ELECTRONICS & Wireless world

June 1984 85p.

Multi-standard modem

Emulators

Computer cassette recorder

Cellular radio

GWV 5334a 05:18

What's On Theatre Guides

KEY
1 SCOTLAND
2 NORTH
3 WALES
4 MIDLANDS
5 EAST ANGLIA
6 SOUTH WEST
7 SOUTH EAST
8 GREATER LONDON
9 LONDON, WEST END
0 WHO'S NEW

MICRONET 800 (C) 600a0c 0p

Communications

CC10
1 MESSAGING Mailbox, Telex, Subscribers Mailbox Directory
2 CONTACT User to user bulletin board
3 SWAP SHOP Your free small ads section
4 LETTERS Editors' Mailbag
5 TELESHOPPING Armchair guide to goods you can buy on Micronet 800
6 DATACOMS We tell you how to get the best out of your modems
7 TALKBACK Get in touch with Micronet 800 and other interactive areas

9 MICRONET 800 MAIN MENU

VIEWFAX 2582201E 0p

BELTEL

TIN PIN

dial 01327122 9911 Terminal identification
Terminaal-identifikasie
PIN: Password
Wagwoord

Key # for more

ELECTRONICS &
Wireless world

This month...

Multi-standard
MODEM

micronet 800

Telesoftware Terminal

by SoftMachinery brings your BBC Microcomputer 32K ...to life!

Key *0 to call Micronet800

```
PACE Commstar (C) A Hood 1983    01:00

<B> Copy to buffer     <L> Load Buffer
<R> Reset buffer       <S> Save buffer
<O> Output buffer      <V> View buffer
<W> Wipe buffer

<A> Auto line Feed     <E> Echo switch
<I> Initialise 423     <M> MOS command
<T> Text mode 7/3      <X> Xon/xoff

<C> Chat Mode
<F> File transfer

Buffer  ON   Echo  ON   Xon/Xoff OFF
Auto LF OFF

0000 Characters in buffer : 6000 free

Select ?
```

MicroMouse 800651a 0p

27th March

Key 3 for the latest...

Welcome! to MICROMOUSE The Database

Key 1 for 1/2 for Hard Cheese
0 for Micronet or just key #

Australia	A$	3.00	Norway	Nkr	29.20
Denmark	DKr	34.50	Singapore	M$	5.50
Germany	Dm	7.00	Spain	Pts	340.00
Greece	Dra	220.00	Switzerland	SFr	7.00
Holland	DFL	8.50	U.S.A.	$	3.75
Italy	L	3800			

EP8000 EPROM EMULATOR PROGRAMMER

The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules.

Personality cards and hardware changes are not required as the machine configures itself for the different devices.

The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

FEATURES

- Software personality programming/emulation of all EPROMs up to 8k x 8 bytes including 2704, 2708, 2716(3), 2508, 2758A, 2758B, 2516, 2716, 2532, 2732, 2732A, 68732-0, 68732-1, 68766, 68764, 2564, 2764. Programs 25128, 27128 with adaptors.
- No personality cards/characterisers required.
- Use as stand alone programmer, slave programmer, or EPROM development system.
- Checks for misplaced and reversed insertion, and shorts on data lines.
- Memory mapped video output allows full use of powerful editing facilities.
- Built-in LED display for field use.
- Powerful editing facilities include: Block/Byte move, insert, delete, match, highlight, etc.
- Comprehensive input/output – RS232C serial port, parallel port, cassette, printer O/P, DMA.
- Extra 1k x 8 scratchpad RAM for block moving.

● EP8000 8k x 8 Emulator Programmer – £695 + £12 delivery ● BSC8 Buffered emulation cable – £49 ● SA27128 Programming adaptor – £69 ● SA25128 Programming adaptor – £69 ● EP4000 4k x 8 Emulator Programmer – £545 + £12 delivery ● BSC4 Buffered emulation cable – £39 ● BP4 (TEXAS) Bipolar PROM Module – £190 ● Prinz video monitor – £99 ● UV141 EPROM Eraser with timer – £78 ● GP100A 80 column printer – £225 ● GR1 Centronics interface – £65

VAT should be added to all prices

DISTRIBUTORS REQUIRED ● EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

Tel: Plymouth (0752) 332961
Telex: 42513

Unit E, Huxley Close, Newnham Industrial Estate, Plymouth PL7 4JN

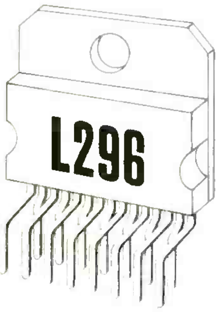
CIRCLE 001 FOR FURTHER INFORMATION

Trackdown SWITCHMODE power supply

...Barlec-Richfield and SGS have the solution

L296

SWITCHING REGULATOR



- Available ex-stock
- Cost effective
- Short circuit protected
- Output over voltage protection
- 5.1v to 40v output
- 4A output current
- Up to 160w output power
- Programmable current limiter
- Soft start
- Reset output
- Precise (± 2%) on-chip reference
- Very few components
- Switching frequency to 200kHz
- Very high efficiency (up to 90%)
- Thermal shutdown
- Remote inhibit and sync input
- Control circuit for crowbar SCR

For complementary evaluation kit please write to Barlec-Richfield on your company headed paper.

SGS

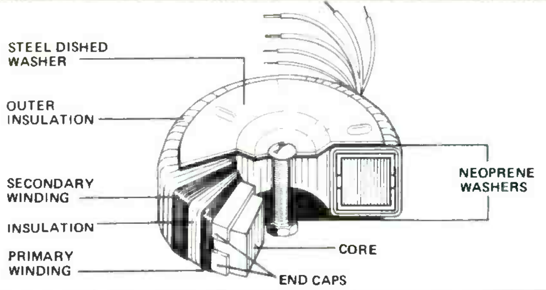
Phone: 0403 51881
Telex: 877222

BARLEC RICHFIELD
now better served to serve you better

Barlec-Richfield Ltd.,
Foundry Lane, Horsham, West Sussex RH13 5PX
A member of the IBR Electronics Group

CIRCLE 22 FOR FURTHER DETAILS.

TOROIDALS



The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0.83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

Why a Toroid?

- * Smaller size & weight to meet modern 'slimline' requirements.
- * Low electrically induced noise demanded by compact equipment.
- * High efficiency enabling conservative rating whilst maintaining size advantages.
- * Lower operating temperature.

Why ILP?

- * Ex-stock delivery for small quantities.
- * Gold service available. 21 days manufacture for urgent deliveries.
- * 5 year no quibble guarantee.
- * Realistic delivery for volume orders.
- * No price penalty for call off orders.

Prices including P&P and VAT

VA	Size	£	VA	Size	£
15	0	7.43	160	5	12.90
30	1	8.08	225	6	16.30
50	2	10.10	300	7	18.55
80	3	10.81	500	8	25.73
120	4	11.73	625	9	31.63

For 110V primary insert "O" in place of "X" in type number.
For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
IMPORTANT: Regulation - All voltages quoted are FULL LOAD.
Please add regulation figure to secondary voltage to obtain off load voltage.

Mail Order — Please make your crossed cheques or postal orders payable to ILP Electronics Ltd.

Trade — We will open your credit account immediately upon receipt of your first order.

Post to: ILP Electronics Ltd., Dept. 3
Graham Bell House, Roper Close,
Canterbury, Kent. CT2 7EP
Tel: (0227) 54778 Telex: 965780

Access VISA

ILP ELECTRONICS LTD.

CIRCLE 38 FOR FURTHER DETAILS.

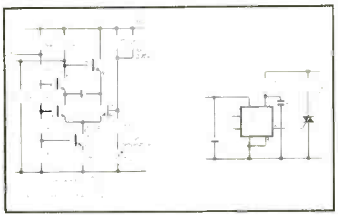
CONTENTS

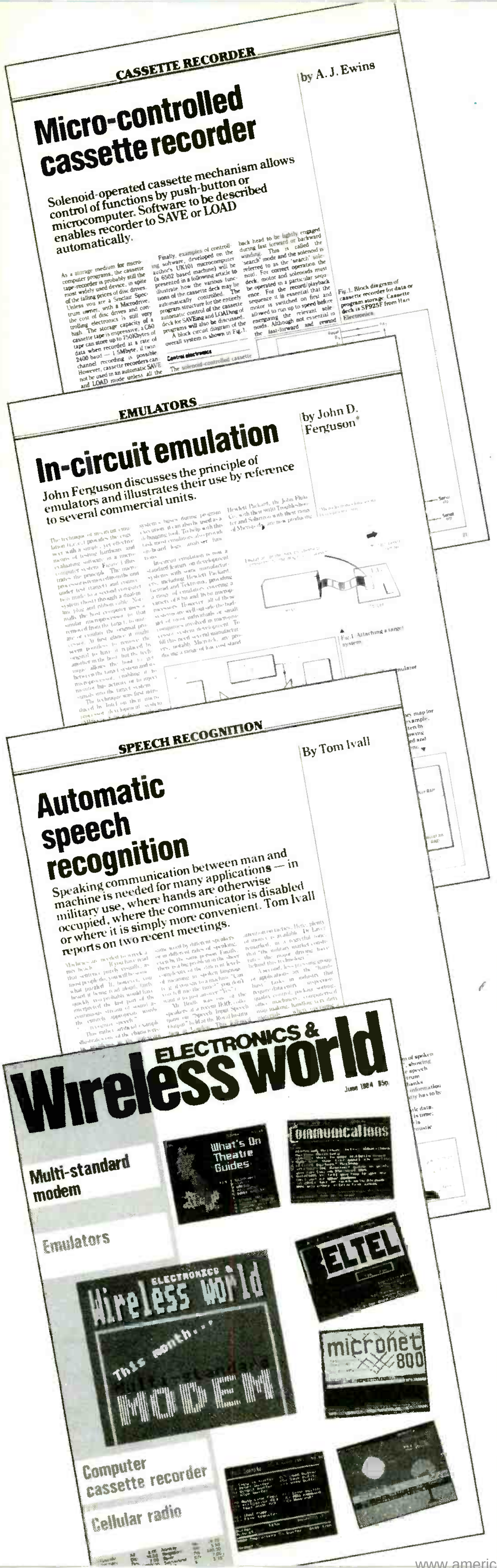
ELECTRONICS &
Wireless world
over 70 years in independent electronics publishing

June 1984 Volume 90 number 1581

FEATURES

REGULARS





CASSETTE RECORDER

by A. J. Ewins

Micro-controlled cassette recorder

Solenoid-operated cassette mechanism allows control of functions by push-button or microcomputer. Software to be described enables recorder to SAVE or LOAD automatically.

As a storage medium for microcomputer programs, the cassette tape-recorder is probably still the most widely used device, in spite of the falling prices of disc drives. Unless you are a Sinclair Spectrum owner, with a Microdrive, the cost of disc drives and controlling electronics is still very high. The storage capacity of a cassette tape is impressive, a C60 tape can store up to 750Kbytes of data when recorded at a rate of 2400 baud — 1.5Mbyte, if twin channel recording is possible. However, cassette recorders cannot be used in an automatic SAVE and LOAD mode unless all the

Finally, examples of controlling software, developed on the author's UK101 microcomputer (a 6502 based machine) will be presented in a following article to illustrate how the various functions of the cassette deck may be automatically controlled. The program structure for the entirely automatic control of the cassette deck for SAVEing and LOADing of programs will also be discussed.

A block circuit diagram of the overall system is shown in Fig.1.

Control electronics

The solenoid-controlled cassette

back head to be lightly engaged during fast forward or backward winding. This is called the 'search' mode and the solenoid is referred to as the 'search' solenoid. For correct operation the deck, motor and solenoids must be operated in a particular sequence. For the record/playback sequence it is essential that the motor is switched on first and allowed to run up to speed before energising the relevant solenoids. Although not essential in the fast-forward and rewind

Fig.1. Block diagram of cassette recorder for data or program storage. Cassette deck is SF925F from Hart Electronics

EMULATORS

by John D. Ferguson*

In-circuit emulation

John Ferguson discusses the principle of emulators and illustrates their use by reference to several commercial units.

SPEECH RECOGNITION

By Tom Ivall

Automatic speech recognition

Speaking communication between man and machine is needed for many applications — in military use, where hands are otherwise occupied, where the communicator is disabled or where it is simply more convenient. Tom Ivall reports on two recent meetings.

ELECTRONICS & Wireless world

June 1984 85p

Multi-standard modem

Emulators

Computer cassette recorder

Cellular radio

Front cover illustrates some communications software and pages from Prestel, one of the databases which can be accessed through our modem design.

NEXT MONTH

Graphics display and up to 32 lines of 96 characters are provided by the v.d.u. circuit of John Adam's microcomputer.

Two-metre transceivers for the radio amateur: as May's RAE candidates await their pass slips, a survey of equipment for this popular band for the beginner.

Timebase correction for C-format vtrs is explained in the second installment of John Watkinson's four-part series on variable speed video.

Multi-standard modem: details of the interface to the telephone line, plus suggestions for software and some databases to dial up.

Current issue price 85p, back issues (if available) £1.06, at Retail and Trade Counter, Units 1 & 2, Bankside Industrial Centre, Hopton Street, London SE1. Available on microfilm; please contact editor. By post, current issue £1.30, back issues (if available) £1.40, order and payments to EEP Sundry Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Tel.: 01-661 3378.
Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.
Telephones: Editorial 01-661 3614. Advertising 01-661 3130. See leader page.
Telex: 892084 BISPRS G (EEP)
Subscription rates: 1 years £15 UK and £19 outside UK.
Student rates: 1 year £10 UK and £12.70 outside UK.
Distribution: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Telephone 01-661 3248.
Subscriptions: Oakfield House, Perrymount Road, Haywards heath, Sussex RH16 3DH. Telephone: 04444 459188. Please notify a change of address.
USA: $49.40 surface mail, $102.60 airmail. Business Press International (USA). Subscriptions Office, 205 E. 42nd Street, NY 10017.
USA mailing agents: Expediters of the Printed World Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022, 2nd class postage paid at New York.

ISBN 0043 6062.

Editor
PHILIP DARRINGTON
01-661 3128

Deputy Editor
GEOFFREY SHORTER, B.Sc.
01-661 8639

Technical Editor
MARTIN ECCLES
01-661 8638

Projects Editor
RICHARD LAMBLEY
01-661 3039

News Editor
DAVID SCOBIE
01-661 8632

Drawing Office Manager
ROGER GOODMAN
01-661 8690

Technical Illustrator
BETTY PALMER

Advertisement Manager
BOB NIBBS, A.C.I.I.
01-661 3130

MICHAEL DOWNING
01-661 8640

ASHLEY WALLIS
01-661 8641

Northern Sales
HARRY AIKEN
061-872 8861

Midland Sales
BASIL McGOWAN
021-356 4838

Classified Manager
BRIAN DURRENT
01-661 3106

IAN FAUX
01-661 3033

Production
BRIAN BANNISTER
(Make-up and copy)
01-661 8648

Publishing Director
DAVID MONTGOMERY
01-661 3241

International Agents and the Advertisers Index appear at the back of this issue.

Cirkit. A new name

This year Ambit will stop being Ambit. And become Cirkit.

Cirkit is more than just a change of name. It means a better service for you. Faster delivery.

A bigger range of the best and latest products with well over 10,000 different items available.

Everything for the home and industrial user.

A whole new Cirkit range of constructional kits, graded for the student, expert and enthusiast.

Modules to build for everyone.

Cirkit is a go ahead company that believes in giving service to its customers.

There's a technically skilled staff to help you.

We keep in touch with the manufacturers and we know what's going on.

As soon as new products are available, Cirkit has them.

Cirkit means a bigger catalogue. A better company to deal with.

And a wider than ever range of products that's growing all the time.

For you, Cirkit means a bigger stock and better service.

For further information send for our latest catalogue or visit one of our three outlets at: 200 North Service Road, Brentwood, Essex, CM14 4SG; 53 Burrfields Road, Portsmouth, Hampshire, PO3 5EB; Park Lane, Broxbourne, Hertfordshire, EN10 7NQ.

To: Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire.

I enclose 80p. Please send me your latest catalogue and 3×£1 discount vouchers!

Name ______________________

Address ______________________

______________________ Telephone ______________________

Area of Special Interest ______________________

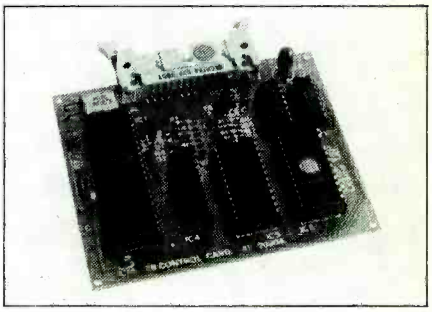
Cirkit

Bigger Stock. Better Service.

EWW6

Computer Products

A complete range from Connectors to Board Level product



C12 Computer Cassette	21-00012	0.55
BBC to Centronics Printer	03-10019	7.25
BBC to 25 way D Male	03-10021	4.50
25 way D Socket	10-25200	1.90
25 way D Plug	10-25100	1.30
Cover for 25 way D	10-25322	0.93
20 up Eprom Eraser	40-82100	31.25
Z80 A Industrial Controller	40-82000	49.95
6802 Industrial Controller	40-68020	49.95
6502 Industrial Controller	40-65020	49.95
Z8 Basic/Debug Controller	41-00904	50.00

Nicad Batteries & Chargers

Minimum life 600 (300 PP3 size) full charge/discharge cycles. Batteries must be charged from a constant current source only. All batteries are supplied only with a residual charge and should be charged before used.

				1-9	10-49
AA	1.2V	500mAH	01-12004	0.80	0.74
'C'	1.2V	2.2AH	01-12024	2.35	1.99
'D'	1.2V	4.0AH	01-12044	3.05	2.85
PP3	8.4V	110mAH	01-84054	3.70	3.50
CH1/22 PP3 Charger 11mA for 16 hours			01-00159		4.30
CH8/RX Multi-purpose Charger			01-02204		9.40

Will recharge AA, C, D and PP3 size cells with automatic voltage selection. Will recharge following combination: 6×D, 6×AA, 6×C, 2×PP3, 2×D+2×C, 2×D+2×AA, 2×D+1×PP3, 2×C+2×AA, 2×C+1×PP3, 2×AA+1×PP3.

Battery Adaptor	01-12001	0.96

Sold in pairs: one to convert AA size to C size and one to convert C to D size. Both may be used together to convert an AA to D size.

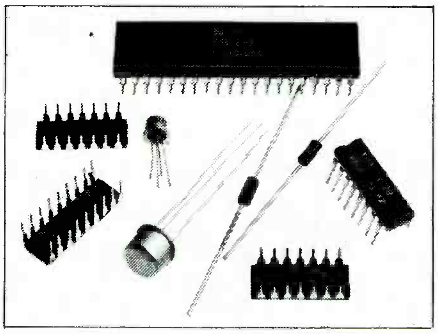
Semiconductors

Linear IC's

LM301AN	DIL version	61-03011	0.44
LM308CN	DIL version	61-03081	0.65
LM311CN	Popular comparator	61-00311	0.46
LM324	Low power quad op amp	61-03240	0.67
LM339N	Low power quad comparator	61-03390	0.68
LM346	Programmable quad op amp	61-00346	3.72
LF347	Quad Bi-FET op amp	61-00347	1.82
LM348	Quad 741 type op amp	61-03480	1.26
LF351	Bi-FET op amp	61-03510	0.49
LF353	Dual version of LF351	61-03530	0.76
LM380N	IW AF power amp	61-00380	1.00
NE555N	Multi-purpose low cost timer	61-05550	0.45

for a better service.

NE556N	Dual version of the 555	61-05560	0.50
uA741CN	DIL low cost op amp	61-07411	0.22
uA747CN	Dual 741 op amp	61-07470	0.70
uA748CN	741 with external frequency comp	61-04780	0.40
HA1388	18W PA from 14V	61-01388	2.75
TDA2002	8W into 2 ohms power amp	61-02002	1.25
ULN2283	1W max. 3-12V power amp	61-02283	1.00
MC3357	Low power NBFM IF system and detector	61-03357	2.85
ULN3859	Low current dual conversion NBFM IF and detector	61-03859	2.95
LM3900	Quad norton amp	61-39000	0.60
LM3909N	8-pin DIL LED flasher	61-39090	0.68
KB4445	Radio control 4 channel encoder and RF	61-04445	1.29
KB4446	Radio control 4 channel receiver and decoder	61-04446	2.75
ICM7555	Low power CMOS version of timer	61-75550	0.98
ICL8038CC	Versatile AF signal generator with sine/square/triangle OPs	61-08038	4.50
TK10170	5 channel version of KB4445	61-10170	1.87
HA12002	Protection monitor system for amps, PSUx, TXs etc	61-12002	1.22
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Eduro/US specs)	61-14412	6.85



Microprocessor & Memories

Z80A	Popular and powerful 8-bit CPU	26-18400	3.40
Z80AP10	2 port parallel input/output	26-18420	2.95
Z80A CTC	4 channel counter/timer	26-18430	2.90
Z8671	Z8 Micro comp. and Basic	26-08671	17.50
6116-3	16K (2kx8) CMOS RAM 200nS	26-36116	6.68
Z6132-6	32K (4kx8) quas. RAM 350nS	26-06132	15.00
4116-2	16K (16kx1) 150nS	26-24116	1.59
2764	64K (8kx8) 450nS	26-02764	9.50
2732	32K (4kx8) 450nS	26-02732	5.70

Voltage Regulators

7805	5V 1A positive	27-78052	0.40
7812	12V 1A positive	27-78122	0.40
7815	15V 1A positive	27-78152	0.40
7905	5V 1A negative	27-79052	0.49
7912	12V 1A negative	27-79122	0.49
7915	15V 1A negative	27-79152	0.49

Transitors

BC182	General purpose	58-00182	0.10
BC212	General purpose	58-00212	0.10
BC237	Plastic BC107	58-00237	0.08
BC238	Plastic BC108	58-00238	0.08
BC239	Plastic BC109	58-00239	0.08
BC307	Complement to BC237	58-00307	0.08
BC308	Complement to BC238	58-00308	0.08
BC309	Complement to BC239	58-00309	0.08
BC327	Driver/power stage	58-00327	0.13
BC337	Driver/power stage	58-00337	0.13
MPSA13	NPN Darlington	58-04013	0.30
MPSA63	PNP Complement to MPSA13	58-04063	0.30
J310	JFET for HF-VHF	59-02310	0.69
J176	JFET analogue switch	59-02176	0.65
3SK51	Dual gate MOSFET-VHF amp	60-04051	0.60
3SK88	Dual gate MOSFET-Ultra lo noise	60-04088	0.99
TIP31A	Output stage	58-15031	0.35
TIP32A	Complement to TIP31A	58-15032	0.35
VN66AF	VMOS Power FET	60-02066	0.95
ZTX3866	E-line version 2N3866	58-03866	0.45
IN4001	Rectifier diode	12-40016	0.06
IN4002	Rectifier diode	12-40026	0.07
IN4148	General purpose silicon	12-41486	0.05

Silicon Controlled Rectifiers

BRY55-100	100V .8A	52-55100	0.50
C106DI	400V 4.0A	52-00106	0.70
C122DI	400V 8.0A	52-00122	1.45

3mm Diameter LEDs

V178P	Red	15-01780	0.15
V179P	Green	15-01790	0.16
V180P	Yellow	15-01800	0.18

5mm Diameter LEDs

CQY40L	Red	15-10400	0.12
CQY72L	Green	15-10720	0.15
CQY74L	Yellow	15-10740	0.15

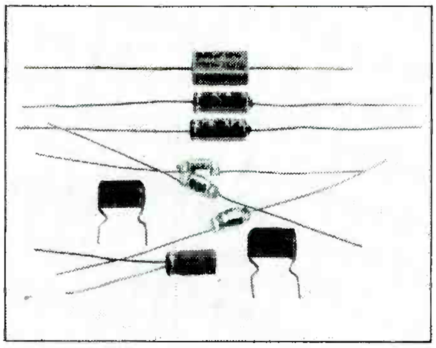
Infra-Red LEDs

CQY99	Emitter	15-10990	0.56
BPW41	Detector	15-30410	1.51

Tri Colour LED

V518	Orange-Green-Yellow	15-05180	0.60

Capacitors



Aluminium Electrolytics Radial PCB Mounting

			Pack of 4
10u	16V	05-10606	0.24
47u	16V	05-47606	0.28
47u	25V	05-47607	0.28
470u	6.3V	05-47705	0.36
470u	16V	05-47706	0.48

Tantalum Beads

			Each
1uf	35V	05-10501	0.18
10uf	16V	05-10601	0.28
47uf	6.3V	05-47601	0.45
47uf	16V	05-47602	0.92

Monolithic Capacitors

		Pack of 3
1n	04-10204	0.39
10n	04-10304	0.42
100n	04-10404	0.45

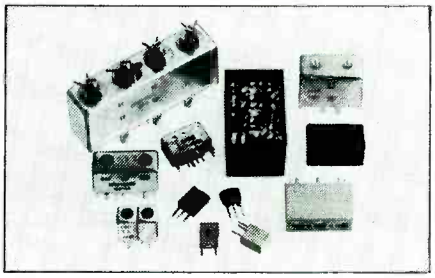
Low Voltage Disc Cermaic

		Pack of 5
1n	04-10203	0.20
10n	04-10303	0.20

Polyester (C280)

		Pack of 3
10n	04-10305	0.18
47n	04-47305	0.24
100n	04-10405	0.24
470n	04-47405	0.51
1uF	04-10505	0.66

R F Components



Filters

CFU/LFB CFW/LFH SERIES

Miniature 455kHz filters. I/P and O/P impedance 2K.

	−6dBW	−40dBW		
LFB6/CFU455H	6kHz	18kHz	16-45512	1.95
LFB12/CFU455F	12kHz	26kHz	16-45515	1.95
LFH6S/ CFW455HT	6kHz	14kHz	16-45525	2.45
LFG12S/ CFW455FT	12kHz	22kHz	16-45528	2.45
CFM2455A Mechanical IF Filters for 455kHz			19-45530	0.77

Crystal Filters 2 Pole Types

10M15A	10.7 Centre Freq.	20-10152	2.10
10MO8AA	10.695 Centre Freq.	20-11152	3.49

Inductors

We offer the complete Toko range of fixed and variable inductors. Over 500 coils from audio to V.H.F. See catalogue for details.

Soldering Irons (Antex)

CS240	Iron 240VAC 17 Watts	54-22300	5.20
XS-240	Iron 25W 240V High heat capacity	54-22500	5.40
SK6	Presentation pack of one XS-240 with ST4 stand	54-22510	7.20
MLXS	Handy 12V 15W soldering iron complete with crocodile clips and solder	54-20004	5.60

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £2 please. We reserve the right to vary prices in accordance with market fluctuation.

CIRCLE 20 FOR FURTHER DETAILS.

Basic leap-frog

There is evidence that universities running courses for electronic engineers are playing leap-frog.

Circuit design does not seem to be considered a vital part of the curriculum, perhaps because many of the circuit functions that used to be taught are now contained in integrated circuits. The effect of this, in recent times, is that new graduates are somewhat diffident in the basics of circuit design, though fully proficient in the development of i.cs. "They all know how to shuffle little black bugs around on a board, but ask them to design a feedback amplifier and they want to go home" is how one manufacturer describes a recent influx of design staff.

Clearly, education and training must move with the times, but such a policy of leap-frogging the basics of design to concentrate on using modules of other people's design does appear to be a little short-sighted. There is obviously a lower level of complexity below which one simply buys and fits — no one wants to make resistors and capacitors — but, since i.cs now constitute the largest part of most designs, it surely makes sense to know enough circuit design to understand how they work. Not to do so is not to be an electronic engineer at all. It has always been the case in the past that an engineer should be familiar with the design and construction of components such as inductors and transformers, delay lines, power supplies and thermonic devices, even though they were usually bought 'off the peg' and fitted. Nothing has changed — but i.cs are commonly connected together to form a highly complicated piece of equipment, the 'designer' having only a hazy notion of what the individual components are doing. Time in a university course is limited, and our industry has evolved so rapidly that a great deal of new technology must now be taught, but even so, to gloss over the rudiments of any subject is a practice fraught with danger. We may still see a generation of highly skilled designers who are unable to design.

Telephone hang-up

The home computer magazines are calling 1984 the year of the modem. As an entertainment medium. The modem has a lot to recommend it — certainly when you compare it with the handful of games cassettes you might get for the same money. So it's a pity that the majority of modems available to the impecunions home user are (how can I put it?) illegal. Illegal to use, anyway.

The problem is that anything you connect to a telephone line has by law to be scrutinised by the British Approval Board for Telecommunications — Babtee to its intimats. But getting a device approved by BABT is a slow business, and not a course to embark upon unless you have kilopounds to spare. All right for commercial manufacturers, perhaps, but how about the poor home constructor?

BABT cannot vet a construction kit, still less a paper design. So anyone who wants to build our multi-standard modem may face the icy blast of official disapproval — along with all the other people using bootleg modems.

Most of these illicit modems are undoubtedly perfectly sanitary from a technical point of view. And BT's chances of catching people using them can hardly be very great. BT, who are probably more concerned about the menace of improted cordless telephones, may even be happy to take the extra revenue.

Nobody stands to gain from doing damage to the telephone network, least of all the modem users themselves. So who are they harming? In some countries the telephone authorities can provide simple isolators for connecting subscribers' equipment to their lines. Would it be such a sacrifice to allow that in Britain?

Alternative energy

Did you know that on the larger wind generators, it's predicted that a broken blade could fly through the air for up to 2km? Imagine the devastation should such an object hit an unsuspecting bus queue from the back.

We're about to set up a campaign against these lethal devices before it's too late; electronic safety measures are fine but they can't hold back a broken blade once it has set off at around Mach 0.9. Current propaganda has convinced us that nuclear power stations are the only option for alternative energy, especially the extra safe ones that we use in the UK. The only slight reservation we still have is about the possible leakage of one of the massive chlorine tanks used for water purification, but we haven't found any figures on this subject yet, so our money is on nuclear energy.

After all, even when the dead weight of Britain's industry has been cleared — iron foundries, heavy engineering and the like — we'll still need a lot of electricity to power the computers used by the millions of retrained workers. And workers not prepared to retrain will have lots of spare time in which they'll be using their electric-powered microwave ovens and dish washers. That is, when they realise that fish and chips with v.a.t. are a little over the top.

£10million Alvey contracts

Two contracts worth £10million in the Alvey Programme of advanced information technology placed last month are the first major contracts in the five year £350million collaborative project. Alvey (*WW* page 31 December 1982) was given the go-ahead a year ago and under it the Government will fund 50% of industrial costs and 100% of university costs. The first for what is called an "integrated project support environment', is a multi-language advanced software tool that aims to support developers of real-time distributed computing systems at the centre of large complex systems such as industrial process control, avionics, and advanced communication systems. The £3.6million project, called Aspect, is a 'first-generation' IPSE led by Systems Designers who will use their IPSE 'Perspective' that supports production of Pascal programs for embedded applications, University of York who developed an Ada compiler, MARI with the 'Newcastle Connection' software for linking distributed Unix machines, as well as ICL with Perq expertise and GEC, with Series 63 computers. (A second generation IPSE will support distributed software development, and a third generation will contain knowledge-based tools to give 'intelligent' support to software developers, otherwise called an 'information systems factory'.)

Announcing the contract Kenneth Baker, minister for information technology, said Aspect will play a vital role in increasing productivity throughout the software engineering community: "The Alvey Programme aims to turn writing software from a craft into an engineering discipline" he said.

A consortium led by ICL has been awarded the second contract, worth £6.5million over five years, for a large scale demonstrator project to evaluate the role of new computing technologies in the formulation, interpretation and application of complex policies and rules. A team of DHSS officials will work with the consortium of ICL, Logica, Imperial College, Universities of Lancaster and Surrey. The project will cover investigations of intelligent knowledge-based systems and man-machine interfaces, as well as software engineering techniques.

Efp conferences

Electronics for Peace is organising three regional Saturday conferences this summer for electronics and computing engineers to meet and discuss the wider social and military implications of the electronics industry.

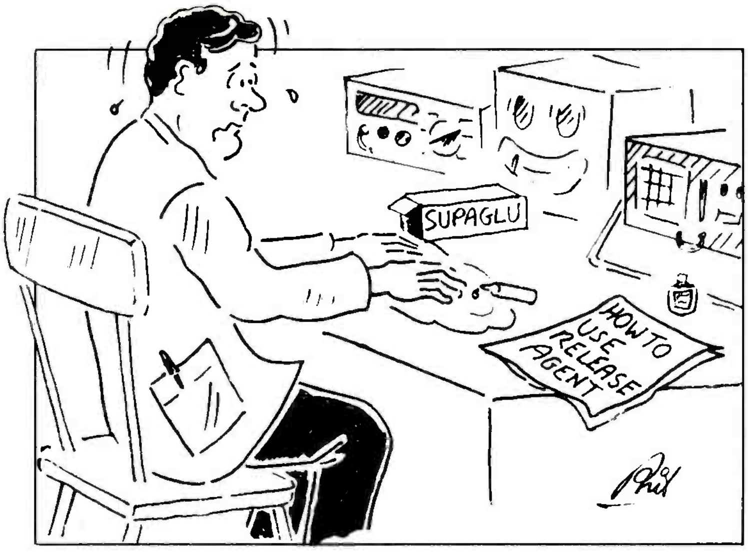
The dates and places are

Saturday June 2nd, Sheffield
Saturday June 9th, Bristol
Saturday June 16th, London.

Details from Efp, 151 Courthouse Road, Maidenhead, Berks, or tel. (evenings) 0892-46354 or 0628-20225.

For Ambit read Cirkit

Following rapidly on the report that Ambit, the component distributors, were to move to Broxbourne, was another report that they have been sold to A.F. Bulgin & Co. Bulgin are to combine this company with others (Solent Component Supplies, Broxlea Ltd and Projex Distribution) into a single company to be known as Cirkit. The new company will retain the policy of Ambit of selling components in small quantities to the home constructor as well as in bulk to industry. The catalogues of all the different companies listing over 10 000 different products are to be combined into a single consolidated catalogue later in the year. Cirkit commences trading from Broxbourne, Herts, from May 1st.



Pointing a satellite

Ways of improving the orientation of satellites in space are to be investigated by Marconi Space and Defence on behalf of the European Space Agency. The study is to concentrate on the problems presented by large, flexible solar power panels which are to be used on the very large telecommunications satellites. Large satellites with high output powers need to be manoeuvered with a high degree of accuracy to ensure that their communications antennae are correctly oriented with respect to Earth receivers; even a tenth of a degree error in the direction of a communications beam can mean a serious loss of data. In addition some satellites use very narrow beams, making the need for accuracy even more important. Greater precision has been achieved already in smaller craft where the solar energy panels are attached to the body of the craft. In the large craft however, the panels tend to flex under the impulses generated by correction thruster rockets. The flexing can introduce unwanted movement in the craft and further compensation is required, which in the extreme case can lead to a 'hunting' effect; wasteful in fuel and reducing the life of the satellite. The study is to take a mathematical approach to the problem. There is an algebraic theorem by Sturm, proposed in 1836, which may be used to calculate a correctly timed sequence of thruster commands. The commands should correct the pointing of the craft and take into account the vibration of any flexible parts at the same time. The research programme will also look at the modes of vibration of such flexible structures by using a single sensor, typically a gyroscope, attached to the spacecraft. By adopting these techinques it should be possible to improve the accuracy of pointing the satellite from the present 0.15°to better than 0.05°

TV deliveries record

More than $4\frac{1}{2}$ million television sets were delivered to the trade in 1983, a record for the industry according to BREMA, and nearly 17% higher than the previous year. The trend toward portables increasing their share continued, with the small screen segment taking 36%, an increase of 16%. Both teletext and small-screen monochrome deliveries were 12% up on 1982. Surprisingly however deliveries of video recorders and of music centres, the other two main categories that Brema analyse, have levelled off and show no growth over the previous year. For video this was in some measure due to rising prices of the more 'sophisticated' machines coming onto the market, say Brema, together with a run-down of stocks in the wake of uncertainties relating to format trends and the level of Japanese imports following the recent MITI and EEC agreement.

Adaptive delta modulation for tv sound

With an eye to satellite and cable reception for tv sound, Dolby Laboratories have developed a digital encode-decode system that could also be used for terrestrial broadcasting of stereophonic tv. The new digital audio system — shown at Eurocast, Basel, in May — has already been licensed to General Instrument in the USA for use in its satellite tv plans. Under the terms of the licensing agreement, General Instrument will build subscriber decoders and Dolby will manufacture encoders for use at the up-link satellite station or at the cable system head-end.

The specifications of the process, a form of adaptive delta modulation, are comparable to those of the Compact Disc: 'The high cost of the CD process and of other promised home digital home media may well impede the growth of consumer acceptance of digital audio' say Dolby Labs. The Dolby/GI pact they say will allow tv audio to be the first to deliver digital audio quality to the regular consumer.

Dolby aimed at a narrow bandwidth, around 200 to 350kbit/s, the exact rate being chosen to suit the transmission system, and chose delta modulation rather than p.c.m. because of superior performance at low data rates and lower sensitivity to errors. No precision components are needed in the decoder, the performance and bandwidth advantages being gained by placing more complex circuitry in the transmission encoders. The system is said to be particularly useful for electronic delivery systems such as cable tv, satellite-delivered programmes and d.b.s. audio systems, where minimal error correction will lead to cheaper decoder designs.

Dolby Laboratories must be hoping to have more luck in interesting the BBC in this development than they did with the analogue Dolby f.m. scheme; the BBC have said they are now considering a digital system for stereophonic television.

934MHz Club UK

A club for users of 934MHz Citizens' Band has been formed to encourage and further the use of this band and to represent users to the official bodies concerned with radio communications. There will be a quarterly magazine to keep members informed of news and events with details of new equipment, letters and technical queries. Projected is a National QSL bureau for use by members, with club log books and QSL cards. The club organizers have already written to those users that they know of and have had a good response but they are aware that there is a large number of users that they haven't contacted but who might like to join. Details from the Honorary Secretary, 934MHz Club UK, Glenys Anthony, PO Box 424, Chelmsford, Essex CM6 3UR.

New Research Head at BBC

Bruce Moffat has been appointed the new Head of BBC Engineering Research Department, where he has spent most of his working career. He has undertaken investigations into the causes and prevention of head clogging in video tape recorders, and into the possible techniques for digital television recording. As Head of the baseband systems section he worked on the development of multi-channel digital audio transmission systems and near-instantaneous digital companding, the forerunner of Nicam, accepted by the CCIR as part of a system for satellite broadcasting. On transferring to the storage and recording section he managed many projects including real-time digital audio signal processing, which has made feasible the development of a digital sound mixing desk. Another project was digital multi-image storing and animation. As head of the studio group he became responsible for the workings of several sections. Dr. Moffat has written or contributed to numerous papers, mostly on digital audio and video techinques. He also serves as chairman of the UK CCIR working group on high-definition tv.

Optical data storage

Two agreements have been signed for the development of laser-read disc systems for the storage of computer data. The first is between Philips and the US Computer manufacturer, Control Data. They plan to extend their existing co-operation in optical disc storage development to also include the design, manufacture and marketing of optical recording peripherals and associated media for use with computers. The discs are likely to be only written on once to give a permanent record of up to a billion characters. The reading process will be similar to that used in Laservision and compact discs. The jointly owned company is to be known as Optical Storage International (OSI).

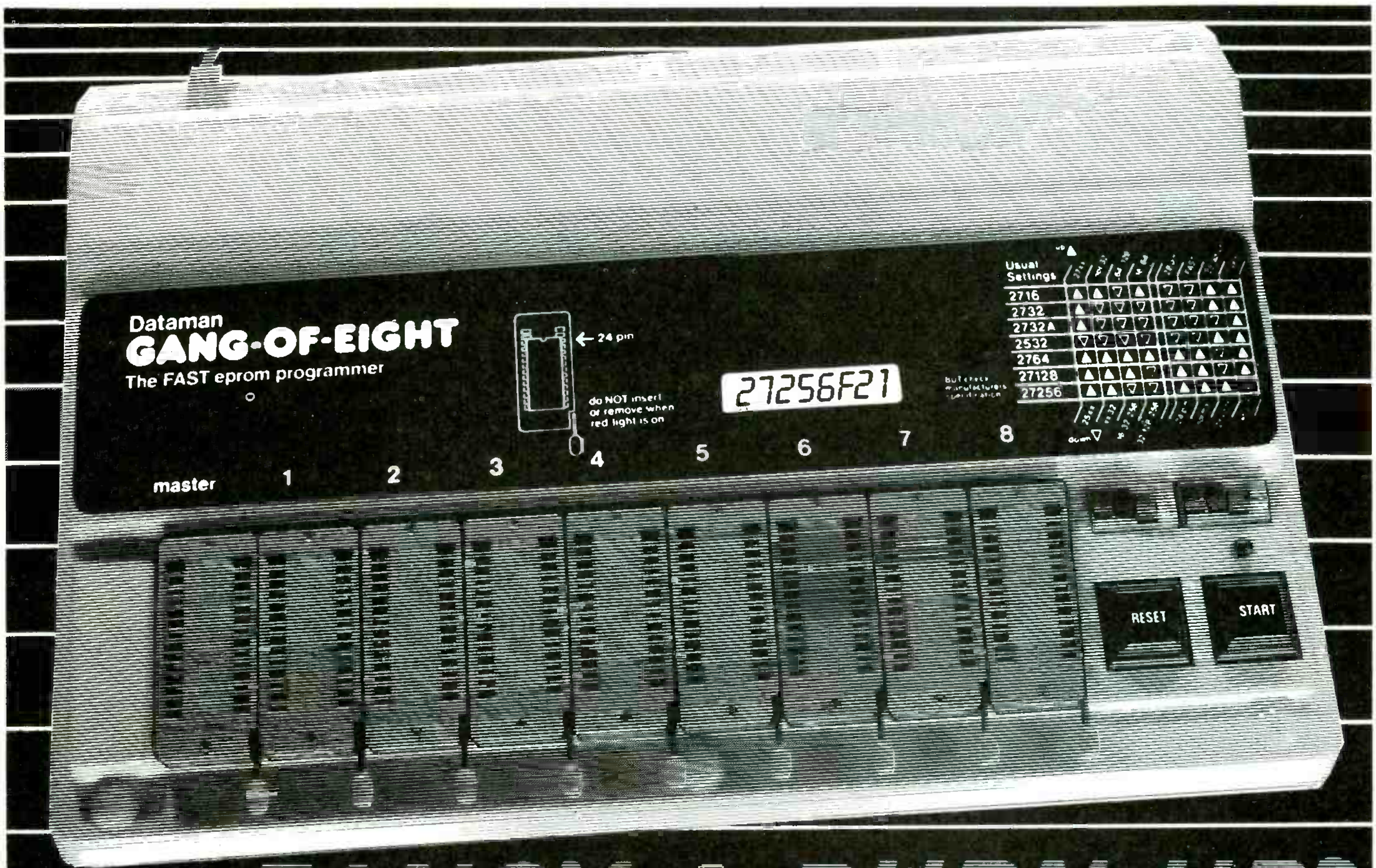
With a slight rearrangement of the initials we get OIS, Optical Information Systems, another joint company this time formed by an agreement between Acorn Computers and BSR International. They too intend to develop a new digital, optical data storage. BSR is to provide the high volume manufacturing facilities while Acorn uses their computer technology know-how. Their first joint product will be a compact laser disc drive with significantly greater storage capacity, and faster access time than presently available with conventional floppy discs.

6809 newsletter

First issue of the 6809 User Group Newsletter (March-April) is priced at 75 pence but subsequent issues will cost 50p, according to its editor Paul Hills, and includes a free 6809 instruction card, "After long pauses and polite arguments" says Paul "we exist" and although only a small group he believes '6809' will stay alive because for every reader 90% of it is relevant. "Looking through another newsletter, I found *only* one out of 13 articles that were relevant to my interests." The first issue contains articles on an assembly course for upgrading from 6502, software for 6809 based microcomputer with normal memory-mapped screen, interfacing 76489 sound generator, and is available from Paul Hills at 28 Woburn Road, Launceston, Cornwall.

Electronics consultancy

John Woodgate, B.Sc (Eng), A.M.I.E.E., with over 25 years of product design and marketing experience, has left ITT Consumer Products (UK) as products manager to set up his own consultancy J.M. Woodgate & Associates. Currently specializing in standards advice, he is chairman of two BSI committees on electronic equipment for domestic and educational use, as well as being involved with international standards work. J.M. Woodgate also offer prototype design and evaluation of audio and video equipment, display equipment for exhibitions and consultancy in marketing. 3 Bramfield Road East, Rayleigh, Essex SS6 8RG.



FANCY A BURN-UP?

FAST PROGRAMMING

When manufacturers' recommended Fast Programming Algorithms can be used. GANG-OF-EIGHT IS FIVE TIMES AS FAST AS A STANDARD PROGRAMMER. This means you can program a set of 27128's in 2 minutes — not 14 minutes. Or 2764's in 1.25 minutes instead of 7 minutes.

GANG-OF-EIGHT will program all single-rail devices from 2716 to 27256 with FAST or NORMAL algorithms. All possible levels of programming voltage are covered — even the latest 10.5 and 12.5 volt levels.

FAST THROUGHPUT

GANG-OF-EIGHT has SINGLE-KEY OPERATION, which makes life very easy for the operator. It always performs VERIFY and BLANK-CHECK operations automatically: it won't let you program the same EPROMS twice, or program EPROMS which are not blank. In the FAST programming mode, GANG-OF-EIGHT can produce several times the output of a standard programmer.

FAST DELIVERY

At the time of writing, DATAMAN has more than enough stock to meet the expected demand for GANG-OF-EIGHT. If you want confirmation before sending your cheque, please telephone us with an order number and a GANG-OF-EIGHT will be packed and set aside for you.

FAST MONEY BACK GUARANTEE

Part of our value-for-money deal is the REFUND GUARANTEE: if you don't want your GANG-OF-EIGHT you can return it within a fortnight and we'll send your money back immediately, less the cost of postage. We realise that this is like operating a free hire service, but we believe that most engineers are straight. *We will be most surprised if we get any GANG-OF-EIGHTS back.*

FEATURES

- ★ CONVERSATIONAL LIQUID CRYSTAL DISPLAY
- ★ NINE INDUSTRY — STANDARD TEXTOOL ZIF SOCKETS
- ★ SWITCH-SELECTION OF EPROM TYPE (NO MODULES TO BUY)
- ★ PROGRAMS ALL SINGLE RAIL EPROMS INCLUDING 27256
- ★ USER CAN CHOOSE NORMAL OR FAST PROGRAMMING ALGORITHM
- ★ SINGLE KEY OPERATION
- ★ WORKS FASTER THAN STANDARD PROGRAMMER
- ★ INTELLIGENT OPERATION TRAPS OPERATOR ERRORS
- ★ SAFETY FEATURES BUILT-IN
- ★ LOW-COST DESIGN

GANG-OF-EIGHT, including instruction card, power supply and carriage **£395** + VAT (= £454.25)

Dataman Designs

Lombard House, Cornwall Road,
Dorchester, Dorset, United Kingdom
Telephone: Dorchester (0305) 68066.
Telex: 418442

CIRCLE 27 FOR FURTHER DETAILS.

LINSLEY-HOOD 300 SERIES AMPLIFIERS

35 Watt Complete Kit. MosFet O/P	£79.50
45 Watt Complete Kit. MosFet O/P	£83.50
Reprints of Original Articles from 'Hi-Fi News'	£1 no VAT.

LINSLEY-HOOD 100-WATT MOSFET POWER AMPLIFIER

The very latest amplifier design, published in 'Wireless World' by the renowned John Linsley-Hood. This may now be taken as the standard by which the rest are judged! Our kit, approved by the designer, has massive heat sinks and power supply and includes all components needed to build. Case size 412mm wide, 254mm deep and 145mm high. Automatic switched speaker protection is included as standard. Cost of all parts is over £120. Our complete stereo kit price **£105.50**.

SOLENOID CONTROLLED HI FI/DIGITAL CASSETTE MECHANISM

Front loading deck with full solenoid control of all functions including optional read in fast wind modes. 12 volt operation. Fitted 3-digit memory counter and Hall IC Motion Sensor. Standard erase and stereo R/P Heads. Cheapest price ever for all these features. Only **£38.90** plus VAT. Full technical specification included.

LINSLEY-HOOD CASSETTE RECORDER CIRCUITS

Complete record and replay circuits for very high quality low noise stereo cassette recorder. Circuits are optimised for our HS16 Super Quality Sendust Alloy Head. Switched bias and equalisation to cater for chrome and feric tapes. Very easy to assemble on plug-in PCBs. Complete with full instructions.

Complete Stereo Record/Play Kit	£25.26
VU Meters to suit	**£2.30 each**
Reprints of original Articles	**75p. No VAT.**

STUART TAPE RECORDER CIRCUITS

Complete stereo record, replay and bias system for reel-to-reel recorders. These circuits will give studio quality with a good tape deck. Separate sections for record and replay give optimum performance and allow a third head monitoring system to be used where the deck has this fitted. Standard 250mV input and output levels. Full details are in our lists.

Reprint of Original Articles	**£1.30. No VAT.**

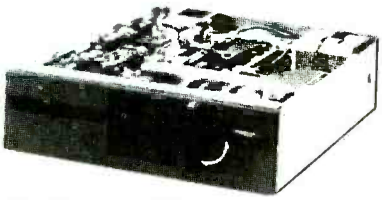
ALPS FF317U FM FRONT END

Beautiful, precision made High Quality variable capacitor tuned FM Front End with Dual-gate MosFet. The tuning capacitor also has 2-AM Gangs and built in 3:1 reduction gear. Covers full FM range of 87 to 109MHz. Supply needed is 12V at only 30mA Max. Inputs are provided for AGC and AFC signals. These have recently been on special offer from another supplier at **£4 plus VAT. OUR PRICE IS ONLY £3.99 INCLUDING VAT AND POSTAGE!** Circuit if required **35p.**

COMPLETE STEREO TUNER MODULE

Three band LW/MW/FM Stereo Tuner fully assembled on PCB 165 × 85mm. Supplied with Ferrite rod aerial and band switch fully wired. Facility provided to drive tuning meter and stereo LED. Only needs 12v DC supply. FM sensitivity. 2.5uV. **Price only £7.99 inc. VAT and post.**

HALF HEIGHT 5¼" FLOPPY DISK



Latest MPU controlled 80 Track Drives, support single or double density. Fully compatible with Teac, Shugart and many other full and half height drives.

80 Track. Single side	£179
80 Track. Double side	£225

Full manual for each type £14.50. No VAT.

HIGH QUALITY REPLACEMENT CASSETTE HEADS

Do your tapes lack treble? A worn head could be the problem. Fitting one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our TC1 Test Cassette helps you set the azimuth spot-on. We are the actual importers which means you get the benefit of lower prices for prime parts. Compare us with other suppliers and see! The following is a list of our most popular heads, all are suitable for use on Dolby machines and are ex-stock.

HC20 Permalloy Stereo Head. This is the standard head fitted as original equipment on most decks **£5.11**

HM90 High Beta Permalloy Head. A hard-wearing, higher performance head with metal capability **£8.06**

HS16 Sendust Alloy Super Head. the best head we can find. Longer life than Permalloy, higher output than Ferrite, fantastic frequency response **£9.91**

HQ551 4-Track Head for auto-reverse or quadrophonic use. Full specification record and playback head **£9.73**

Please consult our list for technical data on these and other Special Purpose Heads.

HART TRIPLE-PURPOSE TEST CASSETTE TC1

One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only **£4.66** plus VAT and 50p postage.

Tape Head De-magnetiser. Handy size mains operated unit prevents build up of residual head magnetisation causing noise on playback .... **£4.54.**

Curved Pole Type for inaccessible heads **£4.85**

COMPONENTS

We now list a wide range of individual components many of which are not available elsewhere. Send for your copy of our latest list which also gives further information on our Kits.

Please add part cost of post, packing and insurance as follows:

INLAND
Orders up to £10 – 50p
Orders £10 to £49 – £1
Orders over £50 – £1.50

OVERSEAS
Please send sufficient to cover
Surface or Air Post as required.

ALL PRICES EXCLUDE VAT UNLESS STATED

Personal callers are always very welcome but please note that we are closed all day Saturday

(0691) 652894

HART ELECTRONIC KITS LTD
PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

Valradio

DC-AC INVERTERS

Valradio Transvertors are being used all over the world for standby AC purposes, vital services, mobile, field and industrial applications including computers, video TV, Hi-fi, alarms and many other types of equipment.

SINE/SQUARE WAVE INVERTERS 30 to 1000 watts, 50 (or 60) HZ, 115/230V, single phase AC. From 12, 24, 48, 110 or 220 Volts DC.

We also manufacture Frequency Changers, Power Supplies, Standby Systems and No-Break Systems, and we are always happy to quote for your special requirements

Please send for full details to:

Valradio POWER LIMITED
AK INTERNATIONAL BUILDING, LAWRENCE ESTATE,
GREEN LANE, HOUNSLOW, MIDDX TW4 6DU,
ENGLAND. Tel: 01-570 5622

CIRCLE 9 FOR FURTHER DETAILS.

BIRD Electronic Corporation

THRULINE® Directional Wattmeters
TERMALINE® RF Coaxial Load Resistors
TENULINE® Attenuators and accessories from stock

Aspen Electronics Limited

The exclusive UK representative for Bird Electronic

2/3 Kildare Close, Eastcote, Ruislip
Middlesex HA4 9UR
Tel: 01-868 1188 Tlx: 8812727

CIRCLE 43 FOR FURTHER DETAILS.

Lynwood GD1 VDUs: Intelligent Green micro controlled, RS232, printer port, 101 key k/b. Full Video enhancements. .... ONLY **£149** + £15 P&P (S/H)

Burroughs MT686/7/TD710: Intelligent Green 12" VDU with 3 micros and 64K store. RS232. Programmable. . . Only **£199** new or £149 S/H + £15 P&P

Videcom Apollo VDUs: Stylish 15" Green Z80 controlled VDU with printer port and lots of very advanced features. .... Only **£399** new or £249 S/H £15 P&P

Centronics 306 Line printers: Professional fast (120 cps), superb quality 80 column printer. Parallel i/f..... ONLY **£99** + £15.00 P&P

Computhink Act 800 Computer system. Dual floppies (2.4Mb) and lots of business software	ONLY **£1200**
Diablo 630 Daisywheel printer. OEM i/f	NEW **£599** + £15 P&P
Diablo Hitype 2 Daisywheel, Tractor unit,	S/H **£399** + £15 P&P
Calcomp 565 Drum Plotter, 10thou steps.	ONLY **£450** + £10 P&P

BECKENHAM PERIPHERALS LTD
01-778 3600
124 Lennard Road, Beckenham
Kent BR3 1QP

Callers welcome by appointment

SAE for LIST and enquiries

CIRCLE 15 FOR FURTHER DETAILS.

Electronic Brokers

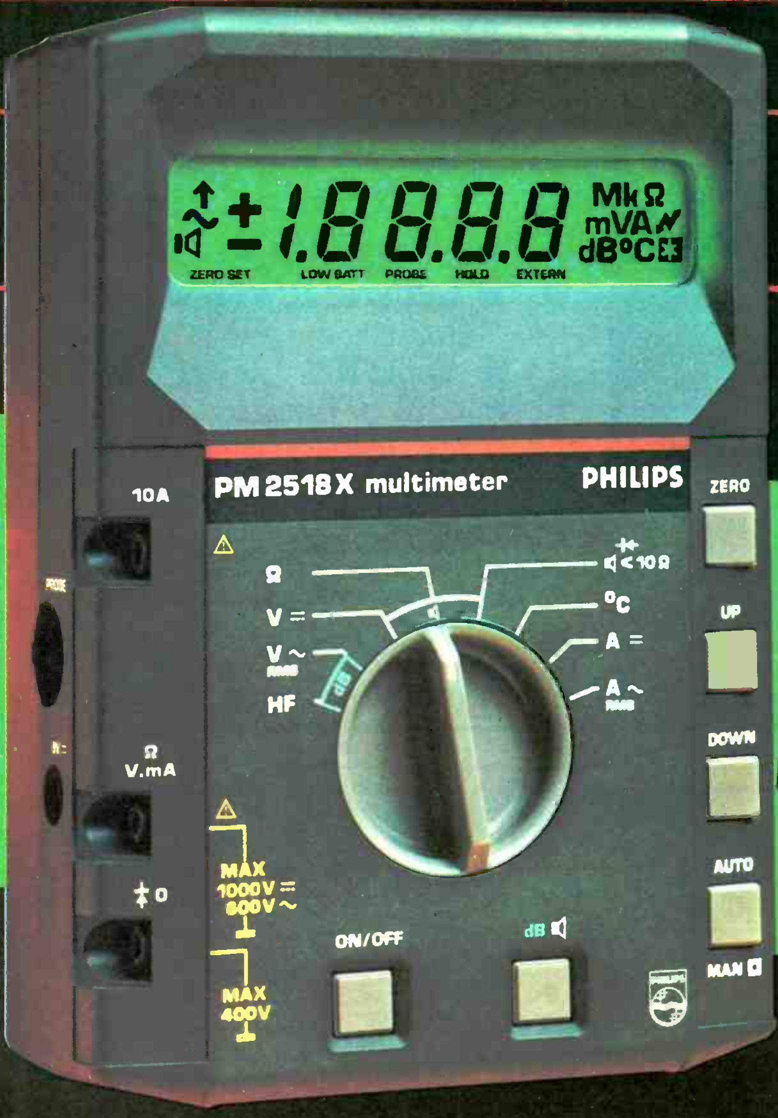
INTRODUCE THE

New Generation

PM2518X

Portable Multimeter with

ELECTRO LUMINESCENT DISPLAY



Electronic Brokers bring you the PM2518X — an exciting new development in electronic test and measuring. The PM2518X is a hand held digital multimeter with accuracy and performance equal to more expensive bench models.

An outstanding feature is the Electro Luminescent Display which automatically switches itself on in the dark — invaluable when taking readings in dimly lit areas.

The PM2518X also offers autoranging, 20 amp current range, true RMS measurements on AC voltage/current, extended 4 digit capability, dB/relative reference, and much, much more.

Contact Electronic Brokers today for the full facts on this amazing new multimeter.

£199 **+ VAT**
Complete with Batteries.

Also available without Luminescent Display at £165 + VAT.

Display	:LCD, 12 cm tall with range and message characters
ADC System	:Delta modulation with auto zeroing, 11,000 counts
Reading rate	:2.5 measurements/sec
CMRR DC	:>100 dB
CMRR 50 Hz AC	:>80 dB
SMRR 50 Hz ± 1%	:>60 dB
Ranging	:Fully Auto ranging except 100 Mohm
Range Selection	:Auto range up at 110% fs :Auto range down at 10% fs :Manual ranging by UP/DOWN keys
Data hold	:By PM 9267 probe
Overload	:Indicated by OL on display
Underload: (dB)	:Indicated by UL on display
Crest Factor Overload	:Indicated by ↑ on display
High voltage >110 V	:Indicated by ↯ on display
Beeper Function	:Selectable on >100% Vdc or <1% ohms
Max V x Hz product	: 10^7
Reference Conditions	:23°C±1°C Humidity 20-80% Dew point 28°C
Rated range of use	: −10°C to +55°C
Specified range of use	:0°C to +45°C
Storage range	: −40°C to +70°C
Calibration Interval	: 1 year
Power supply	:4 x R14 type batteries or PM 9218 power supply
Battery life	:For PM 2518 X/01 >400 hrs. :For PM 2518 X/11 >200 hrs.
Safety	:Class II according to IEC 348/VDE 0411
Guarantee Period	: 1 year
Accessories supplied	:Set of PM 9266 safety measuring leads and probes, operating manual and spare fuses
Dimensions l x b x h	: 170 x 55 x 118 mm
Weight	:0.7 kg

Electronic Brokers Ltd., 61/65 Kings
Cross Road, London WC1X 9LN.
Tel: 01-833 1166. Telex 298694

Electronic Brokers

A copy of our trading conditions can be supplied on request.

CIRCLE 201 FOR FURTHER DETAILS.

COLOURJET 132

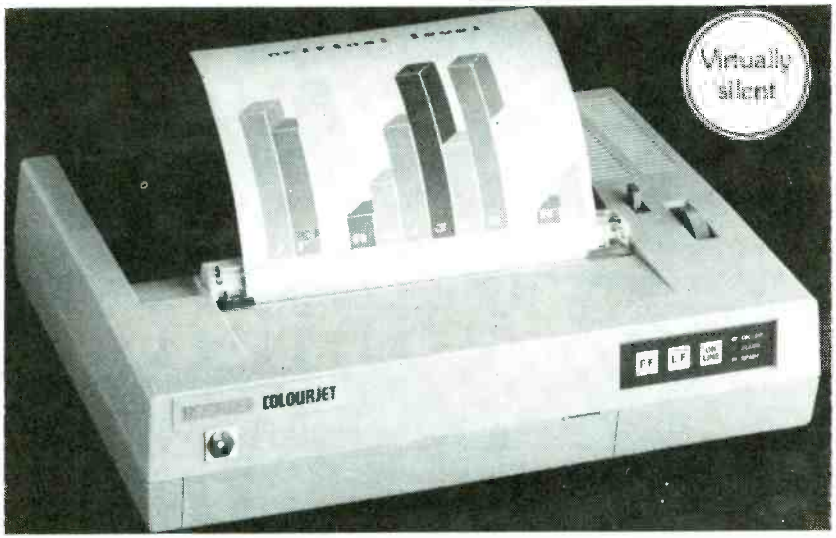
7 COLOUR INK JET PRINTER

Logic seeking in dot address mode

132 Column Compressed Mode

Cash price **£499** + VAT

Centronics parallel interface with **full Viewdata** and free BBC Micro dump listing.



also: prints OVERHEAD TRANSPARENCIES

Options available
- Buffered RS232/Viewdata interface
- Apple II & IIe interface
- IBM pc dump

Specifications:
1280 dots/line in double res. mode
37cps in full colour
Friction feed roll paper and single sheet feed A4
Ink cartridges 4 million character life

INTEGREX LIMITED

Portwood Industrial Estate, Church Gresley
Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432. Telex: 377106

Sowter Transformers

With 42 years' experience in the design and manufacture of several hundred thousand transformers we can supply

AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES:

Microphone transformers (all types), Microphone Splitter/Combiner transformers, Input and Output transformers, Direct Injection transformers for Guitars, Multi-Secondary output transformers, Bridging transformers, Line transformers, Line transformers to G.P.O. Isolating Test Specification, Tapped impedance matching transformers, Gramophone Pickup transformers, Audio Mixing Desk transformers (all types), Miniature transformers, Microminiature transformers for PCB mounting, Experimental transformers, Ultra low frequency transformers, Ultra linear and other transformers for Transistor and Valve Amplifiers up to 500 watts, Inductive Loop transformers, Smoothing Chokes, Filter, Inductors, Amplifier to 100 volt line transformers (from a few watts up to 1,000 watts), 100 volt line transformers to speakers, Speaker matching transformers (all powers), Column Loudspeaker transformers up to 300 watts or more.

We can design for RECORDING QUALITY, STUDIO QUALITY, HI-FI QUALITY OR P.A. QUALITY. OUR PRICES ARE HIGHLY COMPETITIVE AND WE SUPPLY LARGE OR SMALL QUANTITIES AND EVEN SINGLE TRANSFORMERS. Many standard types are in stock and normal despatch times are short and sensible. OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING AUTHORITIES, MIXING DESK MANUFACTURERS, RECORDING STUDIOS, HI-FI ENTHUSIASTS, BAND GROUPS AND PUBLIC ADDRESS FIRMS. Export is a speciality and we have overseas clients in the COMMONWEALTH, EEC, USA, MIDDLE EAST, etc. Send for our questionnaire which, when completed, enables us to post quotations by return.

E. A. Sowter Ltd.

Manufacturers and Designers

E. A. SOWTER LTD. (Established 1941), Reg. No. England 303990
The Boat Yard, Cullingham Road, Ipswich, IP1 2EG, Suffolk, P.O. Box 36, Ipswich, IP1 2EL, England
Phone: 0473 52794 & 0473 219390 : Telex: 987703G SOWTER

CIRCLE 54 FOR FURTHER DETAILS.

Electronic Brokers Ltd

FOR
Philips • Fluke
Hameg • Ice
Test Equipment

Full Colour Catalogue
Send for your free copy now.

Philips PM3207 15MHz Oscilloscope £325
Compact, portable, lightweight oscilloscope designed for field and workshop use. 15MHz bandwidth with 5mV sensitivity. TV and auto triggering from either channel, with adjustable level. Add and invert facilities and X-Y mode. Large screen with internal graticule.

