the light intensity is above a certain level. This causes the transistor to switch a relay which in turn triggers the flash.

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

TOP PROJECTS No. 3

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.

£1.00 + 20p P&P

ELECTRONICS — IT'S EASY, Vol. 1

The first thirteen parts of our very successful series produced in a 100 page book form. These take the reader through the introduction to electronics and up to Operational Amplifiers.

£1.20 + 20p P&P

ELECTRONICS — IT'S EASY, Vol. 2

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

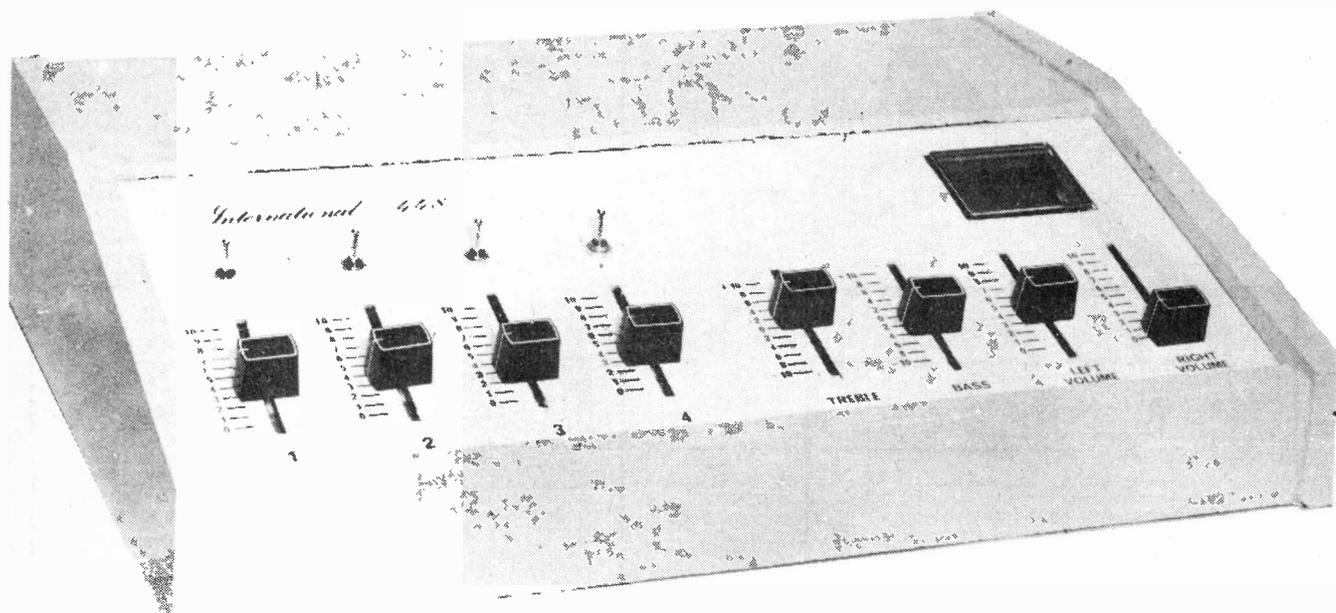
£1.20 + 20p P&P

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

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!

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 impedance 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 $R2 = 15k$.

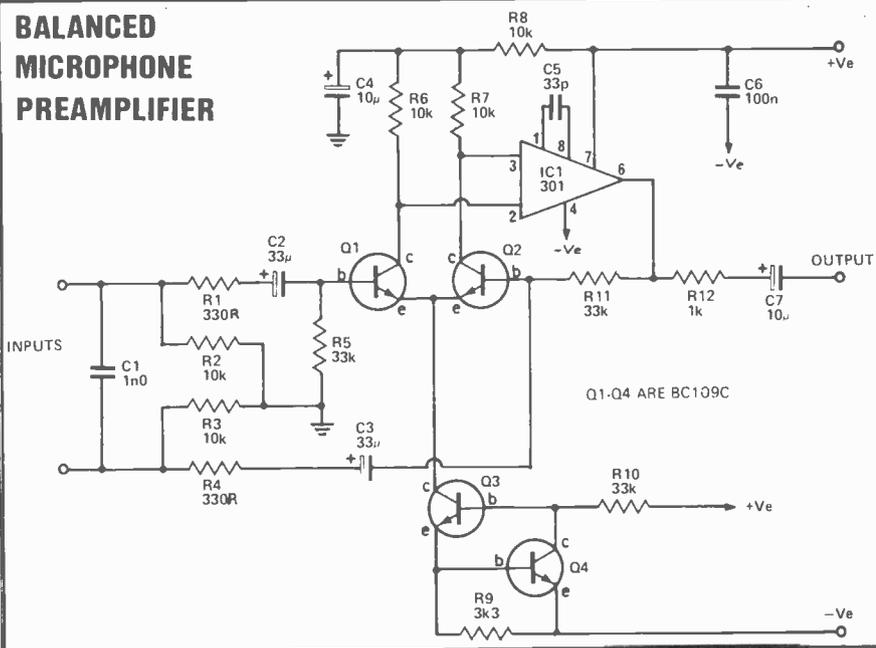
MIXER AND POWER SUPPLY

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.

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

BALANCED MICROPHONE PREAMPLIFIER

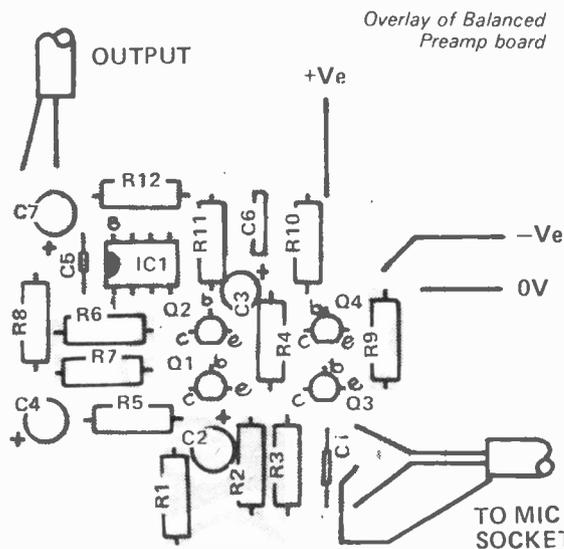


Frequency Response	10 Hz – 20 kHz (<5 V output) ⁺⁰ dB -3
Gain	40 dB
Equivalent Input Noise	-123 dB (0.5 μV)
Distortion	0.05% 300 mV – 5 V output 100 Hz – 10 kHz
Max Input Voltage	100 mV
Common Mode Rejection Ratio	60 dB
Maximum Common Mode Signal	3 V

Connection of Cannon plug for microphones

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

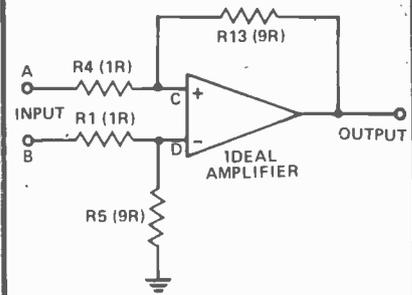
FOR UNBALANCED INPUT CONNECT PIN 1 AND 2 TOGETHER ON MICROPHONE PLUG.



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
R6,7,8	10k	C6	100n polyester
R9	3k3	C7	10μ 16v
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 2 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 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

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

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

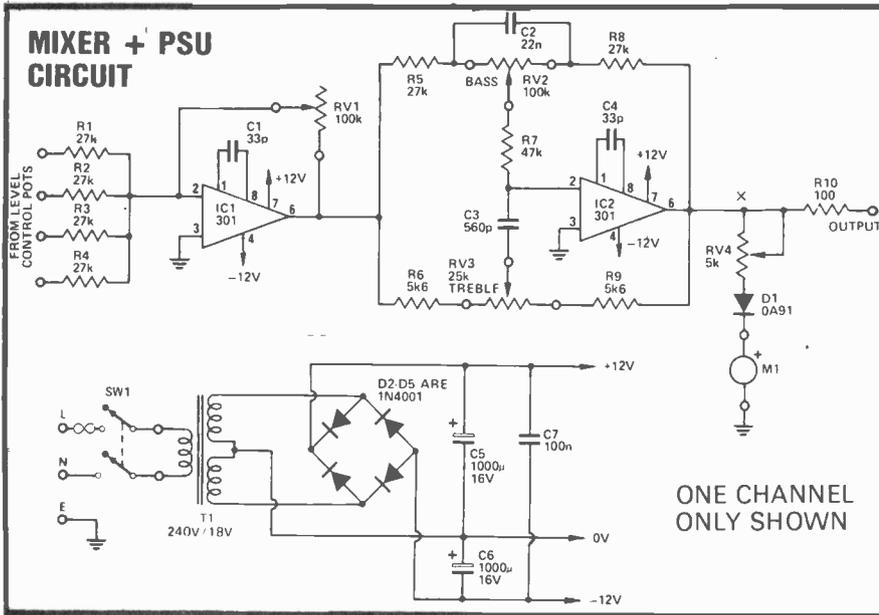
This means the output voltage must be +900mV. This is also a gain of nine. Notice, however, that the polarity (or phase) is different.

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



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 $\pm 12\text{VDC}$.

PARTS LIST ETI 448

Resistors all 1/4w 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

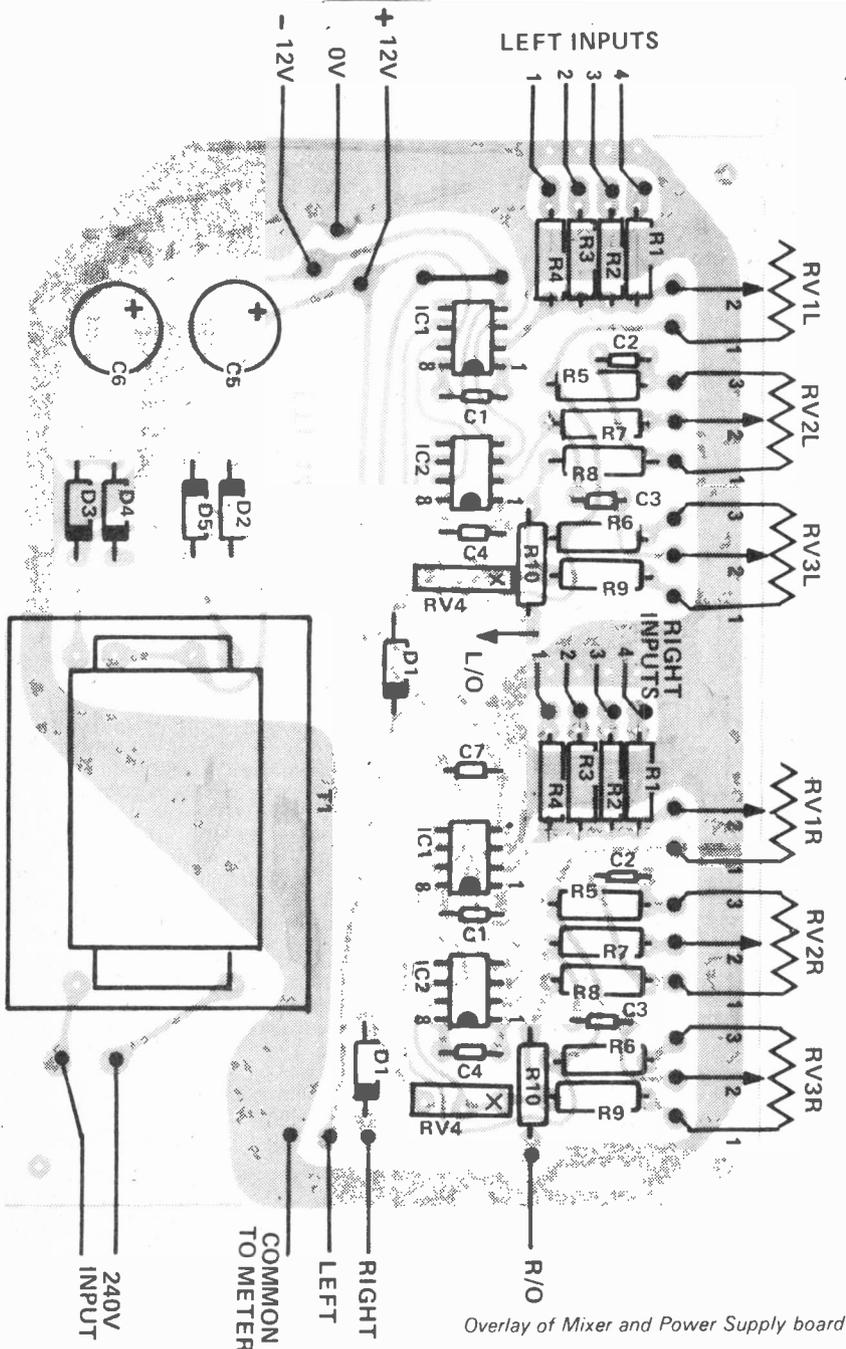
C5, 6	100 μ 16V
C7	100n polyester

D2 - D5 IN4001 or similar

Transformer	240V : 9-0-9
pc board	ETI 448
Fuseholder	250mA fuse to match

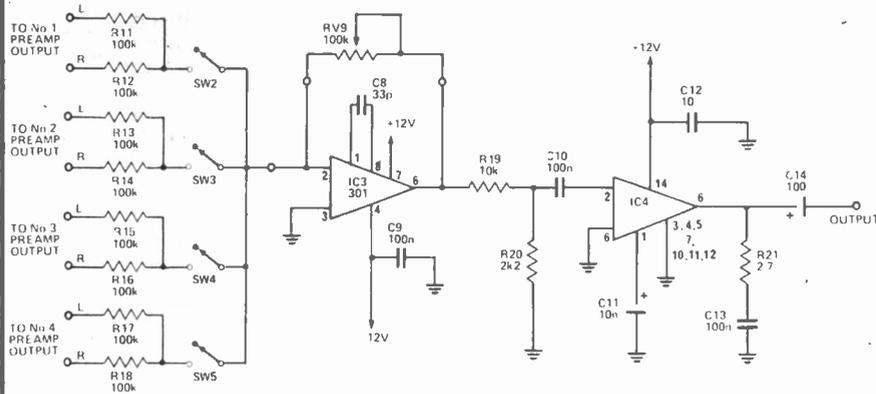
Switch 2 pole 2 position 240 V toggle

*See text



Overlay of Mixer and Power Supply board

HEADPHONE AMPLIFIER

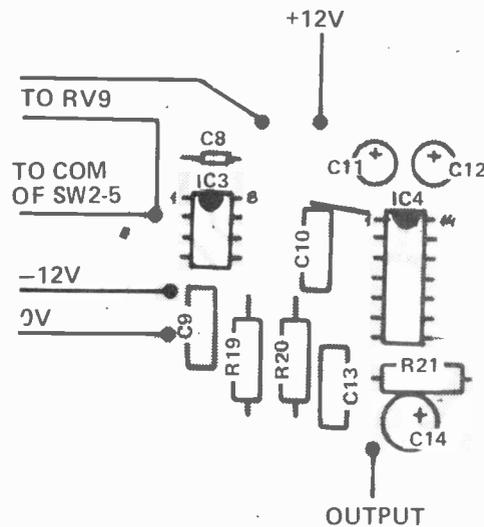


The resistors bridging Left and Right channel outputs are to provide a composite mono signal, without seriously degrading the main mixer stereo separation. The signal is selected by SW2-SW5 and fed to a buffer with variable gain (IC3). The output is then fed to a LM380 power amplifier which drives the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

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

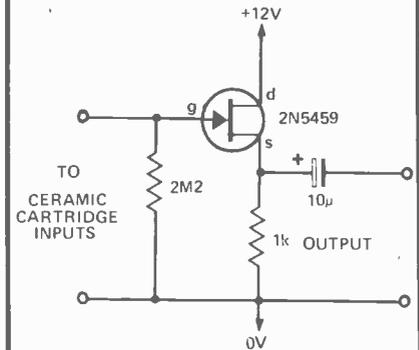
PARTS LIST — ETI 448A

- Resistors all 1/2w 5%
- R11-R18 100k
- R19 10k
- R20 2k2
- R21 2.7R
- Potentiometer
- RV9 100k log rotary
- Capacitors
- C8 33p ceramic
- C9, 10 100nF polyester
- C11, 12 10µ 16 V
- C13 100nF 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 resistor 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.

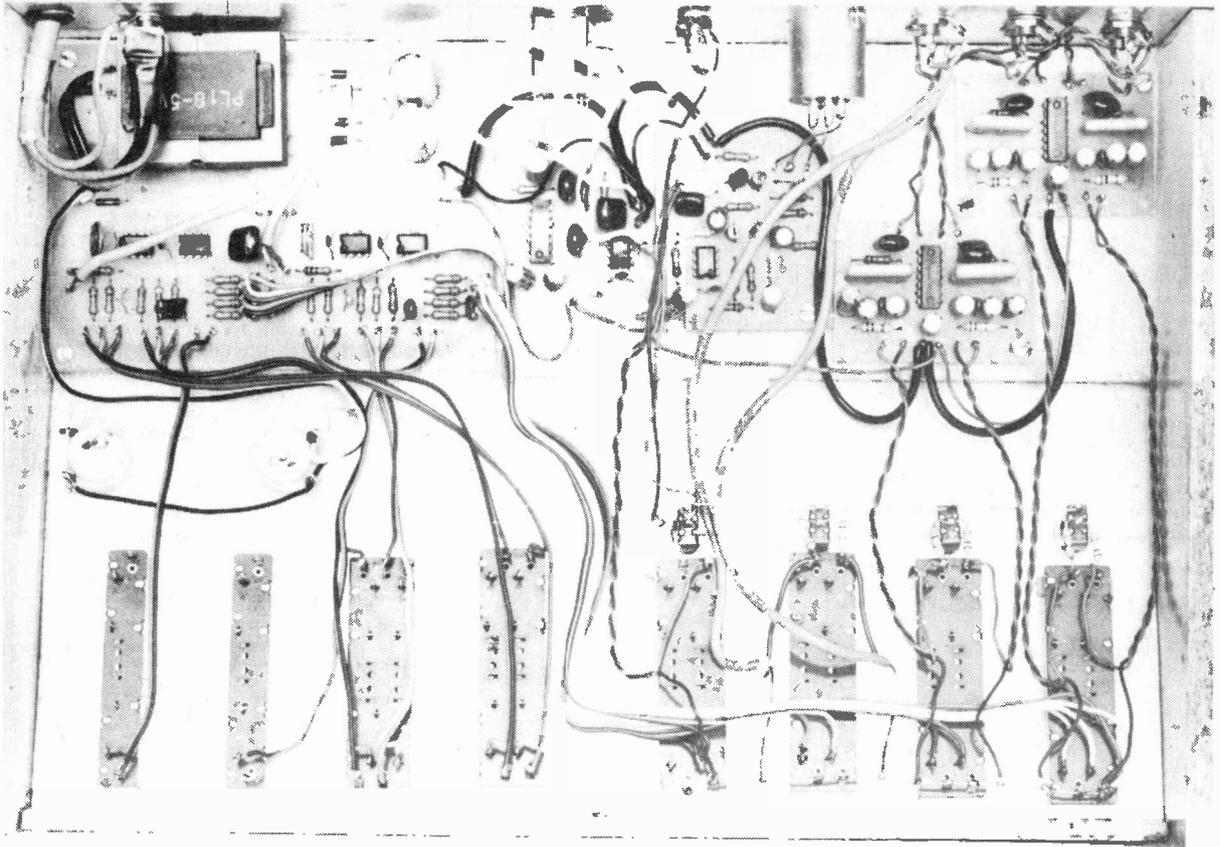
We strongly recommend the VU board. If used omit RV4 and D1 from the mixer board and connect point X to the input of the VU board. Calibration is by the preset on the VU board, feed a signal through the mixer until the output is just distorting the amplifier, and adjust the preset to indicate +3VU.

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.

DISCO MIXER



GENERAL PURPOSE PREAMPLIFIER

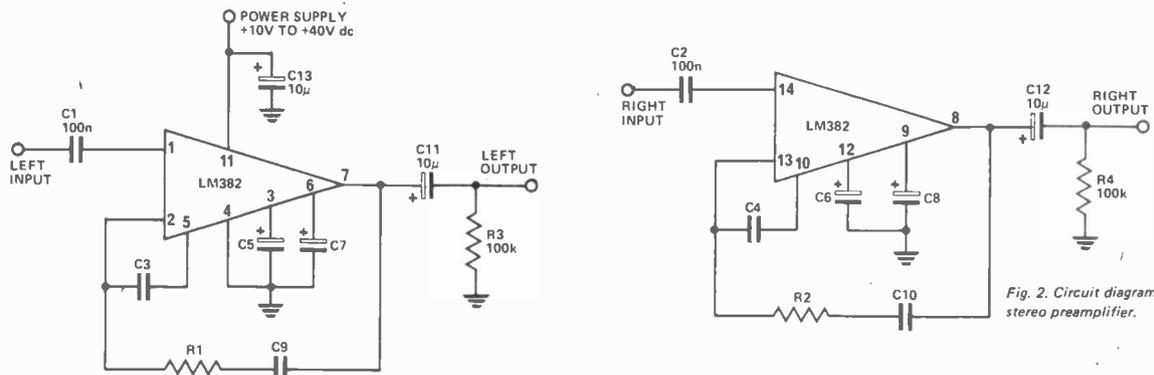


Fig. 2. Circuit diagram of the stereo preamplifier.

PARTS LIST — ETI 445

Resistors

R1, 2 see table
R3, 4 100k ½watt 5%

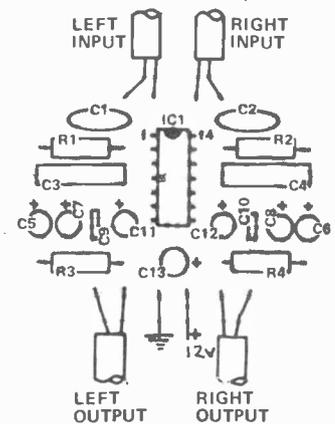
Capacitors

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.



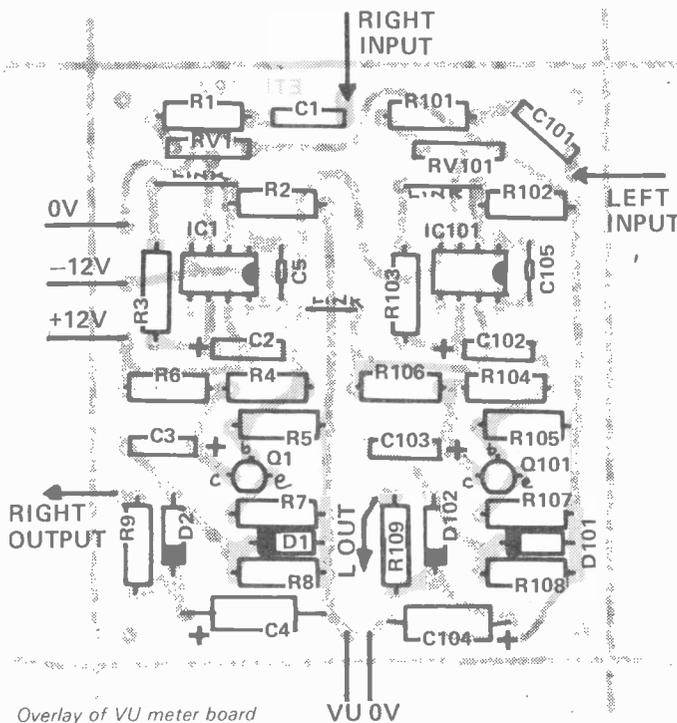
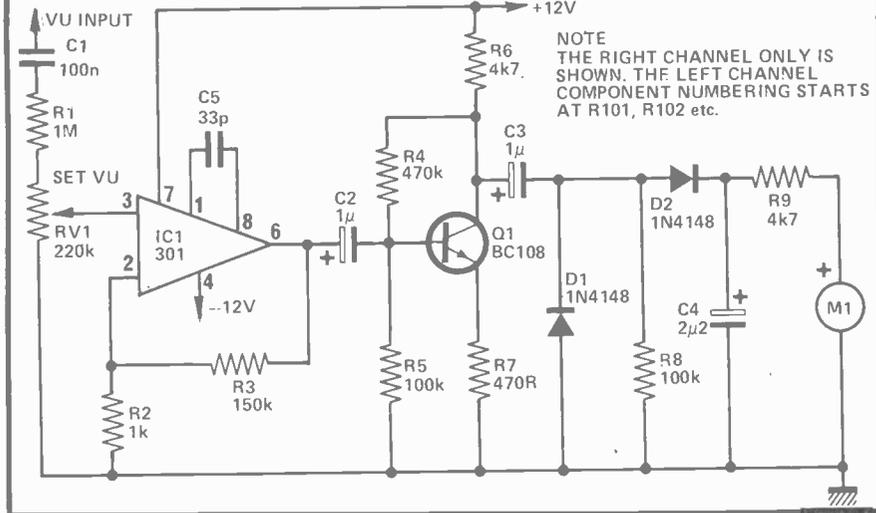
Overlay of General Preamp board

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	—	—

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 0V because of R8. When a negative going signal appears at collector of Q1, C3 will discharge through the negative peak. Difference between negative and positive peaks is transferred through D2 to C4, and hence to the VU meter.

VU METER CIRCUIT



PARTS LIST — ETI 449A

Resistors all 1/4 w 10%

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

Potentiometers

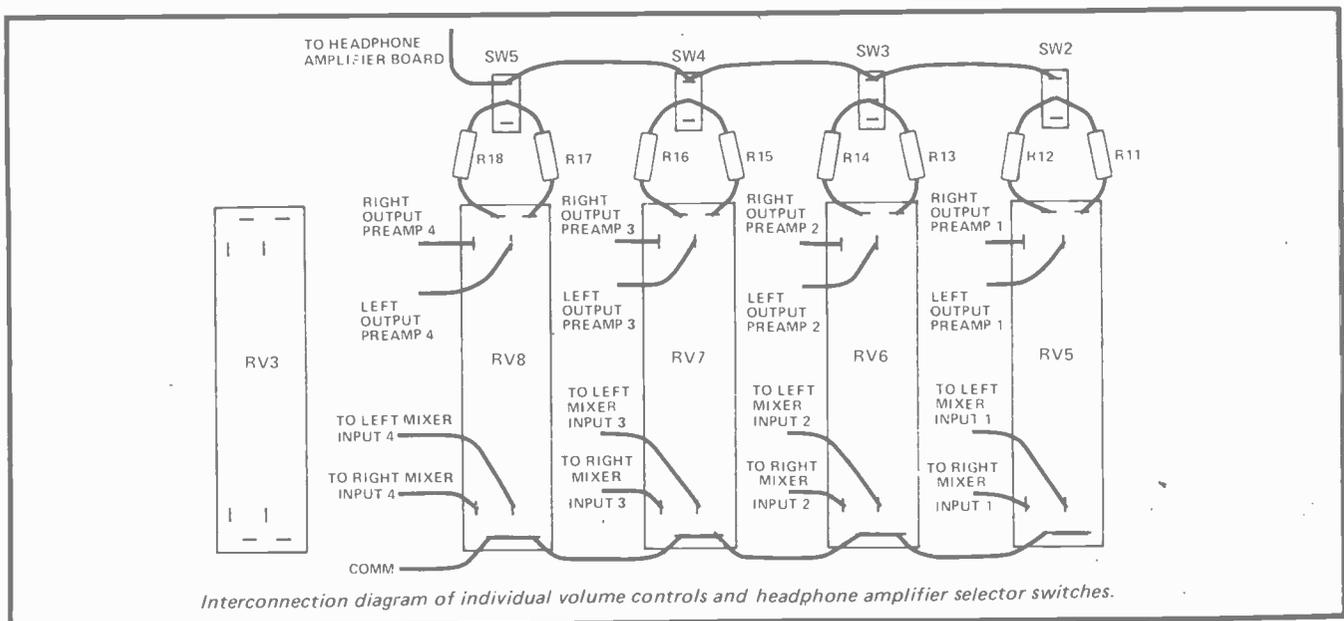
RV1	220k preset
-----	-------------

Capacitors

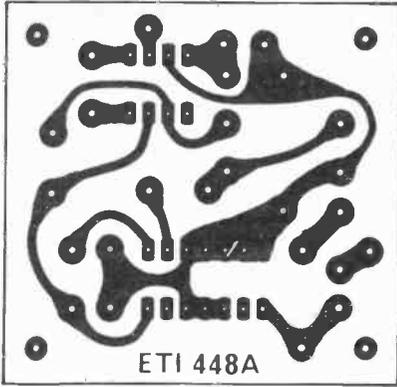
C1	100n polyester
C2,3	1µ 16V
C4	2µ2 16V
C5	33p ceramic

1C1	LM301
Q1	BC108
D1,2	1N4148

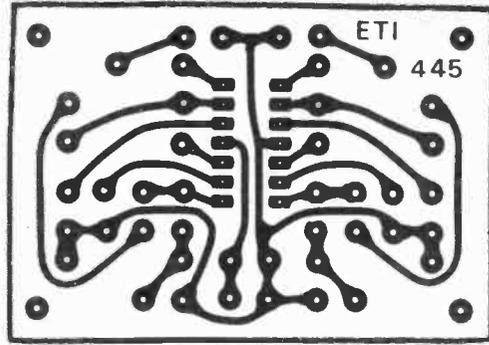
M1 VU meter
Two of each required for stereo
PC Board ETI 449A



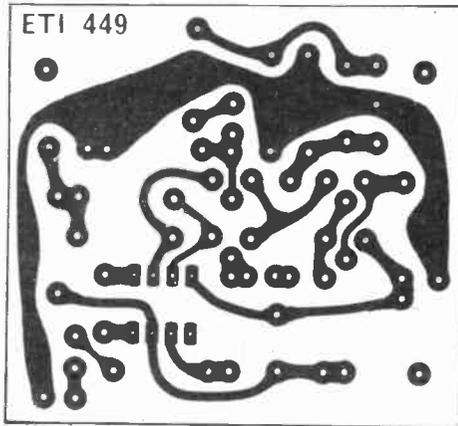
DISCO MIXER



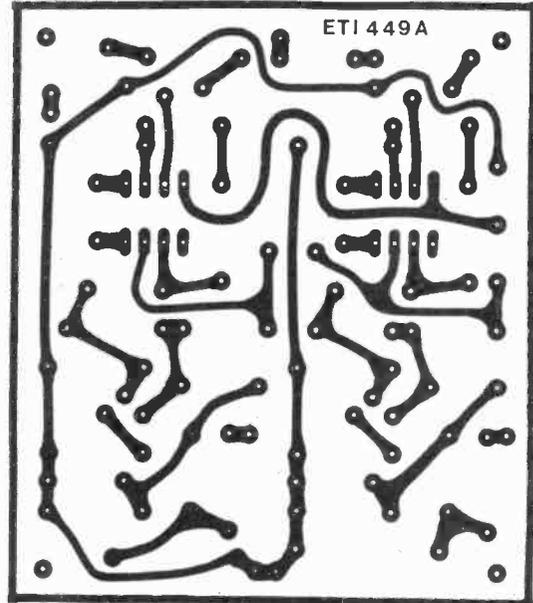
HEADPHONE AMPLIFIER



GENERAL PREAMPLIFIER

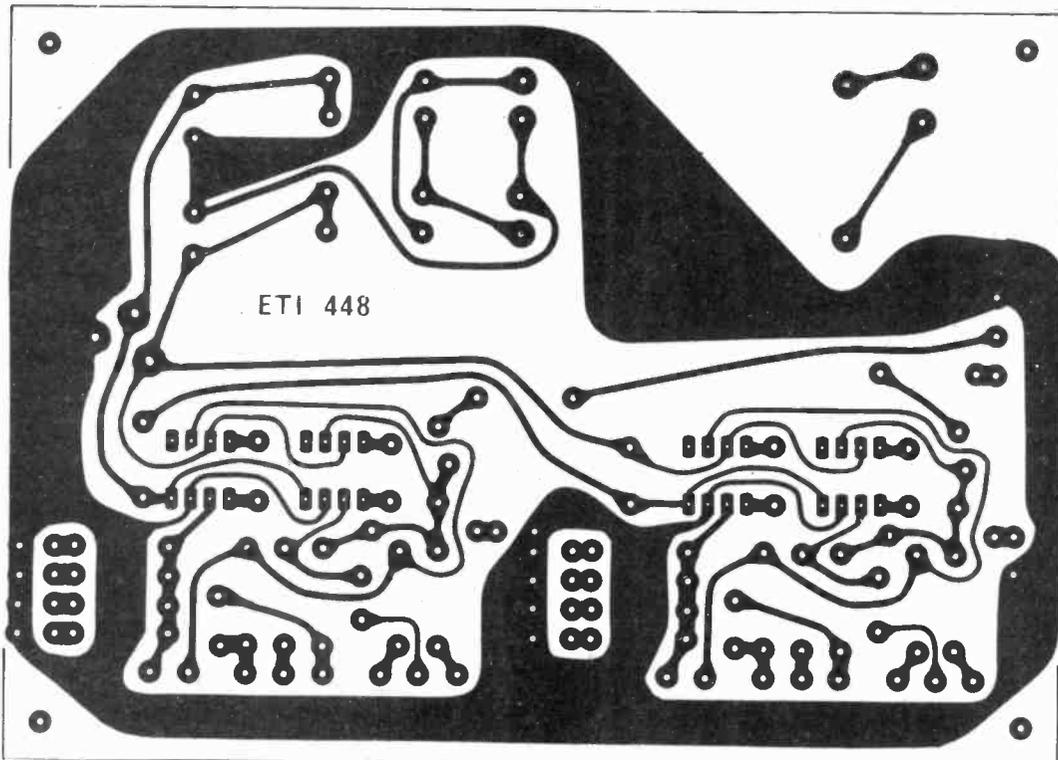


BALANCED PREAMPLIFIER

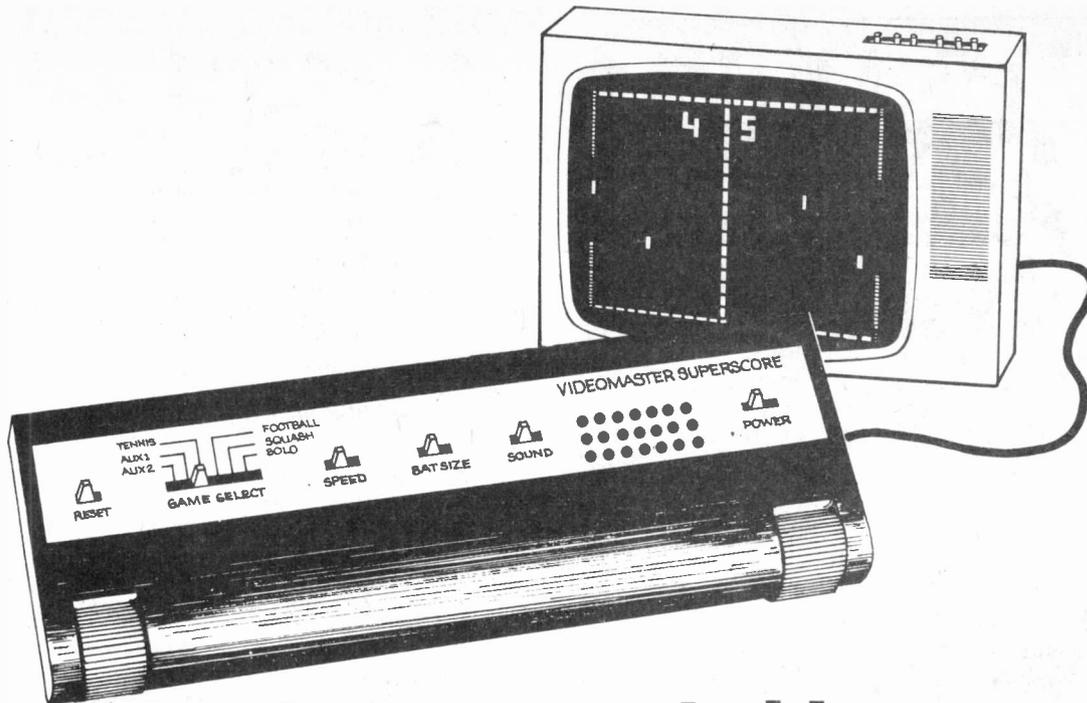


VU METER

COMPONENT OVERLAYS FOR THE DISCO MIXER



MIXER AND POWER SUPPLY



Here's the remarkable new **VIDEOMASTERTM** Superscore Home TV Game Get it together for only £24.95

Available to you in kit form at the same moment as its national launch, the brilliant new Videomaster Superscore contains the latest product of MOS technology: a TV game chip.

The logic contained in it had previously to be generated by 100 TTL devices. Now it is condensed into one 28-pin chip.

This all-new Videomaster plugs into your 625-line UHF TV set (for overseas customers having VHF sets we can supply the necessary VHF modulator) to give you four exciting games (including tennis and football) and two future game options. It features on-screen digital scoring, realistic hit sounds, two bat sizes, two

ball speeds, automatic serving and much more. It runs on six 1½ volt SP11 type batteries (not supplied).

The Videomaster Superscore kit costs only £24.95 including VAT (recommended retail price of the ready built model is over £40.00) and comes complete with ready-tuned UHF or VHF modulator, circuit board with printed legend, all resistors, transistors and diodes, built-in loudspeaker, socket for mains adaptor, and, of course, the TV game chip itself.

Easy to put together the Superscore has full assembly instructions, circuit diagram and circuit description. Don't miss this chance to own the newest electronic game at such low cost.

POST TODAY TO:

Videomaster Ltd 14/20 Headfort Place, London SW1X 7HN



Please send me (insert No. requ'd).....Videomaster Superscore Kits at £24.95 (inc. VAT & P&P in UK) or £23.10+£4.00 for P&P overseas)

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

VHF modulator required YES/NO*

NAME _____

ADDRESS _____

(ET B4)

ALLOW 21 DAYS FOR DELIVERY

* delete as necessary

Sparkrite mk2

Capacitive discharge
electronic ignition kits

VOTED BEST
OF 8 SYSTEMS
TESTED BY
'POPULAR'
MOTORING
MAGAZINE
Oct. '74



- * Smoother running
- * Instant all-weather starting
- * Continual peak performance
- * Longer coil/battery/plug life
- * Improved acceleration/top speeds
- * 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.

THE KIT COMPRISES EVERYTHING NEEDED

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).

CALLERS WELCOME. For Crypton tuning and fitting service - phone (0922) 33008.

Improve performance & economy NOW

Note: Vehicles with current impulse tachometers (Smiths code on dial R.V. 1) will require a tachometer pulse-slave unit. PRICE £3.35

PRICES INCLUDE VAT, POST AND PACKING.

POST TODAY!

Quick installation
No engine modification
required

Electronics Design Associates, Dept. ET2
82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 33652

Name

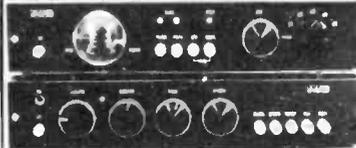
Address

Mk. 2 DIY Ass. Kit @ £11.80	QUANTITY REQD.	I enclose cheque/PO's for £
Mk. 2 Ready Built Negative Earth @ £14.97		
Mk. 2 Ready Built Positive Earth @ £14.97		Cheque No.
Ignition Changeover switches @ £4.30		Send SAE if brochure only required.
R.P.M. Limit systems in above units @ £2.42		

AMBIT international (dept 85)

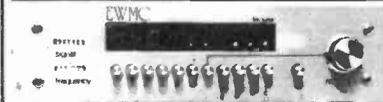
The Dynamic Twosome: Signalmaster/Audiomaster

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



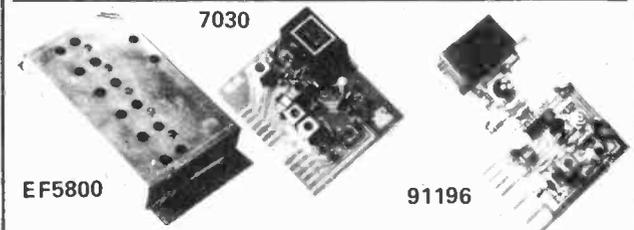
Power: 25+25W RMS
THD: Less than 0.3%
Dynamic range: an exceptional 80dB
(Signalmaster shown on top of the Audiomaster)

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 experienced 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 tuner set, 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)



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/YMCS 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 32v0.50*	BLR2007 (3k3 imp) 1.75
NE560/2B PLL IC ea:2.50	23 or 36mH chokes 0.33
NE561B PLL IC 3.50	Tunerheads: (& tuner sets)
NE565A/567V PLL ea:2.50	EF5600 5 gang varicap 12.80
810k kit for TBA810 amp2.75	EC3302 3 gang varicap 5.50
2020k kit for 2020 amp 9.35	8319 (Larsholt) 12.00
92310 kit for mpx decoder5.35	7252 tuner set complete 26.00
7020 kit for 3089 FM IF 6.65	7253 stereo tuner set 26.00
971197 kit for varicap AM radio tuner 9.65	Standard transistors also kept in stock - see lists for further detail
7700 built TV sound tuner 27.00	and price information.

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

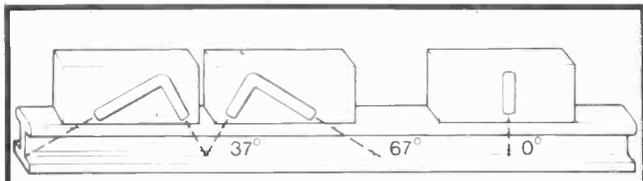


Fig. 1. The layout of the three water-coupled probes on the rail. The air probe is omitted.

there, two other probes are 'air-coupled' to the rail from the sides, to detect the fish plate joints holding the rails together.

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 judicious 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 it is 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

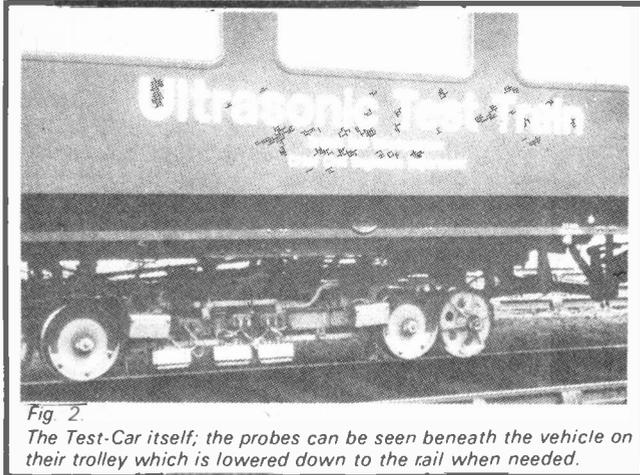


Fig. 2. The Test-Car itself; the probes can be seen beneath the vehicle on their trolley which is lowered down to the rail when needed.

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 pattern on the film.

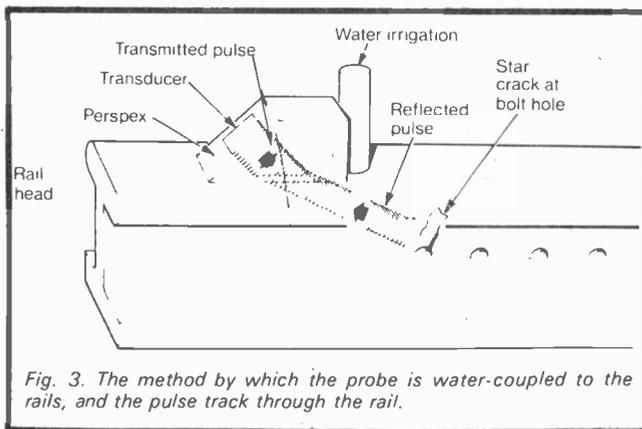


Fig. 3. The method by which the probe is water-coupled to the rails, and the pulse track through the rail.

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

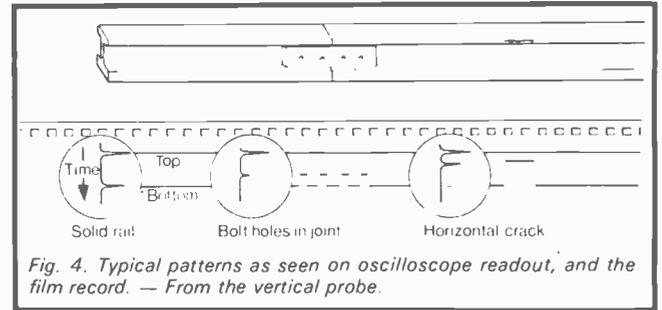


Fig. 4. Typical patterns as seen on oscilloscope readout, and the film record. — From the vertical probe.

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.

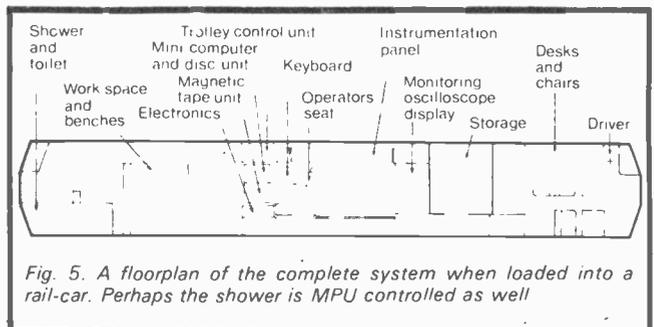


Fig. 5. A floorplan of the complete system when loaded into a rail-car. Perhaps the shower is MPU controlled as well

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

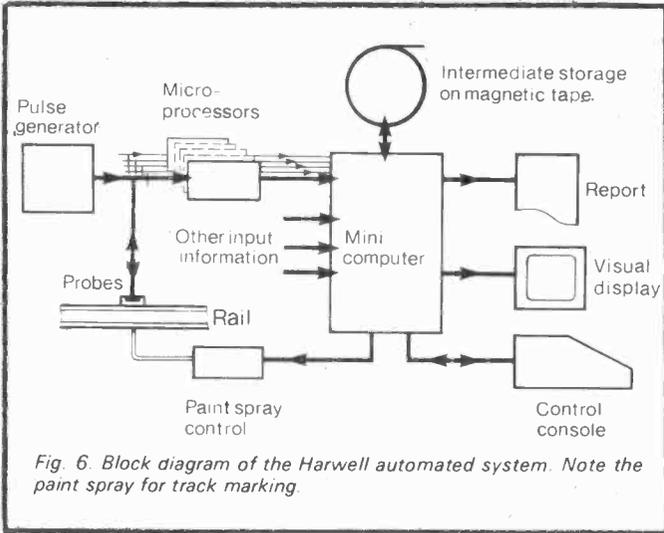


Fig. 6. Block diagram of the Harwell automated system. Note the paint spray for track marking.

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!

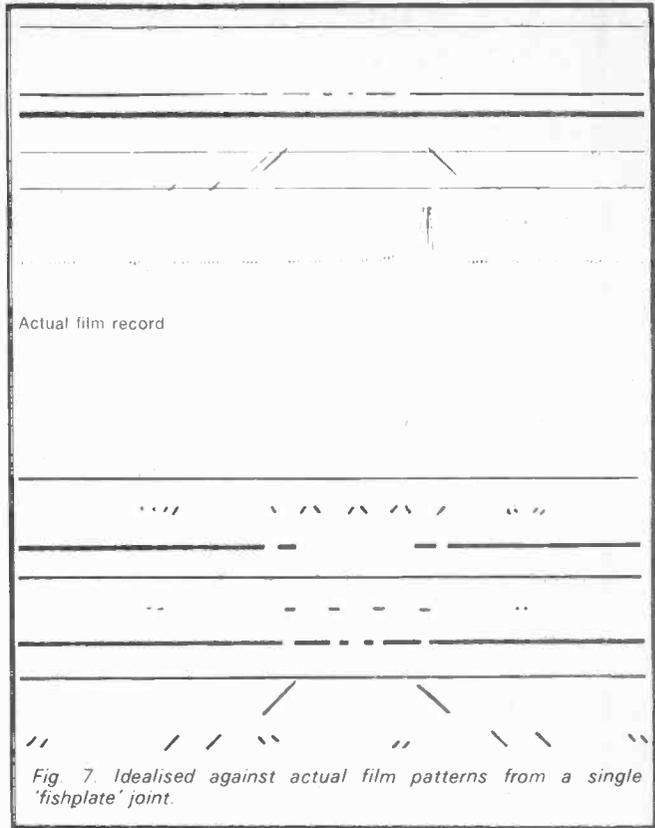


Fig. 7. Idealised against actual film patterns from a single 'fishplate' joint.

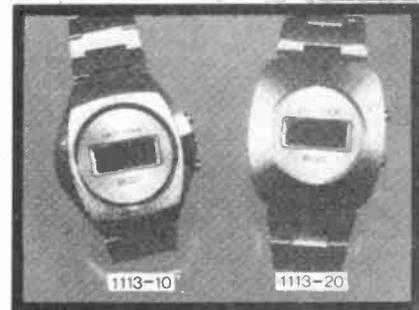
CONTINUOUS DISPLAY LCD WATCHES

UNIQUE ALTERNATING DISPLAY FEATURE

The watch continuously displays HRS. and MINS. with MONTH, DAY and SECONDS on demand. The owner selects the feature where the HRS. and MINS. or MONTH and DAY display alternatively for 2 second intervals until owner resets to normal display. During the alternating cycle seconds are still available on demand.

- **Finest American MOS technology
- **Quartz accuracy.
- **Multi-function:
Hrs., Mins., Month, Day, Seconds.
Alternating display Back-light.
Programmed 28, 30, 31 day months.
A.M./P.M. indication for ease of date setting
- ***All important: UK factory manufacturing and servicing facilities.

Watch despatched with matching Gold plated bracelet, in presentation box with instruction booklet and guarantee. Model 1113-10 is also available in a stainless-steel bracelet.



CHRISTMAS OFFER VALID TO DECEMBER 31st, 1976

Price ~~£34.50~~
NOW £27.50
incl. VAT & P&P

Leetronic

Watch Division, Lee Instrumentation Ltd.
Bedwas, Newport, Gwent NP1 8YZ
TEL. (0222) 885756-7-8. TELEX: 497084
Reg. No. 639437. VAT Reg. No. 133 8154 80

To: Leetronic, Lee Instrumentation Ltd., Newport, Gwent NP1 8YZ
Print — FREEPOST — no stamp required.

Please forward _____ (qty) model _____ at _____ each TOTAL: £ _____

I enclose

Name _____ cheque _____

Address _____ postal order _____

_____ money order _____

Signed _____

Barclaycard/Access no. _____



Learn to understand electronics for your hobbies

1. Lerna-Kit course

Step by step, we take you through all the fundamentals of electronics and show you how easily the subject can be mastered.

- (1) BUILD AN OSCILLOSCOPE.
- (2) READ, DRAW AND UNDERSTAND CIRCUIT DIAGRAMS.
- (3) CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS AND SEE HOW THEY WORK.

2. Become a Radio-Amateur

Learn how to become a radio-amateur in contact with the wide world. We give skilled preparation for the G.P.O. licence.

FREE!

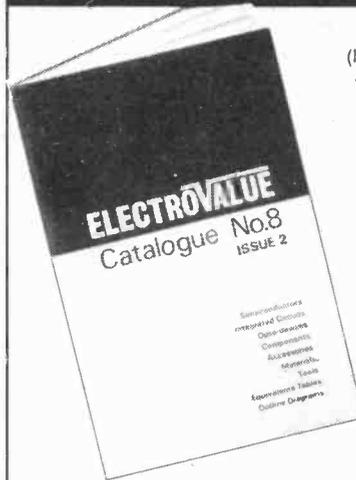
Brochure, without obligation to:
BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL
 P.O. BOX 156, JERSEY, CHANNEL ISLANDS.

NAME _____

ADDRESS _____

BLOCK CAPS PLEASE ETA17

THE OPEN DOOR TO QUALITY



Electrovalue Catalogue No. 8 (Issue 2, up-dated) offers items from advanced opto-electronic components to humble (but essential) washers. Many things listed are very difficult to obtain elsewhere. The Company's own computer is programmed to expedite delivery and maintain customer satisfaction. Attractive discounts are allowed on many purchases; Access and Barclaycard orders are accepted.

PLUS FREE POSTAGE

on all C.W.O. mail orders in U.K. over £2.00 list value (excluding VAT). If under, add 15p handling charge.

UP-DATED 2nd EDITION

With Prices stabilised to Dec. 31st.

144 pages, 40p

Post paid, inc. refund voucher for 40p

ELECTROVALUE LTD

All communications please to Head Office, Egham address. Dept. ET.1

28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY TW20 0HB. Tel. Egham 3603. Telex 264475. Shop 9-5.30, 9-1 pm Sats. NORTHERN BRANCH, 680 Burnage Lane, Burnage, Manchester M19 1NA. Tel. (061) 432 4945. Shop 9-5.30 pm, 1 pm Sats.

ETI CLOCK: £13.95

THE LONG-RUNNING OFFER ON A DIGITAL ALARM CLOCK HAS BEEN ONE OF OUR MOST SUCCESSFUL EVER! OUR PRICE **INCLUDES** VAT AND POST & PACKING



Full size = 5in across and 3½ in deep

Our clock shows the time 0.7in. high on bright Planar Gas Discharge displays (there is a brightness control on the back). The dot on the left of the display shows AM/PM, and the flashing (1Hz) colon shows that the alarm and clock are working.

A beeper alarm sounds until the clock is tipped forwards. Then the "snooze" facility can give you 5 minutes sleep before the alarm sounds again, and then another 5 minutes, etc., until you switch the alarm off. The clock also features a mains-failure indicator, and is 12hr. — the alarm being 24 hour.

We have a large number of units in stock for this offer but please allow 28 days for delivery.

**CLOCK OFFER
 ETI MAGAZINE
 25-27 OXFORD STREET
 LONDON W1R 1RF**

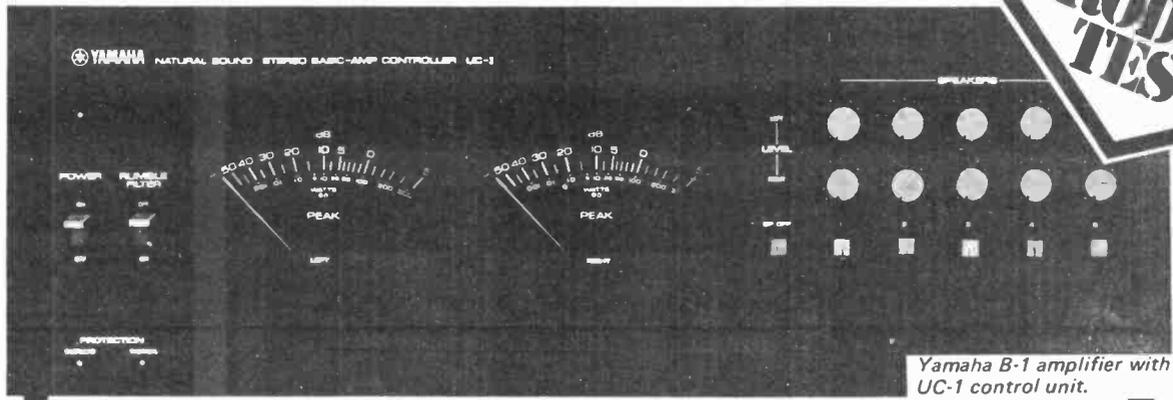
I enclose cheque/P.O. for £13.95 (payable to ETI) for an Alarm Clock. Please write your name and address on the back of your cheque to speed processing of your order.

Name
 ADDRESS

Those not wishing to cut their magazine may order on their own notepaper.

YAMAHA B-1

ETI
PRODUCT
TEST



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 of 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 FETs, 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 amp-

lifier 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 LEDs indicating the operation of the overload protection, the state of the thermal overload 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 B-1 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 ± 0.4 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.

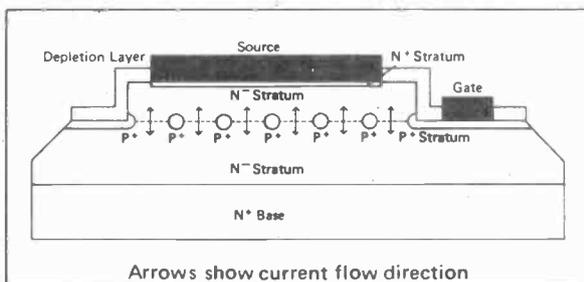
Distortion is very low indeed — over most of the frequency and power output range the unit introduced no

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: (Both channels driven)	210 watts (8 Ω 1 kHz) 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: (Both channels driven)	100 W 8 Ω	100 Hz 0.03% 1 kHz << 0.01% 6.3 kHz 0.07%
	1 W 8 Ω	100 Hz < 0.03% 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 (8 Ω)	
Input Impedance:	92 k Ω at 1 kHz	
Output Impedance:	0.08 Ω at 1 kHz	

*Max measurable frequency with test gear used.

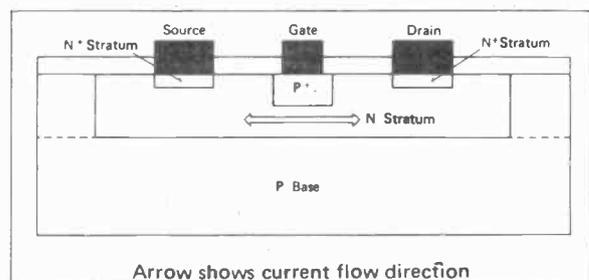
YAMAHA VERTICAL FET CONSTRUCTION



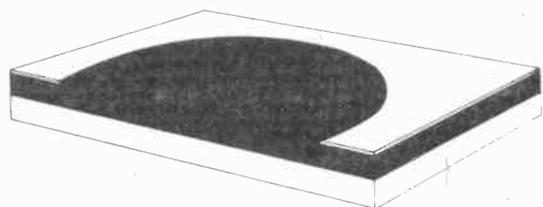
As the vertical FET illustration below shows, the source, gate and drain are aligned vertically, permitting much higher power capacity. Each element of the mesh is, in effect, equivalent to an independent FET; a single Yamaha vertical FET contains tens of thousands of such elements.

The mesh itself measures 5-10 μ 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



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

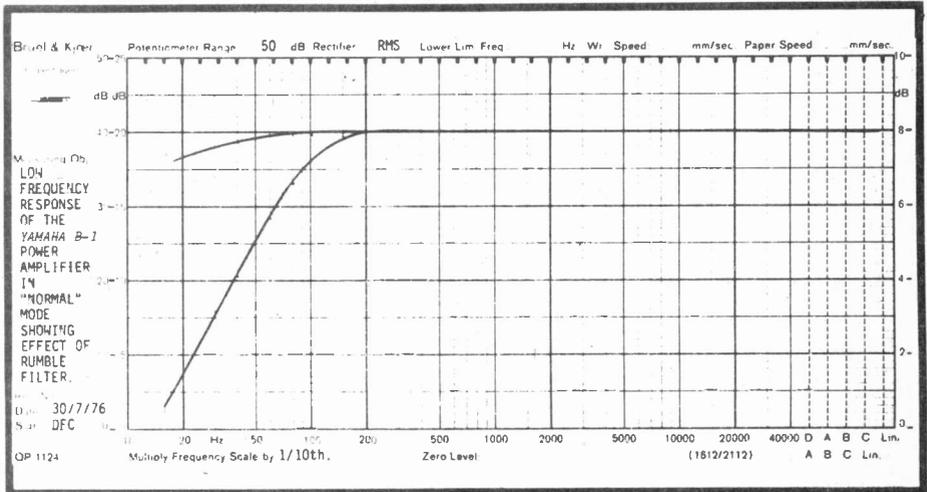
As hard as we tried we could in no way fault the performance of this unit, except lamely to say that when we picked it up we found it too heavy!

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.



DOLBY™ 'B' NOISE REDUCTION KIT

Trademark of Dolby Laboratories Inc

Build your own Dolby system using this exclusive approved kit.

Featuring:

- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions.
- no equipment needed for alignment.
- suitability for both open-reel and cassette tape machines.
- check tape switch for encoded monitoring in three-head machines.

The kit includes:

- complete set of components for stereo processor.
- regulated power supply components.
- board-mounted DIN sockets and push-button switches.
- fibreglass board designed for minimum wiring.
- solid mahogany cabinet, chassis, twin meters, front panel, knobs, mounting screws and nuts.

Dolby level cal. tapes are available for open-reel use and for cassette (specify which) **Price £2.00 + VAT***

Please add VAT at 12½% unless marked thus*, when 8% applies
We guarantee full after-sales technical and servicing facilities on all our kits

High performance Tuner-Amp and Tuners available.

Typical performance

Noise reduction: better than 9dB weighted.
Clipping level: 16.5dB above Dolby level (measured at 1% third harmonic content).
Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%.
Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output.
Dynamic Range > 90dB.
30mV sensitivity.

PRICE: £37.90 + VAT

INTEGREX LTD.

Please send SAE for complete lists and specifications
Portwood Industrial Estate, Church Gresley
Burton-on-Trent, Staffs. DE11 9PT
Burton-on-Trent (0283) 215432. Telex 377106



EXCLUSIVE OFFER!

WIRE DISTRIBUTION SYSTEM



WIRE DISTRIBUTION PENCIL:

A well balanced, easy to handle wire dispenser. Design features include:
 ★ A unique threading/tensioning system plus
 ★ Long life steel tip for high-speed wiring
 ★ Supplied with full bobbin of wire, threaded ready for use

SPARE BOBBIN:

Wound with 36 swg solderable synthetic enamel wire with polyurethane base



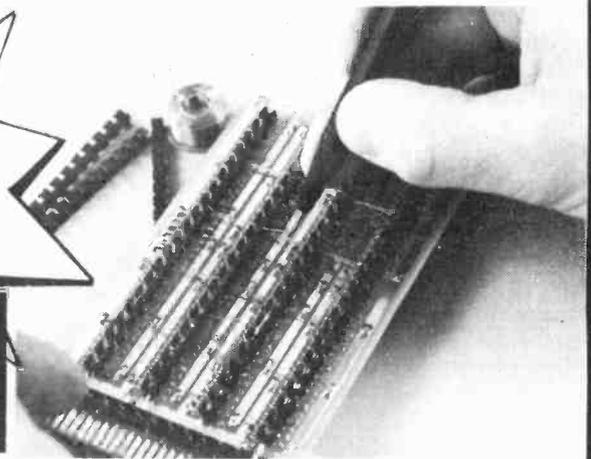
INTRODUCTORY
KIT

PRICE **£5.95**

inclusive of VAT
post and packing

KIT CONSISTS OF:

- ★ Circuit Board
- ★ Wire Distribution Strips
- ★ Spare Spool
- ★ I.C. Leg Deformer
- ★ Comprehensive Instructions



HIGH PACKING DENSITY DIL BREADBOARD:

Designed specifically for Wire Distribution System, may be used as general purpose breadboard. Single sided with two voltage planes. 20 14-pin or 16 16-pin I.C. locations, or various combinations of 4-40 pin I.C.s. 28 contact fingers with 2.54mm pitch. Dimension 6.2mm x 67mm (3" x 5")

WIRE DISTRIBUTION STRIPS (Pat. Pending): The 'Strips' are designed to press-fit into the board between the leads of the integrated circuits. They are designed to ★ retain large capacity of wires ★ protect wires from breakage ★ aid fast wiring (i.e. no posts to impede wiring and modification techniques ★ make packing density non-restrictive; and ★ be cut to length easily

LEAD DEFORMATION TUBE: Is placed between the legs of the IC and used to deform the pins -- thus securing the IC.

The solution to economic quality I.C. Prototyping

Please send Money Order / Cheque with order or S A E for further details
TRADE & OVERSEAS ENQUIRIES WELCOME

ETI DIGITAL MULTIMETER KIT DMKI

This kit has been specially made available to ETI readers, and comes complete, down to the last screw. All you need is a few spare hours and some tools. The result will be a superb piece of test equipment that will be of invaluable use to the serious constructor or test lab.

Special Note:

This kit has been produced in conjunction with the designer and author of the project in the October issue of ETI as several parts are not normally available, or specially manufactured.



- ★ High accuracy, spec as in project text.
- ★ Designer approved kit.
- ★ Silk screened panel with all lettering.
- ★ Test leads, prods, etc., supplied.
- ★ Assembly instructions included.
- ★ All parts available separately.

Please allow 21 days for delivery.

★ A demonstration model can be seen working at our electronics centre. Full list and specifications. Send s.a.e. please.

PRICE
£65-50
Inc. VAT & Postage (UK)

ORDER FORM
TO B H COMPONENT FACTORS LTD.
59 NORTH ST., LEIGHTON BUZZARD, BEDS.

Please supply 1 DMK1 kit

Name

Address

I enclose cheque/PO for £

Access of B / card No

B H COMPONENT FACTORS LTD.

LEIGHTON ELECTRONICS CENTRE
59 NORTH ST., LEIGHTON BUZZARD, BEDS. LU7 7EG
TEL: 2316 (STD 05253)

GOVERNMENT & EDUCATIONAL ORDERS ACCEPTED
GIRO NO. 331 7056 ACCESS & BARCLAYCARDS ACCEPTED

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.

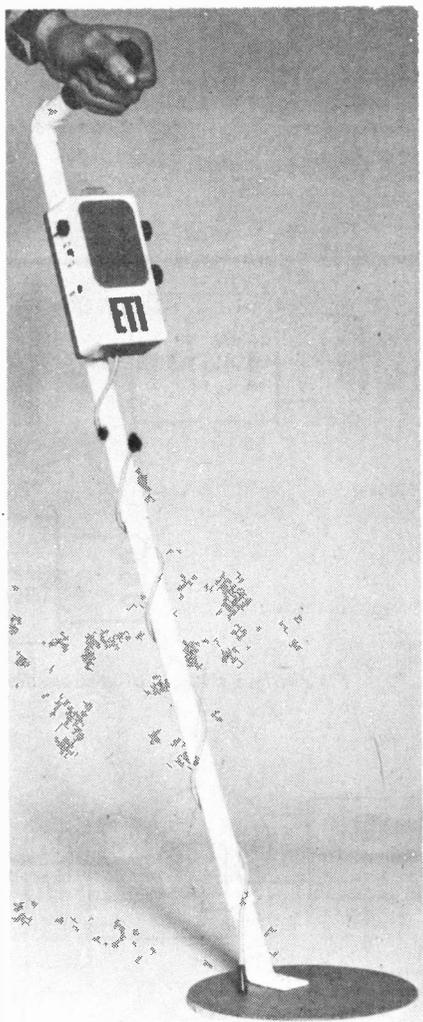
"ANOTHER METAL LOCATOR," some of you will say. Yes and no. Several designs have been published in the hobby electronics magazines; some good, some downright lousy but they have invariably been Beat Frequency Oscillator (BFO) types. There's nothing wrong with this principle — they are at least easy to 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 principle 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 as 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 identifying 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

ETI Project 549

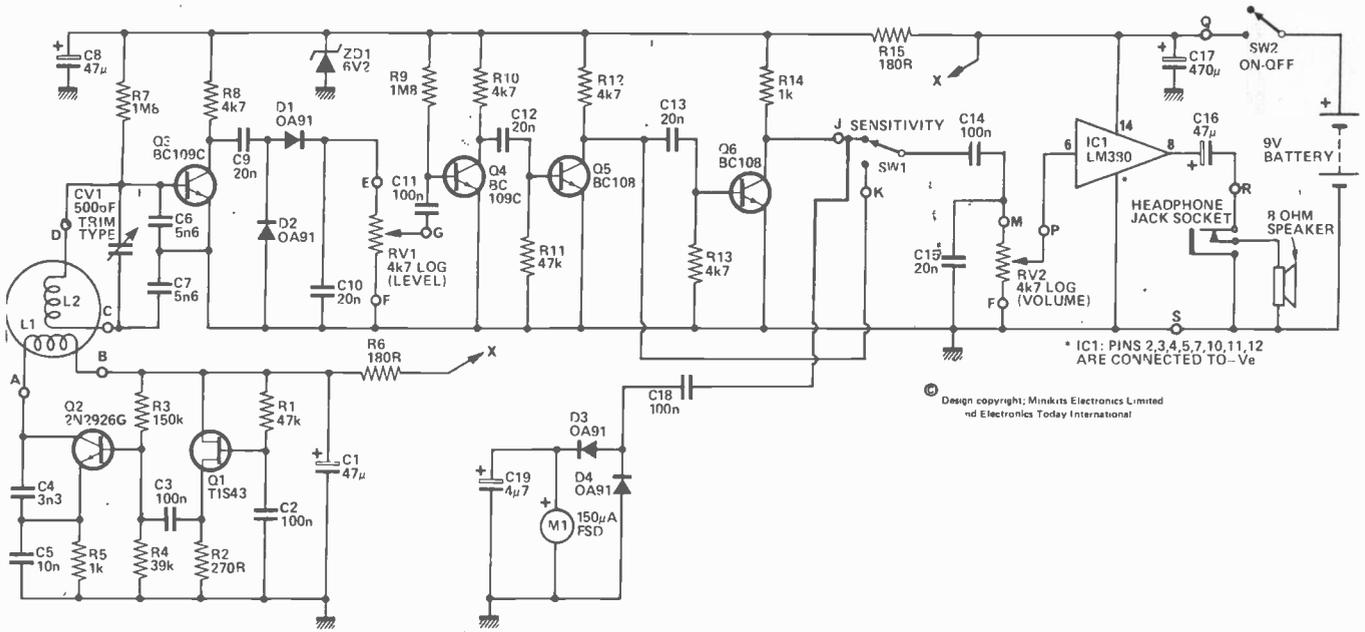


Fig.1 Complete circuit of the metal locator. Note that though the electronics is simple using very common parts, the whole operation depends on the coils L1 and L2 which must be arranged so that

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.

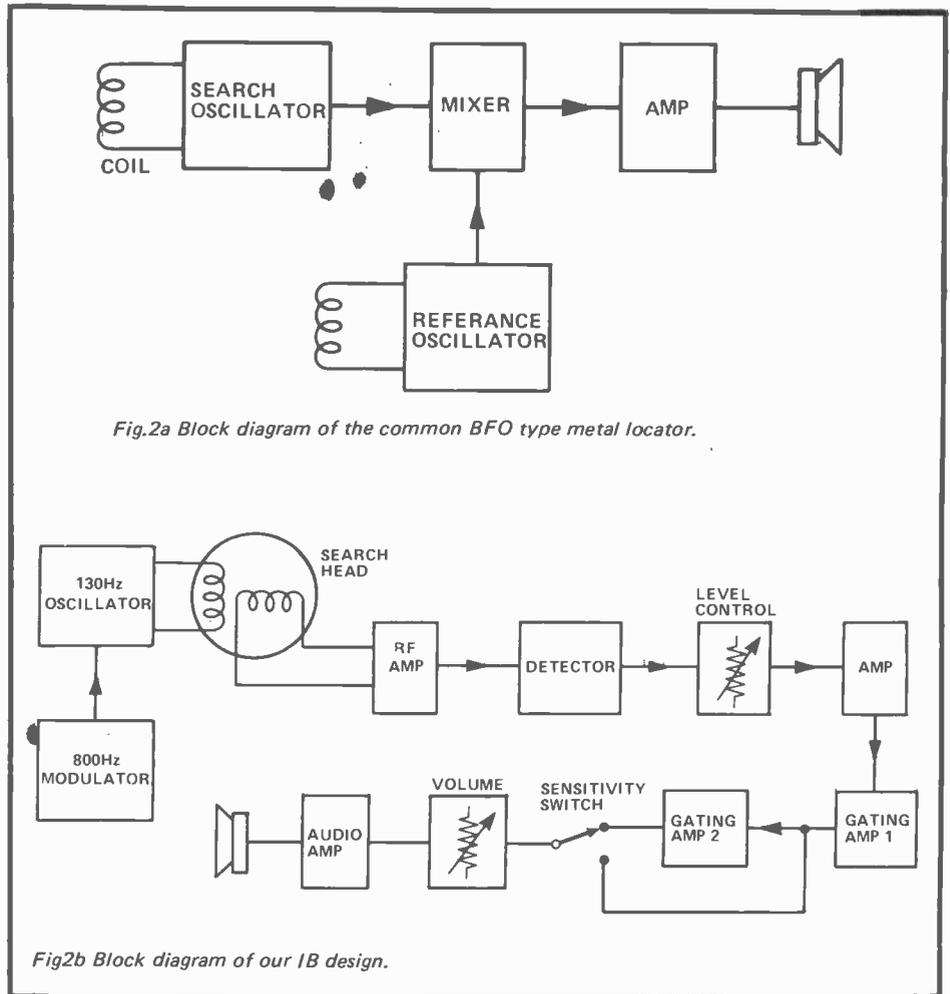


Fig.2a Block diagram of the common BFO type metal locator.

Fig.2b Block diagram of our IB design.

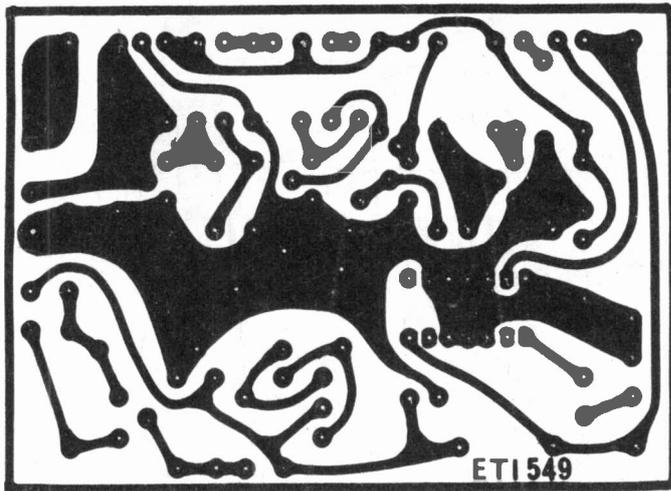


Fig.3 The PCB pattern. Most components other than the meter circuitry is built on this.

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 it 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 CV1 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.

ETI Project 549

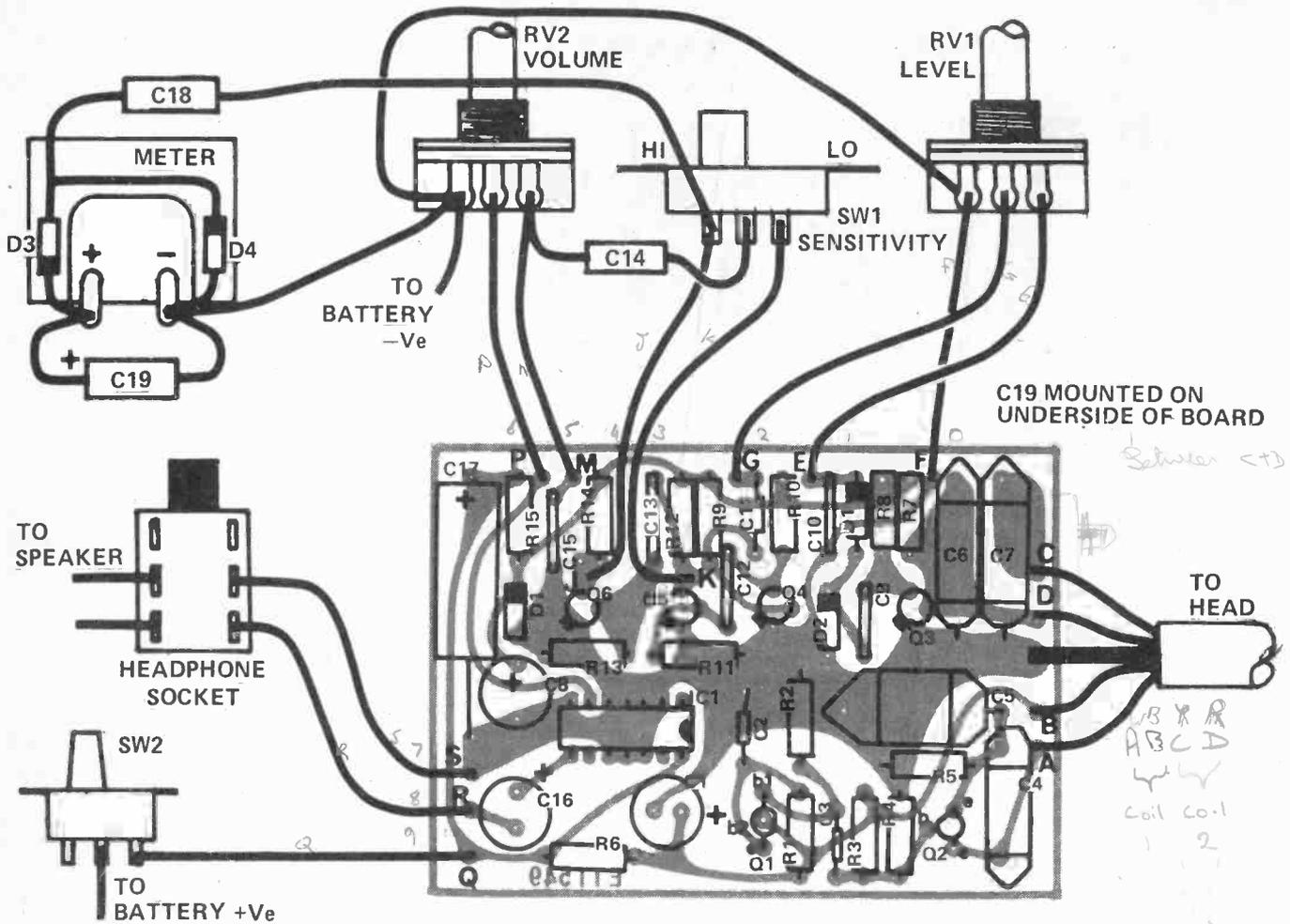


Fig. 4. The component overlay and wiring diagram to other parts of the circuit not on the PCB.

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 <i>level</i>	4k7	log rotary
RV2 <i>volume</i>	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 electrolytic
-CV1	4µ7 16V electrolytic
-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,

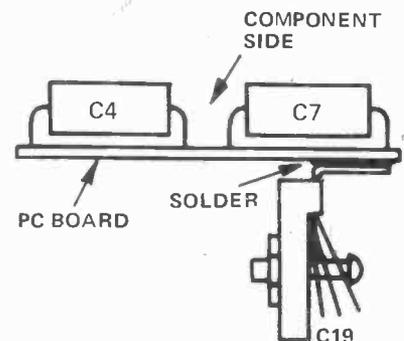
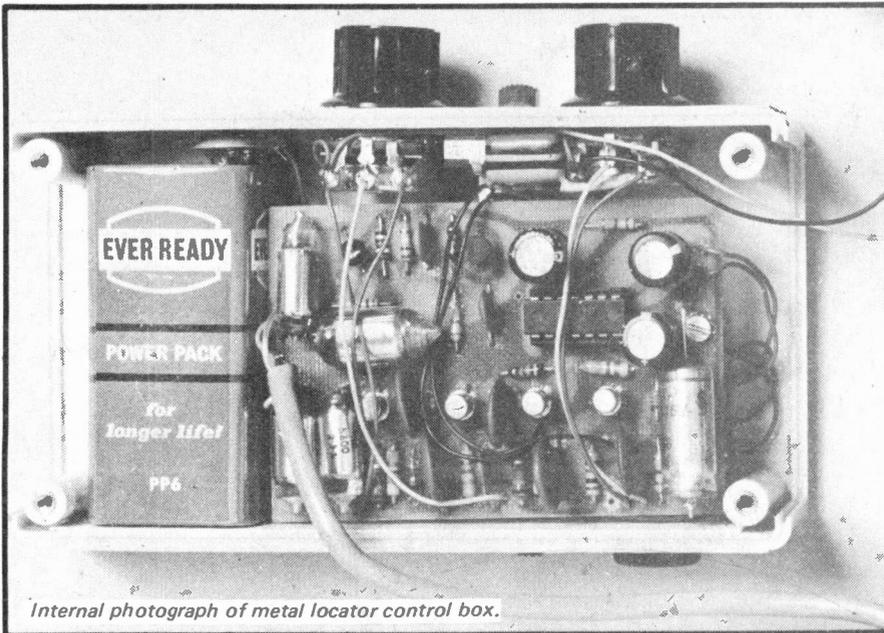


Diagram showing C19 mounted on copper side of P C Board



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 glued 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.