Philips PM3217 50MHz Oscilloscope £850
High 2mV sensitivity, dual trace, 8 x 10cm display with small spot size, high light output and illuminated graticule, auto trigger mode, TV triggering on line and frame. Full X-Y display facilities. Comprehensive second time base facility. Compact dimensions and low weight.
Philips PM 3215 Single time base £695

Philips PM3219 Storage Oscilloscope £2675
Provides comprehensive, cost effective storage of single-shot transients and low frequency events. Variable persistence and variable storage. Auto erase between 1 and 10 seconds, and read button facility. Auto store up to 1 minute, up to 24 hours in 'baby sit' mode. 2mV sensitivity at 50MHz

Philips PM3256 75MHz Oscilloscope £1245
Tough, light-weight ruggedised unit, with shoulder strap, that can be used in harsh service environments. Fast trigger circuits to over 100MHz. TTL triggering is standard. Trigger view third channel and full X-Y display. Dual trace with 2mV sensitivity and delayed time base.
Philips PM 3254 Single time base £1145

Philips PM3267 100MHz Oscilloscope £1250
Versatile and economic instrument designed for advanced electronic environments. Separate main and delayed time base controls with comprehensive triggering facilities and trigger view third channel. Dual trace, 2mV sensitivity, full X-Y display, Z modulation and internal illuminated graticule.

Hameg HM103 10MHz Oscilloscope £158
This small oscilloscope has been designed specifically for field service personnel and advanced electronic hobbyists. Single trace, 10MHz bandwidth with 2mV sensitivity. TV and auto triggering with adjustable level. Internal graticule and in-built component tester.

Hameg HM203-4 20MHz Oscilloscope £264
Designed for general purpose applications in industry and education. Versatile triggering performance to at least 40MHz. Dual trace X-Y operation, TV triggering, add and invert mode and component tester make the price/performance ratio of this scope most attractive.

Hameg HM204 20MHz Oscilloscope £365
High performance scope with peak value triggering up to 50MHz. Versatile triggering facilities and variable hold off control. Dual trace, delayed sweep mode, Z modulation, X-Y operation, internal illuminated graticule and component tester complete the attractive specification.

Hameg HM605 60MHz Oscilloscope £487
Outstanding performance with versatile triggering to 80MHz. Sensitivity 1mV to 30MHz and 2mV above. Bright display from 14kV CRT. Switchable 1kHz/1MHz probe calibrator. Dual trace, delayed sweep, X-Y operation, Z modulation, internal illuminated graticule and component tester.

Hameg HM705 70MHz Oscilloscope £588
General purpose scope with multitude of operatiing modes and trigger facilities. Extremely bright and well defined displays, with 8 x 10 cm. screen and internal illuminated graticule. TV triggering, Z modulation, X-Y display facilities and sweep delay mode. Dual trace

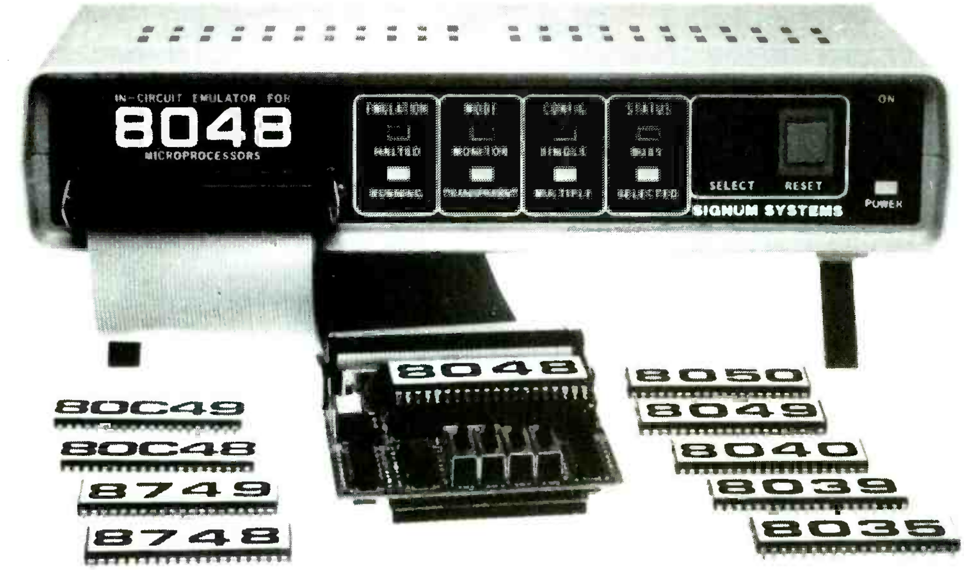
ADD 15% VAT TO ALL PRICES Carriage and Packing extra

Electronic Brokers

Electronic Brokers Ltd., 61/65 Kings Cross Road,
London WC1X 9LN. Tel 01-833 1166. Telex 298694

CIRCLE 202 FOR FURTHER DETAILS.

In-circuit emulation at a price you can afford



small systems engineering limited
2-4 Canfield Place, London NW6 3BT.
Telephone: 328 7145 Telex 264538

E232-48 Stand-alone Emulator for the 8048 microprocessor family

The E232-48 emulates the 8048,8049,8050 microcomputers at their maximum rated speeds. It also provides tools for development, debugging and analysing software and hardware of an MCS-48 microcomputer based system,

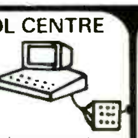
- Connects via a switch configurable universal RS232 link.
- Up to eight emulators may be linked together allowing multiprocessor system emulation.
- Debugging facilities include Dissassembler, In-line assembly, hardware break points, single stepping, scope triggers, external break input and an array of Display/Substitute/Fill commands for Program, internal and external memory. I/O ports, registers and flags. E232-48 £1995 S100 version £1100

Avocet Cross assemblers:
Fast, reliable and user-proven

Cross-assembler	Target microprocessor	CP/M-80	CP/M-86 MSDOS PCDOS
XASM05	6805	£145	£195
XASM09	6809	£145	£195
XASM18	1802	£145	£195
XASM48	8048/8041	£145	£195
XASM51	8051	£145	£195
XASM65	6502	£145	£195
XASM68	6800/01	£145	£195
XASMZ8	Z8	£145	£195
XASMF8	F8/3870	£145	£225
XASM400	COP400	£145	
XASM75	NEC7500	£390	
XASMZ80	Z80	N/A	£195
XASM85	8085		
XASM68K	68000	Coming soon	

CIRCLE 41 FOR FURTHER DETAILS.

HOME CONTROL CENTRE



This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities — and no wiring!

The Kit comprises a transmitter with pre-drilled box and two receivers. XK112 £42.00

XK111 (additional receivers) £10

REMOTE CONTROL KITS

FOR A DETAILED BOOKLET ON REMOTE CONTROL — send 30p + 6" × 9" S.A.E

These kits have been designed to enable infra-red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi Fi or TV. The exact application will determine the interface circuitry (not supplied) between the receiver and the device to be controlled. In many cases this could by a relay or triac. General instructions and applications are supplied with the kits. The kits are coded and provide a high degree of noise immunity and security.

MK18 Transmitter Kit For use with MK11 MK12 Receivers and MK9 10 13 keyboards. Requires PP3 battery. Size 8 × 2 · 1 3cms. Range approximately 60ft £6.80

MK11 Receiver Kit. Mains powered. Provides 10 latched plus 3 analogue outputs. Ideal for controlling audio amplifiers, TV or lighting circuits where control of lamp brightness is required £13.50

MK12 Transmitter Keyboard £4.35

MK19 DC Controlled Stereo Amplifier Kit. If control of stereo amplifier is required the MK19 may be used, providing for remote control of base, treble and volume (or balance). This kit also includes a one of 10 decoder with LEDs for remote selection of programme or channel. May be connected between the pre-amp and power amp sections of almost any audio amplifier £10 70

MK12 Receiver Kit

MK12 (state latched or momentary)	£13 50
MK9 4-way Transmitter Keyboard	£1.90
MK10 16 way Transmitter Keyboard	£5 40
MK15 Dual Latched Solid State Relay	£4 50

SEND SAE 9"x6" for FREE YELLOW CATALOGUE

MICROPROCESSOR CONTROLLED MULTI-PURPOSE TIMER

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre set times over a seven-day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set and forget it — the clock will do the rest. £39.00

XK 114 OPTIONAL RELAY KIT £3.90

Kit includes one relay, PCB to accommodate up to four relays, terminal blocks, etc., to fit inside CT6000 box. Provides up to four 3amp 240V changeover contacts. Additional relays £1.65 each

Add 65p postage & packing + 15% VAT to total
Overseas Customers:
Add £2.50 (Europe), £6.00 (elsewhere) for p&p
Send S.A.E. for further STOCK DETAILS.
Goods by return subject to availability.
OPEN 9am to 5pm (Mon to Fri)
10am to 4pm (Sat)

COMPUTER SHOWROOM

TOP HARDWARE, LATEST SOFTWARE PERIPHERALS, ACCESSORIES AND MUCH, MUCH MORE!

FAST SERVICE · TOP QUALITY · LOW LOW PRICES

No circuit is complete without a call to

TK ELECTRONICS
11-13 Boston Road
London W7 3SJ

TEL. 01-567 8910 ORDERS
01-579 9794 ENQUIRIES
01-579 2842 TECHNICAL AFTER 3PM

CIRCLE 55 FOR FURTHER DETAILS.

AA117	0.09
AA119	0.09
AAY32	0.09
AC107	0.28
AC126	0.17
AC127	0.15
AC128	0.15
AC128K	0.23
AC141K	0.23
AC142K	0.22
AC153K	0.23
AC176	0.18
AC176K	0.20
AC187	0.15
AC187K	0.20
AC180	0.17
AC188K	0.23
ACY18	0.48
ACY19	0.48
AD142	0.60
AD149	0.45
AD161	0.22
AD162	0.22
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.22
AF239	0.22
AL112	0.70
AL113	0.80
ASZ15	1.00
ASZ17	1.00
AU110	1.10
AY102	1.80
AY106	1.80
BA145	0.10
BA148	0.10
BA154	0.06
BA157	0.12
BB101	0.13
BB103	0.16
BB105B	0.18
BB205B	0.24
BC107	0.07
BC108	0.07
BC109	0.07
BC115	0.10
BC118	0.11
BC140	0.19
BC141	0.19
BC142	0.18
BC143	0.19
BC147	0.05
BC148	0.05
BC149	0.05
BC157	0.05
BC159	0.05
BC182	0.06
BC182L	0.06
BC183	0.06
BC183L	0.06
BC184	0.06
BC184L	0.06
BC212	0.06
BC212L	0.06
BC213	0.06
BC213L	0.06
BC214	0.06
BC214L	0.06
BC237	0.07
BC238	0.07
BC300	0.16
BC301	0.18
BC302	0.18
BC303	0.18
BC327	0.06
BC382	0.06
BC337	0.06
BC328	0.06
BC557	0.06
BCY32	1.50
BCY33	1.50
BCY34	1.50
BCY42	0.20
BCY56	0.16
BCY70	0.16
BCY71	0.16
BCY72	0.16
BD115	0.26
BD124P	0.50
BD124	1.10
BD128	0.35
BD131	0.25
BD132	0.25
BD135	0.20
BD136	0.20
BD137	0.20
BD138	0.20
BD139	0.20
BD140	0.20
BD144	0.90
BD150	0.30
BD157	0.38
BD158	0.38
BD166	0.30
BD175	0.30
BD177	0.30
BD179	0.32
BD181	0.45
BD201	0.33
BD202	0.38
BD203	0.42
BD204	0.42
BD222	0.31
BD225	0.31
BD232	0.31
BD237	0.21
BD238	0.24
BD433	0.28
BD437	0.28
BD535	0.38
BD536	0.38
BD537	0.40
BD538	0.40
BDX32	1.00
BDX65	0.80
BF180	0.16
BF181	0.18
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.05
BF195	0.05
BF196	0.06
BF199	0.06
BF200	0.16
BF257	0.18
BF258	0.18
BF259	0.18
BF336	0.20
BF337	0.20
BF338	0.20
BF362	0.30
BF422	0.21
BF458	0.19
BF459	0.19
BFX29	0.20
BFX84	0.20
BFX85	0.20
BFX87	0.15
BFX88	0.15
BFY50	0.14
BFY51	0.14
BFY52	0.14
BFY56	0.25
BYF57	0.25
BFY64	0.25
BR100	0.14
BSX19	0.15
BSX20	0.15
BSX21	0.16
BSX26	0.16
BSX29	0.19
BZX76	0.18
BT106	0.90
BT109	0.90
BT116	0.80
BT119	1.00
BT120	1.00
BU104	1.00
BU106	0.80
BU108	1.00
BU110	1.10
BU111	1.40
BU126	0.70
BU204	0.75
BU205	0.70
BU208	0.75
BU208A	0.80
BU208D	1.20
BU326	0.85
BU406	0.85
BU407	0.75
BU408	1.00
BU500	1.10
BU526	0.80
BY126	0.06
BY127	0.08
BY133	0.08
BY164	0.22
BY176	0.85
BY179	0.35
BY182	0.32
BY184	0.32
BY187	0.32
BY196	0.20
BY206	0.11
BY207	0.11
BY223	0.72
BYX10	0.15
CA270	0.40
CA3086	0.25
CA3089	1.50
CA3240	0.90
C106D	0.23
MC1327	0.70
MJ2500	1.00
MJ2501	1.10
MJ2955	0.55
MJ3000	1.15
MJ3001	1.15
MJE29A	0.30
MJE30A	0.30
MJE340	0.25
MJE350	0.80
MJE520	0.38
MJE2955K	0.90
OA47	0.06
OA90	0.04
OA91	0.04
OA200	0.07
OA202	0.07
OC28	1.00
OC29	0.80
OC35	1.00
OC45	0.50
OC71	0.30
OC72	0.50
OC200	1.80
OCP71	1.00
ORP12	1.00
ORP60	1.00
ORP61	1.00
R2008B	0.80
R2010B	0.80
SAS560	1.10
SAS570	1.10
SN76003N	1.40
SN76013N	1.40
SN76023N	1.40
SN76033N	1.50
SN76110N	0.70
SN76115	0.70
SN76226	0.90
SN76227	0.80
T2800D	0.52
TAG06-60	0.42
TAG521-200	0.72
TAG4443	0.76
TAG4444	0.76
TAA550	0.16
TBA120S	0.45
TBA395	0.60
TBA396	0.60
TBA520	0.75
TBA530	0.75
TBA540	0.75
TBA560	0.70
TBA800	0.35
TBA810S	0.60
TBA820	0.75
TBA920	0.80
TBA950	0.80
TBA990	0.80
TCA800	0.80
TCA940	0.85
TDA1170	0.90
TDA1412	0.60
TDA2002	0.80
TDA2003	1.50
TDA2020	1.40
TDA2030	1.40
TDA2522	0.80
TDA2530	0.80
TDA2532	0.75
TDA2540	0.70
TDA2560	0.70
TDA2593	0.80
TDA2690	0.70
TIP29	0.15
TIP29A	0.22
TIP29C	0.25
TIP30	0.16
TIP31A	0.24
TIP32	0.24
TIP32A	0.24
TIP33	0.50
TIP34	0.50
TIP41A	0.22
TIP41C	0.25
TIP42A	0.22
TIP42C	0.25
TIP47	0.40
TIP48	0.40
TIP49	0.40
TIP110	0.47
TIP112	0.54
TIP115	0.45
TIP117	0.56
TIP120	0.43
TIP121	0.46
TIP122	0.47
TIP125	0.47
TIP126	0.56
TIP127	0.56
TIP2955	0.34
TIP3054	0.38
TIP3055	0.34
TIS61	0.15
TIS90	0.15
TIS91	0.18
2N.2904	0.20
2N.2905	0.20
2N 2906	0.18
2N.2907	0.18
2N 2926	0.08
2N 3019	0.28
2N 3063	0.18
2N.3054	0.35
2N.3055	0.32
2N 3055H	0.38
2N 3440	0.58
2N 3442	0.85
2N.3771	0.85
2N 3772	0.90
2N 3773	1.00
2N.4031	0.25
2N.4036	0.25
2N.4037	0.25
2N.4443	0.76
2N.4444	0.76
2N.5061	0.20
2N.5294	0.30
2N 5296	0.30
2N.6106	0.40
2N 6107	0.40
2N.6109	0.40
3N 128	0.55
3N 143	0.65
IN 914	0.02
IN 4001	0.04
IN.4002	0.04
IN.4003	0.04
IN.4004	0.04
IN.4005	0.04
IN.4006	0.04
IN.4007	0.06
IN.4148	0.02
IN.5400	0.09
IN.5401	0.10
IN.5402	0.10
IN.5403	0.11
IN.5404	0.11
IN.5405	0.12
IN.5406	0.13
IN.5407	0.13
IN.5408	0.13
VOLTAGE REGULATORS	
7803	0.35
7812	0.35
7815	0.35
7818	0.35
7824	0.35
7905	0.35
7912	0.40
7915	0.40
7918	0.40
7924	0.40
78L05	0.28
78L12	0.28
78L15	0.28
74L18	0.28
74L24	0.35
LM309K	1.00
LM317K	2.20
LM317T	1.80
LM323K	4.20
LM723	0.32
78HGKC	5.70
78H05KC	5.20
78GU1C	1.90
79GU1C	2.15
79HGKC	6.70
JAPANESE TRANSISTORS	
2SA73	0.30
2SA104	0.32
2SA198	0.22
2SA203	0.30
2SA473	0.37
2SB54	0.25
2SB77	0.32
2SB337	1.20
2SB405	0.22
2SC460	0.21
2SC495	0.60
2SC733	0.40
2SC1161	1.10
2SC1172Y	1.50
2SC1279	0.24
2SC1306	1.00
2SC1307	1.00
2SC1520	0.25
2SC1969	1.30
2SC2029	1.20
2SC2078	1.20
2SC2122A	2.00
2SC2952	0.27
2SD234	0.37
2SK135	4.00
MB3712	1.50
TA7205	1.50
UPC575	1.00
ICS SOCKETS	
8 pin	0.06
14 pin	0.08
16 pin	0.09
18 pin	0.12
20 pin	0.14
22 pin	0.16
24 pin	0.18
28 pin	0.20
40 pin	0.25
VALVES	
DY87	0.53
DY802	0.45
ECC82	0.40
ECC83	0.43
ECC83	0.40
ECC85	0.40
ECH81	0.49
ECH84	0.52
ECL80	0.57
ECL82	0.25
ECL84	0.57
ECL85	0.57
ECL86	0.49
EF80	0.31
EF85	0.34
EF89	0.43
EF183	0.45
EF184	0.53
EL34	1.90
EY86	0.31
EY87	0.31
PC97	1.00
PCC85	0.42
PCF80	0.58
PCF200	1.35
PCF801	1.10
PCF802	0.57
PCF806	1.15
PCH200	1.00
PCL81	0.54
PL519	4.50
PCL82	0.63
PCL84	0.50
PCL85	0.55
PCL86	0.55
PCL805	0.55
PFL200	0.85
PL36	0.80
PL504	0.95
PL508	1.90
PY81	0.70
PY88	0.48
PY500A	1.60
ZENERS	
400MV BZY88 Range 2V7 to 39V0	060
13W Zeners BZX61 Range 2V7 to 39V0	120
MEMORIES	
2114	2.00
2716	3.00
2532	4.00
2732	4.00
2764	7.00
4116	0.75
6116	6.00
LM324	0.30
LM380	0.50
LM381	1.00
LM709 Dil	0.30
LM723	0.32
LM741 Dil	0.15
LM741 Met	0.45
LM3900	0.25
NE555	0.15
NE556	0.40
BYX55/350	0.30
BYX55/600	0.30
BYX55/600	0.30
BYX55/800	0.32
BYX70/500	0.29
BYX70/500	0.31
BYX70/800	0.36
BYX71/600	0.80
LED	
LED 3mm RED	0.05
LED 3mm YELLOW	0.10
LED 3mm GREEN	0.10
LED 5mm RED	0.05
LED 5mm YELLOW	0.10
LED 5mm GREEN	0.10
BRIDGE RECTIFIERS	
1A/50V	0.16
1A/100V	0.18
1A/200V	0.19
1A/400V	0.21
1A/600V	0.23
1A/800V	0.28
2A/100V	0.35
2A/200V	0.36
2A/400V	0.42
2A/600V	0.54
2A/800V	0.58
3A/200V	0.66
3A/400V	0.68
3A/600V	0.78
6A/200V	1.00
6A/400V	0.80
25A/100V	1.60
ELECTROLYTIC	
4700UF-16V CAN	0.20
TRIPLERS	
LP1195 (4000Ser)	2.25

Please add 50p P&P and VAT at 15%. Govt. Colleges, etc. orders accepted
Quotations given for Large Quantities
Please allow 7 days for delivery
All brand-new Components. All valves are new and boxed
Ring for items not listed. We stock 3,000 items

GRANDATA LTD.
9 & 12 THE BROADWAY, PRESTON ROAD
WEMBLEY, MIDDLESEX, ENGLAND
Telephone: 01-904 2093 & 904 1115/6
Telex: 932885 Sunmit

CIRCLE 36 FOR FURTHER DETAILS.

Stereo on tv

Some ten years ago, American television engineers put 'stereo sound' at the top of those developments they expected to see introduced during the next decade. Sure enough, Japan has had some stereo tv for several years, the Federal Republic of Germany for rather fewer, using its own two-carrier system; the BBC has been experimenting with several systems, including digital stereo test transmissions from Wenvoe and Crystal Palace. British hopes are also pinned on the multiplexed digital sound and data channels of the C-MAC/packet satellite transmission system that can provide up to about eight mono or four high-quality stereo channels per transmission. In the USA, the industry (EIA) has been attempting to evaluate three different systems for several years and has picked a Zenith f.m. system using a 31kHz subcarrier and with a 78kHz sub-carrier possible as a bilingual channel.

EIA also favours the use of dbx noise reduction to provide amplitude companding to reduce the dynamic range during transmission. It is claimed that suitable stereo decoding could be provided for $25 (plus the cost of the extra audio amplifier/loudspeaker unless used with an existing external amplifier). Stereo tv sets for this system are likely to appear in prototype form at the Chicago Consumer Electronics Show this June.

Broadcasters have been concerned that, as for medium-wave a.m. — stereo, the FCC would leave the systems decision to the marketplace. In fact, FCC has refused to come out in favour of a single system but has announced that it will enforce interference protection for Zenith-dbx transmissions which, in effect, prevents rival systems using the subcarrier frequency, and makes Zenith-dbx virtually the American standard. So it is the green light for Zenith-dbx but still leaving at least three other systems in contention in Europe. Meanwhile v.c.r.-type stereo tv sets are being marketed in the UK, including those with pseudo-stereo circuitry for use on mono television broadcasts. Some broadcasters have been recording at least some programmes in stereo for several years, aided by the stereo tracks of the 1in "A" format.

While some programmes, such as stage opera, are a natural for stereo, this is not true of many others, where we are used to sudden changes in camera angles, etc. There are still some people who argue that you need a much wider and larger screen before stereo is effective — but the experience with simulcasts has shown that this does not deter enthusiasts for a wider "sound stage".

Digital distortions

Chris Dillon, a lecturer in electronics at The Open University, agrees with some of the speakers at the research meeting organized last year by The Royal Society (*Communications Commentary*, October 1983) that the impact of digital techniques is tending to distort the whole emphasis of formal electronic engineering training with many young engineers and others believing that "everything will be digital once the speed limitations of digital integrated circuits have been overcome." The result is that industry is finding it extremely difficult to recruit enough competent analogue engineers. As one recruiter put it: "They can all connect matchboxes together but we can't find enough people who understand how a simple emitter-follower works". In his own field of crystal filter design, manufacturers are facing a chronic shortage of design engineers, Chris Dillon believes. One also hears of trainee r.f. engineers being tempted into industry even before completing their training as broadcast field engineers.

The basic problem is partly that many of those who make decisions in government and education are profoundly dazzled by the euphoria surrounding "new technology" and "information technology" and fail to appreciate the skills really required from electronics engineers now and in the future.

The way in which British and European firms are losing out in fields in which they were formerly up with the leaders was all too evident at a recent Royal Television Society meeting on electronic cameras. Although the world's first "automatic" camera was the Marconi Mark VIII a decade ago, a succession of speakers described recently installed computerized cameras in re-equipped British tv studios. All the cameras actually installed during the past two or three years appeared to be of American or Japanese manufacture.

NAB more technical

The character of the large annual shindig of the American National Association of Broadcasters (this year at Las Vegas, April 28 to May 2) appears to be changing. The 'international' aspects are increasingly being emphasized and this year an extra full day of technical sessions on the Saturday was inserted into the programme as a sign that NAB is expanding beyond a trade show to the level of a full-blown technical conference. This year's technical talking points were multichannel tv sound; solid-state (c.c.d.) cameras; analogue "component" recording and cartridge machines; high-efficiency and computerized directional m.f. aerials; and the use of microprocessors in transmitters.

The United States Information Agency is seeking a large increase in funds for the financial year next September with plans to spend a billion dollars over the next five years to modernize "Voice of America" equipment. USIA is currently busy establishing a "Worldnet" of tv circuits based on satellites; Euronet linking Washington with European capitals became operational last October and has been followed by Arnet for South America. During 1985, tv circuits will be leased for up to three hours, five days a week, to the Pacific, Africa and the Middle East.

Multipath and radiodata

For many sub-carriers on v.h.f./f.m. broadcasts in the USA have been used to carry a second mono channel in the system known as SCA (subsidiary communications authorization), or often called storecasting since its original use was to provide uninterrupted background music in department stores. More recently it has been deregulated by the FCC to permit its use for many applications, including a further sub-carrier that can be used for radiopaging.

SCA has always been frowned upon in Europe on the grounds that in some circumstances, particularly under multipath conditions, the quality of the main stereo channel can be degraded by cross-talk. However, over the past few years, European broadcasters have been developing a radiodata system to carry identification, switching and information data signals, but not a mono audio channel, on v.h.f. broadcasts. There have been several field trials in various countries including Sweden, whose system has come near to acceptance by EBU, and has recently been undergoing further field trials by the BBC at Wrotham, Kent.

The level of the data signals, it was thought, would be low enough to avoid interference with the stereo signal signal even under bad multipath conditions. This does not seem to have proved the case since there have been a few, but very vocal, complaints from listeners. Wrotham now uses 'mixed' polarization which, in some terrains, can increase the amount of multipath. Now the EBU and BBC will have to decide whether the complaints are few enough to be ignored — or whether once again it is a question of back to the drawing board. Multiplexing works well when the radio path is good — but can prove a real problem in some circumstances. Even supersonic control signals can present difficulties.

Baird in history

One of the very few surviving 30-line televisors, made for the Baird company by Plessey around 1930, has been carefully restored by Ian Moth of Plessey Radar and loaned for exhibition at the Arreton Wireless Museum on the Isle of Wight, run by Douglas Byrne, G3KPO.

As a historical curiousity, 30-line televisors deserve to be carefully preserved. But I have been surprised to find how furiously a number of people still resent any suggestion that Baird's low-definition tv system was barely "true television" since, even in its final broadcast form, it contained no real sync. signals. The televisors, by the time they reached the market, included a phonic wheel system that had to depend upon the black edge of the picture, as a crude and most uncertain form of synchronization. The instructions recommended running the motor for some 15 minutes before attempting to lock the picture! There were no sync. pulses and these would have been virtually impossible to transmit on medium waves.

Logie Baird *does* deserve a firm place in the history of television but primarily for the interest he stirred up that led so quickly to the development of high-definition tv on v.h.f. In 1959, Peter Eckersley, who as first chief engineer of the BBC recognized the futility of the Baird 30-line system, wrote in *Wireless World*: "Baird stood above his contemporaries in imagination, but, as events proved, below them in knowledge...I was truly sorry for him. He was 'fooled to the top of his bent; told by a sensation-seeking press that he was the world's greatest technical genius, dazzled by the prospect of millions of money....how fatal to hopes are the brute facts of physics."

Yet there are still those who believe that he was the sole inventor of television and refuse to question the way in which his early demonstrations were 'contrived' (to quote Frank Haynes) or to realise that much of what was published about them was more a tribute to Baird's imagination than his actual results, innovative experimenter though he undoubtedly was. It is essentially a sad story but not one that should be buried in myths.

Amateur Radio

Cable woes

The problems experienced by radio amateurs in the Milton Keynes area due to radiation of signals from the BT cable tv system within the amateur 144MHz band has proved harder to overcome than originally appeared. Despite additional filtering interference to local amateurs continued and has led to the offending channel being taken out of service.

In the USA it is not only radio amateurs who are affected by wide-band cable distribution. During 1983, the FCC fined cable systems a total of more than $200,000 for violations of the rules under which channels within the aeronautical bands can be used; this is permitted subject to prior clearance and a specified maximum level of signal leakage. It would appear that some cable operators have infringed both these conditions, and a number have been ordered to cease using these frequencies.

Meanwhile throughout the world, the list of consumer appliances, car electronics etc. that have proved to be either susceptible to local transmitters or alternatively to radiate r.f. interference or electrical noise continues to grow. Electronic telephone handsets with i.c. amplifiers; cordless telephones; smoke detectors; v.c.r. machines; microwave ovens; microprocessor controls; home computers, etc., etc. Yet many of the problems could have been avoided if the designers had paid more attention to basic questions of electromagnetic compatibility and had some screening, by-pass capacitors, r.f. chokes, etc.

40 years on

With the approach of the 40th anniversary of D-Day, June 6, 1944, several groups of amateurs are planning to participate in events designed to mark that event. The G-QRP Club, for instance, is organizing a contest in which its members will design and construct a modern 'suitcase' two-way h.f. set in recognition of the role played by such sets in 1944, including the use of the B2 by the Jedburgh and SAS groups who dropped by parachute into Normandy.

Sid Hall, G3BR (53 New Street Hill, Bromley, Kent) has been compiling lists of the radio amateurs who joined the Civilian Wireless Reserve in 1938-39 and subsequently served at the outbreak of war in the RAF in the W/T Emergency Fitting Parties, or with the Wireless Intelligence Screen which included the "Early Birds" who reached France on September 5, 1939. He has traced no less than 120 former C.W.R. members, most of them still active radio amateurs. Some 50 have joined in the s.s.b. nets he runs on 3760kHz at 10a.m. local time on the first Monday of each month or on the second Mondays on about 7050kHz.

The Emergency Fitting Parties, whose commanding officer was (the Rev.) H.A.M. Whyte, now VE3BWY but a leading pre-war dx operator as G6WY, absorbed more of the C.W.R. members than the Y service and were formed to install emergency radio equipment at RAF airfields. Some units helped install early radar equipment and also later helped jam and disrupt the German navigational aids.

Silent Uosat

Following a perfect launch on March 1, beacon signals from Surrey University's Uosat-2 satellite were well received on 145.825MHz during the first three orbits, but then ceased. It was thought that a 30-day switching sequence written into the software would bring the satellite back under control. Up to the time of writing, however, this has not happened and hopes are fading.

The RSGB has expressed concern that the intermediate frequencies being proposed for 12GHz DBS receivers could prove vulnerable to interference from strong local signals from transmitters working in either the 1.3GHz or 144MHz bands.

Here and there

The Chinese Radio Sports Association has now applied to join the IARU as a further move towards restarting normal amateur radio in that country. In view of the continued use of frequencies in the 'exclusive' amateur band between 7000 and 7100kHz by Chinese external-broadcast transmitters, as noted by R. E. Knowles, ZL1BAD, in the March 'Letters' (my earlier report of the apparent reduction of this nuisance proved short-lived although spring 1983 did see a noticeable improvement in Europe) not every society may feel inclined to vote the Chinese in; others may hope that the Chinese could exert more influence on their broadcasting authorities from within IARU. A headquarters station, BY1PK, in Peking became active in March 1982 after 16 years of no amateur radio in China. But very few other stations have yet been permitted.

The British Amateur Radio Teleprinter Group has launched an ambitious new quarterly magazine called 'Datacom' replacing the former BARTG Newsletter. The first issue, which runs to 108 pages, includes a special feature on 'packet radio' and also information on the r.t.t.y. repeater located at Cambridge. Editor is Ian Wade, G3NRW, but for membership details contact John Beedie, G6MOK, 161 Tudor Road, Hayes, Middlesex (01-561 0010).

June mobile rallies include: June 3 Spalding (Springfields, Spalding), Welsh mobile rally at Barry Leisure Centre, Holton Road, Barry and RAIBC Picnic, Broadlands, Romsey, Hants; June 10 Elvaston Castle Country Park, 5 miles south-east of Derby; June 17 RNARS rally at HMS Mercury, near Petersfield, Hants and Denby Dale rally at Shelley High School, nr Skelmanthorpe, Huddersfield; June 24 Longleat rally at Longleat Park, Warminster.

A former Californian radio amateur, Richard Burton, is serving an 18-month prison sentence for continuing to operate his transmitter after his licence had been cancelled by the FCC for repeated use of obscene language.

At the Amberley Chalk Pits Museum and open-air industrial history centre, near Arundel, Ron Ham has recently completed the assembly of a "vintage amateur radio shack" in tribute to old-time radio amateurs including G2YL, G6YL and G2NM.

The RSGB National VHF Convention held at Esher at the end of March was attended by over 2500 people, considerably more than in 1983.

PAT HAWKER, G3VA

THE SOURCE OF ALL GOOD USED TEST EQUIPMENT

Electronic Brokers are Europe's largest specialists in quality second user test equipment, computers and associated peripherals. All second user test equipment offered by Electronic Brokers is calibrated to meet the original manufacturer's sales specifications and guaranteed for 12 months. Our latest catalogue contains full details of our extensive inventory. Contact us for your free copy now.

BRYANS SOUTHERN XY/T Recorder 25000

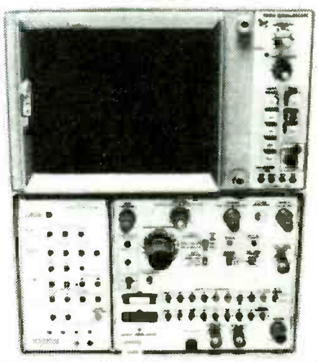
THESE UNITS ARE UNUSED
A4 Size.
X-Y Ranges: 1mV to 1V Per CM.
Slew Speed: 49 CM/Second.
Timebase: 0.1 to 10 SEC/CM.
Price: **£750**

Save: £388 On New Price.

TEKTRONIX Logic Analyser 7D01 with DF1.

16 Stored Channels, up to 1024 words deep. State and timing with up to 100MHz sample rate.
Price: **£2,000**

Save £4,558 On New Price



Illustrated with 7603 Mainframe (Extra)

TEKTRONIX Portable Data Analyser 308

For Timing, State, Serial and Signature Analysis.
8 Data Lines.
20MHz
Price: **£2,100**

AS NEW

Save: £1,027 On New Price.

RACAL-DANA Counter/Timer 9514

0.100MHz Counter
100nS to 10^9 Sec Period
IEEE Interface

Superb Condition
Price: **£850**

ANALYSERS

Hewlett Packard	
1611A Logic Analyser	**£3,000.00**
1615A Logic Analyser 20MHz Clock	**£3,750.00**
3556A Spectrum Analyser Plug In 20Hz-300KHz	**£2,250.00**
Tektronix	
DAS 9103 Logic Analyser 660MHz Clock	**£7,500.00**
DF1 Display Formatter For 7D01	**£500.00**
492 (opt 01, 08) Spectrum Analyser 50KHz-21GHz	**£13,000.00**
7L5 opt 25 (Tracker) and L3 (Input plug in) 20Hz-5MHz	**£7,800.00**
7L18 Spectrum Analyser 1.5GHz-60GHz	**£3,950.00**
TR502 Tracking Generator 100KHz to 1.8GHz (for use with 7L13 or 7L14)	**£3,000.00**
TR503 Tracking Generator (for 492/496 series)	**£4,250.00**
7D01 16 Channel 100MHz Sample Rate	**£1,500.00**
7D02/01 Logic Analyser	**£3,950.00**

OSCILLOSCOPES

Hewlett Packard	
1332A High Quality CRT Display 9.6 x 11.9cm	**£1,250.00**
1715A 200MHz Dual Trace Oscilloscope	**£2,450.00**
1740A 100MHz Dual Trace Oscilloscope	**£1,450.00**
1744A 100MHz Variable Persistance Storage	**£3,000.00**
1809A 100MHz 4 Channel Plug in	**£2,000.00**
1821A Timebase Plug in	**£1,000.00**
Philips	
PM3232 Dual Bean 10MHz	**£495.00**
PM3244 50MHz 4 channe	**£1,500.00**
Tektronix	
212 500KHz Dual Trace Miniscope	**£850.00**
335 Dual Trace 35MHz Small portable with delay T'Base	**£1,300.00**
434 opt 01 25MHz Storage	**£2,350.00**
475A 250MHz Dual Trace Portable	**£3,300.00**
475 200MHz Dual Trace Portable	**£2,500.00**
7104 1GHz Oscilloscope Mainframe	**£16,500.00**
7313 100MHz Storage Mainframe	**£2,225.00**
7603 100MHz Mainframe	**£1,950.00**
7704A Scope DC-200MHz Mainframe	**£2,850.00**
7834 400MHz Storage Oscilloscope Mainframe	**£9,850.00**
7904 500MHz Oscilloscope Mainframe	**£5,950.00**
C12 Camera	**POA**
Telequipment	
CT71 Curve Tracer	**£550.00**

SIGNAL SOURCES

Bruel & Kjaer	
1023 Sine Generator with Lin-Log Sweep	**£2,075.00**
E H Labs	
139B Pulse Gen.	**£950.00**
Hewlett Packard	
204C LF Oscillator	**£200.00**
214A Pulse Gen.	**£950.00**
11720A Pulse Modulator	**£1,950.00**
8004A Pulse Gen.	**£450.00**
8011A-01 Pulse Gen.	**£695.00**
8013B Pulse Gen.	**£750.00**
8620C Sweeper Mainframe	**£2,100.00**
86240B Sweeper Plug In 2-8.4GHz	**£4,200.00**
8640A Sig Gen.	**£2,750.00**
8690B + 8698B Sweeper 0.4-100MHz	**£3,000.00**
Marconi	
TF2002B AM/FM Sig Gen 10KHz-88MHz with TF2170B Synchroniser	**£1,750.00**
TF2008 Sig Gen.	**£3,000.00**
TF2015 Sig Gen.	**£1,350.00**
TF2120 Waveform Gen	**£850.00**
Tektronix	
284 70pS Pulse Generator	**£950.00**

TEKTRONIX PLUG INS

We stock a complete range of Plug Ins for use with 7000 and 5000 series Mainframes.

TEKTRONIX TM500 SERIES

We stock a very wide range of these versatile modular equipments

MISCELLANEOUS

Avo	
Model 8 Multimeters	**£80.00**
7 Electricians Multimeter	**£65.00**
Bruel & Kiaer	
2209 Sound Level Meter	**£850.00**
1613 Filter	**£400.00**
Bryans Southern	
25000 XY/T Recorder	**£750.00**
26001 A4 with 2 x 26116 Amplifiers and 26201 Timebase	**£1,400.00**
As above but with 26202 Power Unit instead of Timebase	**£1,250.00**
29300 XY/T Recorder	**£1,000.00**
Fluke	
887AB AC/DC Differential Voltmeter	**£1,950.00**
893A AC/DC Differential Voltmeter	**£750.00**
3010A Logic Tester in 'As New' condition	**£8,000.00**
8010A-01 3½ digit DMM with built in battery pack	**£150.00**
8050A 4½ Digit DMM	**£200.00**
931B Diff V'Meter	**£1,000.00**
2020A-3-6 Printer	**£500.00**
8921A DMM	**£695.00**
Hewlett Packard	
427A AC/DC Voltmeter	**£495.00**
461A Amp 20/40DB 1KHz-150MHz	**£120.00**
467A Amplifier	**£725.00**
3476B 3.5 Digit DMM	**£100.00**
3556A Psophometer	**£850.00**
3552A Trans Test Set	**£1,500.00**
4815A Vector Impedance Meter	**£3,850.00**
5300B + 5306A DMM/Counter	**£1,000.00**
Marconi	
2438 520MHz Counter/Timer	**£795.00**
TF1313A LCR Bridge	**£775.00**
TF2603 RF Millivoltmeter	**£750.00**
Racal	
9514 Counter/Timer IEEE	**£850.00**
9919 1.1GHz Counter	**£525.00**
Tektronix	
106 Square Wave Generator 1nS risetime 10Hz-1MHz without accessories	**£175.00**
1503 TDR	**£3,000.00**
2701 Step Attenuator 50Ω 0.79dB in 1dB steps. DC to 2GHz	**£295.00**

WE NOW STOCK A RANGE OF HEWLETT PACKARD COMPUTERS AND CALCULATORS.

ADD 15% VAT TO ALL PRICES   Carriage and Packing extra   Trading Conditions Available on request

Electronic Brokers

Electronic Brokers Ltd., 61/65 Kings Cross Road,
London WC1X 9LN. Tel:01-278 3461. Telex 298694

CIRCLE 203 FOR FURTHER DETAILS.

SAMSONS

(ELECTRONICS) LTD.
9-10 Chapel Street, Marylebone
London NW1 5DN
21-23 Bell Street, London, NW1
01-262 5125 & 01-723 7851

BARCLAYCARD VISA

CREDIT CARDS ACCEPTED FOR TELEPHONE ORDERS

We are stockists of the complete range of "DOUGLAS" transformers.
Please ring or send S.A.E. for details.

MARCONI TF 1370

Wide range Oscillator sine/square, 10 c/s to 10 meg. Very nice condition **£160** inc. VAT and carriage.

OLIVETTI TE3000 TELEPRINTERS

With stand. Only **£99** inc. VAT
Ring for carriage details

WODEN HEAVY DUTY TRANSFORMER

Pri 220-240V Sec 2.5V 35A 4-5-6.3V 12A. Both secs 10KVAC WKG **£30** inc. carriage and VAT

NEW TRANSFORMER BARGAINS

By famous makers

No. 1. Pri 115-230V Sec 21V 3A + 40V 300 M/A **£5.25**
No. 2. Pri 220-240V Sec 17.5V 1A 3 times **£5.75**
No. 3. Pri 220-240V Sec 29-28-27-0-27-28-29V 0.3A **£4.00**
No. 4. Pri 220-240V Sec 6.3V 5ACT 6.3V 2ACT **£5.00**
No. 5. Pri 220-240V Sec 40V 3A **£6.25**

All prices inc. VAT and carriage

OSCILLOSCOPES

TEKTRONIK 545A **£125**
HEWLETT PACKARD 1858 .... **£100**
TEKTRONIK 585 .... **£125**
TELEQUIPMENT D67A 25meg dual beam scope, in first class condition. Special offer Price **£299** inc. VAT
Callers only or ring for special delivery

CONSTANT VOLTAGE TRANSFORMERS

Gould Advance
Typ 240V output ± 1%

150W .... **£15.00** carr £2.95
250W .... **£39.50** carr £3.75
500W .... **£85.00** carr £7.50
3000W .... **£295.00** carr £20.00

All prices inc. VAT

PAPER BLOCK CAPACITORS

8MFD 2500V WKG DC **£6.50**
10MFD 350V WKG DC **£15.00**
8 MFD 400V WKG DC **£2.50**
4 MFD 1000V WKG DC **£2.00**
1 MFD 1000V WKG DC **£1.25**

All prices inc. VAT and carriage

FANS

MUFFIN 4½" 110V **£4.00**
WOODS 6" and 8" 240V **£9.50**
Tangential Blowers 240V approx 3"x15" vent. Very powerful. **£11.**

All prices inc. VAT and carriage

AUTO STEPDOWN TRANSFORMERS FOR AMERICAN EQUIPMENT

240/110 Volts. 80-2250 watts. Regular stock line. Types 80-1500 watts are fully shrouded. Fitted with American two or three pin socket outlets and 3 core 240V mains lead. Types 1750 and 2250 watts are steel cased with two American socket outlets. Neon indicator, three core mains lead and carrying handle. Send SAE for price list and further details. American sockets, plugs, adaptors also available.

AVOMETERS

We have in stock a limited quantity of excellent quality AVOs.
AVO 8 **£59.95** inc. VAT. AVO 7 **£37.50** inc VAT. AVO MINOR **£20** inc. VAT. Callers only, or ring for special delivery.

MEGGERS

Special offer!! 250V and 500V metrohms at give-away prices. Buy now while stocks last. **£35** + VAT. Callers only or ring for special delivery.

DISC DRIVES

Disc drives by magnetic peripherals including 8" floppy disc single sided, without control card. Circuit diagram can be obtained from manufacturer. Excellent value at **£27.50** inc. VAT and carriage.

SWITCH MODE POWER SUPPLIES

By Gould Advance

5V 40 amp **£35**. 5V 20 amp **£25**. 10.5V 20 amp **£30**. Inc. VAT and carriage.

HIGH GRADE LT TRANSFORMERS

ALL PRIMARIES 240v
OPEN FRAME TOP PANEL CONNECTIONS

No 1 tapped 2-3-4-5-6-7-8-9-10-11-12-13-14-15v 8A **£10.** No 2 12v 8A **£7.50.** No 3 tapped 13-12-10-8v 8½A **£9.** No 4 Sec 6.3v 2A 6.3v 2A and 32-0-32v 280 m/a **£4.75.** No 5 Sec 37v 1.5A, 15v ½A, 9v 50 m/a **£3.95.** No 6 Sec 14v 2A **£3.95.** No 7 Sec 27.5-0-27.5v 1.2A and 7-0-7v 750 m/a **£3.50.** All prices include postage and VAT.

PARMEKO LT TRANSFORMERS

Open frame type top panel connections, prices include postage and VAT

No 1 12-18-32V 2A (DC rating) and 12-18-32V ½A (DC) **£9.** No 2 12-18-32V 1A (DC) and 12-18-32 ¼A **£5.** No 3 12-18-32V ½A (DC) and 12-18-32V 100 m/a **£3.95.** No 4 12-18-32V ¼A (DC) and 12-18-32V ¼A (DC) and 12-18-32V 50 m/a (DC) **£2.50.** No 5 32V 100 m/a (DC) and 32V 25 m/a DC **£2.50.**

SPECIAL OFFER!!! SERVALCO SERVOMOTORS

We have a limited amount of printed circuit motors in first-class condition. Spec: 60V DC 5.5 Amps continuous torque 140 oz in ¾" dia output shaft. Overall dimensions 2½" x 7½", rpm 2350. **£29.95** inc VAT and carr.

INSTRUMENT CASE BARGAIN! FANTASTIC OFFER

Stylish aluminium case in dark blue finish with integral carrying handles and movable front legs for tilt facility. Fitted with IEC mains socket and 20mm fuse carrier. Comes complete with mains lead with 13 amp plug and IEC plug. Size: 20×28×33cm. **£13.50** inc. VAT and carr.

SPECIAL OFFER. CLAUDE LYONS VOLTAGE STABILISER. Input 210-270V a.c. Output 240V a.c. ± ·5%!!! Rated at 2.9kVA. Ideal for stabilising computer supplies
£195 inc. **VAT.** Carriage £12
Hurry – only a few left

GOULD ADVANCE P.S.U.s. 13.8V 30amp d.c. supplies. Great for linears!!! **ONLY £65** inc. **VAT.** Carriage £3. Limited offer

12" BLACK AND WHITE MONITORS

Made by leading USA firm, will handle 80 columns, suitable for most makes of computers. **£28.50** inc VAT. Callers only.

HIGH POWER ISOLATION TRANSFORMER. FANTASTIC OFFER!! 240V input, 240V output at a hefty 90 amps!!
Ideal for large electronic workshop, computer room or recording studio, one only so don't delay. **ONLY £250** inc. **VAT.** Ring for delivery details

HENGSTLER

Low voltage resettable counters, 52 ohms 6-12v DC 6 digit. Compact size. Only **£3.25** inc VAT and carr.

E.H.T. TRANSFORMERS

High-grade E.H.T. Tranny, PRI 240V, sec. 10,000V, 18 M/A. Probably used for boiler ignition but with 101 other uses!!!
£5 inc. carr. & VAT.

PARMEKO OP TRANSFORMERS

Pri 6000 or 8000Ω or CT Sec 3.75 or 15Ω Ser/Par for EL84×2 12.5W **£4.50.** Pri 5000 for EL84 3W Sec **£3.75** or 15Ω Ser/Par **£2.50.** Pri 30-45-60-90 to 1 also 90TOI for push/pull Sec 3.75Ω **£2.** All prices include postage and VAT.

AC WKG CAPACITORS

MFD	AC wkg	Price	MFD	AC wkg	Price
0.25	1500v	£1.50	5	360v	£1.75
0.75	440v	£1.00	5	440v	£2.00
1	400v	£1.50	4	600v	£2.00
2.5	360v	£1.50	6	300v	£2.00
2.7	700v	£1.75	8.4	250v	£1.50

All prices include postage and VAT

ELECTROLYTIC CAPACITORS

22,000 63V DC wkg. 33,000 40V DC wkg. 3,000 50V DC wkg. 20,000 45V DC wkg. 6,500 50V DC wkg. **All £4 each** inc VAT and carr.

PARMEKO HT CHOKES

10H 250m/a	£5.95	20H 75m/a	£3.50
5H 250m/a	£5.50	10H 75m/a	£2.95
5H 180m/a	£4.75	7.5H 60m/a	£2.50
2.5H 500m/a	£5.95	15H 120m/a	£3.95
2.5H 250m/a	£5.50	50H 10m/a	£2.50
20H 120m/a	£4.75	25H 60m/a	£2.75

All prices include postage and VAT

HEAVY-DUTY L.T. CHOKES

C core type 10 m/h 25 amps **£10** carr. £3, VAT £1.95

SPECIAL OFFER HIGH-GRADE ISOLATION TRANSFORMERS

Open frame terminal block connections **£29.50**, carr. £4, VAT £5.02. Pri 240V, Sec 240V, 250 watts, open frame type tag connections, **£10**, P&P £2, VAT £1.80. Pri 100-110-200-210-220-230-240-250V, Sec 220-230-240V 600W, can be used in reversed open frame type terminal block connections, **£15**, carr. £2.80, VAT £2.67.

PARMEKO NEON TRANSFORMERS

PRI tapped 200-220-230-240-250V. Size 7000V 55 M/A. Totally enclosed in wall mounting steel case. Size 9½x8½x4½in.
£17.50 inc. VAT and carriage

PRI tapped 200-220-230-240-250V. Size 5000V 20 M/A. Totally enclosed in wall mounting steel case. Size 7x6x5in.
£12.50 inc. VAT and carriage

COMPUTER GRADE LT TRANSFORMERS

BY FAMOUS MAKERS
ALL PRIMARIES 220-240V
PRICES INCLUDE POSTAGE AND VAT

No 1 Sec 43V 3A **£6.95.** No 2 Sec 40V 3A **£6.95.** No 3 Sec 65V 1A and 18-24V ½A **£5.95.** No 4 Sec 25V 2A **£4.50.** No 5 Sec 24V 2A **£4.50.** No 6 Sec 27.5-0-27.5V and 7-0-7V 0.75A **£5.25.** No 7 Sec 13-0-13 A and 12V A £ . No 8 Sec 60V 1½A **£4.95.** No 9 Sec 40V 1½A **£4.50.** No 10 Sec 10-7-0-7-10V ½A and 29-21-0-21-29V 370 m/a, c core **£4.25.** No 11 Sec 55V ½A **£3.75.** No 12 Sec 24V 3A and 110V ½A **£7.95.** No 13 Sec 28V 1½A and 24V 1½A **£5.50.** No 14 Sec 36V ½A **£3.50.** No 15 Sec 20V 2A **£3.75.** No 16 Sec 12-25V 2A **£3.75.** No 17 Sec 24-0-24V 1A and 6.3V 1A **£4.95.** No 18 Sec 24V 4A **£5.50.** No 19 Sec 12-15-20-24-30V 1A **£4.75.** No 20 Sec 4.5V 5A twice **£4.50.**

PARMEKO HT TRANSFORMERS

ALL PRIMARIES 220-240V
POTTED TYPES

No 1 Sec 500-0-500V 120 m/a 6.3V 5A 6.3V 3A 5V 3A **£8.50**, inc postage and VAT. No 2 Sec 300-0-300V 60 m/a 6.3V 2A CT 6.3V 1A **£6.50** inc postage and VAT. No 3 400-0-400V 180 m/a **£6.50** inc postage and VAT. No 4 Sec 400-0-400V 150 m/a and 150-0-150V 20 m/a **£6.50** inc postage and VAT. No 5 Sec 350-325-0-325-350V 120 m/a **£6.50** inc postage and VAT. Gresham Pri 220-240V, Sec 250V 80 m/a 6.3V 4.5A 15V 1.2A **£5.95** inc postage and VAT. Pri 230-250V, Sec tapped 190-210V 24 m/a 6V 1A **£3.95** inc postage and VAT. Pri 220-240V Sec 300V 200 m/a 30V 100 m/a 6.3V 5A half shrouded, sub chassis mounting **£6.50** inc postage and VAT. Pri 220-240V Sec 370-390-410V 6 m/a **£2.75** inc postage and VAT. WW-16

CIRCLE 40 FOR FURTHER DETAILS.

VALVES

Minimum Order £1 | *SPECIAL QUALITY | VALVES VAT IS INCLUDED

A1065	1.40
A2293	8.80
A2900	13.75
AR8	0.75
ARP3	0.70
ATP4	0.60
B12H	3.90
CY31	1.40
DAF96	0.70
DET22	28.50
DF96	0.70
DH76	0.75
DL92	0.60
DY86/87	0.65
DY802	0.70
E92CC	2.80
E180F	7.70
E182CC	6.25
EA76	2.25
EABC80	0.80
EB91	0.60
EBC33	1.15
EBC90	0.90
EBF80	0.60
EBF83	0.60
EBF89	0.80
EC52	0.65
EC91	4.40
EC92	0.85
ECC81	0.85
ECC82	0.60
ECC83	0.65
ECC84	0.60
ECC85	0.60
ECC88	0.80
ECC189	0.95
ECC804	0.90
ECF80	0.85
ECF82	0.65
ECF801	1.05
ECH34	2.25
ECH42	1.20
ECH81	0.70
ECH84	0.80
ECL80	0.70
ECL82	0.75
ECL85	0.80
ECL86	0.90
EF37A	2.15
EF39	1.50
EF80	0.65
EF83	1.75
EF85	0.60
EF86	0.75
EF89	1.60
EF91	1.50
EF92	2.90
EF95	0.65
EF96	0.60
EF183	0.80
EF184	0.80
EF812	0.75
EFL200	1.85
EH90	0.85
EL32	1.10
EL34	1.80
	3.50*
EL37	5.20
EL82	0.70
EL84	0.80
EL86	0.95
EL90	1.00
EL91	4.20
EL95	0.80
EL504	1.70
EL509	3.95
EL519	6.90
EL821	8.20
EL822	9.95
ELL80(SE)	2.80
EM80	0.85
EM87	1.30
EY51	0.95
EY81	0.65
EY86/87	0.60
EY88	0.65
EZ80	0.70
EZ81	0.70
GM4	5.90
GY501	1.30
GZ32	1.05
GZ33	4.20
GZ34	2.75
GZ37	3.95
KT66	10.95
KT88	10.50
	13.80*
ML4	2.80
ML6	2.80
N78	9.90
OA2	0.70
OB2	0.80
PCL82	0.95
PCL84	0.90
PCL805/85	0.95
PD500/510	4.30
PFL200	1.10
	2.80*
PL36	1.10
PL81	0.85
PL82	0.70
PL83	0.60
PL84	0.95
PL504	1.00
PL508	2.40
PL509	5.80
PL519	5.80
PL802(SE)	2.95
PY80	0.70
PY81/800	0.85
PY82	0.65
PY88	0.60
PY500A	2.10
QQV03/10	3.20
	7.50*
QQV03-20A	21.50
QQV03-25A	36.50
QQV06/40A	19.50/36.50*
QV03-12	4.20
SP61	1.80
TT21	23.00
TT22	23.00
UABC80	0.75
UAF42	1.20
UBF80	0.70
UBF89	0.70
UCC84	0.85
UCC85	0.70
UCF80	1.30
UCH42	1.65
UCH81	0.75
UCL82	0.95
UF41	1.35
UF80	0.95
UF85	0.95
UL84	0.95
UM80	0.90
UM84	0.70
UY82	0.70
UY85	0.85
VR105/30	1.25
VR150/30	1.35
X66	0.95
X61M	1.70
Z759	19.00
Z749	0.75
Z800U	3.45
Z801U	3.75
Z803U	16.00
Z900T	2.45
1A3	1.40
1L4	0.50
1R5	0.80
1S4	0.45
1S5	0.45
1T4	0.45
1U4	0.80
1X2B	1.40
2X2A	2.50
3A4	0.70
3AT2	2.40
3B28	12.00
	19.50*
3D6	0.50
3E29	19.00
3S4	0.60
4B32	18.25
5R4GY	1.80
5U4G	0.75
5V4G	0.75
5Y3GT	0.95
5Z3	1.50
5Z4G	0.75
5Z4GT	1.05
6/30L2	0.90
6AB7	0.70
6AC7	1.15
6AG5	0.60
6AH6	1.15
6AK5	0.65
6AK8	0.60
6AL5	0.60
6AL5W	0.85
6AM5	4.20
6AM6	1.50
6AN8A	2.50
6AQ4	3.40
6AQ5	1.00
6AQ5W	1.80
6AS6	1.15
6AT6	0.90
6AU6	0.60
6AV6	0.85
6AX4GT	1.30
6AX5GT	1.30
6BA6	0.70/1.20*
6BE6	0.60/1.20*
6BG6G	1.60
6BJ6	1.30
6BQ7A	0.85
6BR7	4.80
6BW6	6.20
6BW7	1.80
6C4	0.50
6C6	0.55
6CH6	8.20
6CL6	2.75
6CW4	8.50
6CX8	3.80
6CY5	1.15
6D6	0.70
6F6	1.60
6F6GB	1.10
6F7	2.80
6F8G	0.85
6F12	1.50
6F14	1.15
6F15	1.30
6F17	3.20
6F23	0.75
6F24	1.75
6F33	10.50
6FH8	17.80
6GA8	1.95
6GH8A	1.95
6H6	1.60
6JU6	5.85
6J4	1.35
6J4WA	2.00
6J5	2.30
6J5GT	0.90
6J6	0.65
6J6W	0.90
6JE6C	4.85
6JS6C	4.85
6K7	0.80
6KD6	4.50
6L6M	2.80
6L6GC	3.70
6L6GT	1.80
6L18	0.70
6LD20	0.70
6LQ6	4.85
6Q7G	1.30
6SA7	1.80
6SG7	1.50
6SJ7	1.50
6SK7	1.40
6SL7GT	0.85
6SN7GT	0.80
6SQ7	0.95
6SR7	4.60
6V6G	1.50
6V6GT	0.95
6X4	0.95
6X5GT	0.65
6Y6G	0.90
6Z4	0.70
9D6	2.90
11E2	19.50
12A6	1.00
12AT6	0.70
12AT7	0.85
12AU7	0.60
12AV6	0.95
12AX7	0.65
12BA6	0.90
12BE6	1.25
12BH7	2.30/2.95*
12E1	18.95
12J5GT	0.55
12K7GT	0.70
12K8GT	0.80
12Q7GT	0.60
12SC7	0.65
12SH7	0.65
12SJ7	0.70
12SQ7	1.45
12SQ7GT	0.85
12Y4	0.70
13D3	2.80
13D5	0.90
19AQ5	0.85
19G3	11.50
19G6	8.50
19H5	39.55
20D1	0.80
20E1	1.30
20P1	0.65
25L6GT	0.95
25Z4G	0.75
35W4	0.80
85A2	1.40 2.55*
807	1.60/2.40*
813	19.32 68.50*
829B	24.00
832A	8.90
866A	3.80
866E	6.25
931A	19.80
954	1.20
955	1.20
956	1.20
5763	4.80
6060	1.95
6080	5.30
6146	6.80
6146B	6.80
6360	2.85
6550	8.05

VALVES AND TRANSISTORS

Telephone enquiries for valves, transistors, etc: retail 749 3934, trade and export 743 0899.

FIELD TELEPHONE, CABLE TYPE D10

HARNESS "A" & "B" CONTROL UNITS "A" "R" "J1" "J2." Microphones No 5, 6, 7 connectors, frames, carrier sets, etc.

FIELD TELEPHONES TYPE "J". Tropical, in metal cases.
10-line MAGNETO SWITCHBOARD. Can work with every type of magneto telephones.

PRICES MAY VARY

POSTAGE: £1-£3 45p; £3-£5 55p; £5-£10 60p; £10-£15 80p; £15-£20 100p.

COLOMOR (ELECTRONICS LTD.)170 Goldhawk Rd,London W12
Tel. 01-743 0899 or 01-749 3934.**Open Monday to Friday 9 a.m.-5.30 p.m.**

TOROIDAL TRANSFORMERS

We are now able to offer a range of high quality Toroidal transformers at very competitive prices:
30VA £6.27, 50VA £7.73, 80VA £8.51
120VA £9.33, 160VA £11.43, 300VA £15.27

Prices include P&P and VAT

Available in the following voltages: 6-0-6, 9-0-9, 12-0-12, 15-0-15, 18-0-18, 22-0-22, 25-0-25, 30-0-30, 35-0-35, 40-0-40, 45-0-45, 50-0-50.

Qty. discount 50 plus 10%, 100 plus 20%.

TRADE ENQUIRIES WELCOME

AIRLINK TRANSFORMERS LTD
28 Bullfields, Sawbridgeworth, Herts. Tel: 0279-724425

CIRCLE 37 FOR FURTHER DETAILS.

ELECTRONICS C.A.D.

"ANALYSER"

PERFORMANCE ANALYSIS of LINEAR CIRCUITS using the BBC MODEL B SPECTRUM AND NEWBRAIN MICRO'S.

Simulates Resistors, Capacitors, Inductors, Transformers, Bipolar and Field effect Transistors, and Operational Amplifiers in any circuit configuration.

Performs FREQUENCY RESPONSE ANALYSIS on Circuits with up to 16 Nodes and 60 Components, for Phase and Gain/Loss, Input Impedance and Output Impedance.

Ideal for the analysis of ACTIVE and PASSIVE FILTERS, AUDIO, WIDEBAND and R.F. AMPLIFIERS, LINEAR INTEGRATED CIRCUITS etc., etc.

"ANALYSER" can greatly reduce or even eliminate the need to breadboard new designs.

USED BY INDUSTRIAL AND UNIVERSITY R&D DEPARTMENTS WORLD WIDE.

LOW COST ... VERY EASY TO USE.

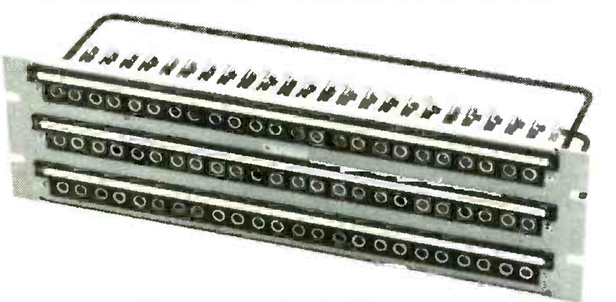
For further details write or phone NUMBER ONE SYSTEMS

DEPARTMENT WW
9A CROWN STREET, ST IVES
HUNTINGDON
CAMBS. U.K. PE17 4EB
TEL: 0480 61778 TELEX: 32339

AME/LRC 12.4.84

CIRCLE 23 FOR FURTHER DETAILS.

Audio Jackfields?



Over 100 listed in our Catalogue.

Write or call for your free copy.

FFD FUTURE FILM DEVELOPMENTS
114 Wardour Street, London W1V 3LP. Telephone: 01-434 3344.
Telex: 21624 ALOFFD G. Cables: Allotrope-London. W1.

CIRCLE 50 FOR FURTHER DETAILS.

Keep those Contacts CLEAN

BY USING A

DIACROM SPATULA

Manufactured in France
British Patents applied for

No other cleaner has all these advantages:—

1. Only 100% pure, natural diamond grains are utilised.
2. Blades are treated with hard chrome to reinforce the setting of the diamond grains, to obviate loosening or breakaway during use. This process also prevents clogging of the diamonded surface by residues resulting from use.
3. All diamonded blades are rectified to ensure an absolutely smooth surface by eliminating diamond grains which may rise above the surface. This eliminates all excessive scratching during use.
4. All diamond grains are rigidly calibrated to ensure a perfectly uniform grain size of either 200, 300 or 400.
5. The chrome gives a very weak co-efficient of friction and the rigidity of the nylon handle is calculated to permit proper utilisation and yet pliant enough to avoid undue pressures on highly delicate relays.

- Grain size 200, thickness 55/100 mm., both faces diamonded. For quick cleaning of industrial relays and switching equipment, etc.
- Grain size 300, thickness 55/100mm., both faces diamonded. For smaller equipments, like telephone relays, computer relays, etc.
- Grain size 400, thickness 25/100 mm., one face diamonded. For sensitive relays and tiny contacts. Two close contacts facing each other can be individually cleaned, because only one face of the spatula is abrasive.