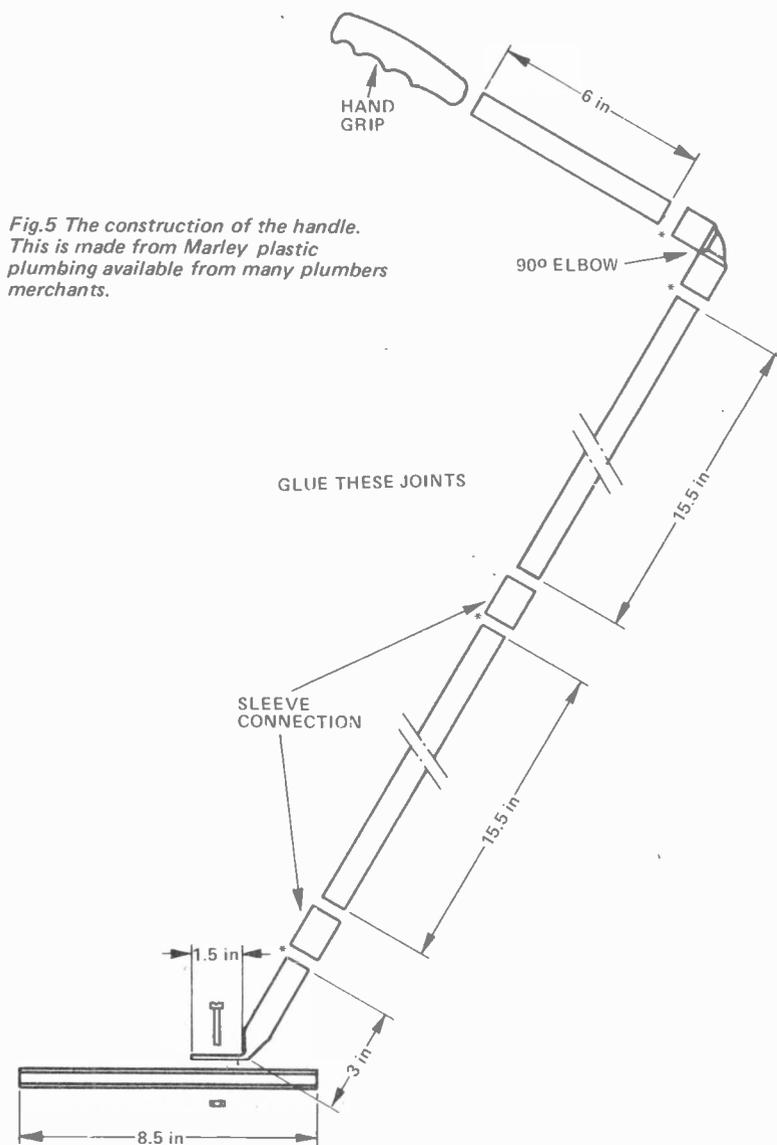
You'll now have to find something cylindrical with a diameter of near enough 140mm (5½in). A coil will then have to be made of 40 turns of 32 s.w.g. enamelled copper wire. The wire should be wound close together and kept well bunched and taped to keep it together when removed from the former. Two such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

One of the coils is then fitted into the 'dish' and spot glued in six or eight places using quick setting epoxy resin: see photograph 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 preferably 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.



ETI Project 549

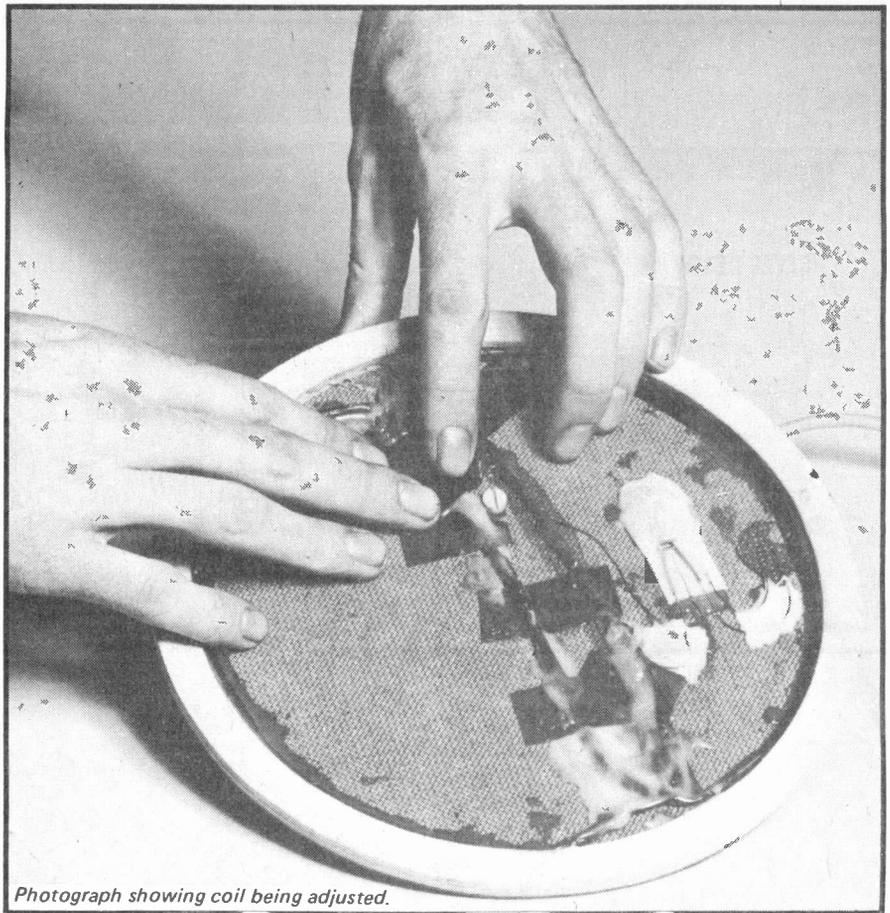
Now connect up the remainder of the circuit and set RV1 so that it is *just* passing through a signal to the speaker. Bring a piece of metal near the coil and the signal should rise. If it falls in level (i.e. the crackling disappears) the coil has to be adjusted until metal brings about a rise with 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"

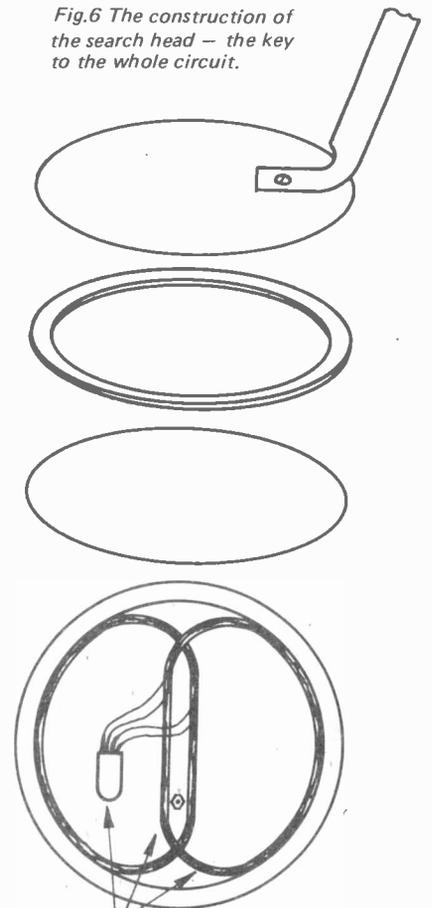
Table showing sensitivity of the metal locator in free air. (Buried objects can usually be detected at greater depths.)

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.

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



COILS AND POWER CORD ARE GLUED INTO POSITION WITH FIVE MINUTE EPOXY

ETI PCB's

TITLE	PROJECT NO.	BOARD NO.	TOTAL	TITLE	PROJECT NO.	BOARD NO.	TOTAL
Int. 25W Stereo Amp.	Int. 25	Int. 25	£3.80	Musical Synthesiser	601	601A	£2.30
Dual Power Supply	105	014	£1.48			601B	£2.30
Wide Range Voltmeter	107	022	£1.09			601C	£1.48
L.C. Power Supply	111	111	£1.43			601D	82p
Thermocouple Meter	113	113	£1.57			601E	£3.36
Dual Beam Adaptor	114	114	£1.00			601F	£1.11
Impedance Meter	116	116	£1.01			601G	£1.58
Digital Voltmeter	117	117A	58p			601H	£2.14
		117B	68p			601I	£2.30
Simple Freq. Counter	118	118	68p			601J	97p
The Revealer	213	213	68p			601M	89p
Brake Light Warning	303	007	68p			601N	£2.75
Auto. Car Theft Alarm	305	019	99p			601P	£1.40
Int. Battery Charger	309	309	99p			601R	£1.51
Tacho Timing Light	311	311	80p	Radar Int. Alarm	702	702	£1.13
Elect. Ign. C&A/Tacho	312	312	£1.72	Int. F.M. Tuner	751	751	£2.49
Car Alarm	313	313	67p	Light Dinner	—	—	68p
Auto Amp.	314	314	99p	Print Timer	—	—	68p
Four Input Mixer	401	005A	67p	Inter Com.	—	—	68p
Super Stereo	410	025	£1.37	Intruder Alarm	—	—	94p
100W Guitar Amp.	413	413	£1.73	Digital Alarm Clock	Timtronic	5017	£1.24
Master Mixer	414	414A	£1.14	Ultrasonic	—	—	£1.68
		414B	£1.52	Bicycle Speedometer	—	—	68p
		414C	£1.52				
		414D	£1.89				
Stage Mixer	414	414E	£1.78				
		417	68p				
The Over L.E.D.	417	417	68p				
Mixer Pre-Amp	419	419	53p				
Int. 420 Four C/Amp.	420	420A	70p				
		420B	97p				
		420C	£1.10				
		420D	£1.10				
Discrete SQ Decoder	420E	420E	£1.54	Logic Probe	120	120	£1.01
422 Stereo Amp. 50W	422	422	£2.69	Logic Tester	121	121	£1.01
Plus 2 Add on Decoder	423	423	83p	Onos Tester	122	122	£2.65
Spr. Reverb. Unit	424	424	£1.62	Onos Tester	123	123A	89p
Stereo Rumble Filter	426	426	70p			123B	89p
Graphic Equaliser	427	427	£1.79	Tone Burst Generator	124	124	£1.19
Colour Organ	428	428	£2.10	Audio Mini Voltmeter	128	128	£1.97
Simple Stereo Amp.	429	429	70p	Temperature Meter	130	130	£1.00
Line Amp.	430	430	70p	Active Crossover	433	433A	£1.18
						433B	£1.18
Fluorescent Lamp Dimmer	508	011	76p	Gen. Purpose Power Supply	131	131	£1.19
Photographic Timer	512	023	76p	Audio Level Meter	438	438	£1.08
Tapo Slide Synchroniser	513	026	76p	Audio Expander	443	443	£3.94
Digital Stop Watch	520	520A	£2.05	Compressor	457	457	£2.16
		520B	40p	Sweet 16	534	534	£1.00
				Calculator Stop Watch	441	441	£1.00
Low Cost Laser	524	524	£1.30	Audio Mixing Generator	539	539	£1.00
Push Button Dimmer	527	527	96p	Touch Switch	506	706	£1.00
Elec. One Arm Bandit	529	529A	£2.32	Marker Generator	706	706	£1.00
		529B	£2.32	Crossover Amp.	1553B	1553B	£2.30
Temp. Controller	530	530	85p	Low Diff. Thermostat	—	—	89p
Photo Timer	532	532	87p	Exposure Meter	—	—	£2.16
Digital Display	533	533A	88p	Switching Regulator	—	—	£2.97
		533B	68p	Digital Stopwatch	—	—	£6.10
						—	£2.02
				Guitar Attack	—	—	£1.04
				Base Booster	—	—	£2.45
				Optical Communications (Both PCB's)	—	—	£2.94

Orders of less than £5.00 Postal Orders only. Delivery time approximately 3 weeks.
Large quantity orders — discount by negotiation. All P.C.B.'s prices include P&P and VAT.
Majority of orders despatched within a week.

CROFTON ELECTRONICS LTD.

35 Grosvenor Road, Twickenham, Middlesex Tel. 01-891 1923

Metac Digital Watches

NEW TO METAC

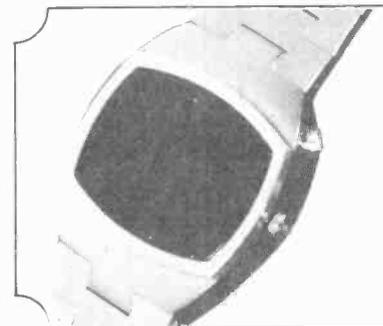


THE GRUEN EXECUTIVE
Continuous display of hours, minutes and seconds. Press a button and display the date. Back light for night time viewing. Quality stainless steel case. A superb man's watch.

Price

£54.00 2-year guarantee

NEW TO METAC



LADY'S WATCH
Small, graceful lady's watch. LED display. Hours, mins., secs., day, month, day of week. Gold or silver finish metal case.

THE GIFT FOR SOMEONE SPECIAL.
Price

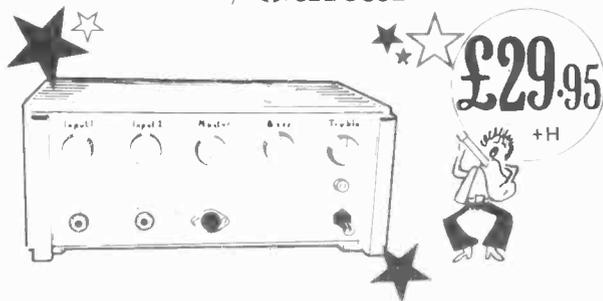
£33.00

2-year guarantee

Doram kits

DORAM KITS CONTAIN EVERYTHING DOWN TO THE LAST NUT!

50W PA/Guitar AMP



Especially designed for general purpose use with guitars, PA systems etc. This amp will provide 50 Watts RMS into 8 ohms with harmonic distortion level as low as 0.15%. Robust case and load fault protection contribute to the rugged design, which incorporates an IC mixer pre-amp (giving 2 separate inputs) and a thermally compensated power amplifier. Overall freq. response (-3dB) is 15Hz to 100KHz with sensitivity 30mV for full output and 52dB sig. to noise ratio.

£29.95 +H VAT (Order 997-011)

O'seas orders — add 15% for P+P. All items offered for sale subject to the Terms of Business set out in Doram Edition 3 catalogue, price 60p. The Doram Kit brochure is also available, price 25p. Combined price only 70p which also entitles you to 2 x 25p vouchers, each one usable on any order placed to the value of £5.00 or more (ex. VAT).

DORAM ELECTRONICS LTD., P.O. BOX TR8
WELLINGTON ROAD INDUSTRIAL ESTATE, LEEDS LS12 2UF

An Electrocomponents Group Company

TLC6 B LIQUID CRYSTAL ELECTRONIC WATCH

Continuous display with backlight. Hours, mins, secs, date, month. Automatic 28, 30, 31 day calendar. Metal bracelet in choice of gold or rhodium. Slimline case.



£29.95

£33.95 No more to pay 2-year guarantee

TLE5EA QUARTZ CRYSTAL ELECTRONIC WATCH

8 separate functions, Hours/minutes/day/date/a.m./p.m. indicators/Auto-Fade. Available in 18ct. Gold/Rhodium plated. Slimline Case.



£16.95

£18.95 No more to pay 2-year guarantee

THIS IS LAST MONTH'S BEST SELLING MAGAZINE SPECIAL WATCH OFFER.

REMEMBER with every WATCH you get METAC SUPER COVER. Full 2 years' guarantee. Two year replace or repair if faulty. Free Calibration check 1st, 2nd and 3rd year. Free Technical advice.

To METAC INTERNATIONAL, 67 High Street, Daventry, Northants. Tel. 03272 76545. Showroom open 9-6 daily. Please fill in the coupon on page 9.

Get a great deal from Marshall's

A. MARSHALL (LONDON) LTD. DEPT. E.T.I.
LONDON — 40-42 Cricklewood Broadway, NW2 3ET
Tel. 01-452 0161. Telex 21492
GLASGOW — 85 West Regent Street, G2 2QD
Tel. 041-332 4133
BRISTOL — 1 Straits Parade, Fishponds Rd., BS16 2LX
Tel. 0272 654201

Call in and see us 9-5.30 Mon-Fri 9-5.00 Sat Trade and export enquiries welcome. Catalogue price 55p post paid. 40p to callers.

Top 600 Semiconductors from the largest range in the UK — all devices manufacturers' branded stock from RCA, TEXAS, MULLARD, MOTOROLA, NATIONAL, SIEMENS, ITT, THOMSON, CSF, SGS, SSSI, FERRANTI, etc.

2N696 0.35	2N3704 0.15	40362 0.48	BC181 0.50	BD135 0.37	BFX89 1.25
2N697 0.30	2N3705 0.15	40363 1.20	BC182 0.12	BD136 0.35	BFY50 0.34
2N698 0.62	2N3706 0.16	40406 0.58	BC188 0.12	BD137 0.38	BFY51 0.38
2N699 0.55	2N3707 0.18	40407 0.45	BC169 0.12	BD138 0.38	BFY52 0.36
2N706 0.24	2N3708 0.16	40408 0.65	BC170 0.16	BD139 0.40	BFY53 0.34
2N706A 0.12	2N3709 0.18	40409 0.65	BC171 0.14	BD140 0.40	BFY90 1.37
2N708 0.21	2N3710 0.16	40410 0.65	BC172 0.12	BD239 0.40	BRV39 0.50
2N709 0.50	2N3711 0.18	40411 2.85	BC177 0.20	BD240 0.45	BSK20 0.31
2N718 0.27	2N3712 1.20	40594 0.75	BC184 0.12	BD241 0.45	BSX21 0.32
2N718A 0.50	2N3713 2.30	40595 0.85	BC179 0.23	BD242 0.47	BU105 1.50
2N720A 0.80	2N3714 2.45	40673 0.73	BC182 0.11	BD243 0.60	BU205 2.20
2N914 0.35	2N3715 2.55	40673 0.73	BC182L 0.14	BD244 0.62	ME0402 0.10
2N916 0.30	2N3716 2.80	40673 0.73	BC183 0.11	BD245 0.65	ME0404 0.15
2N918 0.38	2N3717 1.85	40673 0.73	BC183L 0.14	BD246 0.66	ME0412 0.20
2N929 0.25	2N3722 2.00	40673 0.73	BC194 0.12	BD246 0.66	ME0412 0.20
2N930 0.26	2N3723 2.90	40673 0.73	BC184L 0.14	BD530 0.47	ME4104 0.10
2N1131 0.60	2N3789 2.00	40673 0.73	BC207 0.12	BDY20 0.13	MJ480 1.35
2N1132 0.60	2N3790 3.10	40673 0.73	AC153 0.49	BF115 0.38	MJ481 1.55
2N1613 0.35	2N3791 3.10	40673 0.73	AC153K 0.55	BF117 0.16	MJ490 1.35
2N1711 0.37	2N3792 3.50	40673 0.73	AC176K 0.60	BF121 0.17	MJ491 1.85
2N1893 0.35	2N3794 0.20	40673 0.73	AC187K 0.55	BF123 0.58	MJ2965 1.25
2N2102 0.60	2N3819 0.36	40673 0.73	AC188K 0.55	BF128 0.16	MJ340 0.58
2N2218 0.33	2N3820 0.75	40673 0.73	AD161 0.85	BF153 0.25	MJ370 0.58
2N2218A 0.37	2N3823 0.38	40673 0.73	AD162 0.85	BF154 0.25	MJ371 0.60
2N2219 0.30	2N3904 0.21	40673 0.73	AF106 0.55	BF159 0.35	MJ520 0.45
2N2219A 0.32	2N3906 0.22	40673 0.73	AF109 0.75	BF160 0.30	MJ521 0.65
2N2220 0.35	2N4035 0.67	40673 0.73	AF124 0.65	BF161 0.60	MJ521 0.65
2N2221 0.22	2N4037 0.55	40673 0.73	AF125 0.65	BF166 0.40	MJ520 0.45
2N2221A 0.26	2N4058 0.20	40673 0.73	AF126 0.65	BF167 0.38	MPB111 0.35
2N2222 0.25	2N4059 0.20	40673 0.73	AF127 0.65	BF173 0.38	MPB112 0.40
2N2222A 0.25	2N4060 0.20	40673 0.73	AF139 0.69	BF177 0.30	MPB113 0.45
2N2368 0.25	2N4081 0.17	40673 0.73	AF186 0.50	BF178 0.35	MPF102 0.30
2N2369 0.25	2N4082 0.18	40673 0.73	AF200 0.70	BF179 0.35	MPSA05 0.23
2N2369A 0.25	2N4126 0.17	40673 0.73	AF219 0.74	BF180 0.40	MPSA06 0.24
2N2646 0.75	2N4289 0.20	40673 0.73	AF240 0.98	BF180 0.40	MPSA12 0.35
2N2647 1.40	2N4919 0.65	40673 0.73	AF279 0.80	BF182 0.45	MPSA55 0.24
2N2904 0.36	2N4920 0.70	40673 0.73	AF280 0.85	BF183 0.45	MPSA56 0.24
2N2904A 0.37	2N4921 0.50	40673 0.73	BC107 0.15	BF184 0.48	MPSU05 0.50
2N2905 0.37	2N4922 0.55	40673 0.73	BC108 0.15	BF185 0.35	MPSU06 0.56
2N2905A 0.38	2N4923 0.70	40673 0.73	BC109 0.15	BF189 0.14	MPSU55 0.60
2N2906 0.28	2N5190 0.60	40673 0.73	BC113 0.17	BF195 0.13	MPSU56 0.60
2N2906A 0.25	2N5191 0.70	40673 0.73	BC115 0.19	BF196 0.14	TIP29A 0.45
2N2907 0.21	2N5192 0.75	40673 0.73	BC116 0.19	BF197 0.17	TIP30A 0.49
2N2907A 0.22	2N5195 0.90	40673 0.73	BC116A 0.20	BF198 0.18	TIP31A 0.50
2N2924 0.15	2N5242 0.25	40673 0.73	BC117 0.22	BF200 0.35	TIP32A 0.50
2N2926 0.13	2N5294 0.40	40673 0.73	BC119 0.18	BF205 0.24	TIP33A 0.90
2N3019 0.55	2N5295 0.40	40673 0.73	BC119 0.18	BF225 0.25	TIP34A 0.90
2N3053 0.30	2N5296 0.40	40673 0.73	BC121 0.45	BF245 0.34	TIP35A 2.50
2N3054 0.60	2N5298 0.40	40673 0.73	BC132 0.30	BF246 0.25	TIP36A 3.35
2N3055 0.70	2N5447 0.15	40673 0.73	BC134 0.15	BF254 0.74	TIP41A 0.70
2N3390 0.25	2N5448 0.25	40673 0.73	BC135 0.15	BF254 0.74	TIP42A 2.00
2N3391 0.25	2N5449 0.19	40673 0.73	BC136 0.19	BF257 0.37	TIP29C 0.80
2N3391A 0.25	2N5457 0.32	40673 0.73	BC137 0.14	BF258 0.45	TIP30C 0.65
2N3392 0.16	2N5458 0.33	40673 0.73	BC140 0.40	BF259 0.49	TIP31C 0.66
2N3393 0.15	2N5459 0.29	40673 0.73	BC141 0.45	BF459 0.45	TIP32C 0.75
2N3394 0.15	2N5484 0.34	40673 0.73	BC142 0.30	BF493 0.28	TIP33C 1.10
2N3439 0.88	2N5485 0.26	40673 0.73	BC143 0.30	BF494 2.50	TIP34C 1.20
2N3440 0.84	2N6027 0.53	40673 0.73	BC149 0.12	BF528 0.14	TIP41C 1.10
2N3441 0.85	2N6101 0.65	40673 0.73	BC148 0.12	BF561 0.30	TIP42C 0.95
2N3442 1.35	2N6107 0.62	40673 0.73	BC149 0.13	BF598 0.27	TIP2955 0.65
2N3638 0.16	2N6109 0.42	40673 0.73	BC153 0.27	BFX29 0.38	TIP3055 0.55
2N3638A 0.16	2N6121 0.38	40673 0.73	BC154 0.27	BFX30 0.40	HS43 0.30
2N3639 0.30	2N6122 0.41	40673 0.73	BD117 0.12	BFX81 1.20	
2N3641 0.20	2N6123 0.43	40673 0.73	BD118 1.20	BFX85 0.41	
2N3702 0.17	2N6126 0.45	40673 0.73	BD131 0.51	BFX87 0.40	
2N3703 0.15	40361 0.45	40673 0.73	BD132 0.54	BFX88 0.40	

INTEGRATED CIRCUITS

CA3020A 1.78	LM3301N 0.85	TAA661B 1.32
CA3020A 2.29	LM3302N 1.40	TAA700 3.91
CA3028B 1.01	LM3401 0.70	TAA930A 1.00
CA3028B 1.29	LM3900 0.75	TAA930B 1.05
CA3030 1.24	LM3905 1.60	TAD100 1.95
CA3030A 1.89	LM3909 0.68	TBA120 0.65
CA3045 1.40	MC1035 1.75	TBA400 1.50
CA3046 0.89	MC1303 1.47	TBA500 2.21
CA3048 2.23	MC1304 1.85	TBA500Q 2.30
CA3049 1.66	MC1305 2.85	TBA510 2.20
CA3052 1.62	MC1366 1.00	TBA510Q 1.00
CA3053 0.60	MC1310 1.91	TBA520 2.21
CA3080 0.68	MC1312 1.98	TBA520Q 2.30
CA3080A 1.88	MC1327 1.54	TBA53D 1.98
CA3086 0.51	MC1330 0.92	TBA530Q 2.07
CA3086 1.58	MC1350 0.75	TBA540 2.21
CA3089 2.52	MC1351 1.20	TBA540Q 2.30
CA3090 3.80	MC1352 0.97	TBA550 3.13
CA3130 0.94	MC1357 1.45	TBA550Q 3.22
LM301A 0.65	MC1458 0.91	TBA560Q 3.22
LM301N 0.44	NE555 0.53	TBA570 1.29
LM304 2.45	NE555 1.05	TBA570Q 1.38
LM307N 0.65	NE565 1.20	TBA841B 2.50
LM308C 1.82	NE566 1.65	TBA851 1.80
LM308N 1.17	NE567 1.80	TBA700 1.52
LM309K 2.10	SAS550 2.50	TBA700Q 1.61
LM317K 3.00	SAS570 2.50	TBA720Q 2.30
LM318N 2.25	76001N 1.57	TBA750 1.98
LM323K 6.40	76003N 2.55	TBA750Q 2.07
LM360N 1.75	76008K 1.50	TBA800 1.20
LM348N 1.91	76013N 1.70	TBA810 1.16
LM360N 2.75	76013ND 1.57	TBA820 1.03
LM370N 3.00	76018K 2.50	TBA920 1.79
LM372N 2.15	76023ND 1.57	TBA920Q 2.99
LM373N 2.25	76110N 1.46	TBA940 1.62
LM374N 2.25	76114N 1.87	TCA180C 1.85
LM377N 1.75	76116N 2.06	TCA270 2.25
LM378N 2.25	76131N 1.30	TCA280A 1.30
LM384N 1.45	76226N 1.94	TCA290A 3.13
LM380N 0.98	76227N 1.84	TCA420A 1.84
LM381A 2.45	76228N 1.75	TCA730 3.22
LM381N 1.60	76530N 0.91	ICA740 2.76
LM382N 1.25	76532N 1.50	TCA750 2.30
LM384N 1.45	76544N 1.44	TCA760 1.38
LM386N 0.80	76545N 2.08	TCA800 3.13
LM387N 1.05	76546N 1.44	TCA810 2.00
LM388N 1.00	76550N 0.41	UAA180 2.00
LM389N 1.00	76552N 0.65	
LM702C 0.75	76570N 2.08	
LM709C 0.65	76620N 1.10	
LM709N 1.10	76650N 1.10	
LM710C 0.60	76660N 0.60	
LM710N 0.60	76666N 0.92	
LM723C 0.85	TAA301A 1.50	
LM723N 0.75	TAA320A 1.15	
LM741C 0.65	TAA350A 2.00	
LM741N 0.50	TAA621 1.00	
LM747N 0.90	TAA522 1.90	
LM748N 0.50	TAA550 0.60	
LM748N 1.75	TAA560 1.60	
LM748N 1.32	TAA611B 0.95	
LM748N 1.32	TAA621 1.15	
LM748N 1.32	TAA661A 1.32	

CLOCK MODULES

Built and tested - requires only switches and transformer to complete 12 or 24 hr alarm modules
MA1002F 12hr 5" display 11.90
MA1002H 24hr 5" display 11.90
MA1010E 12hr 84" display 17.00
MA1010G 24hr 84" display 17.00
Transformers £1.50

CAR CLOCK MODULE

Built Tested 12v supply
MA1004 digit module 17.50
Data Sheet 5p + SAE

TRIACS

Plastic pack 400V
4 amp 0.70 10 amp 0.90
5 amp 0.75 12 amp 1.10
8 amp 0.80 16 amp 1.60

THYRISTORS

Plastic C106 116
5 amp 100V 0.35 8 amp 100V 0.43
5 amp 200V 0.40 8 amp 200V 0.49
5 amp 400V 0.49 8 amp 400V 0.62

BRIDGE RECTIFIERS

W005 0.30 BY164 0.57
W01 0.32 840C1500 0.48
W02 0.36 840C3200 1.10
W04 0.40 880C1500 0.75
W06 0.50 880C3200 1.15

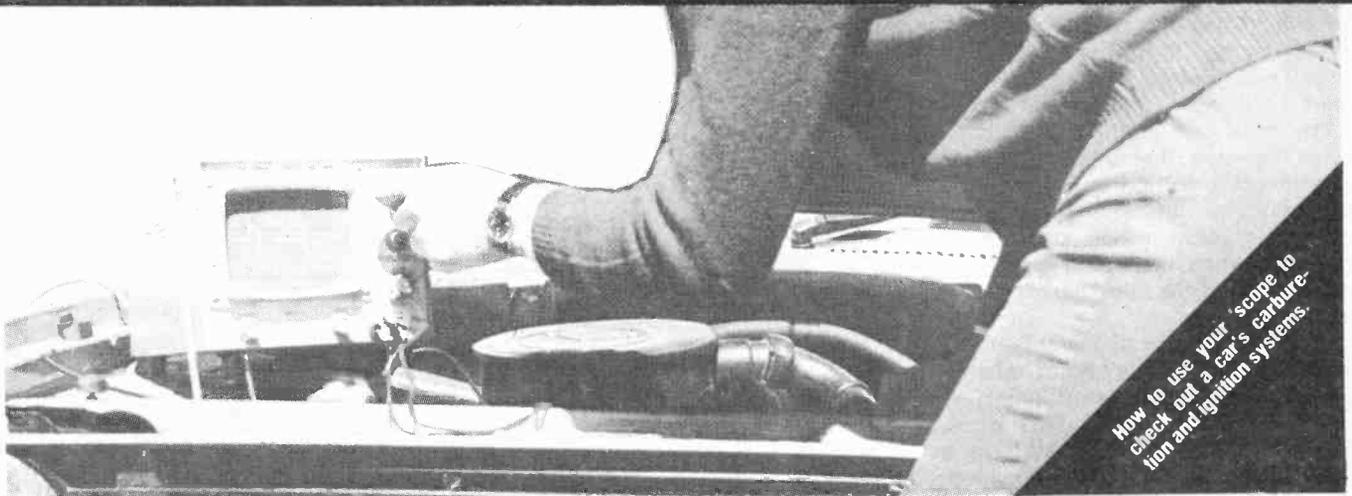
SEE MARSHALL'S FOR CMOS

CD4000 0.24	CD4018 1.15	CD4042 0.96
CD4001 0.24	CD4019 1.15	CD4043 1.15
CD4002 0.24	CD4020 1.27	CD4044 1.06
CD4006 1.34	CD4021 1.15	CD4045 1.59
CD4007 0.24	CD4022 1.10	CD4046 1.52
CD4008 1.10	CD4023 0.24	CD4047 1.15
CD4009 0.64	CD4024 0.84	CD4048 0.64
CD4010 0.64	CD4025 0.24	CD4050 0.64
CD4011 0.24	CD4027 0.64	CD40510 1.56
CD4012 0.24	CD4028 1.02	CO4511 1.79
CD4013 0.64	CD4029 1.30	CD4516 1.56
CD4014 1.15	CD4030 0.64	CD4518 1.43
CD4015 1.15	CD4031 2.53	CD4520 1.43
CD4016 0.64	CD4037 1.60	
CD4017 1.15	CD4041 0.96	

EXTENDED RANGE NOW IN STOCK

1-15
+0.60
-1-12
0-36
0-25
-2-13

'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

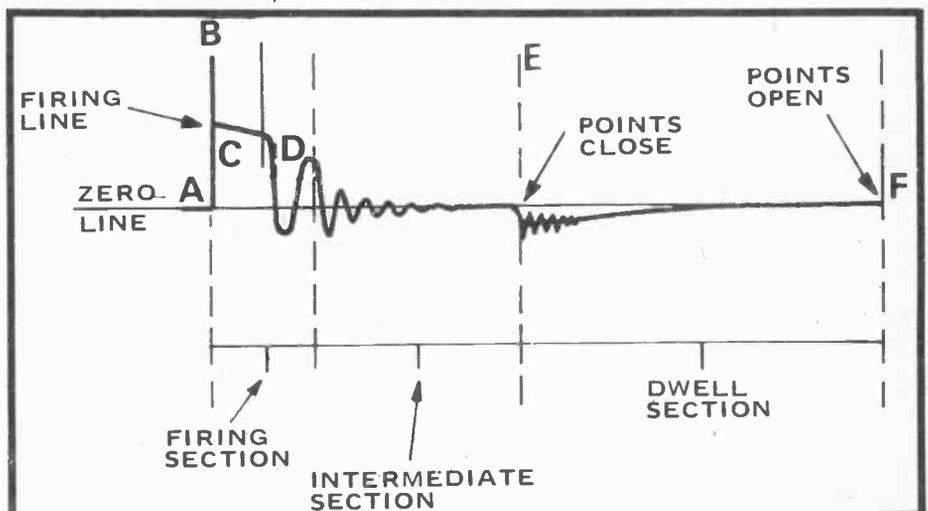
The simple waveform shown at the beginning of this article is a typical secondary waveform that is derived from the secondary (or high voltage) side of the ignition system. This waveform is the one most commonly used since phenomena occurring in the primary side of the system will be reflected through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

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.

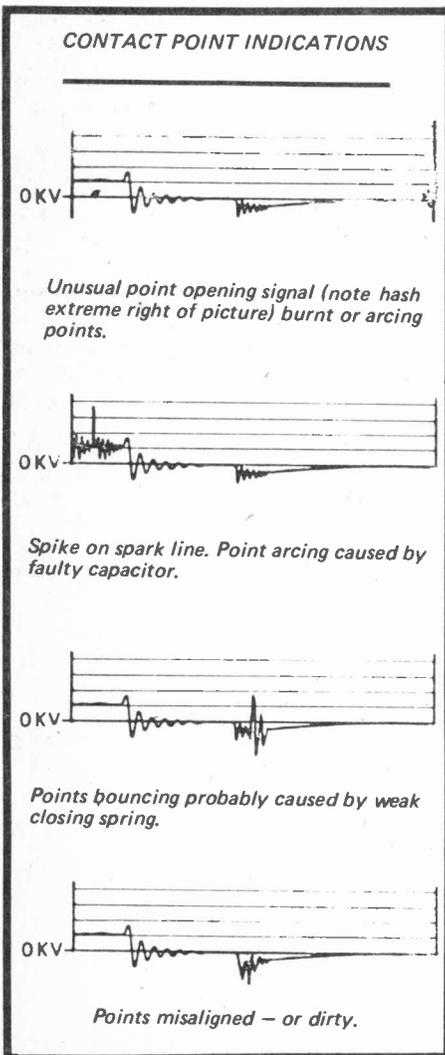
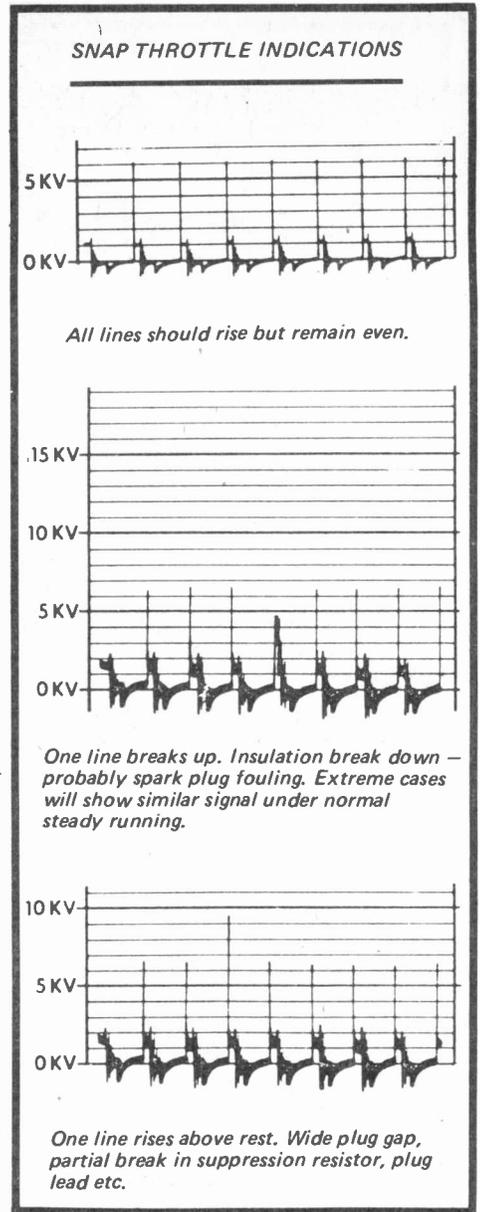
If the firing lines are unequal on a multi-carburetted engine check to see if the lines which are higher correspond to those cylinders fed by one common carburettor. If so it is probable that the mixture from the carburettors is unbalanced. A further but less common fault that may be spotted this way 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.

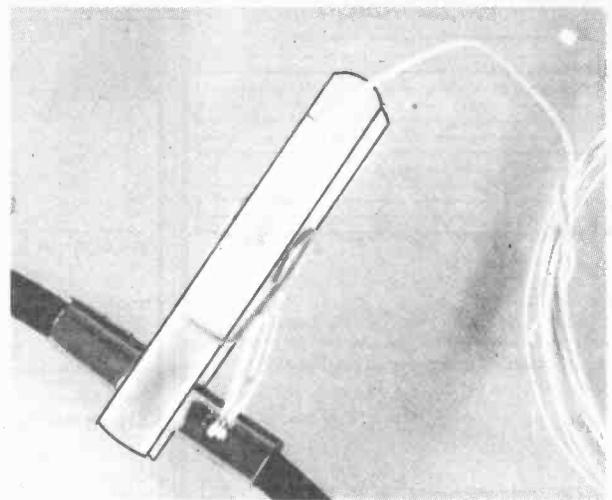
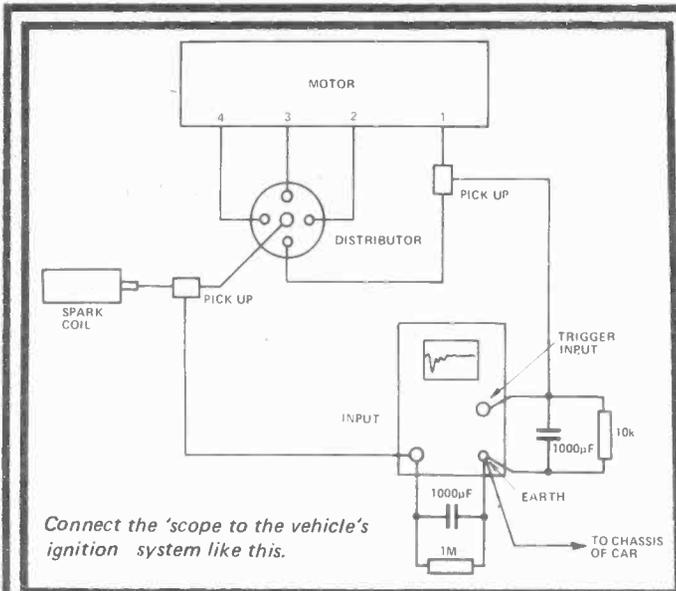
If the firing line is short or intermittent — or if the lower section does not appear — then there is an insulation breakdown in the distributor cap, plug leads, rotor or coil.

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



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 plugs 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

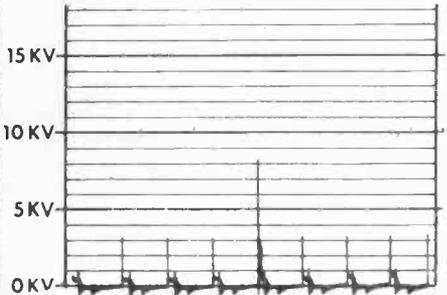
FIRING LINE INDICATIONS



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*.

Semiconductors from LYNX ELECTRONICS

THYRISTORS All ratings RMS

PIV	0.8A (TO92)	1A (3TO5)	3A (C106)	4A (TO220)	6A (TO220)	8A (TO220)	10A (TO220)	10A (TO220)	15A (TO6-4)
50	0.20*	0.25	0.35	0.32	0.41	0.42	0.42	0.47	0.96
100	0.25*	0.25	0.40	0.37	0.47	0.48	0.48	0.54	1.02
200	0.27*	0.35	0.45	0.40	0.58	0.60	0.60	0.68	1.14
400	0.30*	0.40	0.50	0.45	0.87	0.88	0.88	0.98	1.40
500	---	0.65	0.70	---	1.09	1.19	1.19	1.26	1.80

TRIACS (PLASTIC TO-220 PKGE ISOLATED TAB)

	4A		6.5A		8.5A		10A		15A	
	(a)	(b)								
110V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.78	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.78	0.80	0.83	0.97	1.01	1.13	1.19	1.70	1.74
600V	0.96	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

N.B. Triacs without internal trigger diac are priced under column (a). Triacs with internal trigger diac are priced under column (b). When ordering please indicate clearly the type required.

TTL 74 SERIES PLASTIC

7400	0.16	7484	0.85
7401	0.16	7485	1.25
7402	0.16	7486	0.32
7403	0.16	7489	2.92
7404	0.18	7490	4.45
7405	0.18	7491	0.68
7406	0.51	7492	0.57
7407	0.18	7493	0.45
7408	0.18	7494	0.85
7409	0.18	7495	0.67
7410	0.16	7496	0.78
7412	0.25	7497	4.32
7413	0.25	74100	1.15
7414	0.72	74107	0.35
7416	0.43	74118	1.16
7417	0.43	74119	1.92
7420	0.16	74121	0.34
7422	0.38	74122	0.47
7423	0.40	74123	0.40
7425	0.30	74125	0.79
7427	0.48	74141	0.75
7428	0.53	74145	0.74
7430	0.16	74150	1.20
7431	0.37	74151	0.77
7433	0.49	74153	1.09
7437	0.35	74154	1.62
7438	0.35	74155	1.32
7440	0.16	74157	0.78
7441	0.76	74160	1.20
7442	0.65	74161	1.20
7445	1.50	74162	1.20
7446	2.56	74163	1.20
7447	0.81	74164	0.93
7448	0.81	74165	0.93
7450	0.85	74167	3.70
7451	0.16	74174	1.06
7453	0.18	74175	0.54
7454	0.18	74176	0.86
7450	0.18	74180	1.23
7470	0.32	74181	3.20
7472	0.26	74190	1.33
7473	0.30	74191	1.33
7479	0.32	74192	1.38
7475	0.47	74193	1.39
7476	0.36	74196	1.64
7480	0.55	74197	0.81
7484	1.26	74198	2.74
7482	0.75	74199	2.74
7483	1.12		

LINEAR ICS

307		0.55*
380	14 Pin Dil	0.90*
555	8 Pin Dil	0.45
565	14 Pin Dil	2.00*
566	8 Pin Dil	1.50*
567	8 Pin Dil	2.00*
Y09	8/14 Pin Dil	0.35
741	8/14 Pin Dil	0.28
748	8 Pin Dil	0.35
3900	14 Pin Dil	0.70*
CA3045		0.85*
CA3046		0.80*
CA3130		1.68
MC1304		1.58
MC1307P		1.17*
MC1458P		0.77
SN75324		2.55
SN75451		0.98*
SN75452		0.99*
TAA300		1.61
TAA310		1.38
TAA550		0.45*
TAA611B12		1.25*
TBA530		1.85*



Special Offer
Red LED
TIL209
10p

OPTOELECTRONICS

Displays	Discretes		
704	0.2 Red		0.13
707	0.2 Clear		0.14
727	1.95 0.2 Green		0.20
728	1.95 OCP71		0.90
747	1.80		
750	1.80		

ITT BRANDED TO-18 TRANSISTORS

Type BSY65 Med. Voltage High Gain. Sim. to BC107/8/9

5 pcs	0.35
25 pcs	1.20
100 pcs	3.50

SPECIAL OFFER - LM309K
1A TO3 5V £1.25

REGULATORS

723	0.45	7818	1.50
1 amp Plastic		LM340-5	1.35
7805	1.50	LM340-12	1.35
7812	1.50	LM340-15	1.35
7815	1.50	LM340-18	1.35

IC SOCKETS

8 Pin	0.16	24 Pin	0.45
14 Pin	0.18	40 Pin	0.80
16 Pin	0.18		

TO3 HARDWARE INC.

- 1 Mica-2 washers
- Solder TA6
- 2 Nuts/Bolts
- Washers
- 50 for 65p

TRANSISTORS, DIODES, RECTIFIERS

AC126	0.15	BC153	0.18*	BD183	0.97	BT109	1.00	OA90	0.08	2N2484	0.16
AC127	0.16	BC157	0.09*	BD232	0.60*	BT116	1.00	OA91	0.08	2N2646	0.50
AC128	0.13	BC158	0.09*	BD233	0.48*	BU105	1.80*	OC41	0.15	2N2905	0.18
AC128K	0.25	BC159	0.09*	BD237	0.55*	BU105/02	1.90*	OC42	0.15	2N2905A	0.22
AC141	0.18	BC160	0.32	BD238	0.60*	BU126	1.60*	OC44	0.32	2N2926R	0.10*
AC141K	0.28	BC161	0.38	BD184	0.20	BU204	1.60*	OC45	0.32	2N2926G	0.09*
AC142	0.18	BC168B	0.09*	BDY20	0.50	BU208	2.60*	OC70	0.30	2N2926V	0.09*
AC142K	0.28	BC182	0.11*	BDY38	0.60	BY206	0.15	OC71	0.35	2N2926G	0.10*
AC176	0.16	BC182L	0.11*	BDY60	1.70	BY207	0.20*	OC72	0.22	2N3053	0.15
AC176K	0.16	BC183	0.10*	BDY61	1.65	BYX36		OC84	0.40	2N3054	0.40
AC187	0.18	BC183L	0.10*	BDY62	1.15	300	0.12*	SC40A	0.73	2N3055	0.50
AC187K	0.25	BC184	0.11*	BDY93	2.52	600	0.15*	SC10B	0.81	2N3440	0.56
AC188	0.18	BC184L	0.11*	BDY94	2.14	900	0.18*	SC40D	0.98	2N3442	1.20
AC188K	0.25	BC207B	0.12*	BDY95	2.14	1200	0.21*	SC40F	0.65	2N3525	0.50
AD140	0.50	BC212	0.11*	BDY96	4.68	BYX38		SC41A	0.65	2N3570	0.80
AD142	0.50	BC213	0.12*	BDY97	3.93	300	0.50	SC41B	0.70	2N3702	0.10*
AD143	0.46	BC213L	0.12*	BDY98	3.56	600	0.55	SC41D	0.85	2N3703	0.10*
AD149	0.45	BC214	0.14*	BF178	0.28	900	0.60	SC41F	0.60	2N3704	0.10*
AD161	0.35	BC214L	0.14*	BF179	0.30	1200	0.65	ST2	0.20	2N3705	0.10*
AD162	0.35	BC237	0.16*	RF194	0.10*	BZK61 Series		TIP29A	0.44	2N3706	0.10*
AL102	0.95	BC238	0.16*	BF195	0.10*	Zeners	0.20	TIP30A	0.52	2N3707	0.10*
AL103	0.93	BC300	0.34	BF196	0.12*	BZX83 or		TIP31A	0.54	2N3714	1.05
AF114	0.20	BC301	0.32	BF197	0.12*	BZX88 Series		TIP32A	0.84	2N3715	1.15
AF115	0.20	BC323	0.60	BF224J	0.18*	Zeners	0.11	TIP34	1.05	2N3716	1.25
AF116	0.20	BC327	0.18*	BF244	0.17*	C106A	0.40	TIP41A	0.68	2N3771	1.60
AF117	0.20	BC328	0.16*	BF257	0.30*	C106B	0.45	TIP42A	0.72	2N3772	1.60
AF118	0.50	BC337	0.17*	BF258	0.35	C106D	0.50	IN2069	0.14	2N3773	2.10
AF139	0.35	BC338	0.17*	BF337	0.32	C106F	0.35	IN207D	0.16	2N3819	0.28*
AF239	0.37	BCY30	0.55	BFV60	0.17*	CRS1 05	0.25	IN4001	0.04*	2N3904	0.16*
AU103	1.30*	BCY31	0.55	BFX29	0.26	CRS1 10	0.25	IN4002	0.05*	2N3906	0.11*
AU106	1.70*	BCY32	0.60	BFX30	0.30	CRS1 20	0.35	IN4003	0.06*	2N4124	0.14
AU113	1.60*	BCY33	0.55	BFX84	0.23	CRS1 40	0.40	IN4004	0.07*	2N4290	0.12
BC107	0.09	BCY34	0.55	BFX85	0.25	CRS1 60	0.65	IN4005	0.08*	2N4348	1.20
BC107B	0.09	BCY38	0.50	BFX88	0.20	CRS3 05	0.34	IN4006	0.09*	2N4870	0.35*
BC108	0.09	BCY39	1.15	BFY50	0.20	MJ481	1.05	2N1131	0.15	2N4871	0.35*
BC109	0.09	BCY70	0.12	BFY51	0.18	MJ481	0.90	2N1132	0.16	2N4919	0.70*
BC109C	0.12	BCY71	0.18	BFY52	0.19	CRS3 10	0.45	2N696	0.14	2N4920	0.50*
BC117	0.19*	BD172	0.12	BFY64	0.35	CRS3 40	0.60	2N706	0.10	2N4922	0.58*
BC125	0.18*	BD115	0.55	BFY90	0.65	CRS3 60	0.85	2N929	0.14	2N4923	0.46*
BC126	0.20*	BD131	0.36	BR100	0.20	MJ480	0.80	2N930	0.14	2N5060	0.20*
BC140	0.25	BD132	0.40	BFY39	0.40	MJ481	1.05	2N1131	0.15	2N5061	0.25*
BC142	0.23	BD135	0.36	BSX19	0.16	MJ490	0.90	2N1132	0.16	2N5062	0.27*
BC143	0.23	BD136	0.39	BSX20	0.18	MJ491	1.15	2N1304	0.45	2N5064	0.30*
BC144	0.30	BD137	0.40	BSX21	0.20	MJE340	0.40*	2N1305	0.40	2N5496	0.65
BC147	0.09*	BD138	0.48	BSY95A	0.12	MJE371	0.60	2N1711	0.18		
BC148	0.09*	BD139	0.58	BT106	1.00	MJE520	0.45	2N2102	0.44		
BC149	0.09*	BD181	0.86	BT107	1.60	MJE521	0.55	2N2369	0.14		
BC152	0.25*	BD182	0.92	BT108	1.60	OA5	0.50*	2N2369A	0.14		

P & P. 20p per order - overseas 80p. Matching 20p per pair
VAT 8% EXCEPT FOR ITEM WHICH ARE 12½%. NO VAT ON OVERSEAS
ACCESS & BARCLAYCARD WELCOME

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 is released is the same for each LED.

The LEDs may therefore 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 conductive 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 is inserted with the correct polarity.

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



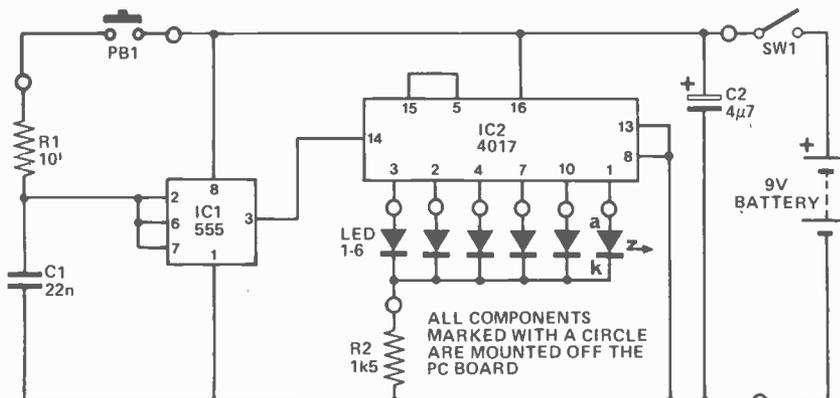
How it works

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.



Short Circuits

by means of a small flat on the plastic body of the component adjacent to the cathode lead or the cathode lead may 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.

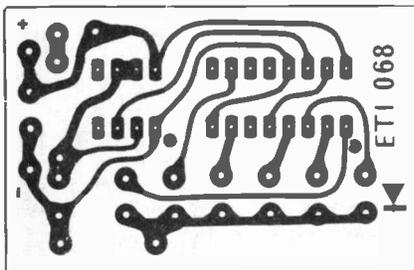


Fig. 2. Printed-circuit board layout for the LED dice. Full size 55mm x 35mm.

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

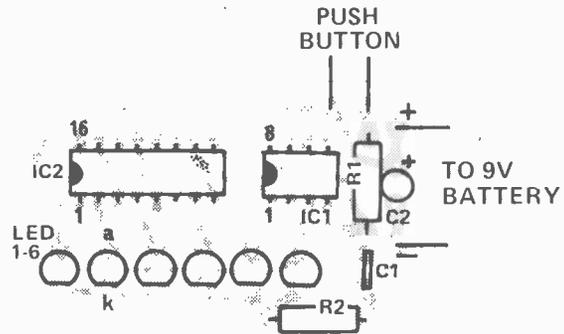


Fig. 3. How the components are mounted to the printed-circuit board.

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.

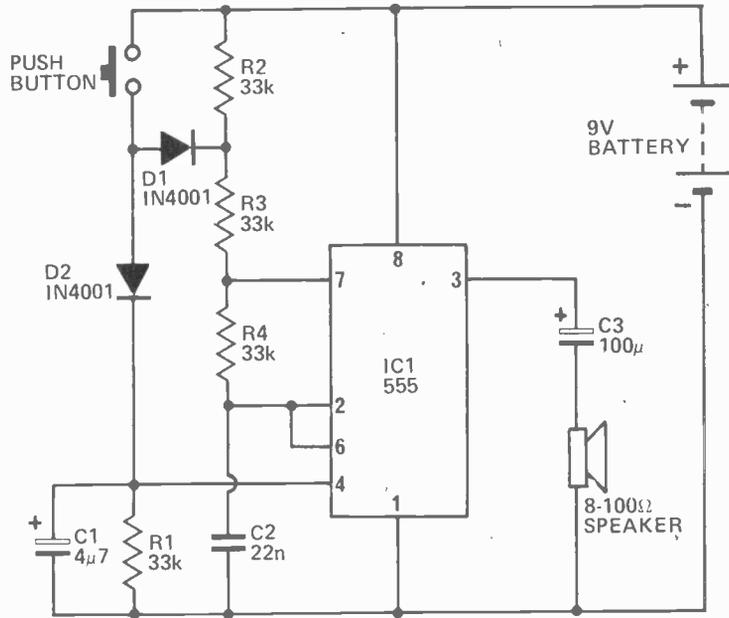
The integrated circuit, diodes, and the electrolytic capacitors, must be mounted the correct way round. The overlay shows the distinguishing marks on each component, and the component must be placed so that the marks on the component are the same way as on the overlay diagram.

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.

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

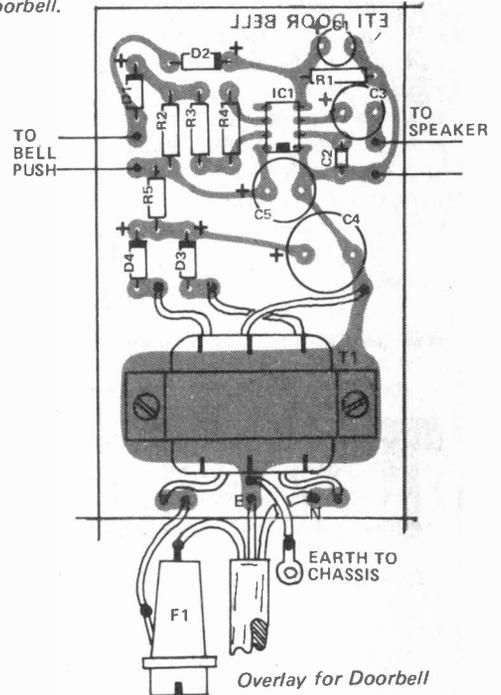
IC1	555 timer
D1, D2, D3, D4	IN4001

TRANSFORMER

T1	240V - 6/0/6	100mA
----	--------------	-------

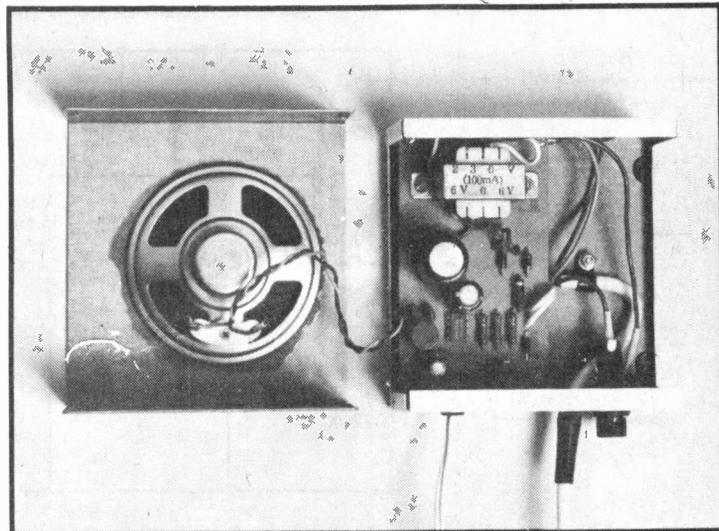
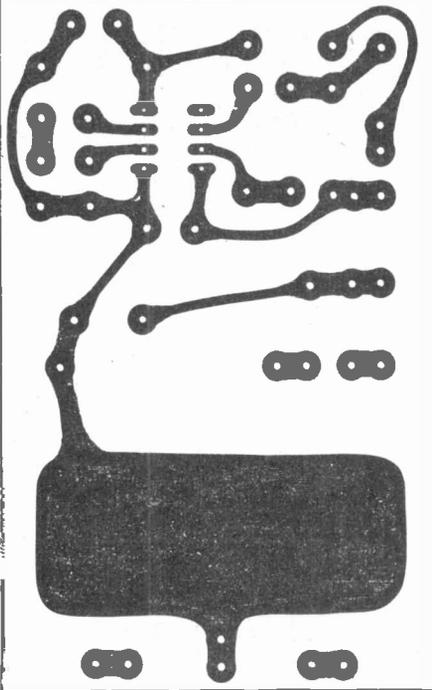
MISCELLANEOUS

F1	fuse holder	250mA fuse
3-core mains flex		
2-core bell flex		
Panel gromet		
4 board spacers		
Nuts, bolts, etc.		



Overlay for Doorbell

ETI DOOR BELL



Internal view of Doorbell

Short Circuits

BENCH AMP



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.

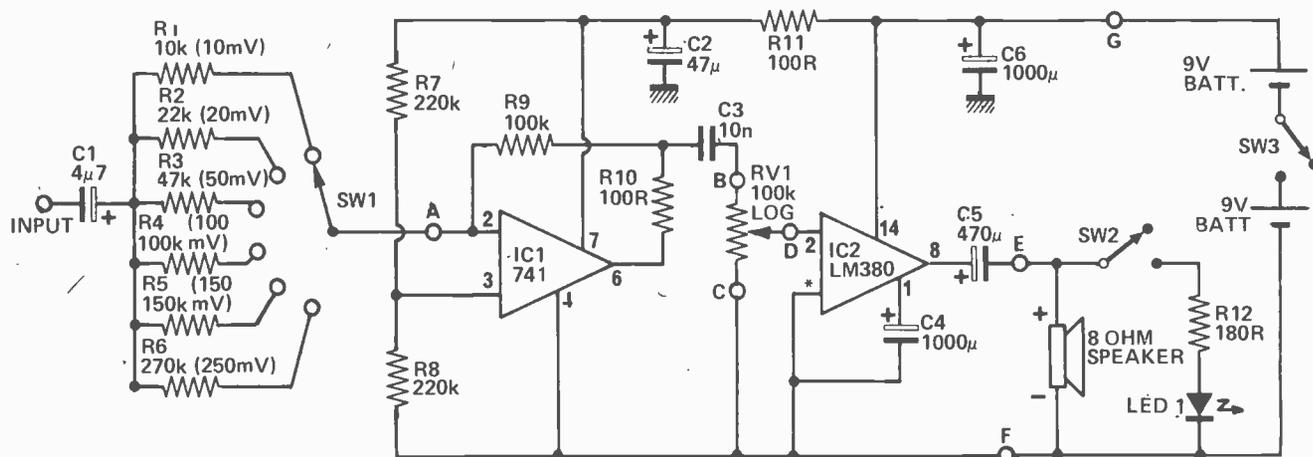
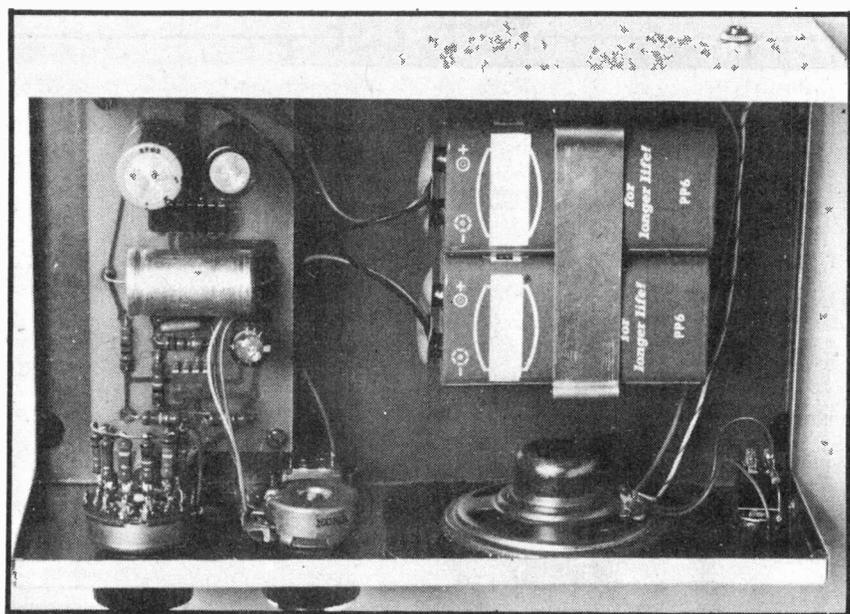
To measure an A.C. signal, turn the volume control to maximum, and apply the input to the socket and work down from the lowest sensitivity until LED just comes on. The value of the input is now indicated by the switch. We tried several 380s and

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!

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 approximately 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.

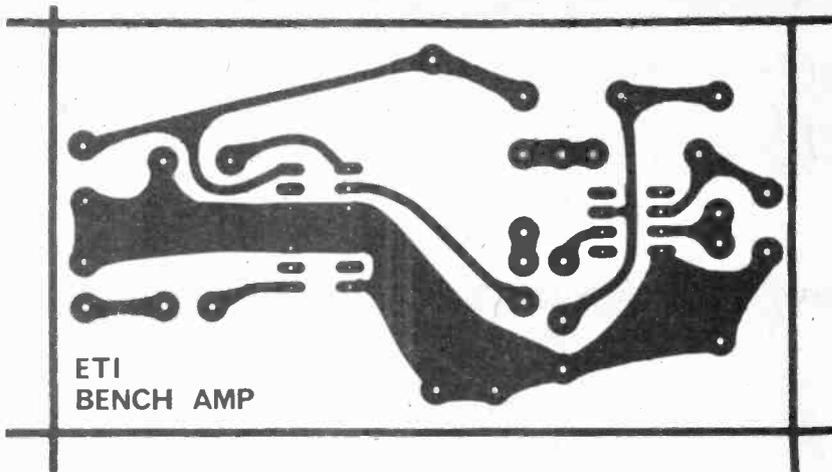


* PINS 3,4,5,7,10,11,12 ARE CONNECTED TO 0V

Circuit diagram of the Bench Amp

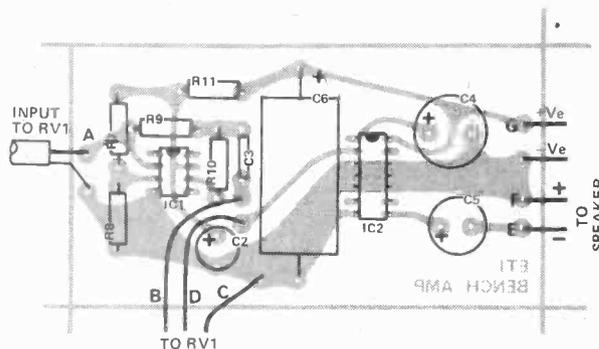
Construction is not critical, but a metal box is a good idea to help screen the amplifier from extraneous radiations etc. Ours came from Doram, and very nice they were too. Battery power was chosen so as to leave as much bench supply free as possible.

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	Nuts, bolts, etc.
R1 10K	3.5mm jack socket
R2 22K	
R3 47K	CAPACITORS
R4,9 100K	C1 4u7 16V electrolytic
R5 150K	C2 47u 16V electrolytic
R6 270K	C3 10n ceramic or similar
R7,8 220K	C4 1000u 16V electrolytic
R10,11 100R	C5 470u 16V electrolytic
R12 180R	C6 1000u 25V electrolytic
All 1/2W 5%	
POTENTIOMETER	SWITCHES
RV1 100K Log rotary	SW1 1 pole 6-way rotary
	SW2 single pole / Off-On toggle
SEMICONDUCTORS	SW3 single pole / Off-On rocker
IC1 741 op-amp	
IC2 LM380 power amp	CASE
LED1 0.2" type	Samos S7 Doram
MISCELLANEOUS	SPEAKER
Phono socket	LS1 2 1/4" 8Ω type



Component overlay for the Bench Amp



SUBSCRIPTIONS

Well, Mr. Quigley & Son may have got **THEIR** Scanning Electron Printer working but we are not **YET** sending ETI out on the Viewdata Link!

So if you can't get it from your newsagent, fill in the form below to ensure a regular copy — by post.

Help us to help you, please write your name and address on the back of your cheques.

To: SUBSCRIPTIONS DEPARTMENT
ETI MAGAZINE
25-27 Oxford Street
London W1R 1RF

ALL PAYMENTS MUST BE IN STERLING

I enclose £6.00 (£7.00 overseas) for the next twelve issues of ETI starting with the issue

Name

Address

Feb. 77

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.

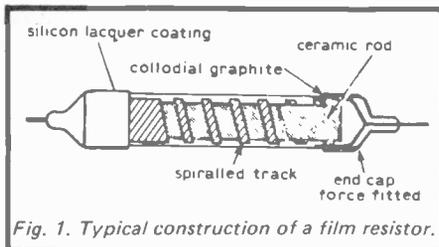


Fig. 1. Typical construction of a film resistor.

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

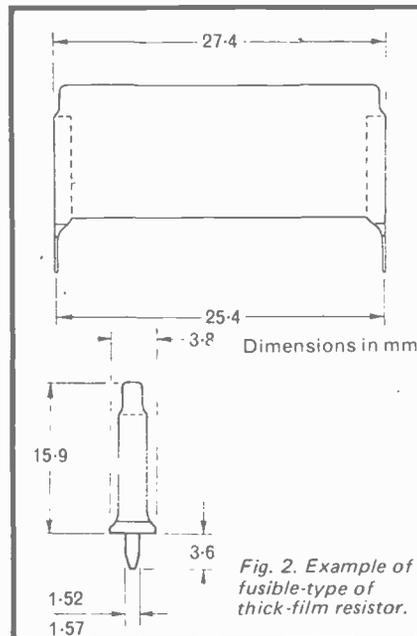


Fig. 2. Example of fusible-type of thick-film resistor.

printed circuit board and can dissipate considerable power owing to their large surface area and high hot-spot temperature (150°C).

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	Max. Working Voltage		Max. Operating (= hot-spot) Temperature		Critical Resistance	Uninsulated Types		Insulated Types		Typical Resistance Range		
	Commercial	Mil.	Commercial	Mil.		Length	Diameter	Length	Diameter			
0.5	0.125	500	150	150	2 M	180 k	6.4 mm	2.3 mm	3.7 mm	1.6 mm	4.7 Ω - 1 M	
0.25	0.25	700	250	107	130	3M9	250 k	4.1 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	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 commercially-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 $\mu\text{V/V}$, and for values between 10k and 100k it may be as low as 0.2 $\mu\text{V/V}$ and up to 1.0 $\mu\text{V/V}$. For values above 100k, the noise ranges from 0.5 $\mu\text{V/V}$ to 1.5 $\mu\text{V/V}$.

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

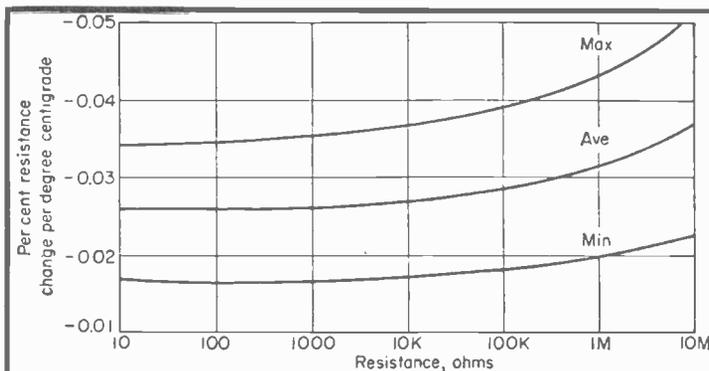


Fig. 3. Typical temperature-coefficient spread for deposited-carbon resistors.

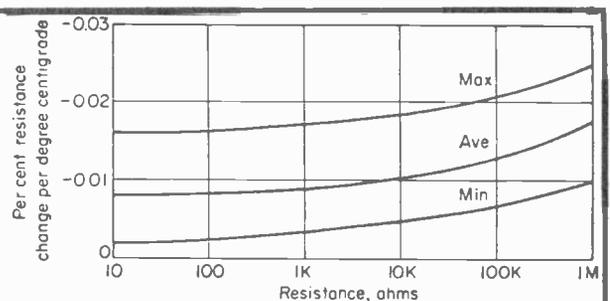


Fig. 4. Typical temperature-coefficient spread for boron-carbon resistors.

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 1/2W deposited-carbon film resistors in Figure 5.

as shown in Figure 6. This mainly applies to the miniature 0.25W and 0.33W 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

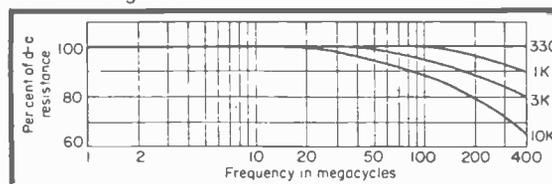


Fig. 5. Approximate frequency characteristics for 1/2-watt deposited-carbon resistor.

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.

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

FILM RESISTORS

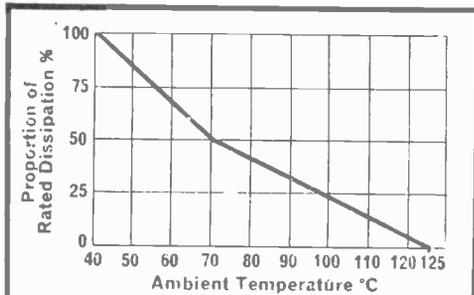


Fig. 6. Derating curve for miniature moulded carbon-film resistors.

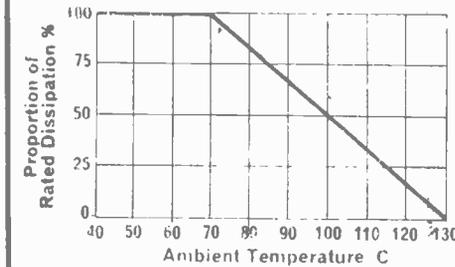


Fig. 7. Derating curve for coated carbon-film resistors.

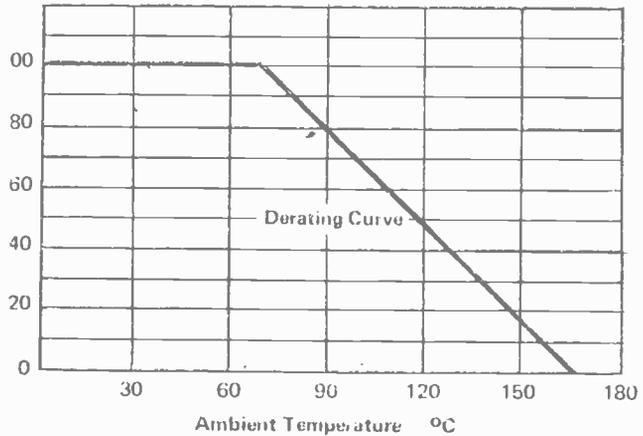


Fig. 8. Power derating curve for specially constructed carbon film resistors.

commonly available units and up to 100M on special order. They are manufactured to tolerances of $\pm 0.5\%$ (E192 series), $\pm 1\%$ (E96 series), $\pm 2\%$ (E48 series) and $\pm 5\%$ (E24 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 excellent 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.