Sole Distributors for the United Kingdom
SPECIAL PRODUCTS (DISTRIBUTORS) LTD
81 Piccadilly, London W1V 0HL. Phone: 01-629 9556
As supplied to the M.O.D., U.K.A.E.A., C.E.G.B. British Rail and other Public Authorities; also major industrial and electronic users throughout the United Kingdom.

CIRCLE 46 FOR FURTHER DETAILS.

DEC SALE

a selection from our huge stocks. All items reconditioned unless otherwise stated.

Visit us at
DEXPO® Europe 84
Kensington
Exhibition Centre
London
May 30-June 1, 1984
BOOTH No. 2

DEC 11/70 SYSTEMS

11/70 CPU
Dual Rack Cabinet
1MB MOS Memory
2 x RM03 Disk Drives
DH11AD Multiplexor
LA120 Console **£55,000**

DEC 11/34 SYSTEMS

11/34A CPU
10½" Chassis
256KB MOS. Cabinet
2 x RK07 Disk Drives
DZ11A Multiplexor
VT100 Console **£10,250**

DEC 11/23 SYSTEMS

11/23AB CPU 5 ¼" Chassis
128KB MOS Memory
DLV11J 4-line Interface
RXV21 Dual Floppy Disk Drive
Cabinet
VT100 Console **£5,795**

DEC 11/03 SYSTEMS

11/03N CPU 5 ¼" Chassis
64KB MOS Memory
DLV11 Serial Interface
RXV11 Dual Floppy Disk Drive
Cabinet
LA36 Console **£3,500**

DEC DISK DRIVES

RK05F 5MB fixed	£695
RK05J 2.5MB	£975
RK06 14MB	£750
RK07 28MB	£1,200
RLV22 RL02 and 11/23+ ctl NEW	£4,500
RM02 67MB	£5,750
RM05 256MB	£14,500
RX11	£995
RXV11	£995

Range of Controllers also available

DEC MEMORY

PDP11	
MJ11BM 32KW Core	£600
MK11CE 512KB MOS	£2,500
MM11DP 16KW Core	£225
MS11KE 32KW MOS	£195
MS11LB 128KW MOS	£500
MS11LD 256KB MOS	£975
MS11MB 256KB MOS	£925
LSI	
MSV11DD 64KB	£225
MSV11LF 128KB	£500
MSV11LK 256KB	£750
MSV11PL 512KB	£1,395

DEC MULTIPLEXORS

DZ11A 8-line Master	£1,800
DZ11B 8-line Extender	£995
DZ11E 16-line	£2,750

DEC TERMINAL OFFER

Fully Reconditioned Units covered by 90 days parts & labour warranty

LA36 30cps KSR Terminal
Tractor feed unit
with integral stand
Price:
(with 20mA I/F) £295
(with EIA I/F) £325

VT100 VDU
Terminal Price:
from **£695**
Extra Cost
Options available: —

VT1XXAA (20mA)	£112
VT1XXAB (AV)	£75
VT1XXAC (Printer Port)	£125

LOW COST VDUS

Hazeltine 1500	£325
Newbury 7009	£325

TEKTRONIX GRAPHICS

606B Monitor	£950
4006 Terminal	£1,275
4010/1 Terminal	£1,500
4015/1 Terminal	£7,250
4027A Colour Terminal	£1,995
4052 Desktop Computer	£4,950
4114 Terminal	£10,500
4662 Plotter	from £1,995
4952 Joystick	£225

SPECIAL PURCHASE DAISY WHEEL PRINTERS

DIABLO HYTYPE II Model 1345

45 character-per-second letter quality printer with microprocessor control and solid die-cast aluminium frame. Receive-only bidirectional model with 12-bit parallel input and variable 10/12 pitch printing. Fully reconditioned and covered by our 90 day parts and labour warranty.
OUR SPECIAL PRICE
ONLY **£395** inclusive of integral desk unit.

A copy of our Trading Conditions can be supplied on request

ADD 15% VAT TO ALL PRICES Carriage and Packing extra

Electronic Brokers Ltd., 61/65 Kings Cross Road, London WC1X 9LN. Tel: 01-278 3461. Telex 298694

Electronic Brokers

CIRCLE 204 FOR FURTHER DETAILS.

This list contains only a fraction of CRICKLEWOOD'S stock. Please add 60p p&p & 15 VAT to all orders. Official orders from schools, colleges, Govt. Depts. etc. welcome.

THE TELEPHONE & MAIL ORDER SPECIALISTS
PRICES SUBJECT TO ALTERATION, PHONE FOR LATEST PRICES AND DELIVERY

CRICKLEWOOD
ELECTRONICS LTD
40 CRICKLEWOOD BROADWAY
LONDON NW2 3ET
01-452 0161/01-450 0995 Tlx:914977

RESISTORS

CARBON FILM 5% HI STAB LOW NOISE 10Ω TO 10MΩ

¼W E24	2p
½W E24	3p
1W E24	6p
2W E24	12p

METAL FILM ULTRA STABLE 0.4 W EXTRA LOW NOISE 10Ω TO 1MΩ

2% E24	5p
1% E24	6p

LOW OHMIC GLAZE ½W 0 22Ω to 8 2Ω E24 11p

WIRE-WOUND ON CERAMIC E 12 SERIES

2 to 3W 0 22Ω to 330Ω	28p
4 to 7W 0 47Ω to 6K8	33p
10 to 11W 1Ω to 33K	37p

POTS & PRESETS

ROTARY POTS LOW NOISE ¼" SPINDLES E3 SERIES

4K7 TO 2M LIN	38p
4K7 to 2M LOG	38p
As above with DP Mains Switch	88p
As above stereo (no switch)	90p

PRE-SETS PIHER (DUSTPROOF) E3 100Ω to 10MΩ

Mini Vert	15p
Mini Horiz	15p
Standard Vert	18p
Standard Horiz	18p

CERMET 20 TURN PRECISION PRESETS ¼" E3 SERIES 50Ω to 500K 89p

CAPS

CERAMIC 100V DISC (PLATE) E12 MICRO MINI TYPICALLY ± 5%
1pF to 10nF 7p

POLYCARB 5% SIEMENS 7 5mm MINI BLOC E12

1nF to 6nF	7p
8nF to 47nF	8p
56nF to 150nF	10p
100V	
100nF to 150nF	11p
180nF to 270nF	14p
330nF to 390nF	20p
470nF to 560nF	26p
680nF	30p
1μF (10mm)	35p

POLYESTER 250V RADIAL (C280)

10nF 15nF 22nF 33nF 47nF 68nF 100nF	7p
150nF 200nF	10p
330nF 470nF	13p
680nF	18p
1μF	22p
1 5μF	39p
2 2μF	39p

FEEDTHROUGH 1nF 500V 7p

HIGH VOLTAGE Capacitors please enquire many types in stock

TANT BEADS

1 35V	14p
22 35V	14p
33 35V	14p
47 35V	14p
68 35V	14p
1 0 35V	14p
2 2 35V	14p
3 3 35V	18p
4 7 16V	18p
4 7 35V	20p
6 8 25V	20p
6 8 35V	21p
10 16V	18p
10 35V	27p
15 10V	22p
15 16V	30p
15 25V	32p
22 6 3V	26p
22 16V	29p
33 10V	30p
47 3V	14p
47 6 3V	34p
47 16V	39p
100 3V	32p

ELECTROLYTICS Mainly Matsushita (Panasonic) &

Siemens AXIALS (Wires each end)

uFd	V	
.47	63	8p
47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2 2	63	9p
2 2	100	11p
2 2	350	30p
3 3	25	10p
3 3	40	11p
3 3	63	12p
4 7	16	8p
4 7	25	9p
4.7	40	11p
4 7	63	12p
4 7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	1.34p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end) Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

7400
7401
7402
7403
7404
7405
7408
7409
7410
7411
7412
7413
7414
7416
7417
7420
7421
7422
7423
7425
7426
7427
7428
7430
7432
7433
7437
7438
7440
7441
7442
7443
7444
7445
7446
7447
7448
7450
7451
7453
7454
7460
7470
7472
7473
7474
7475
7476
7480
7481
7482
7483
7484
7485
7486
7489
7490

PHONE FOR LATEST PRICES AND DELIVERY

7491
7492
7493
7494
7495
7496
7497
74100
74104
74105
74107
74109
74110
74116
74118
74119
74120
74121
74122
74123
74125
74126
74128
74132
74136
74141
74142
74143
74144
74145
74147
74148
74150
74151
74153
74154
74155
74156
74157
74159
74160
74161
74162
74163
74164
74165
74166
74170
74172
74173
74174
74175
74176
74177
74178
74180
74181
74182
74184
74185
74186
74188
74190
74191
74192
74193
74194
74195
74196
74197
74198
74199
74221

PHONE FOR LATEST PRICES AND DELIVERY

74LS TTL

74LS00
74LS01
74LS02
74LS03
74LS04
74LS05
74LS08
74LS10
74LS11
74LS12
74LS13
74LS14
74LS15
74LS20
74LS21
74LS22
74LS27
74LS28
74LS30
74LS32
74LS33
74LS37
74LS38
74LS40
74LS42
74LS47
74LS51
74LS54
74LS55
74LS73
74LS74
74LS75
74LS76
74LS78
74LS83
74LS85
74LS86
74LS90
74LS92
74LS93
74LS95
74LS96
74LS107
74LS109
74LS112
74LS113
74LS114
74LS122
74LS123
74LS124
74LS125
74LS126
74LS132
74LS133
74LS136
74LS138
74LS139
74LS145
74LS147
74LS148
74LS151
74LS153
74LS154
74LS155
74LS156
74LS157
74LS158
74LS160

PHONE FOR LATEST PRICES AND DELIVERY

74LS161
74LS162
74LS163
74LS164
74LS165
74LS168
74LS169
74LS170
74LS173
74LS174
74LS175
74LS181
74LS183
74LS190
74LS191
74LS192
74LS193
74LS194
74LS195
74LS196
74LS197
74LS221
74LS240
74LS241
74LS242
74LS243
74LS244
74LS245
74LS247
74LS248
74LS249
74LS251
74LS253
74LS257
74LS258
74LS259
74LS261
74LS266
74LS273
74LS275
74LS279
74LS280
74LS283
74LS289
74LS290
74LS293
74LS295
74LS298
74LS299
74LS323
74LS324
74LS325
74LS326
74LS327
74LS347
74LS348
74LS352
74LS353
74LS362
74LS365
74LS366
74LS367
74LS368
74LS373
74LS378
74LS386
74LS390
74LS393
74LS395
74LS396
74LS398
74LS399
74LS445
74LS490
74LS540
74LS541
74LS640
74LS641

PHONE FOR LATEST PRICES AND DELIVERY

CMOS

4000	16p
4001	16p
4002	16p
4006	49p
4007	19p
4008	32p
4009	24p
4010	24p
4011	16p
4012	19p
4013	19p
4014	46p
4015	39p
4016	19p
4017	32p
4018	45p
4019	24p
4020	42p
4021	39p
4022	39p
4023	19p
4024	32p
4025	19p
4026	79p
4027	28p
4028	39p
4029	43p
4030	19p
4031	1 19
4032	79p
4033	1 19
4034	1 29
4035	44p
4036	2 49
4037	1 13
4038	99p
4039	2 45
4040	39p
4041	39p
4042	39p
4043	39p
4044	39p
4045	99p
4046	44p
4047	69p
4048	39p
4049	22p
4050	23p
4051	44p
4052	58p
4053	49p
4054	79p
4055	83p
4056	83p
4059	4 35
4060	79p
4063	72p
4066	22p
4067	2 39
4068	19p
4069	19p
4070	19p
4071	19p
4072	19p
4073	19p
4075	19p
4076	45p
4077	19p
4078	19p
4081	19p
4082	19p
4085	49p
4086	60p
4089	1.23
4093	19p
4094	69p
4095	71p
4096	69p
4097	2.88
4098	74p
4099	89p
4502	55p
4503	39p
4507	33p
4508	1.26
4510	44p
4511	44p
4512	48p
4514	1.13
4515	1.13
4516	55p
4518	39p
4519	29p
4520	48p
4521	88p
4526	68p
4527	62p
4528	74p
4532	69p
4534	3.96
4536	2 59
4538	78p
4539	89p
4543	68p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.65
4584	39p
4585	59p

PHONE FOR LATEST PRICES AND DELIVERY

LOGIC

CPUs
1802
2550A
6502
6800
6802
6809
8035
8080A
8085A
Z80A
Z80B

MEMORIES
2114(200ns)
2532
2564
2708
2716 (5v)
2764
4116(200ns
4118 3
5204
6116P3
6514
6810
7489
74189
74LS188
74LS287
74LS288
74LS289

MISC LOGIC IC s
ADC0804
ADC0816
ADC0817
INS1671
INS1771
RO2513LC
RO2513UC
SAA5000
SAA5010
SAA5012
SAA5020
SAA5030
SAA5040
SAA5041
SAA5050
SAA5052
SAA5070
8T26
8T28
8T95
8T97
81LS95
81LS96
81LS97
81LS98
6522
6532
8154
8155
8212
8216
8224
8226
Z80ACTC
Z80ADART
Z80ADMA
Z80APIO
ZN425E8
ZN426E8
ZN427E8

PHONE FOR LATEST PRICES AND DELIVERY

V.REGS

Positive 100mA

78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO202

7805T	45p
7812T	45p
7815T	45p
7824T	45p

Negative 100 mA TO92

79L05	49p
79L12	49p
79L15	49p

1 Amp TO220

7905T	57p
7912T	57p
7915T	57p
7924T	57p

TRANSISTORS

2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2368	25p
2N2369	19p
2N2369A	20p
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	9.25
2N2926	10p
2N3053	32p
2N3054	56p
2N3055	60p
2N3055H	1.20
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3553	2.65
2N3638	55p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3773	1.99
2N3819	35p
2N3820	68p
2N3866	90p
2N3903	13p
2N3904	13p
2N3905	13p
2N3906	13p
2N4030	75p
2N4031	65p
2N4032	69p
2N4036	63p
2N4037	49p
2N4240	3 00
2N4400	15p
2N4401	27p
2N4402	30p
2N4902	1 85
2N4903	1 98
2N4904	2.15
2N4905	2 75
2N4906	2 99
2N4907	3 20
2N4908	3 15
2N4909	2 90
2N5089	37p
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2 88
2N5293	98p
2N5294	1 28
2N5295	1 37
2N5401	35p
2N5415	1 10
2N5416	1 54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5551	37p
2N5884	5.95
2N5886	5.95
2N6121	57p
2N6122	59p
2N6123	65p
2N6124	59p
2N6125	65p
2N6126	75p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1 14
2N6134	1.36
2N6253	1 45
2N6254	1 55
2SC1306	95p
2SC2078	1.70
2SJ49	3.95
2SJ50	4.50
2SJ82	4.75
2SK134	3.95
3SK135	4.50
2SK226	4 75
3N128	1 12
3N140	1 07
3N200	6 93
3N201	2 95
40360	60p
40361	67p
40362	67p
40363	2 95
40406	1 39
40407	75p
40408	1 59
40410	1 80
40411	3 95
40412	90p
40673	70p
40822	1.80
40871	1 00
40872	1 00
AC125	49p
AC126	32p
AC127	32p
AC128	35p
AC132	68p
AC141K	28p
AC142K	28p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
AF239	55p
AF240	1.00
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p
BC140	29p
BC141	37p
BC142	29p
BC143	30p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC186	24p
BC187	24p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LA	13p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	15p
BC239	15p
BC239A	16p
BC239C	18p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC440	32p
BC441	49p
BC460	32p
BC461	33p
BC516	40p
BC517	40p
BC546B	15p
BC547	13p
BC556B	15p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	15p
BC550C	25p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC558C	17p
BC559	15p
BC559B	16p
BC559C	17p
BC560	25p
BC560C	25p
BC650	45p
BC651	46p
BCY70	16p
BCY71	16p
BCY72	19p
BD131	44p
BD132	44p
BD135	35p
BD136	35p
BD137	37p
BD138	37p
BD139	38p
BD140	38p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1 14
BD245C	1 30
BD246A	1 20
BD246C	1 50
BC249A	2.00
BD249C	2 31
BD250A	2 11
BD250C	2 46
BD419	1 29p
BD420	1 37
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1 50
BD530	1 70
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1 10
BD540	85p
BD540C	1 20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1 32
BD712	1 32
BDX32	3 47
BDX66B	5 95
BDX67B	5 95
BDY54	1 70
BDY55	1 75
BDY56	2.25
BDY57	5 25
BDY58	6 15
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	75p
BF224J	32p
BF225J	35p
BF244A	55p
BF244B	55p
BF245A	55p
BF245B	65p
BF246	70p
BF246A	70p
BF246B	70p
BF247A	75p
BF247B	75p
BF254	39p
BF255	42p
BF256A	58p
BF256B	58p
BF256C	65p
BF257	30p
BF258	32p
BF259	35p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2 11
BFS28	2 95
BFS61	1 00
BFS98	1 10
BFX29	35p
BFX30	35p
BFY50	36p
BFY51	36p
BFY52	36p
BFY53	31p
BSX19	24p
BSX20	24p
BSX21	40p
BU104	2.22
BU105	1.70
BU108	3.95
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU226	4.95
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU500	2.95
BUY18S	3.95
E430	5.95
J300	70p
J310	70p
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3 00
MJ1800	3 60
MJ2500	2.19
MJ2501	2.25
MJ2955	1 00
MJ3000	2.19
MJ3001	2.25
MJ4502	3.99
MJ15003	4.85
MJ14004	5.55
MJ15015	2.45
MJ15016	3 34
MJE340	53p
MJE350	1.50
MJE2955	1.95
MJE3055	1.95
MJE2955T	99p
MJE3055T	69p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	46p
MPSL51	49p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
NE5534A	1.65
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	36p
TIP31A	33p
TIP31C	34p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1 29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	59p
TIP49	1 20
TIP50	1.40
TIP53	1 57
TIP54	1 59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP130	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1.04
TIP142	1.04
TIP145	1 15
TIP147	1 15
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS43	50p
TIS88A	80p
VN10KM	60p
VN46AF	95p
VN66AF	99p
ZTX107	10p
ZTX108	10p
ZTX109	12p
ZTX300	13p
ZTX301	15p
ZTX302	16p
ZTX304	23p
ZTX310	10p
ZTX311	12p
ZTX312	32p
ZTX313	26p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX450	39p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	24p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	3p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5404	16p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1S44	10p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA155	15p
BA156	38p
BA157	25p
BA158	30p
BA150	32p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAX13	10p
BB109G	65p
BY126	11p
BY127	12p

SCR's. TRIACS DIACS

THYRISTORS 4, 8 & 12 Amps Texas TO220
Suffix A – 100V
B – 200V
C 300V
D 400V
M 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p
4A	
TIC106D	49p
TIC106M	68p
TIC116A	66p
TIC116B	68p
8A	
TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p
12A	
TIC126C	73p
TIC126D	77p
TIC126M	96p

TRIACS Texas 400V TO220 Case

TIC206D (4A)	66p
TIC225D (6A)	74p
TIC226D (8A)	88p
TIC236D (12A)	1 16
TIC246D (16A)	1 22
TIC253D (20A)	1 90
TIC263D (25A)	2 11

DIACS

BR100	29p
ST2	29p

ZENER'S

many inc specials see our CAT
400 500mW E24 Series 2 4 47V 7p
1 3 Watt E24 Series 3 3 82V 14p

BRIDGE

(PIV shown in brackets) 1 amp type

W01 (100)	28p
W02 (200)	34p
W04 (200)	38p
W08 (800)	50p

2 amp type Square with hole

S01 (100)	46p
S02 (200)	50p
S04 (400)	55p
S08 (800)	66p

6 amp type Square with hole

PW01 (100)	95p
PW02 (200)	99p
PW04 (400)	1.30
PW06 (600)	1.39

25 amp type Metal clad with hole

K01 (100)	2.62
K02 (200)	2.75
K04 (400)	3.25
K06 (600)	4 10
BYW64	
35A 400V	4.50

OPTO

many inc specials see out CAT

LED LAMPS
R = Red
G = Green
Y = Yellow

Large Diffused 1·	
R5D	9p
G5D	15p
Y5D	15p
Small diffused	
R3D	8p
G3D	12p
Y3D	12p
Micro 0 1"	
R1M	25p
G1M	27p
Y1M	27p
Lage clear	
R5C	12p
G5C	17p
Y5C	17p
Super bright high efficiency Large (100 times brighter)	
R5U	38p
G5U	42p
Y5U	42p
Rectangular Stackable LEDs	
R5R	17p
G5R	18p
Y5R	19p

LIN ICS

AY1 5050	95p
AY3 8910	3 99
AY3 8912	4 95
CA3048	2 15
CA3059	2.80
CA3090AO	3.70
CA3130E	87p
CA3130T	2.35
CA3140E	39p
CA3140T	1 40
HA1366W	2 40
HA388	2 54
ICL7106	7 50
ICL7107	9 50
ICL7611	97p
ICL8038	2 99
ICM7555	80p
ICM7556	1.50
LC7120	3.20
LC7130	3.40
LC7137	3.95
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	1.25
LF357	1 30
LF398	4 62
LM335Z	1 60
LM348N	62p
LM349N	1 09
LM350K	4.60
LM379S	5.50
LM380N14	1.10
LM380NB	1 50
LM381AN	2.26
LM381N	1.40
LM382N	1 12
LM383T	3.40
LM384N	1.40
LM386	88p
LM388N	2.43
LM391N60	2 10
LM391N80	2 40
LM723CH	95p
LM723CN	35p
LM725CH	3.40
LM725CN	3.19
LM741CH	96p
LM741CN	22p
LM741CN14	80p
LM747CN	69p
LM748CH	1 00
LM748CN	35p
LM1871	3.25
LM1872	4.39
LM1877	5 95
LM1886	7 44
LM1889	3 77
LM2907N	2 76
LM2907NB	2 60
LM2917N	2 40
LM2917N8	2.40
LM3900	48p
LM3911	1 20
LM3914	3.25
LM3915	3.25
LM13600	1 15
MF10	3.50
NE531N	1 36
NE543N	2 50
NE544N	1.95
NE555	22p
NE556	65p
NE558	1 89
NE560	3 25
NE565	1 18
NE566	1 49
NE570	4.07
NE571	3 95
NE5534A	1 45
RC4194	3 95
RC4195	2 95
RC4558	44p
SL490	3.47
SN76003	2.95
SN76013	2.95
SN76023	2.95
SN76033	2.95
TA7204	1.99
TA7205	1.20
TA7222	1.75
TA7227	5.82
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TDA1002	3.39
TDA1003	3.94
TDA1004	P.O.A.
TDA1005	3.94
TDA1010A	2.25
TDA1022	4.95
TDA2002	3.25
TDA2003	3.25
TDA2020	2.99
TDA2030	2.85
TDA2611A	2.50
TDA7000	3.45
TL061	40p
TL062	60p
TL064	1.35
TL071	34p
TL072	45p
TL074	1.35
TL081	34p
TL082	45p
TL084	1.20
UAA170	2.49
UAA180	2.49
ULN2003	75p
UPC575C2	2.00
UPC1156	2.75
UPC1156H	2.75
UPC1182	3.75
UPC1185	1.95
UPC2002	2.95
XR2206	3.95
ZN409	2.25
ZN414	1.00
ZN1034	1.99

TRANSFORMERS

All 240V Primary
6.0 6V, 9 0 9V
12 0 12V
15 0 15V

100mA	95p
1A	2 65
20 0 20V	
0.125A	2.65
12 0 12V	
50VA	5.25
12 0 12V	
100VA	9.50
0-6-6-9-9	
1.25A	4 25

These goods are heavy send extra p & p We will credit any difference

VERO

0 1" COPPER TRACKS

2 5 × 3 7	83p
2 5 × 5	99p
3 75 × 3 75	99p
3 75 × 5	1.14
2 5 × 17	2 99
3 75 × 17	3 85
4 79 × 17	4 93
VO Board	1 92
Dip Board	3.90
Track Cutter	1 48
Pin Insertor	1.79
100Pins	55p
Verobloc	3.99
Vero Wiring	
Pen · Spool	3.35
Spare Spool	75p
Combs	6p

PCB

FERRIC CHLORIDE Quick dissolving Enough to make over 1 litre 1 69

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots · holes
8 0 1" edge connectors
9 Mixture
Any sheet of above 35p

GRADE ONE GLASS PCB SINGLE-SIDED

178 × 240mm	150p
420 × 195mm	1 95
420 × 245mm	2.95

DALO ETCH RESIST PEN · spare nib 1 20

PHOTO SENSITIVE PCB 1st Class Epoxy Glass For better results than spraying Expose to UV

Single Sided

100 × 160	2.10
100 × 220	2.50
203 × 114	2.40
233 × 220	5.20
Double Sided	
100 × 160	2.20
100 × 200	2.80
203 × 114	2.90
233 × 220	5.90

Developer for above (do not use Sodium Hydroxide) 500 ml 2.95

WIRE

PRICES PER METRE

Solid connecting wire

MAINS/SPEAKER	
Twin 1 Amp	14p
Twin 2½ Amp	16p
3 Core 2½ Amp	18p
3 Core 6 Amp	31p
3 Core 13 Amp	56p
SCREENED	
Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core. Single Screen	54p
8 Core	61p
12 Core	80p
Heavy Duty Mike/Guitar Lead	25p
AERIAL	
50Ω RG58A	25p
75Ω UHF	29p
75Ω VHF	28p
300Ω Flat	14p
RAINBOW RIBBON Prices per foot	
8 way	25p
10 way	25p
16 way	39p
20 way	48p
24 way	62p
30 way	75p
32 way	82p
40 way	88p
64 way	1.49

RECHARGE BATTERIES

Top quality Don't throw these batteroes away – they charge up to 1000 times!

HP2(1 2AH)	2.39
HP2(4AH)	4.75
HP7(½AH)	99p
HP11(1 2AH)	2.29
PP3(110mAH)	4.95

Chargers
TYPE H: Adjusted to 6 of any HP type Above £15 59
TYPE M As above but faster charge for 4AH £25 95
TYPE P PP3 £5.50
TYPE A: HP7 (Up to 4 at a time) £5.85

SOLDER

ANTEX SOLDERING IRONS

C240 (15W)	5.20
XS240 (25W)	5.40
Iron Stand	1 75
Elements (State Iron)	2 05
C240 Bits	
No 2 (Small)	85p
No 3 (Med)	85p
No 6 (Micro)	85p
XS240 X25 Bits	
No 50 (Small)	85p
No 51 (Med)	85p
No 52 (Lge.)	85p
SOLDER 125gms	
18swg	2 96
22swg	3.10

PLUGS & SOCKETS

'D' Connectors 25 Way Solder	
Male	1.60
Female	2.09
PCB Wire Wrap	
Male	1 60
Female	2.09
Covers	1.00
Phono Plugs Blk. Red Grn Wt or Yell	15p
Line Skts	1.20
Chas Skt · 1	20p
Dual	30p
Quad	40p

ZIF SOCKET

24pin	4 35
28pin	5 00
40pin	5 35

SWITCHES

TOGGLE (MINI)

SPST	49p
SPDT	59p
DPDT	69p
DPDT C OFF	90p
4PDT	2 95

CIRCLE 51 FOR FURTHER DETAILS.

www.americanradiohistory.com

Micro-controlled cassette recorder

by A. J. Ewins

Solenoid-operated cassette mechanism allows control of functions by push-button or microcomputer. Software to be described enables recorder to SAVE or LOAD automatically.

As a storage medium for microcomputer programs, the cassette tape-recorder is probably still the most widely used device, in spite of the falling prices of disc drives. Unless you are a Sinclair Spectrum owner, with a Microdrive, the cost of disc drives and controlling electronics is still very high. The storage capacity of a cassette tape is impressive; a C60 tape can store up to 750Kbytes of data when recorded at a rate of 2400 baud — 1.5Mbyte, if twin-channel recording is possible. However, cassette recorders cannot be used in an automatic SAVE and LOAD mode unless *all* the functions of the deck can be controlled by the microcomputer.

For some time now, Hart Electronics have been selling an entirely solenoid-controlled cassette deck of excellent quality. This series of articles describes the design of controlling electronics for this deck, enabling it to be operated by electrical push-buttons or direct from the 8-bit parallel output port of a microcomputer. Additionally, there is a design for a highly reliable f.s.k. system of electronics that enables the data from the microcomputer's serial line output (RS232 or t.t.l. level) to be recorded at a rate of 2400 baud. An electronic counter, clocked by the cassette deck's motion sensor, can be 'read' and 'reset' by the microcomputer via an additional 8-bit I/O port. This enables the tape to be wound or rewound to any desired position for the automatic SAVEing and LOADing of programs. The record/playback electronics are briefly discussed, since they are based on Linsley Hood's excellent design of a few years ago.*

Finally, examples of controlling software, developed on the author's UK101 microcomputer (a 6502 based machine) will be presented in a following article to illustrate how the various functions of the cassette deck may be automatically controlled. The program structure for the entirely automatic control of the cassette deck for SAVEing and LOADing of programs will also be discussed.

A block circuit diagram of the overall system is shown in Fig.1.

Control electronics

The solenoid-controlled cassette deck used in this design is the SF925F. Apart from its ability to be controlled electrically, it has all the usual specifications of a first-class cassette-deck mechanism; in particular a 12 volt motor with built-in electronic speed control and a wow and flutter figure of less than 0.08% weighted r.m.s. (0.2% DIN, r+p). Features which are specifically related to the design of the control electronics are micro switches to sense cassette-in-place and record prevention tab; a 3-digit memory counter with rotating magnet and Hall effect i.c. for motion sensing; and three solenoids which need an initial voltage of 16-24V, with a hold voltage of 7-10V. Current consumption per solenoid is 300mA at 12V.

Of the three solenoids, there are two main ones; one to control the fast forward, FF, function and one to control the rewind, R/W. The third allows the record/playback head to be lightly engaged during fast forward or backward winding. This is called the 'search' mode and the solenoid is referred to as the 'search' solenoid. For correct operation the deck, motor and solenoids must be operated in a particular sequence. For the record/playback sequence it is essential that the motor is switched on first and allowed to run up to speed before energizing the relevant solenoids. Although not essential in the fast-forward and rewind

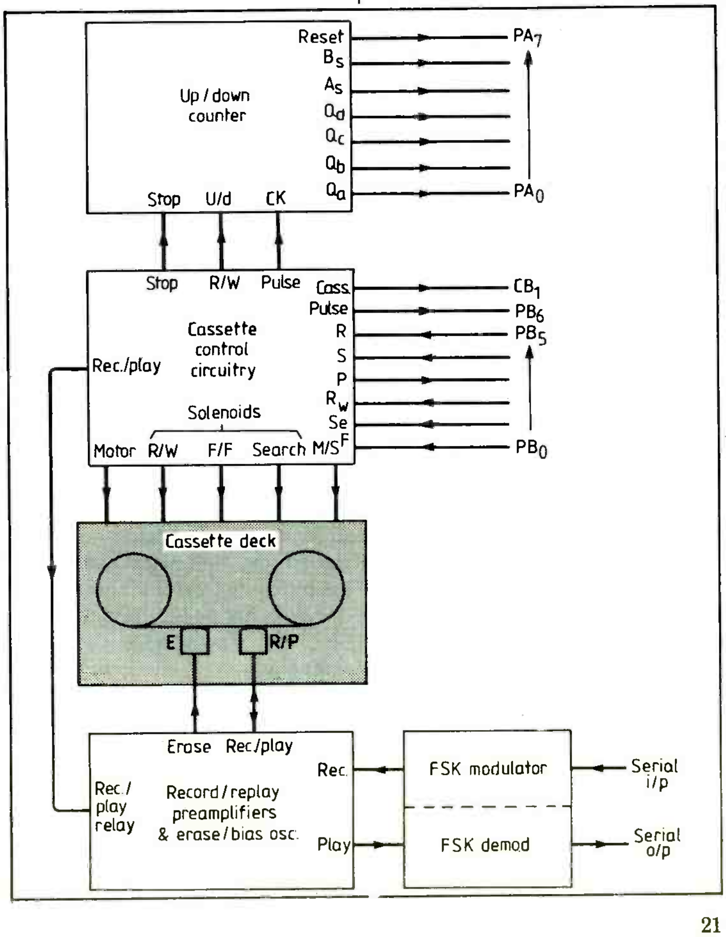


Fig.1. **Block diagram of cassette recorder for data or program storage. Cassette deck is SF925F from Hart Electronics.**

---

*Wireless World, May, June, August, 1976. Reprinted in High-fidelity Designs, Vol.2.

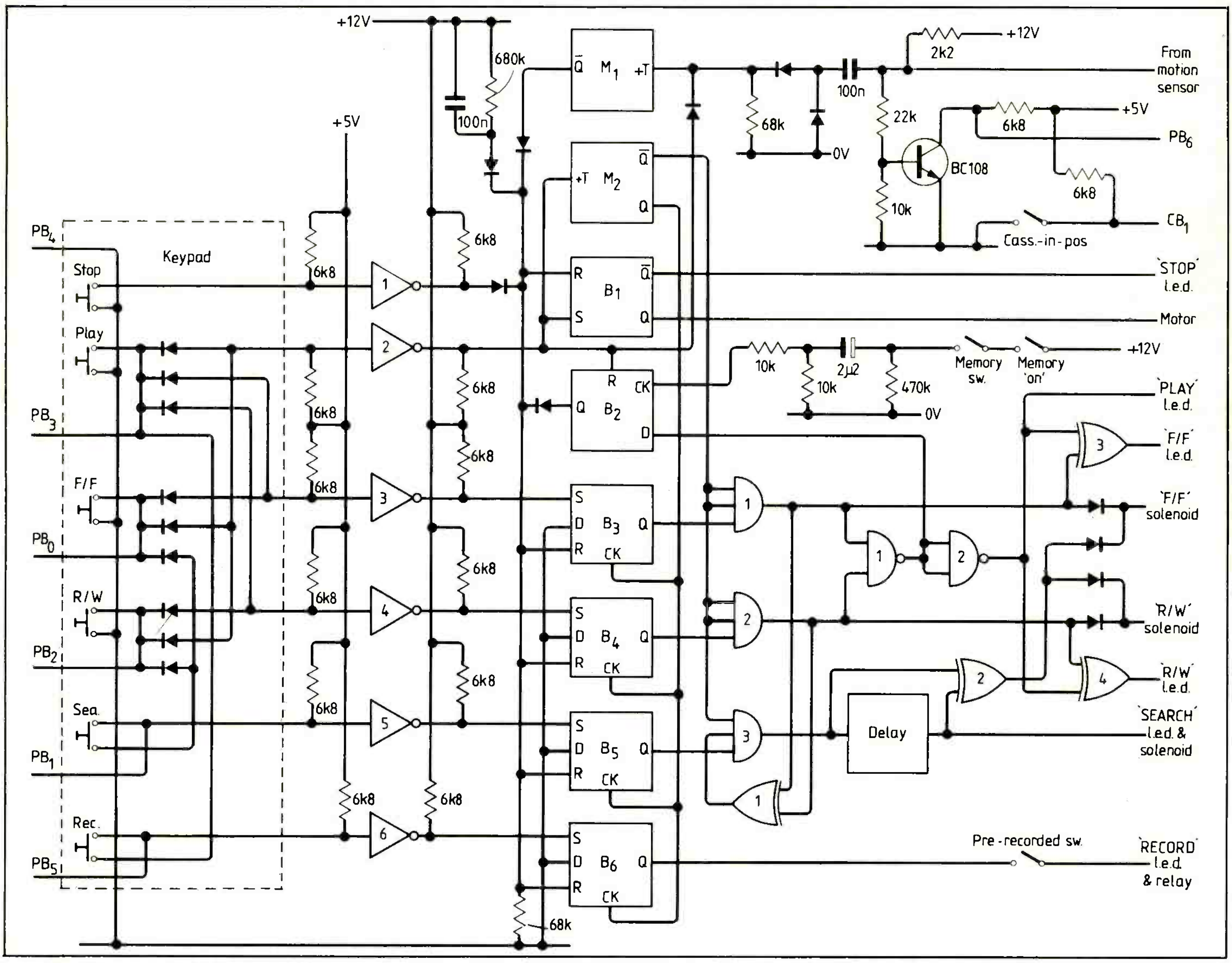


Fig.2. **Control circuitry for either push-button or computer-controlled operation.**

sequences it is good practice to do so. Assuming then that the motor is switched on first, the usual type functions are performed in the following ways:

1. Fast forward — energize the FF solenoid.
2. Rewind — energize the R/W solenoid.
3. Play/record — energize the FF and R/W solenoids simultaneously. (For this function the momentum of the motor is used to assist the raising of the head/pinch-roller plate.)
4. Fast forward search — energize FF and R/W solenoids simultaneously and after a short delay (0.5s) energize the 'search' solenoid and de-energize the R/W solenoid.
5. Rewind search — as for F/F/S above, but in this case, after the short delay, energize the 'search' solenoid and de-energize the FF solenoid. (N.b., in this mode and the preceding one, the energizing of the 'search' solenoid may be carried out simultaneously with the de-energizing of the R/W or FF solenoids; the slightly 'slugged' response of the de-energized solenoids will ensure that they drop out after the 'search' solenoid has energized.)

It is possible to switch from one function to another directly, provided that the previous function is cancelled first.

The circuit of the control electronics required to perform all the above functions in the correct sequence of motor and solenoids is shown in Fig.2. It has been designed to be controlled by either push-button switches via diode-Or logic or by the correct selection of logic input lines from the 8-bit I/O port of a microcomputer. It is, of course, perfectly possible to control the energizing of the motor and solenoids in the correct order *directly* from the I/O lines of a micro, letting the software within the computer determine the necessary sequence of events. The author chose to design the control circuitry specifically to allow manual operation so that the cassette deck could be operated in 'stand alone' mode and to allow its control to be overridden during software development.

To understand the operation of the control circuitry, consider its control via the six push-button switches. All the logic control elements are contained in c.mos digital i.cs, except for the six inverting input buffers, which are contained in a low powered t.t.l. logic circuit type 74L05. These act as interfaces between the 12V logic levels of the control circuitry and the 5V t.t.l. levels from a microcomputer. The outputs of the six inverters are open-collectors, so 6k8 resistors are used as pull-ups to the 12V line. The inputs to the six inverters are normally open-circuit, and they are also pulled-up via 6k8 resistors, this time to the 5V rail. With the inputs to the six inverters at the logic 1 level, their outputs are at logic 0 and no functions will be operating. The 100nF capacitor in parallel with the 680k resistor and connected between the 12V rail and the reset, R, input of flip-flops B1 and B3 to B6 via a silicon diode ensure that all functions are held off during power-up.

Suppose that the fast-forward function is selected by pressing the FF push-button. The inputs to inverters 2 and 3 will be grounded via the keypad diode-Or logic. Their outputs will thus go high to logic 1. A high on the set, S, input of B1 sets its Q output high and its $\overline{Q}$ output low. The motor is thus switched on and the stop led off. Simultaneously, a high on the set, S, input of B3 sets its Q output high. However, at the same time, the monostable, M2, has been triggered by the output of inverter 2 so that its $\overline{Q}$ output goes low. The output from And 1 thus stays low until $\overline{Q}$ of M2 goes high. When it does so, after the monostable, M2, delay period of about half-a-second, the FF solenoid is energized and the cassette deck goes into the fast-forward function. The Q output of M2, which goes high when M2 is triggered, is used to clock all four flip-flops, B3 to B6, resetting to zero (via the logic 0 on their D inputs) all those whose set inputs are not simultaneously high. In this manner previous functions are automatically cancelled before the new one is selected.

The successful operation of any function depends on the operation of the push-buttons being momentary. This is because of the mode of operation of the motion sensing circuitry and the monostable, M1. When the cassette deck is running with a cassette in position, the output from the motion sensor is a train of positive pulses. This train of pulses is fed to the trigger input, +T, of M1 via the 100nF capacitor and associated diodes and 68k resistor. The monostable, M1, is operated in a retriggerable mode so that its $\overline{Q}$ output will remain low so long as it is continuously triggered. In the event of tape motion ceasing, the pulse train to the trigger input of M1 will also cease and its $\overline{Q}$ output will eventually go high (after a delay of about 2s). When it does, flip-flops B1 and B3 to B6 are reset and the function in operation is cancelled. Prior to the operation of any function the $\overline{Q}$ output of M1 is always high. For a function to operate it is therefore necessary to trigger the $\overline{Q}$ output of M1 low at the same time the function is selected. This is achieved by the diode link from the output of inverter 2 to the +T input of M1. If a push-button such as FF is held pressed, the output of inverter 2 remains high and so does the +T input of M1. M1 cannot be retriggered whilst +T remains high. Thus, at the end of the period of M1's temporary state, $\overline{Q}$ of M1 will again go high, cancelling the selected function. Thus no function button should be held pressed for more than about 2 seconds. It is perfectly natural to operate the push-buttons momentarily and this feature is of no consequence; in fact it can be used to cancel a function wrongly selected.

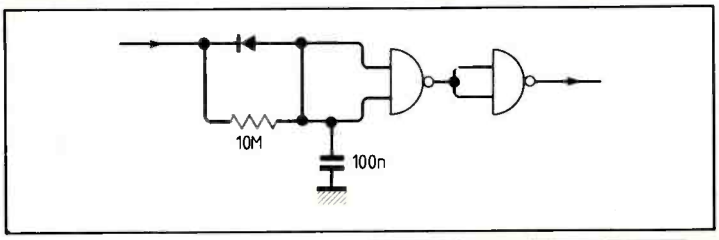


Fig.3. **Delay circuit to energize search solenoid.**

Selection and operation of the rewind function is carried out in a similar manner to the fast-forward function by pressing the R/W button. In this case the R/W solenoid is energized via inverter 4, flip-flop B4, and And 2. The play function selection may also be readily understood as pressing the Play button merely energizes both FF and R/W solenoids simultaneously, after the motor run-up delay period of half a second. The record function is selected by pressing both Play and Record buttons together. The Record button is linked to the Play button such that Record will only operate with the Play button and no other. The record function operates exactly as for Play but with the addition of energizing a record relay via logic signals from inverter 6 and flip-flop B6. No delay is imposed between pressing Record/Play and the operation of the record relay. This gives the Record electronics of the cassette deck time to settle before recording actually begins. The 'pre-recorded' tab microswitch is wired in series with the Q output of B6 and the record relay driver transistor, thus preventing a cassette from being recorded that has had its pre-recorded tab removed.

The remaining functions not so far described, and involving a little more circuit sophistication, are those of the fast-forward and rewind search modes. The Stop function, it is hoped, speaks for itself and merely cancels all functions by resetting flip-flops B1 and B3 to B6. The Search functions are selected by pressing the Search button together with the desired FF or R/W button. The Search button only functions when pressed with FF or R/W; not on its own or with any other button. If all three buttons are pressed together the Play function results. When the search function is selected, the Q output of B5 is set high. A high output from And 3 occurs only after the usual delay period *and* only if the output from And 1 *or* And 2 is high; not if neither And 1 nor And 2 is high, nor if both are high. This logic is determined by the exclusive-Or gate, XOR 1, and its output to the input of And 3. A high output from And 3 *immediately* operates both R/W and FF solenoids via XOR 2 and the two silicon diodes. After a delay of about half-a-second the output from the delay circuit goes high, energizing the search solenoid. As both inputs to XOR 2 are now high, its output goes low. Either the R/W or FF solenoid will thus drop out, the other remaining energized by the high on the output of And 1 or And 2, depending on which search function was selected.

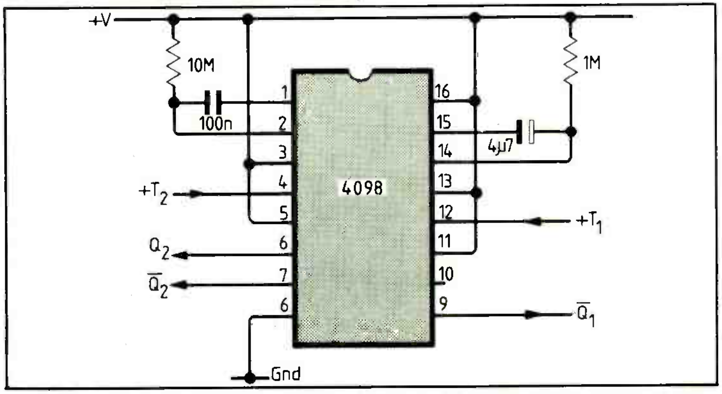


Fig.4. **Circuit of delay flip-flops M1 and M2.**

The cassette deck counter is fitted with a 'memory' function, which is simply a switch closure associated with the 000 count. When a part of the tape is found to which the operator may wish to return at a later time, the counter is simply reset. Winding forward or back to this 000 count position results in the memory switch contacts closing. To stop the R/W or FF functions when this condition is reached, the flip-flop B2 is included. The 2μ2 capacitor, diode and 470k and 10k resistors debounce the memory switch contacts, so that reliable operation of the memory switch is achieved. When the memory switch contacts close, B2 is clocked. If the D input is high, then the Q output will go high, resetting flip-flops B3 to B6 and B1, cancelling the selected function. The D input is taken from the output of Nand 1, so that it is high for all functions except Play or Record. The memory function thus operates only when in the FF, R/W or two search modes.

In addition to operating the required solenoids for a particular function, the control circuitry provides logic signals to illuminate a number of leds to show the function in operation. The operation of the stop, search and record leds is straightforward and needs no further explanation. However, it is necessary to decode the FF and R/W logic signals to provide led indications for the FF, R/W and Play functions. The play led is illuminated when both FF and R/W solenoids are energized by a signal provided by Nand 1's output inverted by Nand 2. The FF led needs to be illuminated when the FF solenoid is energized, but not when FF *and* R/W solenoids are energized; XOR 3 provides this signal. In a similar manner XOR 4 provides the signal for the R/W led.

The BC108 transistor and associated resistors converts the train of pulses from the motion sensor (at a 12V signal level) to a 5V level suitable for reading from the 8-bit I/O port of the microcomputer. The cassette-in-position microswitch is also connected to a 6k8 resistor from the 5V line to provide a logic signal that can be read by the microcomputer. The delay circuit, shown in Fig.3, is made up from the two remaining 2 i.p. Nand gates of a quad i.c., type 4093, which has Schmitt trigger inputs. Figure 4 shows the detailed circuit of the two monostables, M1 and M2, using an i.c. type 4098 or 4538. The motion sensor of the cassette deck mechanism is a Hall-effect i.c. There are three connections to it; two are the supply rails, 0 and +12V and the third is the output to the control circuitry. The i.c. was found to operate better with the addition of the 2k2 pull-up resistor as shown in Fig. 2. Connection details to the i.c. are supplied with the deck.

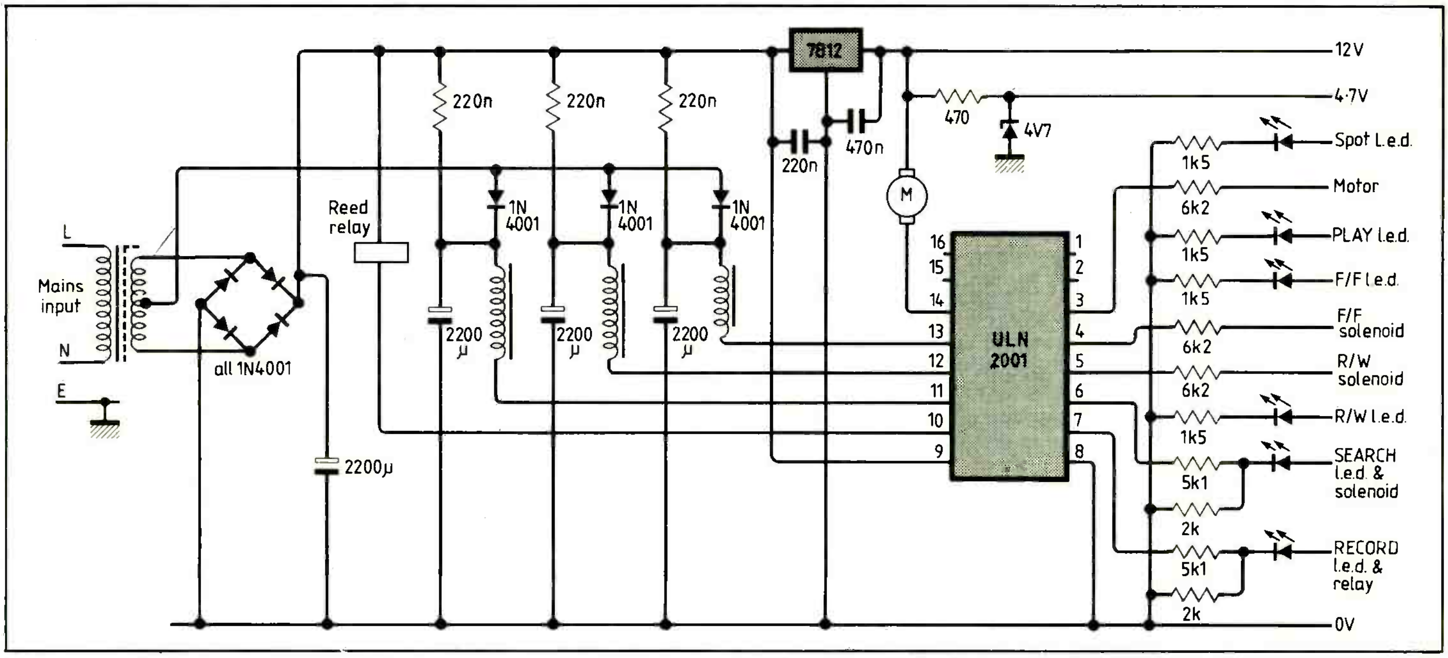


Fig.5. **Power supply for control circuitry.**

To drive the motor and solenoids of the cassette deck and the record relay from the logic signals of the control circuitry, it is obviously necessary to provide suitable driver stages. A suitable circuit is shown in Fig. 5, together with a power supply to drive the cassette deck, control circuitry and solenoids. The i.c. ULN2001, contains seven stages of Darlington transistors capable of sinking up to 500mA each. It is therefore capable of driving the solenoids, motor and relay directly. 'B' type c.mos devices are quite capable of delivering up to 10mA at a supply voltage of 12V.

To achieve a high switch-on voltage for the solenoids, 2200μF capacitors are charged from a 20V supply through 220 ohm resistors. The supply side of the solenoids and capacitors is also connected, via diodes, to a 10V peak, unsmoothed, d.c. supply. Thus, at the instant of energizing, the initial voltage across a solenoid will be nearly 20V, and will fall to a 'holding'voltage of about 10V provided by the 10V unsmoothed d.c. supply. Since the voltage drop across a 220 ohm resistor is about 11V (when its solenoid is energized) it must be capable of dissipating $(11^2/220)$ watts, i.e. just over 0.5W. 1 watt resistors should therefore be used. The value of the 220 ohm resistors is chosen to be low enough for the 2200μF capacitors to charge to a high voltage during the period of M2's 0.5 second delay. Thus no problems should occur when switching from one function to another when both use the same solenoid.

The motor of the cassette deck requires a stabilized voltage of 12V, which is supplied by the 1 amp regulator i.c., type 7812, fed from the 20V unregulated, d.c. supply. The c.mos logic circuitry is also supplied by this 12V source.

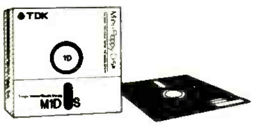
Flip-flops, B1 to B6, are all halves of dual, D-type flip-flop i.c., type 4013. Thus three such i.cs are required. The three triple i.p. And gates are all contained in an i.c., type 4073. The four, 2 i.p. exclusive-Or gates are all contained in the 4070. Finally, the two, 2 i.p. Nand gates are the other half of a quad, 2 i.p. Nand gate i.c., type 4093, the first half being used by the delay circuit.

In the next part of the article, the f.s.k. modulator/demodulator, will be described.

DISKPOST

* BETTER VALUE MAIL ORDER SUPPLIES FOR YOUR MICRO *

TDK DISKS



High grade flexible disks from one of the world's most famous suppliers. 5¼" and 8" disks, in boxes of 10.

5.25" DISKETTES

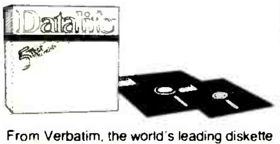
M1D-S	S/S, D/D, 48 TPI	£24.30
M2D-S	D/S, D/D, 48 TPI	£34.80
M2DX-S	D/S, D/D, 96 TPI	£45.50

48 TPI suitable for 35 or 40 track operation.
96 TPI suitable for 77 or 80 track operation.

8" DISKETTES

F1-S128	S/S, S/D	£27.60
F1-H32	S/S, S/D	£27.60
F2D-S1024	D/S, D/D	£40.10

DATALIFE DISKS



From Verbatim, the world's leading diskette manufacturer. Full 5 year warranty. All minidisks are certified for double density recording, and are fitted with hub ring reinforcement as standard.
Prices per box of 10 disks.

5.25" DISKETTES

MD525	S/S, D/D, 48 TPI	£18.25
MD550	D/S, D/D, 48 TPI	£27.15
MD577	S/S, D/D, 96 TPI	£25.55
MD557	D/S, D/D, 96 TPI	£34.20

48 TPI suitable for 35 or 40 track operation.
96 TPI suitable for 77 or 80 track operation.
10 and 16 hard sectored versions available at same prices.

8" DISKETTES

FD34-9000	S/S, S/D	£26.10
FD34-8000	S/S, D/D	£26.60
DD34-4001	D/S, D/D	£30.95

32 hard sectored versions available at same prices.

XIDEX DISKS

The new premier quality standard, against which all other manufacturers will have to be judged. All products certified for double density recording. Now with a **lifetime** warranty. Unreservedly recommended.
Prices per box of 10 disks.

5.25" DISKETTES

5012-1000	S/S, D/D, 48 TPI	£19.55
5022-1000	D/S, D/D, 48 TPI	£27.55
5012-2000	S/S, D/D, 96 TPI	£27.75
5022-2000	D/S, D/D, 96 TPI	£35.80

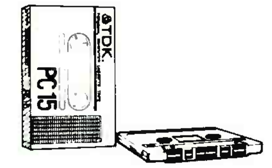
48 TPI suitable for 35 or 40 track operation.
96 TPI suitable for 77 or 80 track operation.
10 and 16 hard sectored versions available at same prices.

8" DISKETTES

8012-1000	S/S, D/D	£26.40
8022-1000	D/S, D/D	£31.90

32 hard sectored versions available at same prices.

TDK CASSETTES



You know the name and the quality's the same. 15-minute computer grade cassettes for optimum performance in all standard microcomputer cassette drives. In boxes of 10.

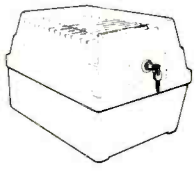
TDK PC15	£5.90

DISK DRIVE HEAD CLEANING KITS

Helps to protect your valuable data, and minimise expensive downtime and repair costs. Consists of a flexible jacket, which receives a pre-saturated cleaning disk. Each disk is sealed within a foil sachet to ensure that it contains the right quantity of cleaning fluid when used. After use the disk is disposed of, and the jacket is kept for future use.
Suitable for single or dual head drives. Please specify 8" or 5.25" disks.

STARTER KIT (contains jacket and two cleaning disks)	£7.70
REPLACEMENT CLEANING KITS (pack of 10)	£14.80

DISKETTE STORAGE BOXES



Protect your diskettes and valuable data from external contamination. Lockable, portable and secure. Two part box made from anti-static ABS plastic. Price includes dividers and index labels. Capacity 80 disks.

A5 Storage box (for 8" disks)	£32.00
A6 Storage box (for 5.25" disks	£22.00

CTI – CP80 PRINTER

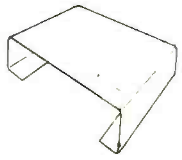
Features:—

Friction and tractor feed as standard
80 c.p.s.
Bi-directional logic seeking.
13 x 9 dot matrix giving true descenders.
Sub and superscripts.
Italic printing and auto underlining.
Condensed, emphasised, expanded and double strike printing (can be mixed in a line).
Parallel interface fitted as standard.
12 month warranty.

Print sample available on request.

CP-80 PRINTER	£249.00
Optional RS-232 interface	£40.00
Special VIC20/VIC 64 interface	£46.00

PRINTER STAND



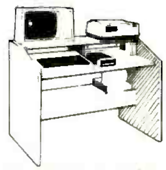
Suitable for use with dot matrix printers. Lifts printer sufficiently to enable continuous stationery to self-stack. Painted steel unit.
Dimensions: 39cm wide
x 28cm deep
x 10cm high

Comes as package which also contains:—

200 sheets continuous stationery.
1 x 9½" binder.
1 x highlighter pen.
choice of rubber feet/sticky pads.

PRINTER STAND	£19.95

COMPUTER FURNITURE



Suitable for use with all leading personal computers. Features a top shelf for monitor/printer, lower shelf for books, paper and general storage; large desk top surface at keyboard height; attractive teak finish, and castors for mobility.

U.K. Manufacture. Comes in flat pack for self assembly – full instructions provided.

A further range of more sophisticated units is available – please ask for details.

THE ORGANISER	£55.00

To: DISKPOST, FREEPOST, WEST MOLESEY, SURREY, KT8 0QF. Tel: 01-941 4066

Qty	Product	Price
		£
		£
		£
		£
	Sub Total	£
	Delivery/Insurance	£ FREE
	V.A.T.	£
	TOTAL VALUE OF CHEQUE PAYABLE TO DISKPOST	£

Company Orders

If you are unable to raise cheques without an invoice, please post or telephone your order to us. We will then forward a pro-forma invoice, for your accounts department to pay against.

All prices inclusive of delivery and insurance on British mainland.

YOUR NAME ……………………………

ADDRESS ……………………………

……………………………

……………………………

Tel. No.: ……………………………

Please charge to my Visa/Mastercharge/American Express/Diners Club account.

My card number is ……………………………

VISA DINERS CLUB INTERNATIONAL

Credit Card Orders

We welcome Visa, (Barclaycard), Mastercharge, (Access), Diners Club and American Express. There is no credit card surcharge. Either write your card number on your order, or telephone your order to our sales office.

WW6

* NEW 1984 PRICES *

DISKPOST

DISKPOST® is the mail order division of the BFI Electronics Group Europe's largest independent diskette supplier.

FREEPOST West Molesey
Surrey KT8 0QF. Tel: 01-941-4066

CIRCLE 28 FOR FURTHER DETAILS.

OUT OF PHASE?

Find out with the Farnell PM1 phasemeter

- **Low cost**
- **Simple to operate** *(no controls)*
- **Accepts wide range of inputs** *(no attenuator needed)*
- **Auto display of leading or lagging phase**

The Farnell PM1 is a mains operated analogue phasemeter which will register 0 to 180° phase difference and will indicate whether the difference is leading or lagging.

The instrument has many general applications in testing, calibration and research. The wide input frequency range makes it useful for audio work, stereo broadcast measurements, setting up microphones, aligning record/playback heads on tape recorders, and other possible applications include work on servomechanisms, synchro-resolvers, sine-cosine generators, network analysis, Nyquist diagrams and filter plotting.

Leaflet available from:

Farnell Instruments Limited,
Sandbeck Way, Wetherby, West Yorkshire LS22 4DH
Telephone: 0937 61961 Telex: 557294

CIRCLE 017 FOR FURTHER DETAILS.

B. BAMBER ELECTRONICS

Marconi Modulation Meter Type TF2301A	£330.
Marconi RMS AC/DC Voltmeter Type TF2607	£185.
Marconi RF Power Meter Type OA 7024/4	£195.
Marconi UHF Attenuator Type TF 2168	£100.
Wavetek LF Generator Type	£380.
Solartron DVM Type 1420.2	£65.
Hewlett Packard Power Supply 0-40v @ 30amp. Type 6268B	£450.
Schomandl Modulator Type MAF BN B41962	£650.
Schoolmandl Synthesizer Type ND 100M	£1200.
Rohde & Schwarz Decade Signal Generator 0.3 - 500 Mhz Type SMDV BN 41104	£1200.
Rohde & Schwarz Sweep Signal Generator 50Khz - 12Mhz Type BN4242/2	£75.
Rohde & Schwarz Power Signal Generator 0.1 - 30Mhz Type BN41001	£125.
Rhode & Schwarz Frequency Indicator Type BN47051	£50.
Rhode & Schwarz Group Delay Measuring Equipment Indicator	£50.
Marconi AM Signal Generator 10 - 500Mhz Type TF801B	£125.
Marconi AM Signal Generator 10 - 310Mhz Type TF801A/1	£85
Marconi Standard Signal Generator 15Khz - 440Mhz Type TF867	£85.
Marconi RC Oscillator 20Hz - 200Khz Type TF 1101	£85.
Marconi AM/FM Signal Generator Type TF 995A/5	£230.
Marconi VHF Signal Generator Type TF 1064B/5M	£125
Marconi Tx & Rx Output Test Set Type TF 1065	£85.
Pye Modulation Meter 68 - 510Mhz Type MM1	£60.
Airmec Sweep Signal Generator 20Hz - 200Khz Type 352	£45.
Marconi Universal Bridge Type TF868B	£110.
Marconi Universal Bridge Type TF1313	£220.
Tektronix Oscilloscope Type 647	£250.
Tektronix Oscilloscope Type R647A Less Plug ins	£196.
EMI Wide Band Amplifier Plug-in Type 7/1	£25.
Advance Oscilloscope Type OS15A LP Tube 3Mhz	£85.
Advance Oscilloscope Type OS25A Twin Beam 3Mhz	£125.
Tektronix Oscilloscope Type 502	£85.

Pye Base Station Type F30 AM High Band & Low Band from	£220.
Pye Base Station Type F401 AM High Band	£250.
Pye Base Station Type F17 FM High Band	£250.
Pye Reporter Type MF6 AM High Band & Low Band	£90.
Pye Europa Type MF5 FM High Band.	£70.
Pye Europa Type MF5U UHF	£70.
Pye Olympic Type M201 AM High Band	£65.
Pye Motofone Type MF5 AM High Band & Low Band	£45.
Pye Westminster Type W30 Low Band	£25.
Pye Pocketphone Type PF5 UHF Complete with Batteries	£35
Burndept UHF Portable Type BE 471 with manual	£125.

WANTEO Second Hand Radiotelephone Equipment.

Pye Bantam Battery Chargers	£10.
Rank Telecoms Battery Charges	£10.
Pye pocketphone PFI Battery Chargers 12 Way	£10.
ITT Starphone Battery Chargers	£10.
Tektronix Hard Copy Unit Type 4601	£125
Advance Pulse Generator Type PG 5002	£85.
Siemens Milliwattmeter 50ohm 500mW 0-12.4Ghz	£95.
Gaumont — Kalee Flutter Meter	£40.
Siemens Transistor Power Unit 0-30v 2amp.	£30.
Avo Valve Characteristic Meter Type 3	£40.
Airmec Wave Analyser Type 853 30Khz - 20Mhz	£45.
Sullivan RC Oscillator 40Hz - 125Khz	£35.
MESL Sweep Oscillator Type M1000 8-12Ghz	£125.
Electrohome 9" Video Monitor metal case	£50.
Aztec 20" Video Monitor metal case	£40.
ITT 20" & 24" Video Monitors wooden case	£30.
General Radio Microwave Oscillator Type 1360B 1.7 - 4.1Ghz	£125.
Wayne Kerr Component Bridge Type B521	£45.
Marconi Dscillator Type TF 1246 40Khz - 50Mhz	£95.
Wandel & Goltermann Level Meter Type TFPM 43 10Khz - 14Mhz	£60.