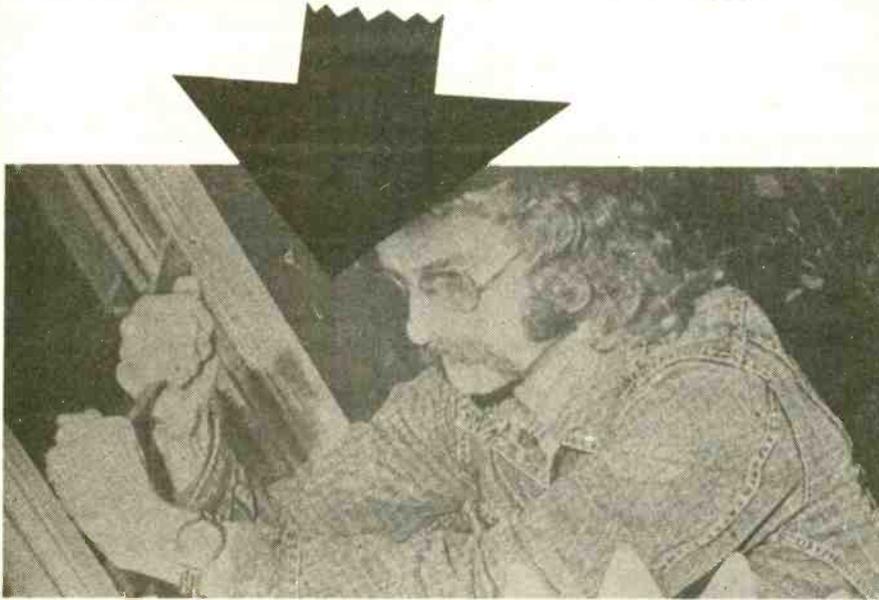
TTLs by TEXAS		7485 130p		74191 156p		OP. AMPS		TRANSIS-TORS		BF178 30p		TIP42C 88p		2N5089 34p		RECTIFIER		BRIDGE							
7400	16p	7486	36p	74192	130p	301A	Ext Comp	8 pin DIL	40p	AC125	20p	BF195	11p	TIP3055	85p	2N5296	65p	BY100	31p	RECTIFIERS					
7401	18p	7489	34p	74193	130p	5361	FET Op Amp	8 14 pin DIL	300p	AC126	20p	BF196	17p	TIP3055	70p	2N5401	62p	BY126	12p	1A 50V 25p					
7402	18p	7490	43p	74194	130p	709	Ext Comp	8 14 pin DIL	39p	AC127	20p	BF197	19p	TIS93	30p	2N6107	70p	BY127	12p	1A 100V 27p					
7403	18p	7491	81p	74195	96p	741	Int Comp	8 14 pin DIL	25p	AC128	18p	BF200	40p	ZTX108	11p	2N6247	175p	1N4001	6p	1A 400V 31p					
7404	25p	7492	55p	74196	120p	747	Dual 741	14 pin DIL	70p	AC176	20p	BF257	34p	ZX500	16p	2N6254	140p	1N4002	6p	1A 600V 37p					
7405	25p	7493	43p	74197	120p	748	Ext Comp	8 14 pin DIL	160p	AC187	20p	BF258	39p	ZTX504	19p	2N6254	140p	1N4004	7p	2A 50V 37p					
7406	45p	7494	81p	74198	270p	776	Prog Op Amp	TO 99	40p	AC187K	25p	BFR39	34p	ZTX500	19p	2N6254	140p	1N4005	7p	2A 100V 44p					
7407	45p	7495	70p	74199	220p	1458	Dual Op Amp	8 pin DIL	70p	AC188	20p	BFR40	34p	2N698	45p	40360	43p	1N4007	8p	3A 200V 56p					
7408	25p	7496	84p	C-MOS IC		3130	CMOS Op Amp	8 pin DIL	105p	AC188K	25p	BFR79	34p	2N706	22p	40361	43p	1N4007	8p	3A 600V 37p					
7409	27p	7497	34p	4000	21p	3140	BIMOS FET input	8 pin DIL	105p	AD149	54p	BFR80	34p	2N708	22p	40362	45p	1N4007	8p	2A 100V 44p					
7410	18p	74100	116p	4001	21p	3900	Quad Op Amp	14 pin DIL	70p	AD161	39p	BFR88	37p	2N918	43p	40410	75p	1N4007	8p	4A 100V 75p					
7411	26p	74104	60p	4002	21p	LINEAR I.C.s				AD165	22p	BFX30	36p	2N930	19p	40409	75p	1N4007	8p	6A 50V 75p					
7412	27p	74105	60p	4006	120p	AY-10212	Tone Generator	16 pin DIL	650p	AF115	22p	BFX84	30p	2N1131	20p	40411	325p	1N4007	8p	6A 100V 78p					
7413	35p	74107	32p	4007	31p	CA3028A	Diff Cascade Amp	9 pin	112p	AF116	22p	BFX85	30p	2N1132	20p	40584	90p	1N4007	8p	6A 200V 84p					
7414	36p	74109	96p	4009	67p	CA3046	5 Transistor Array	16 pin DIL	85p	AF117	22p	BFX88	30p	2N1304	45p	40595	97p	1N4007	8p	6A 400V 90p					
7416	34p	74110	55p	4011	21p	CA3048	4 In Noise Amp	16 pin DIL	250p	AF139	43p	BFX87	30p	2N1305	45p										
7417	40p	74116	216p	4012	18p	CA3080	Diff Cascade Amp	8 pin DIL	70p	AF239	48p	BFX88	30p	2N1306	48p	FETs									
7420	18p	74118	90p	4013	55p	CA3080E	Op Transcond Amp	8 pin DIL	97p	BC107	8 pin	BFY50	18p	2N1306	48p	BF244	36p	TRIACS							
7421	43p	74120	130p	4015	90p	CA3089E	FM IF System	16 pin DIL	250p	BC108	8 pin	BFY51	16p	2N1311	27p	MPE102	40p	4 400 130p							
7422	24p	74121	32p	4016	54p	CA3090AQ	FM Stereo Decoder	16 pin DIL	500p	BC109	8 pin	BFY52	18p	2N1312	27p	MPE103	40p	6 400 162p							
7423	40p	74122	52p	4017	110p	CA3095	VCO Fun Gen	16 pin DIL	370p	BC147	9p	BRV39	45p	2N2719	25p	MPE104	40p	6 500 194p							
7425	33p	74123	73p	4018	247p	ICL8038CC	2W Audio Amp	14 pin DIL	115p	BC148	9p	BSX19	20p	2N2722	25p	MPE105	40p	10 400 200p							
7427	40p	74126	75p	4020	140p	LM380N	Stereo Pre Amp	14 pin DIL	170p	BC149	10p	BSX20	20p	2N2369	25p	1N3819	27p	10 500 270p							
7428	39p	74132	75p	4022	180p	LM389N	Aud Amp +3 Trs Array	16 pin DIL	850p	BC157	11p	BU105	175p	2N2484	32p	2N3820	50p	15 400 310p							
7430	18p	74136	81p	4023	19p	M252	Rhythm Generator	16 pin DIL	850p	BC158	13p	BU108	312p	2N2904 A	25p	2N3823	54p	50 400 340p							
7432	37p	74141	90p	4024	18p	MC1310P	FM Stereo Decoder	14 pin DIL	190p	BC159	13p	MJ160	48p	2N2905 A	25p	2N5457	40p	1N4007	8p	6A 200V 84p					
7437	37p	74142	300p	4025	19p	MC1310P	Lim Det Aud Pre Amp	14 pin DIL	104p	BC169C	15p	MJ2955	130p	2N2906	25p	2N5458	40p	1N4007	8p	6A 400V 90p					
7438	37p	74145	75p	4026	200p	MC3340P	Electronic Attenuator	8 pin DIL	180p	BC171	12p	MJE2955	130p	2N2926RR	9p	2N5459	40p	DIAC							
7440	18p	74148	173p	4027	81p	NFC3400P	4W Audio Amp	16 pin DIL	97p	BC172	12p	MJE3055	80p	2N2926G11	11p	3N128	95p	40430	108p						
7441	85p	74150	155p	4028	152p	NE540L	Aud Pwr Driver	8 pin DIL	90p	BC173	12p	MPSA06	80p	2N2926G11	11p	3N128	95p	40669	105p						
7442	75p	74151	77p	4029	130p	NE555V	Trimer	8 pin DIL	140p	BC174	20p	MPSA12	62p	2N3054	54p	3N141	95p	MEMORY							
7443	116p	74153	92p	4030	59p	NE555	Dual 555	14 pin DIL	96p	BC177	17p	MPSA56	40p	2N3054	54p	3N141	95p	2102 RAM							
7444	116p	74154	184p	4042	150p	NE561B	PLL with AM Demod	16 pin DIL	425p	BC178	17p	MPSA68	78p	2N3054	54p	40603	63p	2107 RAM							
7445	90p	74155	96p	4043	216p	NE562V	PLL with VCO	16 pin DIL	425p	BC179	20p	MPSU08	98p	2N3442	151p	40673	70p	2112 RAM							
7446	90p	74156	96p	4046	150p	NE568	PLL	14 pin DIL	200p	BC182	12p	MPSU56	98p	2N3702	14p			2513 RAM							
7447	90p	74157	87p	4047	110p	NE568V	PLL Fun Gen	8 pin DIL	200p	BC183	12p	OC2R	28p	2N3703	14p	UJTS									
7448	85p	74160	116p	4049	68p	NE567V	PLL Tone Decoder	8 pin DIL	200p	BC184	14p	OC35	90p	2N3704	14p	TIS43	40p								
7451	20p	74161	116p	4050	50p	NE567V	PLL Tone Decoder	8 pin DIL	200p	BC187	32p	OC71	25p	2N3705	14p	2N2160	95p	SCR THYRISTORS							
7453	20p	74162	116p	4054	130p	NE567V	PLL Tone Decoder	8 pin DIL	200p	BC212	14p	TIP29A	60p	2N3706	14p	2N2656	48p	1A 50V TO5							
7454	20p	74163	116p	4055	140p	SG3402N	Ring Modulator	16 pin DIL	275p	BC213	12p	TIP29C	62p	2N3708	14p	2N4871	40p	1A 100V TO5							
7460	20p	74164	130p	4056	145p	SN72710	Diff Comparator	14 pin DIL	54p	BC214	17p	TIP30A	60p	2N3709	14p			1A 400V TO5							
7470	32p	74166	136p	4060	130p	SN72723	Viduo Amp	16 pin DIL	150p	BC247	32p	TIP30C	72p	2N3709	14p	PUJT									
7472	30p	74167	370p	4069	30p	SN7600N	Aud Pwr Amp with HS	16 pin DIL	275p	BC547	12p	TIP31A	56p	2N3773	270p	2N6027	60p	RA 50V PLASTIC							
7473	34p	74174	131p	4071	29p	SN7600N	10W Amp in 8 ohms	5 pin Plastic	280p	BC557	12p	TIP31C	68p	2N3866	97p			12A 400V PLASTIC							
7474	36p	74175	82p	4072	29p	SN7603N	Aud Pwr Amp with HS	16 pin DIL	175p	BCV70	22p	TIP32A	63p	2N3866	97p	DIODES									
7475	48p	74176	131p	4081	21p	SN76023N	Aud Pwr Amp with HS	16 pin DIL	175p	BCV71	24p	TIP32C	85p	2N3905	25p	SIGNAL									
7476	34p	74177	120p	4082	29p	SN76033N	Aud Pwr Amp with HS	16 pin DIL	275p	BD124	140p	TIP33A	97p	2N3906	22p	OA7	10p	BT106	1A 700V STUD						
7480	54p	74180	120p	4510	142p	TAAR71A	Aud Amp for TV	QIL	270p	BD131	30p	TIP33C	120p	2N4058	19p	OA81	15p	18A 100V PLASTIC							
7481	103p	74181	322p	4511	200p	TBA6418	Audio Amp	QIL	300p	BD132	43p	TIP34A	124p	2N4060	19p	OA85	15p	16A 400V PLASTIC							
7482	75p	74182	89p	4516	140p	TBA800	5W Audio Amp	QIL	100p	BD136	55p	TIP35A	243p	2N4124	22p	OA91	9p	2N3525	5A 300V TO66						
7483	99p	74185	146p	4518	140p	TBA810	7W Audio Amp	QIL	125p	BD139	54p	TIP35C	290p	2N4125	22p	OA95	9p	2N4444	8A 600V PLASTIC						
7484	103p	74190	155p	4528	130p	TBA820	2W Audio Amp	QIL	100p	BD140	60p	TIP36A	290p	2N4126	22p	OA200	8p	2N5062	0 RA 100V TO92						
VOLTAGE REGULATORS		Fixed Plastic 3 Terminals				SEVEN SEGMENT DISPLAYS																			
1 Amp +ve		-ve				3015F		1																	

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 DUM is quickly

built and aligned. Basic range is $\pm 2V$, 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** £11.75
L. Altman
Gives a general overview of the technology design ideas and practical application

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

- MICROPROCESSORS AND MICROCOMPUTERS** £15.90
B. Soucek
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**
L. W. Turner £25.60
A completely new and up-to-date reference book for all engineers and students

- BASIC MATHS COURSE FOR ELECTRONICS**
H. Jacobowitz £1.75
Quick short cut way to learn the language of maths as applied to electronics

- DESIGNING WITH TTL INTEGRATED CIRCUITS**
Texas Instruments £8.95
Covers the entire family of TTL and practical applications of circuits in digital systems

- 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**
B. Wells £1.90
Selection and installation home maintenance and business security devices

- 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. Sreater £3.25
Helps those unfamiliar with digital logic circuits

- INTEGRATED ELECTRONICS** £7.60
J. Millman
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
Covers the basic theory of IC op amps in great detail, also includes 250 practical circuit applications

- LINEAR INTEGRATED CIRCUIT APPLICATIONS**
G. Clayton £4.90
A practical approach, is emphasised throughout, encouraging the reader to try out devices himself

- LINEAR IC PRINCIPLES EXPERIMENTS AND PROJECTS**
E. M. Noll £6.20
An introduction to one of electronics most exciting devices

- 110 OPERATIONAL AMPLIFIER PROJECTS FOR THE HOME CONSTRUCTOR**
R. M. Marston £2.85
Outlines the essential characteristics of op amps and presents useful projects

- 110 SEMICONDUCTOR PROJECTS FOR THE HOME CONSTRUCTOR**
R. M. Marston £2.85
Introduces the reader to FET's, SCR's and IC's with full construction details of many useful circuits

- 110 COSMOS DIGITAL IC PROJECTS FOR THE HOME CONSTRUCTOR**
R. M. Marston £3.10

- 110 INTEGRATED CIRCUIT PROJECTS FOR THE HOME CONSTRUCTOR**
R. M. Marston £2.85
All the projects have been devised, built and fully evaluated by the author

- 110 THYRISTOR PROJECTS USING SCR'S**
R. M. Marston £2.85
A companion to the author's previous books

- MOS DIGITAL IC'S**
G. Flynn £4.50
This book contains information about MOS and CMOS from basic construction to circuit application

- OPERATIONAL AMPLIFIERS DESIGN AND APPLICATIONS (Burr Brown)**
G. Tobey £7.30
Covers the entire field of operational amplifiers

- PIN POINT TRANSISTOR TROUBLES IN 12 MINUTES**
L. Garner £2.85
Complete information on circuit operations, troubleshooting charts and service procedures

LATEST EDITIONS

- THE OSCILLOSCOPE IN USE**
Ien Sinclair £3.00
A practical handbook aimed at the more advanced enthusiast

- 110 ELECTRONIC ALARM PROJECTS**
R. M. Marston £3.35
The latest in this popular series.

- MASTER HI-FI INSTALLATION**
Gordon J. King £3.00
All you need to know about setting up your audio system.

- TV TYPEWRITER COOKBOOK**
Don Lancaster £7.00
All the circuitry and explanations for making your own VDU.

- PRACTICAL ELECTRONIC CIRCUIT BUILDING**
Ainslie and Colwell £2.35
A concise introduction to some of the modern methods of project building.

- PRINTED CIRCUIT ASSEMBLY**
Hughes and Colwell £2.35
Abundant information on making and assembling PCBs.

- ELECTRONIC DIAGRAMS**
M. A. Colwell £2.35
Comprehensive information on circuit symbols and diagrams.

- ELECTRONIC COMPONENTS**
M. A. Colwell £2.35
Information on the different types of components and their selection.

- PROJECT PLANNING AND BUILDING**
M. A. Colwell £2.35
How to convert an idea into a practical model.

- SIMPLE CIRCUIT BUILDING**
M. A. Colwell £2.35
How to build projects without taking the theoretical approach.

- PRACTICAL TRIAC/SCR PROJECTS FOR THE EXPERIMENTER**
R. Fox £2.15
Thyristor theory and practical circuits with low cost SCR TRIACs and DIACs

- PRINCIPLES OF TRANSISTOR CIRCUITS**
S. Amos £4.40
Generally accepted as being a standard textbook on fundamental principles underlying the design of circuits and using transistors

- RAPID SERVICING OF TRANSISTOR EQUIPMENT**
G. King £2.85
A systematic guide to the servicing of transistor radio, television tape and hi-fi equipment

- SEMICONDUCTOR CIRCUIT ELEMENTS**
T. D. Towers £6.00
Gives readers an account of all semiconductor devices commercially available, for each device it covers a general description, circuit diagram symbols and working principles

- SOLID STATE CIRCUIT GUIDE BOOK**
B. Ward £2.15
Step by step instructions to design circuits to your own specifications

- TRANSISTOR CIRCUIT DESIGN**
Texas £9.25

- TTL COOKBOOK**
D. Lancaster £6.00
Complete and detailed guide to TTL, how it works, how to use it and practical applications

- UNDERSTANDING ELECTRONIC CIRCUITS**
R. Sinclair £4.00
Describes various circuits encountered today with a strong emphasis on fault finding and servicing procedures

- UNDERSTANDING ELECTRONIC COMPONENTS**
R. Sinclair £4.00
Explains about components and bridges the gap between elementary textbooks and unapproachable advanced treatments

- UNDERSTANDING CMOS INTEGRATED CIRCUITS**
R. Meien £3.50
Begins with basic digital IC's, covers semiconductor physics, CMOS fabrication technology and design

- UNDERSTANDING SOLID STATE CIRCUITS**
N. Crowhurst £1.90
Written to service the interests of anyone at sub-engineering level

ELECTRONIC ORGAN BOOKS

- TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR**
A. Douglas £4.90
Written in a simple style, this gives a complete explanation of everything to do with transistorized organs and is profusely illustrated with clear diagrams

- THE ELECTRONIC MUSICAL INSTRUMENT MANUAL**
A. Douglas £8.00
A comprehensive guide to the theory and design of electronic musical instruments

SEMICONDUCTOR DATA

- POPULAR VALVE/TRANSISTOR SUBSTITUTION GUIDE** £2.15
Substitution data for both valves and transistors in one new volume

- RADIO VALVE AND SEMICONDUCTOR DATA**
A. M. Ball £2.50
Characteristics of 1,000 valves, cathode ray tubes, transistors, diodes, rectifiers and optical semi-conductors. This new edition (1975) is right up to date and over 450,000 copies have been sold.

RADIO AND TELEVISION

- FOUNDATIONS OF WIRELESS AND ELECTRONICS**
M. G. Scroggie £4.35
(New 1975 edition) Covers the whole basic theory, no previous technical knowledge is assumed

- SERVICING TRANSISTOR RADIOS**
L. D'Airo £2.30
Complete guide giving theory analysis and servicing techniques

TEST EQUIPMENT AND OSCILLOSCOPES

- BASIC ELECTRONIC TEST PROCEDURES**
I. M. Gottlieb £2.35
Shows how to get accurate measurement with VOMs meters and oscilloscopes

- THE OSCILLOSCOPE**
G. Zwick £2.10
Starts from the first principles and takes the reader to an advanced level

- PRACTICAL TEST EQUIPMENT YOU CAN BUILD**
W. Green £2.15
For technicians, radio, TV service operators and serious experimenters

- TEST INSTRUMENTS FOR ELECTRONICS**
M. Clifford £1.65
Easy modifications to your VOM, VTVM and scope with the aid of this book

- WORKING WITH THE OSCILLOSCOPE**
A. Saunders £1.85
Includes workshop test projects with large size drawings

- SERVICING WITH THE OSCILLOSCOPE**
G. King £5.00
Includes a unique series of photographs showing oscilloscope traces to be found in normal and faulty equipment, stereo radio, colour TV. Circuits servicing is dealt with

HOW TO ORDER

All prices are correct at the time of going to press but are subject to alteration without notice. All prices include postage. Please print your name and address clearly and list each title and price separately. Cheques and postal orders should be made payable to ETI Book Service. Books are sent on seven days' approval against a full cash remittance, plus postage. Book stock is not held at ETI's London offices and orders should be sent to ETI BOOK SERVICE, P.O. BOX 79, MAIDENHEAD, BERKS SL6 2EG.

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 micro-computer 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 wavetorm 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

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

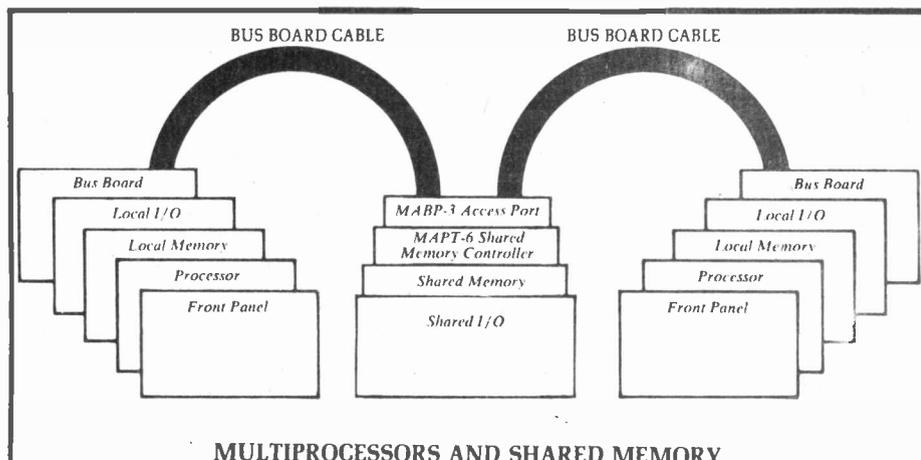
- 1. Speed** due to one processor being optimised for dealing with the outside world.
- 2. Programs are simpler** because interrupts (servicing the outside world) which normally divert the processor temporarily can be handled by one processor optimised for this task, enabling the other to be expert at 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



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.

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 micro-computer 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?

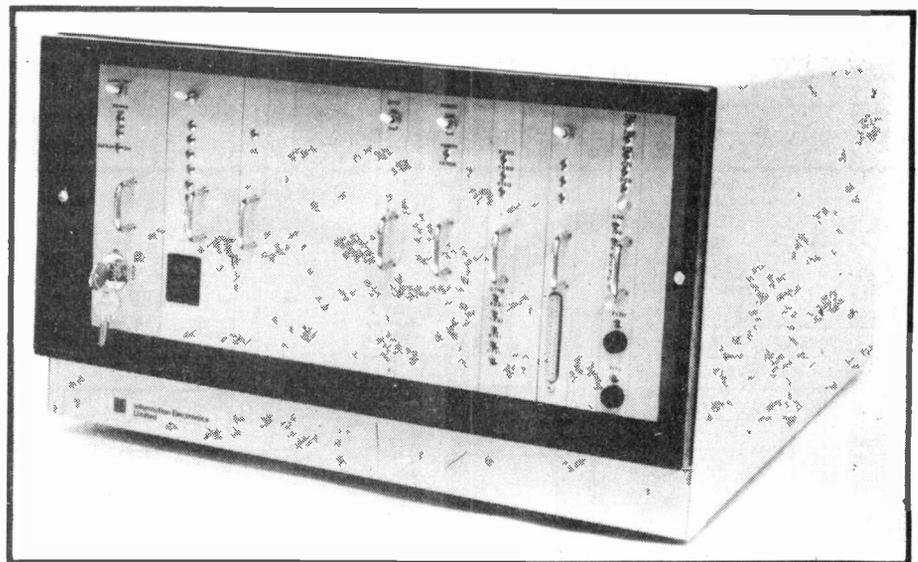
The advantage for the guy who doesn't know so much about microprocessors is that he doesn't have to diddle about with input-output routines to try out programs. Once he knows the two processors behave identically he can load his program under the control of one with the other switched off, then he can start it running which immediate-

ly 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 of 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 exotics 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.

MEMORY IC's

Intel 2102A-6 (new version of 2102-2), 16 pin IC, TTL compatible, Single +5V supply, 650nsec., 1024 x 1 bit Static NMOS RAM **£3.61**
Intel 2112A-4 650nsec. 256 x 4 bit Static NMOS RAM **£4.76**
Intersil IM6508C CMOS 1024 x 1 bit Static RAM **£8.05**

CMOS/TTL COUNTERS

DB2 Complete kit one on small PCB for two digit CMOS counter with lach. Includes 2 x FND500 or TIL322, 3 CMOS IC's, Sockets, R's PCB, Instructions. Order as DB2 kit **£8.60**
PCB + layout etc available sep. Order as 912.950 **£2.10**
PCB Set for 6 DIGIT TTL COUNTER with lach. All you need are 6 x TIL321, 6 each of 7447 7475 7490 + R's (Kit not yet available)
Counter PCB + display PCB 876.001 layout etc. Order as 610.950 **£5.50**

KITS

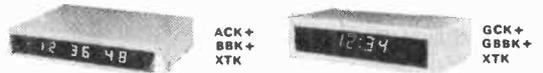


CAR CLOCK
The SINTEL Car Clock. Four digits. White mini case. Large 0.5" red LED displays. High frequency quartz crystal timebase. Internal battery backup. Full instructions. Suitable for all 12v negative earth cars. 154mm x 85mm x 40mm **£17.85**
Also available less case—Order as AUT-MODULE KIT **£16.45**



50Hz CRYSTAL TIMEBASE KIT: provides an extremely stable output of one pulse every 20msec. Uses. May be added to all types of digital clocks to improve accuracy, to within a few seconds a month. If used with battery back-up also makes clocks power-off or switch-off proof. Replacing 50Hz signal on battery-powered equipment. Providing film synchronisation. Monitoring or improving turntable speed. Complete kit. Order as "XTK" **£8.28**

DIGITAL CLOCK KITS WITH CRYSTAL CONTROL AND BATTERY BACK-UP



These two kits incorporate our Crystal Timebase Kit (XTK), together with components for battery back-up. All components, plus a PP3-type battery, fit neatly in the clock cases. Accurate to within a few seconds a month. If mains power is disconnected (through a power cut, accidental switching off or moving clock) the clocks will still keep perfect time. While on back-up, the displays are off to conserve battery life.

ATTRACTIVE 6-DIGIT ALARM CLOCK: Uses Red 0.5" displays. Features bleep alarm. "Touch switch" snooze control and automatic intensity control. Alarm remains fully operational while clock is on back-up. Complete kit including case, less mains cable and plug. Order as "ACK+XTK+BBK" **£3.58**
Kit also available less crystal control and back-up. Order as "ACK" **£26.80**

MINI GREEN CLOCK. Attractive 4-digit Mantelpiece Clock with bright 0.5" Green display. Complete kit including case, less mains cable and plug. Order as "GCK + XTK + GBBK" **£19.65**
Kit also available less crystal control and back-up. Order as "GCK" **£14.40**

DATABOOKS and Datasheets

(do not add any VAT)

New 1976 RCA CMOS and Linear IC Combined Databook **£6.70**
New 1976 RCA "Power and Microwave" Databook **£7.30**
1976 National Semiconductor 7400 series TTL Databook, c. 200 pages **£3.45**
TTL Pin-Out Card Index. Set of cards with pin-outs (top and bottom views) of T.I. TTL range and many other T.I. IC's **£2.95**
Intel Memory Design Handbook, c. 280 pages **£5.20**
Intel 8080 Microcomputer Systems Users Manual, c. 220 pages **£5.25**
Motorola McMOS Databook (Vol. 5 Series B) c. 500 pages **£3.50**
Motorola M6800 Microprocessor Applications Manual, c. 650 pages **£12.95**
Motorola M6800 Programming Manual, c. 200 pages **£5.35**
Motorola Booklet introducing Microprocessors **£1.80**
2650 Microprocessor Manual 220 pp **£24.50**
National SC/MP Introkit Users Manual **£0.75**
National SC/MP Programming and Assembly Manual **£6.30**
National SC/MP Technical Description **£1.95**

DATASHEETS on Microprocessors: (usually Xerox Copies)

Intersil IM6100 12 bit CMOS **£0.75** RCA CDP1802 8 bit CMOS **£0.75**
National SC/MP 8 bit, Low cost **£0.75** Zilog Z80 (enhanced 8080) **£0.75**
Signetics 2650 8 bit, Low cost **£0.75** Motorola MC 6800 **£0.75**
TMS 8080 **£0.75** TMS 5501 for 8080 **£0.75**

microprocessors

Please: Microprocessors should only be bought by experienced constructors. Sorry, we cannot answer technical queries or supply data other than from our selection.

IM6100CCDL **£45.36** ISPA/100 (SC/MP) **£18.75**
8080A (2uS) **£32.25** 2650 **£27.00**
6800 **£33.87**

MICROPROCESSOR MANUFACTURERS' DEVELOPMENT KITS

These include main IC's, PCB, Manuals and Data **£137.00**
MEK6800D1 — with the 6800 MPU **£93.55**
ISP8K/200E — SC/MP Intro Kit **£176.65**
MCS-80 Kit C — with 8080A (no PCB) **£176.65**

Send for **FREE CATALOGUE** giving details of our complete range of Clock kits, LED displays, Cases and other components.

CASES and other COMPONENTS

32.768 kHz Min. Watch Quartz Crystal **£4.50**, 5.12 MHz Crystal **£3.60**
8-way BOSS Switch: 8-ultra-min. toggle switches in 16-pin DIL **£2.60**
Miniature Transformers (Both fit in all Verocases below)
Clock transformer 6-0-6/300mA. Order as "LED-TRF" **£1.95**
For 5LT01 12-0-12/100mA, 1.5-0-1.5/50mA. Order as "5L-TRF" **£1.95**
VEROCASES. Neat cases with PCB guides, etc., front and rear aluminium panels. We have pre-cut perspex for some cases, making them ideal for clocks or instruments. For 751247J PX-R-J-12 (Red) **28p**, PX-G-J-12 (Green) **28p**, For 751410J PX-R-J-14 (Red) **30p**, PX-G-J-14 (Green) **30p**, For 751411D PX-R-D-14 (Red) **40p**. The cases are as used in our ACK & GCK.

Dimensions are in mm
751410J (205x140x40) **£3.36** 751237J (154x85x40) **£2.15**
751411D (205x140x75) **£3.77** 751238D (154x85x60) **£3.00**

We have many other Verocases and Vero products in stock — see our Price List

FAST SERVICE

We guarantee that Telephone Orders for goods in Stock, received by 4.15 p.m. (Mon-Fri.) will be despatched the same day. 1st Class Post (Books and Kits by parcel post), and our Stocking is good. Private customers should telephone and pay by giving their Access or Barclaycard number, with a minimum order value of £5. Official orders, no minimum.

CMOS

CD4000	0.17	CD4033	1.60	CD4072	0.24
CD4001	0.18	CD4034	2.19	CD4073	0.24
CD4002	0.17	CD4035	1.35	CD4075	0.24
CD4006	1.35	CD4036	3.65	CD4076	1.61
CD4007	0.18	CD4037	1.09	CD4077	0.60
CD4008	1.11	CD4038	1.24	CD4078	0.24
CD4009	0.64	CD4039	3.55	CD4081	0.24
CD4010	0.64	CD4040	1.23	CD4082	0.24
CD4011	0.20	CD4041	0.96	CD4085	0.82
CD4012	0.19	CD4042	0.96	CD4086	0.82
CD4013	0.64	CD4043	1.16	CD4089	1.78
CD4014	1.16	CD4044	1.07	CD4093	0.92
CD4015	1.16	CD4045	1.61	CD4094	2.15
CD4016	0.64	CD4046	1.53	CD4095	1.20
CD4017	1.16	CD4047	1.04	CD4096	1.20
CD4018	1.16	CD4048	0.64	CD4097	4.28
CD4019	0.64	CD4049	0.64	CD4098	1.26
CD4020	1.28	CD4050	0.64	CD4099	2.11
CD4021	1.16	CD4051	1.07	CD4502	1.43
CD4022	1.11	CD4052	1.07	CD4510	1.57
CD4023	0.24	CD4053	1.07	CD4511	1.80
CD4024	0.89	CD4054	1.33	CD4514	3.15
CD4025	0.24	CD4055	1.51	CD4515	3.60
CD4026	1.98	CD4056	1.51	CD4516	1.56
CD4027	0.64	CD4059	5.48	CD4518	1.25
CD4028	1.03	CD4060	1.28	CD4520	1.43
CD4029	1.31	CD4063	1.26	CD4527	1.82
CD4030	0.64	CD4066	0.71	CD4532	1.65
CD4031	2.55	CD4067	4.28	CD4555	1.04
CD4032	1.23	CD4068	0.24	CD4556	1.04
		CD4070	0.67	MC14528	1.22
		CD4071	0.24	MC14553	4.68
				IM6508	8.05

COMPONENTS

CLOCK CHIPS

AY51202 **2.89**
AY51224 **3.50**
MK50253 **5.60**

VEROCASES

751410J **3.36**
751411D **3.77**
751237J **2.15**
751238D **3.00**
751239K **3.58**

SOLDERCON I.C. PINS

100 **0.50**
1,000 **4.00**
10,000 **34.00**

SUNDRY

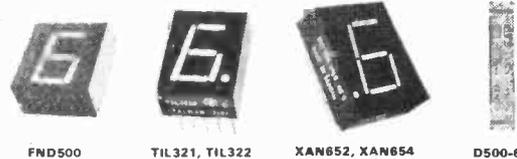
CA3130 **1.14**
uA741 **0.35** (RCA 8 DIL)
78L12WC **0.77**

LOW COST IC SOCKETS

Soldercon Pins are the ideal low cost method of providing sockets for TTL CMOS, Displays, ICs. Simply cut off the lengths you need, solder into board and snap off the connecting carrier. A single purchase of Soldercon Pins gives you any socket you may need, and at low prices. 50p per strip of 100 pins, 1,000 for £4, 3,000 for £10.50.

DISPLAYS

These Jumbo LED displays take no more current than D.3" types. All our Common Cathode (CC) digits can be used in place of any other CC display (DL704, D1750, MAN3640, etc.) as they are all electrically identical (but may have different pin-outs). Similarly our Common Anode digits may be used in place of any other C.A. types (DL707, DL747, RS/Ooram 586/699, etc.)



Part No	Manufacturer	Colour	Type	Size	Price
FND500	Fairchild	Red	Common Cathode LED	0.5"	£1.02
TIL321	Texas Instr	Red	Common Anode LED	0.5"	£1.30
TIL322	Texas Instr	Red	Common Cathode LED	0.5"	£1.20
XAN652	Xcition	Green	Common Anode LED	0.6"	£2.45
XAN654	Xcition	Green	Common Cathode LED	0.6"	£2.45
5LT01	Futaba	Green	Phosphor Diode	0.5"	£5.80

Display PCBs (each fits neatly into Verocase 751410J) - all are for multiplexed arrays. all are suitable for FND500, TIL321, TIL322
D500-4 (for 4 digit clock) **90p**; D500-6 (for 6 digit clock) **£1.35**
D500-8 (for counter, up to 8 digits) **£1.35**
876-001 (for counter, up to 6 digits - non-multiplexed) **£1.30**
USING DISPLAYS WITH CMOS OR TTL? Send size asking for free application note, SN1, which gives simple circuits with component values.

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.

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

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

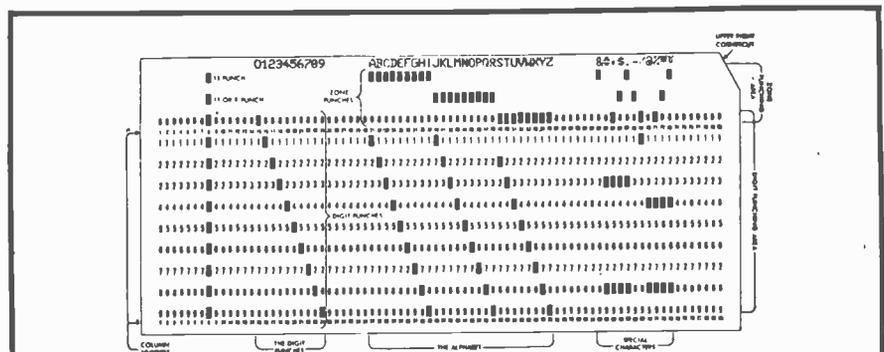


Fig 1 Standard Hollerith Code used for punched cards



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.

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

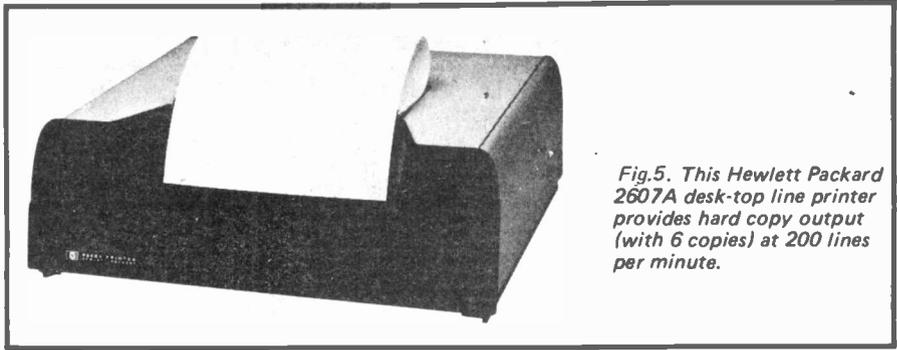


Fig.5. This Hewlett Packard 2607A desk-top line printer provides hard copy output (with 6 copies) at 200 lines per minute.

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

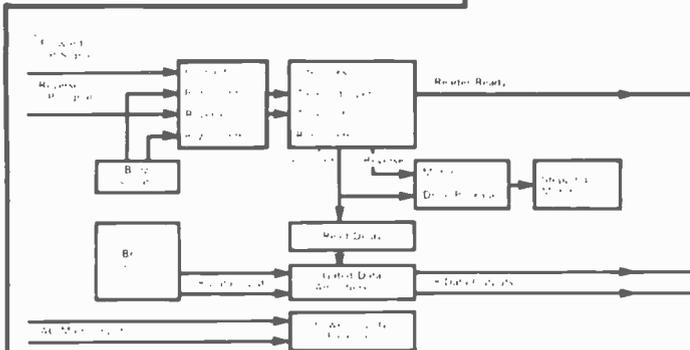
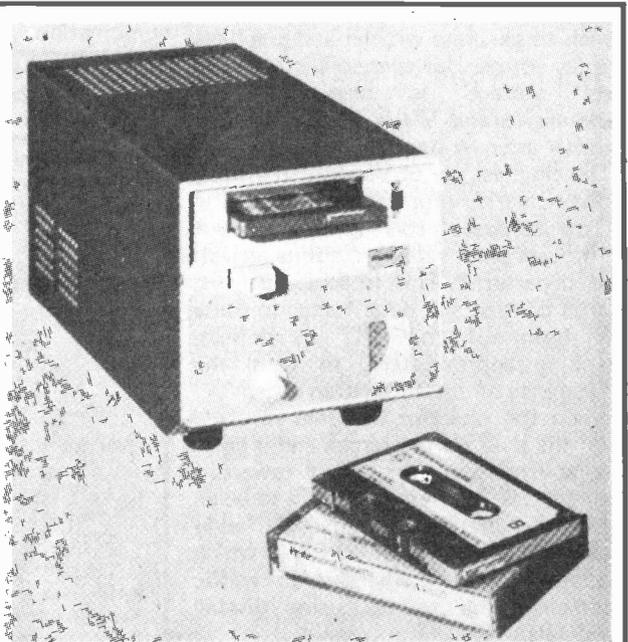


Fig.3 Block diagram of early model Data Dynamics low-speed tape reader (30 c.p.s.).

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



ELECTRONICS—it's easy!

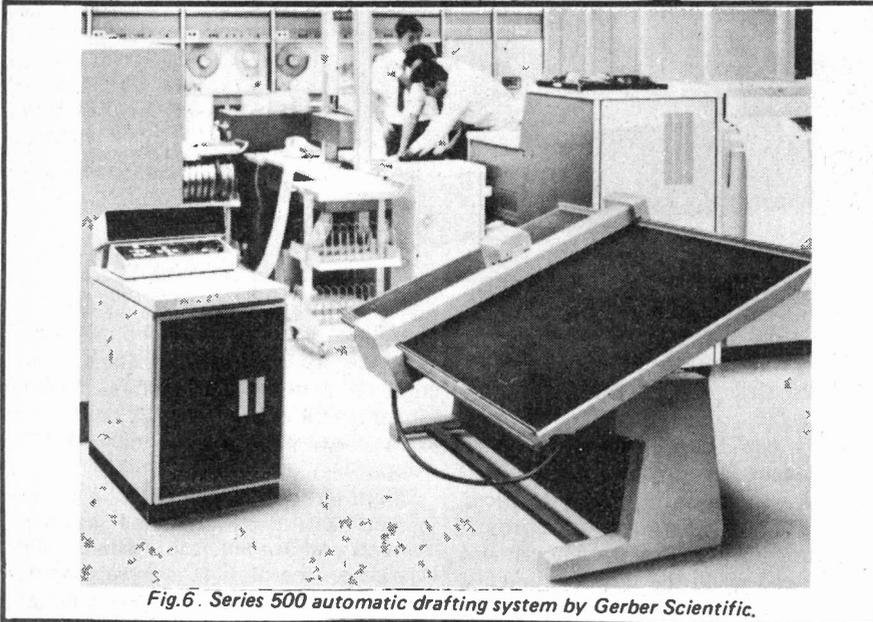


Fig.6. Series 500 automatic drafting system by Gerber Scientific.

to precisions of 25 μ m.

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 to 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.

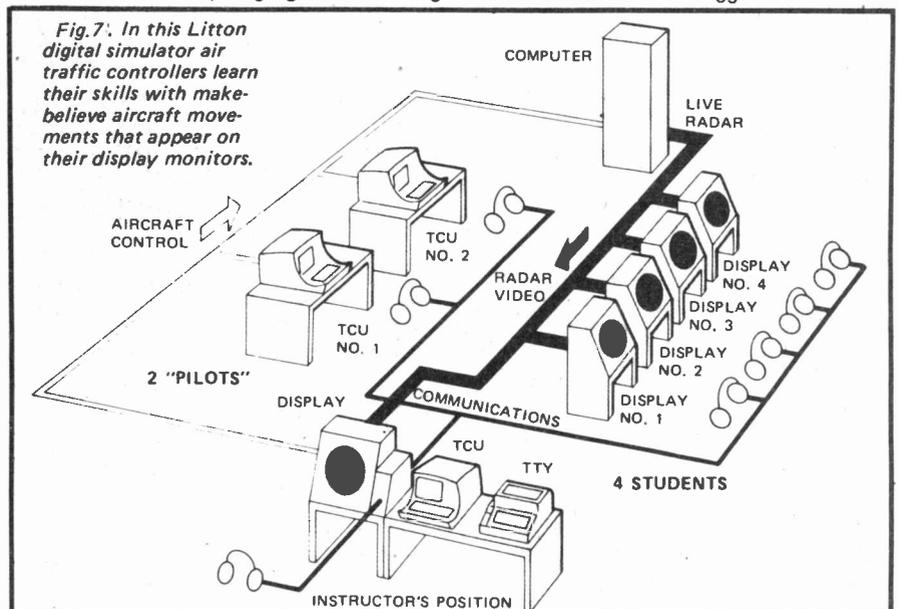


Fig.7. In this Litton digital simulator air traffic controllers learn their skills with make-believe aircraft movements that appear on their display monitors.

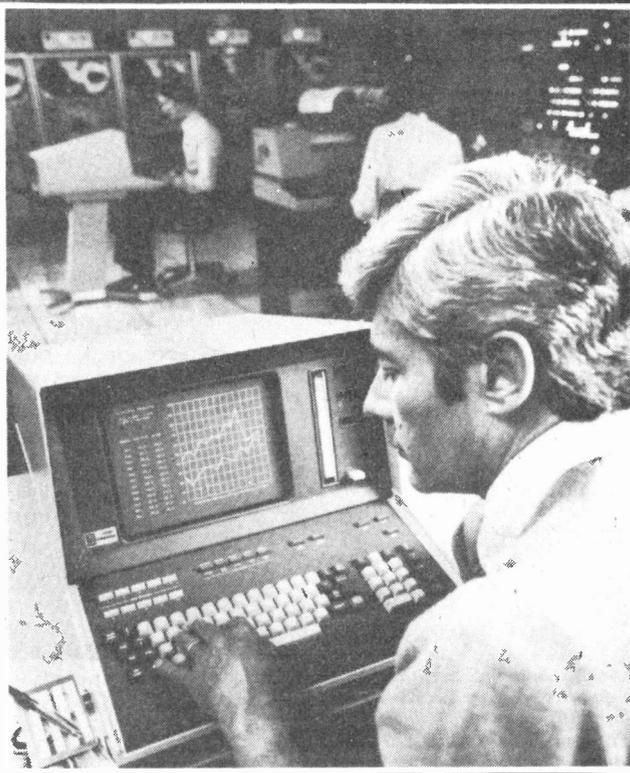


Fig.8 . Interactive graphic units often now incorporate their own processing and memory to form an off-line self-contained unit — 4051 Tektronix BASIC graphic computing system.

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 hardware 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.

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 tolerated 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

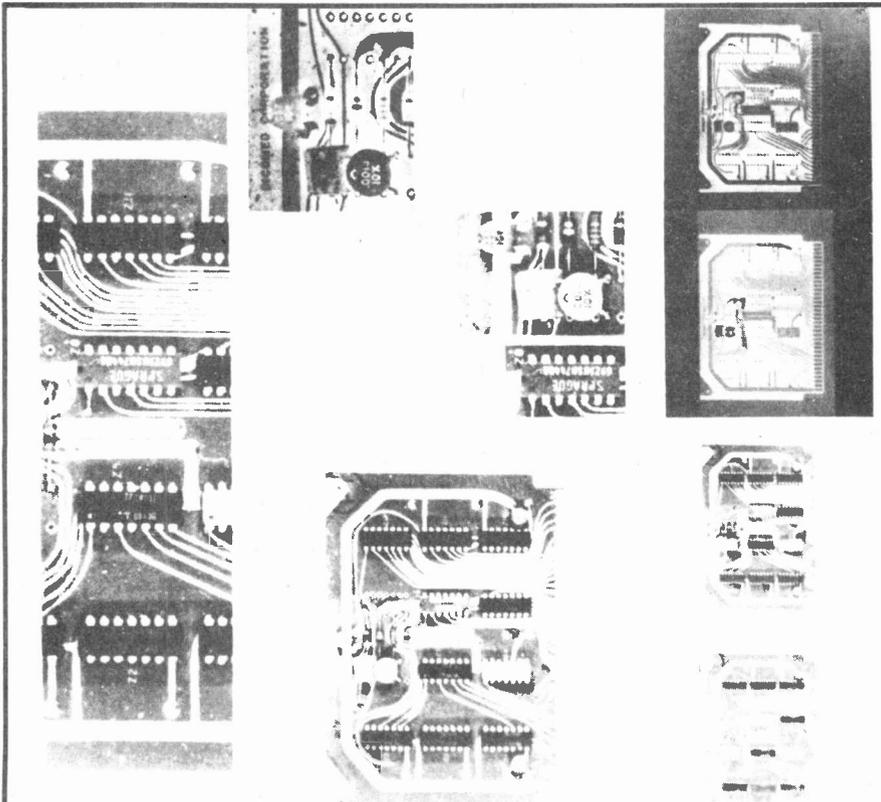


Fig.9 This multiple image presentation is photographed from the screen of DICOMED digital image display unit.

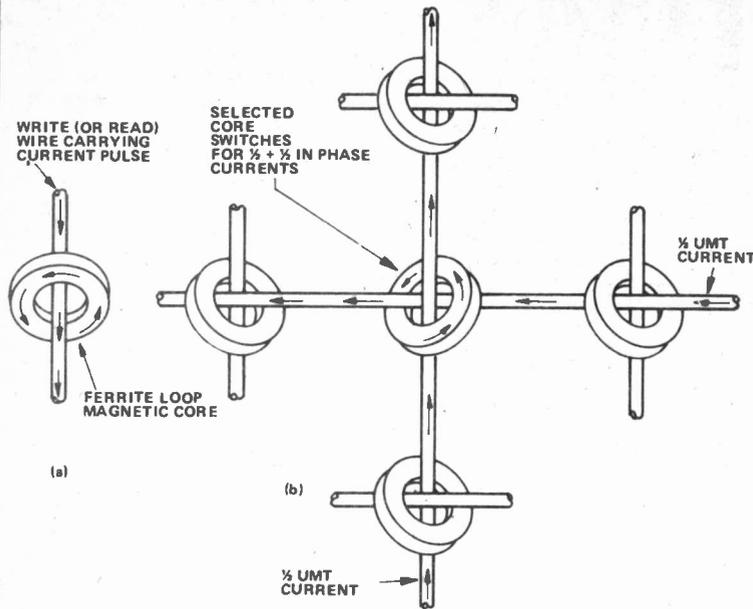


Fig. 10. (a) When a large enough write current passes in one direction through the ferrite core the core becomes magnetised in one polarity. It thus records a bit.
 Fig. 10 (b) A second wire is added to act as an inhibitor or enhance line.
 Fig. 10 (c) Finishing touches being added to a Philips 3-D core 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. ●

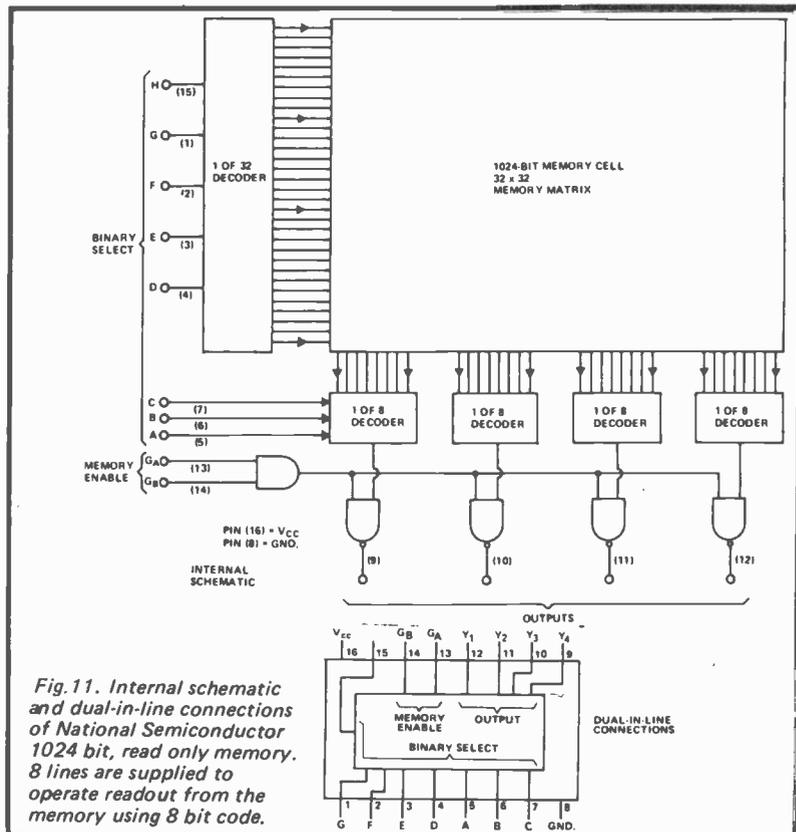


Fig. 11. Internal schematic and dual-in-line connections of National Semiconductor 1024 bit, read only memory. 8 lines are supplied to operate readout from the memory using 8 bit code.



NEW! For home constructor FREE BLOB BOARD!

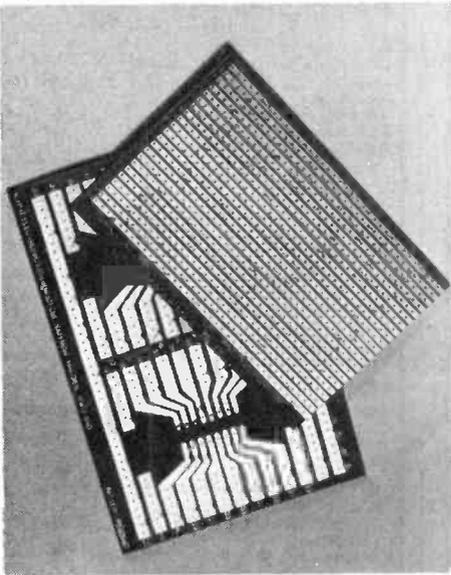
worth
30p

Now stocked by all good components suppliers

BLOB BOARDS

Circuit diagram to circuit board in minutes. Layout circuit plan on .1" graph paper. Select Blob Board, lay components out with leads on copper strip. Blob of solder onto lead and your circuit is complete. Blob Boards normally half price of competitive boards. Roller tinned to solder components directly. No drilling or mounting. Modifications in seconds. Blob Board is re-usable.

Blob Boards are circuit boards designed exclusively for the home constructor and prototype engineer and are normally half the price of competitive boards. Blob Boards are roller tinned for ease of soldering, most require no cutting or breaking of contact rails. **HALF PRICE AND RE-USABLE. That is NEW!**



Blob Board .1" or .15"	1 off	3 off	Dip Blob Boards	1 off	3 off
All approx. inch sizes					
ZB1V 2.5 x 5	£0.30	£0.75	ZB11C 4.5 x 3	£0.36	£0.90
ZB2V 2.5 x 3.75	£0.23	£0.57	ZB21C 4.8 x 3.2	£0.40	£0.96
ZB3V 3.75 x 5	£0.46	£1.14	ZB41C 4.75 x 7.5	£0.85	£2.13
ZB4V 10 x 6	£1.51	£3.78	ZB81C 9.5 x 7.5	£1.70	£4.26
Discrete Blob Board	1 off	3 off			
ZB5D 3.6 x 2.4	£0.20	£0.51			
ZB6D 2.4 x 7.3	£0.42	£1.05			
ZB7D 4.9 x 7.3	£0.69	£1.75			
ZB8D 9 x 7.5	£1.62	£4.05			

Sample pack: 1 off ZB1V + 1 off ZB8D + 1 off ZB21C normally £2.32 only £2.00 + free Blob Board.
Many other sizes and patterns available add 30p post + 8% VAT to all orders.

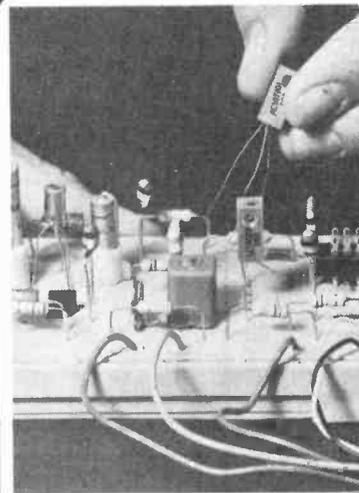
S-DeC

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.



DRILL-SAW GRIND-BURR BRUSH-POLISH

PB announce a precision British built drill for the home constructor. Works better than most bigger drills and can be used for fine detailed work. Drills through any circuit board, need to break copper strip simply grind it off.
9000 RPM Drill + 20 Assorted tools £11.20 (+VAT + post) Send £13.00.
9000 RPM Drill only £5.22 + post + VAT send £6.00.
Multi-purpose Drill stand £10.60 + Post + VAT send £12.00.



POT LUCK

Off cuts of fibre glass circuit board 5 sq. ft.	£1.50.
Double sided fibre glass p.c.b. 5 sq. ft.	£2.00.
Ferric chloride 5 litre mix	£2.00.
Negative developer 1 litre	£1.50.

Add £0.75p. to all above for Post + VAT.

Mr. Trader please exchange for 1 Blob Board ZB1V worth 30p when purchasing any of the above items
Trade enquiries please contact Banbridge, London.
Mr. John Evans Tel: 01-228 9227

30p

PB Electronics Scotland Ltd.
57 High Street, Saffron Walden, Essex. CB10 1AA.
For leaflets and further information please send stamped addressed envelope.

PRINTED CIRCUIT KIT £4.25*

Make your own printed circuits. Contains etching dish 100 sq. ins. of pc board, 1lb ferric chloride, dalo pen, drill bit, laminate cutter

JC12 AMPLIFIER

6W IC audio amp with free data and printed circuit £2.25



DELUXE KIT FOR JC12

Contains extra parts except JC12 needed to complete the amp including balance volume bass and treble controls Mono £2.33 Stereo £4.95

JC12 POWER KIT

Supplies 25V 1 Amp £3.75

JC12 PREAMP KITS

Type 1 for magnetic pickups mics and tuners Mono £1.50 Stereo £3.00 Type 2 for ceramic or crystal pickups Mono 88p Stereo £1.76

SINCLAIR IC20

IC20 10W+10W stereo integrated circuit amplifier kit with free printed circuit + data £4.95

P220 Power supply kit for above £3.95

VP20 Volume tone-control and preamp kit £7.95

JC40 AMPLIFIER

New integrated circuit 20W amplifier kit complete with chip, printed circuit and data £4.45

FERRANTI ZN414

IC radio chip £1.44 Extra parts and pcb for radio £3.85 Case £1 Send sae for free data

BATTERY ELIMINATOR BARGAINS

MILLENNIA KITS*

5 Transistor highly stabilized power units. Switched 1 to 30V in 0.1V steps. Send sae for free leaflet. 1 Amp kit £12.45 2 Amp kit £14.95 Case £2.95 extra

RADIO MODELS

50mA with press-stud battery connectors 9V £3.45 6V £3.45 9V+9V £5.45 6V+6V £5.45 4 1/2V+4 1/2V £5.45

CASSETTE MAINS UNITS

7 1/2V with 5 pin din plug 150mA £3.95

3-WAY MODELS*

With switched output and 4-way multi-jack connector Type 1 3/4V/6V at 100mA £3.20 Type 2 6/7 1/2/9V at 150mA £3.30

FULLY STABILIZED MODEL £5.45*

Switched output of 3/6/7 1/2/9V stabilized at 400mA

CAR CONVERTERS £5.10*

Input 12V DC Output 6/7 1/2/9V DC 1Amp stabilized

BATTERY ELIMINATOR KITS

Send sae for free leaflet on range

100mA radio types with press-stud battery terminals 4 1/2V £2.10 6V £2.10 9V £2.10 4 1/2V+4 1/2V £2.80 6V+6V £2.80 9V+9V £2.80

100mA cassette type 7 1/2V with 5 pin din plug £2.10 **Transistor stabilized 8-way type** for low hum 3/4 1/2/6/7 1/2/9/12/15/18V 100 mA £3.50 1Amp £6.50

Heavy duty 13-way types 4 1/2/6/7/8 1/2/11/13/14/17/21/25/28/34/42V. 1 Amp model £4.95 2 Amp model £7.95

Car converter kit. Input 12V DC Putput 6/7 1/2/9V DC 1A transistor stabilized £1.95

MAINS TRANSFORMERS

6.0-6V 100mA: 1 9.0-9V 75mA: 1 18V 1A: 1 95 0 12/15/20/24/30V 1A: 4 30 12.0-12V 50mA: 1

0/12/15/20/24/30V 2A: 5 95 20V 2V: 2 95 6.0-6V 1 1/2A: 85 9.0-9V 1A: 2 55 12.0-12V 1A: 2 95

15.0-15V 1A: 3 20 30.0-30V 1A: 4 10

S-DECS AND T-DECS*

S-DeC: 2 24 T-DeC: 4 05 u-DeCA: 4 45 u-DeCB: 7 85 IC carriers with sockets

16 dit £2.05 10T05: £1.95



SINCLAIR CALCULATORS AND WATCHES*

Cambridge memory £5.95 Cambridge Scientific £8.95 Oxford sci £13.30 Programmable Scientific with free mains unit £19.95 Mains adaptors for other models (state type) £3.20 Assembled Grey Watch with free stainless steel bracelet £16.45 White watch £14

SINCLAIR PROJECT 80 AUDIO MODULES

P25: 4 95 P26: 8 70 Z40: 5 75 Pro 805Q: 18 95

BI-PAK AUDIO MODULES*

S450 tuner £20.95 CA310 £4.60 PA100 £13.95 MK60 audio kit £30.60 Teak 60 £13.95 Stereo 30 £16.95 SPM80 £4.25 BMT80 £3.50 Send sae for free data

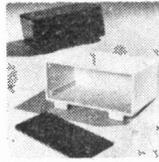
SAXON ENTERTAINMENTS MODULES

SA1203 £20.50 SA1204 £19 SA608 £13 SA604 £12 PM1201/8 £12 PM1202/8 £19 PM1201/4 £12 PM1202/4 £19 PM601/8 £12 PM601/4 £12

SWANLEY ELECTRONICS

Dept. ET1, PO Box 68, Swanley, Kent Send sae for free leaflets on all kits. Post 30p on orders under £2.23 otherwise free. Prices include VAT Overseas customers deduct 7% on items marked * otherwise 11%. Official orders welcome

Greenbank



TIME BOX. Digital Clock Case 56 x 131 x 71.5 mm with red acrylic window. Choice of case colour: white, red, orange, blue £2.25.

LED DISPLAYS. Class II devices, but fully guaranteed by us for even segment brilliance etc. - money back or exchange if not satisfied

DL 704 0.3m	70p	DL 727E 2 x 0.5in	£1.80
DL 707E 0.3in	70p	DL 750E 0.6in	£1.50
DL 728E 2 x 0.5in	£1.80	DL 747E 0.6in	£1.50

SOLOERCON PINS		DIL SOCKETS	
100	60p	8 14 16 pin	15p
1000	£4.00		
2500	£8.75		

CMOS WITH DISCOUNTS! Any mix 10% for 25+ 25% for 100+ 33 1/3% for 1000+

74C00 Series			
74C00 0.25	74C85 1.96	74C165 1.31	74C90 7.72
74C02 0.25	74C86 0.89	74C173 2.11	74C908 2.63
74C04 0.25	74C89 4.65	74C174 2.11	74C909 1.74
74C08 0.25	74C90 0.90	74C175 2.11	74C910 7.18
74C10 0.25	74C93 0.90	74C182 1.48	74C914 1.51
74C14 1.51	74C95 1.31	74C193 1.48	74C918 8.89
74C20 0.25	74C107 1.29	74C195 1.31	74C925 8.28
74C30 0.25	74C151 2.63	74C200 7.19	74C926 8.28
74C32 0.25	74C154 3.92	74C221 1.49	74C927 8.28
74C42 1.93	74C157 2.35	74C901 7.72	74C928 8.28
74C48 2.37	74C160 1.48	74C902 7.72	80C95 0.72
74C73 0.70	74C161 1.48	74C903 7.72	80C97 0.72
74C74 0.63	74C162 1.48	74C904 7.72	88C29 4.13
74C76 0.70	74C163 1.48	74C905 7.70	88C30 4.13
74C83 1.96	74C164 1.31	74C906 7.72	

4000 Series			
4000 0.20	4027 0.60	4051 1.04	4081 0.24
4001 0.20	4028 1.00	4052 1.04	4082 0.24
4002 0.20	4029 1.27	4053 1.04	4085 0.80
4006 1.31	4030 0.60	4054 1.29	4086 0.80
4007 0.20	4031 2.46	4055 1.46	4089 1.74
4008 1.07	4032 1.19	4056 1.46	4093 0.89
4009 0.60	4033 1.55	4057 29.81	4094 2.08
4010 0.60	4034 2.11	4059 6.20	4095 1.16
4011 0.20	4035 1.31	4060 1.24	4096 1.16
4012 0.20	4036 3.09	4061 25.60	4097 4.13
4013 0.60	4037 1.96	4062 10.10	4098 1.22
4014 1.12	4038 1.20	4063 1.22	4099 2.03
4015 1.12	4039 3.09	4066 0.69	40101 1.76
4016 0.60	4040 1.19	4067 4.13	40102 2.16
4017 1.12	4041 0.93	4068 0.24	40103 2.16
4018 1.12	4042 0.93	4069 0.24	40104 2.26
4019 0.60	4043 1.12	4070 0.65	40107 0.66
4020 1.24	4044 1.04	4071 0.24	40108 6.18
4021 1.12	4045 1.56	4072 0.24	40109 2.21
4022 1.07	4046 1.48	4073 0.24	40181 4.30
4023 2.00	4047 1.01	4075 0.24	40182 1.73
4024 0.87	4048 0.60	4076 1.71	40194 2.26
4025 0.20	4049 0.60	4077 0.65	40757 2.26
4026 1.92	4050 0.60	4078 0.24	

14100 and 14400 Series			
14160 1.18	14175 1.04	14415 7.35	14450 2.67
14161 1.18	14194 1.17	14419 2.67	14451 2.67
14162 1.18	14410 5.70	14422 4.98	14490 6.51
14163 1.18	14411 9.54	14435 7.93	
14174 1.08	14412 17.07	14440 11.58	

1450 Series			
14501 0.20	14518 1.39	14537 13.17	14561 0.70
14502 1.38	14519 0.57	14539 1.24	14562 5.59
14503 0.75	14520 1.39	14541 1.62	14566 1.67
14505 4.38	14521 2.77	14543 1.82	14568 3.15
14506 0.57	14522 2.15	14549 4.10	14569 3.72
14507 0.60	14526 2.15	14556 10.50	14577 0.27
14508 3.08	14527 1.76	14557 4.65	14580 8.35
14510 1.51	14528 1.22	14558 1.67	14581 4.30
14511 1.74	14529 1.72	14555 1.01	14582 1.64
14512 3.03	14530 0.95	14556 1.01	14583 0.84
14514 1.47	14531 1.74	14557 4.65	14584 0.71
14515 3.47	14532 1.39	14558 1.25	14585 1.10
14516 1.51	14534 8.15	14559 4.10	
14517 4.02	14536 4.00	14560 2.17	

'VEROBOARD'		0.1" Plain board (no strips)	
0.1" Patch with copper strips		3/4" x 2 1/2"	28p
2 1/2" x 1" (pack of 5)	61p	3/4" x 5"	45p
2 1/2" x 3 1/2"	42p	3/4" x 12 1/2"	£1.28
2 1/2" x 5"	50p	Terminal pins	£1.50/500
2 1/2" x 1 1/2"	£1.54		
3 1/2" x 3 1/2"	50p		
3 1/2" x 5"	56p	DIP breadboard	£2.44
3 1/2" x 1 1/2"	£1.98	Spot face cutter	74p
4 7/8" x 17 9/16"	£2.55	Pin insertion tool	£1.00

CLOCK CHIPS		LEDs (red only)	
AY 5 12 24A	3.50	0.11" dia	15p
MK 50253	£5.50	0.2" dia	15p

OP-AMPS		QUARTZ CRYSTALS	
CA 3130 (COS MOS)	£1.00	32.768 kHz 100 kHz 1	
CA 3140 (BI MOS)	95p	MHz 2 097 152 MHz	
741 Minidip	25p	3 2768 MHz 4 194 304	
		MHz All types same price	
		each £3.75	

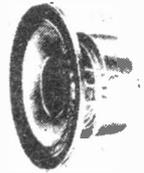
TIMER IC NE 555 45p

CATALOGUE. Free on request. Terms: G.W.O. Add VAT to all prices at 8% Post etc. UK 25p (+2p = 27p) per order. Export add 75p (Europe) + 2.50 elsewhere. no VAT. Polys. universities regd. Cos. etc. can telephone their orders for immediate despatch.

GREENBANK ELECTRONICS (Dept. T2E)
94 New Chester Road, New Ferry
Wirral, Merseyside L62 5AG
England. Tel: 051-645 3391

Wilmslow Audio

THE firm for speakers!



Baker Group 25 3 8 or 15 ohm	£9.00
Baker Group 35 3 8 or 15 ohm	£10.25
Baker Deluxe 8 or 15 ohm	£13.38
Baker Major 3 8 or 15 ohm	£10.69
Baker Regent 8 or 15 ohm	£9.00
Baker Superb 8 or 15 ohm	£16.31
Celestion MH 1000 horn 8 or 15 ohm	£13.50
Coles 400 1 G super tweeter	£5.90
Coles 400 1 K super tweeter	£5.90
EMI 14" x 9" bass 14A/700 8 ohm	£11.92
EMI 8 x 5 10 watt d/c roll/s 8 ohm	£3.75
Elac 59RM 109 15 ohm, 59RM114 8 ohm	£3.38
Elac 6 1/2" d/c roll/s 8 ohm	£3.95
Elac 10" 10RM239 8 ohm	£3.95
Fane Pop 15 watt 12"	£5.50
Fane Pop 55 12" 60 watt	£16.75
Fane Pop 60 watt 15"	£19.95
Fane Pop 70 watt 15"	£21.75
Fane Pop 100 watt, 18"	£33.95
Fane Crescendo 12A or B 8 or 15 ohm	£42.95
Fane Crescendo 15 8 or 15 ohm	£54.95
Fane Crescendo 18, 8 or 15 ohm	£75.95
Fane 801T 8" d/c roll/s 8 ohm	£8.96
Goodmans 8P 8 or 15 ohm	£6.50
Goodmans 8P 8 or 15 ohm	£6.45
Goodmans 12P 8 or 15 ohm	£16.50
Goodmans 12P-D 8 or 15 ohm	£18.75
Goodmans 12P-G B or 15 ohm	£17.75
Goodmans Audiom 200 8 ohm	£14.95
Goodmans Axiom 100 B ohm	£8.50
Goodmans Axiom 402 8 or 15 ohm	£22.00
Goodmans Twinaxiom 8" 8 or 15 ohm	£10.60
Goodmans Twinaxiom 10" B or 15 ohm	£10.95
Kef 12"	£5.75
Kef T15	£10.75
Kef B110	£7.95
Kef B200	£9.25
Kef B139	£17.95
Kef DNB	£2.50
Kef DN12	£6.95
Kef DN13	£4.95
Baker Major Module each	£13.28
Goodmans Mezzo Twinkit pair	£51.95
Goodmans DIN 20 4 ohm each	£15.75
Helme XLK30 pair	£21.95
Helme XLK35 pair	£26.75
Helme XLK40 pair	£38.50
Kefku I pair	£51.00
Kefku III each	£46.00
Peerless 20 50 pair	£39.50
Peerless 20 60 pair	£53.00
Richard Allan Twinkit each	£13.95
Richard Allan Triple 8, each	£20.75
Richard Allan Triple 12, each	£25.95
Richard Allan Super Triple each	£29.50
Richard Allan CG8T 8" d/c roll/s	£7.95
Wharfedale Linton 2 kit pair	

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 '1's and logical '0'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 '0' or 8 cycles of 2400Hz to define logical '1', 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 '0'.

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.

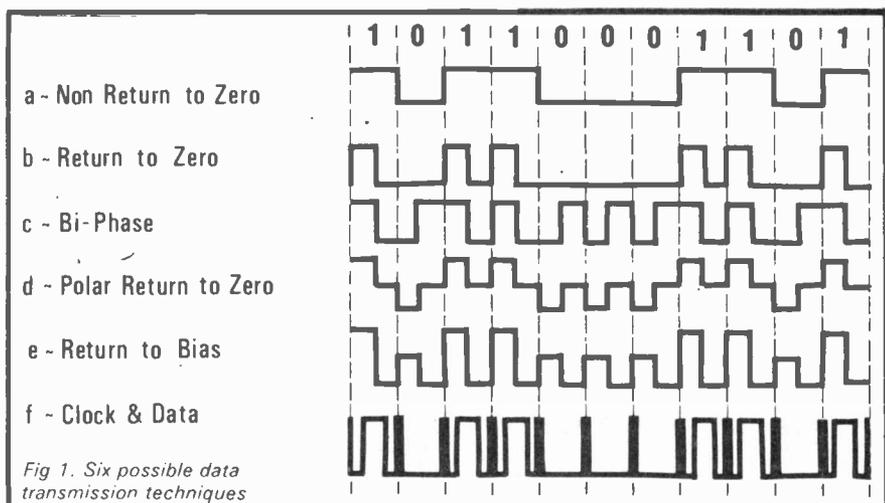
Possibly the simplest system available at low cost is to use a stereo tape unit and to record data on one track and the sampling pulse on the other track. Wow and flutter errors will be low, because the fault

will be common to both tracks but the system cannot be used for single line data 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 '0'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 '0' will leave the signal unchanged —



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 2 μ s 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.

ROTEX Emmen Holland

**SPECIAL
INTRODUCTION
OFFER**



£ 64.79

**RX-6
2 METER RECEIVER** 144-146 Mc/s
Order no. 02.003
With VFO tuning, so that you can listen to all 2 meter transmissions.
Sensitivity : 0,8 uV
Bandwidth : 15 kHz
Built-in 5 meter and loudspeaker
Power Supply : 12 V
Dimensions : 22 x 21 x 6,5 cm
I.F. : 10.7 Mc/s and 465 kc/s



£ 57.22

**RX-6
MINI 2 METER RECEIVER** 144-146 Mc/s
Order no. 02.006
This receiver has the same electronic modules built-in as its bigger brother. The mini, however, has its loudspeaker in the base of the set. Indispensable for those who want to pass the examination to get a license.

In both RX-6 Receivers there is enough space to build-in the RZB-6, the ROTEX 2 meter 6 channels transmitter module with built-in FM modulator, crystal controlled oscillator, 48..... Mc/s, FM modulation, output approx. 0,5 Watt, output imped. 50-70 Ohm. Completely built module, dim. 15x7 cm, exclusive X-tals.
Order no. 06.308.



FREQUENCY COUNTERS RFC-30 AND RFC-250

A professional frequency counter with up to 4 measuring ranges to resp. 30 and 250 Mc/s. Indication by 6 clear 8 mm cipher LEDs. Count- and overflowindication by green and red indicator LED. Max. input voltage 200Vrms, input sensitivity till 10Mc/s better than 250mV. Crystal time base 1 Mc/s. Accuracy ± 1 digit \pm time-base stability. Power supply 220V 50c/s. Dimensions: bxhxd 16x8x25cm Weight: 1,2 kg. Double side plated through epoxy print has been used.
This real quality with 12 months guaranty at the best price possible. A special designed cabinet which can stand upright and with a very handy solution to get rid of the cable when not in use.
THE BEST VALUE FOR MONEY NOT ONLY FOR AMATEURS, BUT ALSO FOR INDUSTRY - SCHOOLS ETC.

RFC-30 £ 85.36
RFC-250 £ 111.07



Terms of Business
Prices are excl. VAT, C.W.O.
Post and packing, add £4.00 per order. Any difference will be credited or charged. Prices are subject to alteration without notice.
All these articles are available at time of going to press. Send your cheque or money order to
ROTEX
P.O. Box 260, Emmen, Holland
Telef. 0031-5910-16810
Telex 53910



£ 51.08
RMZ-8
£ 42.51
RMZ-7

METALDETECTOR

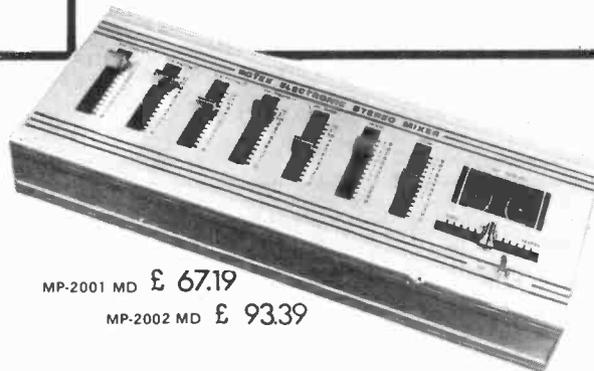
RMZ-7
Order no. 25.057
A simple, reliable water proof, shock proof, well balanced and very light weight treasure finder. Operating according to BFO (Beat Frequency Oscillation) system. With tone signal, built-in loudspeaker and connection for an ear-phone, which is supplied. Operates on a simple 9 Volt battery.
RMZ-8 as the RMZ-7, but with both sensitive signal intensity meter and signal indication.

STEREO MIXERS

MP-2001 MD STEREO MIXER
Order no. 15.068
Your house-sound-studio with the semi-professional ROTEX stereo-mixer.
● 4 stereo-inputs for pick-up, microphone, tuner, taperecorder etc.
● Separate volume control
● Level indication by means of illuminated stereo VU-meter
● Separate controls for treble and bass
● Built-in 220V/50c/s mains supply
● Freq. range 20c/s - 20kc/s $\pm 1,5$ dB
● Output level 0 dB, 600mV, Output 2,5 k Ohms
● 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
Order no. 15.134
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

TRANSDUCERS IN MEASUREMENT AND CONTROL

TRANSDUCERS IN
MEASUREMENT
AND CONTROL

by PETER H SYDENHAM
M.E., Ph.D., M. Inst. M.C., F.I.I.C.A.

This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard textbook.

Written by Peter Sydenham, M.E., Ph.D., M.Inst.M.C., F.I.I.C.A., this publication covers practically every type of transducer and deals with equipment and techniques not covered in any other book.

ETI-UK has obtained a quantity of this fine book, and it is available at present only from us. Send to: Transducers in Measurement and Control, ETI Specials, Electronics Today International, 25-27 Oxford Street, London W1.

£2.75 inc. postage

Enquiries from educational authorities, universities and colleges for bulk supply of this publication are welcomed. These should be addressed to H. W. Moorshead, Editor.

*Now there's a better way
to keep your ETI copies*



We reckon ETI is worth keeping: and our surveys indicate that a staggering 97% of readers keep their copies for at least three months. Now we can offer you a binder which holds 12 issues whose quality befits the magazine: excellent. Send £2.50 (which includes VAT and postage) to:

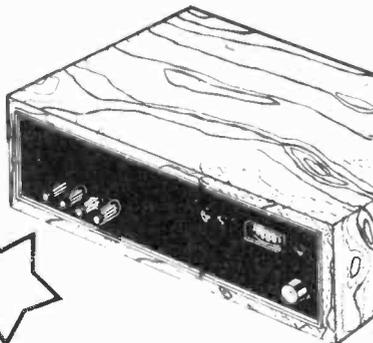
ETI BINDERS, 25-27 OXFORD STREET, LONDON W1R 1RF

DORAM kits

DORAM KITS CONTAIN
EVERYTHING DOWN TO
THE LAST NUT

TV SOUND ONLY TUNER

£36.95
+H



At last you can enjoy the benefit of high quality TV sound. This unit offers a high fidelity alternative to the audio stage of a TV set and is completely independent. The 4-channel push-button Varicap tuner picks up a UHF signal direct from the aerial, the output being suitable for feeding through most hi-fi systems.

SPEC: INPUT: 10µV Typ. for 26dB quieting OUTPUT: 100mV Frequency meter.

£36.95+H VAT (Order code 991-928)

Subject to availability

O'seas orders—add 15% for P+P. All items offered for sale subject to the Terms of Business set out in Doram Edition 3 catalogue, price 60p. The Doram Kit brochure is also available, price 25p. Combined price only 70p which also entitles you to 2 x 25p vouchers, each one usable on any order placed to the value of £5.00 or more (ex. VAT).

DORAM ELECTRONICS LTD., P.O. BOX TR8,
WELLINGTON ROAD INDUSTRIAL ESTATE,
LEEDS LS12 2UF.

An Electrocomponents Group Company

PHILIPS



YOU & PHILIPS HI-FI KITS

**The top sellers for home assembly in
Europe — now available in the U.K.**

Now — read all about the Philips range of quality kits for home assembly — mixers, amplifiers, speakers, etc, etc. Send today to

S.S.T. Distributors (Electronic Components) Ltd.,
West Road, Tottenham, London N17 0RN

Please send me, quickly, the new colour catalogue. ET10

Name _____

Address _____

Postcode _____



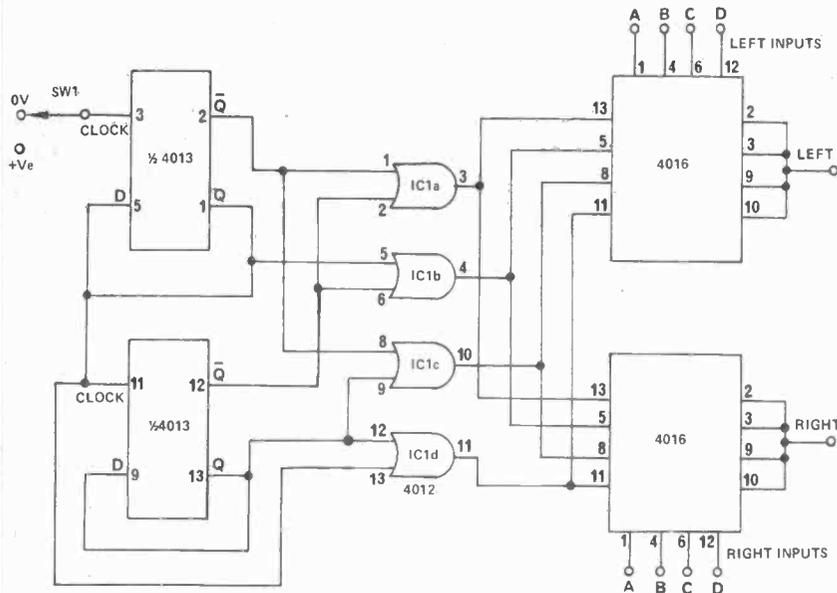
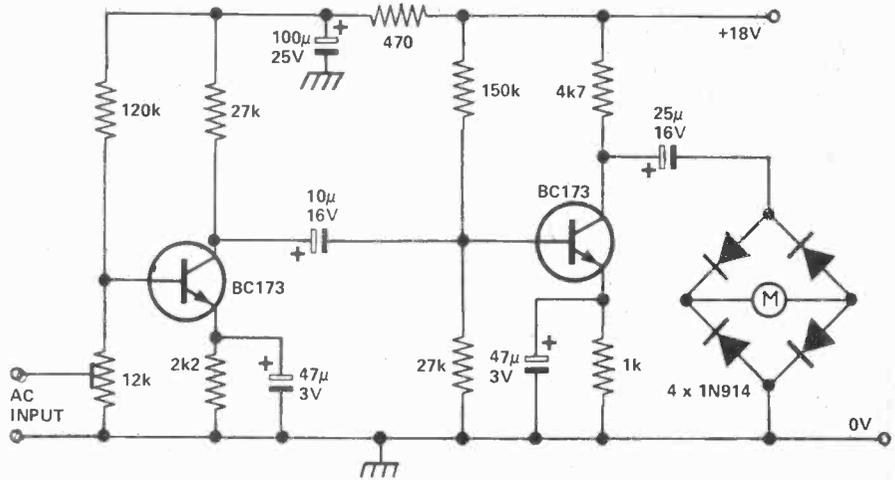
free SEND TODAY!