Servomex AC Voltage Stabiliser Type AC2 240 vac 9amp.	£45.
Servomex AC Voltage Stabiliser Type AC7 240 vac 40amp.	£95.
Hewlett Packard Sweep Generator Type 692D 1.8 - 4.2Ghz	£300.
Tektronix Plug in Power Unit Type 133 with Type O Plug in	£85.
Tektronix Storage Display Unit Type 611	£120.
Tektronix Oscilloscope Type 515A	£85.
Tektronix Plug in Type CA	£25.
Schomandl Frequency Meter Type FD1 30 - 900Mhz	£50.
Rohde & Schwarz AF Wave Analyzer Type BN48302	£50.
Rohde & Schwarz UHF Test Receiver Type BN1523 280-940Mhz	£75.
Airmec Modulation Meter Type 210 3-300Mhz	£95.
Marconi Carrier Deviation Meter Type TF 791 D 4-1024Mhz	£125.
Marconi FM Signal Generator Type TF 1066B/1 10-470Mhz	£280.
Marconi AM Signal Generator Type TF 144H/4S 10Khz - 72Mhz	£125.
Marconi Out of Limits Indicator Type TF 2404	£60.
UCC Micro — Film Reader Cassette Type	£35.
Marconi Transmission Line Test Set Type TF 1267	£40.
Marconi Variable Attenuator 75ohm Type TF 1073A/2S	£20.
60 amp Alternator & Generator Noise Filter	£1.00 each.
Instrument Fans 4 1/2" × 4 1/2" 240vac	£3 each, 110vac £1.50 each.
Garrard Car Cassette Player Mechanisms, Stereo Head	£2.50.
Tektronix Oscilloscope Probes	£10 each.
Pye Pocketphone Rx Ni-Cad Batteries.	3 for £1.00.
Mullard Vari-cap TV Tuners Type ELC 2003 Ex. Brand New Sets.	£3.50.
Pye Cambridge/Vanguard 18 Way Control Leads	£4.00.
Sony 1/2" Video Tape 5" Reels	£2.00.
BNC Plugs 75 ohm	50p. each.
IC Test Clips 28 pin & 40 pin	£2.00 each.
Circulators 590 - 720 Mhz 'N' sockets	£25.
Transistors Type 2N3055	4 for £1.00.
Transformers 30 volt @ 1 amp.	£1.00.
Transformers 36 volt @ 1.5 amp	£1.00.
Transformers 600 - 0 - 600 @ 250mA plus 460 - 0 - 460 @ 230mA	£10.00.
'Variacs' 2 amp, 5 amp, 8 amp, 15 amp, 20 amp, 25 amp.	
Loudspeakers Richard Allan Type CP12, 12" 15 ohm	£6.00.
Capacitors 16 mfd 6.5kv £25 each, 0.33 mfd 10kv	£4.00 each.

PYE POCKETFONE PF1 UHF RECEIVER

440-470 MHz, Single Channel, int. speaker and aerial. Supplied complete with rechargeable battery and service manual, **£6 each plus £1 p.p. plus V.A.T.**

BREAKING TEK 545A SCOPES FOR SPARES

CRT type T543 P2 **£12** each. Mains Transformers T601 **£15.** High Volume Transformer T801 with valves **£25.** Also Switches, Knobs, Fans, Capacitors and Metalwork.

RADIOSONDE RS21 METEOROLOGICAL BALLOON TRANSMITTER

with Water Activated Battery, contains all-weather sensors, fully solid state, **£5 each plus £1 p.p. plus V.A.T.**

P. & P. or Carriage and V.A.T. at 15% on total must be added to all orders.
Callers very welcome, strictly between 9 a.m. and 1 p.m and 2 and 5 p.m. Monday to Friday inc.
Barclaycard and Access taken
Official orders welcome WW27

5 STATION ROAD, LITTLEPORT, CAMBS CB6 1QE
PHONE: ELY (0353) 860185

CIRCLE 45 FOR FURTHER DETAILS.

Fibre optic communications

by Brett Wilson

Part 2 — optical sources, detectors and receivers

This second article looks at the different types of optical sources and detectors available and clarifies the best combinations for different types of system.

Optical sources for fibre transmission systems must be compatible with the fibre characteristics. They should be small, reliable, inexpensive and efficient in the conversion of electrical input power to optical power coupled into the fibre. In addition it must be possible to modulate them at high data rates, preferrably directly. Two main candidates have emerged; light emitting diodes and injection laser diodes. Both devices operate in a forward-biased mode (low voltage, high current) and emit light as a result of hole-electron combination at the p-n junction. Direct modulation is possible for both l.e.ds and i.l.ds by varying the drive current, although there are certain complications for i.l.ds at very high data rates.

The early infra-red gallium arsenide l.e.ds operating at 0.9µm are no longer used since their emission is too near to an OH water absorption peak to result in reliable low-loss transmission. They have been replaced by aluminium-gallium arsenide types with an output wavelength of 0.85µm. Because of the broad spectral width of l.e.ds (50-100nm being typical) and non-coherence they are best suited for applications in multimode fibre systems.

Longer wavelength operation at the 1.3µm dispersion minimum for optical fibres is made possible by InGaAsP heterostructure materials, allowing the use of l.e.ds in up-graded communciation links. However, they have only recently become commercially available at the longer wavelength, in contrast to the 0.85µm AlGaAs l.e.ds that have been on the market for several years. The reliability of l.e.ds is extremely good with mean lifetimes in excess of 10^9 hours being predicted from accelerated ageing tests.

The Burrus-type geometry has been the basic design over several years for the surface-emitting l.e.ds specifically intended for coupling to optical fibres, Fig. 1. It is characterized by small contact area and an etched well for butt coupling to a fibre end. It is important that the etched well in the Burrus-fabricated l.e.d. does not reach down to the thin active layer or surface contamination can drastically reduce the servicable life of the device. A small emitting area is obtained by localizing the drive current by etching only a small contact on the underside of the device.

Depending on the core size and numerical aperture of the fibre used it is practical to launch optical powers of around 50 to 100µW into a fibre, although 25µW at an l.e.d. drive current of 100mA is more typical. Up to 300µW can be attained with specially optimized fibres. The Burrus l.e.d. can be supplied with the attached fibre pigtail ready terminated in an SMA-style connector or left bare where direct low-loss fusion splices are intended. A variation on the basic Burrus design is to locate a truncated glass microsphere lens in the etched well for increased optical coupling efficiency.

Mainly because of the lower current densities encountered, l.e.ds are more reliable than injection laser diodes and do not need output stabilization since their output power varies little with temperature. Direct drive current modulation up to about 150MHz is obtainable, higher in specially optimized devices, but at the expense of available optical power[1]. Linear intensity modulation can be used for l.e.ds in an analogue system because their input/output characteristics is substantially linear up to about 80% of their maximum light output, Fig. 3(a).

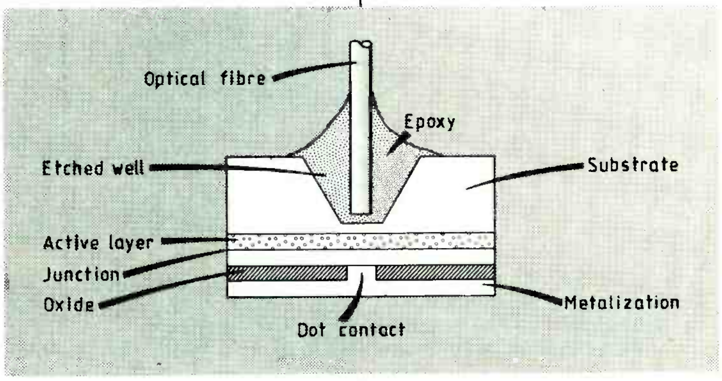


Fig.1. **The most successful general-purpose l.e.d. for optical fibres in produced by permanently bonding a fibre 'pigtail' into the l.e.d. itself.**

A new edge-emitting type of l.e.d. can ultimately couple more power into a fibre by virtue of a narrower light confinement angle, leading to better coupling efficiencies. In addition, it exhibits a narrower spectral width than the surface-emitting type of l.e.d., resulting in a greater maximum bandwidth-distance product through the restrictions of fibre material wavelength dispersion (discussed in Part 1).

The injection laser diode (i.l.d.) also relies on heterojunctions to confine injected carriers to the diode active layer with the attendent refractive-index steps forming a waveguide to confine light to the same active region, Fig. 2. Partially reflecting surfaces at the light emission faces are formed by the refractive-index difference between diode material and air. There are several alternative ways of producing confinement in the lateral direction, the earliest of which was the oxide-defined stripe of Fig. 2. When the injected current

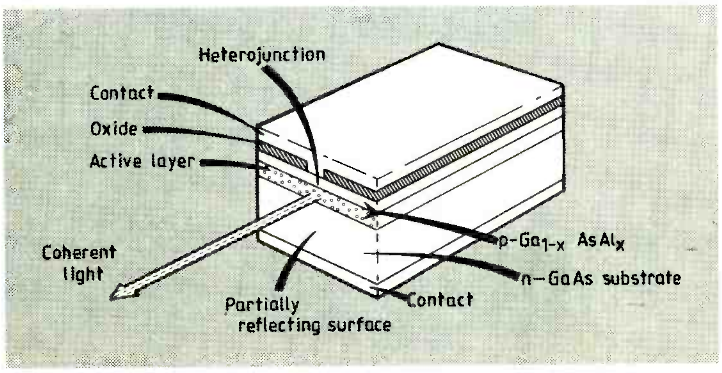


Fig.2 **An injection laser diode must have some method of containing the light within a narrow portion of the active layer between the end mirrors.**

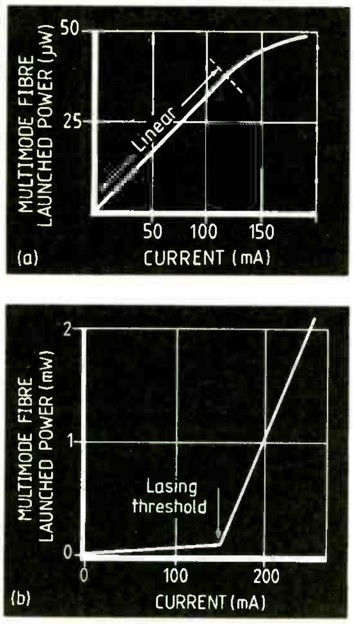


Fig.3. **Injection lasers can launch more power into a fibre than an l.e.d. but their non-linear behavious requires more complex drive circuits.**

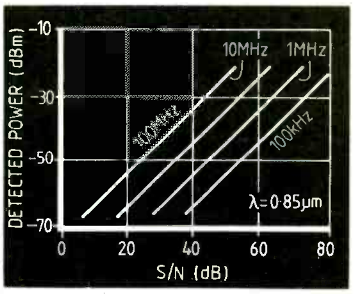


Fig.4. **For a given wavelength and data rate there is a linear relationship between received power and signal to noise ratio.**

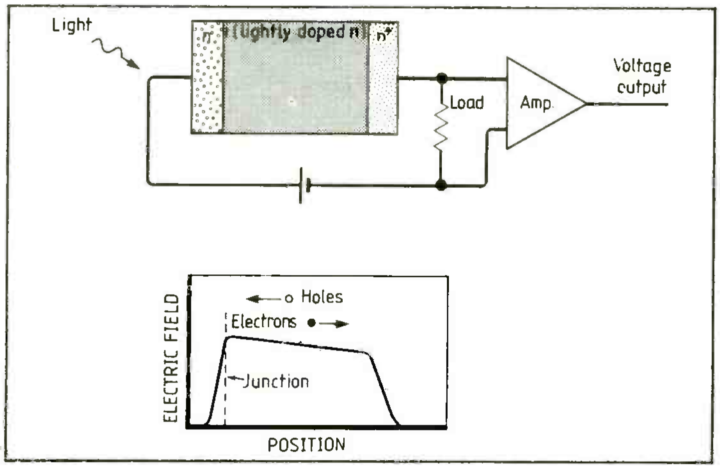


Fig.5. **A p-i-n diode photodetector operates by converting photons into electron-hole pairs in a region of low electric field gradient.**

density is sufficiently high to cause the necessary population inversion, gain rather than loss occurs in the active layer and coherent oscillations are produced in one or more cavity modes.

Early i.l.d. lifetimes were very short, but have been improved to around 10^6 hours by paying close attention to processing and coating the mirror facets, along with the provision of adequate heatsinking[2]. Again AlGaAs formulations are used to produce continuous infra-red light at around 0.85μm but with a much narrower spectral width, typically 2nm. Unlike l.e.ds, laser diode exhibit a threshold effect below which coherent light is not emitted. Injection lasers used with first-generation fibre optic systems usually exhibit a threshold around 150mA and are able to couple perhaps as much as 2mW of light into the fibre for an extra 100mA drive current, Fig. 3. The higher coupling efficiency is simply a result of the much narrower light confinement angle of the i.l.d. interfacing more effectively to the requirements of an optical fibre. For a similar drive power an i.l.d. can launch about 10 to 20dB more light power than an l.e.d. into a fibre.

The main research interest has now shifted to i.l.ds fabricated from InGaAsP that emit at longer wavelengths (1.3μm), where the dispersion minimum of fibres allows a very high potential bandwidth-distance product. Various configurations are currently being tried to obtain the lowest lasing threshold and highest optical powers. The stripe geometry and the newer buried heterostructure devices, both emitting at 1.3μm, are commercially available and are currently used in the more demanding roles.

Multimode rather than monomode operation is most common for i.l.ds with useful output powers in the 2 to 10mW range. In fact, multimode lasers are preferred as sources for multimode fibres to reduce modal noise. Single-mode lasers are obviously required for ultra-high bit-rate systems using narrow monomode fibres. Unfortunately the lasing threshold of InGaAsP lasers is strongly temperature sensitive (much more so than the 0.85μm AlGaAs types) and, in common with most lasers, they tend to break into multimode operation when modulated rapidly. The effect is reduced by biasing the laser to just below its temperature-sensitive threshold, but at the expense of increased drive circuit complexity. Recently, stable single-mode operation in an InGaAsP laser has been demonstrated using a distributed feedback technique to enable modulation up to around 1GHz.

The decision to use an l.e.d. or an i.l.d. source will be made on grounds of intended repeater spacing, maximum modulation rate and system cost and reliability. Light emitting diodes are used almost exclusively in short-haul low-to-medium data rate systems, with i.l.ds being chosen for the long-haul high data-rate links. Single-mode i.l.ds would be used for the most demanding monomode fibre applications. There is however an overlapping range of distances and modulation rates in the middle ground where 1.3μm l.e.ds and i.l.ds compete, and the final choice in this area is often determined by reliability and commercial factors.

Optical detectors

An optical detector is essentially a photon to electron converter. The converson is a statistical process and even with a noiseless amplifier connected to the detector there is a theoretical lower limit on detection sensitivity for specified error rates.

The consequence of this fundamental statistical sensitivity can be seen at work when considering detection of digital information with specified error rates. Information is transmitted in the form of 'marks' and 'spaces' and reaches the detector as pulses of energy E or 0. If no electrons are emitted from the photon detector in the appropriate time slot the assumption is that a space was received. Even if only one electron is emitted it must be assumed that a mark was intended since our idealized detector produces no electrons in the absence of an optical input pulse. However, even in the presence of a pulse of energy E it is still possible for the detector to emit no electrons at all and hence make an error by misdetecting a mark as a space. From the Poisson distribution that governs the behaviour of the detector it can be shown[4] that even a perfect photodetector must sense at least 21 photons for there to be a 10^{-9} probability of misinterpretation. (10^{-9} is a common value for an acceptable bit-error rate in digital communication systems.) This lower limit on the sensitivity of a binary digital receiver is usually referred to as the quantum limit and is a convenient measure against which real digital detectors can be judged.

There is also a quantum limit for analogue systems, this time relating detector sensitivity to output signal to noise ratio, even assuming noiseless electronics. It turns out that the minimum detected optical pulse power is given by twice the product of the signal to noise ratio, the bandwidth and the photon energy. Fig.

4 illustrates this relationship for different bandwidths at the optical wavelength of 0.85μm. This again is the quantum limit and real detectors and receivers fall short of this limit.

The p-i-n diode, Fig. 5, is the simplest optical detector suitable for fibre optic systems. It is composed of an n^+ substrate, a lightly doped intrinsic n-region i, and a thin p-zone. Operated with a reverse bias, mobile carriers to leave the p-n junction producing a zone of moderate electric field on both sides of the junction into the i-region. Because it is only lightly doped this field extends deeply. Incident light power is mainly absorbed in the i-region (the p-region is extremely thin), causing electron-hole pairs to be generated. These carriers are separated by the influence of the electric field in the i-region and represent a reverse diode current that can be amplified.

For detectors operating at wavelengths shorter than 1μm the p-i-n diode material is silicon but at longer wavelengths, the popular 1.3μm window for example, other materials must be used because the quantum efficiency of silicon drops rapidly at around 1μm: it becomes transparent and fails to convert photons to electrons. Germanium is often used beyond 1μm, with complex materials such as InGaAs becoming increasingly popular. Unfortunately there is presently a penalty to be paid in the size of the residual dark current (<nA for Si, maybe 5nA for InGaAs) currently setting a higher practical limit on the minimum incident optical power which the longer wavelength devices can be used to detect.

The second popular type of photodetector, the avalanche photodetector (a.p.d.) shown in Fig. 6, has the advantage of internally multiplying the primary detected photocurrent by an avalanche process, thus increasing the signal detection sensitivity. However, because the avalanche multiplication is statistical in nature some excess noise is generated.

The fabrication of an a.p.d., Fig. 6, is very similar to the p-i-n diode just discussed except that the high electric field region in the p-type zone produces the desired avalanche process to amplify the primary signal current. The signal multiplication of the a.p.d. depends on the applied reverse bias voltage and the temperature. In contrast to p-i-n diodes where reverse bias voltages of around 10-20V are typical, an a.p.d. may require up to several hundred volts to produce an avalanche gain of 100. High performance systems normally require that the gain of the a.p.d. is temperature stabilized and will probably include a measure of automatic gain control operating via the reverse bias voltage.

The frequency response of p-i-n and a.p.ds is similar, with transition times across the lightly doped intrinsic region less than 1ns, making them both usuable up to around 1GHz. The main advantage of a.p.ds over p-i-n diodes is simply greater gain-bandwidth product due to the inbuilt gain, permitting lower detected optical powers for the same error rate or signal-to-noise ratio.

Again silicon is the usual material for short wavelengths (<1μm), with Ge, InGaAsP and AlGaAsP becoming popular at the longer wavelengths around 1.3μm. Ultimately germanium will be superseded by the newer materials due to its poorer dark current (≈500nA) and high excess noise.

Practical optical receivers

Because of the very small output signal available from a photodetector noise in the preamplifier input stage is a serious problem. For a real receiver this results in the required number of detected photons per data bit being much higher than the quantum limit of 21 photons for a 10^{-9} error rate. Typical figures at 1.3μm are around 400 photons per bit with an a.p.d. and 1000 photons per bit with a p-i-n diode when both are used with optimized receiver preamplifiers at 100Mbit per second. That this ratio is not as large as might be expected, considering the inbuilt gain of the a.p.d., is mainly due to the higher dark current and the fact that the avalanche process itself contributes a certain amount of excess noise.

The most popular form of optical receiver front end is the simple trans-impedance amplifier configuration, Fig. 7(a), where the output voltage is given by the product of the input (photodetector) current and the feedback impedance. This approach to front-end design has supplanted the earlier high impedance integrating amplifier, (b), that suffered from problems of complex equalization to retrieve the pulse shape. But careful choice of values of feedback resistance for the transimpedance amplifier is still because of relative noise contributions and restricted phase margins arising from stray capacitance in the feedback loop. In general, an upper limit of around 5MΩ at low data rates (<1Mbit/s) decreasing to perhaps 10kΩ at 500Mbit/s is commonly encountered. Lower values also help to maintain receiver dynamic range. Calculations for optimum receiver sensitivity usually point to the importance of a restricted bandwidth to reduce various noise contributions, often resulting in the upper —3dB point being significantly less than the data rate used[5].

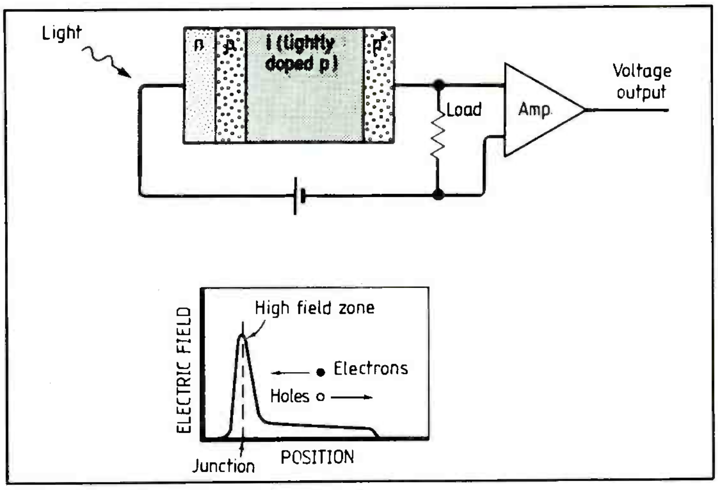
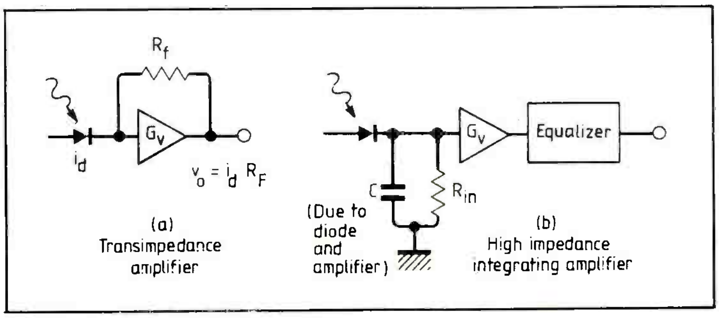


Fig.6. **High field gradient in an avalanche photodetector causes the photo-electrons to multiply by an avalanche process.**

The transistor used as the first active device in the preamplifier obviously plays a major part in the performance of the receiver. It is here that rapid developments are occuring and most performance figures are soon improved on.

Gallium arsenide m.o.s. fets and silicon bipolar microwave transistors have probably been the most effective combination with the p-i-n photodiodes, although the silicon short-channel m.o.s. fet is showing promise. At lower data rates (<10Mbit/s) a silicon junction f.e.t. has a superior performance because it does not suffer from the 1/f noise associated with GaAs and Si f.e.t.s. Silicon

Fig.7. **Transimpdeance amplifier is replacing the high impedance integrating amplifier as the preferred optical receiver preamp configuration.**



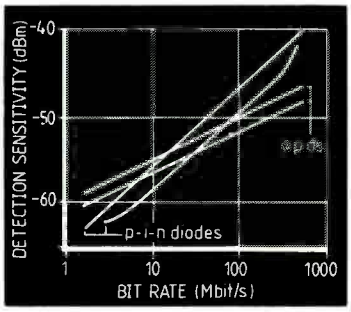


Fig.8. Choice between a p-i-n and a.p.d. detector for optimum receiver sensitivity depends on data rate.

devices posses the advantage over GaAs ones in that they can be integrated into a preamplifier chip with present silicon technology.

Performance zones of 1.3μm receivers based around p-i-n diodes and a.p.ds, followed by the best choice of the devices discussed above, are shown in Fig. 8. Even taking into account their higher dark current and excess noise a.p.ds will provide around 5dB higher sensitivity than the InGaAs p-i-n diode for data rates beyond about 100Mbit/s. At lower data rates p-i-n diodes display better sensitivities of their lower dark current.

At the longer wavelengths where experience of the technology is still limited no clear optimum choice has emerged that can satisfy all of the requirements for inexpensive fast and sensitive optical receivers.

Recent research[6] has been stimulated in the area of coherent transmission and detection because of the promise of detection sensitivities approaching the quantum limit without using a high performance a.p.d receiver. For these techniques of phase shift keying and frequency shift keying stabilized monochromatic sources with a high spectral purity are needed as transmitters and receiver local oscillators, ruling out the use of l.e.ds. To achieve the best performance the carrier source and the local oscillator laser must operate in a single mode with their frequencies maintained to within a small fraction of the data rate. The behaviour of lasers under direct frequency modulation is complicated and investigations are still in their early stages for application of coherent transmission to fibre optic systems.

To be continued

REFERENCES

1. T. P. Lee and A. G. Dentai, "Power and modulation bandwidth of GaAs-AlGaAs high radiance l.e.ds for optical communication systems", *IEEE Journal of Quantum Electronics*, vol.QE-14, 1978, pp.150-9.

2. A. A. Bergh, J. A. Copeland and R. W. Dixon, "Optical sources for fibre transmission systems", *Proceedings IEEE*, vol.68, 1980, pp.1240-7.

3. K. Sakai, K. Utaka, S. Akiba and Y. Matshushima, "1.5μm range InGaAsP/InP distributed feedback lasers", *IEEE Journal of Quantum Electronics*, vol.QE-18, 1982, pp.1272-8.

4. S. D. Personick, "Receiver design for optical fibre systems", *Proceedings IEEE*, vol.65, 1977, pp.1670-8.

5. K. Ogawa, "Considerations for optical receiver design", *IEEE Journal on selected areas in Communications*, vol.SAC-1, 1983, pp.524-32.

6. Y. Yamamoto and T. Kimura, "Coherent optical transmission systems", *IEEE Journal of Quantum Electronics*, vol.QE-17, 1981, pp.919-35.

EVENTS

May 16 to 18
Communications 84
Telecommunications, radio and information technology. Exhibition and conference at the Metropole Hotel and NEC, Birmingham. Industrial and Trade Fairs Ltd.
Telephone: 021 705 6707.

May 21 to 24
European Telemetry Conference and Exhibition
Kongresshalle, Boblingen, Network Events Ltd,
Tel: 0280 815226

May 22 to 25
Communicasia 84 and Infotechasia
3rd Asian international electronic communications show and conference. World Trade Centre, Singapore. Overseas Exhibition Services Ltd. Tel: 01-486 1951.

May 24
Underwater Navigation
IEE (and others) colloquim. At the IEE, Savoy Place, London WC2R 0BL. Tel: 01 240 1871, Ext. 222

May 27 to 30
CETEX 84.
Consumer electronics Trade exhibtion. Earls Court. Montbuild Ltd, Tel: 01-486 1951.

May 31 to June 1
Videodisc and Digital Optical Disc Conference
Cunard International Hotel. London. Meckler Communications.
Tel: 01-240 0856.

June 5 to 7
Scotelex 84
Scottish electronics exhibition and conference. Royal Highland Exhibiton Halls, Ingliston, Edinburgh. Institution of Electronics. Tel: 0706 43661.

June 5 to 7
Software 84
Professional and business software exhibition. Earls Court, London Reed Exhibitions,
Tel: 01-643 8040.

June 6 to 7
Interconnection 84
Conference and exhibition Hilton Hotel, Park Lane, London. Benn Electronics Publications,
Tel: 0582 417438.

June 12 to 14
IBM Computer User Show
Conference and exhibition. Wembley Conference Centre, London. Online Conferences Ltd,
Tel: 01-868 4466.

June 19 to 22
Promecon C & I
Control and instrumentation exhibition and conference. Olympia, London. Asten Associates. Tel: 01-773 0938.

June 22 to 24
Training for the Television Industry
Royal Television Society conference at the College of Ripon & York St John, Ripon, Yorks. Royal Television Society,
Tel: 01-387 1970.

June 26 to 29
Transborder Dataflow Policies
Second international conference to be held in Rome. Intergovernmental Bureau for Informatics, PO Box 10253, 00144 Rome, Italy.

July 3 to 5
Networks 84
European computer communications conference and exhibition. Wembley Conference Centre, London. Online Conferences Ltd.
Tel: 01-868 4466.

July 10 to 12
Cable 84
International conference and exhibition. Wembley Conference Centre, London. Online Conferences Ltd.
Tel: 01-868 4466.

July 10 to 12
Development of Flexible Automation Systems
First international conference. IEE, Savoy Place, London WC2.
Tel: 01-240 1871 Ext. 272 & 282.

July 15 to 17
ShowTech 84
Trade fair and congress for entertainment technology. AMK Berlin. Postfach 191740, Messdamm 22, D-1000 Berlin 19, Germany.

Developments in cellular radio

Source: 'International Developments in Cellular Radio', a seminar sponsored by the Mobile Radio Users' Association (London, Februrary 1984).

Cellular radio-telephone systems are now in service or are being installed in many countries, Britain included: Richard Lambley reports on the current scene with particular reference to Europe

Cellular radio systems have their roots in the late 1960s when proposals for such a service were made in the US by Bell Laboratories and others. Two systems were subsequently licensed by the FCC to undergo field trials: the Advanced Mobile Telephone System (AMPS) in Chicago and the American Radio Telephone Service (ARTS) in Washington DC.

Installed by Motorola using Dynatac equipment, ARTS currently serves an area some 80 miles long extending from the Northern Virginia suburbs of Washington to the city of Baltimore in Maryland. Initially the area was divided into eight cells with between three and 16 channels allocated to each one. The base stations, with an e.r.p. of 100 watts covered a radius of about 11 miles with large overlaps. In the final designs for the Washington area, aerial height was reduced from 150 to 60-70 metres above sea-level to reduce interference. Landlines have been used to link the base stations, but microwave links are to replace them.

Unlike the Chicago system, ARTS was designed to serve portable units as well as car telephones, and special attention was given to the problem of providing good performance inside buildings. A form of diversity reception was adopted with six-sector base station receivers and 17dB-gain aerials: the two best aerials are combined in the i.f. section to reduce fading and multipath distortion.

Another problem occurred at first during hand-off between adjacent cells, when fluttering signal strengths were liable to cause repeated switching back and forth. To help counteract such disturbances the control computer now waits 15 seconds before handing back.

Despite a few difficulties with adjacent channel selectivity, ARTS has worked well. According to Andrew Lamothe, former technical director of Cellular Radio Corporation, customers make more calls than other radio telephone users and talk for longer: 260 to 280 minutes per month as against 60 or 70. This he attributes to the greater clarity and reliability of the cellular service. Subscribers are willing to use it for important business calls, including long-distance and international calls, as well as just for ringing in to their offices.

ARTS was awarded a full operating licence in December 1983. It now has over 1000 subscribers, new ones being added at a rate of 30 a day in spite of heavy call charges and the high cost of the equipment. Mr Lamothe quotes prices in the region of $2400-$2700 plus taxes, aerials and installation.

By the end of 1984, cellular radio networks are expected to be in service in 24 US cities, some of which will have more than one system. Specifications of the subscriber's equipment for ARTS and AMPS have been standardized by the FCC so that the same telephones should be usable on any network in the US.

Canada

Canada's Department of Communications policy is to encourage growth of the service on a competitive basis with a minimum of regulation. Two contrasting cellular radio systems have been licensed, and the first to enter service is Aurora, an automatic roaming radio system from Novatel Communications Ltd.

Instead of the large central switching centres favoured by other systems for linking cell-sites to the public telephone network, Aurora is based on distributed switching nodes with interconnections at local telephone exchanges. This avoids the expense of installing dedicated trunk cables and greatly reduces starting up cost. Aurora is therefore suited to serving rural areas as well as big cities. Aurora has a central control point (the master mobile centre), but it has no real-time control over the operation of the network: its functions are connected mainly with administration and maintenance.

What is cellular radio?

Cellular radio provides a way of satisfying the large demand for mobile communications by extending the public automatic telephone network to users on the move.

To achieve this goal with conventional mobile radio technology would mean an unacceptably large bandwidth requirement. A base-station serving mobile users in a city of moderate size might have to handle thousands of calls at once during busy times. Further, the number of radio channels available would have to be twice the number of telephone calls in progress, as telephone users expect full duplex communication — push-to-talk operation would not be acceptable in a public service.

By dividing the territory to be covered by the radio system into smaller units or cells, each one served by its own low-power base station, a cellular network can handle the same traffic with far fewer radio channels. The frequencies used in each cell can be re-used in other cells at a distance. In effect, a cellular system has solved the problem of frequency availability by trading it for a high degree of complexity in its network of base stations and switching centres. A large demand for channels in any particular area — a city-centre, for example — can be satisfied by dividing it into sub-cells (cell-splitting) and serving each sub-cell from a base station of even lower power.

However, in practice there is a lower limit to cell size and thus to the traffic capacity of the system. Although a cell could be set up to cover an area as small as, say, an hotel or even an airport departure lounge, there would be a risk that a well-sited caller within that building might unwittingly access distant base stations as well as the local one.

To be attractive to the potential subscriber, a cellular radio telephone must feel just like an ordinary wired telephone. The user, whether in a car or on foot, must be able to dial outgoing calls direct and to receive incoming dialled calls too. Most cellular systems offer the full range of services available on the public network and often more.

As neither party to a call can be expected to know precisely where the mobile user is, the call must be routed through the appropriate base station automatically. Moreover, the mobile user is liable to wander out of one cell and into another as the call progresses. To cope with this, the system must re-route the call through the new base station, switching the call to new radio channels without interrupting it. This procedure, known in the jargon as 'hand-off', is one of the distinguishing features of cellular systems.

The cellular radio systems now in service are expensive to the user both in call charges and in the price of the mobile equipment. The cost of establishing a network is heavy, and it may seem unlikely that cellular radio will replace the ordinary wired telephone, at least in urban areas. But to business users who can justify it, cellular radio offers some attractive prospects: the 'carry anywhere' pocket telephone, for example.

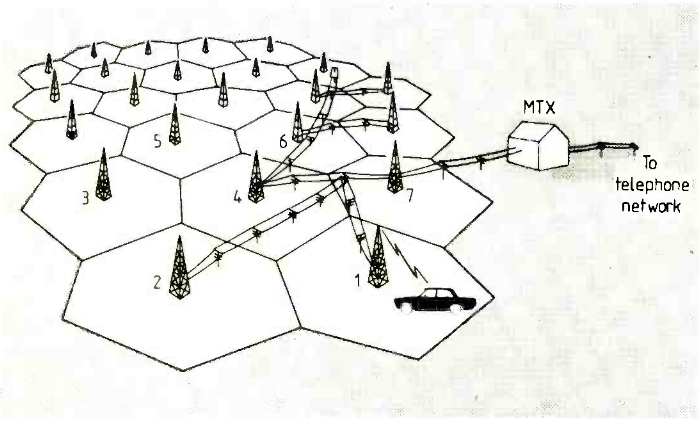


Fig. 1. Typical layout of a cellular radio network. A minimum of seven frequency groups is required, but the same frequencies can be re-used in other cell clusters.

The system began field trials in Alberta in 1981 and entered commercial service in mid-1983. By the end of the year it is expected to cover three quarters of the province using 123 cell sites. The frequencies used are in the 400MHz region.

Canada's other cellular system, now being installed in Montreal and Toronto, will be ready for business in September. This 800MHz system has a centralized architecture, with a 'mobile telephone exchange' acting as a control and switching node to connect mobile subscribers to the public switched telephone network.

Problems have been encountered with wired links in the system: among them echo, noise and signal loss. According to Bell Canada, echo-cancellation equipment is now included to improve transmission performance with the aim of providing a sound quality not worse than on the ordinary telephone network.

The service is designed to emulate the public facilities such as call forwarding and conference calls. Services are available to roaming subscribers as well.

United Kingdom

The system adopted for use in Britain, TACS, is modelled on the Chicago AMPS. Two companies have been licensed to provide a service: Racal Millicom and Telecom-Securior Cellular Radio. As it stands, AMPS is unsuitable for direct application in Britain because of differing frequency allocations and channel spacings in the two sides of the Atlantic. In addition, there is a need for a nationwide roaming capacity, a facility not required in the US. The British network also has to allow for inter-systems roaming, so that a Telecom-Securior subscriber can wander into Racal's areas and vice versa.

TACS (it stands for 'total access communications system') is due to begin operations in 1985. It will use the band 890-960MHz (there is a gap in the middle for c.b.) with a channel spacing of 25kHz: this implies tighter filtering and narrower frequency deviation than in the American 30kHz systems. John Carrington, chief executive of Telecom-Securior Cellular Radio Ltd expects an initial demand for between 10 000 and 25 000 mobile sets when the trial service begins later this year, using equipment already ordered. These would be available through independent retailers who would 'front' the system on behalf of TSCR. Cellular radio, he says, would not be suitable for private mobile radio users such as taxi fleets, who already had an effective system, though it would have to compete with p.m.r. on price.

West Germany

A more technically complex cellular system is the C-900 system of Siemens. A C-system is already in operation in Germany on 450MHz and will enter full public service in October. The network of 35 base stations is to be expanded rapidly to 95, covering about 70% of the Federal Republic. The system should have a capacity of over 100 000 subscribers: but the 900MHz version now being planned is expected to be able to handle more than two million. The system has many advanced features designed to secure efficiency of spectrum use, freedom from interference and privacy.

A critical problem in mobile radio is in defining cell boundaries. The limits marked by field-strength distribution and signal quality are not always ideal from the point of view of traffic management. To get round this, the C-system can adjust cell boundaries dynamically, spreading the traffic load over adjacent cells. In this mode, adjoining base stations compare the signals from each mobile and so measure its position. Having done this they can force hand-off from one cell to another on the criterion of distance alone, even though signal quality is still perfectly satisfactory.

Another special feature of the C-system is mutual power control of both the mobile and the base station. When the two are close together, power is reduced to minimize interference elsewhere. The system also offers intra-cell hand-off; calls may be switched automatically to alternative frequencies if co-channel interference occurs.

Signalling in the C-system is more complicated than in other cellular systems. Each base station identifies all the mobiles within its area by interrogating them automatically over a data channel. The network then knows whether an individual subscriber is available and where he is to be found. When the mobile subscriber is called, or when he initiates a call, a suitable pair of speech channels is allocated by the computer and the connection made. This procedure avoids ineffective use of radio channels by assigning them only when both parties are ready to speak: according to Siemens it saves about 30% of channel capacity.

To make features such as intra-cell hand-off possible, data communications are maintained even during the call. The speech is time compressed, each 12.5ms segment being squeezed into 10ms to make room for a 5.28kbit/s f.s.k. data burst.

A dynamic four-band scrambling procedure is applied to the speech signals, with 256 possible key combinations. The correct key is selected automatically when the call is set up and different keys are used for subsequent calls.

System architecture is decentralized, and the modular switching equipment can be expanded to match traffic requirements. C-900 is due to be introduced in Germany in 1987.

Scandinavia

If you disregard a small system installed by Cable and Wireless in Qatar in 1978, the cellular network longest established in public service is the Nordic Mobile Telephone System (NMT). Opened in Sweden in 1981 this 450MHz network now covers large parts of Sweden, Norway, Finland and Denmark, and in January this year was serving over 75 000 subscribers. The system is also in operation in Spain, Tunisia and Saudi Arabia, and has lately been selected by the Netherlands, Austria and Ireland.

Each cluster of base stations is linked to a 'mobile telephone exchange' (MTX), a standard AXE-10 digital exchange, which provides interfacing with the public switched telephone network. One channel at each base station is designated a calling channel; and when someone dials the number of mobile sub-

Some cellular radio systems compared

	TACS (UK)	FCC (USA)	NMT	NTT (Japan)	C-system
Frequency (MHz)	860-960	825-890	450-470 (860-960)	900	450 (900)
Channel spacing (kHz)	25	30	25	25	
Duplex spacing (MHz)	45	45	10 (45)	55	
Signalling (kbit/s)	8	10	1 · 2	0 · 3	5 · 28
Signalling channel	separate	spearate	combined	separate	both
Scrambling	no	no	no	no	yes

(Main source: Ericsson)

scriber, a calling signal is broadcast over all the calling channels in the traffic area. When the mobile detects this call, it returns an acknowledgement on the same frequency. Speech channels are then assigned by the MTX.

When the mobile subscriber initiates a call, the equipment hunts for a clear traffic channel on which to call the base station. On receiving the signal the MTX checks the number dialled and the category of the subscriber and sets up the call.

Transmission quality of every call is monitored by means of a 4kHz pilot tone which is added to the speech channel by the base station and looped back by the mobile. If reception deteriorates the mobile transmits a hand-off request to the MTX, which then attempts to find a more suitable routing for the call. Adjacent base stations make field-strength measurements on the traffic channel, and if one of them is able to offer better transmission quality, and has a free channel available, the call is switched over.

Each mobile is registered on one particular MTX, the 'home exchange'. If it moves into the area of another MTX, any calls are automatically re-routed. The system permits subscribers to roam without restriction throughout the four Nordic countries, though at the behest of the PTT authorities 'country' switches are fitted to the mobile sets.

A practical problem with any cellular radio system is the question of call charges. A subscriber dialling a mobile user has no way of knowing in advance whether the recipient of the call is in the next street or in another country. The Scandinavian countries have taken what seems a reasonable line by charging a flat rate corresponding to an ordinary medium-distance call.

NMT's 180-channel allocation was thought very generous at the time the network was being planned, according to Christina Callmer of Ericsson Radio Systems. However, fully capacity is likely to be reached much sooner than had been expected and plans for a 900 MHz version were now being finalized.

France

The move towards cellular radio has taken France in a rather different direction, Matra Radiocommunications is now installing a national radiotelephone network which combines a public telephone service with private business communications.

The RTA system is founded upon cellular principles, but seems to place more restrictions on the user than other systems. Subscribers can access only the repeater stations with which they are registered. There is a three-tier service: access to one station only, up to ten stations (which need not be adjacent) or, for certain users, nationwide coverage.

RTA offers business users the option of a private communication system using push-to-talk simplex operation; this is available as well as or instead of the ordinary car telephone service. These closed user groups use the same technical facilities as the public service.

As with some other cellular systems. RTA can give certain users priority when there is a queue of cells waiting to be set up. At busy times repeater stations may invoke an automatic time limit facility which informs users that the call may be cut short: the limit is programmable between 30 seconds and 16 minutes.

Frequencies assigned to the RTA network are 173-223 MHz and 406-430MHz, with 12.5kHz channel spacing. Repeater stations have a transmitter power of 50W and cover a radius of 20-30km. Connections between them are via the existing public switched telephone network; and this, according to Michel Canitrot of Matra, has helped to make RTA significantly cheaper to set up than other cellular systems. The network is modular in form, with no centralized control.

The user's view

In Britain, the Mobile Radio Users' Association has encouraged the development of the new services and technology, particularly cellular radio for its effective use of frequencies. Nevertheless, according to Walter Stevenson of the MRUA, there is still a requirement for conventional mobile radio and paging systems, at least in the short term. Most vehicles operate within a limited area and are unlikely to need a nationwide roaming facility.

But Mr Stevenson is nervous that the Government is trying to force cellular radio as the sole solution to the mobile user's problems. Additional frequencies are urgently needed as well.

The future

The next two or three years will see the introduction of a patchwork of mutually incompatible cellular systems all over Western Europe; only Italy, Portugal and Switzerland have not yet made a choice. Some countries will have more than one system.

However, one market analyst, Malcolm Ross of Arthur D. Little International, thinks that there is no need for a European standard in the short term since the market for mobile radio on a national basis is so big that it should be dealt with first. Quoting statistics to the effect that only 25% of telephone calls to offices reach the right person, Mr Ross predicts a big demand for pocket telephones for businessmen. And he suggests that before the end of the decade a mobile telephone may become cheaper than a wired line, costing perhaps as little as $120 for a consumer model.

Nevertheless, steps are being taken to overcome the present lack of standardization. A working party under the CEPT is discussing the possibility of a pan-European mobile telephone system, and it is probable that this will be a 900MHz cellular system. The total bandwidth for cellular radio in Europe will eventually be 50MHz and of this only 15MHz has so far been released in Britain.

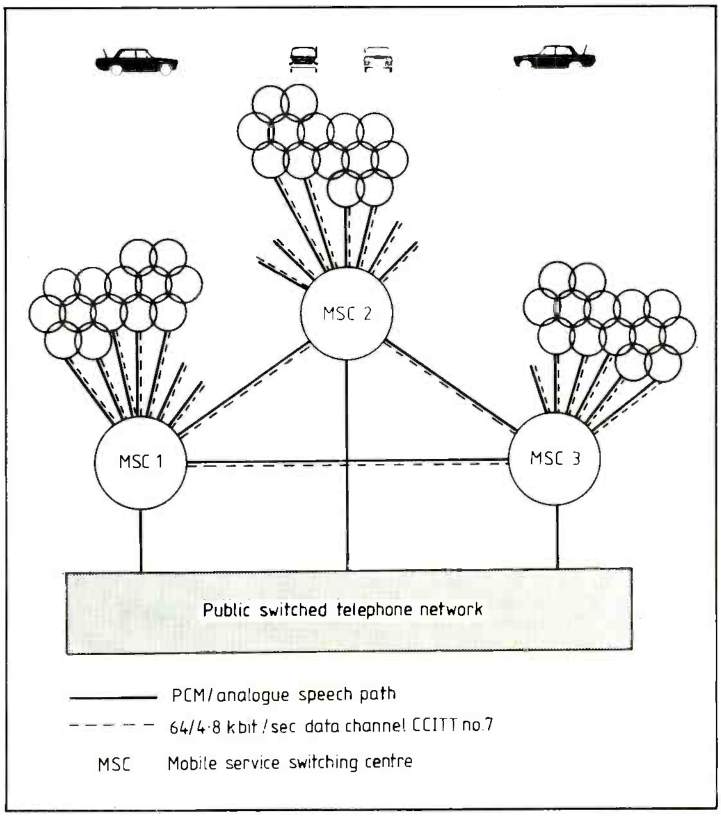


Fig. 2. **The German C system has separate data links for setting up speech channels at the start of each cell. As the call proceeds it is controlled and monitored by another data signal multiplexed with the speech.**

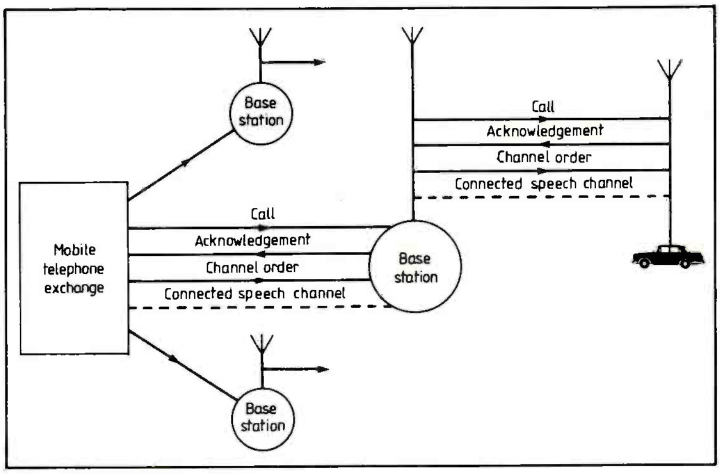


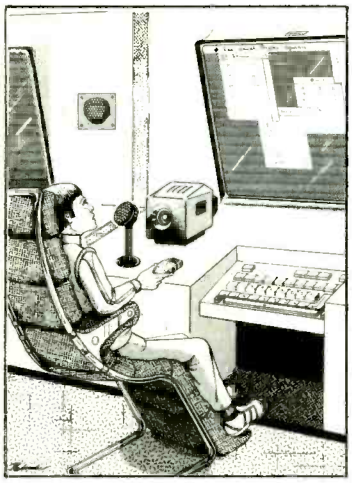
Fig. 3. **Call set-up procedure with the Scandinavian NMT system. Signalling takes place on a calling channel and a speech channel is then allocated by mobile telephone exchange.**

by A. E. Cawkell

The information society

2 – Politics of telecommunications

The growth of infrastructure services and the influence of politics on British Telecom and its operations.



Political, technical, and economic factors impede the formation of a unified network in the foreseeable future.

Private industry is unlikely to introduce networks or services unless it considers that the market will return an adequate short or medium term profit. For PTT monopolies this aspect is less important, consequently marketing skills are also of less importance to them.

The PTTs possessed the cables, and with EEC backing, added the facilities to provide the Euronet network. Upon it ride the host computers, mainly privately owned, which provide services for a fee. Consequently the desirable objectives of providing scientific information services, and encouraging the generation of European-compiled databases has been achieved.

However the absence of a market-driven approach can be disadvantageous. The Prestel service would have been long since shut down had it been a commercial system.

In the United States, a range of new services is gradually appearing in consequence of market forces. The country also possesses a strong electronics industry, a propensity to innovate, and a large number of people with some disposable income. I was able to observe the market-driven entrepreneurial approach at work during a visit in 1981.

Communication networks for home computers were being operated by two companies, The Source and Compuserve. Compuserve's Micronet was gatewayed to Tymnet. Charges were $5 per hour plus $2 for Tymnet. The Source and Compuserve then had about 8000 subscribers, mainly with TRS80s or Apple 2s. Compuserve offered Micronet terminal programs for both machines and a videotex program for TRS80s.

The Source and Compuserve are also information providers. Compuserve provided a range of services included with its $5/hour fee — for instance an electronic mail service for all listed users — but charged extra for special services like access to 32 000 continuously updated stocks in its Microquote service. A set of detailed information about a stock cost 5 cents.

Perceiving that it might have a customer base, a bank in Knoxville concluded an agreement with Compuserve and Radio Shack who supplied TRS80 microcomputers, and offered banking services for viewing statements, paying bills etc., by the page (videotex) at $5 per hour. Users also required the TRS80's videotex program. The service included the provision of a special modem for use with a TRS80 into which a magnetic card carrying an encryption key had to be inserted. At that time about 300 people used this service.

It was not clear whether prices for domestic users had dropped to a level which made success probable. The fact is that a structure has been gradually assembled in which operational costs were shared by many. Consequently an information provider or customer could join at a low incremental cost. There was no public financial burden. The foundation of the undertaking was the existence of a corps of people with a common self-interest — they were computer buffs. However there is no reason why business and professional users could not use the common resource and some did.

This kind of approach seems to be prospering according to a September 1983 article[24]. The Source, now owned by Reader's Digest, has expanded greatly and Compuserve, a subsidary of H & R Block, has over 20,000 subscribers.

The politics of telecommunications

The fusion, usefulness, modification, or convergence of the networks shown in Fig. 1 will obviously be affected by control, administration, and investment. The best way of administering the UK telephone system, currently being modified into a digital telephone/data system, is controversial. The consensus of opinion was, and still is, in countries where information technology is less advanced, that a regulated monopoly is the best way to run a national telephone system.

The classic case for monopolies is set out in references 25 and 26. A 'natural monopoly' is a service or industry in which it assumed that economies of scale make it cheaper for one organization to produce a product or provide a service than for two or more to do so. Regulations can be imposed by the government to set prices which are in line with costs. The result, says the conventional wisdom, is a service provided at relatively low cost, obtained by regulating the prices charged by a single organization which is able to operate at the scale needed to achieve maximum economies.

'Cream-skimming' is one of the major factors used in pro-monopoly arguments. Competitors could provide new profitable business services, eroding the incumbent's (British Telecom in the UK) revenues needed to fulfil its social obligation to provide loss-making rural telephone services.

In the 1960s the US telephone network started to be pressed into service for data transmission, since it was the only ubiquitous network available. It became very difficult to determine where telecommunications ended and information processing began. New requirements prompted the following questions: would consumer's needs be best fulfilled by entrusting all services to the traditional carriers? was it rational to extend the monopolistic structure to control the closely associated technology and processing involving modems, terminals, private line and microwave facilities, special data services, communication satellites, etc.?[27]

The British Post Office depreciates plant and equipment over 25 years. The organization's finances and price structures are arranged accordingly. But in the computer/data processing industry, obsolescence proceeds on five-year or less cycle, not because equipment has by then come to the end of its useful life, but because it is replaced by something better and cheaper.

The wind of change which first blew in the United States was not generated so much because the regulated monopoly for the telephone network was found wanting, although it had its critics, but because the telephone system, once a definable entity, was becoming the major component in a total information system.

One of British Telecom's (then the Post Office) strategy directors said[28] back in 1977 "The absence of competition removes information about markets which could otherwise be inferred from competitors. Changeable government policies influence the amount of investment, borrowing, and the levels of tariffs. The UK Post Office...lays down procedures for its 237 000 staff, whose working lives are spent usually in a single organization, in 112 000 separate instructions varying from 1 to 100 pages in length. Size, complexity, plant life of 40 years etc., all militate against rapid change".

Egalitarianism requires the generation of wealth to support it. Wealth-generating compaines have to compete internationally, and for them a poor telecomms system is an expensive overhead. "The competitiveness of UK industry depends in part on the efficiency and related costs of the telecommunications services, especially compared with the USA and Japan. The UK and European computer, telecommunications and electronics industries need to expand at a rate at least commensurate with world demand so as to provide substitute jobs for those being abolished in declining industries"[29].

In a recent press release, BT claimed "Major achievements including...a reduction in the line waiting list from 122 000 to 20 000...a net growth of 5 . 6% despite the long recession radio-paging....new electronic mail system...lowest failed calls on record - local 1.3%, trunk 2.7%...longest fibre-optic cable in the world...etc.,etc[30].

One critic disagrees, using the standard anti-monopoly argument; "I love to see people making profits but monopoly profits are something else. A monopoly profit is the difference between how much they can get away with charging and how much they can get away with wasting. If you can't take your business elsewhere then there is no market, no competion, no price mechanism "[31].

Various criticisms have been levelled at BT. Its charges for telephone services have consistently been near the top of inter-country comparison tables[32,33,34]. Its differential pricing policy has been questioned; according to reference[35], the cost of a PABX per extension in London was £650, but £198 in Dublin for a similar PABX. It was suggested that this was because BT's specifications for home suppliers are unnecessarily tight.

In the same article some calculations were made showing that a London-New York private satellite link, if it was allowed, would cost £53 000 a year, compared with the BT tariff of £565 000 for a similar link. the BT price for a single-circuit leased link between London and New York was £49 900 a year, while a coast-to-coast link of about the same length in the USA cost £4500 a year. In a recent letter to the Financial Times, a reader complained that increases of 17% and 7% announced by BT in the last two years were misleading. Charges in the writer's company increased from £80 000 in 1980 to £150 000 in 1982.[36]

Government policies for the Post Office 'protect inefficiency, remove incentives to self-improvement, penalise consumers and lower the gross national product' according to a well know authority writing in 1975[37]. BT added a high surcharge to certain services provided via Tymnet, an efficient US network with a London node (access point). Tymnet would not agree to it, so users had to dial the Tymnet node in Paris at a cost almost as great.

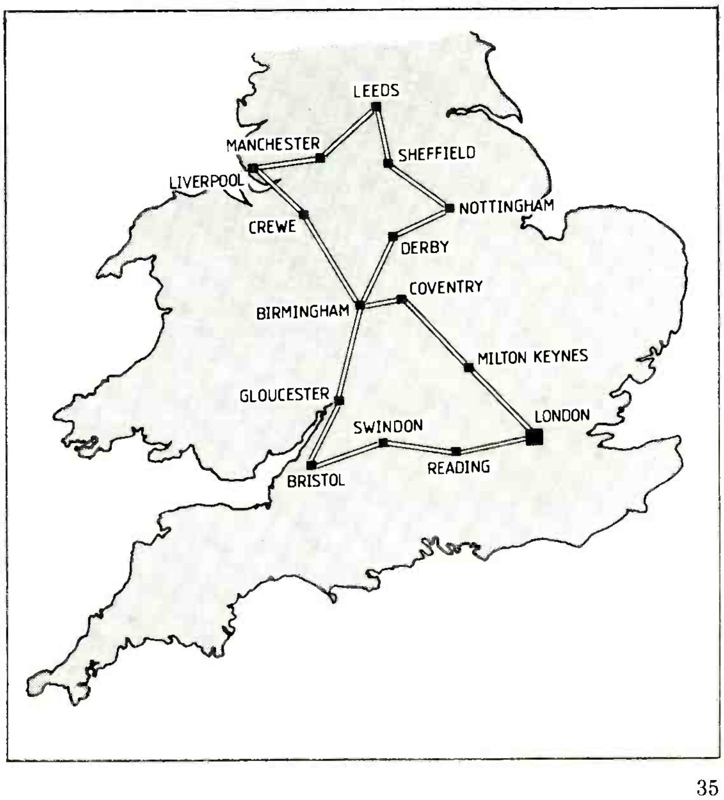
A better way of doing it?

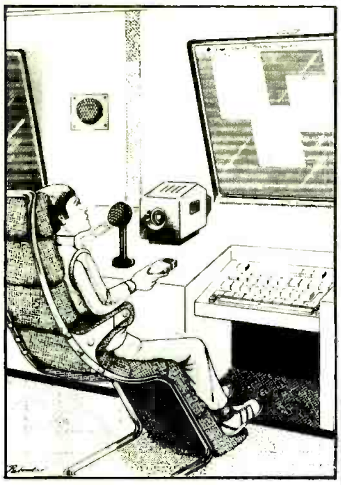
A Conservative government was returned to power in May 1979, having released a document proposing policies for information technology in the previous month. It presented the British Telecommunications Bill in November 1980, proposing to split Postal and Telecommunications services as recommended in the earlier Carter report[38] and to allow competition controlled by the Department of Trade and Industry (DTI). Connection to the BT network would be allowed by others who could set up their own networks or services.

BT would retain its monopoly over the Public Switched Telephone Network (PSTN). The government would dispose of its shares in Cable and Wireless.

In the Beesley report of April 1981[39] it was said that the consumer benefits of allowing competition would outweigh any BT loss of revenue. BT should be free to set prices and compete for non-voice services, subject to DTI regulation. It seemed likely that cream skimming and leased line price increases would follow. The bill became the British Telecommunications Act on October 1st 1981. The Labour opposition stated that it would re-possess BT assets without compensation if returned to power.

Fig. 1. **Project Mercury's proposed trunk network, which is intended to employ optical fibres, microwave and cellular radio and satellite communications.**





Mercury

In June 1981, a consortium set up by Barclays Bank, Cable and Wireless and British Petroleum sought permission to set up a communications network to be called Mercury, in the first instance to link up a limited number of UK cities. High capacity optical-fibre cables would be laid alongside British Rail lines, and the system would include microwave and cellular radio communications with satellite extensions to other parts of the country. The government granted a 25 year licence to Mercury in February 1982.

Mercury started preliminary operation in the City of London during April 1983 with a point to point microwave service. Its proposed network is shown in Fig. 2. Later, Mercury announced that it would establish a transatlantic link via a spur from its network to an earth station in the London docks and an Intelsat satellite[40].

The 1982 Bill

A new Telecommunications Bill was introduced in October 1982. Its main purpose is to sell 51% of British Telecom — in other words to 'privatise' it. The government also proposed to set up an Office of Telecommunications (OFTEL) early in 1984, and to grant an operating license to BT as its first act. The Bill was lost in the general election of June 1983, re-introduced when the Conservatives were returned to power, and received its second reading in July in 1983.

Also in 1983, Professor Littlechild, an advocate of free markets, reported as requested to the DTI[41]. In responding to terms of reference including 'regulation with a light rein' he said that new competitors should be encouraged, and that for five years after privatisation BT should be required to keep its price increases below the rise in the retail price index.

Opinions have been expressed about the timing of liberalisation, a relatively non-controversial issue, and privatisation, a controversial separate issue, but linked with or merged into liberalisation in the minds of many people. Perhaps it would have been better to let the liberalisation dust settle before risking general muddiness produced by the rain of privatisation. The case against privatisation has been well presented by BT's management trade union — the Association of Telecom executives[42].

BT's 1982/83 results showed the replacement cost of net assets at over £16 000M, income at £6377M and net profit down from £458M to £365M, a return on capital of 5.8%[30].

The threat of deregulation and then privatisation produced a remarkable effect. BT concluded an agreement with Satellite Business Systems for a transatlantic business service, and joined in with a UK private industry consortium to provide a direct broadcast satellite (DBS). The 18 month waiting time for services in the City of London has been cut to 3 months.

In October 1982 BT took three full pages in the Financial Times to advertise Teletex, satellite, facsimile, business systems, Prestel, and digital overlay services. It will offer complete packages to companies for external and internal private services, the latter using Local Area Networks (LANs) — strong competition for Mercury.

Also in October government announced that BT's operating licence would include obligations to provide rural telephone services, kiosks, and emergency services, which are lossmakers. Competitors would have no such obligations. On the other hand an organisation which has for so long not needed to take much account of its customers will take time to re-orient itself. The intent is there, but the proof of ability to sell into a competitive market is awaited.

To be continued

REFERENCES

1. Cawkell, A.E. *Wireless World* 84 (1511/1512), 38-42 69-74, July/August 1978. The paperless revolution.
2. Machlup, Fritz. The production and distribution of knowledge in the United States. Princeton University Press, 1962.
3. Parker, Edwin B., Porat, Marc. In Proc. OECD Conf., Paris, Feb. 1975. Published by OECD, 2 rue Anfre Pascal, Paris, Cedex 15, France. Pps 87-131.
4. Cawkell A. E. Information Technology & People 3(6), 144-147, October 1983. Published by Citech, PO Box 5, Ickenham, Middx, England.
5. Abramson, N. Chapter 14 in Computer Communication Networks. Prentice Hall 1972.
6. Kao, K.C., Hockham, G.A. *IEE Proc.* 113(7), 1151-1158, July 1966. Dielectric fribre surface waveguides for optical frequencies.
7. Clarke, Arthur C. *Wireless World 51,* 305-308, October 1945. Extra-terrestrial relays.
8. Senders, John. *Amer. Sociol.* 160-164, August 1976. The scientific journal of the future.
9. Turoff, Murray., Hiltz, Roxanne. *J. Amer. Soc. Info. Sci.*, 33(4), 195-202, July 1982. The electronic journal — a progress report.
10. Schakel, Brian. *The Computer Journal*, 25(2), 161-168, 1982. The blend system: programme for the study of some electronic journals.
11. Reddy, Raj D. *Proc. IEEE* 64(4), 501-531, 1976. Speech recognition by machine — a review.
12. Cawkell, A.E. *Program* 17(3), 111-129, July 1983. Human, electronic, and reprographic aspects of image and text processing: a tutorial and review.
13. Raskin, Jef; Whitney, Tom *Computer,* 62-73, January 1981. Tutorial series 4: Perspectives on personal computing.
14. Noyce, Rober N. *Scientific American* 237(3), 62-70, September 1977. Microelectronics.
15. Bowers, Dan M. *Mini-micro systems,* 10(2), 36-51, February 1977. Floppy disc drives and systems. Part 1: Historical perspective.
16. Moralee, Dennis. *Electronics & Power,* 637-641, September 1978. Floppy discs.
17. McLeod, Jonah. Elsevier, banbury Rd., Oxford, England. 1983 Winchester discs in microcomputers.
18. Johansen, Robert; Jansell, Kathleen J., Green, David. *Telecommunication Policy* 5(4), 289-295, December 1981. growth in teleconferencing: looking beyond the rhetoric of readiness.
19. Davis, Garth W.P. *Int. Forum. Inf. Doc.* 5(1), 29-34, 1980. Euronet Diane: origins, gaols and present status.
20. Baker, T.W. *Electronics & Power,* 447-450, June 1982. The evolution of private communication.
21. Anon. Data Communications, 99-107, September 1982. Interconnect net navigates airline reservations.
22. Guilaume, Jeanne. *Can. J. Info. Sci.* 5, 21.29, 1980. Computer conferencing and the development of the electronic journal.
23. Parker, Edwin B. *Telecmmunications Policy* 1(1), 3-20, December 1976. Social implications of computer/telecoms systems.
24. Dewey, Patrick R. *Online,* 36-41, September 1983. A professional librarian looks at the consumer online service.
25. Littlechild, S.C. Peter Peregrinus, Stevenage, England, for the IEE, 1979. Elements of telecommunications economics.
26. Meyer, John R., Wilson, Robers W., et al. Delegeschlager, Gunn & Hann, Cambridge, Mass., USA, 1980. The economics of competition in the telecommunications industry.
27. Wiley, Richard E. *Telecommunications Policy* 1(2), 99-111, March 1977. The US communications consumer and the monopoly supply: The FCC position.
28. Teid, A.A.L. *Telecommunications Policy,* 1(3), 2070211, June 1977. Uncertainty and inertia.
29. Lamond, Frederic E. *Telecommunications Policy* 3(3), 209-216, September 1979. The UK telecommuncications monopoly.
30. Anon. British Telecom Press Release, July 20th, 1983. Annual report and accounts.
31. McNulty, John. *Computer Weekly,* March 31st 1983. We can show the world that we can lead.
32. Lorenz, Christopher. *Telecommunications Policy* 2(1), 49-59, March 1978. International comparisons of common carrier rates and efficiency.
33. Anon. *New Scientist* 94(1300), p424, April 1982. Approvals scheme for telephone is slow to connect.
34. BT letter to the *Sunday Times,* August 1st, 1982.
35. Stapley, Barry. *Telecommunications Policy* 5(2), 149-151, June 1981. Managing communications — the value of choice.
36. Jacobs, Anthony. *Financial times,* July 22nd, 1982. (Letter). Sale of British Telecom.
37. de Sola Pool, Ithiel. In *Proc. OECD Conf.*, Paris, February 1975. Published by OECD, 2 Rue Andre Pascal, Paris Cedex 15, France. Pps 281-308. Social implications of computer and telecommunications systems: background report.
38. Anon. HMSO, July 1977. Report of the Post Office review committee (The 'Carter report').
39. Anon. HMSO, London, 1981. Liberalisation of the use of British telecommunications network (The 'Beesley report').
40. Cott, P.J. *Electronics & Power,* 489-491, June 1983. Mercury: high-speed integrated business telecommunications.
41. Anon. Department of Industry, London, 1983. Regulation of British Telecommunications; profitability. (The 'Littlechild report').
42. Anon. Society of British Telecom Executives, 102-104 Sheen Road, Richmond, Surrey TW9 1US, England. July 1983. Liberalisation, privatisation & regulation. What future for British Telecom?.

E.M.S. POWER SYSTEMS

Solve all your Power Problems by contacting E.M.S.

E.M.S. specialise in systems to eliminate your power problems.

Products range from 35VA switched square wave Power Packs to 1KVA fully uninterruptible sine wave systems.