S.S.T. Distributors is a member of
the Philips Group of Companies.

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

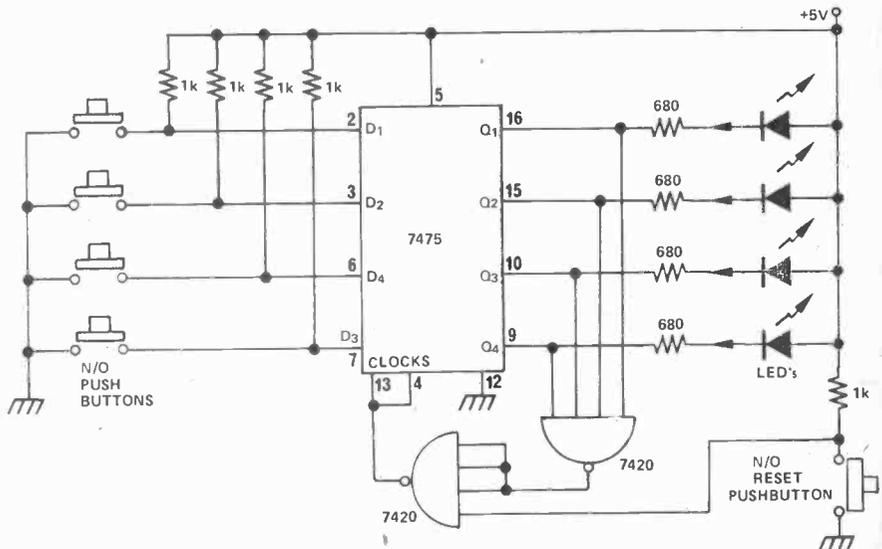
Four different inputs can be switched through by the continual pressing of SW1.

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.



MPU BITS

SC/MP Introk: 256 bytes RAM, 512 byte PROM with KITBUG debugging program, needs TTY device for operation **£92.50**
 SC/MP SCRUMPI: 256 byte RAM, 16 switches, LEDs, and interface chips on 5 1/2" x 6" PCB. Requires simple power supply or batteries **£64.81**
 SC/MP Chip: with data sheet **£18.50**
 ME6800 Kit: Uses 6800 MPU. Requires TTY **£135.00**
 FS Kit: Mostek F8 MPU, requires TTY **£165.00**
 MM2112 256 x 4 bit RAM **£4.30**
 2513 Character Generator, u/c ASCII **£9.00**

HARDWARE

Power Supply: P197 gives 5v at 2A, -5, -12v, suitable for many MPU systems, P197 Kit **£15.50**
 Keyboard Kit: 55 keys, upper/lower case options, KDP 5 Kit **£42.00**
 Printer: 40 column dot matrix printer with interface for parallel ASCII input, PR-40 kit **£225.00**
 Floppy: SA800 or SA801 floppy disk drive, disks and interface, built, not kit **£625.00**
 Minifloppy: SA400 mini disk drive, disks and interface, delivery end of year **£495.00**

BOOKS, DATA

SCRUMPI Data **75p***
 SC/MP Technical Description **£1.95***
 SC/MP Programmers Guide **£6.30**
 6800 Data (Xerox) **75p***
 F8 Data (Xerox) **75p***

(*Free with appropriate kits)

CONSULTANCY

Bywood would be pleased to quote for hardware/software solutions to your design problems.

GET HUNG UP!

Our new range of clock kits is based on designs hundreds of years old. These clock kits use wood, stone and iron to reproduce authentic "olde worlde" wall clocks in full detail. The kits contain all you need including glue, screws, etc., and very comprehensive instructions. This range complements our fully electronic clock kits.



PRICES (All inclusive)	KIT	BUILT
Gothic Clock Kit—Diam. 6 1/2"	£23.95	£36.50
Rotating Dial Kit—Diam. 6"	£19.95	£32.50
Wrought-Iron Kit—Diam. 5 1/2"	£46.35	£69.50
Wooden Wheel Kit—Diam. 6 1/2"	£31.50	£45.25
Knight Clock Kit—Diam. 7 1/2"	£39.50	£62.45
Oak Foliot Kit—Diam. 14"	£89.50	£125.00

(As illustrated)

For coloured Brochure please send 15p stamps. Completed clocks can be seen at our offices.

SCRUMPI

Bywood's evaluation kit for SC/MP. Kit contains MPU chip, 256 x 8 bit RAM, 2 4-bit I/O latches, 24 LED lamps and drivers, 16 data and control switches, all sockets, all associated components, PCB and cable. The switches allow you to program the 256 x 8-bit RAM and then execute the program in that RAM, several operating modes allow for ease of programming and testing. SCRUMPI can be extended to address up to 64K bytes and can easily be interfaced to other RAM, PROM, Keyboard, VDU, Printer, etc. Requires +5, -7v at 200mA **£64.81**

BYWOOD

BYWOOD ELECTRONICS
 68 Ebbens Road
 Hemel Hempstead
 Herts HP3 9QRC
 Tel 0442 62757

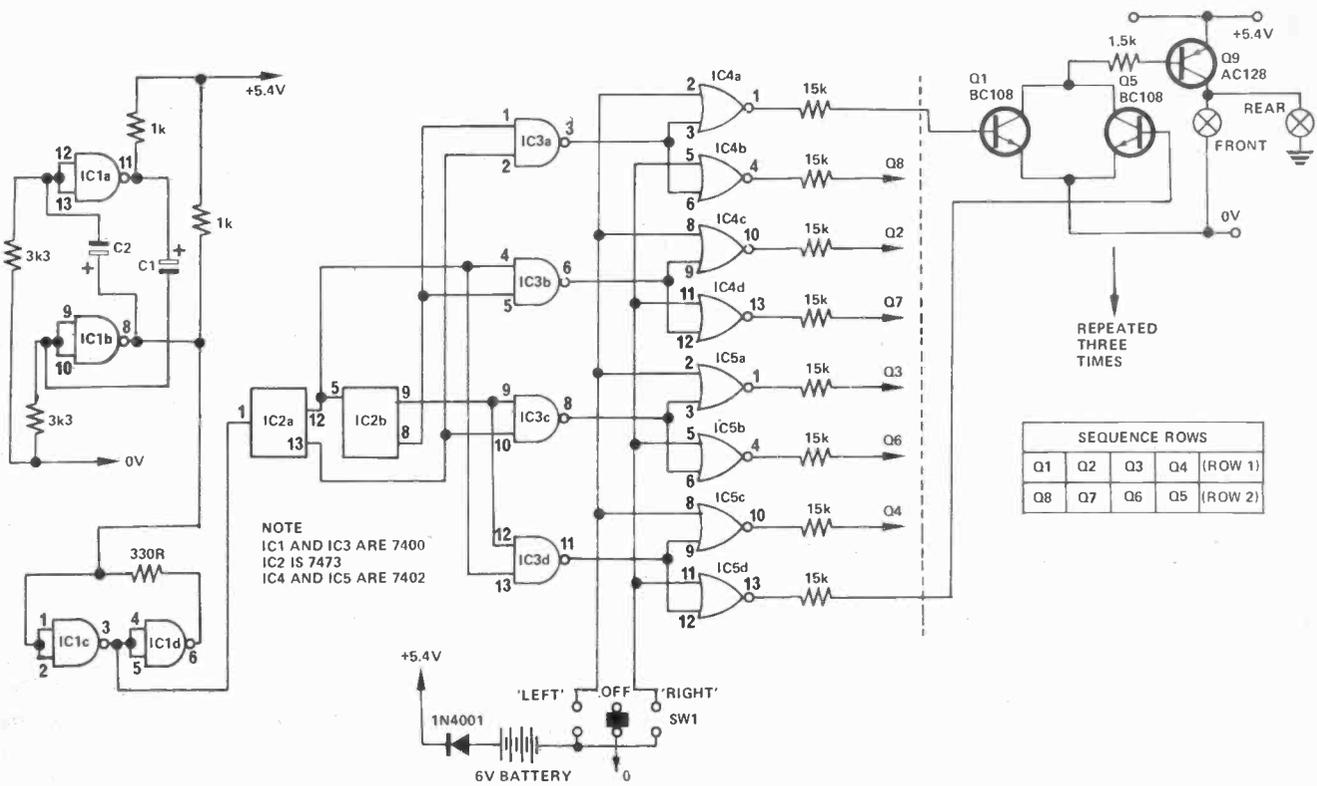
PRICE INCREASES!!

Some prices have already risen, buy now at these old prices before increases due early in 1977.

CLOCK CHIPS		ALL PRICES EXCLUDE VAT AT 8%		DISPLAYS	
NATIONAL					
MM5309 7 seg + BCD with reset	1-9				
MM5311 7 seg + BCD	5 69				
MM5312 7 seg + BCD 4 digit only	5 69	LITRONIX			
MM5313 7 seg + BCD	4 88	DL707, 704, 701	1 48	CLOCK MODULES	
MM5314 7 segment	5 69	DL727, 728, 721	3 75	MA1002F (12 hr) or MA1002H (24 hr) with Alarm and Clk/Rad features	
MM5315 7 seg + BCD with reset	4 88	DL747, 746, 750	2 45	Module only	£7.95
MM5316 Non-imp alarm clock	5 69			MXT101 Transformer	£0.90
MM5318 7 seg + BCD (external digit select)	10 17	LITRONIX CLASS 11 PRODUCTS		Vero Case	£3.00
MM5377 Car clock, crystal controlled, LCD	3 36	DL707E, 704E	0 70	Mod + Tfmr + Case	£11.75
MM5378 Car clock, crystal controlled, LED	8 14	DL727E, 728E	1 80	Complete Kit	£13.00
MM5379 Car clock, crystal controlled, Gas discharge	7 21	DL747E, 750E	1 50		
MOSTEK					
MK50250 Alarm clock (12Hr+60Hz/24Hr+50Hz)	6 73				
MK50253 Alarm clock (12Hr+50Hz 24Hr+50Hz)	6 73	CASES (WITH PERSPEX SCREEN)			
MK50204 Stopwatch/Calculator	14 50	VERO 1 8" x 5 1/2" x 3"	} £2.95 + 25p P&P		
MK50395 UP/DOWN Counter—6 Decade	14 50	VERO 2 6" x 3 1/4" x 2 1/4"			
MK50396 UP/DOWN Counter—HHMMSS	14 50				
MK50397 UP/DOWN Counter—MMSS 99	14 50				
CALTEX					
CT7001 Alarm/calender 7 segment	9 00			MHI DISPLAY KITS	
CT7002 Alarm/calender BCD	9 00	MHI-707/4 (digit) 0.3"	1-9	MHI-727/6 0.5"	12.00
CT7003 Alarm/calender 7 seg Gas discharge	9 00	MHI-707/6 0.3"	6 60	MHI-747/4 0.6"	9 80
CT7004 Alarm/calender 7 seg	9 00	MHI-727/4 0.5"	9 50	MHI-747/6 0.6"	14.70
GENERAL INSTRUMENTS					
AX5-1202 4 digit 7 seg	4 76	PAYMENT TERMS			
AY5-1230 on-off -- alarm, 7 seg	5 25	Cash with order. Access, Barclaycard (simply quote your number and sign). Credit facilities to accredited account holders. Pro-forma invoices can be issued.			
MHI CLOCK KITS					
MHI-5309	1 9	MHI-50396	19 50		
MHI-5311	7 35	MHI-50397	19 50		
MHI-5314	7 35	MHI-7001	13 00		
MHI-5318	6 60	MHI CASE Please include 25p post + packing)	2 95		
MHI-5378	7 35	SOCKETS			
MHI-50250	15 10	18 pin	0 60		
MHI-50253	8 35	24, 28 or 40 pin	0 60		
MHI-50204	8 35	Soldercon strip sockets	0 30		
MHI-50395	14 00				
	19 50				

BYWOOD

BYWOOD ELECTRONICS
 68 Ebbens Road
 Hemel Hempstead
 Herts HP3 9QRC
 Tel 0442 62757



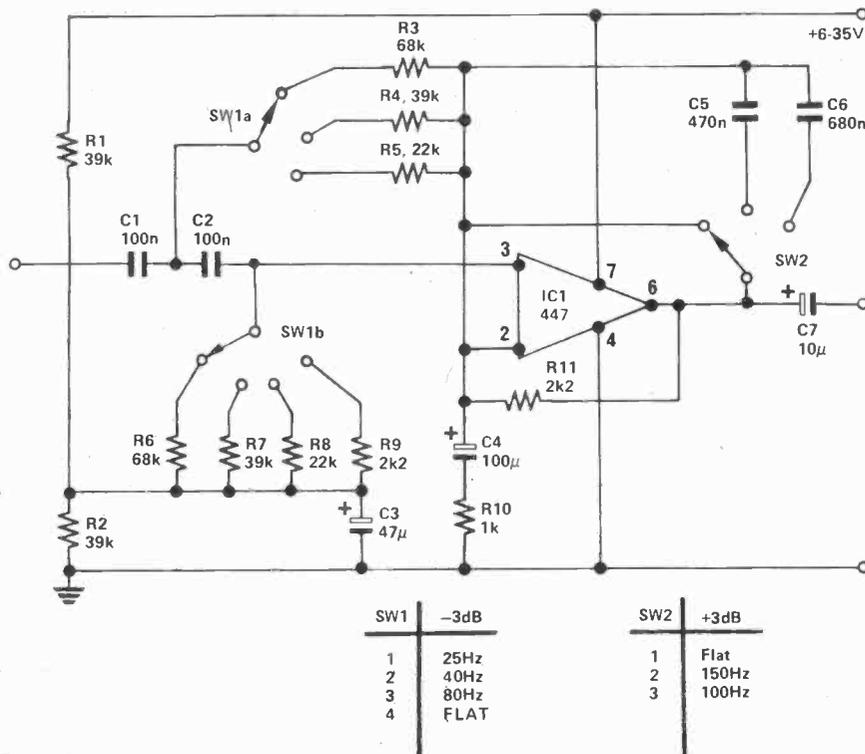
NOVEL INDICATORS

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.



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.

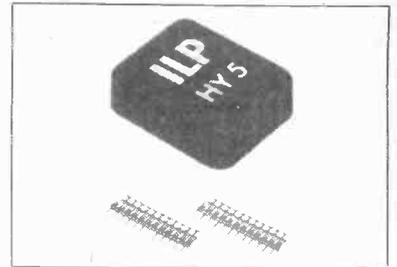
SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV, Ceramic Pick-up 30mV, Tuner 100mV, Microphone 10mV, Auxiliary 3-100mV, input impedance 47k Ω at 1kHz
OUTPUTS: Tape 100mV, Main output 500mV R.M.S.

ACTIVE TONE CONTROLS: Treble \pm 12dB at 10kHz, Bass \pm at 100Hz
DISTORTION: 0.1% at 1kHz, Signal/Noise Ratio 68dB

OVERLOAD: 38dB on Magnetic Pick-up. SUPPLY VOLTAGE: \pm 16 50V

Price **£4.75 + 59p VAT P&P free**



HY30 15 Watts into 8 Ω

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 8 Ω , DISTORTION 0.1% at 15W
INPUT SENSITIVITY 500mV, FREQUENCY RESPONSE 10Hz-16kHz — 3dB
SUPPLY VOLTAGE: \pm 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 8 Ω

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 8 Ω LOAD IMPEDANCE 4-16 Ω , DISTORTION 0.04% at 25W at 1kHz

SIGNAL/NOISE RATIO 75dB, FREQUENCY RESPONSE 10Hz-45kHz — 3dB

SUPPLY VOLTAGE: \pm 25V, SIZE 105 50 25mm

Price **£6.20 + 77p VAT P&P free.**



HY120 60 Watts into 8 Ω

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:

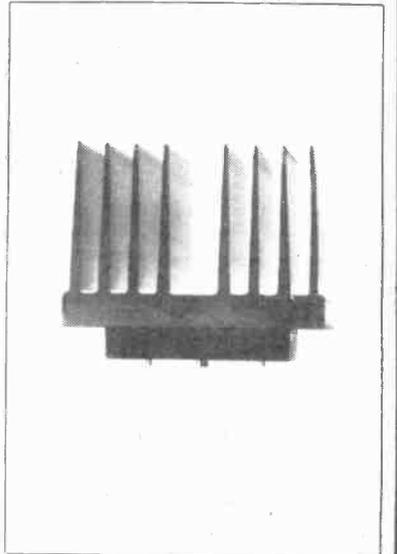
INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8 Ω , LOAD IMPEDANCE 4-16 Ω , DISTORTION 0.04% at 60W at 1 kHz

SIGNAL/NOISE RATIO 90dB, FREQUENCY RESPONSE 10Hz-45kHz — 3dB, SUPPLY VOLTAGE: \pm 35V

SIZE 114x50x85mm

Price **£14.40 + £1.16 VAT P&P free.**



HY200 120 Watts into 8 Ω

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 8 Ω , LOAD IMPEDANCE 4-16 Ω , DISTORTION 0.05% at 100W at 1kHz

SIGNAL/NOISE RATIO 96dB, FREQUENCY RESPONSE 10Hz-45kHz — 3dB, SUPPLY VOLTAGE: \pm 45V

SIZE 114 100 85mm

Price **£21.20 + £1.70 VAT P&P free.**

HY400 240 Watts into 4 Ω

The JY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

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

APPLICATIONS: Public address — Disco — Power slave — Industrial

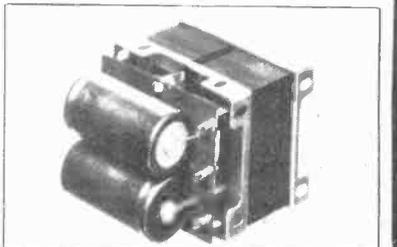
SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4 Ω , LOAD IMPEDANCE 4-16 Ω , DISTORTION 0.1% at 240W at 1 kHz

SIGNAL/NOISE RATIO 94dB, FREQUENCY RESPONSE 10Hz-45kHz — 3dB, SUPPLY VOLTAGE: \pm 45V

INPUT SENSITIVITY 500mV, SIZE 114 x 100 x 85mm

Price **£29.25 + £2.34 VAT P&P free.**



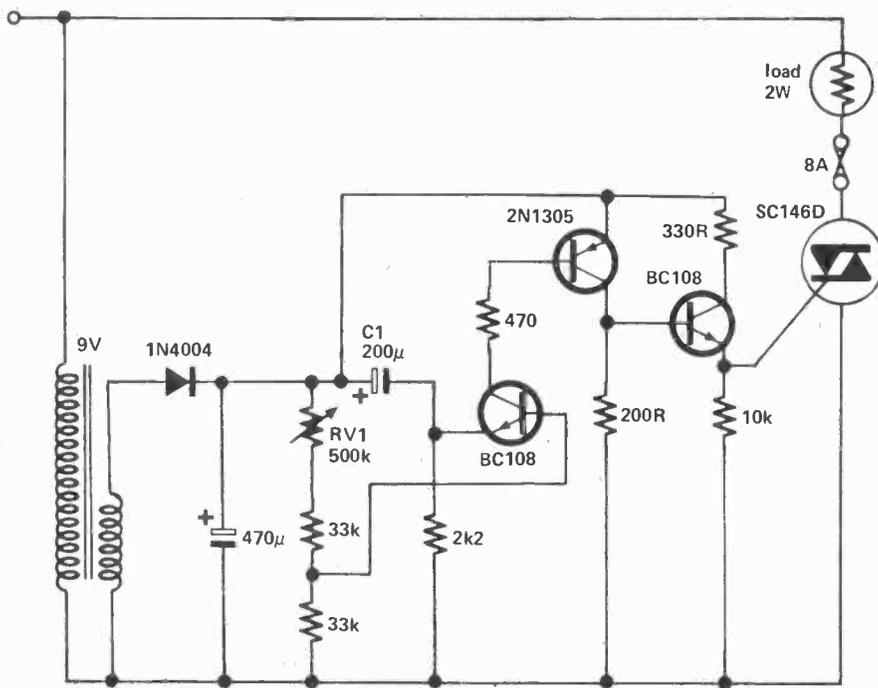
POWER SUPPLIES

PSU35 suitable for two HY30 s **£4.75** plus 59p VAT P. P free
PSU50 suitable for two HY50 s **£6.20** plus 77p VAT P. P free
PSU70 suitable for two HY120 s **£12.50** plus 1.00 VAT P. P free
PSU90 suitable for one HY200 **£11.50** plus 92p VAT P. P free
PSU180 suitable for two HY200 s or one HY400 **£21.00** plus 1.68 VAT P. P free

TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS

I.L.P. Electronics Ltd
Crossland House
Nackington, Canterbury
Kent CT4 7AD
Tel (0227) 63218

Please Supply _____
Total Purchase Price _____
I Enclose Cheque Postal Orders Money Order
Please debit my Access account Barclaycard account
Account number _____
Name & Address _____
Signature _____



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.

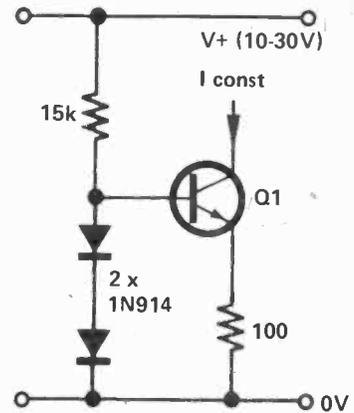


Fig. 1

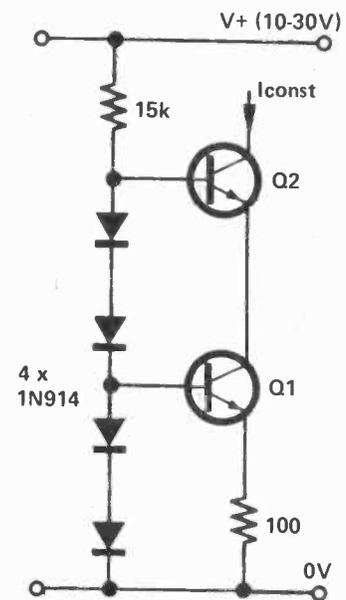
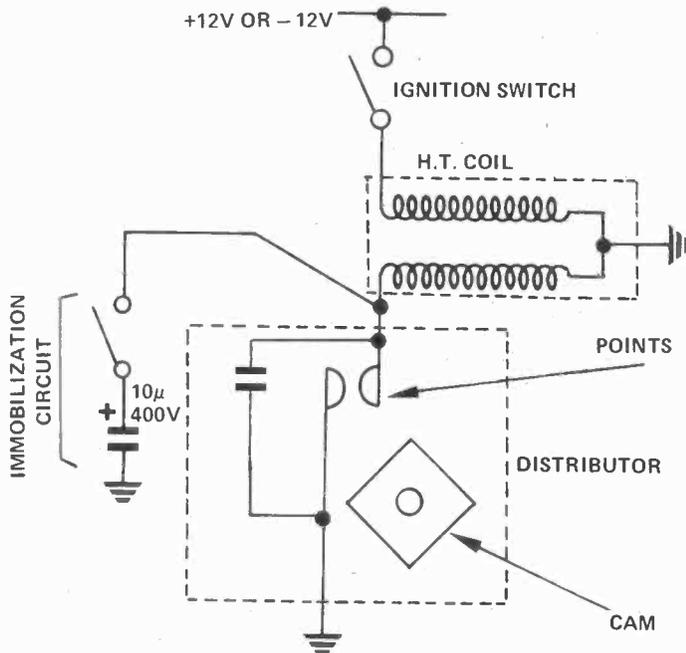


Fig. 2

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.



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 bypassed using 'jumper' leads.

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

Hi-Fi Systems that *GROW* with you

At last someone has come up with a flexible approach to quality hi-fi that doesn't become obsolete as you become more discerning.

Take an initial standard 20W r.m.s. + 20W r.m.s. stereo and with simple modifications this can be expanded to give a powerful 40W + 40W stereo system together with additional multi frequency rumble, hiss and stereo image width controls.

Currently available from stock:— Stereo Pre-Amp Module CP-P1

- * 2 channel pre-amplifier.
- * Ideal for use with record player, tape, microphone, tuner inputs etc.
- * No external components required other than potentiometers for bass, treble, balance, volume controls and input selector switch.
- * The CP-P1 is internally protected against accidental reverse power connection.

PRICE **£13.30**
+ £1.66 VAT



Specification

Input	Sensitivity	Signal/Noise	Impedance
Magnetic	3mV	>70dB	47kΩ
Tuner	100mV	>70dB	10kΩ
Tape	100mV	>70dB	10kΩ
Auxiliary	1-100mV	60dB-70dB	200kΩ

Magnetic i/p overload: 33dB;
Distortion: 0.04% at 1kHz;
Output: 1V r.m.s. into 10kΩ;
Supply voltage: ± 18V nominal;
Tone controls: Bass ±12dB at 100Hz,
Treble ±12dB at 10kHz.

Stereo Amplifier Module CP2-15-20

- * The CP2-15-20 is designed to give either a 20W + 20W stereo amplifier or alternatively a 40W single channel amplifier.
- * No external components required.
- * Safety features include built-in protection against accidental reverse power connection and thermal shut down facility to prevent over dissipation.

Specification:

Power output:
40W r.m.s. into 8Ω, 1 channel; or
30W r.m.s. into 15Ω, 1 channel; or
20W r.m.s. + 20W r.m.s. into 4Ω, 2
channel; or
15W r.m.s. + 15W r.m.s. into 8Ω, 2
channel.
Input sensitivity: 1V r.m.s.; Frequency
response: 20Hz-20kHz, at -3dB; Distortion: 0.04% at 15W; Supply Voltage:
± 18V nominal; Size: 5-1 x 4 x 1-25in.
(130 x 102 x 32mm).

PRICE **£12.85** + £1.61 VAT



Also available:—

Audio Function Module CP-FG1

For those requiring a wider range of facilities this module provides:—

- * Bass and treble filter controls including switchable cut-off frequencies for rumble and hiss reduction
- * Stereo separation control.
- * Complete except for switches and potentiometers.

PRICE **£11.75**
+ £1.47 VAT

Power supply: Module CP-PS 18/2D

Suitable for one 20W + 20W complete system. A 40W + 40W system can be produced using 2 power supplies.

PRICE **£5.75** + 72p VAT

These products carry a 2-year guarantee

Cliffpalm Ltd.

DEPT. HF/ETI
13 HAZELBURY CRESCENT
LUTON, BEDS. LU1 1DF

Prices include full
application data,
post and
packaging.

Please rush me
I enclose a cheque/postal order crossed and made payable to
Cliffpalm Limited for: £

NAME _____
ADDRESS _____

complete DIGITAL CLOCK KITS TEAK CASES

prompt order despatch



NON ALARM **£10.65** VAT + £0.85

ALARM **£13.43** + £1.07

including P&P

"DELTA"

GENUINE TEAK OR PERSPEX CASE

DELTA DATA: 4 Radiant Red 1/2 inch high LEDs. 12 hr display with AM/PM indication. Beautiful Burma Teak Case or Pretty Perspex in White, Black, Blue, Red, Green. Power failure is indicated by flashing display.

MODULES: Kits can be bought without case Non Alarm £9.00
Alarm £12.50 incl.

READY BUILT: Buy a working tested module and fit your own case
Non Alarm £9.50. Alarm £13.00. Or put it with our case parts @
£4.32 and save on complete clock price.
Complete Clock ready built. 2 yr. guarantee. Non Alarm £13.50.
Alarm £16.50

ALARM FEATURES: Pulsed tone. Tilt operated 10 minute 'Snooze' period. Single switch setting. Optional extra mercury switch (45p) allows Alarm reset by tilting clock. Digit brightness is automatically controlled to suit lighting level.

"ALPHA" CHRISTMAS OFFER

4 Glowing Green 1/2" High Digits
12 or 24 hr. Non Alarm
Built & Tested Module - Plus Perspex Case **£11.00** incl.

Send payment with order. S.a.e. for complete range of clocks, calculators & components



PULSE ELECTRONICS LTD.

DEPT. E3, 202 SHEFFORD ROAD
CLIFTON, SHEFFORD, BEDS.
Telephone: Hitchin (0462) 814477

NEW FROM AMERICA

SUPERBLY STYLED QUALITY LIQUID CRYSTAL DISPLAY WATCHES FROM FAIRCHILD



TIMEBAND 5 + 4 functions. CONTINUOUS READOUT of Hours, Minutes and pulsating Seconds. Single Command button; push once for Month/Date — auto reset to time, twice for Seconds — continuous run until reset.

* PLUS automatic 28, 30, 31 day calendar. Backlight for night-time. Optional continuously alternating Time/Date display. AM/PM setting indicator.



High contrast LCD display visible in bright sunlight. The best looking watches we have seen under £100. Fairchild LCDs sell in jewellers' shops for up to £80.

TC 411 Base Metal/Stainless Steel **£29.50**
TC 410 Gold Plated **£32.50**
On Leather Strap

TC 413 Base Metal/Stainless Steel **£34.50**
TC 412 Gold Plated **£37.50**
Matching adjustable bracelet

We now stock the superb CASIO Casiotron LCD watches. Arguably the best watch in the world. Prices from **£44.95 to £99.95**.

We also stock the full range of IBICO LCDs. Prices from **£44.50** and OPTIM quality jeweller's L.E.D. watches. Send for details. Large s.a.e. or stamp appreciated.

No moving parts to wear out, clean or oil. Accuracy to a very few secs/month. We believe our prices are the lowest anywhere and INCLUDE VAT at 8% and P. & P. Free battery/s. No quibble one year guarantee. Offers subject to availability.

Send cheque / money order to:

TEMPUS

Talk of the Town
21 Fitzroy Street, Cambridge
CB1 1EH
Telephone: Cambridge (0223) 312866

A LOT OF TIME FOR THE MONEY

CREED 5 LEVEL COMBINED PRINTER AND PERFORATOR NEW CRATED £35 each

**CREED 5 LEVEL
PAPER TAPE READER
£25 each**

**CREED 7B
TELEPRINTER CRATED
£40 each**

£5 discount on any pair plus FREE carriage. Otherwise £2.50 carriage each item.

**MARCONI TF675F
WIDE RANGE
PULSE GENERATOR**
+/- variable outputs up to 50V
Optional delay. Small compact unit.

£22.50 each

**COMPRESSOR/
VACUUM PUMP**
Twin Cylinder opposed with Integral
1/2 H.P. 220/110V 50HZ Single Phase
Motor. Tested

Now only
£17.50 each

**MARCONI NOISE
GENERATOR
TF987/1**
4 ranges 0-5, 0-10
0-15, 0-30

ONLY £17.50 each

**PRECISION SIGNAL
GENERATOR**
Type 62 Covers
95-160 mHZ

Recommended
£15 each

HAPPY NEW YEAR TO ALL OUR CUSTOMERS

and to help you on your way we give you a **10%** discount on all orders over
£25 until Jan. 31st. 1977

TRANSFORMERS — All 240V 50HZ inputs

Type A. 170-17V 250 MA. 7.5-0-7.5V 250MA; 0-20V 5 Amps. 0-4V 5 Amps; 0-1-1.5V 5 Amps. **£2 each. P&P £1.25**
Type B 17-0-17V 250MA; B-0-8V 250MA; 0-12.5-13.5V 5 Amps; 0-1.5-2V 5 Amps. **£1.50 ea. P&P £1**
Type C 19-0-19V 250MA; B-0-8V 250MA; 0-7.5V 5 Amps; 0-1.4V 5 Amps. **£1.25 ea. P&P £1.25**
Type E 3V 1 Amp. **25p ea. P&P 50p**
Type G 20-0-20V 200MA. 0-6V 100MA. **75p ea. P&P 75p**. Atlantic series.
All Brand New (APT surplus types A, B, C Honeywell surplus type E, Recordacall surplus type F, Parmeko Atlantic Series type G).

ONLY £10 EACH

Stabilised Power Supply. 240V 50HZ input. Outputs — 15V @ 10A, +15V @ 4A — 4.5V @ 12A — 21.5V @ 15A. Size 16 x 20 x 9". Auto overload trips on each voltage rail with push button resets. Many OTHER POWER SUPPLIES — call and see.

*POT PACK. All Brand New Modern. Single and Ganged, our choice. **7 for 25p. P&P 48p.**

SEMICONDUCTORS — All at **8p ea.** P&P extra. Guaranteed all full spec. devices. Manufacturer's markings.

BC147, BC158, 2N3707, BC107, BF197, BC327, 2N4403, BC172B, BC261B, BC251B, BC348B, BC171A/B, 2N3055RCA **50p ea. P&P 8p**
2N5879 with 2N58B1 Motorola 150 Watt. Comp. pair **£2 pr. P&P 15p**
*Linear Amp 709 **25p ea. P&P 8p**

FOR THE VDU BUILDER. New stock of Large Rectangular Screen 30 x 20cm tube Type M3B at the ridiculous price of **£4 ea.** And also still available the CME1220, 24 x 15cm at **£9 ea.**

VARIACS 240V input 0-270V output.
B Amp **£18 ea.** 20 Amp **£30 ea.** Carr. extra.

BNC Plug to BNC Plug lead. assembled ready to use **75p ea. P&P 20p.**
Ex-req. BNC Socket **15p.** BNC Plug **20p.** BNC Plug & Socket **30p pair.** P&P 15p.

TUBES. All Brand New Boxed Electrostatic deflection.
Type 40BA 1 1/2" dia., 7 1/2" long. Blue Trace **£2.50 ea. P&P 75p**
Type CV1526 (3EG1) 3" dia. **£3. P&P £1**
Type DB7/36 3" dia. (Replacement for Teleguipment S31) **£12 ea. P&P £1.50.**
Type 5BVP1 5" dia. PDA. X, Y Low Capacitance Side Pins. Green Trace **£5 ea. P&P £1.50.**
Type GEC 924F 3 1/2" dia. (Replacement for Teleguipment D33 & Solartron 1016 scopes) **£30 ea. P&P £1.50.**
Type GEC 924E 3 1/2" dia. (Replacement for Solartron 1015 scope) **£20 ea. P&P £1.50.**

NEW — UPGRADED CONTENTS — FOR LESS MONEY
*31b Electronic Goodies **£1.60 post-paid.**
*High Value Printed Board Pack — hundreds of components, transistors, etc. — no flat to the board transistors **£1.65 post-paid.**

VERY SPECIAL PRICES
*1000F Feed thru Capacitors **10 for 30p. P&P 15p.**

*BEEHIVE TRIMMERS 3/30pf. BRAND NEW
10 off **40p** P&P 15p; 100 off **£3.50** P&P 75p; 500 off **£15** P&P £1.25; 1,000 off **£25** P&P £1.50

MARCONI TF142F DISTORTION FACTOR METER giving percentage distortion on a directly calibrated dial and includes all spurious components up to 30KHZ **£37.50 ea.**
AVO TRANSISTOR ANALYSER CT446 **£30 ea.**
MARCONI PORTABLE FREQUENCY METER TF1026/11. 100 to 160MHZ. Very fine condition. Sorry, now **£27.50 ea.**
DECCA NAVIGATOR DISPLAY UNIT. Very impressive. **£12.50 ea.**

HIVAC Miniature NEONS
App 60V. Brand New. **10 off 20p.**
P&P extra.
*Meter PACKS — 3 different meters **£2, P&P £1.**

DON'T FORGET YOUR MANUALS. S.A.E. with requirements.
GRATICULES 12 x 14 cm high quality plastic **15p ea. P&P 10p.**
*CAPACITOR Pack. 50 Brand New components, only **50p. P&P 48p.**
*TRIMMER PACK. All Brand New. 2 Twin 50/200pf ceramic; 2 Twin 10/60pf ceramic; 2 min. strips with 4 preset 5/20pf on each; 3 air spaced preset 30/100pf on ceramic base **25p the lot, P&P 15p.**
RESETTABLE COUNTERS. 4 digit by Stonebridge/Sodeco 1000ohm coil **£2 ea. P&P 35p.**

*POTENTIOMETERS — All **5p ea. P&P** extra. Metal bodied AB Linear. PCB Mount. Brand New. 10K single; 100K ganged, 250K ganged; 100K ganged, concentric shafts.

FIBREGLASS BOARD PACK. More board — less money. Larger pieces. Not less than 2.5 sq. ft. for **95p. P&P 65p.** Double or single sided cut to any size. New Lower Price **1p per sq. in.** P&P extra

LARGE RANGE ELECTROSTATIC VOLTMETERS, from 0-300V 2" **£3;** to 250KV Max. General guide 5KV 3 1/2" **£5;** thereafter **£1** per KV. P&P 75p.

MARCONI TF1101 Audio Oscillator. 20c/s to 200kc/s. Low distortion. 60dB step attenuator **£50 each.**

MUFFIN FANS 230 volt. Size 5 x 5 x 1 1/2". Superbly quiet and reliable. Ex-req. but tested **£2.50. P&P 75p.**

*SPECIAL OFFER
Guaranteed full spec. devices. Manufacturers markings.
BC 204 & BC 207A **4p ea. P&P extra.**

*TELEPHONES
Post Office Style 746. Black or two-tone Grey **£6.50 ea.**
Modern Style 706 Black or two-tone Grey **£4.60 ea.**
older BLACK Style **£1.50 ea.**
All telephones complete with standard dial and bells. P&P all styles 75p ea. Handsets, complete with 2 inserts and lead **£1.75 ea. P&P 65p.**

ROYAL INVERTORS manufactured USA. 2BV DC input. Output 115V AC 400HZ up to 2KVA. Brand new. Crated **£12.50 each.**

HONEYWELL MAGNETIC TAPE UNITS

Self-contained, complete with heads, magnetic tape, leads, etc.
Tested. Carriage paid **£65 each.**

NOW AVAILABLE

Various punches, tape reader, low voltage power supplies, card frame, modular cases, etc. Lists available

Minimum Mail Order **£2.** Excess postage refunded

Unless stated — please add **£2.50** carriage to all units

VALUE ADDED TAX not included in prices — Goods marked with **★ 12 1/2 % VAT,** otherwise **8 %**
Official Orders Welcomed. Gov./Educational Depts., Authorities, etc., otherwise Cash with Order

Open 9 a.m. to 5.30 p.m., Mon. to Sat.



CHILTMHEAD LTD



7/9 ARTHUR ROAD, READING, BERKS. (rear Tech. College, King's Road). Tel. Reading 582605

MINI-ADS & CLASSIFIED

THIS SECTION IS A PRE-PAYMENT SERVICE ONLY
MINIADS: 3 1/4" x 2 1/8" (1-3) £26 (4-11) £23 (12 or more) £22 per insertion. **CLASSIFIED DISPLAY:** £3.50 per single column centimetre. **SEMI-DISPLAY:** £2.70 per single column centimetre. **LINEAGE:** 75p per line average six words, minimum 3 lines. **BOX NO.:** allow 60p extra.
Contact: BOB EVANS (01-437 5982), 25-27 Oxford Street, London W1R 1RF.

VALVES

Radio — TV — Industrial — Transmitting
 We dispatch Valves to all parts of the world by return of post, air or sea mail, 2700 Types in stock. 1930 to 1976. Obsolete types a speciality List 20p. Quotation S.A.E. Open to callers Monday to Saturday 9.30 to 5.00 Closed Wednesday 1.00 We wish to purchase all types of new and boxed Valves
Cox Radio (Sussex) Ltd., Dept. E.T.I., The Parade, East Wittering, Sussex PO20 8BN. West Wittering 2023 (STD Code 024366).

FREE TV CIRCUIT DIAGRAMS

All main British TV sets (plus many foreign) comprehensively covered in our easy-to-follow TV Repair Manuals — 4 mono and 3 colour.
 Just send Model No., if colour (mfrs. chassis type helps) with **£4.50** and receive the manual covering your set — plus your set's circuit diagram on request free. Set of 7 only **£27.50**.