E.M.S. also manufacture chargers which range up to 60 amps.

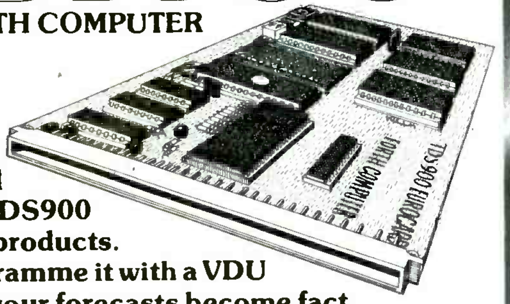
For further details please contact:

E.M.S. Manufacturing Limited
Chairborough Road
High Wycombe
Bucks
Tel: (0494) 448484

CIRCLE 66 FOR FURTHER DETAILS.

TDS900

FORTH COMPUTER



Build the TDS900 into products. Programme it with a VDU and your forecasts become fact.

Software costs are significant in all industrial applications of microprocessors. They cannot be amortised over the large quantities associated with personal computers and electronic games. This C-MOS embedded computer card aims at resolving this problem by including FORTH high level language programming and developmental facilities. The software can be written quickly and made to work correctly at lowest possible expense. Using a high level programming language rather than assembler gives a fast reaction time to market opportunities. Production products use the same board as employed in the prototypes.

No microprocessor development system is needed since the card contains a screen editor working with simple visual display units (VDUs). It also has the compiler for the FORTH source code. Debugging is inherent in the FORTH language and once the code is working, this can be output to a PROM programmer.

Use of C-MOS throughout has brought the power consumption down to 28mA , making the TDS900 especially suitable for portable and battery-driven applications.

Triangle Digital Services Limited
100a Wood Street, Walthamstow, London E17 3HX Tel: 01-520 0442

Visitors to our laboratories at are welcome by appointment

CIRCLE 26 FOR FURTHER DETAILS.

Keithley's 130A & 136.

Another pair of hands.

Ready and willing to give you the accuracy and flexibility you've come to expect from all handheld DMM's.

On the one hand, the new 130A has the design and performance of our most popular 130 model but with greater basic DVC accuracy – 0.25% and the need to calibrate only once every two years – all this at no increase in price.

On the other, there is the new unbeatable value 136, a high performance full autoranging 4½ digit DMM permitting precise measurements in 22 ranges of AC/DC voltage, resistance AC/DC current including 10A capability.

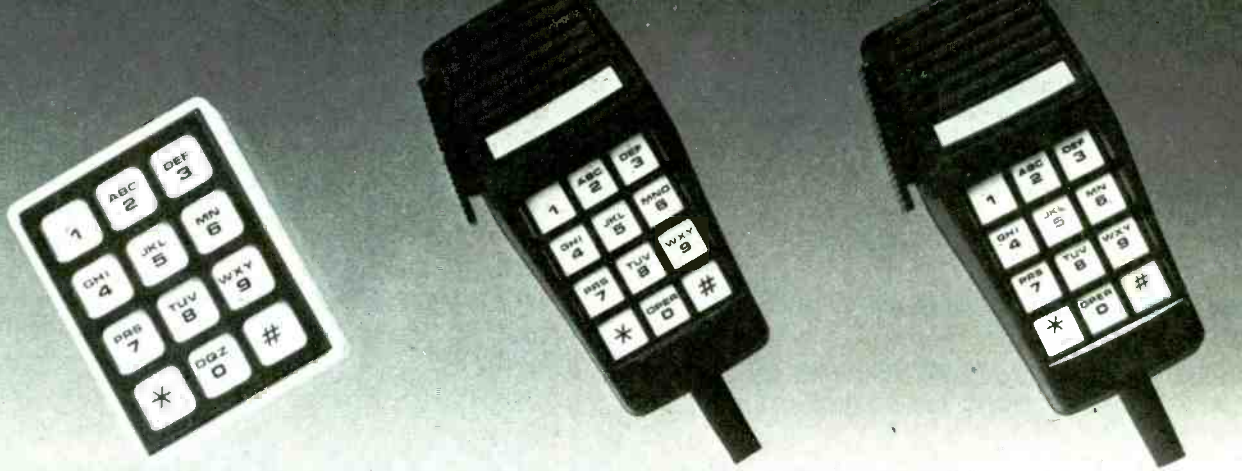
If you could use an extra pair of hands, or would just like to find out about our complete range of DMM's – phone 0734 861287 or contact a Keithley distributor now. Prices start at £69.00

KEITHLEY

Keithley Instruments Limited
1 Boulton Road
Reading Berkshire RG2 0NL
Telex 847047

Berkshire	(0734) 861287	Glasgow	(02367) 28170
Essex	(0279) 29522	London	(01) 639 0155
Gwent	(0633) 280566	Cleveland	(0287) 32397
Eire	(0001) 984147	Hertfordshire	(07073) 38623

CIRCLE 08 FOR FURTHER DETAILS.



Three new names from IQD-
the leaders in DTMF equipment.

CODEPAD MICROPAD SELCALL

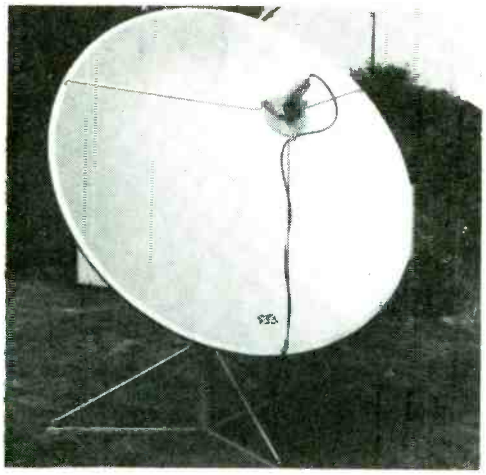
IQD offers the most advanced DTMF signalling equipment on the market.
IQD Codepad: the best in portable tone diallers, available in three models.
IQD Micropad: a microphone with not only the standard functions, but many additional features including an illuminated keyboard version.
IQD Selcall: a superior DTMF signalling unit with an extensive program facility giving you selective access to 99 sub-stations.

Telephone (0460) 74433 for further information.

IQD Ltd
North Street
Crewkerne
Somerset TA18 7AR
England
Facsimile (0460) 72578
Telex 46283

CIRCLE 014 FOR FURTHER DETAILS.

SATELLITE RECEIVING EQUIPMENT



1.9M, 2.5M and 5M Harrison Dishes. Sat-Tec R5000 4GHz Receivers. Avcom COM-2B 4GHz Receivers. California Amplifier 4GHz LNAs. Chaparral Horns. Harrison Feed Horns.

Demonstrations by appointment only.

Dealer enquiries welcome

For further details contact: Harrison Electronics, 22 Milton Road, Westcliff-on-Sea, Essex SS0 7JX. Telephone: Southend (0702) 332338.

COMPLETELY NEW EQUIPMENT

Westminster Mobile Sets type W15AM tuned and including crystals for 121.7 Mc/s, complete with loudspeakers, microphone and mobile aerials.
Price: **£95.00 each.**

Pye SSB type 130M 2 Channell — Price: **£440.00 each**
Pye SSB type 130M 4 Channell — Price: **£515.00 each**

For above: PSU 12 VDC — Price: **£88.00 each**
PSU 230 VAC — Price: **£105.00 each**
Remote Control — Price **£72.00 each**

Reflectometers type R.F.L.1A made by Telecommunication Ltd freq. 68 - 174 Mh, 50 ohms impedence.
Price: **£75.00 each.**

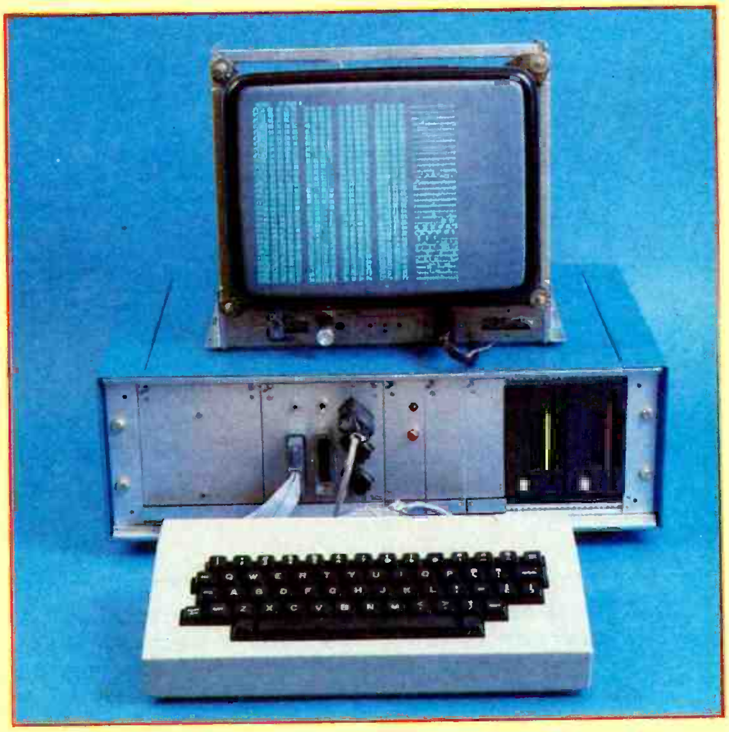
Prices shown do not include VAT.

Large quantity of spare parts for:
Pye Linear Amplifier A200
Pye Otimpic type M202
Pye 1000T SSB
Pye Tx Type T1000 FM VHF
Pye W15 FM
Pye TX Type R17/R18 VHF FM
Pye SSB 130 M & F

COLOMOR (ELECTRONICS LTD.) 170 Goldhawk Rd, London W12
Tel. 01-743 0899 or 01-749 3934. Open Monday to Friday 9 a.m.-5.30 p.m.

www.americanradiohistory.com

SC84 Micro-computer



This second section of the SC84 professional microcomputer for engineers and enthusiasts — the input/output interface — provides control for any floppy-disc drive, three parallel ports, an RS232 serial port and more.

by J.H. Adams

As well as providing basic serial, parallel, keyboard and disc input/output, this board also provides some system control and special facilities. At its heart is the Mostek STI, the MK3801N-6. This device is one of several types recently introduced which provide a set of peripheral facilities; for those familiar with Z80 peripherals, it combines a CTC, a PIO, an SIO and an interrupt controller. As befits the complexity of most Z80 peripherals, it has 24 internal registers, 16 of which are directly addressable and eight of which are indirectly addressable, and 16 sources of interrupts.

The STI comprises an eight-bit parallel port, a universal synchronous/asynchronous receiver transmitter (usart) for serial i/o, and four counter/timers, two of which are able to provide delays, count events and measure pulse widths, and two of which are only capable of providing delays. In delay mode, each timer switches the state of an individual output pin at precise intervals so the generators may be used to generate accurate frequency signals up to 500kHz — even four-part music. The two limited capability timers provide internal timing and/or determine usart bit rates.

The parallel i/o port has three features. It can be used just as an i/o port and as such each line may be configured as an input or output. Alternatively, some pins have special functions. Two are event and pulse-measurement inputs for the timers and two are 'handshake' lines for the usart. Thirdly, each line of the port may be used as a Z80 interrupt line. This is especially useful as the Z80 interrupt system is excellent but difficult to use with non-Z80 i.cs, a good example of this being control of a floppy disc drive. There is no Z80 disc controller and yet interrupts are really useful in a disc interface because of high data-transfer rates. The STI is the answer to this, providing 16 distinct interrupts each with its own priority. These could be integrated into a larger system, but the STI is so versatile that it is the only Z80 peripheral i.c. in the basic computer. If there is a blemish in the STI design it is that usart receiver and transmitter handshake lines are both outputs, presumably for compatibility with another rather odd Z80 device. This is unfortunate as logic would dictate that handshaking signals pass in the opposite direction to the data they are controlling, but the STI signals indicate that either the receiver or transmitter in the usart is empty. The former signal correctly warns external devices that the receiver is not ready but the latter is the wrong way round, the handshake being required from the external device to the STI and not away from it. As a result, these signals are disabled in this design and their i/o port lines provide handshaking in the conventional manner. It's a pity that this option was not designed into the chip.

Floppy-disc drive interfacing is handled by a Fujitsu MB8877A which is an improved and yet cheaper version of the common 1793 controller. The Fujitsu device only requires a +5V supply but for readers with a 1793 to hand, +12V is available on the p.c.b. so either part may be used. To the Z80, the controller looks like a specialized microcontroller with its own instruction set, comprising instructions to reset the system (i.e. move the head of the selected drive to the outermost track, track zero, as a means of getting the head over a known track), move the head to a particular track on the disc, and read or write one or more sectors or a complete track. Inside the con-

Table 1. Signal connections for typical drives.

Signal	Sony D32 3.5in	Std 34 way for 5.25in	Std 50 way for 8in
READY	26	6	22
RDDATA	24	30	46
WPRT	22	28	44
TR00	20	26	42
INDEX	18	8	20
SIDE	16	32	14
HLD	14, 1	16, 2	18
WG	12	24	40
WD	10	22	38
LC	—	—	—
STEP	8	20	36
DIRC	6	18	34
SEL1	4	12	28
SEL0	2	10	26
GND	7-25	1-33	1-49

The 5.25in pattern is used on BASF, Canon, Shugart and Tandon drives and the 8in pattern is used on DRE 7100 and 7200 types. Many other drives conform to these standards, but connections should be confirmed before the drive is used. Ground connections are joined over the range of odd-numbered pins indicated.

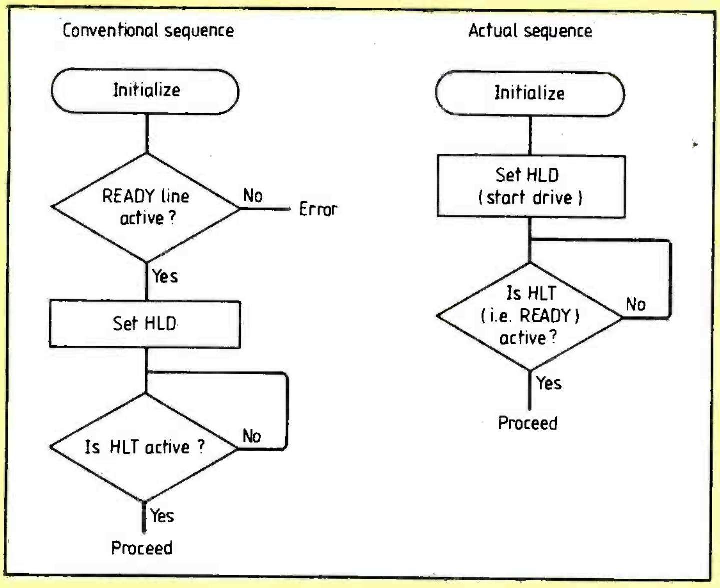


Fig.3. **Floppy-disc controller read/write execution sequence.**

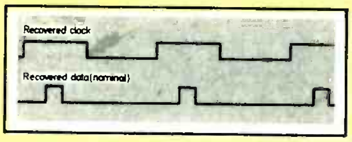


Fig.1. **The only requirements on disc data pulses are that they should not start within 40ns of a clock edge and that they must be entirely within one clock half cycle or must not be longer than 300ns for 8in double density or 600ns for 8in single density. This gives a wide margin of error in data recovery.**

Fig.2. **Floppy-disc, serial and parallel input/output are provided by this section (far right). Heart of the circuit is the 3801, containing a parallel port, a usart for serial communications, four counter/timers and an interrupt controller.**

troller there are several parameter registers which are loaded with the track and sector numbers required before a command is executed and read from or written to during data transfers between disc and Z80. The controller has two interrupt channels to the Z80 through the STI. One, DRQ, indicates that the controller is ready for data transfer, the other, INTRQ, that the controller has completed a command. In response to the second type, the system can read a status register within the controller to determine whether or not command execution ended satisfactorily, or whether an error pre-empted the command, e.g. the sector could not be found, or a write operation was attempted on a protected disc. The circuit handles both single and double density for all sizes of floppy disc. Switch S_{201} selects double density when closed and S_{202} is shown in the 5.25in, 3.25in and 3.5in/300rev/min drive position (the other is for 3.5in/600rev/min and 8in.

The MB8877A does not provide all of the facilities required for interfacing disc drives to a system. Data separation and regeneration of the data clocking signal is achieved by the SMC9216B (the B version, which is more expensive, only being required for double density) and write precompensation by the 74LS195. It is possible to get all of these facilities in one i.c. but at considerably greater expense and complexity.

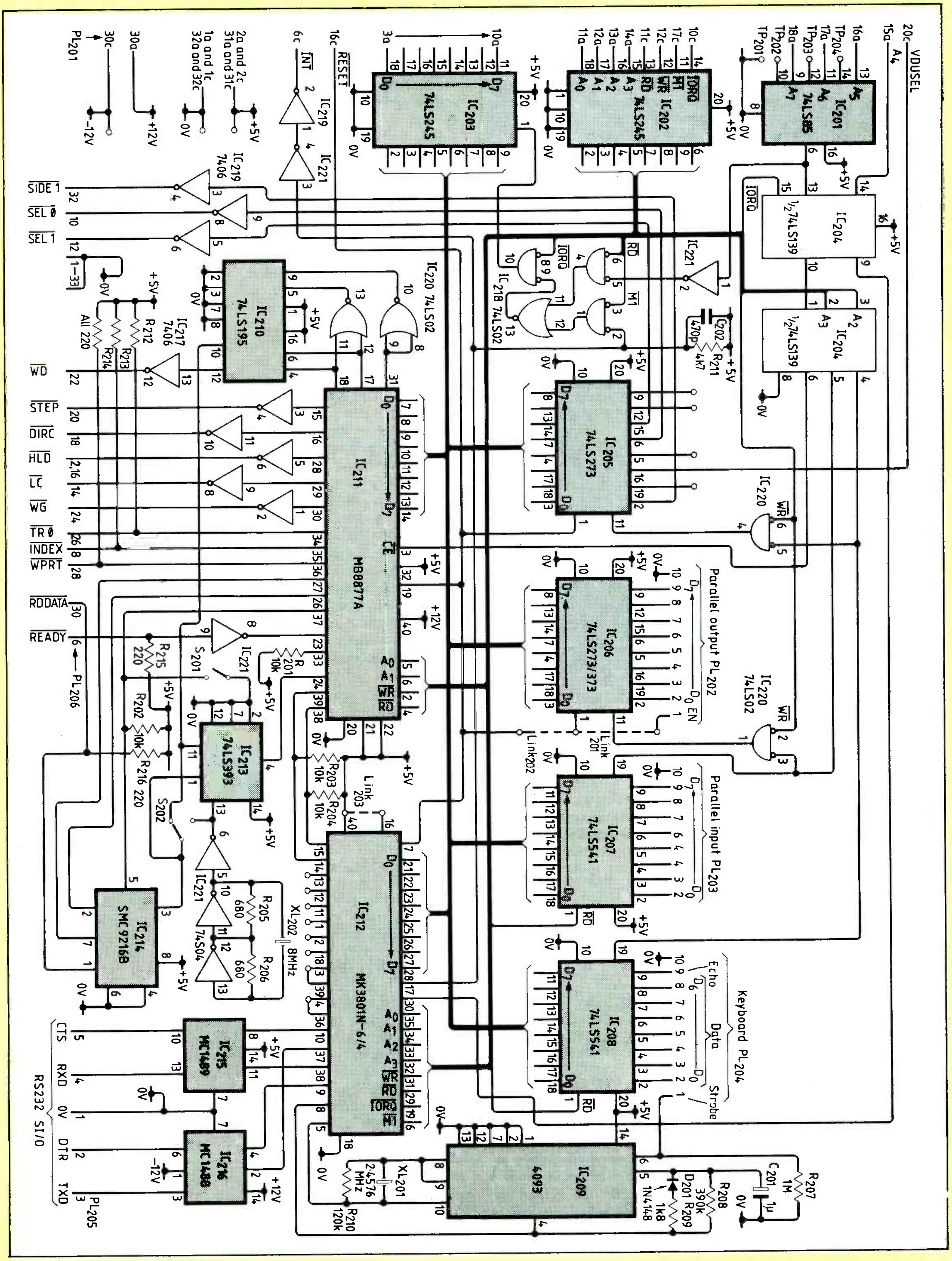
Data is recorded on disc by converting the stream of data bytes into serial form and recording the occurrence of binary 'ones' by reversing the sense of the flux recorded on the disc. The rate at which these flux reversals are made, and hence the amount of data stored, is limited by the calibre of the disc and recording head in the same way that higher frequencies are limited in audio systems. On playback these transitions are sensed, amplified and returned to digital form. Different systems have drives running at different speeds; discs change shape and data may consist of long strings of binary zeros, leaving long intervals where no transitions come from the disc. Thus additional and more regular information must be written on the disc to keep the playback process in step with the original recording rate. For this reason, extra flux transitions are inserted into the recording; for single-density recording an extra transition is inserted between every data bit period, making sure that there is a lot of synchronizing information available during playback but reducing the amount of data transferred by half. In double density recording, extra transitions are only inserted between bit periods corresponding to two adjacent zeros in the data bit stream, ensuring that an all-zeros sequence still contains some synchronizing data but, by being inserted in a natural gap in the bit stream, retaining the speed of the ideal system and not asking for a recording density, i.e. a frequency response, greater than that needed for single density. One method gives easier decoding at the expense of storage capacity, the other optimises storage at the expense of decoding complexity. Note that the physical requirement on the drive is the same for both methods so descriptions of some drives as being 'suitable for double density' — and the price premium — can be misleading.

Two data input signals are required by the controller. One is raw data from the disc drive, the other a clock signal derived from the data. The relationship between these two is that each half cycle of the clock signal is a window in which a data pulse must lie. There are two approaches to recovering the original clock signal — analogue and digital. The analogue technique uses a phase-locked loop with a fast lock-up time. This is an effective technique but requires adjustment of components for correct working and a fair amount of circuitry, not the least because the recovered frequency differs between densities and disc size. The digital technique used here requires just one, albeit rather expensive, eight-pin i.c. which extracts the clock signal from all permutations of density and disc size without adjustment. It works by dividing an 8MHz signal to the nominal clock rate — 125kHz for 5in single density up to 500kHz for 3.5in/8in double density — and adding or dropping a divider count to keep incoming data pulses two counts short of the maximum divider count. This roughly phase-locks data pulses to the counter rate, i.e. data pulses definitely fall within a window framed by the state of the most-significant counter bit. The data pulse is not centralized within the window as it would be ideally, but more than adequately meets controller-input specifications.

As hinted earlier, to get more data on a disc requires better and hence more expensive discs and drive heads. In practice the head in particular will not be grossly over-specified. Adjacent flux changes interact. As flux changes become closer together, the effect of this interference becomes more noticeable and transitions appear to be displaced on the disc and hence in time. Fortunately, the sense of the error is predictable, although its magnitude varies from drive type to type, so a correction — write precompensation — can be made before data is written on the disc. The algorithm sensing whether a pulse should be written late, on time or early is implemented in the controller, and the 74LS195 parallel-loading shift register produces a compensation of 250ns, 0 or —250ns, these being values shown to suit most drives. Again, the digital solution is preferred, the write pulse loading a single bit into a shift register being clocked every 250ns. The bit lines come from the controller EARLY and LATE pins and from a gate which derives a NOMINAL signal (logically *not early or late*). At the output of the register a bit appears for one clock period, 250ns, which is either late, 250ns later or 250ns

Table 2. Formatted capacities for single-sided drives.

Disc size	Tracks	Single density	Double density
3.5"	70	140K	350K
3.5"	80	160K	400K
5.25"	35	70K	175K
5.25"	40	80K	200K
5.25"	80	160K	400K
8"	77	250K	616K


IC201 74LS85
IC202 74LS245
IC203 74LS245
IC204 1/2 74LS139
IC205 74LS273
IC206 74LS273/373
IC207 74LS541
IC208 74LS541
IC209 4093
IC210 74LS195
IC211 MB8877A
IC212 MK3801N-6/4
IC213 74LS393
IC214 SMC 9216B
IC215 MC1489
IC216 MC1488
IC217 7406
IC218 74LS02
IC219 7406
IC220 74LS02
IC221 74LS04
VDUSEL
IORQ
RD
WR
M1
INT
RESET
SIDE 1
SEL 0
SEL 1
WD
STEP
DIRC
HLD
LC
WG
TR0
INDEX
WPRT
RDDATA
READY
PL201
PL202
PL203
PL204
PL205
PL206
Parallel output PL202
Parallel input PL203
Keyboard PL204
Echo
Data
Strobe
RS232 SI/O
CTS
RXD
DTR
TXD
XL201 2.4576 MHz
XL202 8MHz
S201
S202
Link 201
Link 202
Link 203
R202 10k
R203 10k
R204 10k
R205 680
R206 680
R207 1M
R208 390k
R209 1k8
R210 120k
R211 4k7
R212
R213
R214
R215 220
R216 220
All 220
C201 1µ
C202 470p
D201 1N4148
+5V
+12V
−12V
0V

I/O board specification

Serial i/o

Speed	1 to 38 400 baud, separate receiver and transmitter clocks
Format	synchronous 5-8 bit, auto-search and sync. asynchronous 5-8 bit, 1, 1.5 or 2 stop bits
Control	RTS (ready to send) and CTS (clear to send)
System	RS232C, +12V and −12V levels

Parallel I/o

Input	8-bit port, 1 low-power Schottky t.t.l. load, schmitt buffered.
Output	8-bit port, t.t.l. compatible, 5 t.t.l. loads

Special I/o

3 mos I/o lines operating event counters, pulse timers and Z80 interrupts.

Disc I/o

Output lines can sink 40mA. Input lines terminated with 220Ω to +5V. Bus lines are active low but have the following specification.

Signal	Direction	Function
READY	Input	Implies disc in drive and rotating at correct speed
RDDATA	Input	Raw data consisting of (nominally) 250ns pulses
WPRT	Input	Indicates disc in drive is write protected
INDEX	Input	Pulses once every disc revolution
TR00	Input	Indicates that head is over the outermost track
WG	Output	Enables disc write circuitry
WD	Output	Data to be written to disc
LC	Output	Indicates that the write current should be reduced
HLD	Output	Loads drive head against disc
DIRC	Output	Sets direction of head stepping. Active means step in
STEP	Output	Steps head one track in direction set by DIRC
SEL0	Output	Selects Drive 0
SEL1	Output	Selects Drive 1
SIDE	Output	Selects Side 1

later still, this being an effective method of simulating early, nominal or late write pulses.

Interfacing to the drives is standard in its signals although you will see that the READY line from the drive, generally indicating that there is a disc in the drive and that it is rotating at the required speed, is not taken to the READY input of the controller (which is instead wired permamently active) but to the HLT (head-loaded test) input of the controller i.c. — an input usually driven by a monostable device triggered by the leading edge of the HLD (head load) signal coming from the controller. Part of the algorithm followed by the controller when executing one of its read or write commands is shown in the flow diagrams. One can see that if READY is used conventionally, extra software and hardware must be provided to start up the disc motors (unless they are left continuously running, which will shorten the life of both disc and drive motor) and then wait for the speed to stabilize before attempting to execute a controller command. In this system the drive motor is turned on by the HLD signal, drive connections labelled Head load and Motor on, or the like, being connected together. READY being inactive does not abort the command; the controller simply starts the drive and waits for READY. What of the time delay between sensible data coming from the disc and the missing pause normally inserted by the monostable device to give the head time to load, and is it a good idea to accelerate the disc with the head already loaded against it? Some drives such as the Tandon TM100 do not have a separate head-loading mechanism and those machines that do usually gate READY with the loading signal within drive so the head will not load until the disc is up to speed. Head loading and settling delay and the time taken to get up to speed amount to less than one revolution, and as the controller has to have counted five revolutions before it gives up attempting a command, this system optimizes the delay between a command being issued and its completion while using the barest minimum of hardware and software. As an example, the disc operating system loads and the directory is scanned and noted in just over 1s when using double density.

Some drives do not give a READY signal, if so, leave the READY input to the computer open or wire it to the 5V supply. Also, some drives have optional links on their circuit boards, one of which offers the choice of head loading being solely controlled by the drive-select line or by a combination of drive select and head load inputs. If so, use the latter option. Advice on using different types of drive will be available through the users' group.

Nominal allocation of drives is that there are two drives designated A and B by the disc operating system, dos, hardware selection being by control lines SEL0 and SEL1 respectively. If double-sided drives are used, the reverse side of drive A will be designated C and that of drive B, D. This is nominal as the selection of each logical drive surface can be altered temporarily.* Open-collector drivers are used between the interface and drive. It is important that the total length of the cable does not exceed 3m (less for the 3.5in drives) and preferably as short as possible. Where more than one drive is used, drive-signal connectors are wired in parallel, from the computer to the nearest drive, then from this drive to the next etc. The only exceptions to this are the SEL signals which are individual to each drive although possibly carried by the same cable. You will find that 5.25in and 8in drives contain a pack of resistors usually in a dual-in-line package plugged into an i.c. socket wired to the signal connectors and probably labelled 220/330Ω. These packs must be removed from all but the physically furthest drive from the computer. It is good practice to provide a separate, well-rated, power supply for the drives. Disc drives tend to take large amounts of current when the drive motor starts and when the head loads. This can momentarily overload the supply with devastating results if the computer shares the same power source. Also the ground lead between the drive and interface, which should be substantial, is happier when it only carries signals.

Table 1 gives connections to widely used disc drives. There are many second-hand drives around at the moment; buying such drives is rather like buying a second-hand car — there are bargains but there is also rubbish. In particular, I would advise personal inspection and that you watch out for incomplete drives (large areas of p.c.b. without any components) unless they are a bargain and information on the missing parts is available, worn down head pads (the pad that pushes the disc onto the head) and, at least in the U.K., for drives with 110V and/or 60Hz motors. *Caveat emptor.* I would recommend that you obtain a drive with a distinct head-loading mechanism (usually a solenoid) rather than one that puts the head to the disc as soon as the door of the drive is closed. As to the choice between two single-sided drives and one double-sided one, there are many advantages to using two drives, such as the ease with which back-up copies of discs can be made, reduced head replacement costs and that the computer remains useful when one drive is out of action. Many types of drive — Sony, Canon/BASF, DRE, Shugart and CDC — have been used with the computer and the names given in the table are not intended as an indication of merit. Table 2 gives some typical capacities for drives used in single and double density modes.

A listing of SC84's machine-code operating system — MCOS — can be obtained by sending an s.a.e. to *Wireless World* SC84, Room L303, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Details of how to obtain other software including the disc operating-system and Basic were given last month together with a source of p.c.bs and newsletter information.

John Adams has recently designed a switch-regulated p.s.u. for SC84 and we hope to publish its design in the near future. He also plans to provide SC84's two eproms ready programmed; for details send an s.a.e. to the author at 5 The Close, Radlett, Herts.

V.D.U. interfacing, memory and control are detailed in the next article following a description of parallel I/o options and keyboard input.

**or permanently — Ed.*

WHAT RESOLUTION FOR ONLY £230.(EX.VAT)

Our RGB high resolution colour monitors (580 × 470 pixels) sell for £229.95 (excluding VAT)–a saving of over £100 compared to other leading monitors of similar specifications.

That's a bargain we guarantee you won't see from any other micro retailer.

We've managed to acquire the sole distribution rights enabling us to offer these superb monitors at this unbeatable price.

And just because you're saving on price doesn't mean you're sacrificing quality. Here's what Personal Computer News had to say about our monitors.

"There is no doubt that the JVC range of ECM colour monitors is excellent value for money... there is no loss in quality of picture after long periods... remember as more and more resolution is available with new micros, the need for a better display will be that much greater."

For those who only require medium resolution we also have a model (370 × 470 pixels) at £179.95 (excluding VAT) which is equally excellent value for money.

Both units have a 14" screen and are suitable for the BBC Micro, Sinclair QL, Lynx, Oric, Apple, IBM, the Electron and most other leading micros.

And naturally there's a years full guarantee.

Another one of our commitments is to make certain we deliver your monitor by courier within ten days of receiving your order.

You can order by filling in the coupon below and posting to: Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE. Or by telephoning 01-701 8668 quoting your credit card number. Or, of course, you can buy at our showroom between 9.00–6.00pm, Monday–Friday 9.00–1.30pm, Saturday.

MODEL REFERENCE	1302-2 High Resolution	1302-1 Medium Resolution
RESOLUTION	580 x 470 Pixels	370 x 470 Pixels
C.R.T.	14"	14"
SUPPLY	220/240v. 50/60Hz.	220/240v. 50/60Hz.
E.H.T.	Minimum 19.5kv Maximum 22.5kv	Minimum 19.5kv Maximum 22.5kv
VIDEO BAND WIDTH	10MHz.	6MHz.
DISPLAY	80 characters by 25 lines	80 characters by 25 lines
SLOT PITCH	0.41mm	0.63mm
INPUT: VIDEO	R.G.B. Analogue/ TTL Input	R.G.B. Analogue/ TTL Input
SYNC	Separate Sync on R.G.B. Positive or Negative	Separate Sync on R.G.B. Positive or Negative
EXTERNAL CONTROLS	On/off switch and brightness control	On/off switch and brightness control

To: Opus Supplies Ltd., 158 Camberwell Road, London SE5 0EE.
Please send me:

_______ High Resolution Colour Monitor(s) at £229.95 each (ex. VAT).

_______ Medium Resolution Colour Monitor(s) at £179.95 each (ex. VAT).

_______ Connection lead(s) at £6.00 each.

I understand carriage per monitor will cost an extra £7.00. (N.B. A High Resolution Monitor including VAT, lead, and carriage costs £279.39. A Medium Resolution Monitor including VAT, lead and carriage costs £221.89).

I enclose a cheque for £ _______ Or please debit my credit card account with the amount of £ _______ My Access/Barclaycard (please tick) no. is _______

Please state the make of your computer _______

Name _______

Address _______

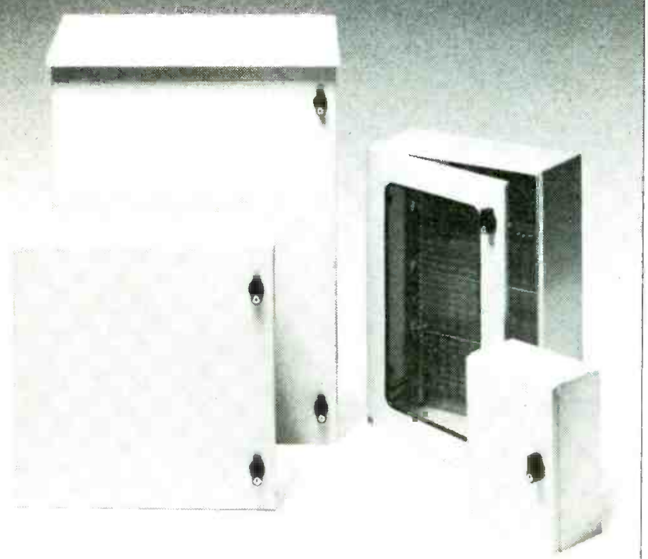
____

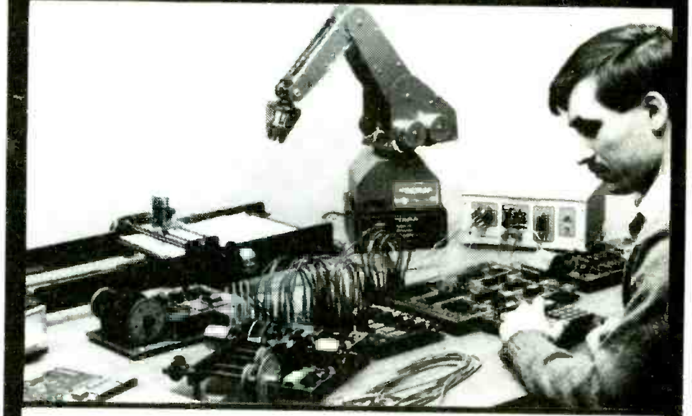
Telephone: _______

Opus.
Opus Supplies Ltd.

WW14

CIRCLE 34 FOR FURTHER DETAILS.






JUNE ISSUE
£1.00
TELEVISION
SERVICING·VIDEO·CONSTRUCTION·DEVELOPMENTS

Multi-standard modem

by Richard Lambley

Circuit details of an f.s.k. modem suitable for any microcomputer with an RS232-compatible serial port

Since the Am7910 i.c. is billed as a single-chip modem, you may wonder at the number of additional components it takes to make it work.

It is certainly possible to connect the device direct to a uart with the addition of little more than the interface to the telephone line. But the circuit of Fig.1 is for a stand-alone modem, and as such it has to be able to drive an RS232 line and receive from it. In addition, switching is needed to select the various modes of operation, and gating of the data and handshake signals may be necessary. Nevertheless, in many applications it will be possible to omit some of the components shown.

Selection of the signalling mode of the Am 7910 (IC_8) is by way of the five inputs MC_0 to MC_4. Of the 32 possible configurations only 19 are available to the user, the others being reserved by the manufacturer. The ten-way switch suggested for the mode selector S_1 reduces the user's chances of stumbling upon the one of the reserved modes (see table 1). The Am7910 makes extensive use of digital signal processing and there are no external filters to adjust, which simplifies greatly this part of the circuit.

Between S_1 and the control inputs of the Am7910 is a t.t.l. priority encoder IC_1. The circuit diagram shows pull-up resistors R_{11-14} at its outputs to ensure that the encoder will drive the cmos logic reliably; but if a 74C series device is used instead (74HC147 or 74HCT147) the resistors should be omitted.

The use of a priority encoder may seem a little untidy here, since it would have been possible to use a b.c.d. switch and connect it direct to the 7910. However, it is difficult to specify a b.c.d. switch which every constructor can be certain of obtaining. The cheapest sort is a printed-circuit mounting rotary type which stands upright on the board; but this would mean having the controls sticking out of the top of the box. The alternative, fitting the controls to a second p.c.b. would involve additional wiring and extra cost. An edge-wise thumbwheel switch would have been neat, but difficult to interpret unless you had a look-up table constantly to hand.

In any case, gating is needed to control the operation of the modem, and the arrangement shown here simplifies it a little. For example, position 9 of S_1, which is used solely to provide a means of testing the narrow-band back channel in the CCITT V.23 mode, gives automatic selection of the test mode. This loops the output of the Am7910's transmitter back to the input of its receiver and at the same time inhibits the line-seize relay RL_1, if fitted. Decoding of the select lines would otherwise be needed to achieve this.

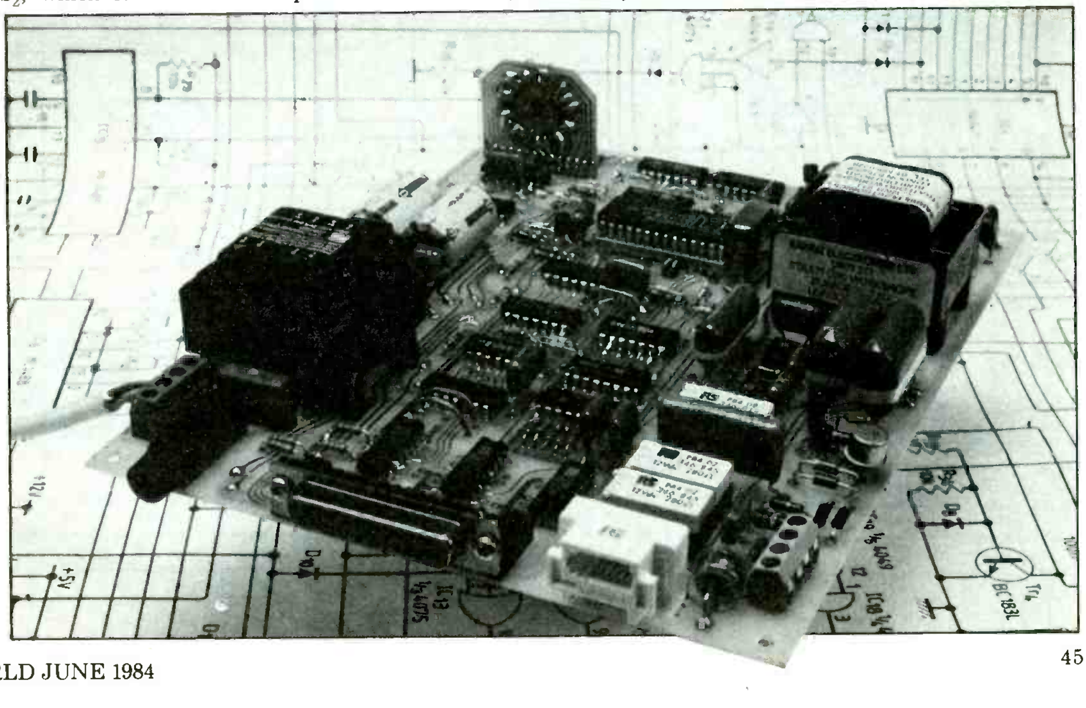
For other signalling standards, the test mode is selected by S_2, which can be a double-pole double-throw toggle switch with a centre-off position. In the test position, S_2 causes the output of the Am7910 to be looped back and it adjusts the device's transmit and receive filters to the same setting. This allows the user to test the modem off-line.

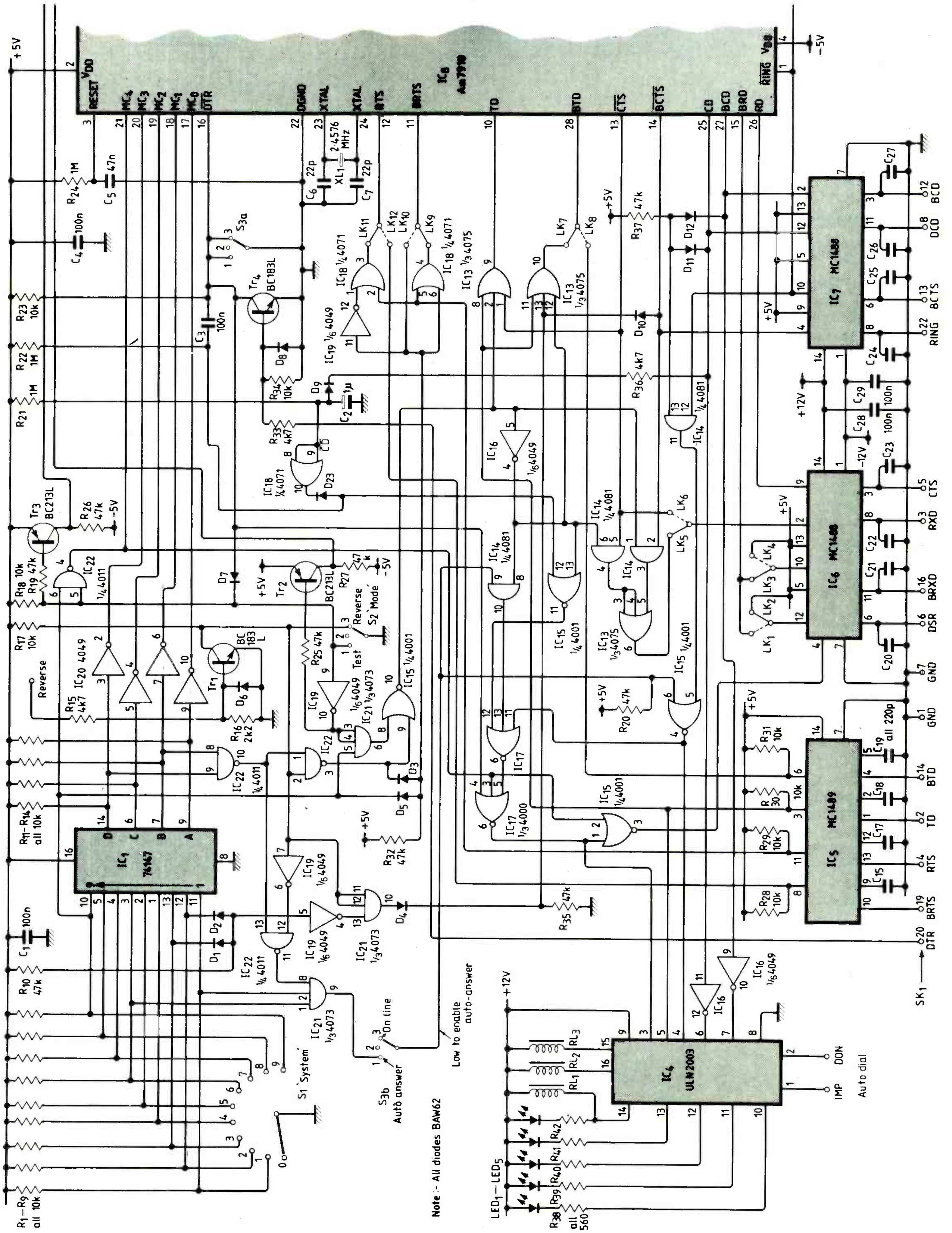
A further possibility here is remote-testing of the modem. Data received by the Am7910 can be connected straight into its transmit input and so looped back along the telephone line for tests by the computer at the other end; but the value of this to the private user seems relatively small and so the facility has not been implemented.

RS232 interface

Some microcomputers have a full RS232 interface brought out to a 25-way D-connector, and the circuit board designed for this project has space for a corresponding socket. The RS232 interface includes data and handshake lines for both the nain channel and the back channel (secondary transmit data, secondary clear-

A ready-made printed circuit board for this project will be available shortly. The board, measuring 200mm x 160mm, will be double-sided, with plated-through holes to allow the use of i.c. sockets and to avoid the need for the through-the-board links seen in this prototype. Details next month.





Note:- All diodes BAW62

to-send and so on); and with an arrangement of this sort the RS232 drivers and receivers on the board can be linked direct to the corresponding pins on the Am7910. These links are shown dotted in Fig. 1.

However, the contructor may wish to connect the modem to a computer with a less comprehensive serial interface. The BBC Microcomputer, for example, has an RS423 serial port. This is compatible electrically with the RS232 standard but has its connections brought out to a five-pin domino (reversible DIN) connector. Here the only lines available are a data line in each direction and the associated clear-to-send and request-to-send lines. In the 300 baud modes, these lines must be linked to the main channel connections of the Am7910; but in the CCITT V.23 and Bell 202 modes, it is necessary to switch some of them to the corresponding back-channel pins.

Thus, for accessing Viewdata systems such as Prestel, data to be sent back to the Viewdata computer must be applied to the BTD input, and the clear-to-send signal taken from the $\overline{BCTS}$ pin. Wide-band data from Prestel appears on the RD pin as does received data in the 300 baud modes.

Normally the RTS output from the local computer would be wired to the $\overline{RTS}$ input of the modem, and the $\overline{CTS}$ output of the modem to the CTS input of the computer. However, this may not always give the right results, and some experiment may be required. One possibility might be to connect RTS from the computer to $\overline{DTR}$ on the modem. With some low-cost commercial Viewdata modems the RTS connection is omitted and the input of the modem is wired so that RTS is asserted whenever the device is powered.

A feature of this design is that it allows the user to operate the asymmetrical V.23 and Bell 202 standards in the reverse direction, sending 1200 baud signals while receiving on the back-channel. This makes it possible to communicate with the many individuals who have standard 1200/75 baud Prestel modems. This mode is entered by switching $S_2$to the 'reverse' position. The same result can be effected by applying a high level to the free end of R_{15}. With suitable software, both computers could send at 1200 baud alternately.

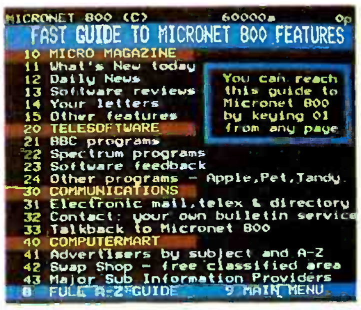
The switching logic is complicated slightly by the fact that the Bell 202 mode does not allow duplex communication in the sense that the V.23 modes do. The back channel carrier, instead of being modulated with Ascii data by frequency-shift keying, is merely keyed on and off by the $\overline{BRTS}$ line. When $\overline{BRTS}$ is low in the Bell 202 mode, a 387Hz tone appears at the Am7910's TC output. The BTD input is therefore without a function to perform in this mode and is fixed at +5V by a section of IC_{13}. In the same way, the $\overline{BCTS}$ and BRD pins carry meaningful signals only in the V.23 mode.

Managing the Bell half-duplex mode is likely to be a complicated business for most home computers. The low signalling rate in the back channel (not more than 5 bit/s) is outside the scope of a simple serial interface and will entail the use of some other i/o port. Fortunately I have not yet come across any U.K. systems which follow this standard.

The RD and BRD outputs, carrying received data in the main and back channels respectively can be gated together at the RS232 driver (part of IC_6). Internal logic in the Am7910 ensures that in normal use only one is active at a time.

Capacitors can be connected across the outputs of the line-drivers ($IC_{6,7}$) and to the response control pins of the receiver (IC_5) for adjusting the signal rise and fall times. Ideally these should be restricted to conform with the

Using the modem board (bottom) in the 1200/75 baud mode; two frames from Prestel.



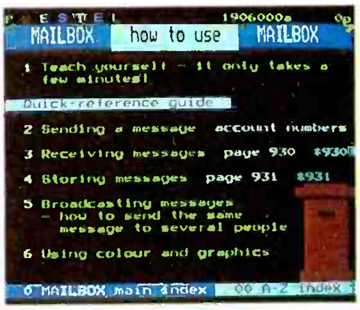
MICRONET 800 (C)   600000a   0p

FAST GUIDE TO MICRONET 800 FEATURES

10 MICRO MAGAZINE
11 What's New today
12 Daily News
13 Software reviews
14 Your letters
15 Other features
20 TELESOFTWARE
21 BBC programs
22 Spectrum programs
23 Software feedback
24 Other programs – Apple,Pet,Tandy
30 COMMUNICATIONS
31 Electronic mail,telex & directory
32 Contact: your own bulletin service
33 Talkback to Micronet 800
40 COMPUTERMART
41 Advertisers by subject and A-Z
42 Swap Shop – free classified area
43 Major Sub Information Providers

You can reach this guide to Micronet 800 by keying 01 from any page

8 FULL A-Z GUIDE   9 MAIN MENU



PRESTEL   1906000a   0p

MAILBOX how to use MAILBOX

1 Teach yourself – it only takes a few minutes!

Quick-reference guide

2 Sending a message   account numbers
3 Receiving messages   page 930   *930
4 Storing messages   page 931   *931
5 Broadcasting messages – how to send the same message to several people
6 Using colour and graphics

0 MAILBOX main index   00 A-Z index

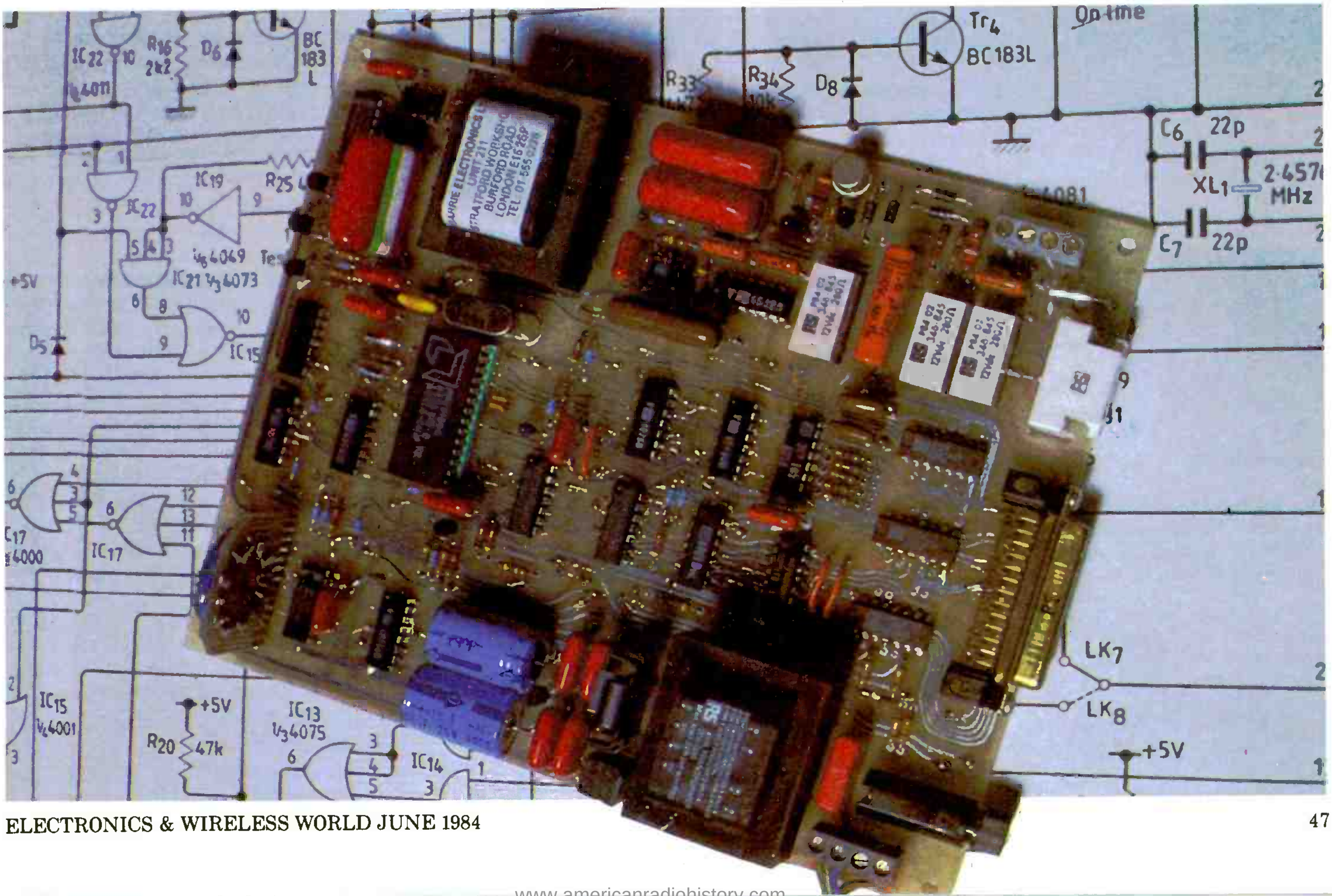
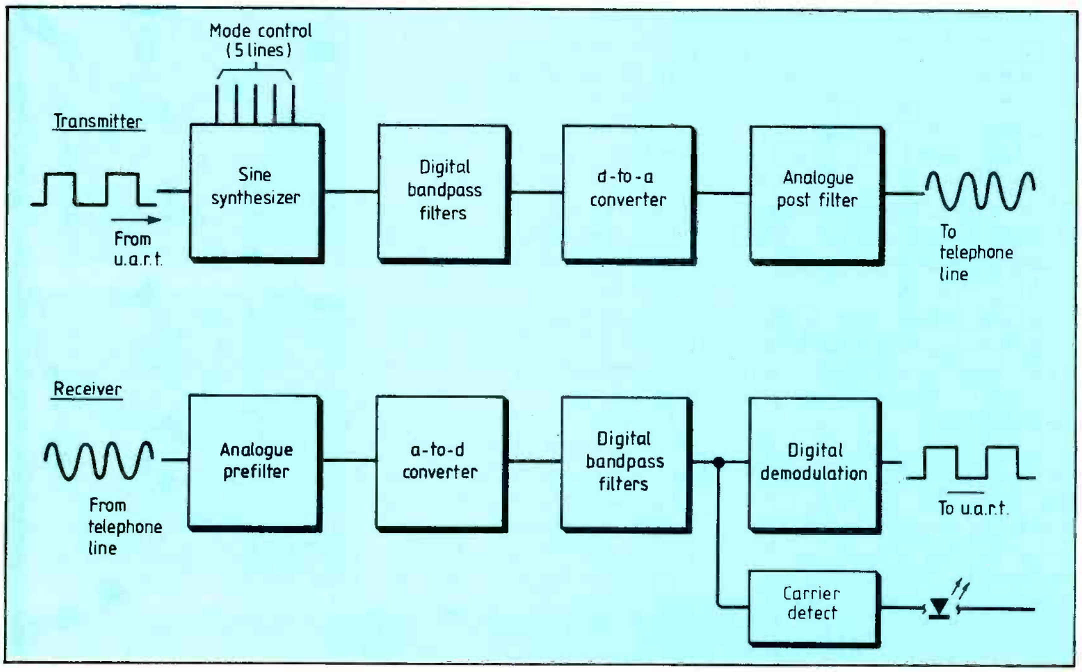


Table 1: mode selection using switches S_1 and S_2. An equaliser is available in the 1200 baud modes to compensate for poor high-frequency performance over long lines.

S_1 signalling mode	normal	test
0 Bell 103 300 baud	originate	originate loopback
1 Bell 103 300 baud	answer	answer loopback
2 Bell 202 1200 baud	half-duplex	main channel loopback
3 Bell 202 1200 baud	with equaliser	loopback with equaliser
4 CCITT V.21 300 baud	originate	originate loopback
5 CCITT V.21 300 baud	answer	answer loopback
6 CCITT V.23 mode 1	1200/75 baud	main channel loopback
7 CCITT V.23 mode 1	1200/75 with eq	main ch. loopback with eq.
8 CCITT V.23 mode 2	600/75 baud	main channel loopback
9 CCITT V.23 (test)	(reserved)	back channel loopback



RS32 specifications, although for driving short lines they can probably be omitted. Unused inputs of the MC1488s should be connected to the +5V line.

For normal transmission in, say, one of the 300 baud modes, S_2would be in its centre (off) position and S_3 in the on-line position. In this condition, the Am7910 would be enabled by $\overline{\text{DTR}}$ and the line-seize relay RL_1 would be closed. For accessing Prestel, however, it is desirable that the relay remain closed only so long as the incoming carrier is being received. This allows the user to disconnect in the conventional way by sending *90#, which causes the Prestel computer to send its sign-off page and then drop carrier.

When the call is first set up, the relay closes for a brief period as S_3 is switched on-line. The Am7910 should detect the carrier within about 15ms. Its CD output will go low and via R_{36} and D_9 will maintain the relay for the rest of the call.

In other modes, it is probably useful to have the relay enabled whenever the modem is in a normal transmission mode and switched on-line. This would allow user-to-user communication where the connection is first established in voice. Further conversation might be necessary after the exchange of data, and the operator could thus avoid accidentally dropping the line on switching back to the telephone receiver.

Acquisition of carrier is indicated by leds, one for the main channel and one for the back channel. The receiver in the Am7910 is more than adequate: its sensitivity is good enough to cope with signals of —43dBm and below.

The line connection can be broken at any time by switching S_3 to its centre position or S_2 to 'test'. This will disable the Am7910 (its $\overline{\text{DTR}}$ terminal acts as a chip-select) and, via IC_{17}, cause RL_1 to drop out.

Automatic answering is possible with the Am7910 if a suitable line interface is connected. When pin 3 is taken low by a ringing detector, an auto-answer sequence is activated. The modem sends a period of silence followed by an answer tone for the calling modem to detect and so to complete the setting up of the call. In this design, the $\overline{\text{RING}}$ signal is stretched by a monostable IC_{12} in the line interface section (to be described later) and used to hold RL_1, until an incoming carrier signal is available to take over. It does not matter that the $\overline{\text{RING}}$ input remains low while the call proceeds as it has no further effect.

The auto-answer mode can be enabled only when a suitable signalling standard has been selected by S_1: that is, in one of the 300 baud answer modes or in a reverse half-duplex mode.

Component notes

The following notes relate mainly to the ready-made printed circuit board for this project, details of which will appear in the next part.

Switch S_1 is a miniature printed circuit-mounting switch wafer — RS Components type 327-591 is suitable. For the other switches, double-throw centre-off toggle switches can be used. S_3 should be a double-pole type, S_2 single-pole.

Relay RL_1 is miniature p.c.-mounting telecommunications type, such as RS Components' 346-845 or Farnell Electronic Components' 170-529. Other miniature relays may not have contacts suitable for the voltages encountered across telephone lines.

There will be space on the p.c.b. for two additional relays of the same type, RL_2 and RL_3: these are for an optional auto-dialling facility. Drivers are provided in the ULN2003 and the connections brought out to the terminals marked IMP and DON.

The D-connector for the R232 line is a 25-way socket. The printed circuit will accept a p.c.-mounting version, RS Components' 125-856 or equivalent. If a full RS232 interface is not required one of the MC1488 line drivers may be omitted and a cheaper connector used. Some low-cost Prestel modems use a 6-pin DIN socket. The reversible domino connector fitted to the BBC Micro might appear to have the advantage that it could be turned round if the RS423 connections happened to be back-to-front; but as it is, it has unfortunately not been wired symmetrically.

The transistors are general-purpose small-signal silicon types: the p.c.b. will take BC183L and BC213L. Diodes are BAW62 or other silicon signal diodes, except where indicated otherwise. The crystal is a standard-value parallel resonance type and should be available at low cost.

Details of the interface to the telephone line will follow next month.

Further reading

Am7910 data sheet: Advanced Micro Devices (U.K.) Ltd, A.M.D. House, Goldsworth Road, Woking, Surrey. Tel: 04862-22121.

The chip heard around the world: application note on the Am7910 published by Advanced Micro Devices.

Frank J. Derfler jr.: Microcomputer data communication systems. A Spectrum book, Prentice-Hall International, 1982.

RAEDEK ELECTRONICS

DISTRIBUTORS FOR RICHARDSONS CETRON AND NATIONAL ELECTRONICS

102 PRIORY ROAD, SCRIBERS LANE, HALL GREEN, BIRMINGHAM B28 0TB
TEL: 021-474 6000

VALVES – National, Varian, Mullard, RCA, ITT . . .

A2426	28.50
AH205	708.00
AH211A	85.00
AH221	48.00
AH238	35.00
AH2511	90.00
AH2532	31.50
AJ2256	7.50
BD512A	31.50
BK66	90.00
BK448	110.00
BK482	485.00
BK484	144.00
BK486	375.00
BK488A	525.00
BK7703	250.00
BLT119	320.00
BT5	51.50
BT5B	51.50
BT17	142.00
BT17A	142.00
BT19	36.00
BT69	295.00
BT95	129.90
BT125	72.50
BT127	95.00
C1K	20.00
C3J	22.50
C3JA	28.80
C3JL	30.00
C16J	120.00
CK1907	17.70
CK5687WA	4.10
DLS16	18.00
DQ4	31.50
DR2010	4.80
DR2100	7.50
DR2110	9.00
DX453	42.00
DX453A	47.50
DX555	96.00
DY51	1.85
E55L	44.00
E80CC	8.60
E80F	13.10
E80L	12.95
E81CC	3.20
E88CC	3.90
E89F	9.25
E90CC	8.50
E92CC	6.50
E130L	23.50
E180F	8.50
E188CC	7.50
E5070	27.50
EB91	1.95
EBC91	1.30
EBF89	1.50
EC90	1.85
ECC32	2.50
ECC40	2.95
ECC70	3.70
ECC81	1.60
ECC82	1.60
ECC83	1.60
ECC85	2.20
ECC88	1.70
ECC91	3.00
ECC189	2.10
ECF80	1.45
ECF86	2.50
ECF801	1.85
ECH81	2.50
ECL82	1.50
ECL83	2.50
ECL86	1.70
EF40	8.50
EF80	1.35
EF85	1.65
EF86	1.75
EF89	2.30
EF91	2.95
EF92	2.20
EF93	1.60
EF94	1.80
EF95	3.90
EF183	2.00
EF184	2.00
EFL200	2.95
EK90	1.90
EL34	3.50
EL36	2.30
EL38	4.95
EL81	10.95
EL83	6.00
EL84	1.60
EL86	1.95
EL91	9.10
EL360	7.95
EL500	2.80
EL503	39.00
EL505	6.00
EL519	6.75
EL803	9.95
EL803S	9.95
EL821	9.95
EM84	2.00
EN32	16.25
EN91	2.80
EN92	3.30
EZ35	1.85
EZ41	2.45
EZ80	1.95
EZ81	1.65
EZ90	2.00
FG17	24.50
FG105	95.00
GXU1	15.00
GXU4	37.50
GXU5	120.00
GZ34	3.50
KT66	6.90
KT77	8.75
KT88	15.95
KU72Z	280.00
L5047	890.00
M8223	5.50
M8224	5.95
MD1901	10.00
ML7815	96.00
ML8536	220.00
ML8741	215.00
MU7235	66.00
NL604	44.50
NL604L	50.00
NL606L	66.50
NL664L	130.50
NL676	162.00
NL714	28.80
NL740	52.50
NL740P	66.80
NL760	99.20
NL760L	103.50
NL840	17.35
NL843	17.70
NL1022A	300.00
NL1036	150.00
NL1052A	144.00
NL1052D	144.00
NL1053A	485.00
NL1082S	244.00
NL2923	525.00
NL5440	19.20
NL5440A	23.90
NL5441	21.50
NL5550	90.00
NL5553B	375.00
NL5750 (NIXIE)	23.80
NL6844A	28.50
NT2	2.50
PCL805	1.85
PL509	5.50
PL519	5.75
QQV02-6	19.50
QQV03-10	5.50
QQV07-50	12.00
QV03-12	4.50
QY3-65	52.50
QY3-125	49.00
QY4-250	59.00
R1169	80.00
RG3-1250	35.00
RG3-250A	15.50
RG4-1250	48.00
RG4-3000	90.00
RM126	1360.00
RR3-250	15.00
RR3-1250	34.50
S886A	12.00
S4075	195.00
S4076	225.00
S4092	195.00
S4102	240.00
S4113	220.00
SC1/400	5.00
SK410	28.50
SK600	46.50
SK600A	49.50
SK606	7.50
SK650	32.00
SP41	3.80
SSR-13	12.00
T160L	29.50
T2888HDG	589.00
TB2 5/300	112.00
TY5-500	225.00
UU5	25.00
VLS631	14.50
VR75	5.45
VR150	4.95
XC12	1.30
XG1-2500	51.50
XG2-500	36.00
XG2-6400	152.00
XG5-500	24.50
XQ1275	237.00
XQ1276	269.00
XR1-1600A	29.50
XR1-3200	72.50
XR1-6400	95.00
Y602B	69.40
Z803U	19.50
ZT1011	29.50
ZD100551	13.50
ZM1000	18.15
ZM1001	18.15
ZM1020	15.65
DA2	3.10
DA2WA	5.50
DA3	5.45
OB2	3.95
OB2WA	5.95
OB3	2.50
OC3	2.50
OD3	4.95
1B24A	100.00
1B35A	38.00
1B63A	62.00
1B63B	58.00
1P21	104.50
1P28	30.00
2AS15A	21.10
2C39A	48.00
2C39WA	39.40
2D21	2.80
2E26	7.50
2J42	95.50
2J55	225.00
2K25	114.00
3-400Z	82.00
3-500Z	79.50
3B28	15.00
3BS2A	3.00
3BW2	3.00
3C23	23.75
3C45	24.50
3CX100A5	39.00
3CX1000A7	495.00
3CX1500A7	350.00
4-65A	52.50
4-125A	57.00
4-250A	76.00
4-400A	80.00
4-400B	73.30
4-400C	66.00
4B32	34.50
4C35A	85.00
4CX250B (EIM/AMP)	49.00
4CX250B (NAT)	39.50
4CX350A (EIM)	70.00
4CX350A (AMP)	68.00
4CX350F	72.00
4CX1500A	440.00
4CX1500B	370.00
4CX10000D	785.00
4D21	57.00
4D32	[illegible]4.75
4PR60C	250.00
4X150A	42.50
5-500A	225.00
5AR4	3.50
5AS4A	2.50
5B254M	24.00
5C22	128.00
5CX1500A	535.00
5D22	76.00
5R4	6.00
5R4GYA/B	3.75
5R4WGB	17.90
5SR6	6.00
5U4GB	2.50
5UP1	40.00
5V4GA	2.75
5Z4GT	1.90
6AH6	3.50
6AJ8	2.50
6AK5	3.90
6AK5W	2.90
6AK6	1.95
6AL5	1.95
6AL5W	1.80
6AM5	9.10
6AM6	2.95
6AN8A	2.70
6AQ5A	1.95
6AQ5W	1.90
6AQ8	2.20
6AR5	2.85
6AS6	5.50
6AS7G	7.20
6AU5GT	4.50
6AU6A	1.80
6AV6	1.30
6AW8A	2.65
6AZ8	3.80
6BA6	1.60
6BA8A	2.75
6BE6	1.90
6BH6	2.00
6BJ6	1.85
6BK4C	4.15
6BL6	68.50
6BL7GTA	3.80
6BL8	1.45
6BM6	93.95
6BM8	1.50
6BN8	2.45
6BQ5	1.60
6BR8A	2.95
6BX6	1.35
6BZ6	2.50
6C4	1.85
6CA4	1.65
6CA7	3.50
6CB6A	1.90
6CF6	1.90
6CG7	2.25
6CH6	9.95
6CJ3	2.30
6CJ6	10.95
6CK6	6.00
6CL6	3.30
6CM5	2.30
6CN6	4.95
6CQ6	2.20
6CW4	6.50
6CW5	1.95
6CY5	3.80
6CY7	3.00
6CZ5	3.15
6DA6	2.30
6DC6	2.45
6DC8	1.50
6DJ8	1.70
6DK6	3.95
6DT5	2.30
6DW4B	2.30
6E5	4.20
6EA8	2.45
6EH5	1.65
6EH7	2.00
6EJ7	2.00
6EL4A	4.15
6ES8	2.10
6EV7	2.85
6EW6	1.50
6FG6	2.00
6FH8	16.50
6FQ7	2.25
6FS5	2.25
6GB5	2.80
6GE5	2.90
6GF5	2.10
6GH8A	1.80
6GJ5A	3.00
6GJ7	1.85
6GK6	1.95
6GW8	1.70
6GX6	3.00
6GY6	3.00
6H6	3.00
6HA6	3.05
6HB6	3.05
6HE5	4.00
6HF5	3.85
6HG5	1.95
6HG8	2.50
6HS6	3.95
6HZ6	2.75
6J5	3.15
6J5GT	2.95
6J6	2.20
6J6A	3.00
6JB5	4.00
6JB6A	3.65
6JC6A	3.50
6JE6C	4.95
6JG6A	3.85
6JH8	3.25
6JK6	2.20
6JM6	3.95
6JS6C	3.95
6K6GT	2.75
6K8	4.85
6K11	2.55
6KD6	5.90
6KD8	2.00
6KE8	3.90
6KG6	6.00
6KM8	3.50
6KN8	5.50
6KX8	8.00
6L6GC	3.50
6L6 METAL	15.00
6LF6	4.95
6LN8	2.00
6LQ6	4.95
6M11	4.80
6MJ6	3.50
6Q11	2.55
6SA7	3.00
6SL7GT	1.95
6SN7GTB	2.85
6SR7	3.80
6U4	1.50
6U8A	2.00
6V4	1.95
6V6GT	1.95
6X4	2.00
6X5GT	1.85
6X8A	3.00
6Y9	2.95
7F7	9.50
7K7	10.85
8CG7	2.00
8FQ7	2.00
9SP4	88.00
12AT6	1.70
12AT7	1.60
12AU6	2.00
12AU7A	1.60
12AV6	2.00
12AX7	1.60
12AX7WA	4.80
12B4A	2.90
12BA6	2.00
12BA7	3.00
12BE6	1.90
12BM7A	2.50
12BY7A	2.40
12BZ6	3.70
12DK6	1.50
12DW7	4.25
12E1	25.00
12FQ8	12.00
12GN7A	4.00
12K7GT	1.80
12SL7GT	3.95
13E1	155.00
20PE11	25.00
20PE13A	21.00
20PE14	25.00
20PE15	220.00
20PE19	25.00
20PE20	27.50
21JZ6	3.40
30KD6	5.00
40KG6	5.50
40KG6A	5.75
42EC4	4.00
75C1	2.80
83A1	12.00
90C1	3.50
90CG	12.00
90CV	14.20
150B2	6.50
150C2	3.10
150C3	4.95
150C4	4.50
212E	170.00
290A	1150.00
350A	22.50
350B	22.50
404A	12.00
572B	29.50
575A	35.00
615	18.50
710	29.90
740L	66.80
760P	103.50
805	42.00
807	2.90
810	50.00
811A	14.90
812A	19.90
813 (NAT)	28.50
813 (RCA)	65.00
829B	17.20
833A	61.50
843	10.00
845	48.30
857B	708.00
866A	15.50
868	24.00
872A	19.00
922	12.50
927	17.80
930	14.70
931A	18.50
931B	25.00
934	18.80
935	35.80
1051D	110.00
1052S	144.00
2050	2.85
2050A	2.85
4532U	250.00
4833U	215.00
4848	25.00
4875U	215.00
5517	14.50
5544	72.50
5545	95.00
5551A	110.00
5552A	144.00
5557	24.50
5559	51.50
5581	16.85
5582	24.00
5583	20.65
5632	22.50
5636	7.00
5642	8.20
5644	17.00
5651	2.85
5654	2.90
5665	120.00
5670	2.75
5684	28.80
5684NE	39.50
5696	3.30
5718	6.20
5726	1.80
5727	2.00
5749	2.50
5750	1.90
5751	3.30
5763	4.50
5796	29.50
5814	3.00
5822A	300.00
5847	12.00
5866A	112.00
5867A	120.00
5868	170.00
5869	40.00
5870L	20.00
5870ST	20.00
5876A	27.60
5879	3.80
5886	10.00
5894A	41.25
5894B	45.00
5920	8.50
5963	1.80
5965	2.20
5991	20.00
6005	1.90
6011	29.90
6012	9.90
6014	20.00
6021	3.70
6058	10.50
6063	3.70
6065	7.25
6073	5.50
6080	9.20
6083	72.00
6084	13.10
6085	8.60
6094A	420.00
6101	2.20
6130	24.50
6146A	7.50
6146B	7.50
6155	49.00
6156	59.00
6159B	12.50
6201	6.50
6227	12.95
6267	1.75
6293	14.00
6360A	5.50
6426	1690.00
6442	18.00
6484	42.00
6528	48.00
6550A	7.25
6688	8.50
6689	9.25
6693	90.00
6779	19.50
6856	52.50
6857	66.80
6858	99.20
6859	103.50
6883B	14.20
6922	3.90
6939	19.50
6973	3.70
6975	66.00
7014	44.50
7015	50.00
7017	66.50
7018	18.50
7022	66.80
7023	103.50
7025	2.50
7027	4.60
7034	42.50
7056	2.50
7136	175.00
7189A	2.40
7199	4.20
7203 (NAT)	39.50
7203 (EIM)	49.00
7233	6.75
7234	72.50
7247	3.20
7262A	26.00
7289	39.00
7308	7.50
7322	604.00
7360	9.00
7486AL	80.00
7527	73.30
7527A	140.00
7534	23.50
7543	2.00
7551	5.50
7558	9.50
7581A	18.25
7586	11.50
7587	19.00
7591A	5.00
7723NE	28.65
7735A	26.00
7815AL GE	48.00
7815R AL	48.00
7868	4.20
7903	115.00
7905	13.50
7984	13.50
8008	18.80
8020	35.00
8032	14.20
8056	15.00
8068	13.00
8072	69.20
8117	165.00
8121	90.00
8122	90.00
8163	82.00
8164	298.00
8233	44.00
8278	39.00
8298A	7.50
8321 (EIM)	70.00
8321 (AMP)	68.00
8416	15.70
8417	5.55
8422	20.00
8438	80.00
8541	33.00
8552	14.20
8553	280.00
8608	27.50
8643	66.70
8754	17.35
8794	2330.00
8844	23.00
8874	165.00
8906AL	55.00
8908	10.50
8950	9.50
9001	6.00
9677M	31.00
9844A	420.00
9950	40.00
16411	118.00

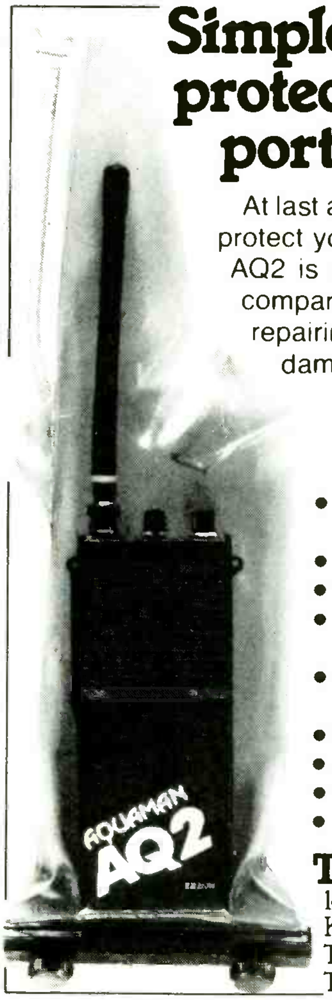
R. F. POWER TRANSISTORS – Many other types available on request

2N3375	9.20
2N3553	2.00
2N3632	10.00
2N3733	13.20
2N3866	0.85
2N3926	11.26
2N3927	11.82
2N4416	0.75
2N4427	0.75
2N5090	13.90
2N5109	2.00
2N5160	4.80
2N5190	1.50
2N5589	6.00
2N5590	8.50
2N5591	8.90
2N5643	13.00
2N5913	2.50
2N5945	8.95
2N5946	15.63
2N6080	6.00
2N6081	8.75
2N6082	9.00
2N6083	12.00
2N6084	13.20
2N6094	8.00
2N6095	8.50
2N6255	3.45
2SC382	0.65
2SC458	0.22
2SC458B	0.36
2SC458C	0.22
2SC460	0.25
2SC460B	0.25
2SC461B	0.25
2SC535	0.38
2SC535A	0.38
2SC535B	0.38
2SC535C	0.35
2SC540	24.95
2SC608	0.75
2SC644	0.25
2SC684	0.28
2SC703	36.00
2SC710	0.45
2SC710D	0.28
2SC715D	0.40
2SC715E	0.40
2SC717P	0.38
2SC730	4.10
2SC731	3.95
2SC732	0.25
2SC741	2.50
2SC821	6.60
2SC28B	0.30
2SC29B	0.25
2SC890	8.50
2SC891	18.00
2SC900	0.18
2SC900F	0.19
2SC908	4.50
2SC911A	18.00
2SC945	0.21
2SC945R	0.21
2SC952	0.60
2SC982	0.30
2SC994	2.50
2SC998	3.90
2SC1001	9.90
2SC1011	15.00
2SC1070	1.15
2SC1096L	0.90
2SC1096M	0.90
2SC1117	£1.50
2SC1120	12.50
2SC1121	24.00
2SC1122	18.00
2SC1162B	0.90
2SC1165	6.95
2SC1169	4.85
2SC1176	14.00
2SC1177	17.25
2SC1178	18.00
2SC1209D	0.64
2SC1213A	0.40
2SC1213C	0.40
2SC1239	2.50
2SC1241	15.00
2SC1251	10.00
2SC1260	1.11
2SC1303	5.00
2SC1306	1.00
2SC1307	1.50
2SC1311	0.40
2SC1311E	0.32
2SC1314	25.00
2SC1318	0.40
2SC1368B	1.00
2SC1383B	0.50
2SC1424	1.35
2SC1509	6.00
2SC1546	0.45
2SC1568	0.45
2SC1589	5.00
2SC1622	0.33
2SC1623	0.30
2SC1688	19.80
2SC1674	0.25
2SC1675	0.20
2SC1678	1.25
2SC1729	18.00
2SC1730	0.25
2SC1740Q	0.20
2SC1765	7.75
2SC1815Y	0.28
2SC1906	0.33
2SC1907	0.30
2SC1945	2.10
2SC1946	18.75
2SC1946A	16.50
2SC1947	9.88
2SC1955	7.20
2SC1966	11.00
2SC1967	15.00
2SC1968	17.50
2SC1968A	22.00
2SC1969	1.50
2SC1970	1.50
2SC1971	4.00
2SC1972	11.00
2SC1978	7.50
2SC2001	0.45
2SC2026	0.75
2SC2053	0.80
2SC2097	36.00
2SC2099	15.00
2SC2100	24.00
2SC2103	18.00
2SC2105	15.00
2SC2116	1.60
2SC2118	9.00
2SC2221	5.50
2SC2233	0.90
2SC2237	16.00
2SC2281	13.00
2SC2283	9.00
2SC2287	11.00
2SC2289	12.50
2SC2290	27.50
2SC2347	0.30
2SC2369	2.00
2SC2370A	18.00
2SC2379	15.00
2SC2395	15.00
2SC2407	1.00
2SC2420	18.00
2SC2494	16.00
2SC2509	6.00
2SC2531	1.30
2SC2538	1.10
2SC2539	15.00
2SC2540	24.95
2SC2545E	0.29
BRF90	1.50
BFR91	2.00
BRF96	2.00
BFY90	1.50
BLW29	10.00
BLW60C	15.00
BLW60CF	15.00
BLW64C3	65.00
BLW78	61.80
BLW80	10.25
BLW81	14.90
BLW90	13.00
BLW98	110.00
BLX39	13.75
BLX65	2.45
BLX67C	9.50
BLX67CF	9.50
BLX68C3	10.00
BLX68CF	10.50
BLX69A	20.00
BLX94A	36.00
BLX98	132.00
BLY87C	7.50
BLY88C	11.00
BLY88CF	11.00
BLY89C	13.00
BLY90	45.00
BLY91CF	11.00
BLY94	45.00
MRF208	12.00
MRF212	12.00
MRF221	12.05
MRF229	3.50
MRF231	12.36
MRF232	13.50
MRF233	14.30
MRF234	16.00
MRF237	2.40
MRF238	12.60
MRF239	20.00
MRF240	24.50
MRF243	35.00
MRF245	30.00
MRF247	30.10
MRF260	5.00
MRF264	11.00
MRF309	42.00
MRF316	55.00
MRF317	73.00
MRF321	35.00
MRF323	35.00
MRF326	63.00
MRF327	70.00
MRF329	58.06
MRF412	18.51
MRF421	36.85
MRF422	42.00
MRF426	23.00
MRF427A	21.00
MRF428	57.00
MRF428A	75.00
MRF433	16.21
MRF449A	14.95
MRF450	11.90
MRF453	11.90
MRF453A	16.90
MRF454	21.00
MRF454A	24.00
MRF455	16.00
MRF455A	21.00
MRF458	19.95
MRF466	24.50
MRF472	4.40
MRF475	2.00
MRF475	2.25
MRF477	12.50
MRF492	27.50
MRF497	18.50
MRF515	3.90
MRF517	3.50
MRF620	18.00
MRF644	27.50
MRF646	28.00
MRF648	33.00
MRF750	6.50
MRF846	46.00
MRF901	2.75
MRF904	2.95
MRF911	2.50
MRF5175	22.50
MRF5176	30.00
MRF5177	43.00
MRF8004	2.00
PT3134A	1.50
PT3134B	2.75
PT3134C	12.00
PT3134D	12.50
PT3134E	30.00
PT3161A	1.75
PT3161B	1.75
PT3161C	8.50
PT3161D	14.00
PT3161F	30.00
PT3503	6.95
PT4261A	16.00
PT4261B	24.00
PT4261C	60.00
PT4316C	12.00
PT4316D	18.00
PT4316E	25.00
PT4316F	30.00
PT5661C	14.00
PT8751	24.00
PT8820	15.00
PY8831	2.75
PT8837	10.00
PT8838	15.00
PT8854B	18.00
PT8861A	15.00
PT8864A	30.00
PT8874	18.00
PT9795	12.50
PT9797	14.00
PT9841	16.00
PT9847	16.00
SD1005	8.20
SD1006	2.10
SD1012-3	10.00
SD1012-4	10.50
SD1013	10.00
SD1014-6	10.50
SD1015	17.50
SD1018-6	13.00
SD1019	24.70
SD1019-5	24.70
SD1020	1.50
SD1074	16.10
SD1076	18.50
SD1077	1.60
SD1078	26.50
SD1080	1.55
SD1080-6	7.50
SD1080-7	7.50
SD1088	26.00
SD1089	28.50
SD1089	40.10
SD1115-2	7.50
SD1115-7	2.10
SD1127	2.50
SD1131	3.25
SD1133	9.50
SD1133-1	10.00
SD1134-1	2.50
SD1134-2	10.00
SD1134-8	10.00
SD1134-STUD	7.60
SD1135	10.25
SD1135-3	12.00
SD1136	12.50
SD1143	9.45
SD1143-1	10.00
SD1144-1	2.50
SD1158	7.95
SD1201	7.35
SD1202	7.50
SD1212-4	6.00
SD1212-7	4.00
SD1214	8.70
SD1216	11.00
SD1219	18.00
SD1219-4	18.00
SD1220-1	9.50
SD1222-5	11.00
SD1222-STUD	11.00
SD1224-2	13.00
SD1229-F1	10.95
SD1229-STUD	10.95
SD1244-6	12.75
SD1256	6.95
SD1262	15.00
SD1270	3.75
SD1272	10.95
SD1272-2	10.95
SD1278	13.75
SD1278-1	13.75
SD1285	12.75
SD1300	1.25
SD1303	2.50
SD1316	2.10
SD1317	8.00
SD1405	21.00
SD1407	27.50
SD1407MP	55.00
SD1410	21.06
SD1410-1	21.00
SD1410-3	21.00
SD1412	36.00
SD1412-3	24.00
SD1413	18.00
SD1414	36.00
SD1416	33.00
SD1418	30.00
SD1421	36.00
SD1428	24.00
SD1429	15.98

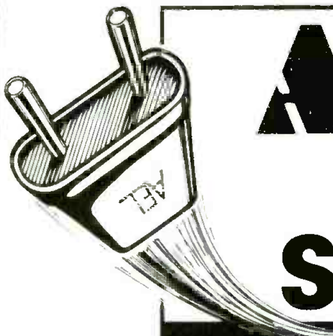
TERMS: C.O.W. **POSTAGE/PACKING**: Add £1 to order under £50 value. **VAT**: All prices are excluding VAT, please add 15% to order and postage. **GUARANTEE**: All goods are of current production and sold with manufacturer's warranty. **ENQUIRIES**: Are welcomed for other types/brands of valves. Please send SAE

CIRCLE 53 FOR FURTHER DETAILS.


Entry
Display
Data
Expansion
Cursor
Acquisition
GOULD
50MHz Logic Analyser LA5000
The Gould LA5000


AQUAMAN
AQ2


TWIN PPM

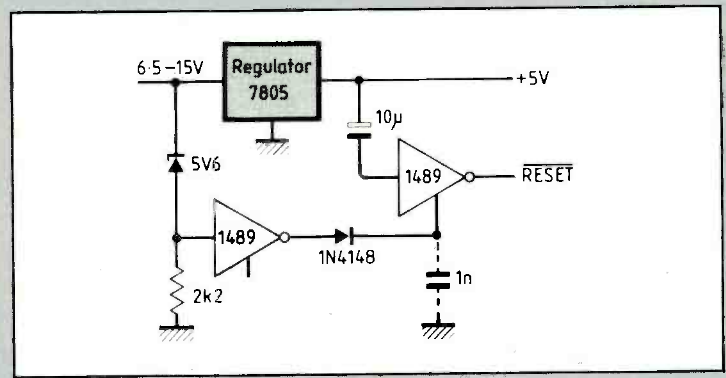

AEL

POWER UP/DOWN RESET

Power failure in microprocessor systems causes spurious operation. This circuit was devised to prevent pulses being sent to an eprom programmer on such occasions by initiating a microprocessor-reset signal when the supply falls below about 6.5V; it also provides power-on reset for about 100ms depending on the power-supply rise time.

Two spare RS232 line receivers are main elements of the circuit. If a stepless transition is required, add the capacitor shown in broken lines. Threshold voltage is varied by connecting a resistor between the first receiver's response control input and ground or +5V. Values will need to be changed if the 1489A receiver is used since this version has different thresholds.

E. Wagner
London

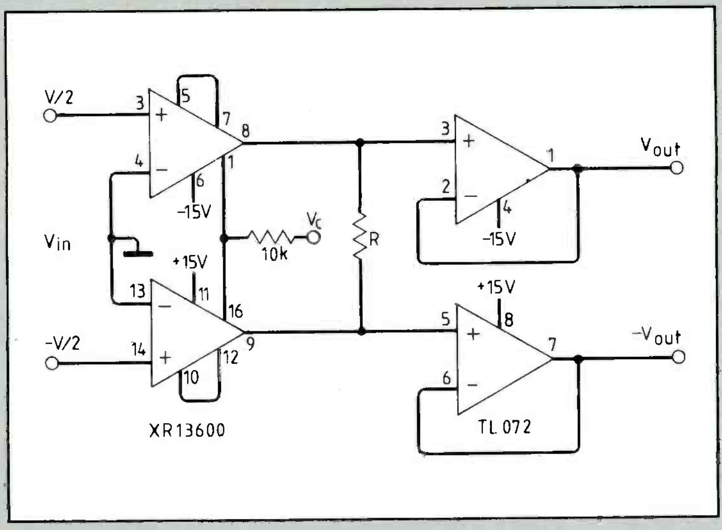


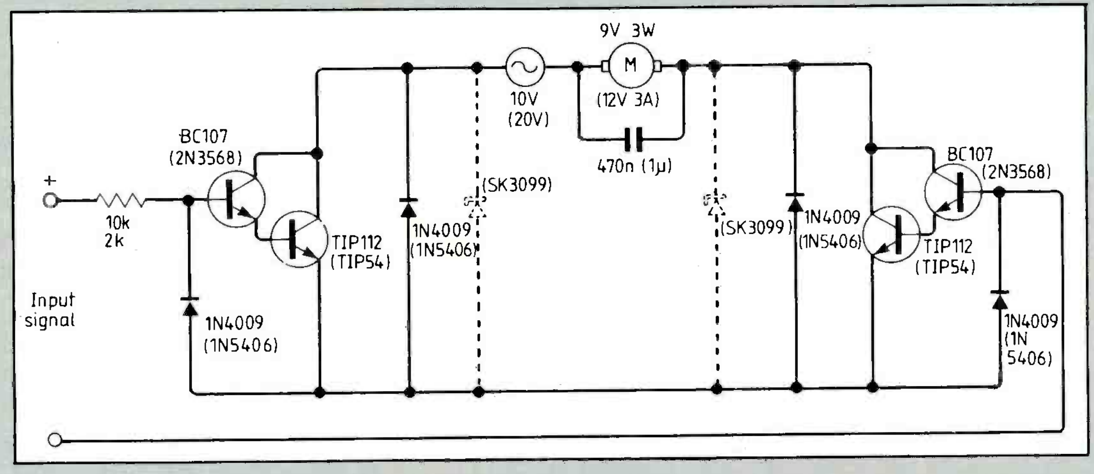
DON'T WASTE GOOD IDEAS
We prefer circuit ideas with neat drawings and widely-spaced typescripts, but we would rather have scribbles on "the back of an envelope" than let good ideas be wasted. Submissions are judged on originality or usefulness — not excluding imaginative modifications to existing circuits so these points should be brought to the fore, preferably in the first sentence. Minimum payment of £30 is made for published circuits, normally early in the month following publication.

INSTRUMENTATION AMPLIFIER HAS DIFFERENTIAL OUTPUT

Combining a TL072C i.c. and an XR13600 transconductance op-amp produces an instrumentation amplifier with differential input and output. Transconductance of the op-amp is $V_{out1}=g_mRV_{in}$ and $V_{out2}=-g_mRV_{in}$ given by $g_m=I_B/V_T$ where $V_T=26mV$. So gain of the amplifier may be set by varying bias current I_B to pins one and 16 only. For simplicity, only control voltage V_c is shown. The circuit may be useful in applications where V_{out} is above or below zero.

Kamil Kraus
Rokycany
Czechoslovakia

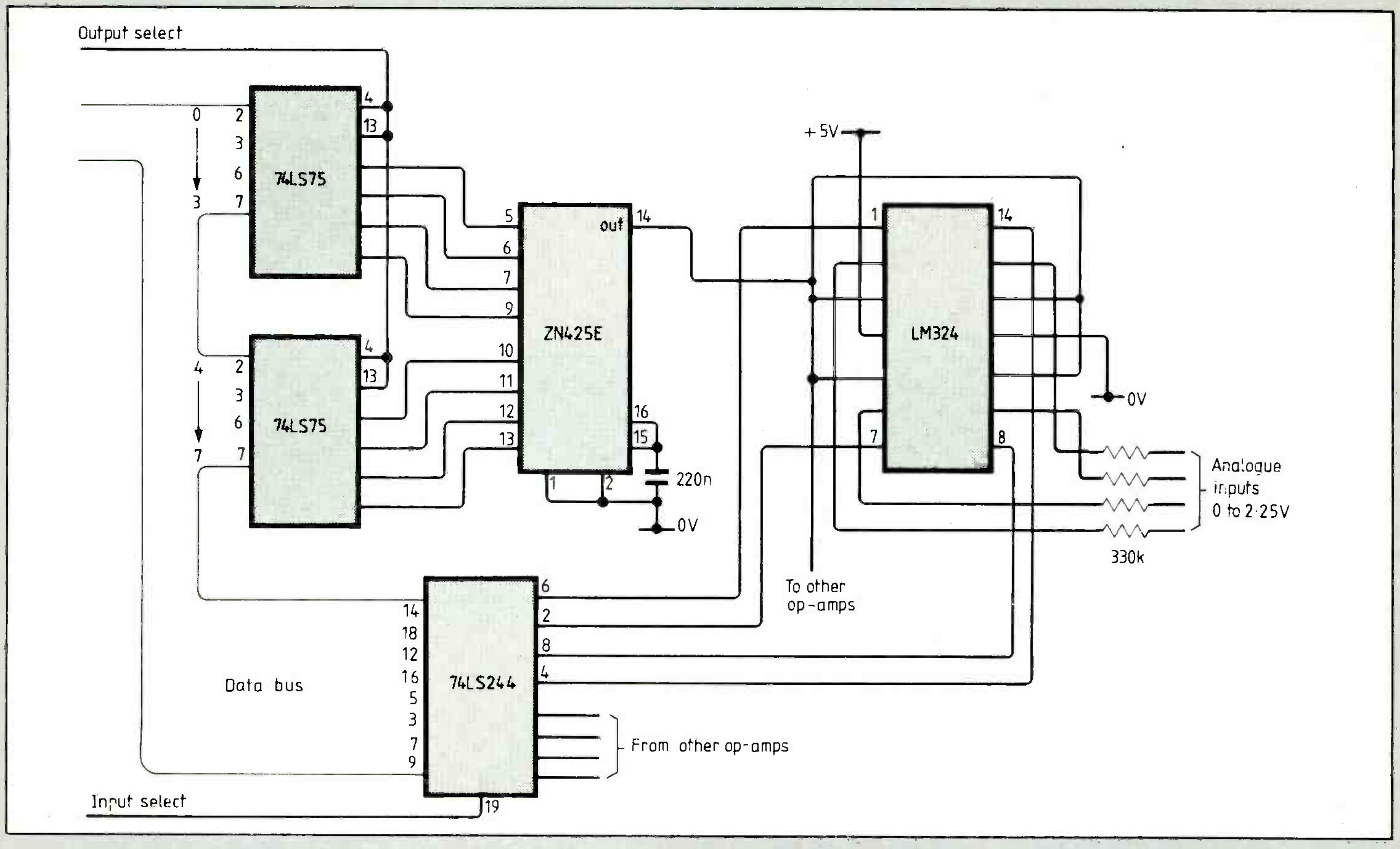




FORWARD/ REVERSE MOTOR CONTROL

Designed for use in a solar tracking system, this forward or reverse motor controller has three advantages over conventional circuits — only an a.c. supply is required, one signal determines forward or reverse, and only four transistors are used. Polarity of the input signal determines direction of rotation and it is impossible to switch both Darlington pairs on together. Zener diodes are included for larger motors to prevent overvoltage damage during fast commutation.

J.A. Maldonado de la Fuente
Valparaiso
Chile



MULTI-CHANNEL A-TO-D CONVERSION

Excluding address decoding, this four channel analogue-to-digital converter for connecting to a computer requires only five inexpensive i.cs. One more 324 input comparator allows eight analogue channels to be monitored. Further, the circuit needs only one 5V supply and is quite fast when the computer software is designed to determine the input value using successive approximation. Within the limits of the ZN425 output capability, expansion requires only further input comparators and 74LS44 buffers.

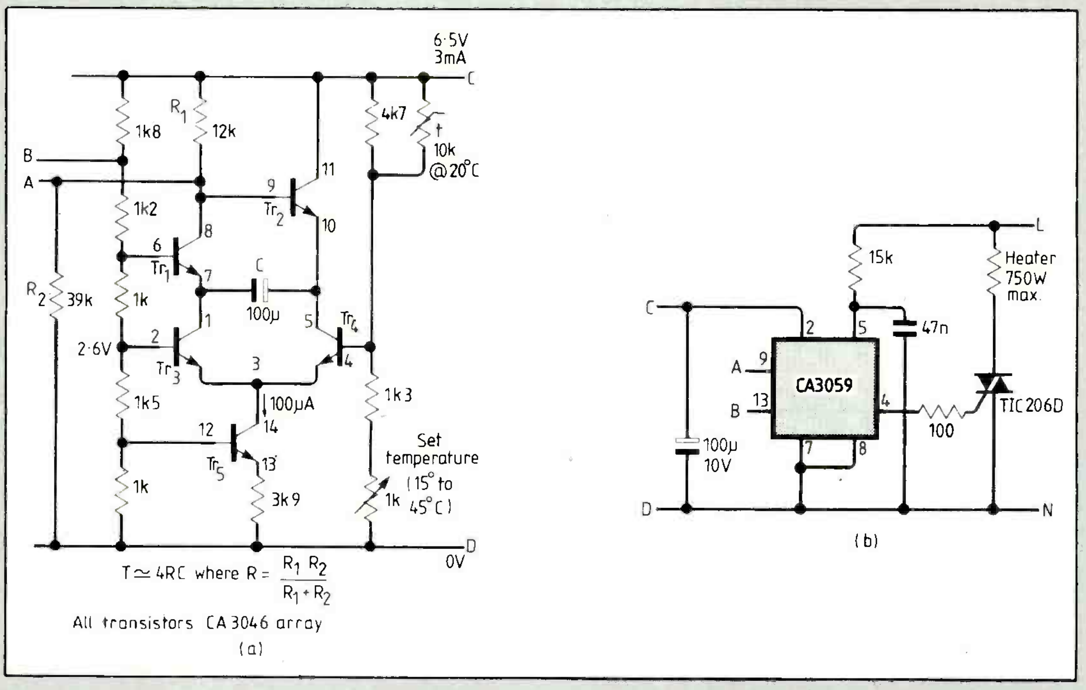
K.P. Tibbetts
Preston
Lancashire.

PROPORTIONAL TEMPERATURE CONTROLLER

In this simple proportional temperature controller designed for photographic processing, none of the transistors saturates so the circuit should be capable of functioning at high frequencies in other applications.

Transistors $Tr_{1,2}$ form an emitter-coupled multivibrator whose period is approximately 4RC — 4 seconds for values shown. Mark-space ratio is controlled by the voltage difference between bases of $Tr_{3,4}$; plus and minus 20mV give about 25% and 75% respectively which corresponds to a proportional band of about 1K. With these component values, C is never reverse biased. A differential output of ±500mV is available between points A and B, or a 1V output can be obtained from a 10kΩ resistor in the collector of Tr_2. Thermistor characteristics over the range 15 to 45°C are linearized by the 4.7kΩ resistor.

J.R. Hunt
Doncaster
Yorkshire



(a)

(b)

In-circuit emulation

by John D. Ferguson*

John Ferguson discusses the principle of emulators and illustrates their use by reference to several commercial units.

The technique of in-circuit emulation (i.c.e.) provides the engineer with a simple, yet effective means of testing hardware and evaluating software in a microcomputer system. Figure 1 illustrates the principle. The microprocessor is removed from the unit under test (target) and connection made to a second computer system (host) through a dual-in-line plug and ribbon cable. Normally the host computer uses a similar microprocessor to that removed from the target, to imitate or emulate the original processor. At first glance it might seem pointless to remove the original to have it replaced by another in the host, but the technique allows the host to get between the target system and its microprocessor, enabling it to monitor bus activity or to inject signals into the target system.

The technique was first introduced by Intel on their microprocessor development system (MDS) to help debug hardware and software problems encountered during the development phase of a project. Early development systems were essentially software orientated, providing editors, assemblers, linkers, and, to a limited extent, some facility to execute and debug the final machine code. However, to test hardware and software effectively it was necessary to commit the final code to eprom before transferring it to the unit under development. Any further debugging that was required was now carried out using a logic analyser. If faults were discovered the engineer returned to the development system to update the software before programming a new eprom.

The introduction of i.c.e. shortened this time-consuming procedure, allowing the design engineer to run the system under development directly from the MDS, thus eliminating the need to use eproms as a means of transporting software into the target system. Further, since the emulator has access to the target system's buses during program execution, it can also be used as a debugging tool. To help with this task most emulators also provide on-board logic analyser functions.

In-circuit emulation is now a standard feature on development systems with some manufacturers, including Hewlett Packard, Genrad and Tektronix, providing a range of emulators covering a variety of 8 bit and 16 bit microprocessors. However, all of these systems are well outside the budget of most individuals or small companies involved in microprocessor system development. To fill this need several manufacturers, notably Microtek, are producing a range of low cost stand-alone emulators that can be driven through an RS232 interface from either a v.d.u. or any popular microcomputer with a serial port.

The value of in-circuit emulation has also been acknowledged by those involved in microcomputer servicing, offering a simple method of injecting test or stimulus programs into a defective board. This can prove an essential facility if the unit under test does not respond to normal keyboard operation or, perhaps, as in the case of some controllers, does not contain a keyboard. Many manufacturers, including Hewlett Packard, the John Fluke Co. with their 9010 Troubleshooter and Solartron with their range of Micropods, are now producing

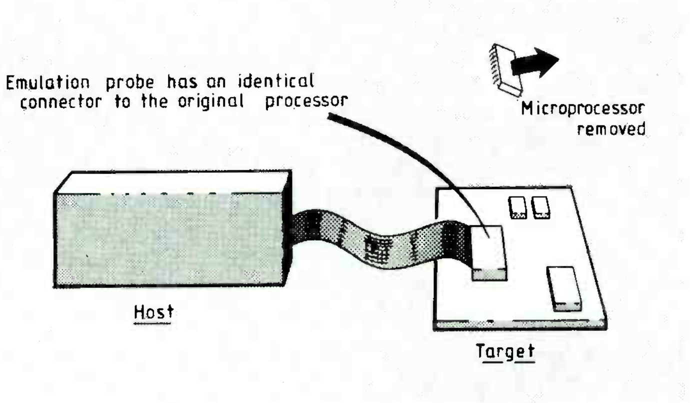


Fig.1. **Attaching a target system.**

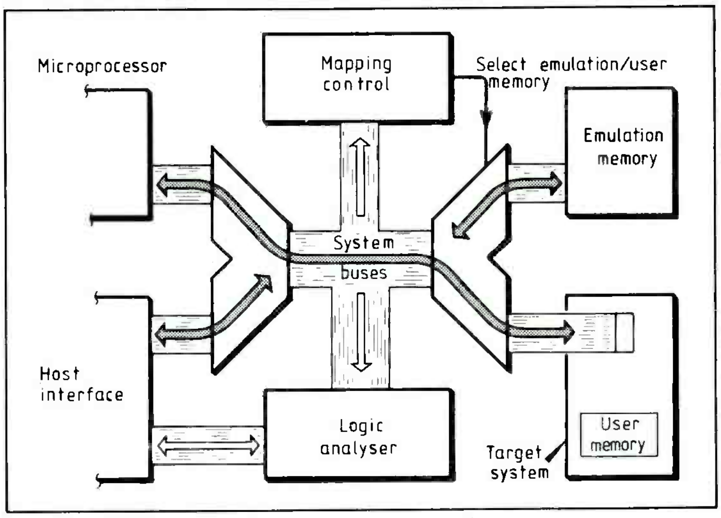


Fig.2. **Simplified emulator architecture.**

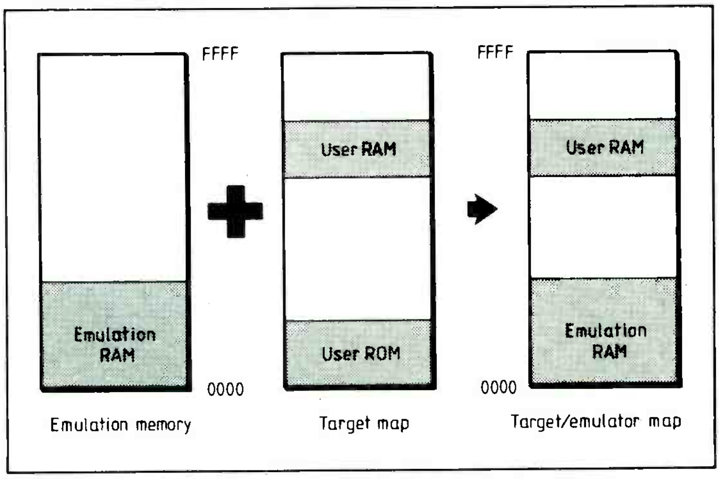


Fig.3. **Mapping — constructing memory map for emulation. In this example, 'user rom' overwritten by emulation ram, allowing software to be loaded and tested by host system.**

---

*Microelectronics Educational Development Centre.

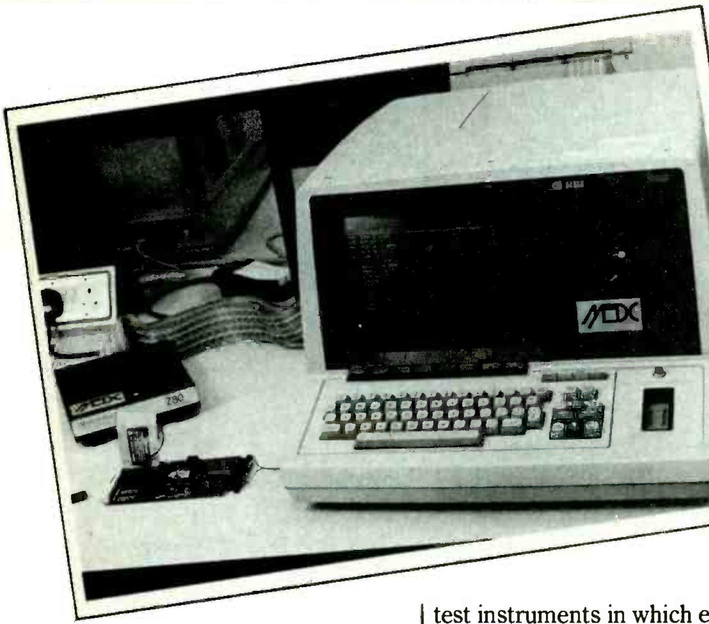
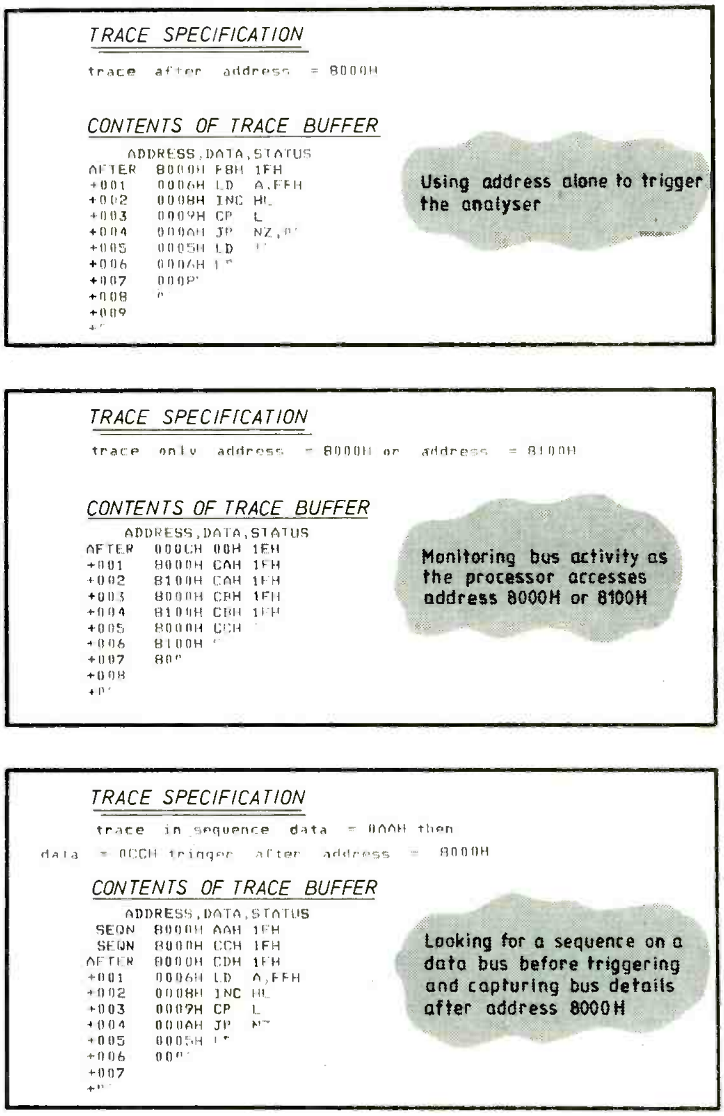


Fig.4. **HP64000 development system — an example of universal system supporting a range of microprocessor families.**

test instruments in which emulation is an essential ingredient.

Basic principles

Figure 2 shows a simplified diagram of an emulator's internal architecture. Control circuitry is used to allow either the host computer or the emulation processor to gain access to the target system's buses.



```
TRACE  SPECIFICATION

trace  after  address  = 8000H


CONTENTS  OF  TRACE  BUFFER

    ADDRESS,DATA,STATUS
AFTER   8000H FBH  1FH
+001    0006H LD   A,FFH
+002    0008H INC  HL
+003    0009H CP   L
+004    000AH JP   NZ,0'
+005    0005H LD   ''
+006    0004H 1"
+007    000P'
+008    '
+009
+'
```

Using address alone to trigger the analyser

```
TRACE  SPECIFICATION

trace  only  address  = 8000H or  address  = 8100H


CONTENTS  OF  TRACE  BUFFER

    ADDRESS,DATA,STATUS
AFTER   000CH 00H  1EH
+001    8000H CAH  1FH
+002    8100H CAH  1FH
+003    8000H CBH  1FH
+004    8100H CBH  1FH
+005    8000H CCH
+006    8100H '
+007    80"
+008
+0'
```

Monitoring bus activity as the processor accesses address 8000H or 8100H

```
TRACE  SPECIFICATION

  trace  in sequence  data  = 0AAH then
data  = 0CCH trigger  after  address  =  8000H

CONTENTS  OF  TRACE  BUFFER

    ADDRESS,DATA,STATUS
 SEQN   8000H AAH  1FH
 SEQN   8000H CCH  1FH
AFTER   8000H CDH  1FH
+001    0006H LD   A,FFH
+002    0008H INC  HL
+003    0009H CP   L
+004    000AH JP   N"
+005    0005H L"
+006    00"
+007
+"
```

Looking for a sequence on a data bus before triggering and capturing bus details after address 8000H

Fig.5. **Example trace specifications on HP64000.**

Most emulators are equipped with random-access memory (emulation memory) that can be used to add to, or take the place of memory on the target board (user memory). This extra ram can often prove useful during program development, providing workspace for software before it is finally commited to rom.

The procedure of establishing a memory layout for the combination of emulator and target is call mapping. In microprocessor development systems this is normally accomplished from the keyboard during a configuration phase prior to emulation. Simpler systems (e.g. Microtek's MICE) use small in-line switches on the emulator's main printed circuit board.

An example of mapping is shown in Fig 3. In this arrangement the memory space occupied by user rom has been overwritten with emulation memory allowing the engineer to load and test different versions of software. After mapping has been decided, control circuitry ensures that all addresses established by the processor or host system are directed to the selected memory devices ie emulation or user memory.

Normally the target system's own clock would be used to run the emulator's microprocessor in 'real-time', thus ensuring that any critical timing of the target system hardware is maintained. If, however, the emulator is used without prototype hardware it can make use of an internal clock option.

Once configuration is complete the operator can then load the machine code into either emulation or user memory before running or single-stepping the program. As all designers are aware, prototypes seldom work first time and most projects would now enter a testing phase in which the engineer would call on the debugging capabilities of the emulator, which can be divided into four areas:

— memory/register display and modification
— single step, single cycling
— software breakpoints
— trace analysis.

The first three features are common to those found in most software debugging packages, e.g. DDT, ZSID. Trace analysis, however, is often enhanced by the inclusion of a logic analyser, allowing the operator to capture bus activity, about some trigger event, in a trace buffer.

Emulation on the HP64000 development system

For ease of use and versatility, Hewlett Packard's 64000 development system, shown in Fig. 4, sets a high standard. The system offers a variety of options ranging from a stand-alone portable station, for use in the field, to a multi-user, hard-disc based network capable of supporting a wide spectrum of microprocessor families. Multi-user capability greatly eases the problem of integrating software produced by a team of engineers, allowing different areas of a project to be developed independently and yet allowing them to be easily shared between members of the team. Hardware options available for the 64000 include

— a wide range of 8 and 16 bit emulators
— a user-configurable emulator (a novel idea allowing customers to 'build' an emulator for any processor not supported by HP)
— state and timing analysis
— a range of eprom programmers.

In common with other systems the operator is provided with a wide range of debugging features for use under emulation. Symbolic debugging, where the operator can refer to program locations using labels defined in the source code, greatly eases use, especially when tracing routines generated by compiling high level language programs written in PASCAL or 'C'.

Depending on your needs (and assets) such a system offers many analysis options starting with a software logic analyser (not real-time) and progressing to plug-in cards that perform state and timing analysis on the emulation subsystem. Fault location with a logic analyser demands flexibility when defining the trigger event, or more completely the 'trace specification'. Figure 5 shows a variety of possible trace specifications highlighting the power of the analyser.

The systems have been on the market now for several years and most of the bugs have been removed. However, a few rough edges still remain, and some typical examples again from the HP 64000 include arithmetic problems evaluating relative jumps when disassembling Z80 code and a rather messy approach to emulating the 8088/8086, where an emulation monitor program has to be linked to and loaded with the user program. Of the other development systems two families can be identified.

manufacture specific: this includes the INTEL MDS and the Motorola EXORmacs development system. Each system will normally deal with all that manufacturer's microprocessors often including devices not yet covered by the 'Universal' systems.

'Universal': examples include the Futuredata and Philips systems as well as the HP64000 detailed above. While covering a wider range of processors from different manufacturers, they are less likely to cope with the latest and fastest from any given supplier.

Low-cost solution - Microtek MICE

Microtek's 'Micro-In-Circuit-Emulator' (MICE) shown in Fig. 6 performs many of the functions found on a development system at a fraction of the cost. A range of personality cards allow MICE to emulate most industry standard microprocessors, including the 8088/8086, 68000, 8085, 6809 and the popular domestic processor, the 6502. Two models are available, differing in the size of the emulation ram and the trace facilities.

MICE I 8Kbytes emulation memory — not real-time trace.

MICE II 32K bytes emulation memory, expandable in blocks of 32Kbytes — real-time trace.

Both models are controlled via an RS232 interface, using either a display terminal or a computer system with a compatible port.

Driving a stand-alone emulator from v.d.u. would only be satisfactory for a small development applications or when used in a servicing role (e.g. to check ram or form signatures of rom using its on-board test routines). The list commands, Fig. 7, includes a line assembler, useful for small routines or when patching a larger piece of software and two-pass disassembler that generates labels for all subroutine and jump instructions - a nice touch not found even in expensive systems, Fig. 8.

Serious applications, however, would utilise a host computer system allowing code generated by assemblers or compilers to be downloaded, in either Intel or Tektronix format, to the target system. When a host system is used it requires a driver program to communicate with the emulator. A range of routines is available for some popular systems:

— Apple

— any CP/M machine

— Digital Equipment minicomputers

— Sharp Personal Computer

Guidelines included in the manual should allow anyone with a reasonable skill in interface programming to generate a driver routine for their machine.

Trace facilities are good, allowing the operator to perform a real-time forward or backward trace capturing address, data and processor status information in a massive 2048 word buffer. However, there are limitations on the sophistication of the trigger event which is limited primarily to address and status, Fig. 9.

To summarize, in-circuit emulation has been available on a range of development systems for several years, where it has proven its usefulness as part of the product development cycle. The appearance of low-cost, stand-alone emulators should widen the appeal of the technique. A list of suppliers follows.

Fig.6. **MICE can be operated from a v.d.u. or, as shown, from a computer system running a driver routine.**

```
>?
ASSEMBLY             A  loc
BACKWARD TRACE       B  [R] addx[c[q]]
CYCLE STEP           C
DISABLE              D  N|I|H|C
ENABLE               E  N|I|H|C
FORWARD TRACE        F  [R] addx[c[q]]
EXECUTION            G  [a1[:a2]]
BREAKPOINT           H  [0[1|2]|1 addx[c[q]]|2 addr]
INPUT                I  port[c[time]]
JUMP                 J  a1[:a2]
LIST TRACE           L  [step[a1[a2[q]]]]|S[step]
MEMORY               M  [CS|DS|SS|ES] a1[a2[d]]
OUTPUT               O  port d1[d2[d3[d4]]]
REGISTER             R  [AX|BX|CX|DX|SP|BP|SI|DI|DS|ES|SS|CS|IP|FS]
INSTRUCTION STEP     S  [S][c]
TRANSFER/TEST        T  [CS|DS|SS|ES] a1 a2 S|M|a3
UPLOAD               U  a1 a2 [T|I]
RESET                X  [a1[:a2]]
DISASSEMBLY          Z  a1 [a2]
DOWNLOAD             :  (INT),/(TEK)
HELP                 ?
ATTENTION            !
>
```

Fig.7. **MICE command summary.**

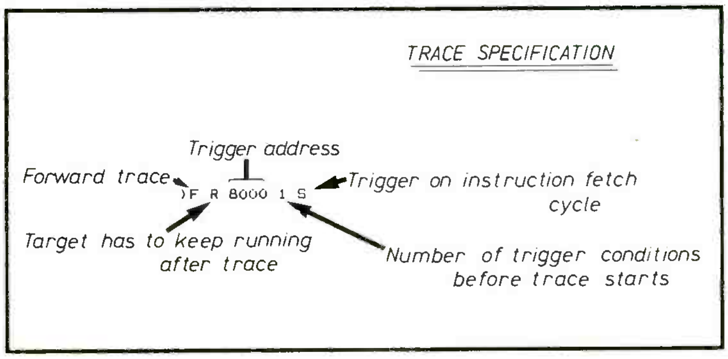
```
)Z 8000 8010

LOC     OBJ          LINE   LABEL    SOURCE CODE

8000    200680       0001   B8000    JSR   8006
8003    4C0080       0002            JMP   8000
8006    A904         0003   S8006    LDA   #04
8008    8D1180       0004            STA   8011
800B    CE1180       0005   B800B    DEC   8011
800E    D0FB         0006            BNE   800B
8010    60           0007            RTS

     DISASSEMBLY COMPLETED
```

Fig.8. **Two-pass disassembler on MICE.**



```
)L
FRAME IFADDR ADDRESS DATA STATUS SPARE(8 BITS)
 0000  8000    8000   20    S      11111111
 0001          8001   06    R      11111111
 0002          01BA   80    R      11111111
 0003          01BA   80    W      11111111
 0004          01B9   02    W      11111111
 0005          8002   80    R      11111111
 0006  8006    8006   A9    S      11111111
 0007          8007   04    R      11111111
 0008  8008    8008   8D    S      11111111
 0009          8009   11    R      11111111
 000A          800A   80    R
 000B          8011   04
 000C  800B    800B
 000D
 000E
```

The 'L' command displays the contents of the trace buffer in Hex.

DISPLAY TRACE IN HEX

Adding an 'S' to the 'L' command displays the trace buffer in mnemonic form

```
)LS
FRAME          ADDRESS DATA         MNEMONIC-CODE
 0000           8000    20           JSR   8006
 0006           8006    A9           LDA   #04
 0008           8008    8D           STA   8011
 000C           800B    CE           DEC   8011
 0012           800E    D0           BNE   800B
 0015           800B    CE           DEC   8011
 001B           800E    D0           BNE   800B
 001E           800B    CE           DEC   8011
 0024           800E    D0           BNE   800B
 0027           800B    CE           DEC   8011
 002D           800E    D0           BNE   800B
 002F           8010    60           RTS
 0035           8003    4C           JMP
 0038           8000    20
 003E
```

DISPLAY TRACE IN MNEMONICS

Fig.9. **Trace analysis with Microtek's MICE II.**

EMULATOR SUPPLIERS

AMF Potter & Brumfield
AMF House
Brislington
Bristol
BS4 4AZ

Electrovalue Ltd
28 St Judes Road
Englefield Green
Egham
Surrey
TW20 0HB

General Instrument
Microelectronics Ltd
Times House
Ruislip
Middlesex
HA4 8LE

Intersil Datel (UK) Ltd
9th Floor
Snamprogetti House
Basing View
Basingstoke
Hants
RG21 2YS

Microsystem Services
11 Duke Street
High Wycombe
Bucks
HP13 6EE

Quarndon Electronics Ltd
Slack Lane
Derby
DE3 3ED

SGS-ATES (UK)
Planar House
Walton Street
Aylesbury
Bucks
HP21 7QJ

Steatite
Microelectronics Ltd
Hagley House
Hagley Road
Edgbaston
Birmingham
B16 8QW

Thomson-CSF Semiconductor
Ringway House
Bell Road
Daneshill
Basingstoke
Hants
RG24 0QG

Advanced Micro Devices (UK) Ltd
AMD House
Goldsworth Road
Woking
Surrey
GU21 1JT

Analog Devices Ltd
Central Avenue
East Molesey
Surrey
KT8 0SN

Arrow Computer Systems Ltd
Rosemount Tower
Stafford Road
Wallington
Surrey
SM6 8RW

Bleasdale Computer Systems Ltd
Francis House
Francis Street
London
SW1P 1DE

Bowthorpe Microsystems
41 Alston Drive
Bradwell Abbey
Milton Keynes
Bucks
MK13 9HA

Brandauer & Co Ltd
401 New John Street
Birmingham
B19 3PF

Computech Systems
168 Finchley Road
London
NW3 6HP

Computing Tech (Internat) Ltd
Brookers Road
Billingshurst
W. Sussex
RH14 9RZ

CW Micro-Systems
29 St Blaize Street
Romsey
Hants
SO5 8JY

Dagnall Electronics (Cranfield) Ltd
Wood End Road
Cranfield
Bedford
MK43 0ED

Data Applications (UK) Ltd
16B Dyer Street
Cirencester
Glos
GL7 2PF

Data General Ltd
Hounslow House
724 London Road
Hounslow
Middlesex
TW3 1PD

Dicoll Electronics Ltd
Bond Close
Kingsland Estate
Basingstoke
Hants
RG24 0QB

Digital Equipment Co Ltd
Worton Grange Industrial Estate
Imperial Way
Basingstoke Road
Reading
RG2 0TG

Eagle Controls (England) Ltd
Orchard Road
Royston
Herts
SG8 5HF

Fairchild Camera & Instruments
(UK) Ltd
230 High Street
Potters Bar
Herts
EN6 5BU

Ferranti Comp. Syst. Ltd
The Courtyard
20 Denmark Street
Wokingham
Berks
RG11 2BB

Fulcrum (Europe)
Valley House
Purleigh
Essex
CM3 6QH

Gemini Microcomputers Ltd
Oakfield Corner
Sycamore Road
Amersham
Bucks
HP6 5EQ

Giltspur Microsystems Ltd
74 Northbrook Street
Newbury
Berks
RG13 1AE

Golden River Co. Ltd
Churchill Road
Bicester
Oxon
OX6 7XT

Gould SEL Computer Systems Ltd
31 St Nicholas Way
Sutton
SM1 1EA

Harris Semiconductor Ltd
P.O. Box 27
145 Farnham Road
Slough
SL1 4XD

Hitachi Electronic Comp (UK) Ltd
Hitec House
221 Station Road
Harrow
Middlesex
HA1 2XL

Intel Corp (UK) Ltd
Pipers Way
Swindon SN3 1RJ

Intelligent Artifacts Ltd
Cambridge Road
Orwell
Royston
Herts
SG8 5QD

Jasmin Electronics Ltd
St Matthews Way
Leicester
LE1 2AA

Kode Ltd
Station Road
Calne Wilts
SN11 0JR

Lucas Logic Ltd
Welton Road
Wedgnock Industrial Estate
Warwick
CV34 5PZ

Mostek UK
Masons House
1 Valley Drive
Kingsbury Road
London
NW9 9NJ

Motorola Ltd
Taylors Road
Stotfold
Hitchin
Herts SG5 4AY

Mullard Ltd
Mullard House
Torrington Place
London WC1E 7HD

National Semiconductor Ltd
Harpur Centre
301 Home Lane
Bedford
MK40 1TR

NEC Electronics (UK) Ltd
116 Stevenston Street
New Stevenston
Motherwell
Lanarks
ML1 4LT

Plessey Microsystems Ltd
Water Lane
Towcester
Northants
NN12 7JN

Plessey Peripheral Systems Ltd
3 Harrowden Road
Brackmills
Northants
NN4 0EB

RCA Solid State Ltd
Lincoln Way
Windmill Road
Sunbury-on-Thames
Middlesex
TW16 7HW

RCS Microsystems Ltd
Gresham House
Twickenham Road
Feltham
Midlesex
TW13 6HA

Rockwell International Inc.
Heathrow House
Bath Road
Hounslow
Middlesex
TW5 9QW

Sintrom Electronics Ltd
14 Arkwright Road
Reading
RG2 0LS

Spectra-Tek (UK) Ltd
Swinton Grange
Malton
N. Yorks
YO17 0QR

Synertek Inc.
Honeywell House
Charles Square
Bracknell
Berks
RG12 1EB

Techex Ltd
5B Roundways
Elliot Road
W. Howe
Bournemouth
BH1 8JJ

Texas Instruments,
Semiconductors Div.
Manton Lane
Bedford
MK41 7PA

Vako Electronics Ltd
Pass Street
Wemeth
Oldham
OL9 6HZ

Zilog (UK) Ltd
Zilog House
Moorbridge Road
Maidenhead
Berks
SL6 8PL

MICE details

ARS Computers
Doman Road
Camberley
Surrey

Hewlett Packard
South Queensferry
West Lothian
EH30 9TG

Solartron Electronics Group
Farnborough
Hampshire
GU14 7PW

Philips Electronics Instruments
York Street
Cambridge
CB1 2PX

INTEL Co (Ltd)
Piper's Way
Swindon
Wiltshire
SN3 1RJ

GenRad Ltd
Norreys Drive
Maidenhead
Berks
SL6 4BP

Motorola Ltd
York House
Empire Way
Wembley
Middlesex

Improving colour television decoding

by D. C. A. Read B.Sc. (Eng), M.I.E.E.

This article details the performance and setting up of the filters used in the add-on enhancement board of Figs 34 & 36 (March). It leads onto passive filter circuits that can be placed between tuner i.f. and PAL decoder circuits as an alternative to the add-on board, includes analysis of filter networks used in current receivers, and surveys suitable delay lines.

The three filters used in the extra board circuits shown in Fig. 34 and 36 have the following characteristics to suit the signal filtering requirements.

Chroma band-pass filter. The chroma is filtered by L_1, L_2 and L_3 with capacitors C_5, C_6 and C_7 (Fig. 34, March), and the insertion loss conformed approximately to a gaussian band-pass response centred on f_{sc}. If the bandwidth of this filter is narrow, it will result in: reduced chroma risetimes (up to 1µs), reduced cross-colour because high-band luminance reaching U and V chroma demodulations is reduced, and a lower noise spectrum in the displayed chroma. However, with a very high 48 element aerial and steadying guy-wires through the roofs of neighbouring houses, a good signal-to-noise ratio was obtained. Hence, the decision was made that good chroma resolution (decreased risetimes) was required and that the resulting cross-colour increase would be tolerated.

In colour print 2 (top right-hand page 65, February issue) the increased chroma bandwidth results in the increased width of the band of cross-colour across the screen centre with this test signal, in practice, it widens mainly downwards. The faster chroma edges give a subjectively sharper picture and the greater noise spectrum, resulting from the wider bandwidth, was only apparent when viewing Outside Broadcasts (where greater noise with the video signal often occurs), but there are occasions when cross-colour is apparent. The lower trace of Fig. 52 shows the reasonable symmetry between the 0-6dB down points; note that a good i.f. will only roll off above 5.5MHz and the sound trap will bring the level well down by 6MHz. It is also important to have, ideally, a flat group delay response, or one that is symmetrical about f_{sc} as indicated in Fig.53.

The luminance cancelling effect is slightly improved with a flat group delay, but the extra delay introduced by a phase equalizer (and the timing adjustment delay at DL_1) did not seem justified after viewing tests.

The filter is set up first adjusting for maximum f_{sc} at the filter output and then makes a small adjustment of all three cores for minimum 7.8kHz at the chroma transitions (with colour bar test signal). The oscilloscope is best locked to MS (mixed syncs) or the syncs with the incoming video.