British TV Circuit Diagram Manuals — the main mono (over 37 series) for **£9.90** and virtually every colour for **£17.50**.

Full details of these and other publications from:

T.V. TECHNIC (ETI)

76 Church Street, Larkhall, Lanarks, ML9 1HE
 Tel. (0698) 883334

PRECISION POLYCARBONATE CAPACITORS

All High Stability — Extremely Low Leakage

400V AC RANGE: DIMENSIONS VALUE (µF)	D	PRICE EACH	63V	100V	150V	250V	350V	500V
0.1µF	27	12.7	86p	0.47µF	£1.32	77p	31p	
0.22µF	33	16	86p	1.0µF	£1.36	91p	60p	
0.25µF	33	16	92p	2.2µF	£1.98	£1.32	75p	
0.47µF	33	19	£1.10	4.7µF	£2.82	£1.88	£1.23	
0.5µF	33	19	£1.16	6.8µF	£3.48	£2.32	£1.47	
0.68µF	50.8	19	£1.25	10µF	£4.98	£3.32	£2.01	
1.0µF	50.8	19	£1.37	15µF	£7.14	£4.76	£2.88	
2.0µF	50.8	25.4	£1.95	22µF	£9.66	£6.44	£3.90	

ALL ALUM BEAD CAPACITORS — Values available 0.1, 0.22, 0.47, 1.0, 2.2, 4.7, 6.8, 10µF at 15V, 25V or 35V; 10µF at 16V, 20V or 25V; 22.0µF at 6V or 16V, 33.0µF at 6V or 10V, 47.0µF at 3V or 6V, 100.0µF at 3V. All at 12p each, 10 for £1.10, 50 for £5.00, 100 for £9.00.

TRANSISTOR & IC'S	BC267	12p	OC44	OC45	20p	
AC128	14p	BC268A	10p	OC71	72	20p
AC176	16p	BC547	558A	12p	2N2926G	12p
AD149	40p	BCY72	15p	2N2926Y	11p	
AF178	40p	BD131	132	39p	2N2926D	11p
AF239	38p	BF115	167	22p	2N3054	50p
BC107 8 9	4p	BF173	24p	2N3055	30p	
BC114	12p	BF178	26p	2N3702		
BC147 8/9	10p	BF184	12p	3704	11p	
BC153	16p	BF194	195	12p	TIP30A	32p
BC157 8 9	12p	BF196	197	13p	TIP31A	35p
BC177	16p	BF200	27p	TIP32A	64p	
BC182 182L	11p	BF262	263	60p	TIP3055	65p
BC183 183L	11p	BFY50	51	52	MPL131	49p
BC184 184L	12p	BFX84	86	88	NE555	61p
BC212 212L	12p	BFX85	25p	741 8 pin	32p	
BC213/213L	11p	BR101	41p	ZN414	£1.13	
BC214/214L	11p	GET872	25p	SN76013ND	£1.50	

POPULAR DIODES — IN914 8p, 8 for 35p, 18 for 90p; IN118 8p, 6 for 45p, 14 for 90p; 1N4148 3p, 11 for 30p, 26 for £1.00; 1N4148 3p, 6 for 27p, 12 for 40p; 1N4001 3p, 002 6p; 003 6p; 004 7p; 006 6p; 007 8p; 008 8p; 009 8p; 010 8p; 011 8p; 012 8p; 013 8p; 014 8p; 015 8p; 016 8p; 017 8p; 018 8p; 019 8p; 020 8p; 021 8p; 022 8p; 023 8p; 024 8p; 025 8p; 026 8p; 027 8p; 028 8p; 029 8p; 030 8p; 031 8p; 032 8p; 033 8p; 034 8p; 035 8p; 036 8p; 037 8p; 038 8p; 039 8p; 040 8p; 041 8p; 042 8p; 043 8p; 044 8p; 045 8p; 046 8p; 047 8p; 048 8p; 049 8p; 050 8p; 051 8p; 052 8p; 053 8p; 054 8p; 055 8p; 056 8p; 057 8p; 058 8p; 059 8p; 060 8p; 061 8p; 062 8p; 063 8p; 064 8p; 065 8p; 066 8p; 067 8p; 068 8p; 069 8p; 070 8p; 071 8p; 072 8p; 073 8p; 074 8p; 075 8p; 076 8p; 077 8p; 078 8p; 079 8p; 080 8p; 081 8p; 082 8p; 083 8p; 084 8p; 085 8p; 086 8p; 087 8p; 088 8p; 089 8p; 090 8p; 091 8p; 092 8p; 093 8p; 094 8p; 095 8p; 096 8p; 097 8p; 098 8p; 099 8p; 100 8p; 101 8p; 102 8p; 103 8p; 104 8p; 105 8p; 106 8p; 107 8p; 108 8p; 109 8p; 110 8p; 111 8p; 112 8p; 113 8p; 114 8p; 115 8p; 116 8p; 117 8p; 118 8p; 119 8p; 120 8p; 121 8p; 122 8p; 123 8p; 124 8p; 125 8p; 126 8p; 127 8p; 128 8p; 129 8p; 130 8p; 131 8p; 132 8p; 133 8p; 134 8p; 135 8p; 136 8p; 137 8p; 138 8p; 139 8p; 140 8p; 141 8p; 142 8p; 143 8p; 144 8p; 145 8p; 146 8p; 147 8p; 148 8p; 149 8p; 150 8p; 151 8p; 152 8p; 153 8p; 154 8p; 155 8p; 156 8p; 157 8p; 158 8p; 159 8p; 160 8p; 161 8p; 162 8p; 163 8p; 164 8p; 165 8p; 166 8p; 167 8p; 168 8p; 169 8p; 170 8p; 171 8p; 172 8p; 173 8p; 174 8p; 175 8p; 176 8p; 177 8p; 178 8p; 179 8p; 180 8p; 181 8p; 182 8p; 183 8p; 184 8p; 185 8p; 186 8p; 187 8p; 188 8p; 189 8p; 190 8p; 191 8p; 192 8p; 193 8p; 194 8p; 195 8p; 196 8p; 197 8p; 198 8p; 199 8p; 200 8p; 201 8p; 202 8p; 203 8p; 204 8p; 205 8p; 206 8p; 207 8p; 208 8p; 209 8p; 210 8p; 211 8p; 212 8p; 213 8p; 214 8p; 215 8p; 216 8p; 217 8p; 218 8p; 219 8p; 220 8p; 221 8p; 222 8p; 223 8p; 224 8p; 225 8p; 226 8p; 227 8p; 228 8p; 229 8p; 230 8p; 231 8p; 232 8p; 233 8p; 234 8p; 235 8p; 236 8p; 237 8p; 238 8p; 239 8p; 240 8p; 241 8p; 242 8p; 243 8p; 244 8p; 245 8p; 246 8p; 247 8p; 248 8p; 249 8p; 250 8p; 251 8p; 252 8p; 253 8p; 254 8p; 255 8p; 256 8p; 257 8p; 258 8p; 259 8p; 260 8p; 261 8p; 262 8p; 263 8p; 264 8p; 265 8p; 266 8p; 267 8p; 268 8p; 269 8p; 270 8p; 271 8p; 272 8p; 273 8p; 274 8p; 275 8p; 276 8p; 277 8p; 278 8p; 279 8p; 280 8p; 281 8p; 282 8p; 283 8p; 284 8p; 285 8p; 286 8p; 287 8p; 288 8p; 289 8p; 290 8p; 291 8p; 292 8p; 293 8p; 294 8p; 295 8p; 296 8p; 297 8p; 298 8p; 299 8p; 300 8p; 301 8p; 302 8p; 303 8p; 304 8p; 305 8p; 306 8p; 307 8p; 308 8p; 309 8p; 310 8p; 311 8p; 312 8p; 313 8p; 314 8p; 315 8p; 316 8p; 317 8p; 318 8p; 319 8p; 320 8p; 321 8p; 322 8p; 323 8p; 324 8p; 325 8p; 326 8p; 327 8p; 328 8p; 329 8p; 330 8p; 331 8p; 332 8p; 333 8p; 334 8p; 335 8p; 336 8p; 337 8p; 338 8p; 339 8p; 340 8p; 341 8p; 342 8p; 343 8p; 344 8p; 345 8p; 346 8p; 347 8p; 348 8p; 349 8p; 350 8p; 351 8p; 352 8p; 353 8p; 354 8p; 355 8p; 356 8p; 357 8p; 358 8p; 359 8p; 360 8p; 361 8p; 362 8p; 363 8p; 364 8p; 365 8p; 366 8p; 367 8p; 368 8p; 369 8p; 370 8p; 371 8p; 372 8p; 373 8p; 374 8p; 375 8p; 376 8p; 377 8p; 378 8p; 379 8p; 380 8p; 381 8p; 382 8p; 383 8p; 384 8p; 385 8p; 386 8p; 387 8p; 388 8p; 389 8p; 390 8p; 391 8p; 392 8p; 393 8p; 394 8p; 395 8p; 396 8p; 397 8p; 398 8p; 399 8p; 400 8p; 401 8p; 402 8p; 403 8p; 404 8p; 405 8p; 406 8p; 407 8p; 408 8p; 409 8p; 410 8p; 411 8p; 412 8p; 413 8p; 414 8p; 415 8p; 416 8p; 417 8p; 418 8p; 419 8p; 420 8p; 421 8p; 422 8p; 423 8p; 424 8p; 425 8p; 426 8p; 427 8p; 428 8p; 429 8p; 430 8p; 431 8p; 432 8p; 433 8p; 434 8p; 435 8p; 436 8p; 437 8p; 438 8p; 439 8p; 440 8p; 441 8p; 442 8p; 443 8p; 444 8p; 445 8p; 446 8p; 447 8p; 448 8p; 449 8p; 450 8p; 451 8p; 452 8p; 453 8p; 454 8p; 455 8p; 456 8p; 457 8p; 458 8p; 459 8p; 460 8p; 461 8p; 462 8p; 463 8p; 464 8p; 465 8p; 466 8p; 467 8p; 468 8p; 469 8p; 470 8p; 471 8p; 472 8p; 473 8p; 474 8p; 475 8p; 476 8p; 477 8p; 478 8p; 479 8p; 480 8p; 481 8p; 482 8p; 483 8p; 484 8p; 485 8p; 486 8p; 487 8p; 488 8p; 489 8p; 490 8p; 491 8p; 492 8p; 493 8p; 494 8p; 495 8p; 496 8p; 497 8p; 498 8p; 499 8p; 500 8p; 501 8p; 502 8p; 503 8p; 504 8p; 505 8p; 506 8p; 507 8p; 508 8p; 509 8p; 510 8p; 511 8p; 512 8p; 513 8p; 514 8p; 515 8p; 516 8p; 517 8p; 518 8p; 519 8p; 520 8p; 521 8p; 522 8p; 523 8p; 524 8p; 525 8p; 526 8p; 527 8p; 528 8p; 529 8p; 530 8p; 531 8p; 532 8p; 533 8p; 534 8p; 535 8p; 536 8p; 537 8p; 538 8p; 539 8p; 540 8p; 541 8p; 542 8p; 543 8p; 544 8p; 545 8p; 546 8p; 547 8p; 548 8p; 549 8p; 550 8p; 551 8p; 552 8p; 553 8p; 554 8p; 555 8p; 556 8p; 557 8p; 558 8p; 559 8p; 560 8p; 561 8p; 562 8p; 563 8p; 564 8p; 565 8p; 566 8p; 567 8p; 568 8p; 569 8p; 570 8p; 571 8p; 572 8p; 573 8p; 574 8p; 575 8p; 576 8p; 577 8p; 578 8p; 579 8p; 580 8p; 581 8p; 582 8p; 583 8p; 584 8p; 585 8p; 586 8p; 587 8p; 588 8p; 589 8p; 590 8p; 591 8p; 592 8p; 593 8p; 594 8p; 595 8p; 596 8p; 597 8p; 598 8p; 599 8p; 600 8p; 601 8p; 602 8p; 603 8p; 604 8p; 605 8p; 606 8p; 607 8p; 608 8p; 609 8p; 610 8p; 611 8p; 612 8p; 613 8p; 614 8p; 615 8p; 616 8p; 617 8p; 618 8p; 619 8p; 620 8p; 621 8p; 622 8p; 623 8p; 624 8p; 625 8p; 626 8p; 627 8p; 628 8p; 629 8p; 630 8p; 631 8p; 632 8p; 633 8p; 634 8p; 635 8p; 636 8p; 637 8p; 638 8p; 639 8p; 640 8p; 641 8p; 642 8p; 643 8p; 644 8p; 645 8p; 646 8p; 647 8p; 648 8p; 649 8p; 650 8p; 651 8p; 652 8p; 653 8p; 654 8p; 655 8p; 656 8p; 657 8p; 658 8p; 659 8p; 660 8p; 661 8p; 662 8p; 663 8p; 664 8p; 665 8p; 666 8p; 667 8p; 668 8p; 669 8p; 670 8p; 671 8p; 672 8p; 673 8p; 674 8p; 675 8p; 676 8p; 677 8p; 678 8p; 679 8p; 680 8p; 681 8p; 682 8p; 683 8p; 684 8p; 685 8p; 686 8p; 687 8p; 688 8p; 689 8p; 690 8p; 691 8p; 692 8p; 693 8p; 694 8p; 695 8p; 696 8p; 697 8p; 698 8p; 699 8p; 700 8p; 701 8p; 702 8p; 703 8p; 704 8p; 705 8p; 706 8p; 707 8p; 708 8p; 709 8p; 710 8p; 711 8p; 712 8p; 713 8p; 714 8p; 715 8p; 716 8p; 717 8p; 718 8p; 719 8p; 720 8p; 721 8p; 722 8p; 723 8p; 724 8p; 725 8p; 726 8p; 727 8p; 728 8p; 729 8p; 730 8p; 731 8p; 732 8p; 733 8p; 734 8p; 735 8p; 736 8p; 737 8p; 738 8p; 739 8p; 740 8p; 741 8p; 742 8p; 743 8p; 744 8p; 745 8p; 746 8p; 747 8p; 748 8p; 749 8p; 750 8p; 751 8p; 752 8p; 753 8p; 754 8p; 755 8p; 756 8p; 757 8p; 758 8p; 759 8p; 760 8p; 761 8p; 762 8p; 763 8p; 764 8p; 765 8p; 766 8p; 767 8p; 768 8p; 769 8p; 770 8p; 771 8p; 772 8p; 773 8p; 774 8p; 775 8p; 776 8p; 777 8p; 778 8p; 779 8p; 780 8p; 781 8p; 782 8p; 783 8p; 784 8p; 785 8p; 786 8p; 787 8p; 788 8p; 789 8p; 790 8p; 791 8p; 792 8p; 793 8p; 794 8p; 795 8p; 796 8p; 797 8p; 798 8p; 799 8p; 800 8p; 801 8p; 802 8p; 803 8p; 804 8p; 805 8p; 806 8p; 807 8p; 808 8p; 809 8p; 810 8p; 811 8p; 812 8p; 813 8p; 814 8p; 815 8p; 816 8p; 817 8p; 818 8p; 819 8p; 820 8p; 821 8p; 822 8p; 823 8p; 824 8p; 825 8p; 826 8p; 827 8p; 828 8p; 829 8p; 830 8p; 831 8p; 832 8p; 833 8p; 834 8p; 835 8p; 836 8p; 837 8p; 838 8p; 839 8p; 840 8p; 841 8p; 842 8p; 843 8p; 844 8p; 845 8p; 846 8p; 847 8p; 848 8p; 849 8p; 850 8p; 851 8p; 852 8p; 853 8p; 854 8p; 855 8p; 856 8p; 857 8p; 858 8p; 859 8p; 860 8p; 861 8p; 862 8p; 863 8p; 864 8p; 865 8p; 866 8p; 867 8p; 868 8p; 869 8p; 870 8p; 871 8p; 872 8p; 873 8p; 874 8p; 875 8p; 876 8p; 877 8p; 878 8p; 879 8p; 880 8p; 881 8p; 882 8p; 883 8p; 884 8p; 885 8p; 886 8p; 887 8p; 888 8p; 889 8p; 890 8p; 891 8p; 892 8p; 893 8p; 894 8p; 895 8p; 896 8p; 897 8p; 898 8p; 899 8p; 900 8p; 901 8p; 902 8p; 903 8p; 904 8p; 905 8p; 906 8p; 907 8p; 908 8p; 909 8p; 910 8p; 911 8p; 912 8p; 913 8p; 914 8p; 915 8p; 916 8p; 917 8p; 918 8p; 919 8p; 920 8p; 921 8p; 922 8p; 923 8p; 924 8p; 925 8p; 926 8p; 927 8p; 928 8p; 929 8p; 930 8p; 931 8p; 932 8p; 933 8p; 934 8p; 935 8p; 936 8p; 937 8p; 938 8p; 939 8p; 940 8p; 941 8p; 942 8p; 943 8p; 944 8p; 945 8p; 946 8p; 947 8p; 948 8p; 949 8p; 950 8p; 951 8p; 952 8p; 953 8p; 954 8p; 955 8p; 956 8p; 957 8p; 958 8p; 959 8p; 960 8p; 961 8p; 962 8p; 963 8p; 964 8p; 965 8p; 966 8p; 967 8p; 968 8p; 969 8p; 970 8p; 971 8p; 972 8p; 973 8p; 974 8p; 975 8p; 976 8p; 977 8p; 978 8p; 979 8p; 980 8p; 981 8p; 982 8p; 983 8p; 984 8p; 985 8p; 986 8p; 987 8p; 988 8p; 989 8p; 990 8p; 991 8p; 992 8p; 993 8p; 994 8p; 995 8p; 996 8p; 997 8p; 998 8p; 999 8p; 1000 8p; 1001 8p; 1002 8p; 1003 8p; 1004 8p; 1005 8p; 1006 8p; 1007 8p; 1008 8p; 1009 8p; 1010 8p; 1011 8p; 1012 8p; 1013 8p; 1014 8p; 1015 8p; 1016 8p; 1017 8p; 1018 8p; 1019 8p; 1020 8p; 1021 8p; 1022 8p; 1023 8p; 1024 8p; 1025 8p; 1026 8p; 1027 8p; 1028 8p; 1029 8p; 1030 8p; 1031 8p; 1032 8p; 1033 8p; 1034 8p; 1035 8p; 1036 8p; 1037 8p; 1038 8p; 1039 8p; 1040 8p; 1041 8p; 1042 8p; 1043 8p; 1044 8p; 1045 8p; 1046 8p; 1047 8p; 1048 8p; 1049 8p; 1050 8p; 1051 8p; 1052 8p; 1053 8p; 1054 8p; 1055 8p; 1056 8p; 1057 8p; 1058 8p; 1059 8p; 1060 8p; 1061 8p; 1062 8p; 1063 8p; 1064 8p; 1065 8p; 1066 8p; 1067 8p; 1068 8p; 1069 8p; 1070 8p; 1071 8p; 1072 8p; 1073 8p; 1074 8p; 1075 8

LED panel clip 1p	RED	15p	18p	INFRA RED 550nm Axial lead 49p 6mmW £1.55 OPTO Data free				
	G/Y	27p	33p	GRP 12.55p				
	OR	27p	33p					
OPTO-ISOLATORS		SCR a	50V	100V	400V	Diac		
TIL111	1.5kv	150kHz	£1	TO5 1A	25p	27p	46p	BR100
4350	2.5kv	5MHz	£2.25	TO66 3A	27p	35p	50p	21p
AVDEL BOND		2gm	65p	400V TRIACS	2A	60p	10A	£1.50
AC126/6/7/8	15p	2N3053	15p	VOLTAGE REGS				
AD161/162	40p	2N3054	45p	5V 7805	Plastic			
AF117	20p	2N3065	41p	12V 7812	1 Amp			
AF124/5/6/7	34p	2N3702/3/4	12p	15V 7815	all			
BC/107/8/9	9p	2N3903/4/5/6/16p	45p	18V 7818	£1.50			
BC109C	12p	2N2646	45p	723 DIP14	50p			
BC147/8/9	10p	TIS43UJT	25p	BRIDGE RECTS.				
BC157/8/9	11p	MPF102	40p	2A 50V	30p			
BC167/8/9	11p	2N3819	25p	2A 100V	36p			
BC198C	12p	2N3823	30p	2A 200V	41p			
BC177/8/9	17p			2A 400V	46p			
BC182/3/4L	11p	IN914	3p	ZENERS 2.7-33V				
BC186/7	30p	IN4001	5p	BZY88 or sim.	9p			
BC212/3/4L	12p	IN4002/3	6p	555 Timer	60p			
BCY70/71/72	13p	IN4004/5	7p	556, 2x555	£1.10			
BF194/5	12p	IN4006/7	8p	LM380	£1.00			
BF196/7	14p	IN4148	4p	7400	16p			
BFY50/51	16p	BA100	9p	D.I.L. SOCKETS				
BFY29	30p	8Y127	16p	8-pin	12p			
BFY84	24p	OA70 OA79	8p	14-pin	13p			
BSX19/20	15p	OA81 OA90	7p	16-pin	14p			
OC71	10p	OA91 OA95	6p	Micas + bushes				
2N706	10p	OA200	6p	TO3 TO66	5p			
2N1711	20p	OA202	7p	Dalo Pen	70p			
2N2219	20p			OP. AMPS				
2N2904/5/6/7/16p		709 all	25p	741 8-pin	36p			
2N2904/5/6A 18p		748 D.I.L.	36p					
2N2926R	7p			PRICES INCLUSIVE + 15p P&P (1st class)				
2N2926G	12p			ISLAND DEVICES, P.O. Box 11, Margate, Kent				

PRINTED CIRCUITS and HARDWARE

Comprehensive range Constructors' Hardware and accessories.
Sheet aluminium cut to size.
Aluminium lightweight sections.
Selected range of popular components
Full range of ETI printed circuit boards, normally ex-stock, same day despatch at competitive prices.
P.C. Boards to individual designs.
Resist-coated epoxy glass laminate for the d.i.y. man with full processing instructions (no unusual chemicals required).
Send 15p for catalogue.

RAMAR CONSTRUCTOR SERVICES
MASON'S ROAD
STRATFORD-ON-AVON
WARWICKS. Tel. 4879

P.C.B.s

Glass Fibre P.C.B.s for ETI projects, supplied tinned and drilled.

ETI446	98p	ETI445	54p
ETI447	124p	ETI152a	71p
ETI544	90p	ETI152b	174p
ETI543a	81p	ETI252	38p
ETI543b	84p	ETI241	114p
ETI541	68p	ETI710	76p
ETI560 (a b & c)		ETI514b	52p
	424p	Sorry. No ETI602s	

All prices shown include VAT. Add 20p post & packing

P.C.B.s also available for this month's ETI projects. Send SAE for full list of available boards.

Also a comprehensive or part service from Artwork and layout design to assembled P.C.B. for batch quantities or one-off prototypes — Contact:

TAMTRONIK LIMITED
217 TOLL END ROAD, TIPTON,
WEST MIDLANDS DY4 0HW
Telephone 021-557 9144

SHOP FROM HOME with our catalogue. Fully illustrated and covering over 3,000 components, audio and disco accessories, tools and test meters. Reviewed as one of the best catalogues available. Send 30p now for your copy (issue No 5). Access, Giro, Barclaycard, Government and educational orders accepted. (Giro No 331-7056).

B. H. COMPONENT FACTORS LTD.
Leighton Electronics Centre
59 North St., Leighton Buzzard, Beds
Tel: 2316 (0286) Shop hours: 9-12.30, 1.30-5 p.m. Closed Wednesday

Treasure Locator Kits by DETECTOR PRODUCTS

Suppliers to the UK & Abroad
Circuits & Instructions £2
Complete Kit £12
Total £14 incl. VAT p&p

Solid aluminium frame with an efficient Faraday screen. For enquiries please send s.a.e. to:

DETECTOR PRODUCTS
58a King Street, Blackburn, Lancs
Tel. 62561 or 54105

ITT 58705T Nixi 0-9 + Data 50p. MM5314 + Data £3.25. TIL 209 (red) 10p. Fenwal Thermistors, pair encapsulated 20p. Submin Toggle 5p. Change over 38p. P&P 10p. LB 43 Westacott, Hayes, Middx. UB4 8AH

PRESETTABLE 240V. 5 DIGIT COUNTERS

Auto/Man. reset. Auto zero S/W. £4.00 (inc). Power Amps 20w. 0.02% dist. 9 trans. P.C.B. + 30v. WKG £4.00 (inc.) KLIFCO ELECTRONICS. 1 REGENT ROAD, ILKLEY, W. YORKS.

GLASS FIBRE P.C.B.s

From your own tape, film or ink master. Send SAE for quotation
ETI boards glass fibre tinned and drilled

GP Power Supply ETI 131	96p
High Power Beacon ETI 240	52p
100 Guitar Amplifier ETI 413	£1.40
Mixer Pre Amplifier ETI 419	60p
Audio Level Meter ETI 438	75p
Sweet Sixteen Amplifier ETI 457	£1.92
Power Supply 100w Disco Amplifier ETI 458a	92p
100w Disco Amplifier ETI 458b	£1.19
Disco FET Ceramic P.U. ETI 458c	55p
Disco Tone Control Pre Amplifier ETI 458d	85p
Disco Pre Amplifier ETI 458e	£1.14
Disco Headphone Amp/VU Meter ETI 458f/g	£2.10
Disco Fader ETI 458h	84p
Sound Light Flash Trigger ETI 514b	49p
2m Power Amplifier ETI 710	85p

PROTO DESIGN, 4 Highcliffe Way, Wickford, Essex SS11 8LA

anaco

SUPPLIERS OF ELECTRONIC COMPONENTS TO INDUSTRY & ENTHUSIASTS
COMPREHENSIVE STOCKS OF ELECTRONIC COMPONENTS AVAILABLE TO THE ENTHUSIAST AT COMPETITIVE PRICES

SEMICONDUCTORS INTEGRATED CIRCUITS
CAPACITORS RESISTORS PRE SETS BEAD TANTS
HEATS SINKS MINIATURE TRANSFORMERS VERO BOARD
TRANSISTOR HARDWARE DUAL IN LINE SOCKETS R F CHOKES
FUSES L.E.O.s INDICATOR LIGHTS KNOBS
FUSE HOLDERS, ETC. ALSO VARYING RANGES OF REJECT BOARDS FOR COMPONENT RECLAIMING
(PRODUCT RANGE WILL ALTER MONTH BY MONTH)

AC126	35p	BC547	16p	2N3702/3/4	18p
AC127	40p	BC558	18p	2N709	44p
AC128	35p	BCY70/71/72	25p	2N741	37p
AC176	35p	80 131/132	55p	2N748	46p
AF239	60p	80135/6	45p	2N555	55p
BC107/8/9	15p	80139	54p	2N556	£1.30
BC114	16p	BFY50/51/52	32p	LM300	£3.30
BC147/8/9	16p	BR101	40p	LM380	£1.10
BC157/8/9	16p	2N706	15p	LM381	£2.10
BC168	16p	2N708	23p	LM390	65p
BC178	25p	2N1711	25p	SN7613ND	£1.75
BC182/3/4	15p	2N2646	60p	SN76023A	£2.10
BC212/3/4	18p	2N2926	15p		

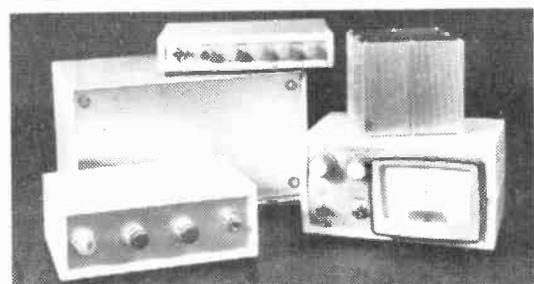
Part built Dolby Units with cabinets £4.50
Anaco Light Dimmers 300 watt £3.50
Metec Metal Detectors £5.50
Anaco's own Copper Clad Print Board (Ddl. sizes)

Call and see us, our shop is 3 mins. from Chelmsford Station or phone Allan Green for prices and delivery. We are here to serve you 9.30 to 5 weekdays, 10 to 4 Saturday. We give a fast 24-hour Mail Order Service on ex-stock items. Prices inc. VAT. Add 25p for P&P on orders under £6.00. Trade enquiries welcome. Telex No 995377. Send now for full product list Price 150 Dept ETI1
DO COME TO SEE US EITHER TO BUY OR BROWSE

50 HAINSFORD ROAD CHELMSFORD ESSEX (0245 58605)

Vero Electronics Ltd, manufacture cases to give your projects a professional finish. Cases are available in plastic, extruded aluminium and PVC coated steel. A new catalogue describing these cases, Veroboard, pins, tools, card frame etc. is available (price 10p + S.A.E. 7" x 9")

THE CASE OF THE PROFESSIONAL FINISH...



Vero Electronics Limited, Retail Dept., Industrial Estate, Chandler's Ford, Hants., SO5 3ZR
Telephone: Chandler's Ford 2956 (STD 04215)

electronics today international reader services

BACK NUMBERS

These cost 40p each. Postage and packing costs 15p for the first, and 10p for each subsequent issue. Orders to ETI BACK ISSUES Dept. please.

We cannot supply the following: All 1972; Jan, Feb, April, Aug, Oct, Nov 1973; Jan, March, Sept, Oct, Nov, Dec 1974; Jan, June, July, Aug, Sept, Oct, Nov, Dec 1975; Jan, Feb, March 1976.

PHOTOCOPYING SERVICE

Due to the steady pressure on our back numbers department, and the dwindling number of issues available, we have set up a photocopying service. This involves our staff in considerable time consuming endeavour, so we hope our readers understand our decision to apply a flat charge of 50p inclusive. This covers any article, regardless of the number of pages involved, from any DNE issue of ETI.

Address envelope to 'ETI Photocopy Service.'

EDITORIAL QUERIES

Written queries can only be answered when accompanied by an SAE, and the reply can take up to three weeks. These must relate to recent articles and not involve ETI staff in any research. Mark your letter ETI QUERY . . . Telephone queries can only be answered when technical staff are free, and NEVER before 4 pm.

BINDERS

Binders, for up to 13 issues, are available for £2.50 including VAT and carriage. Send orders to ETI BINDERS DEPT. . . .

SPECIAL ISSUES

Presently we produce eight specials. See our ads on pages 14, 15 and 70.

T-SHIRTS

ETI T-shirts are available in Large, Medium, or Small sizes. They are yellow cotton with black printing and cost £1.50 each. Send orders to ETI T-SHIRTS Dept. . . .

BOOKS

ETI Book Service sells books to our readers by mail order. The prices advertised in the magazine include postage and packing. Send orders to ETI Book Service, P.D. Box 79, Maidenhead, Berks.

NON-FUNCTIONING PROJECTS

We cannot solve the problems faced by individual readers building our projects unless they are concerning interpretation of our articles. When we know of any error we print a correction as soon as possible at the end of News Digest. Any useful addenda to a project will be similarly dealt with. We cannot advise readers on modifications to our projects.

SUBSCRIPTIONS

The annual subscription to ETI for UK readers is £6. The current rate for readers overseas is £7. Send orders to ETI SUBS Dept. PAYMENT IN STERLING ONLY PLEASE.

PCBs

PCBs are available for our projects from companies advertising in the magazine.

**NEW ADDRESS FOR ALL DEPARTMENTS:
25-27 OXFORD STREET, LONDON, W1R 1RF**

**PLEASE MARK REVERSE OF EACH CHEQUE
WITH NAME & ADDRESS AND ITEMS
REQUIRED.**

ALLOW 10 TO 14 DAYS FOR DELIVERY

AD. INDEX

AMBIT	p24	MAPLIN	p84
ARROW ELECTRONICS	Miniads	MARCO TRADING	Miniads
B.H. COMPONENTS	p32	MARSHALL'S	p40
BI-PAK LTD.	pp4 & 5	METAC	p9/89
B.N.R.S.	p28	MINIKITS	p8
BYWOOD	p74	P.B. ELECTRONICS	p67
CAMBRIDGE LEARNING	p83	PULSE ELECTRONICS	£78
CHILTMead	p79	RADIO ROTOR	p71
CLIFFPALM	p78	RAMAR	Miniads
CROFTON	p39	R.F. EQUIPMENT SPARES	p82
D.B.M. PRODUCTS	Miniads	SINCLAIR	p13
DORAM	p39/72	SINTEL	p61
ELECTRONIC DESIGN ASSOCS.	p24	S.S.T. DISTRIBUTORS	p72
ELECTROVALVE	p28	STERLING SOUND	p2
GREENBANK ELECTRONICS	p68	SWANLEY	p68
I.L.P.	p76	TAMTRONIK	Miniads
INTEGREX	p31	TECHNOMATIC	p56
ISLAND DEVICES	Miniads	TEMPUS	p72
JOSTYKIT LTD	p14	VERO	p81
LEE INSTRUMENTS	p27	VIDEOMASTER	p23
LYNX ELECTRONICS	p48	WILMSLOW AUDIO	p68
		ZARTRONIX	p32

FIBRE-GLASS P.C.B.s

ETI 560 VDU (Corrected) Set of 3 Boards	445p
ETI 458 100 watt Stereo Disco	850p
(Set of 8 Boards A, B, C, D, E, F & H)	
ETI 458 Remote Start Board	70p
ETI 458 Light Modulator Board	300p
ETI 543A STD Timer Display Board	85p
ETI 543B Timing Display Board	85p
ETI 544 See this issue	75p
ETI 620 Touch Organ (SRBP)	500p

ALL OTHER PREVIOUSLY ADVERTISED
BOARDS STILL AVAILABLE

SEMI-CONDUCTORS

BC107	8p	BD519	50p
BC107A	9p	BD520	50p
BC108	8p	BD609 (90 watts)	70p
BC109	8p	UC734E	20p
BC114	10p	ZTX109	10p
BC116	17p	2N5457 (FET)	35p
BC478	25p	2N6259 (200 watts)	80p
BCY32	20p	D1300A Signal Diode	5p
400mW Zeners	9p	1.8W W 2C2012 (12v)	20p

RESISTORS

1/4 watt H.S. Carbon Film	1p	100	80p
1/2 watt H.S. Carbon Film	1.5p	100	120p

ELECTROLYTICS

470mF, 63v	30p	4700mF, 50v	60p	640mF, 16v	14p
500mF, 10v	10p	220 uF, 10v	8p	100mF, 10v	6p
10mF, 12v	5p	330mF, 25v	10p	100mF, 25v	8p

CA3052 Stereo Pre-Amplifier I.C. 16-pin D.I.L. 100p

All Data supplied. Provision for Equalisation and Tone.

Prices VAT inclusive. List 10. P&P 20p

R.F. EQUIPMENT SPARES LTD.

3 LACY CLOSE, WIMBORNE, DORSET

New Course in Digital Design

Understand the latest developments in calculators, computers, watches, telephones, television, automotive instrumentation

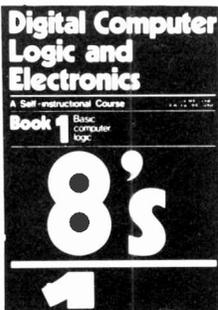
Each of the 6 volumes of this self-instruction course measures 11¼" x 8¼" and contains 60 pages packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and on to a complete understanding of the design and operation of calculators and computers.

After completing this course you will have broadened your career prospects and considerably increased your fundamental understanding of the changing technological world around you.

Design of Digital Systems

A Self-Instruction Course in 6 Volumes

- 1 Computer Arithmetic
- 2 Boolean Logic
- 3 Arithmetic Circuits
- 4 Memories & Counters
- 5 Calculator Design
- 6 Computer Architecture



Also available — a more elementary course assuming no prior knowledge except simple arithmetic.

In 4 volumes:

1. Basic Computer Logic
2. Logical Circuit Elements
3. Designing Circuits to Carry Out Logical Functions
4. Flip flops and Registers

Offer. Order this together with Design of Digital Systems for the bargain price of £9.70, plus 80p p&p.

£4.20 plus 80p p&p

Design of Digital Systems contains over twice as much information in each volume as the simpler course, Digital Computer Logic and Electronics. All the information in the simpler course is covered as part of the first volumes of Design of Digital Systems which, as you can see from its contents, also covers many more advanced topics.

**Designer
Manager
Enthusiast
Scientist
Engineer
Student**

These courses were written so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being quicker and more thorough than classroom learning. You work at your own speed and must respond by answering questions on each new piece of information before proceeding to the next.

Guarantee — no risk to you

If you are not entirely satisfied with Design of Digital Systems or Digital Computer Logic and Electronics, you may return them to us and your money will be refunded in full, no questions asked.



£6.20

plus 80p packing and surface post anywhere in the world (VAT zero rated). Payments may be made in foreign currencies. Quantity discounts are available on request.

To: Cambridge Learning Enterprises, Dept. Dig., FREEPOST, St. Ives, Huntingdon, Cambs PE17 4BR

*Please send me set(s) of Design of Digital Systems at £7.00 each, p&p included

*or set(s) of Digital Computer Logic and Electronics at £5.00 each, p&p included

*or combined set(s) at £10.50 each, p&p included

Name.....

Address.....

.....

*delete as applicable.

ETI 2

No need to use a stamp—just print FREEPOST on the envelope.

The new Maplin Catalogue is no ordinary catalogue...

Hundreds of fascinating new lines.

Several major new projects to build.

MAPLIN ELECTRONIC SUPPLIES



Super Discount Voucher - saves you pounds!

Hundreds of photographs and illustrations



A range of ready-made musical effects units: Echo Chamber, Fuzz-Waa Pedal, Vibra-Chorus (tremolo, vibrato, phasing). Just compare our prices for these professional units.



Projects section includes full construction details of a guitarist's/organist's 13-note foot pedal. Features a very realistic bass guitar sound plus four organ stops on two footages. Self-contained, simply plugs into any amplifier.



Semiconductor section includes full details of a range of fascinating I.C.'s: TV games, Rhythm generator, Preset on and off timer/clock - plus radio I.C.'s, op amps, voltage regulators, mono and stereo power amp I.C.'s, etc.

Catalogue includes a very wide range of components: hundreds of different capacitors; resistors; transistors; I.C.'s; diodes; wires and cables; discotheque equipment; organ components; musical effects units; microphones; turntables; cartridges; styli; test equipment; boxes and instrument cases; knobs, plugs and sockets; audio leads; switches; loudspeakers; books; tools - AND MANY MANY MORE.



* Our bi-monthly newsletter keeps you up to date with latest guaranteed prices - our latest special offers (they save you pounds) - details of new projects and new lines. Send 30p for the next six issues (5p discount voucher with each copy).

SEND THIS COUPON FOR **YOUR** COPY OF OUR CATALOGUE ON APPROVAL! Price 50p - SEND NO MONEY NOW. Please rush me a copy of your brand new 1977/78 catalogue the instant it is published. Only if I am completely satisfied that it is worth every penny, will I send 50p within 14 days of receipt. If I am not satisfied, I may return the catalogue to you within 14 days without obligation. I understand that I need not purchase anything from your catalogue should I choose to keep it.

NAME NEAL

ADDRESS _____

Maplin Electronic Supplies P.O. Box 3, Rayleigh, Essex, SS6 8LR

Owing to delay in completion of larger warehouse, catalogue will be delayed by up to four weeks - so there's still time to order before publication and get your pack of ten super special offer coupons, giving big discounts on ten different popular items. YOU COULD SAVE POUNDS! - SO DON'T DELAY - FILL IN AND POST COUPON NOW!

MAPLIN
ELECTRONIC SUPPLIES
P.O. BOX 3, RAYLEIGH, ESSEX SS6 8LR
Shop: 284, London Road, Westcliff-on-Sea, Essex
(Closed on Monday) Telephone: Southend (0702) 44101