Post-modifier low-pass filter. The modified output chrominance (V-axis switched) signals cancel chroma from the composite video present at the Tr_4 summing point to provide clean luminance (Fig. 34, March). A low-pass filter is required to remove other frequency products around $2f_{sc}$ and $3f_{sc}$, (as shown in the spectral energy diagram of Fig. 19, January) to obtain a clean 0-5.5MHz baseband signal. Components C_{20}, C_{23}, C_{24} and C_{26} with L_{11} and L_{12} form this filter and the group-delay phase equalizer is formed by C_{15}, C_{18}, C_{19} with L_8, L_9 and L_{10}. Figure 54 shows the insertion loss of the filter which is flat to 5.5MHz and is more than 35dB down at $2f_{sc}$ (8.866MHz); L_{11} and C_{23} are in parallel resonance at $2f_{sc}$ to provide this part of the characteristic, L_{12} and the associated capicitors ensure the response remains greater than 35dB in the stop band. Figure 55 is the group delay characteristic of the filter plus equalizer; the insertion delay of 275ns is used to obtain the correct chrominance-to-luminance timing as required by the decoder chip inputs, i.e. to ensure chroma/luminance alignment.

The response is theoretically flat but because all the capacitor values have been rounded to preferred values and the adaptive f_{sc} notch added, the group delay is not as flat as it could be. However testing with a pulse and step signal, see Fig. 56, shows that the overall performance is good.

To set up this filter, it is best to use a 0-10MHz sweep with markers although a generator with set frequencies can be used. If there is difficulty in setting up it may be necessary to isolate the phase equalizer and obtain the correct performance from the filter and

These six installments of 'Improving colour tv decoding' have been the result of the gathering of information and investigation followed by the collection of much valued advice on how to knock the ideas into shape. I particularly wish to thank Dr Mino Gobbetti, for keeping a fatherly theoretical eye on the planning; John Nash of ITCA, for patiently checking and adjusting the worst of the grammatical gaffs, and Cliff White of the BBC for invaluable help on practical aspects of design and construction.

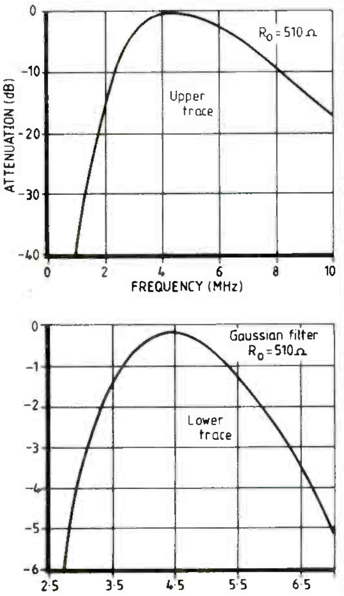


Fig. 52. **Amplitude response of chroma band-pass filter used in the circuit of Fig. 34 (March issue). Lower trace shows the 0-6dB area.**

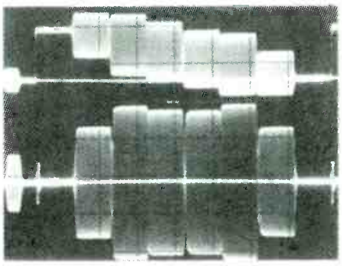


Fig. 52 (b). **Shows the clean chroma, note the transitions, that can be achieved at the output of this band pass filter.**

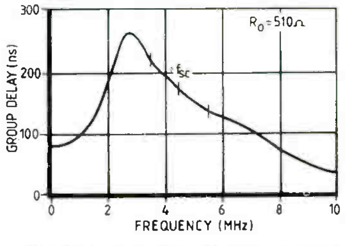


Fig. 53. **Group delay response of the chroma band-pass filter.**

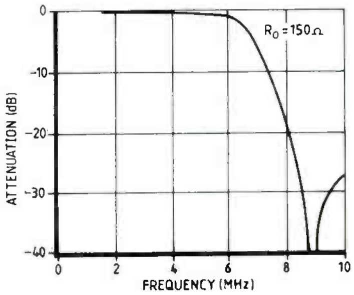
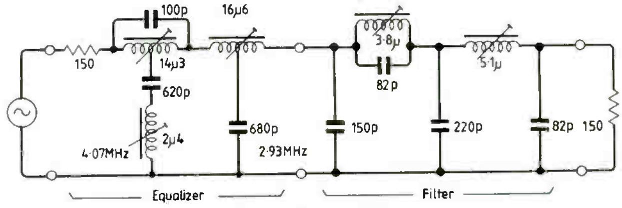


Fig. 54. **Insertion loss performance of the post modifier/modulator low-pass filter L_8 to L_{12} (Fig. 34 March issue).**



Low pass filter from Fig. 34

Fig. 55. **Group delay response of Fig. 34 low-pass filter.**

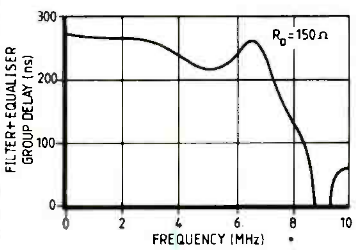


Fig. 56. **2T pulse and step edge. Performance for the low-pass filter shown in Fig. 34.**

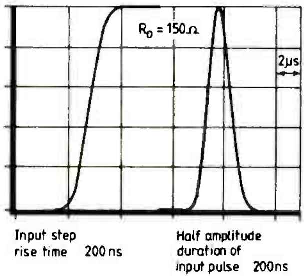
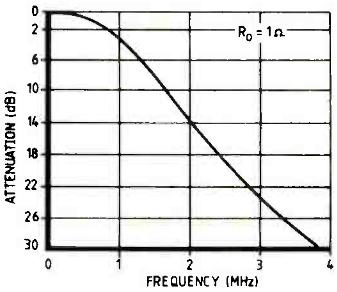


Fig. 57. **Pre-sync filter insertion loss response (Fig. 36 March issue).**



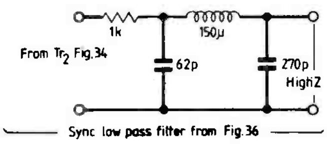


Fig. 58. **Pre-sync filter group delay response.**

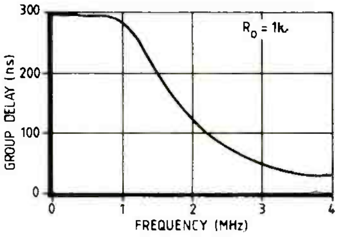
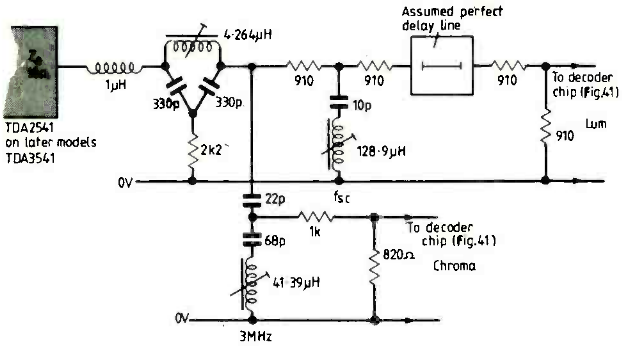


Fig. 59. **Ferguson TX10 circuit: component used between the i.f. demodulator i.c. TDA2541 or 3541 and colour decoder i.c. TDA3561A.**



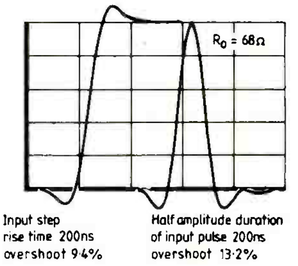


Fig. 60 **Insertion loss performance of the 6MHz sound trap and the colour subcarrier notch in luminance path between i.f. and decoder.**

equalizer separately before reconnecting. But if all the coils are tested for nominal inductance as stated on the circuit, and good quality 2%, 125V polystyrene capacitors have been used, the circuit should be easy to set up with all elements connected. As most test equipment has 75Ω input and output impedance, resistor networks to match the 150Ω filter can be used, as shown in the item 'Impedance matching' page 36, May issue.

IF output home tv receivers

The network used by the Thorn (Ferguson TX10) 26in. receiver in Fig. 59 has the amplitude performance luminance-signal shown in Fig. 60. At first sight, the network insertion loss curve indicates a good response, but the group delay curve, Fig. 61, shows a rise of delay to 320ns as the amplitude falls to 3dB.

As a result of the colour (f_{sc}) notch and (6MHz) sound trap not being group-delay equalized (giving a rising delay with increasing frequency), the luminance signal has asymmetrical rings, as the pulse and step test waveform in Fig. 62 shows. Since the pulse has a half-amplitude duration of 200ns its spectral bandwidth is within 5MHz. Hence, a notch at 4.43MHz will cause ringing. If the circuit is equalized, the rings will be halved in amplitude and distributed symmetrically about the pulse or step. The asymmetrical rings on a television screen appear as shown in Fig. 63, and will marr all the picture detail in a similar way to multipath ghosting with short delays involved.

Analyzing the chroma path, Fig. 64 shows the insertion loss characteristic. The rising response over the chroma bandwidth (f_{sc}±1MHz) is shaped to provide a high-pass response such that, with the i.f. s.a.w. low-pass filter, a bandpass response is formed for the chroma modulation. Many s.a.w. filters are 3-6dB down as f_{sc}, and the rate of fall is similar to the rising response shown in Fig. 64. The end result is a somewhat narrow bandwidth, which is good for giving low cross-colour (little luminance energy reaching the chroma de-modulator), but is at the expense of very poor chroma risetimes resulting in limited chroma detail (the f_{sc}±1MHz points are approximately 12dB down). The group delay curve (Fig. 65) shows delay asymmetry about f_{sc}. In the range f_{sc}±1MHz, the insertion delay with increasing frequency has a high rate of change and reverses in slope with a peak-to-peak delay of 300ns. As this is a delay comparable to the period of f_{sc} (225.5ns), these sidebands will, after passing through the R-Y and B-Y demodulators, result in chroma rise and fall times being mistimed, with pre- or post overshoots; depending on the sideband distribution. There will also be visible moving Hanover-bar effects at the chroma transitions.

Line up of post modifier low-pass filter

The sweep or spot frequency generator can be applied to the powered board (Fig. 34, 36) at its normal video input with the appropriate resistor connected at R_2 as input termination. The filter should then be fed from and terminated in the correct resistances. If the luminance output is driving a 75Ω load, temporarily add 1kΩ across R_{38} and 100μF (6V) across C_{30}, plus a series resistor of 75Ω in the output to suit the input impedance of the test generator. Lift one end each of C_{18} and C_{25}, first adjust L_{11} for a minimum output at 8.866MHz displayed on the oscilloscope or spectrum analyzer, then adjust L_8 for minimum output at 4.07MHz. Reconnect C_{18} and adjust L_9 for a maximally flat response over a range of frequencies from ±1 to ±2MHz about 4.07MHz, or short the delay equalizer L_8 and adjust L_9 for a minimum at 4.07MHz. Insertion-loss response of the equalizer should be flat to within 0.5dB.

Lift one end of C_{13}, short together the collector and emitter of Tr_5, reconnect C_{25} and adjust L_{12} for a minimum value at f_{sc} (4.43361875MHz).

The remaining inductor, L_{10}, may be adjusted using a return loss bridge (being set for a minimum at 2.93MHz). Alternatively, isolate the output of this equalizer and correct an oscilloscope probe to the input, and adjust for a minimum at 2.93MHz. In practice it is easier to use a pulse and bar waveform or i.t.s. off air and adjust L_{10} for best bar corner shape (squareness). Remove the collector/base short on Tr_5 and, if used, the 1kΩ across R_{38} and the 100μF in parallel with C_{30}. Reconnect C_{13}

Pre-sync filter, Figs 57, 58

The pre-sync filter is required to improve the performance of the sync separator and to obtain the correct relative timing of video and 'sandcastle' pulse at the decoder chip blanking/clamping operation point. In order not to produce pre or post-transition overshoots on the filtered signal, the filter is designed to roll off in such a way that the group delay response is flat to the 3dB down point so that the sync separator chip then operates with clean input signals.

The filter operates from 1kΩ

source impedance, is terminated in a high impedance and achieves a miniumum insertion loss of less than 1dB. No setting up is needed provided that the correct components have been used.

Philips filter circuit

The circuit of luminance and chrominance filter derived from a Mullard network is shown in Fig. 66 with the luminance amplitude performance in Fig. 67. The off-set tapping of the 66μH coil was not made clear in the Mullard book. The luminance insertion-loss curve shows a rising response over the range 1.5 to 2.5MHz and a smooth fall to the 4.433MHz trap. The 3-4dB rise provides an aperature-correction effect and the smooth fall of the trap minimizes the group-delay distortion as shown in Fig.68. This is readily equalized by one 'A' type equalizer section.

The overall effect of the notch and the equalizer results in overshoots and symmetrical rings. The overshoots occur because of the rising amplitude response; both the rings and overshoots are made symmetrical by having adequate group delay equalization. The pulse and step waveforms are shown in Fig.69. The size of the symmetrical overshoots provides horizontal aperature correction (by operating along the tv line to enhance the horizontal detail of the picture i.e. vertical edges are sharper). The width of these overshoots is such that, when added to the broadcasters aperature-corrected pictures, they appear as a rather heavy thick outline — typically seen at the sides of faces or dark to bright clothing boundaries. For pictures that are not good initially and for smaller screens (less than 20in) this size of overshoot is beneficial; it would also help receivers that are operating at the end of a long transmission chain.

The chroma-patch circuit is shown in the lower part of Fig.66, with its insertion loss characteristic in Fig.70. The near symmetrical response (to 6 dB points) about f_{sc} is suitable for a flat amplitude response video source. If the video signal is fed from a typical domestic receiver i.f. then, if the centre frequency tuning point of the circuit is raised (so that the i.f. and filter responses together provide a symmetrical bandwidth), the 7.8 kHz twitter at chroma transitions will be minimized. Fig. 70 (s.a.w. filter) and Fig. 64 (TX10 chroma circuit) show that the rates of high-pass and low-pass cut off are nearly the same. Hence, since these responses are effectively in tandem a chroma bandpass results, albeit a somewhat narrow one.

The group-delay curve of Fig. 71 shows that both the upper and lower sidebands occuring at chroma transitions are time advanced with respect to the centre frequency f_{sc}; the resulting amplitude and/or error is illustrated by the vector diagrams in Fig. 72.

Alternative filters designed as second option to comb filter circuit of Fig. 34

As a starting point it is assumed that all recently-designed receivers will use s.a.w. filters with the subcarrier down by between 2 and 6dB. This is equivalent to 35MHz in the i.f. bandpass as shown in Fig. 73 and represents a typical s.a.w. filter. Components such as RW 153P SY 153A (SW155 with f_{sc} 1dB down should be available later this year from SignalTech.) are designed for the UK PAL system I. With the comb filter replaced by an f_{sc} notch, and assuming a s.a.w. i.f. filter is in use, there will be no useful luminance energy above 4.1MHz. Fig. 74 shows the insertion loss of the notch which has a width and depth chosen as a compromise between conflicting picture effects. A narrow shallow notch would provide greater luminance resolution, because less luminance spectrum is removed, but would allow more of the sidebands generated at chroma transition through; a sharp cornered cut-off would result in rings being added to the luminance pulse and step components.

After subjective tests viewing differently shaped notches and with good quality live studio programmes, it was decided that a gentle roll off ±650kHz 3dB points, 16-18dB deep seemed a good compromise. The unequalised group delay curve of the notch in Fig.74 is shown in Fig 75. The 100ns in the group delay curve near to 4MHz can readily be equalised as shown in Fig.76. The circuit of the filter and equalizer is shown in Fig.77. The insertion delay of the filter is 290 ns and the filter was equalised up to this to suit the luminance/chrominance timing requirement of the decoder chip, ie, for the TDA 3561A or 3560, this is the delay between pin 10 lumin-

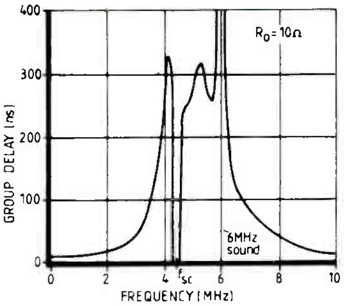


Fig. 61. **Group delay response of the luminance path between i.f. output and colour-decoder input.**

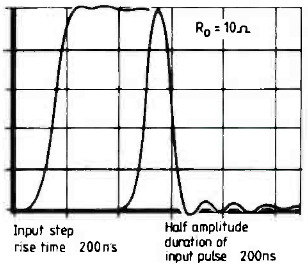


Fig. 62. **2T pulse and step waveforms having passed through the luminance path of i.f. output and decoder input.**

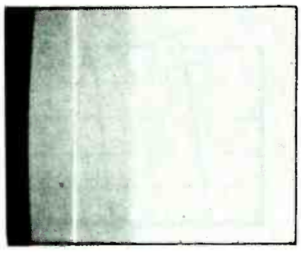


Fig. 63. **Television screen display shows asymmetrical rings due to the lack of group-delay equalisation in the f_{sc} notch or sound traps used between i.f. and colour decoder.**

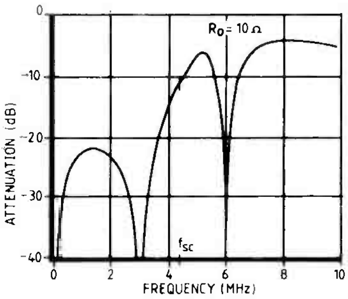


Fig. 64. **Chroma path insertion loss characteristic for the network between the i.f. and chroma demodulation (Ferguson TX10 receiver).**

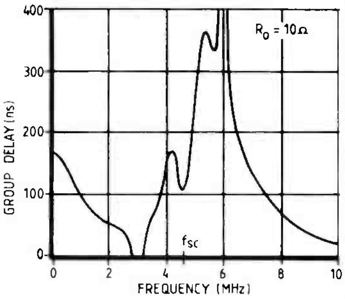
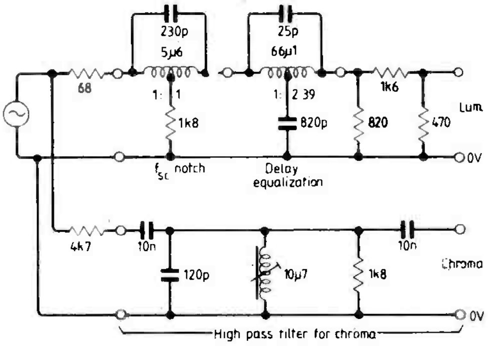


Fig. 65. **Group delay response for the chroma output shown in the circuit of Fig. 59.**

Fig.66. **Circuit taken from the Mullard book on consumer i.cs, March 1979. This 'application circuit' is fed with 2.7V pk-pk compisite video from the i.f. stage and supplies 0.45V (sync bottom to white level) to the luminance input on pin 10.**



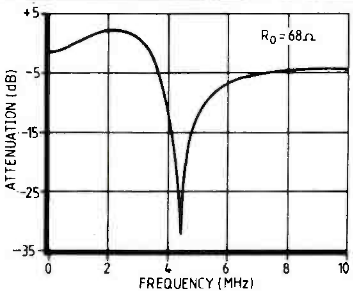


Fig.67. Insertion-loss performance for the luminance path containing colour subcarrier notch and a delay equalizer.

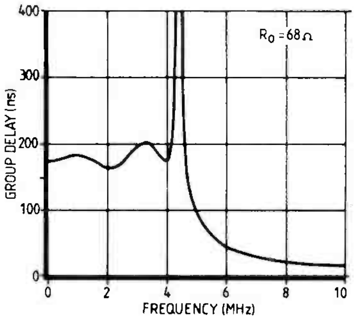


Fig.68. Group-delay response of the luminance path up to the colour decoder chip, pin 10. In the full circuit of a receiver, a 270ns luminance delay line is also used; the performance of this is looked at separately.

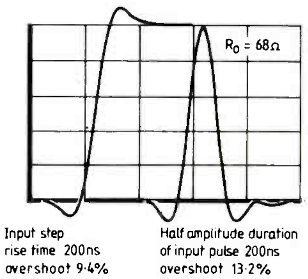


Fig.69. 2T pulse and step output waveforms for the luminance path of Fig.66, showing symmetrical overshoots obtained by good group-delay equalization.

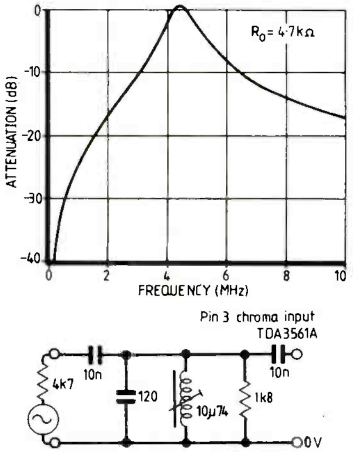


Fig.70. Mullard/Philips chroma path insertion-loss characteristic for the network connected between i.f. output and chroma demodulator input (pin 3 for the TDA3560 and the more recent TDA3561A).

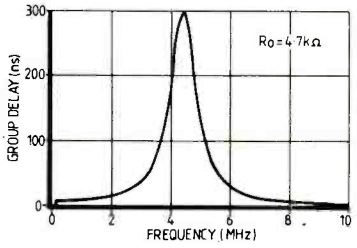


Fig.71. Group-delay response for chroma circuit shown in Fig.66 (lower part).

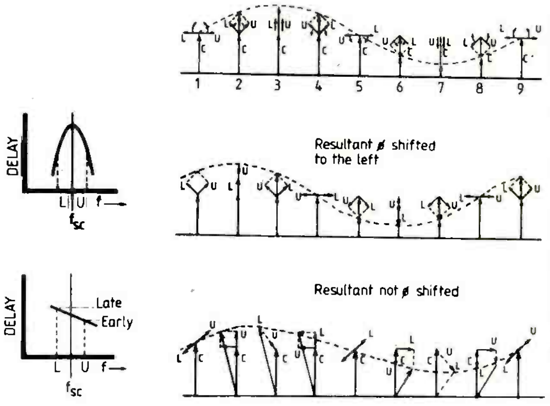


Fig.72. Vector diagrams for double sideband amplitude modulation as applied in the chroma circuits. Broken line represents modulating voltage e.g. h.f. sideband. Balanced modulators are used for R—Y and B—Y modulation, see Fig.6 (December). Carrier C is reinserted at demodulation by the burst-locked oscillator. Middle diagram shows the condition with both sidebands early. The error results in pre-shoots on chroma pulse and step waveform. Bottom diagram shows condition with one sideband early and one late, thus reducing resultant amplitude error and giving good pulse and step shape. Fig.52(b) and 53 give similar performance.

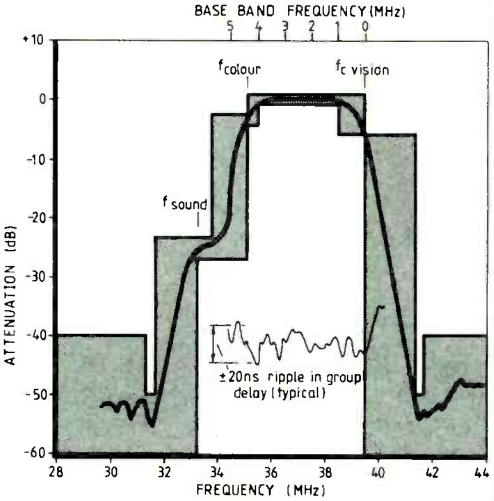


Fig.73. Typical s.a.w. insertion-loss and group-delay performance. Makers are vague about group delay performance. This affects bar corners of i.t.s. bar and on picture appears as a smear after sharp transitions.

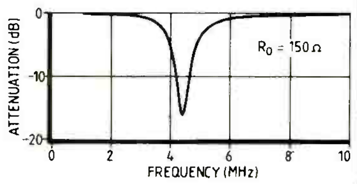


Fig.74. Insertion loss of f_{sc} notch for use in luminance channel for the alternative circuits.

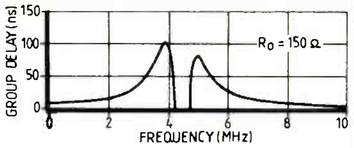


Fig.75. Notch filter unequalized group-delay response.

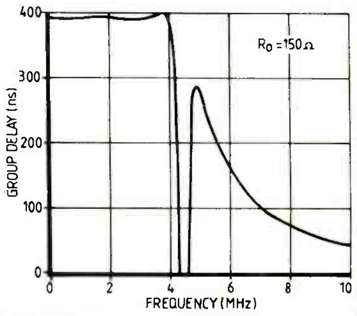


Fig.76. Luminance notch filter with group-delay equalizer sections added one A and two Bs.

A postscript article will introduce an up-dated approach to the tuner/i.f. section of a home receiver, introducing recent i.f. surface-wave filters and the necessary adjustments to the i.f. output and decoder input filtering. It will briefly outline a tv tuner/i.f. demodulator marketed by SPT Video and built to BBC design RC1/511 (about £1,000 to buy). And other methods of picture enhancement will be included, for instance scan/velocity modulation (turbo-scan is the Sony name for it), and use of a controlled switched equalizer with the signal taken from taps on a delay line.

ance input and pin 3 chroma input. No luminance delay line is therefore required. The 2T pulse step performance of this equalized notch filter is shown in Fig.78. The overshoots of 2.1% for the pulse and 0.3% for the step are only visible when viewing electronically-generated test waveforms. This is because the group delay response is flat within a few nanoseconds up to 4MHz the amplitude response has fallen by 5dB, and continues to fall steeply. The group delay performance is therefore not important beyond this point. A suitable filter for the chroma path is an adaptation of the TX10 circuit. The width of the 6MHz trap can be reduced by increasing the capacitor values and reducing the inductors from 4.264 to 0.6μH. More importantly, this modification minimizes the group-delay effects in subcarrier area. Comparison of Fig.64 and 65 with 79 and 80 shows the modification. In the important area f_{sc} 40.5MHz there is now no group-delay reversal and a reasonable degree of symmetry exists. This improves the quality of the chroma waveform (after demodulation) at the chroma transition points. The revised circuit is shown in Fig.81. The chroma band-pass characteristic is determined by the s.a.w. filter response (Fig.73) as it falls to the 'sound shelf'. and by the high-pass response of the network between the i.f. and PAL decoder (Fig.79) If the additional circuit board of Fig.34 is used it will be further modified by the gaussian band-pass response (Fig.52) which has a reasonably symmetrical group delay response between the 0 to 6 dB down point. The sidebands of the chroma signal at the input of the demodulator have a fair degree of both phase and amplitude symmetry. Fig.82 shows the filter and the high-pass responses together representing the first two chroma-shaping components; the gaussian band-pass maintains the amplitude symmetry. The phase symmetry of the chroma sidebands is mainly determined by the two LC networks because the group delay response of the s.a.w. while mostly at low level (typically ±10 ns), shows a number of high rate-of-change spikes. The phase response is mainly determined by the filter group delay curve, Fig.80, which shows that the sidebands are similarly leading and lagging either side of subcarrier $f_{sc.}$ (Note: amplitude modulation, as used for chroma signals, generates symmetrical sidebands.) Where the receiver has a good tuner and i.f. response, or uses a s.a.w. filter which is of the order of the 1dB down at f_{sc}, then the extra board containing the circuit of Fig.34 (*WW* March issue) will result in the gaussian band-pass characteristic also affecting the chroma response. The lower trace of Fig.52 (*WW* April issue) shows that the amplitude symmetry of this band-pass filter is adequate. The group delay response, Fig.53, when added to the group delay response of the high-pass network (Fig.80 *WW* April issue), results in a reduced overall group delay error as shown in Fig.83.

Luminance delay lines

These should ideally be flat from 0-5.5 MHz and have zero group delay error. The performance of a selection of delay lines taken from receivers, professional monitors and video recorders is shown in Fig.84. The performance of these delay lines is adequate for the video recorders, where the bandwidth is of the order of 1.5 to 2.5 MHz, but in the application of an improved PAL colour decoder only the fourth delay line illustrated (using a glass tube) was worth considering. The order of delay required at the DL1 position in Fig.34 (March) is 240ns. By dismantling a tube delay line to adjust the turns (removing delicately about 20% of the 2 thou/48swg/0.04mm wire), a fair performance was obtained as shown in Fig.85 (delay line E). Delay line D would be adequate for the DL2 position in Fig.34.

A 240ns version of the delay line is made by Sprague part no. W3600.Z.145, colour-coded purple body with black rings and has a Z_0 of 1kΩ. However these are difficult to acquire: Sprague say a minimum order of a 1000 is required, they want a turnover of £15,000 p.a., and that no UK distributor has the product! From Mullard/Valvo, however, a 340 ns undipped delay line was obtained. After removing a proportionate number of turns to obtain the required delay ($\frac{60\,\text{mm}}{340\,\text{ns}} = \frac{x}{240\,\text{ns}}$) i.e. x = 42 mm, the results shown in Fig.85 (delay line E) were obtained. If this modified delay line is used, the chroma cancellation at Tr_8 emitter is less effective than for a perfect delay. This is so because,

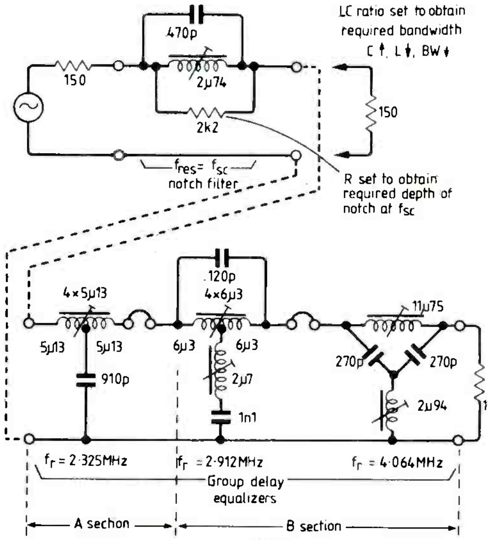


Fig.77. **Circuit of notch filter with addition of a three-section equalizer.**

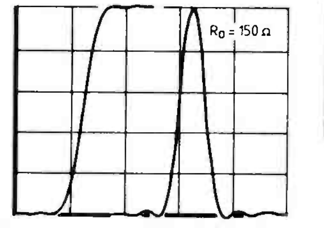


Fig.78. **2T pulse and step performance of the luminance notch filter with equalizer.**

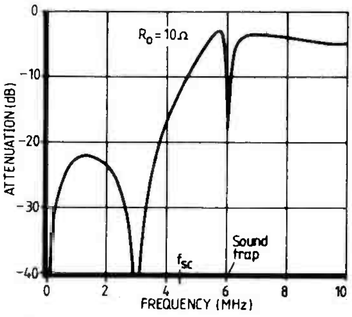


Fig.79. **Chroma path insertion loss with the modified 6MHz sound trap.**

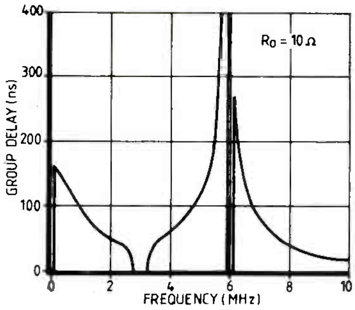


Fig.80. **Group delay performance of the sound trap and chroma path filter.**

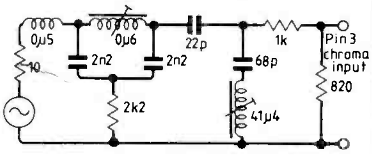


Fig.81. **Circuit used in the alternative circuits for the chroma path up to the chroma decoder. L/C ratio determines notch width (see *WW* October 1952).**

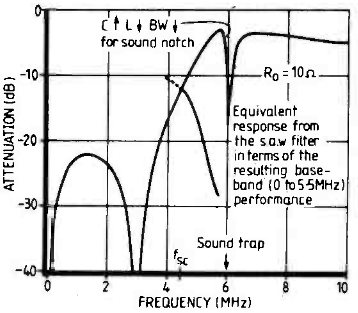


Fig.82. **The surface wave filter characteristic, as it affects the baseband response, drawn together with high-pass filter curve from Fig.79, indicates the approximate band-pass shape required for chroma sideband symmetry.**

Fig.83. Chroma path group delay resulting from the high-pass network with 6MHz sound trap, Fig.81, and the gaussian filter of Fig.79.

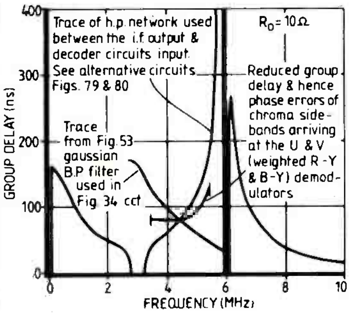
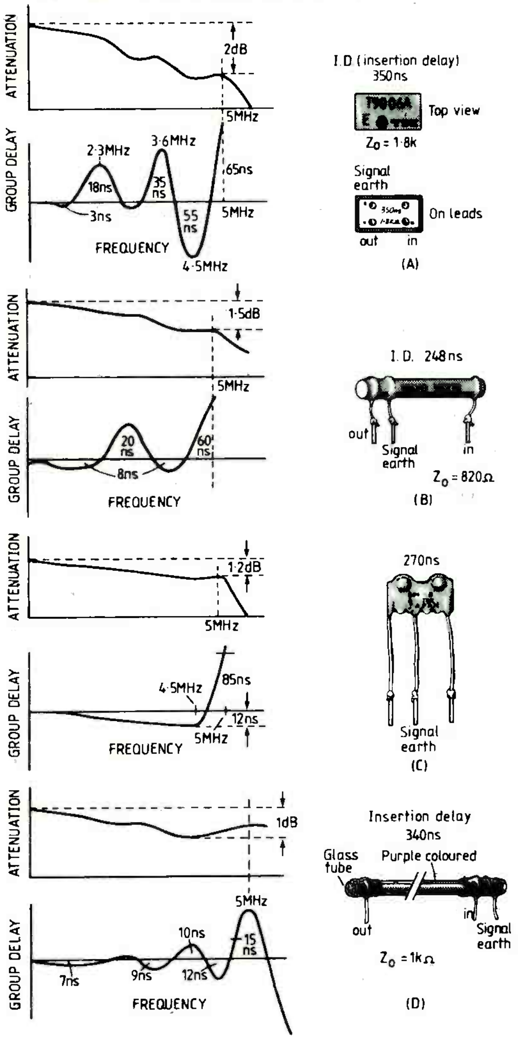


Fig.84. Performance of four video delay lines (A, B, C and D) used in receivers, colour monitors or video recorders.



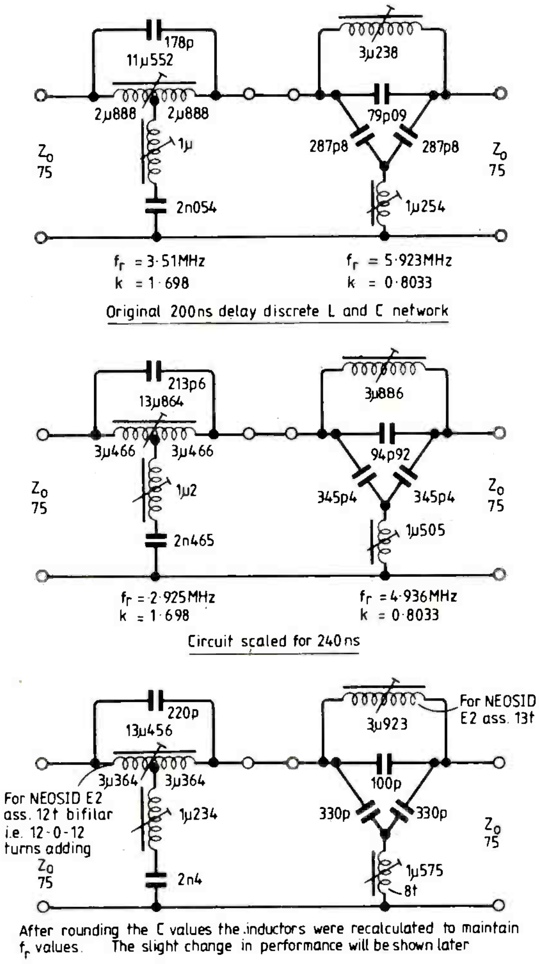


Fig.87 (above right). Two type B group delay sections providing 200 to 240ns of insertion delay, the value required in delay line position DL_1 Fig.34, March issue.

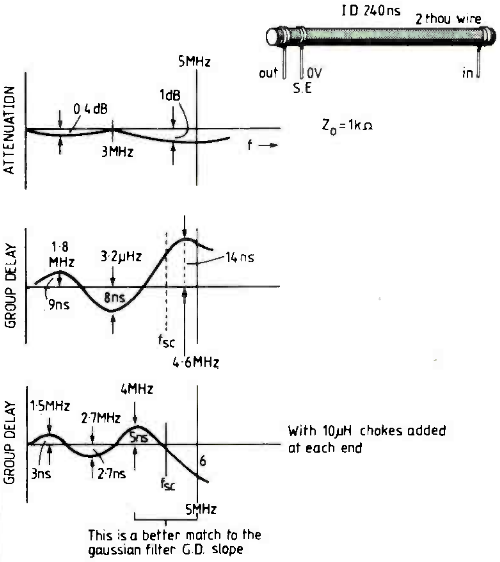


Fig.85. Rewound delay line (E), from which turns were removed until the correct delay value was obtained.

over the range $\pm\frac{1}{2}$MHz about f_{sc}, the delay line tranverses from -8 to $+14$ ns whereas the gaussian filter performance (Fig.53) is $+20$ to -20 ns. Thus, the error is in the opposite direction. Adding 15 µH Painton/Sigma/RS chokes at each end of the delay line will redistribute the delay ripple and could change the shape across the chroma band to advantage as shown in lower traces of Fig.85.

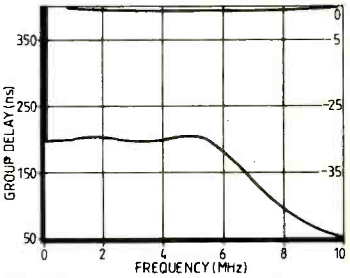


Fig.86. Insertion loss and delay performance of discrete LC delay line.

More luminance delay line options

In the prototype, two Matthey or Bal video delay lines are used each programmable in 5 ns steps up to a total of 155 ns because these give the best performance. An internal amplitude equalizer results in 1.8 kΩ appearing to the signal earth across the line. So as to minimize d.c. disturbance if using these components, balance this by adding 1.8kΩ to the +12v raise for each line used. From agents or distributors the Matthey lines cost up to £36 each; if winding coils is possible the delay line can instead be constructed with descrete L and C components. From a past project a 200 ns delay circuit was utilised, giving performance as shown in Fig.86. By suitable scaling for 240 ns, L and C values are multiplied by 1.2 to divide the frequencies by the same factor. The original (200 ns) and the modified (240 ns) circuits are given in Fig.87 with the bottom circuit showing capacitors as preferred values. Insertion loss response is within 0.2 dB to 10MHz but the delay ripple, with the preferred C values, causes a slight loss in performance of the pulse-and-step test.

The 75 ohm characteristic impedence of the delay line matches most test equipment. However, the delay network can be tested within the circuit of Fig.34 as was the output filter connected between R_{23} and R_{36}. The components can again be scaled to give a characteristic impedance (Z_0) of 220 Ω; then R_9 and C_9 in Fig.34 would not be required. R_6 and R_7 should each then be replaced by 440Ω (or pairs of 220 Ω). To scale Z_0, L values are multiplied by $\frac{220}{75}$ and C values by $\frac{75}{220}$ (using the values from the middle circuit of Fig.87) before rounding the results to preferred values. (i.e. C is set to preferred values and L is then adjusted to return to the resonant frequencies).

If you need assistance in HiFi/audio service:

Here's all the help you need

Philips versatile PM5109 LF generator and unique combined distortion meter/oscillator, the PM6309, give you all the help you need for HiFi and audio service applications. They're easy to operate – and economically priced.

PM5109 brings together all the high technology features you require from a test instrument. It offers symmetrical or asymmetrical outputs; pure sine wave signals; a wide 10 Hz – 100 kHz frequency range and switchable output impedances. A high 30 Vpp amplitude in the asymmetrical mode, with stepped and continuous attenuation; a 10 Vpp floating output in the symmetrical mode, and useful TTL or DIN loudspeaker outputs are further benefits. In addition, there is a choice of low-distortion or fast-settling modes.

PM6309 is a simple-to-operate distortion meter that can handle all types of audio equipment. It has been specially designed to provide appropriate signal generation plus an accurate distortion measuring capability within a single instrument.

It offers a built-in RC oscillator, total harmonic distortion (THD), 3rd harmonic distortion and rms measuring facilities. It not only measures distortion according to DIN45500 – but also determines the distortion figure accurately when unstable audio signals are being applied.

Fully automatic operation means that all you do is connect the input, select the test frequency – and then read-out the distortion. Separate two-channel testing is also possible for stereo equipment.

Use the inquiry service to obtain further information.

	Inquiry No.
PM 5109 LF generator	**061**
PM 6309 distortion meter	**062**

Philips Test and Measuring
Pye Unicam Ltd
York Street, Cambridge CB1 2PX
Tel (0223) 358866 Telex 817331

GN13

PHILIPS Test & Measuring Instruments

PHILIPS

LANGREX SUPPLIES LTD

RST

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED
Tel: 01-677 2424 Telex: 946708

RST

SEMICONDUCTORS

AA119	0.10
AAY30	0.17
AAY30	0.17
AAZ13	0.15
AAZ15	0.15
AAZ17	0.15
AC107	0.55
AC125	0.25
AC126	0.25
AC127	0.25
AC128	0.30
AC141	0.28
AC141K	0.35
AC142	0.28
AC142K	0.35
AC176	0.30
AC187	0.28
AC188	0.28
ACY17	1.30
ACY18	1.15
ACY19	1.10
ACY20	1.10
ACY21	1.15
ACY39	2.50
AD149	0.75
AD161	0.35
AD162	0.35
AF106	0.35
AF114	0.75
AF115	0.75
AF116	0.75
AF117	0.75
AF139	0.33
AF186	1.00
AF239	0.39
AFZ11	4.00
AFZ12	4.00
ASY26	1.40
ASY27	0.90

ASZ15	1.20
ASZ16	1.10
ASZ17	1.00
ASZ20	2.30
ASZ21	2.50
AU113	2.50
AUY10	3.00
BA145	0.13
BA148	0.15
BA154	0.10
BA155	0.11
BA156	0.10
BAW62	0.05
BAX13	0.06
BAX16	0.06
BC107	0.16
BC108	0.16
BC109	0.16
BC113	0.15
BC114	0.15
BC115	0.18
BC116	0.19
BC117	0.23
BC118	0.18
BC125	0.18
BC126	0.18
BC135	0.15
BC136	0.19
BC137	0.19
BC147	0.12
BC148	0.12
BC149	0.13
BC157	0.13
BC158	0.13
BC159	0.13
BC167	0.11
BC170	0.11
BC171	0.11
BC172	0.11

BC173	0.11
BC177	0.28
BC178	0.28
BC179	0.28
BC182	0.11
BC183	0.11
BC184	0.11
BC212	0.11
BC213	0.11
BC214	0.11
BC237	0.11
BC238	0.11
BC301	0.33
BC303	0.34
BC307	0.11
BC308	0.11
BC327	0.12
BC328	0.12
BC337	0.12
BC338	0.12
BCY30	1.25
BCY31	1.50
BCY32	1.50
BCY33	1.10
BCY34	1.00
BCY39	3.40
BCY40	2.80
BCY42	0.30
BCY43	0.30
BCY58	0.19
BCY70	0.17
BCY71	0.18
BCY72	0.17
BCZ11	1.75
BD115	0.42
BD121	1.70
BD123	2.80
BD124	2.00
BD131	0.44

BD132	0.48
BD135	0.40
BD136	0.40
BD137	0.40
BD138	0.48
BD139	0.48
BD140	0.50
BD144	2.00
BD181	1.20
BD183	0.80
BD2137	0.54
BD238	0.54
BDX10	0.91
BDX32	2.00
BDY20	1.50
BDY60	2.75
BF115	0.35
BF152	0.16
BF153	0.16
BF154	0.17
BF159	0.17
BF160	0.17
BF167	0.24
BF173	0.30
BF177	0.35
BF178	0.35
BF179	0.35
BF180	0.28
BF181	0.28
BF182	0.30
BF183	0.28
BF184	0.28
BF185	0.30
BF194	0.14
BF195	0.12
BF196	0.13
BF197	0.14
BF200	0.40
BF224	0.25
BF244	0.28

BF257	0.27
BF258	0.27
BF259	0.28
BF336	0.34
BF337	0.33
BF338	0.36
BFS21	4.00
BFS28	2.25
BFS61	0.20
BFS98	0.20
BFW10	0.97
BFW11	0.96
BFX84	0.30
BFX85	0.30
BFX87	0.30
BFX88	0.30
BFY50	0.25
BFY51	0.25
BFY52	0.25
BFY64	0.30
BFY90	0.95
BSX19	0.27
BSX20	0.27
BSX21	0.29
BT106	1.20
BTY79/400R	2.00
BU205	1.30
BU206	1.50
BU208	2.00
BY100	0.40
BY126	0.13
BY127	0.14
BZX61	0.17
Series	
BZY88	0.10
Series	
CRS1/40	0.60
CRS3/40	0.75
CRS3/60	0.90
GEX66	3.00

GEX541	5.00
GJ3M	1.50
GM0378A	1.75
KS100A	0.45
MJE340	0.60
MJE370	0.73
MJE371	0.71
MJE520	0.47
MJE521	0.73
MJE2955	1.30
MJE3055	1.10
MPF102	0.35
MPF103	0.35
MPF104	0.35
MPF105	0.35
MPSA06	0.26
MPSA56	0.28
MPSU01	0.53
MPSU06	0.65
MPSU56	0.69
NE555	0.45
NKT401	3.50
NKT403	2.50
NKT404	2.20
OA5	1.20
OA7	0.60
OA10	0.55
OA47	0.12
OA70	0.25
OA79	0.12
OA81	0.17
OA85	0.17
OA90	0.08
OA91	0.08
OA95	0.08
OA200	0.15
OA202	0.15
OA211	1.50
OAZ200	1.50
OAZ201	1.50
OAZ206	1.50

OAZ207	1.50
OC16	2.50
OC20	2.50
OC22	2.50
OC23	4.00
OC24	3.00
OC25	1.00
OC26	1.50
OC28	2.00
OC29	2.00
OC35	1.50
OC36	1.50
OC41	0.90
OC42	0.90
OC43	1.50
OC44	0.85
OC45	0.65
OC71	0.55
OC72	1.00
OC73	1.00
OC74	0.70
OC75	0.65
OC76	1.00
OC77	1.00
OC81	0.65
OC81Z	1.20
OC82	0.90
OC83	1.00
OC84	0.80
OC122	2.75
OC123	2.00
OC139	3.00
OC140	4.00
OC141	4.25
OC170	1.25
OC171	1.25
OC200	1.50
OC201	2.50
OC202	2.75
OC203	3.00
OC204	3.00

OC205	2.75
OC206	2.75
OC207	2.50
OCP71	2.00
ORP12	1.00
R2008B	2.00
R2009	2.25
R2010B	2.00
T1C44	0.27
T1C226D	1.20
T1L209	0.16
T1P29A	0.43
T1P30A	0.45
T1P31A	0.33
T1P32A	0.36
T1P33A	0.54
T1P34A	0.67
T1P41A	0.44
T1P42A	0.42
T1P2955	0.70
T1P3055	0.56
T1S43	0.43
ZS140	0.25
ZS170	0.21
ZS178	0.54
ZS271	0.23
ZS278	0.57
ZTX107	0.12
ZTX108	0.12
ZTX109	0.12
ZTX300	0.13
ZTX301	0.14
ZTX302	0.18
ZTX303	0.18
ZTX304	0.20
ZTX311	0.13
ZTX314	0.25
ZTX500	0.14
ZTX501	0.14
ZTX502	0.18
ZTX503	0.19

ZTX504	0.21
ZTX531	0.24
ZTX550	0.25
1N914	0.05
1N916	0.09
1N4001	0.06
1N4002	0.06
1N4003	0.06
1N4004	0.07
1N4005	0.09
1N4006	0.11
1N4007	0.12
1N4009	0.07
1N4148	0.04
1N5400	0.13
1N5401	0.13
1S44	0.04
1S920	0.08
1S921	0.09
2G301	1.00
2G302	1.00
2G306	1.00
2N404	1.30
2N696	0.32
2N697	0.32
2N698	0.32
2N705	1.25
2N706	0.25
2N708	0.25
2N930	0.25
2N1131	0.30
2N1132	0.30
2N1302	1.20
2N1303	0.80
2N1304	1.20
2N1305	1.00
2N1306	1.50
2N1307	1.10
2N1308	1.75
2N1309	1.20
2N1613	0.32

2N1671	5.00
2N1893	0.32
2N2147	4.00
2N2148	3.75
2N2218	0.32
2N2219	0.32
2N2220	0.20
2N2221	0.20
2N2222	0.20
2N2223	4.25
2N2368	0.25
2N2369A	0.25
2N2484	0.25
2N2646	0.50
2N2904	0.32
2N2905	0.32
2N2906	0.21
2N2907	0.21
2N2924	0.26
2N2925	0.22
2N2926	0.15
2N3053	0.26
2N3054	0.55
2N3055	0.65
2N3440	0.70
2N3441	0.85
2N3442	1.25
2N3614	2.20
2N3702	0.11
2N3703	0.11
2N3704	0.11
2N3705	0.11
2N3706	0.11
2N3707	0.11
2N3708	0.10
2N3709	0.11
2N3710	0.10
2N3711	0.10
2N3771	1.40
2N3772	1.60
2N3773	1.80

2N3819	0.30
2N3820	0.39
2N3823	0.60
2N3866	1.00
2N3904	0.17
2N3905	0.17
2N3906	0.17
2N4058	0.20
2N4059	0.20
2N4060	0.16
2N4061	0.16
2N4062	0.16
2N4124	0.16
2N4126	0.16
2N4286	0.15
2N4288	0.18
2N4289	0.18
2N4400	0.11
2N4401	0.11
2N4402	0.11
2N5457	0.32
2N5458	0.32
2N5459	0.32
2S017	10.00
2S019	12.00
2S026	25.00
2S103	1.50
2S302	2.00
2S303	1.50
2S322	3.50
2S324	3.50
2S701	2.00
2S745A	0.95
2S746A	0.95

CV Devices
Large stocks
Prices on
application

VALVES

A1834	9.00
A2087	13.50
A2134	17.50
A2293	16.00
A2426	27.50
A2521	25.00
A2900	15.00
A3343	45.00
AZ31	2.75
AZ41	2.60
BK448	114.90
BK484	155.35
BS90	58.00
BS810	60.00
BT5	58.95
BT17	151.00
BT19	44.05
BT29	349.15
BT69	354.80
BT95	129.90
CBL31	4.00
CL33	4.00
CY31	3.00
C1K	20.00
C3A	22.00
C3JA	22.00
DA41	25.00
DA42	18.70
DAF91	1.75
DAF96	1.75
DET22	35.00
DET24	49.00
DF91	1.75
DF96	1.75
DK91	1.75
DK92	2.00
DK96	1.75
DL92	2.00
DL94	1.75
DL96	1.75
DLS10	14.00
DLS15	12.50
DLS16	12.50
DLS19	12.50
DM70	2.00
DM71	2.00
DM160	4.75
DY87	1.50
DY802	1.50
E55L	45.00
E80CC	8.81
E80CF	11.27
E80F	14.19
E80L	13.73
E81CC	8.00
E81L	13.27
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88C	8.42
E90CC	9.47
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10

E130L	18.50
E180CC	10.50
E180F	10.20
E182CC	13.25
E186F	11.50
E188CC	8.91
E280F	22.51
E283CC	12.00
E288CC	17.50
EA52	32.25
EA76	2.50
EABC80	1.25
EAC91	3.50
EAF42	2.50
EAF801	2.00
EB41	4.00
EB91	1.50
EBC33	2.50
EBC41	2.50
EBC81	1.50
EBC90	1.25
EBF80	1.50
EBF83	1.75
EBF89	1.50
EBL31	4.00
EC90	1.25
EC91	8.00
EC92	1.75
EC157	380.00
ECC33	4.50
ECC35	4.50
ECC40	4.50
ECC81	1.75
ECC82	1.75
ECC83	1.75
ECC84	1.75
ECC85	1.75
ECC86	2.50
ECC88	2.10
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.00
ECF80	1.55
ECF82	1.50
ECF86	2.50
ECH35	3.00
ECH42	3.50
ECH81	3.00
ECH83	2.50
ECH84	2.50
ECL80	1.50
ECL81	1.75
ECL82	1.50
ECL83	3.00
ECL84	1.50
ECL85	1.50
ECL86	1.75
EF37A	5.00
EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
EF54	5.00
EF55	3.50
EF80	1.75
EF83	4.00

EF85	1.75
EF86	1.75
EF89	2.50
EF91	2.95
EF92	6.37
EF93	1.50
EF94	2.50
EF95	5.99
EF98	2.00
EF183	2.00
EF184	2.00
EF804S	12.00
EF805S	15.00
EH90	1.75
EK90	1.50
EL32	2.50
EL33	4.00
EL34MU1	4.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
EL86	2.75
EL90	2.25
EL91	9.69
EL95	2.00
EL156	30.00
EL360	8.50
EL500/504	3.00
EL509	7.00
EL821	13.00
EL822	13.97
EM34	5.00
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	17.46
EN91	£7.05
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
EY84	9.24
EY86	1.75
EY88	1.75
EY500A	3.00
EY802	1.75
EZ35	1.75
EZ40	2.50
EZ41	2.50
EZ80	1.50
EZ81	1.50
EZ90	2.00
FW4-500	3.50
FW4-800	3.50
G1.371K	35.00
G551K	12.00
G180.2M	17.50
G240.2D	12.00
G400.1K	17.50
GN4	9.00
GN4A	9.00
GS16	16.00
GT1C	15.00
GU50	20.00

GU51	20.00
GXU1	15.35
GXU2	30.00
GXU3	25.40
GXU4	44.50
GXU50	20.00
GY501	3.00
GZ32	4.00
GZ33	4.75
GZ34	3.00
GZ37	4.75
KT61	5.00
KT66	12.00
KT77 Gold Lion	9.00
KT88	15.00
KTW61	2.50
KTW62	2.50
KTW63	2.50
M8079	12.34
M8080	8.25
M8081	9.82
M8082	9.69
M8083	8.58
M8091	10.43
M8096	6.80
M8097	8.10
M8098	6.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
M8212	11.37
M8223	6.00
M8224	6.30
M8225	4.50
M8248	14.03
MD2901	115.00
MU14	2.50
MX119	55.00
MX123	72.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
MX168	50.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50

OD3	2.50
OZ4	3.50
PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
PCL84	2.00
PCL85	2.50
PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	45.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504/5	2.50
PL508	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.50
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	4.00
PY800	1.50
PY801	1.50
QF451	82.50
QQV02-6	30.50
QQV03-10	20.50
QQV03-20A	48.38
QQV06-40A	65.34
QQV07-50	68.60
QQZ06-40A	62.20
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	155.70

QY3-65	59.86
QY3-125	66.50
QY4-250	68.00
QY4-400	74.20
QY5-500	175.00
QY5-3000A	420.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
TT15	50.00
TT21	30.00
TT22	37.50
TT100	60.00
TY2-125	65.00
TY4-400	75.00
TY4-500	98.35
TY5-500	201.50
TY6-800	196.50
TY6-5000A	490.00
TY6-5000B	395.00
TY6-5000W	407.00
TY7-6000A	485.00
TY7-6000W	303.60
TZ40	25.00
U18-20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UCF80	2.00
UCH42	2.50
UCH81	2.50
UCL82	1.75
UCL83	2.75

UF41	2.00
UF42	2.10
UF80	1.75
UF85	1.75
UF89	2.00
UL41	3.50
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1-2500	55.00
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	102.00
YD1120	395.00
YD1240	450.00
Z759	25.00
ZM1000	8.00
ZM1001	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.05
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00

4-250A	80.00
4-400A	87.00
4B32	20.00
4C35	78.00
4CX250B	45.00
4CX350A	73.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	5.99
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.02
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
6CB6A	2.50
6CD6GA	5.00

6CG7	2.50
6CH6	13.00
6CL6	3.75
6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	3.00
6L6GC	3.00
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50

12AX7	1.75
12AY7A	4.00
12B4A	3.50
12BA6	2.50
12BE6	2.50
12BH7	2.75
12BY7	3.00
12E1	20.00
12E11TT	28.00
12E14	65.00
13E1	170.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	4.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	13.50
92AV	12.96
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	18.33
812A	18.33
813	125.86
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.50
1624	4.00
1625	3.50
2050	7.50
4212E	300.00
4212H	300.00
5544	81.97
5545	102.00
5551A	114.90
5552A	155.35

5642	9.00
5654	3.00
5651	4.45
5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	15.00
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	8.25
6159B	19.00
6189	9.50
6201	11.40
6442	20.00
6883B	8.25
6973	4.00
7025	3.00
7551	6.25
7586	12.00
7587	18.50
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	90.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

Tested
Ex-Equipment
4CX250B 6.50
CV Devices
Large stocks
Prices on
application

BASES

B7G unskirted	0.25
B7G skirted	0.35
B9A unskirted	0.25
B9A skirted	0.35
Int Octal	0.35
Loctal	0.55
Nuvistor base	2.00
8 pin DIL Texas	0.10
14 pin DIL Texas	0.10
16 pin DIL Texas	0.10
Valve screening cans all sizes	0.40

CRTs

2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	55.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DG7-36	65.00
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00

VCR517B	10.00
VCR517C	10.00

Tube Bases
Prices on
application

INTEGRATED CIRCUITS

7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20

7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18

7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82

7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72

74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
TAA570	2.30
TAA630S	3.50
TAA700	3.90
TBA480Q	1.84

TBA520Q	2.30
TBA530	1.98
TBA540Q	2.30
TBA550Q	3.22
TBA560CQ	3.22
TBA673	2.20
TBA700	1.52
TBA720Q	2.30
TBA750Q	2.07
TBA800	1.20
TBA920	2.90
TBA920Q	2.90
TBA990Q	2.90
TCA270Q	2.90
TCA760A	1.38

Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT, add 15%.
Price ruling at time of despatch.
In some cases prices of Mullard and USA valves will be higher than those advertised. Prices correct when going to press.
Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1.50 on credit orders.
Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

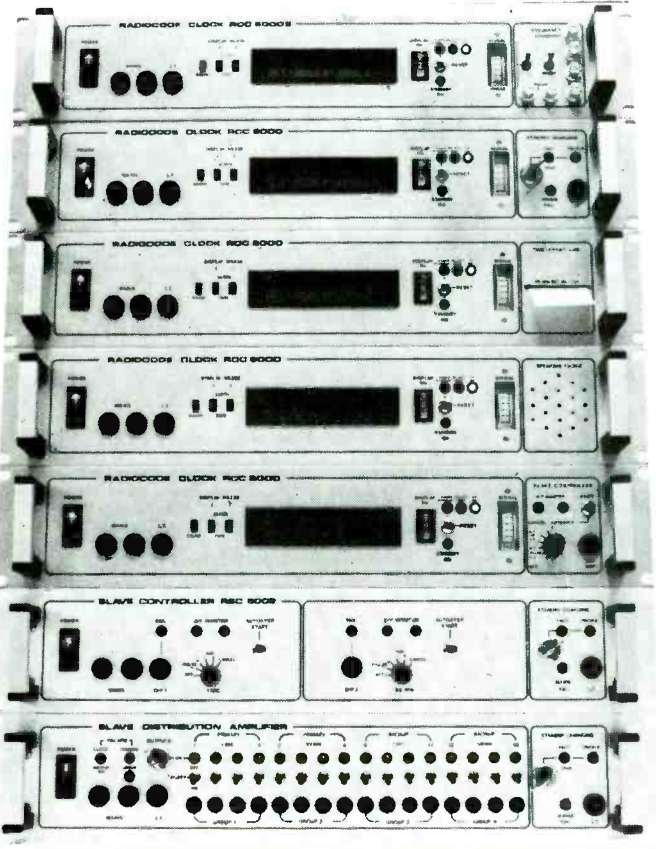
Telephone 01-677 2424/7
Telex 946708
E. & O.E.
Open to callers Monday-Friday 9 a.m.-5 p.m.

WW-11

CIRCLE 21 FOR FURTHER DETAILS.

RADIOCODE CLOCKS SOLVE PROBLEMS

ATOMIC TIME, FREQUENCY AND SYNCHRONISATION EQUIPMENT



NEW PHASE-MODULATION SYSTEMS

Until recently, atomic time and date information was only available on v.l.f. transmissions using amplitude modulation. The RCC 8000AM series of equipment uses these transmissions to offer high noise immunity and high accuracy, particularly at very long range.

The new RCC 8000PM series of equipment uses, for the first time, phase modulated tranmissions with massive radiated powers of up to 2 Mega-Watts to offer long range, excellent noise immunity and no scheduled maintenance periods.

NEW PRODUCTS

The AM and PM series of Radiocode Clock equipment has been further expanded to include seven new models (from top) **8000S** – combined clock, frequency standard and optional stopclock. **Internal standby power supply** – with dual rate constant current charger. **Time-event log** – prints hours, minutes, seconds, milliseconds and day of year, on receipt of a log pulse. **Speaking clock** – time announcement or audio recording. **Slave controller** – total control of single-standard master/slave systems ie one pulse/sec. **Dual standard slave controller** – total control of two different and independent slave systems, ie. one pulse/sec and one pulse/half min. **Slave distribution amplifier** – maximum flexibility for the largest master/slave installations requiring dual standard operation, multiple circuits and complete master/slave backup.

NEW OPTIONS

A continuously expanding range of fully integrated software and hardware is available for both series of Radiocode Clock equipment. Standard options now include:

- IRIG B precision serial o/p
- RS232/V24 1mS resolution
- General purpose parallel o/p
- FSK record/replay system
- Keypad entry of alarm times
- Keypad entry of time/date
- Time code generators
- Intelligent slave systems
- Standard frequency outputs
- Stopclock operation
- Calibrated systems for increased accuracy

Radiocode Clocks Ltd*
Unit 19, Parkengue, Kernick Road Industrial Estate
Penryn, Falmouth, Cornwall. Tel: Falmouth (0326) 76007
(*A Circuit Services Associate Co.)

CIRCLE 24 FOR FURTHER DETAILS.

★ MARCONI SIGNAL GENERATORS ★

TF2002A/S (illustrated) 10kHz-72MHz. AM/FM. **£750**
TF2002. As above but AM only. **£450**

MARCONI TF1066B. AM/FM Generator. 10-470MHz. 0.2uV-200mV output. FM Deviation up to ±100kHz.

MARCONI TF995A/5. AM/FM Generator. Narrow deviation model 995 covering 1.5-220MHz. **£450.** TF2015. 10-520MHz. AM/FM. TF144H. AM 10kHz-72MHz **£295.**

MARCONI TF1064B/5. AM/FM Signal generator covering in three ranges 68-108, 118-185 and 450-470MHz. FM fixed deviations of 3.5 & 10kHz. AM fixed 30%. **£225**

★ 'DOLBY' NOISE WEIGHTING FILTERS ★

Cat. No. 98A. Noise weighting filters for CCIR/ARM signal-to-noise ratio measurements. As new units. **£40** each (+£1 p&p).

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each.

COLOUR-BAR GENERATORS. X-HATCH/DOT GENS.

In stock Unaohm, Korting, Labgear Colourmatch ETC. Colour-bar generators, Cross-Hatch Generators. Also Labgear Field-Strength meters for UHF T.V. PLEASE PHONE FOR STOCK SITUATION. . . . .

OPTICAL ISOLATORS

SPERRY UNIVAC M4000 opto-isolator units providing 2KV of insulation between Modems and Terminals. 25 way 'D' connectors (RS232C Interface) in and out. Measures 9×5×7". Complete with handbook . . . . **£25** – pp£2.

★★ STEPPER MOTORS ★★

Brand new stock of 'ASTROSYN' Type 20PM-A055 stepper motors. 28V DC. 24 steps per rev. 15 oz-in torque @ 100PPS. Body length 2½", diameter 2", shaft ¼" diam × 4¼" spirally threaded. Weight 16oz. Price each **£15** (p&p 50p). Connections supplied. INC. VAT.

★ MILLI-VOLT MEASUREMENT, ANALOGUE ★

MARCONI TF2600. Twelve ranges 1mV-300V FSD. Wide-band to 10MHz.

MARCONI TF2603. Frequency range 50kHz-1.5GHz. High Sensitivity from 300uV.

MARCONI TF2604. Electronic Multi-meter. AC/DC 300mV Full scale to 300V (1kV DC). Resistance ranged. AC Frequency range 20Hz-1500MHz.

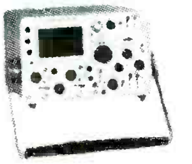
★★ CONSTANT VOLTAGE TRANSFORMERS ★★

'ADVANCE VOLSTAT; Type. Model MT140A. Mains input 190-260V AC. Output 230V AC @ 150W. Price each **£20** + VAT + £2 carriage.

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1 TEL: 01-723 8753

'OSCILLOSCOPES'. PLEASE PHONE FOR CURRENT STOCK



TEKTRONIX 453. Dual-trace 50MHz.
TELEQUIPMENT D75 Dual-trace 50MHz portable **£450**
HEWLETT-PACKARD 1707A Dual-trace 75MHz
TRIO CS1575 5MHz Dual-trace **£250**

★★ TEST EQUIPMENT ★★

MARCONI TF1245 Q-Meter
MARCONI TF1313 ¼% LCR Bridge
MARCONI TF868 LCR Bridge
MARCONI TF2604 Electronic Multi-Meter
MARCONI TF893A Audio Power Meters **£85.**
MARCONI TF2502 RF Power Meters. DC-1GHz. 10w fsd **£350.**
MARCONI TF2701 In-Situ Universal Component Bridge **£250.**
HEWLETT-PACKARD 3450A Multi-Function Digital Multi-Meter.
ROHDE & SCHWARZ 'SDR' AM Signal Generator 0.3-1GHz.
TEKTRONIX 2901 Time-mark Generator.
ROHDE & SCHWARZ Resonance Frequency Meter 470MHz-2.5GHz.
ROHDE & SCHWARZ Polyscop SWOB II.
METROHM 500V Insulation Testers Transistorised **£40** pp £1.50.
BRUEL & KJAER Heterodyne Voltmeter 0.5-240MHz.
AIRMEC Display Oscilloscope 279, 4-trace, 14x10" CRT **£195.**
RIKADENKI 3-channel Chart Recorder, Model B-341.

8" WINCHESTER

UNITED PERIPHERALS model 3100 Mini-disc drives (3 × 8" sealed plattens) capable of over 19MBytes storage. External power supply requirements are 24V @ 3A and 5V @ 4A. Little used condition, believed OK but at the unbelievable price of just **£125** are sold without guarantee. Price inclusive of VAT and carriage and copy of user-handbook.

★ SWEEPERS ★

TELONIC 2003 System. 800-1500MHz **£325**
TELONIC SM2000 with 500-900MHz plug-in **£175**
TELONIC SM2000 with 0-10MHz plug-in **£150**

8" SHUGART DRIVES

8" Shugart type SA800 Floppy disc drives. Small quantity available, single-sided up to 800KBytes of storage. Power requirements, 5V @ 1.3A. Little used, excellent condition. **PRICE £90** – inclusive VAT and carriage and copy of user-handbook.

★ TEKTRONIX ★

FILE MANAGER SYSTEM MODEL 4907 Option 31 (Third disc drive). 4051 Graphic System compatible. **GPIB (IEEE 488-1975)** compatible.

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

★ COMPUTER PERIPHERALS ★

1.6MB 8" FLOPPY DISC DRIVES – New Stock

After our recent sell-out of the DRE7100 FDDs, we are pleased to offer another bargain package as follows: BRAND NEW American 'MFE Corp' model M-700 **DOUBLE-SIDED** 8"Disc Drives. Massive storage capability up to 1.6MBytes. Full IBM compatability. External power requirements are ±5V at 1.2A and +24V at 1.1A. Full spares/back-up available U.K. (Elcomatic's). Current list is over £315. **OUR PRICE JUST £175** + VAT (including full manual worth £15).

DELIVERY (48Hrs) + £10 + VAT.

DRE 4000 — SERIES DRIVES

Data Recording Equipment 5+5MB exchangeable disc drives model 4000A. Brand new units for **£275** – inlcuding power unit and full technical manual.

★ DISK CARTRIDGES ★

Surplus BASF 12-Sector RK05 cartridges available . . . small quantity only remaining at **£15** each. Carriage each £1.50.

★ SWITCHING POWER SUPPLIES ★

The following DC power supplies are available now from stock in limited quantities. All fully tested and guaranteed.

3.5V @ 10 Amps	**£15**	15V 16A (110V IN)	**£20**
5V @ 20 Amps	**£20**	5V @ 40 Amps	**£30**
5V @ 60 Amps	**£40**	19V @ 30 Amps	**£40**
+15V, −12V & +5V @ 11A, 4A and 40A			**£50**

ALL PRICES NOW INCLUDE VAT. CARRIAGE + £2 EACH.

★ CENTRIFUGAL BLOWERS ★

'TORIN' Type U62B1. 230V Cap'Start (supplied), very powerful (200W. 3,000rpm) centrifugal fans for large rack cooling or enclosure extraction applications. Overall dimensions 20x12 cms, outlet 6x4 cms. BRAND NEW. Surplus stock. **£15 each inc. VAT, pp £1.50.**

ROTRON INSTRUMENT COOLING FANS

Supplied in fully tested excellent condition, as follows:
115V, 4½×4½×1½" **£5.** 230V same size **£5.50.** 115V 3×3×1½" **£4.** 230V 3" size, brand new **£6.** Also small quantity 115V 4½" size, brand new **£6.** Postage each + 50p please.

WW10

CIRCLE 19 FOR FURTHER DETAILS.

TRANSTEL DOT MATRIX PRINTER. Compact Serial Interface 230V. With info	£65 ea
TELETYPE ASR33 — DATA DYNAMIC 390 (Printer, Keyboard, Punch & Reader) RS232	£75
RACAL MODEM type 2200/24	£100
TRT SEMATRONS 1022 Modem	£20
CREED 75 TELEPRINTER. Very good condition	£25 ea
9'' MONITOR. Cased. Non-standard, with info	£20 ea
12'' MONITOR. Cased. Non-standard, with info	£15 ea
AZTEC 20'' Black and white MONITOR. Video In	£50 ea
TV Style 20'' MONITOR. Black and white. Video In	£30 ea

Item No	OSCILLOSCOPES	
406	TEK 465 Dual Trace 100MHz Delay Sweep	£950
407	GOULD/ADVANCE OS3300B. Dual Trace 50MHz. Dual Time Base	£450
408	TELEQUIPMENT D83 Dual Trace 50MHz. delay Sweep Large Screen	£450
409	TELEQUIPMENT D75 Dual Trace 50MHz Delay Sweep	£400
376	TEK READOUT SCOPE 567 with 6R1A Digital Unit, 3S1 Dual Trace Sampling unit DC-1GHz and 3T77A Sampling Sweep Unit. Complete with 2 probes	£500
3	H.P. 180A Dual Trace 50MHz Delay Sweep	£400
11	S.E. LABS SM111 Dual Trace 20MHz	£200
5	SOLARTRON/SCHLUMBERGER CD1740 dual trace 50MHz dual TB delay sweep	£325
7	COSSOR CDU120 dual trace 50MHz delay sweep	£250
14	SOLARTRON CD1400 dual beam 15MHz	£90
15	TELEQUIPMENT D43 dual beam 15MHz	£90
16	SOLARTRON CD1014 dual beam 5MHz	£60
	STORAGE OSCILLOSCOPES	
18	PHILIPS PM3234 dual beam 10MHz	£1,200
19	TELEQUIPMENT DM64 dual trace 10MHz	£450
20	TEK 549 with 1A1 plug-in, dual trace 30MHz dual TB delay sweep	£400
22	HP SIGNAL ANALYSER 5480B memory display with 5486B and 5485A Plug-ins	£425
25	MARCONI SIG GEN TF2002A/S. 10kHz-72MHz AM/FM	£475
27	MARCONI SIG GEN TF995A/5 1.5-220MHz AM/FM Narrow deviation	£250
28	MARCONI UNIVERSAL BRIDGE TF1313. 0.25%	£250
29	MARCONI UHF SIG GEN TF1060/2. 450-1200MHz late style	£150
31	MARCONI UNIVERSAL BRIDGE TF868 range	£60
32	MARCONI WIDE RANGE OSC TF1370A 10Hz-10MHz. Sine; 10Hz-100kHz square	£95
33	MARCONI DEVIATION METER TF791D/M 4-1024MHz, late style	£150
34	MARCONI SIG GEN TF995/3S 1.5-220MHz AM/FM	£150
36	MARCONI AF POWER METER TF893A 20Hz-35kHz	£75
38	MARCONI SENSITIVE VVM TF2600 10Hz-10MHz 1mV-300V	£75
41	HP PULSE GEN 222A. Repetition rate to 10MHz	£150
42	HP PULSE GEN 214A. 200 watt pulse power	£250
45	HP VHF SIG GEN 608D 10-420MHz	£150
51	B&K LEVEL RECORDER 2305, solid state	£400
52	B&K LEVEL RECORDER 2305, valve	£200
53	B&K MICROPHONE AMPLIFIER 2603	£100
54	B&K RANDON NOISE GEN 1402	£125
56	B&K RMS AUDIO VOLTMETER 2410	£40
59	B&K MICROPHONE 4111 with stand and cable	£95
61	B&K AUDIO FREQ SPECTROMETER 2109 with level recorder 2304	£150
65	WAYNE KERR UNIVERSAL BRIDGE B221 Mk 3 (meter indicator) with low imp adaptor Q221 Mk 3	£175
67	WAYNE KERR UNIVERSAL BRIDGE B221 with low imp adaptor Q221	£95
68	WAYNE KERR COMPONENT BRIDGE B521	£45
69	WAYNE KERR VHF ADMITTANCE BRIDGE B801	£125
70	WAYNE KERR AF SIG GEN S121 10Hz-120kHz	£40
72	ADVANCE PULSE GENERATOR PG52B	£350
74	ADVANCE DUAL STAB DC PS P.P.3 0-30V0-1A twice. Metered	£50
75	SOLARTRON DVM A223 AC/DC/Ohm 4½ digit	£90
78	AVO MULTIMETER CT471A (Ex-Ministry)	£40
79	AVO MULTIMETER 7X	£25
80	AVO MULTIMETER 8s from	£45
81	AVO TRANSISTOR TESTER TT169 with leads. As new (P&P £2)	£20
82	AVO VALVE CHARACTERISTIC METER VCM163 with data	£250
88	AIRMEC MODULATION METER 210 3-300MHz AM/ FM	£95
90	BRANDENBURG POWER SUPPLY 374SEL 0-1000V	£75
91	BRANDENBURG POWER SUPPLY PM2500/R 0-2.5kv	£125
95	TAYLOR INSULATION TESTER 130C 500VMax (P&P £3)	£25
97	GREEN SYNTHESISED DIGITAL SIGNAL GENERATOR TG1800 1Hz-9.9MHz Sine/Square	£600
410	MARCONI SIG GEN TF2002B. 10KHz-88MHz AM/FM	£500
411	MARCONI SIG GEN TF2012. 400-520MHz. FM	£350
412	MARCONI MOD METER TF2300S 2-1000MHz AM/FM	£375
413	S.E. LABS STROBE SM8	£125
414	RACAL/AIRMEC SIG GEN 365A 1-320MHz AM/FM	£325
375	B & K TAPE RECORDER type 7001	£600
380	H.P. SHF SIG GEN 620A 7-11GHz	£225
381	H.P. CALORIMETRIC POWER METER 434A DC-12.4GHz 10mW-10W	£250
383	H.P. RF MILLIVOLTMETER 411A 500KHz-1GHz 10mV-10V	£150
387	MARCONI DIFF DC VOLTMETER TF2606 0-1100V	£275
390	GR FREQ METER & DISCRIMINATOR 1142-A	£200
392	CLAUDE LYONS VOLTAGE STAB TS2. AC 240V 12A	£100
398	KINGSHILL STAB POWER SUPPLY 500. Metered 0-60V 0-0.5A (P&P £4)	£40

EXECUTIVE TELEPHONES — PUSH BUTTON

Many functions including 10 number memory; repeat dialling, etc. Will connect to GPO System. Brand New. £25 each. P&P £4

SAMPLE OF STOCK — SAE or telephone for LISTS

Please check availability before ordering. Carriage all units £7; VAT to be added to total of Goods and Carriage.

STEWART OF READING

110 WYKEHAM ROAD, READING, BERKS RG6 1PL

Telephone: 0734 68041

Callers welcome 9 a.m. to 5.30 p.m. Monday to Saturday inclusive

CIRCLE 59 FOR FURTHER DETAILS.

SOUTH MIDLANDS COMMUNICATIONS

SALE of TEST EQUIPMENT

½ PRICE!

YC1000L

DATA PROCESSOR
OBSERVE & RECORD:
FREQUENCY PERIOD
PULSES
TEMPERATURE
VOLTAGES & TIMES

£365 +15% VAT +£5 Securicor

The YC1000L is a laboratory grade instrument with versatile microprocessor control. It includes: a frequency (10Hz-600MHz, 0.02 ppm), a period (0.1S to 0.1uS), and a pulse counter (0-99,999,999, TTL level), a voltmeter (AC or DC to 999V, 3 ranges), a thermometer (remote sensor −29.0 to +99.9°C) plus a precision timer (24 hour clock providing; event or period, (local or remote) and alarm functions). Display is via 8 large fluorescent green digits and/or the inbuilt 5X7 (20 characters line 2 line second) Dot Matrix thermal printer.

You will wonder how your laboratory or workshops ever coped without

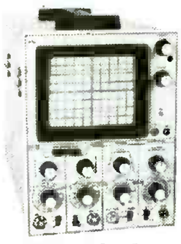
LCD MULTIMETER
3½ DIGIT
HANDHELD

(Auto range/pol)
KD200

£25 +15% VAT +£1 postage

VSWR-POWER
METER
INTERNAL 50Ω
LOAD
2-150 MHz
6/30/150W
35 models stocked
FS800

£99 +15% VAT + £3 postage



OSCILLOSCOPE 4''
20 MHz DUAL TRACE
DT420

£199 +15% VAT +£5 Securicor

S.M. HOUSE, TOTTON, SOUTHAMPTON SO4 4DP, ENGLAND
Tel: SOUTHAMPTON [+44] ([0]703) 867333. Telex: 477351 SMCOMM G

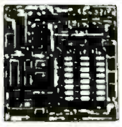
CIRCLE 048 FOR FURTHER DETAILS.

HENRY'S COMPUTER SHOP

OPEN 6 DAYS A WEEK · ORDER BY POST OR PHONE
CALL IN AND SEE FOR YOURSELF

PRICES EXCLUDE VAT

SOFTWARE • PERIPHERALS • MULTI-BOARDS



80 - BUS MULTI-BOARDS

BUILD A CUSTOM SYSTEM FROM SCRATCH or expand your GALAXY or NASCOM
Demonstrations for callers

GM811 CPU	£125.00
GM832 SVC	£195.00
GM829 FDC/SASI	£145.00
GM813 CPU/64K RAM	£225.00
EV814 IEEE 488 CONTROLLER	£140.00
GM802 64K DYNAMIC RAM	£125.00
GM827 87 KEY KEYBOARD	£85.00
GM839 PROTOTYPING	£12.50
MP826 STATIC RAM	£185.00
GM816 MULTI-I/O	£125.00
IO 828A SUPER PLUTO COLOUR GRAPHICS PROCESSOR 192K RAM	£499.00
GM833 RAM-DISK 512K	£450.00

(UK C/P & export extra at cost)
ALSO IN STOCK — MOTHER BOARDS. FRAMES. CABLES. POWER SUPPLIES. KEYBOARDS. SOFTWARE etc.
FULL LEAFLETS/DETAILS OF SUITABLE PERMUTATIONS - SEND LARGE SAE

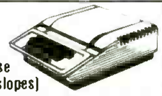
We can advise also with terminals and complete Galaxy computers with monitors and Disks ready to use.

NASCOM - 2

Available in both kit and built form. Featuring Microsoft Basic. NAS-SYS monitor. full QWERTY keyboard of the highest quality. 4MHz Z80A processor. full RS232 I/O and parallel I/O. One of the most flexible computer cards around. expansion cababilities are impressive using the NASBUS and compatible 80-BUS expansion cards. Expansion includes hi-res colour graphics full CP/M disk system and much more.
Send SAE for full leaflets.

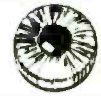
NASCOM 2 kit	£225.00
NASCOM 2built	£265.87

ITT 2020 CABINET



Professional computer case
18'' x 15½'' x 4½'' (Front slopes)
As previously advertised **£23.91** (UK C/P £2.10)

TOROIDAL TRANSFORMER



100 watts isolations
230/240V AC plus 8-0-8V 4A
15-0-15V 0.645A 30V 0.16A
size approx 4½'' dia x 1¾''
£6.91 (UK C/P 75p)

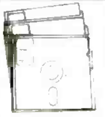
PRESTEL KIT

Complete set of PRESTEL adaptor cards. Consisting of main processor card with battery backed RAM. modem card. direct line coupler and keypad. Outputs are composite monochrome and separate RGB. Suitable for use with colour monitors or suitable TVs. (PS +/−12V and +5V) **£60.83**

ASCII KEYBOARDS

Computer keyboards.
All models brand new
QWERTY (UK C/P £1.00)
All models +5V and −12V 1 Amp P/S **£7.78**
(UK C/P 60p)
69SD5 Exclusive Special Purchase. Compact 64 key (hall effect) +5 function keys −ve/+ve strobe. Normal ASCII but all definable. Steel frame. All facilities complete with plugs **£26.04**
SMK 69 Key general purpose. steel plate. Redefinable output. Neg strobe pulse. 4 user definable keys. shift and control keys etc. With connector **£37.35**
Discounts for quantities – please enquire
Computer/calc., etc. keyboard bargains for callers

PLUS ALWAYS KEYBOARD BARGAINS FOR CALLERS



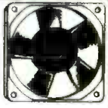
SOFTWARE

MDIS (C) INTELLIGENT DISASSEMBLER
For all CP/M based machines **£50.00**
IVC HI-RES (C) For Gemini and others (please enquire). Provides Pseudo high resolution graphics **£15.00**
DISKPEN(C) Version 3. Low cost word processor for Gemini and others (please enquire) **£50.00**
Plus large range or overlays for Diskpen.
HENRYS CP/M UTILITIES DISK (C)
41 Programs for the CP/M Systems programmer
5¼'' format **£15.00**
8'' format **£17.35**
Ask for details on all of above. WHEN ORDERING PLEASE SPECIFY FORMAT REQUIRED.
Contact Computer Dept. if uncertain.
(C) Copyright Cubegate Ltd – all rights reserved.
All above available to retailers and distributors – contact Computer Dept. for details.

COMPUTER POWER SUPPLY

Switched mode. Stabilised. Self protecting. S/C protected. etc. 220/240V AC. +5V 3.3A. +12V 2.4A 40% cycle. −5V 0.5A. −12V 0.5A. Suitable Apple replacement **£50.00**
(UK C/P £1.50)

COMPUTER FANS



CU7983 115V 50/60Hz
12/13W Impedance protected
(use 2 in series for 230V)
4¾'' x 4¾'' x 1''
Two for **£8.70** (UK C/P 70p)
220/240V 'as new' only **£4.78** (UK C/P 50p) each

THERMAL PRINTER

COMPLETE WITH FULL HANDBOOK. 3 ROLLS PAPER **£43.43**
(UK C/P £1.00)

SUITABLE FOR: TANDY · BBC · ORIC · NASCOM GEMINI · ACORN · NEW BRAIN · DRAGON · ETC. ETC. (interface unit with leads £13 – state model)
(your enquiries invited)

CHERRY KEY PAD

16 button key pad non-encoded
£5.17 (UK C/P 30p)

MODEM CARDS/ COUPLER

Brand new, tested, answer and originate 300 BAUD uncased acoustic modem card by famous manufacturer. RS232 input/output. Power supply +/− 12V at 180mA. Requires 2 magnetic earpieces. 2 switches. 2 LEDs and connectors to complete. Circuits and connection data supplied.
Card only **£26.04**
Card and remainder of small components **£29.09**
Telephone Direct Line coupler type LTU 11 MKII. Suitable for direct coupling PRESTEL adaptors and the above acoustic modems. Integral Line select and autodial relays requiring TTL inputs. Circuits and connection data supplied.
LTU 11 Coupler **£13.00**
1200 BAUD receive 75 BAUD send direct coupled modem for PRESTEL. Requires +5V supply with TTL inputs for data. line select and autodial. LTU 11 direct coupler required. See above. Connection data supplied.
PRESTEL modem card **£13.00**

STOCKISTS FOR Printers: Paper. Thermal. Daisywheel Disk Drives Boxed. Chassis also Winchester Monitors: Green. Orange. White. Colour Micro's: BBC. Electron. Nascom. Galaxy. Plus others. Cables. plugs. blank disks & tapes. software. books. etc.

HENRY'S COMPUTER SHOP

404-406 Edgware Road. London W2
01-402 6822

Official orders welcome.
(Subject to confirmation)

Please add 15% VAT
(UK only)
Export orders allow adequate CIF

Details available most models send SAE

ORDER BY POST OR PHONE

CIRCLE 05 FOR FURTHER DETAILS.

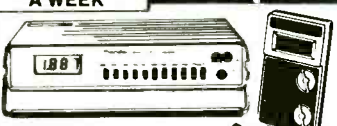
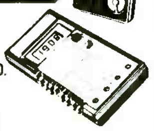
HENRY'S AUDIO ELECTRONICS

OPEN 6 DAYS A WEEK

TEST EQUIPMENT · COMPONENTS · COMMUNICATIONS · COMPUTERS

ALL MODELS ON DISPLAY

ALL PRICES EXCLUDE VAT

DIGITAL MULTIMETERS

(UK C/P & ins Bench type £1.00. Hand held 65p)

PROFESSIONAL SERIES

Thandar Bench Portables

TM355★ 3½ digit LED 29 ranges 10A AC/DC 20 Meg ohm – 0.25% basic	£85.00
TM356★ 3½ digit LCD 27 ranges 10A AC/DC 20 Meg ohm – 0.25% basic	£95.00
TM351★ 4½ digit LCD 29 ranges 10A AC/DC 20 Meg ohm – 0.1% basic	£115.00

(★Optional carry case £5.95)

Thurlby Bench Portables

(★Optional carry case £18.00)

1503★ 4¾ digit LCD 0.05% basic 10uA resolution plus frequency measurement up to 4MHZ AC/DC 10 Amps	£159.00
1503Ha★ 4¾ digit LCD as above but 0.03% basic	£175.00
1054★ 4¾ digit LCD True RMS version	£185.00
1905a 5½ digit intelligent multimeter 1uA resolution 0.015% basic	£325.00

METRIX HAND/BENCH PORTABLES (ITT)

(Size 188 x 86 x 50mm Rotary controls)

MX522 3½ digit LCD 21 ranges 10A AC/DC 2 Meg ohm Basic 0.5%	£67.00
MX562 3½ digit LCD 29 ranges 10A AC/DC 20 Meg ohm Basic 0.2% Plus continuity tester	£95.00
MX563 True RMS 3½ digit. 30 ranges 10A AC/DC. 20 Meg ohm. 20HZ to 30KHZ 0.1% basic	£155.00
MX575 4½ digit True RMS. 21 ranges 10A AC/DC. up to 50KHZ. 0.05% basic	£175.00

HAND HELD MODELS

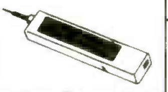
Controls: S = Slide R = Rotary PB = Push button

All feature AC/DC volts, DC amps (many with AC amps) ohms etc. (UK C/P 65p)

ALL MODELS WITH CARRY CASE

KD25C 12 range 0.2A DC 2 Meg ohm (S)	£24.43
KD305 14 range 10A DC 2 Meg ohm (S)	£24.30
KD30C 26 range 1A AC/DC 20 Meg ohm (R)	£29.13
METEX 3000 30 range 10A AC/DC 20 Meg ohm (R)	£33.00
6010 28 range 10A AC/DC 20 Meg ohm (PB)	£33.00
KD55C 28 range 10A AC/DC 20 Meg ohm (R)	£34.74
KD615 18 range 10A DC 2 Meg ohm plus Hfe tester (R)	£34.74
7030 As 6010 but 0.1% basic (PB)	£41.30
DM3350 Autorange plus cont. tester 18 range 10A AC/DC 2 Meg ohm (R)	£43.44
DM2350 Mini autorange plus cont. tester 19 range 10A AC/DC (20A Max) 2 Meg ohm (PB)	£54.73
3100 Pen type auto ranging AC/DC V 20 Meg ohm + buzzer	£39.00

LOGIC PROBES



TTL, DTL etc.

LP10 10MHZ	£19.96
DLP50 50MHZ	£43.44

(UK C/P either model 65p)

ANALOGUE MULTIMETERS

Metrix (ITT)

Professional range

(UK C/P 65p) Size 110 x 45 x 185mm

MX130 25 ranges 5000 ohms per volt 7 DC V 0.1 to 1000, 5 AC V 10V to 1000, 6 DC Amps 100uA to 30A, 5 AC Amps 3uA to 30A 2 ohms 1K to 10K	£65.00
MX230 29 ranges 20K/Volt 100mV to 1000 V DC, 3V to 1000V AC 50uA to 10A DC, 3uA to 10A AC 1K to 10 Meg ohm	£59.00
MX430 32 ranges 40K/Volt DC 4K/V AC 10mV to 1500V DC, 5V to 1500V AC 25uA to 15A DC, 1½uA to 15A AC 50 ohm and 500 ohm (linear scale) 2000K ohm and 20 Meg ohm	£89.00

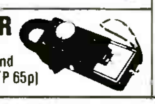
HIGH VOLTAGE METERS

Direct meter reading

LHM80A 0/40KV	£23.00
KHP30N 0/30 0/45KV	£34.74

(UK C/P either model £1.00)

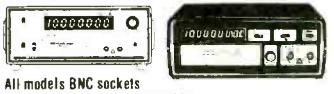
AC CLAMPMETER



0/300A. 0/600V AC 0/1K ohm

Total 9 ranges with carry case and leads ST300 £26.04 (UK C/P 65p)

FREQUENCY COUNTERS



All models BNC sockets

Bench portables (UK C/P £1.00)

(PFM200A pocket counter (C/P 65p)

METEOR SERIES

UK made. 0.1HZ resolution. 8 digit. LED display. mains operated 220/240V AC. switchable gate times.

MET1000 2 range 5HZ to 100MHZ (120MHZ typical)	£89.00
MET600 3 range 5HZ TO 600MHZ (700MHZ typical)	£115.00
MET1000 3 range 5HZ to 1GHZ (1.2GHZ typical)	£159.00

(Optional 6 x nicads £9.95)

SABTRONICS

New models. LED display. switchable gate times.

8110A 8 digit 20HZ to 100MHZ	£79.00
8610B 9 digit 10HZ to 600MHZ	£109.00
8000B 9 digit 10HZ to 1GHZ	£149.00
8500B 9 digit up to 1½GHZ	£239.00

THANDAR

UK made LCD displays with batteries.

TF040 8 digit 10HZ to 40MHZ LCD. 1HZ resolution 40mV sensitivity. 2 gate times with batteries	£120.00
TF200 8 digit 200MHZ LCD. 2 ranges resolution 1ppm. 10mV RHS sensitivity. 5 gate times with batteries	£165.00

Optional carry case £5.95. AC mains adaptor £6.95.

PFm 200A Pocket 8 digit 20HZ to 200MHZ. 2 band LED display with battery 0.1HZ resolution. 10mV sensitivity with battery	£69.50

PRESCALERS

Suitable for most types of counters to extend range. (Thandar) BNC sockets.

TP600 40MHZ to 600MHZ. 10mV RMS. direct powered by counter	£45.00
TP1000 100 to 1000MHZ complete with AC adaptor P/S. 25mV RMS sensitivity	£65.00

Optional probe kits – suitable for all models

X1 £6.90 X10 £8.26

VARIABLE POWER SUPPLIES

220/240V AC input

PP241 single meter. A/V switch. 0/30V 1 amp	£30.43
PP243 3 amp version	£52.13
230N Twin meter 0/30V 1A	£83.00
330N 3 amp version	£142.00

(UK C/P above models £1.00)

PL Laboratory series · LED readout · QMD versions series/parallel etc.

PL310 30V 1A	£118.00	**PL310** QMD	£249.00
PL320 30V 2A	£145.00	**PL320** QMD	£315.00

(UK C/P above models £2.50)

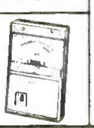
ANALOGUE MULTIMETERS

General range (★mirror scale)

(UK C/P 65p)

HC6015 15 range pocket 10K/Volt 1 meg ohm	£7.39
M200 30 range 20K/Volt 20KHZ Special purchase **£8.65** (list price £19.00)	
HM102BZ★ 22 range 20K/Volt 10A DC plus cont. Buzzer, 10 Meg ohm	£11.74
TMK500★ 23 range bench. 30K/Volt 12A DC Plus cont. buzzer, 20 Meg ohm	£20.83
NH56R★ 22 range 10K/Volt, 6 Meg ohm	£10.39
830A★ 26 range 30K/Volt 10AC/DC: 10 Meg ohm	£20.83
360TR★ 23 range bench, 100K/Volt, large scale, 10A AC/DC plus Hfe tester, 10 Meg ohm	£34.74
AT2100★ 31 range de luxe 100K/Volt 10A AC/DC: 100 Meg ohm	£29.13
AT1020★ 18 range de luxe 20K/Volt plus Hfe tester. 5 Meg ohm	£18.26
YN360TR★ 19 range 20K/Volt plus Hfe tester 1 Meg ohm	£12.13
KRT5001★ Range doubler 35 range total 50K/Volt 10A DC 20 Meg ohm	£17.35
ST303TR★ 22 range 20K/Volt plus Hfe tester 12A DC 1 Meg ohm	£15.61

ELECTRONIC INSULATION TESTER



500V/0-100 Meg ohm with carry case, leads etc.

YF501 £59.13 (UK C/P 65p)

SIGNAL GENERATORS

220/240V AC (UK C/P & ins £1.00)

Bench portable all sine/square/triangle/TTL/etc.

External sweep mode.

FUNCTION

Thandar TG101★ 0-.02HZ to 200KHZ various facilities	£105.00
Thandar TG102★ 0.2HZ to 2MHZ various facilities	£155.00
Jupiter 500 0.1 Hz – 500KHZ	£110.00
Thandar Pulse Bench portable **TG105★** 5HZ to 5MHZ Various facilities	£105.00
★ Optional carry case	£5.95

AUDIO

Leader LAG27 5 band sine/square O/P 0/5V RMS Dist 0.05% 10HZ to 1MHZ	£93.00
Leader LAG120A 5 band 10HZ to 1MHZ to 0-3V RMS into 600 ohm 0.05% dist. sine/square	£145.00
Leader LAG125 5 band 10HZ to 1MHZ to 0-3V RMS into 600 ohm sine/square/burst signals 0.03% dist	£330.00
TRIO AG202A 4 band 20HZ to 200KHZ. 10V RMS O/P 0.5% dist. CR OSC 0/10V pp O/P	£89.00
TRIO AG203 5 band 10HZ to 1MHZ. 0.1% dist 0/7V RMS O/P	£139.00

RF

TRIO SG402 6 range 100KHZ to 30MHZ RF 0.1V RMS Int/ext mod	£72.00
Leader LSG17 6 band 100KHZ to 150MHZ (96 to 450MHZ on Harmonics) RF 0.1V RMS. Int/ext Mod, AF 1KHZ 1 volt (1MHZ Xcal optional £3.00)	£95.00

DIGITAL CAPACITANCE METERS

Direct reading LED meters

DM6013 Pocket/bench 8 range 0.1pf to 2000mfd 3½ digit 0.5% with battery (UK C/P 65p)	£52.13
CM200 Bench model 4½ digit 0.2% 1pf to 2500mfd 6 ranges (UK C/P 85p)	£89.00

DIGITAL THERMOMETERS

Pocket size LCD thermometers complete with battery Accept any type K probe (UK C/P 65p)

TH301 LCD -50°C to +750°C. 1°C resolution with thermocouple	£59.50
TH302 LCD -40°C to 1100°C Cent/Fahrenheit 0.1° and 1° resolution with thermocouple	£79.50

Range of various probes in stock £17.50 to £25.00

COMPONENTS · ACCESSORIES TOOLS

Large range in stock semiconductors, relays, tools. Plus millions of capacitors, resistors, presets, controls, plugs/sockets etc, etc. For bulk export users. Tel: 01-723 1008 with enquiries.

OTHER EQUIPMENT IN STOCK

Send SAE for full specifications

(★UK C/P £1.50 +UK C/P £1.00)

LHC 909★ VHS/BETA video head tester	£45.00 ea
OM358+ Scope multiplexer, 35MHZ. expands any scope to eight channels	£169.00
LTC905★ Scope add-on semicon curve tracer	£99.00
LCT906A+ Transistor tester (all types)	£109.00
LTC907+ Transistor tester, signal injector tracer	£178.00
LVT72+ FET/VOM/transistor tester	£143.00
LCR740★ LCR bridge: cap. inductance and resistance	£195.00
LDM170★ Distortion meter 20HZ to 20KHZ	£310.00
LFG1300★ Sweep 0.3% function generator 0.002HZ to 2MHZ	£395.00
TC40★ VHF/UHF FM and TV field strength meter Battery operated with carry case	£177.00
MC321+ UK PAL TV colour pattern generator	£222.60
MC32B+ As above but PAL B-G-H	£222.60
OM801+ 700KHZ to 250MHZ Dip meter inductive/cap res. freq. measurement etc.	£62.00
CHART RECORDER 100mV (2mA) Panel mount 240V AC	£149.00
LFM39 A-0★ Wow and flutter meter. Jis. CCIR. Din.	£445.00
HZ65+ Scope add on component tester	£24.00
LTC910A★ CRT tester/rejuvenator for b/w and colour	£175.00

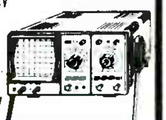
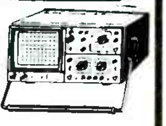
OSCILLOSCOPES

Full specification any model Send SAE

UK C/P – & ins

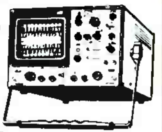
Single trace		Dual trace	
carrier	£2.60	carrier	£3.50
TNT	£5.20	TNT	£7.00
Securicor	£10.45	Securicor	£13.00

HAMEG 2 years warranty

HM103 Single trace. 10MHZ. 2mV. 6 x 7cm display plus component tester	£158.00
HM203 Dual trace 20MHZ 2mV. Algebraic add. 'Z' Mod. plus component tester (Optional carry case £21.50)	£264.00
HM204 Dual trace 20MHZ. sweep delay. 2mV. plus component tester (optional carry case £21.50)	£365.00
HM605 Dual trace 60MHZ. delay line. 1mV. 1MHZ CALGEN (optional carry case £21.50)	£487.00

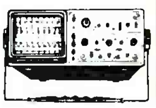
HITACHI



All models 5mV (1mV using x5 magnifier)

All models complete with 2 probes.

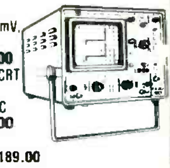
2 years warranty.



V212 Dual 20MHZ. bench portable 6" CRT CH1 O/P	£335.00
V222 Dual 20MHZ. portable with DC offset and alternate magnifier	£375.00
V203F Dual 20 MHZ Lab port with Sweep delay. 5½" CRT	£375.00
V422 Dual 40MHZ. portable with DC offset and alternate amplifier	£580.00
V353F 35 MHZ dual trace lab port. with sweep delay. 5½" CRT.	£580.00
V650F Dual 60MHZ lab portable with dual time base	£850.00

Also in stock V134 storage. VC6015 digital storage scopes. Battery/Mains Scopes. Vector & TV monitor available

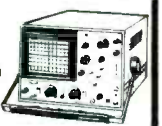
CROTECH



3030 Single trace 15MHZ. 5mV. 95mm CRT plus component tester	£169.00
3132 Dual 20MHZ. 2mV. 5" CRT Algebraic +/−. 'Z' mod. plus component comparator and DC source outputs	£283.00
3035 Single trace 10MHZ + comp. tester 5" CRT	£189.00

TRIO 2 years warranty

GOS3310 Single trace 10 MHZ 5mV. 75mm display. Mains port.	£139.00
CS1562A Dual trace 10MHZ. 130mm CRT. 10mV. 1 microsec. with 2 probes	£260.83
CS1566A Dual 20MHZ. 140mm CRT. 5mV. 0.5 microsec, with 2 probes	£326.00



THANDAR

2 years warranty

SC110A 10MHZ battery bench portable. 10mV 32 x 26mm display. Size 255 x 150 x 50mm **£165.00**

(Optional carry case £5.95. AC adaptor/charge £6.95) **Rech Nicad £11.00**

EDUCATIONAL; MIXED QUANTITY & EXPORT DISCOUNTS

DISCOUNTS

We would be pleased to quote. Contact sales office at 406.

TRANSISTOR TESTER

Direct reading PNP/NPN and diodes.

Hfe. leakage etc. General purpose TC1

£23.43 (UK C/P 65p)

PROBE KITS

In wallets with adaptors etc. BNC fittings for scopes/counters/generators etc.

X1	£6.90	X1/X10 Switchable	£10.00
X10	£8.26	Demodulator	£16.00
X100	£16.00		

(UK C/P free with other item or 65p per 1 to 3 kits)

RETAIL • MAIL ORDER • EXPORT • INDUSTRIAL • EDUCATIONAL

Official orders welcome. (Subject to confirmation)

Please add 15% VAT (UK only)
Export allow adequate CIF

PRICES EXCLUDE VAT

Shop **HENRY'S** 404-406 Edgware Road, London, W2
Computers 01-402 6822 • Equipment 01-724 0323 • Components 01-723 1008
Shop **AUDIO ELECTRONICS** 301 Edgware Road, London, W2
Test Equipment, Audio, Communications 01-724 3564
All mail to Cubegate Ltd, 1st Floor, 406 Edgware Road, London W2 1ED

ORDER BY PHONE OR BY POST OR CALL IN AND SEE FOR YOURSELF

Pay it with Access · VISA · AMERICAN EXPRESS

Order by Post with CHEQUES/ACCESS/VISA or you can telephone your orders.

Up to £1000 instant credit
Available through Lombard Tricity Finance

CATALOGUES

Send large
SAE (20p UK)
Specification sheets
Any model
(State which)
Send SAE
Schools, colleges, companies
Export free on written request

CIRCLE 05 FOR FURTHER DETAILS.

ESTABLISHED 30 YEARS. U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

RECORD DECKS 240 volt AC. Post £2

Make	Model	Drive	Cartridge	Price
BSR	P170	Rim	Ceramic	£22
GARRARD	6200	Rim	Ceramic	£24
BSR	P207	Rim	Ceramic	£20
BSR	P232	Belt	Magnetic	£28
BSR	P200	Belt	Magnetic	£34
BSR 12 Volt	P267	Belt	Ceramic	£24
AUTOCHANGERS 240 VOLT				
BSR	Budget	Rim	Ceramic	£18
BSR	Deluxe	Rim	Ceramic	£20
BSR	Deluxe	Rim	Magnetic	£26
GARRARD	6200	Rim	Ceramic	£22

THE "INSTANT" BULK TAPE ERASER **£11.50** Post 95p
Suitable for cassettes and all sizes of tape reels. AC mains. Will also demagnetise small tools. **Tape Head Demagnetiser £5.**

ALUMINIUM CHASSIS. 2½in. deep 6×4 **£1.75**; 8×6 **£2.20**; 10×7 **£2.75**; 12×8 **£3.20**; 14×9 **£3.60**; 16×6 **£3**; 16×10 **£3.80**; 12×3 **£2.20**; 14×3 **£2.50**; 13x9 **£2.80**.

ALUMINIUM PANELS. 6×4 **55p**; 8×6 **90p**; 14×3 **90p**; 10×7 **£1.15**; 12 × 8 **£1.30**; 16 × 6 **£1.30**; 14 × 9 **£1.75**; 12 × 12 **£1.80**; 16 × 10 **£2.10**.

ALUMINIUM BOXES. 4×4×1½ **£1.20**. 4×2½×2 **£1.20**. 3×2×1 **£1.20**. 6×4×2 **£1.90**. 7×5×3 **£2.90**. 8×6×3 **£3**. 10×7×3 **£3.60**. 12×5×3 **£3.60**. 12 × 8 × 3 **£4.30**; 9 × 4 × 4 **£3**.

POTENTIOMETERS 5k/2meg. LOG or LIN. L/S **50p**. DP **90p**. Stereo L/S **£1.10**. DP **£1.30**. Edge Pot 5L. SP **45p**.

MINI-MULTI TESTER £7.50 Post 50p

Pocket size moving coil instrument. 4000 o.p.v. 11 ranges: DC volts 5, 25, 250, 500. AC volts 10, 50, 500, 1000. DC amps 0-250µA, 0-250mA. Ohms 600K.

De Luxe Range Doubler MULTI-METER **£19.50**
50,000 o.p.v. 7×5×2in. 50 Micro Amp
43 Ranges, 1,000V, AC-DC, 20 MEG 10 amp DC Post £1

PANEL METERS 50µa, 100µa, 500µa, 1ma, 5ma, 50ma, 100ma, 500ma, 1 amp, 2 amp, 5 amp, 25 volt, VU 59×53×34mm. Stereo VU 82×41×25mm **£5.** p.p. 50p

RCS SOUND TO LIGHT CONTROL BOX

Complete ready to use with cabinet size 9×3×5in.
3 channel, 1000 watt each. For home hi-fi or disco **£27**
OR KIT OF PARTS £19.50 Post £1

BATTERY ELIMINATOR Mains to 9 volt D.C. 400MA. Stabilised, safety cutout, 5×3¼×2½in. **£5.** Post £1.

DISCO GRAPHIC MIXER EQUALISER £108. Post £2.
4 channel stereo, 5 band graphic, red + green LED. VU display, headphone monitor.
Deluxe Model, 5 channel 7 band graphic. **£118.**

FAMOUS LOUDSPEAKERS

MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
AUDAX	WOOFER	5in	25	8	£10.50	£1
GOODMANS	HIFAX	7½×4¼	100	8	£30	£2
GOODMANS	HB WOOFER	8in	60	8	£12.50	£1
WHARFEDALE	WOOFER	8in	30	8	£9.50	£2
CELESTION	DISCO/GROUP	10in	50	8/16	£21	£2
GOODMANS	HPG/GROUP	12in	120	8/15	£29.50	£2
GOODMANS	HPD/DISCO	12in	120	8/15	£29.50	£2
GOODMANS	HP/BASS	15in	250	8	£72	£4
GOODMANS	HPD/BASS	18in	230	8	£84	£4

RCS STEREO PRE-AMP KIT. To build. Inputs for high, medium or low imp volume control and PC Board. Can be ganged for multi-channel **£3.50** Post 65p

MAINS TRANSFORMERS

	Price	Post
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	£7.00	£2
350-0-350V 250mA, 6.3V 6A CT	£12.00	£2
220V 25ma 6V lamp **£3.00** 220V 45ma 6V 2 Amp	£4.00	£1
250V 60mA, 6V 2A	£5.00	£1
Step-Down 240V to 115V 150W **£9**. 250W **£12**. 500W	**£14**	£2

GENERAL PURPOSE LOW VOLTAGE

Tapped outputs available

	Price	Post
2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00	£2
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00	£2
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2

5-8-10-16V. ½ amp	£2.50	£1	0-8-12V. 5 amp	£5.00	£1
6V. ½ amp	£2.00	£1	15-0-15V. 1 amp	£4.00	£1
6-0-6V. 1½ amp	£3.50	£1	15-0-15V. 2 amp	£5.00	£1
9V. 400ma	£1.50	£1	20V. 1 amp	£4.00	£1
9V. 3 amp	£4.00	£1	20-0-20V. 1 amp	£3.50	£1
9-0-9V. 50ma	£1.50	£1	0-12-27V. 2 amp	£4.00	£1
9-0-9V. 1 amp	£3.50	£1	20-40-60V. 1 amp	£3.50	£2
10-0-10V. 2 amp	£4.00	£1	25-0-25V. 2 amp	£5.50	£1
10-30-40V. 2 amp	£5.50	£1	24V. 5 amp Twice	£12.00	£2
12V. 100ma	£1.50	£1	30V. 1½ amp	£5.00	£1
12V. 750 ma	£2.50	£1	30V. 5 amp and		
12V. 3 amp	£4.50	£1	17-0-17 2a	£4.50	£2
12-0-12V. 2 amp	£4.50	£1	35V. 2 amp	£4.00	£1

LOW VOLTAGE ELECTROLYTICS
500mF 12V **15p**; 25V **20p**; 50V **30p**. 1200mF 76V **80p**.
1000mF 12V **20p**; 25V **35p**; 50V **50p**; 100V **£1.20**.
2000mF 30V **42p**; 40V **60p**; 100V **£1.40**; 1500mF 100V **£1.20**.
2500mF 50V **70p**. 3000mF 50V **65p**; 4700mF 40V **£1**.

CAPACITORS WIRE END High Voltage
.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V **10p**.
.1MF 400V **14p**. 600V **15p**. 1000V **25p**.
.22MF 350V **12p**. 600V **20p**. 1000V **30p**. 1750V **60p**.
.47MF 150V **10p**. 400V **25p**. 630V **30p**.

HIGH VOLTAGE ELECTROLYTICS

2/500V	45p	32+32+16/350V	90p	8+16/450V	75p
16/450V	45p	100+100/275V	50p	16+16/350V	80p
20/500V	75p	150+200/275V	50p	32+32/350V	85p
32/350V		32+32+32/450V	95p	16+16/450V	£1
32/500V	95p	50+50+50/350V	95p	50+50/300V	50p
125/500V	£2	8+8/500V	£1	50+50/350V	80p

BAKER AMPLIFIERS BRITISH MADE

PA150 Watt MICROPHONE VOCAL AMPLIFIER £129

4 channel mixing, 8 inputs, dual impedance, 50K-600 ohm, volume, treble, bass. Presence controls on each channel. Master volume control, echo send return socket. Slave sockets. Post £3.

150 Watt MIXER AMPLIFIER 4 Inputs £99

Discotheque, Vocal, Public Address. Speaker outlets for 4, 8 or 16 ohms. Four inputs, 20 mv, 50K ohm. Individual volume controls "Four channel" mixing. Slave output. 16"×8"×5½". Wt – 14lb: Master volume control. 240V A.C. Post £2.
100 Volt Line Model, 150 watt £114. MONO SLAVE, 150 watt £80. Baker Stereo Slave 150 + 150 watt 300 watt Mono £125. Post £4.

BAKER MOBILE PA AMPLIFIER. All transistor, 60 watt RMS, 12v DC & 240v AC, 4 inputs 50k. Aux + 2 mics + 1 phono. Output 4-8-16 ohm + 100 volt line. **£89 Post £2**

WATERPROOF HORNS 8 ohms. 25 watt 10in. **£20.** 30 watt 8 × 4½in. **£23.** 40 watt 12in. **£26.** 20 watts 12in. plus 100 volt line **£32.** Post £2.

BAKER PORTABLE DISCO 150 watt. Twin console + amplifier + mike and headphones + twin speakers **£330.** 300 watt **£399.** Carr. £30. Console + decks + pre-amp **£105** Carr. £12.

PA CABINET SPEAKERS, Complete. 8 ohm 60 watt 17×15×9in. **£27.** Post £4. 4 or 8 or 16 ohm 75 watt 23×15×11in. **£52.** 90 watt 32×15×11in. **£71.** 150 watt **£80.** Carr. £10. Black vinyl covered.

BAKER LOUDSPEAKERS

Post £2 each.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE
DISCO/GROUP	10	8-16	50	PA	£18
MIDRANGE	10	8	100	MID	£25
MAJOR	12	4-8-16	30	HI-FI	£16
SUPERB	12	8-16	30	HI-FI	£26
WOOFER	12	8	80	HI-FI	£25
AUDITORIUM	15	8-16	60	Woofer	£37
DISCO/GROUP	12	4-8-16	45	PA	£16
DISCO/GROUP	12	4-8-16	75	PA	£20
DISCO/GROUP	12	8-16	100	PA	£26
DISCO/GROUP	15	8-16	100	PA	£35

REPAIR service to most Baker loudspeakers. **SPEAKER COVERING.** Samples S.A.E. **CABINET WADDING** 18in wide **35p** ft.

MOTOROLA PIEZO ELECTRIC HORN TWEETER, 3⅜in. square £5
100 watts. No crossover required. 4-8-16 ohm, 7⅜×3⅛in. £10
HORN BOXES, complete 200 watt **£30.** 300 watt **£35.** Size 16x6x6in. Black vinyl covered with handle Post £4.

CROSSOVERS. TWO-WAY 3000 c/s 30 watt **£3.** 60W **£3.50.** 100W **£4.** **THREE-WAY** 950 cps/3000 cps. 40 watt rating. **£4.** 60 watt **£6.** 100W **£8.**

LOUDSPEAKER BARGAINS. Please enquire, many others in stock.
4 ohm, 5in, 7×4in, **£2.50**; 6½in, 8×5in, **£3**; 8in, **£3.50.** 6½in 20W, **£7.50.**
8 ohm, 2⅝in, 3in, **£2**; 5×3in, 6×4in, 7×4in, 5in, **£2.50**; 3in, 10W **£4** 8×5in, **£3**; 8in, **£4.50**; 10in, **£5**; 12in, **£6.** 8in 25W **£6.50.** 60W **£12.50**
15 ohm, 2¼in, 3½in, 5×3in, 6×4in, **£2.50.** 6½in 10W **£5.** 8in **£4.** 10in **£7.**
25 ohm, 3in, **£2**; 5×3in, 6×4in, 7×4in, **£2.50.** **120 ohm,** 3¼in dia. **£1.**
EMI 13½x8in. Bass & Tweeter 4 or 8 ohm 10 watt **£8** pp **£1.**

RADIO COMPONENT SPECIALISTS

Dept 1, 337 WHITEHORSE ROAD, CROYDON
Open 9-6. Closed all day Wed. Open Sat. 9-5.

Books and Components Lists 32p stamps. (Minimum post/packing charge 65p.) Access or Barclaycard Visa. Tel: 01-684 1665 for SAME DAY DESPATCH. Cash prices include VAT.
WW-7

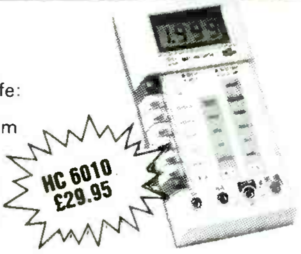
CIRCLE 12 FOR FURTHER DETAILS.

Affordable Accuracy — Low Cost Multimeters from Armon

SPECIFICATION
HC 6010 DIGITAL

- ★ 10 Amp AC/DC
- ★ Battery: Single 9V PP3. Life: 200 hrs.
- ★ Dimensions: 170 × 89 × 38mm
- ★ Weight: 400g inc. battery
- ★ Mode Select: Push Button
- ★ AC DC Current: 200µA to 10A
- ★ AC Voltage: 200mV to 750V
- ★ DC Voltage: 200mV to 1000V
- ★ Resistance: 200Ω to 20MΩ
- ★ Input Impedance: 10MΩ
- ★ Display: 3½ Digit 13mm LCD
- ★ O/load Protection: All ranges
- ★ Accuracy: 0.5% DC Volts

28 RANGES, EACH WITH FULL OVERLOAD PROTECTION. BATTERY & TEST LEADS INCLUDED



SPECIFICATION
HC1015 ANALOGUE

- ★ DC Voltage: 0.25, 2.5, 25, 250, 1,000 Volts, 10,000 Ohms/Volt
- ★ AC Voltage: 10, 50, 250, 1,000 Volts, 4,000 Ohms/Volt
- ★ DC Current: 1, 10, 500mA
- ★ Resistance: 0 to 1 MegOhm in 3 ranges
- ★ Decibels: −20dB to +62dB
- ★ Battery: One 1.5V size AA (incl)
- ★ Size & Weight: 105 × 63 × 32mm; 130gr

19 RANGES, COMPLETE WITH BATTERY AND TEST LEADS

ARMON ELECTRONICS LTD.

Dept "A", Cottrell House, 53-63 Wembley Hill Road
Wembley, Middlesex HA9 8BH
Telephone: 01-902 4321 (3 lines). TELEX No. 923985

Please add 15% to your order for VAT. P&P free of charge. Payment by cheque with order. Offer applicable to mainland UK only.

TRADE ENQUIRIES INVITED. FULL RANGE OF METERS ON APPLICATION

Please allow 15 days for delivery.

CIRCLE 29 FOR FURTHER DETAILS.

RADFORD

Audio Measuring Instruments, Audio Amplifiers, Loudspeakers and Loudspeaker Components for the professional and enthusiast

RADFORD AUDIO LTD.
10 BEACH ROAD
WESTON-S-MARE, AVON BS23 1AU

TEL. 0934 416033

CIRCLE 31 FOR FURTHER DETAILS.

IN VIEW OF THE EXTREMELY RAPID CHANGE TAKING PLACE IN THE ELECTRONICS INDUSTRY, LARGE QUANTITIES OF COMPONENTS BECOME REDUNDANT. WE ARE CASH PURCHASERS OF SUCH MATERIALS AND WOULD APPRECIATE A TELEPHONE CALL OR A LIST IF AVAILABLE. WE PAY TOP PRICES AND COLLECT.

R. Henson Ltd.

21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tally Ho corner

Telephone 445 2713/0749

CIRCLE 32 FOR FURTHER DETAILS.

TARDY TRADERS

On reaching retirement I thought that I would like to undertake some electronic projects to keep me alert and active, so I set about getting information and components.

In the last two months I have sent for catalogues, perused them carefully and then ordered successively as plans matured and I discovered further suppliers. Although I have ordered from fourteen component suppliers advertising in a variety of journals, many of them four or five times, with individual orders worth from just over £4 to £126.

I am sorry for industry and can understand some of their poor performance if they have the same sort of experiences that I have had, as well as for other hobbyists who are treated as I have been. Only two of the firms were fully efficient (E&T) and always sent a correct order — the others all exhibited one or more of the following, often more than once.

1. Wrong items sent.
2. Items sent not as described in advertisement or catalogue.
3. Items sent short.
4. Items not of the quality advertised.
5. Items not of the value ordered.
6. Items out of tolerance — the classic case was one order of metal film 1% resistors which, when measured, were not even with 10% tolerance! What of those items the amateur cannot check, such as complex i.cs.
7. Despite 'phoning, items out of stock by the time the order reached the supplier.
8. Suppliers offering data do not send full information. Manufacturers' data is very slow, sometimes not sent at all, even if s.a.e. is sent, as I nearly always do — do they want orders?
9. Catalogues have misleading, downright misleading and clearly wrong information yet most disclaim responsibility if this results in damage — I wonder whether their disclaimer would stand up in law?
10. Some firms pack individual items and groups of like items: one just bundled the goods together in one jiffy bag.
11. Few firms send with the goods an invoice listing the items sent, a few send receipts and some send nothing of this sort.
12. Despatch is always promised the same day as receipt of order. Despite being on the western fringe of the country I have overnight first-class post to and from most parts, yet only one firm has actually got goods back to me on the third day — the time for the majority from posting here is six days, so why advertise same day despatch? A moderately fast, reliable service would be more acceptable than a very fast unreliable one!

If this is the sort of thing that is going on throughout the industry and commerce on this scale then I think we as a nation have no future, for it is adding unnecessarily to costs and wasting time for productive work. This we certainly cannot afford in the present economic climate of the world and of our country.

D. S. White
Gwynedd

DOMESTIC EMC

The RSGB's 56th a.g.m. which was reported in the November 1983 issue of the Society's journal, *Radio Communication*, contained a number of references to the proposed new Telecommunications Bill. Similar to the Australian Radiocommunications Bill (Act), it replaces the old Wireless Telegraphy Act. However, unlike the Australian Act, the UK Bill seems to contain little or no legislation to cover the EMC problems with domestic electronic and entertainment equipment. When asked why this was not covered, the RSGB President replied that he considered this to be a most difficult area and that the Bill would prove unworkable if extended into this area.

Considering many European countries, the USA and Australia are addressing themselves very positively toward the effective EMC control needed to allow the complex electronic communications and control equipment, which will take us into the 21st century, to function correctly and efficiently: And, the constant flow of reports from the UK which indicate the EMC problems with domestic electronic and entertainment equipment is increasing at an alarming rate. It is therefore, indeed, most surprising to see the RSGB taking such a negative attitude towards a problem which has given UK amateurs such a headache for so many years.

No such difficulty or concern was expressed, or is considered, by the world's most senior amateur radio society — The Wireless Institute of Australia. The WIA worked in close cooperation, as always, with the Australian Department of Communications in the production of the new Radiocommunications Bill. Indeed, the DOC and the WIA gave very special consideration and attention to the extensive and extremely comprehensive EMC section of the new Act.

A.D. Tregale, VK3QQ
ARTAC International
Watsonia
Australia

LICENCE REGULATIONS

There can be few British radio amateurs who have not, at some time, been in a situation where they would have dearly liked to ask the station to whom they were communicating to, for example, send a short greetings message to a friend or relation whom they haven't seen for years or, just ask simple route directions for a friend. For British amateurs this is designated, by the licensing authorities, as 'third-party' and is, in general, forbidden! Any sensible reason for these medieval and totally unnecessary restrictions, remains a mystery!

British amateurs, for years, have had to remember to be extremely careful to avoid mentioning, over-the-air, anything which could, even remotely, be considered 'third-party.' Not only for the fear of repercussions from the authorities, but in consideration of the other station, who also has to live under these austere and antiquated regulations. It appears that the British licensing authorities consider the Amateur Radio Service has progressed little since the days of Marconi, and spark transmitters.

Members of the Amateur Radio Service did, in the old days, a great deal of home construction and experimentation. There were two main reasons for this; the only radio equipment available was built by amateurs and enthusiasts and there was an obvious need to do extensive research into the basic concepts of our primary radio communication modes.

With modern communications technology we are, in the main, addressing ourselves to the more detailed and specialized areas. Our previously developed primary communications systems allow us to communicate ideas and information about these specialised subjects, thereby promoting higher levels of national and international technological development. Equally important, in these days of world tension, is the development of national and international friendship, through communications. Fortunately, this latter area has been especially cared for by many of the new members of our service. Unlike the old days, when it was of prime importance to place great emphasis on the technical aspects of our primary communicatons systems, there is today a leaning towards communicating for friendship, with experimentation and research as closely related secondary subjects.

Modern economic trends are towards shorter working weeks, more leisure time, and increasing psychological pressure during the time at the work place: therefore, a greater number of people are looking for suitable relaxing hobbies and, amateur radio is indeed most suitable. Consequently, the obvious and simple extension for members of the British Anateur Radio Service would be the lifting of the third-party restrictions.

Australian amatuers shook off the third-party restriction shackles some three years ago, took a breath of the fresh air, and never looked back. It is indeed most refreshing not to need a barrister in the shack!

A.R.T.A.C. International would like to hear from anyone interested in the removal of this totally unnecessary restriction on the British Amateur Radio Service.

A.D. Tregale, VK3QQ
ARTAC International
Watsonia
Australia

ELECTRIC CHARGE FROM A RADIO WAVE

In his letter (January 1984) Peter Hesketh gives a step by step method of changing Professor Jennison's apparatus to produce an ideal waveguide bent into a circle. I agree with him that no amplifier is in principle necessary to maintain a wave in such a guide, and so far, his assumptions are completely justified. However, I do not see how he can use this idealised equipment, even in his imagination, to support Professor Jennison's contention.

Is it not true that the velocity in space of a guided electromagnetic wave is independent of the motion of the conductors that do the guiding? In other words, even in principle we cannot drive a waveguide backward so that the wave it carries is arrested in space.

Now this objection does not apply to the discrete component machine described in the article. The waves associated with such a machine are not electromagnetic waves in space, but as I said in my earlier letter, more like the waves we find on a polyphase machine. As such they have a velocity relative to the hardware of the machine. Perhaps Mr Hesketh has raised unwittingly a more serious objection to Professor Jennison's demonstration than at first occurred to me. We cannot use a machine that generates waves having a velocity which can be vectorially combined with the velocity of the machine to explain phenomenon where the waves have a velocity that is independent of the machine velocity.

Perhaps in what I say I am mistaken. I would certainly like to see Professor Jennison's defence of his apparatus.

Chris Parton
Department of Electrical & Electronic Engineering
Bell College of Technology
Hamilton

ENERGY SAVING

Mr Cummins states that he uses no supplementary heating and implies that for this reason he does not need theromostats in individual rooms.

I of course applaud his basic design approach but should be very interested to know how in practice it copes it copes with three unavoidable sources of supplementary heat: (a) solar radiation, (b) people and (c) their reading lights and televisions. I find that the first alone, here in the temperate South at any rate, can entirely obviate the need for heat from the radiators in South-facing rooms even on cold days, and in specifying my central heating installation I considered room thermostats to be essential in South-facing rooms and highly desirable in other rooms whose occupancy was liable to vary much during heating hours.

Ian Leslie
London N 10

PROBLEMS IN SPECIAL RELATIVITY

I am sorry that Professor McCausland found my simple arithmetic derivation somewhat obscure. Had he persevered he would have discovered that C.F. Coleman was quite right. Dingle was, and McCausland is still, confused over the distinction between simultaneity and synchronicity, as the latter's comments on Coleman's letter now make clear.

McCausland states, correctly, that Einstein's procedure for synchronizing clocks was based upon the out and return journey of a light beam between clocks A and B. McCausland, (not Einstein) then adds, 'If the reading on B at the moment of reflection is halfway between the readings of A at emission and return of the flash, the clocks are synchronised'. Not true, as my worked example shows. This requirement actually means that clocks A and B both reach time, say 1200h simultaneously. He has tried to smuggle in simultaneity under the guise of synchronicity and it cannot be done. This is the advantage of a worked example — it uncovers the verbal ambiguities.

Let me spell it out. There is *no* observational procedure which will enable clock B to show the same time simultaneously with A that does not invlove a vicious circle in the procedure. I challenge McCausland, or anybody, to produce one. McCausland's error is fundamental and the remainder of his argument now fails.

Statements invloving the expression 'real effect' need clarifying. If I observed a physical phenomenon using the best instruments, the best scientific procedures, and after repeated measurements arrived at a result, I should be somewhat surprised if somebody said that my results were only an observational effect and that the real effect was something different. I should conclude that the someday either knew something that I did not, or was indulging in metaphysics. In either case I should ask for observational evidence.

J.C. Laine
Lymington
Hants

POWER OSCILLATOR

In the 1970 September and October issues of *Wireless World* you were good enough to publish details of my new 13 Watt sine wave oscillator, which resulted in some adverse comments from Thomas Roddam, one being about the cores used. In order to cut down on the number of cores used it was decided to try using a pair of E cores (Mullard FXI8I8) with the emitter and collector coils on the outer limbs. This arrangement works very well in practice as well as being much cheaper. The phase shift coil was also made using a pair of E cores (Mullard FXI652) The final design resulted in a unit 4in long by 1$\frac{1}{2}$ in wide and $\frac{3}{4}$in thick, weighing 4 ounces. The oscillator in this form was used to drive a 13 Watt fluorescent 21 inch tube. A large number of these were used to provide lighting in a factory during the power cuts of the early 70s. A car ignition unit was also built and tested in a Fiat car on a tour of Europe. I still have the original unit and demonstrate it to those who show interest.

The oscillator was invented in 1959 to provide the bias and erase for a small high quality tape recorder for use in the news gathering business. The circuit was given the final patent in 1962 and also patented in Germany, Japan and America. I am the sole inventor of the oscillator as can be verified by the Patents Office. I must admit to being puzzled by the lack of interest and discussion about the oscillator which is quite a breakthrough in sine wave power oscillators. The fact that the transistor does not need a heat sink and will continue to operate in temperatures up to 1200C I thought would have aroused some interest, particularly as the current falls with an increasing temperature. Also it can survive short circuit of the output indefinitely if capacitively coupled to the load, there being no current flow when oscillation ceases.

I am enclosing photographs of the fluorescent lighting unit and the ignition unit to show the coil assembly used for the emitter and collector coils.

H.L. Armer
Alvaston
Derby

THE MIND-FORG'D MANACLES

I'm pleased to see you quoting from Blake in your April editorial. Perhaps I could answer with another quotation:

> Now I a fourfold vision see,
> And a fourfold vision is given to me;
> 'Tis fourfold in my supreme delight
> And threefold in soft Beulah's night
> And twofold Always. May God us keep
> From Single vision and Newton's sleep!

The single vision which Blake so feared corresponds exactly to what you call the 'technicization of society' Many people outside of technology have noted the acceleration of this process but, lacking inside knowledge, have been unable to challenge it at its base. Their impotence has resulted in a blind despair of technology, a sort of a modern-day Luddism, whose danger is that it could lead to the formation of a dual society: technocratic and desperate on the one hand, anarchic and desperate on the other.

It is left up to engineers and technologists themselves to awake from Newton's sleep and, taking control of the process, direct it back towards the humanization of technology. The 'characteristic mode of thinking and feeling that determines the way machines and systems are designed, used and interact with people' must be consciously recognised and modified if there is to be a human future.

Tim Williams
Tunbridge Wells
Kent

SPECIAL OFFER from ELECTRONICS & Wireless World

HIGH QUALITY PRECISION PLIERS AND CUTTERS

These precision box jointed pliers and cutters are manufactured in West Germany and are of extremely high quality. They are supplied to and used by the electronics industry. They all have double leaf springs, moulded-on PVC grips and polished heads. The cutters have induction hardened cutting edges.

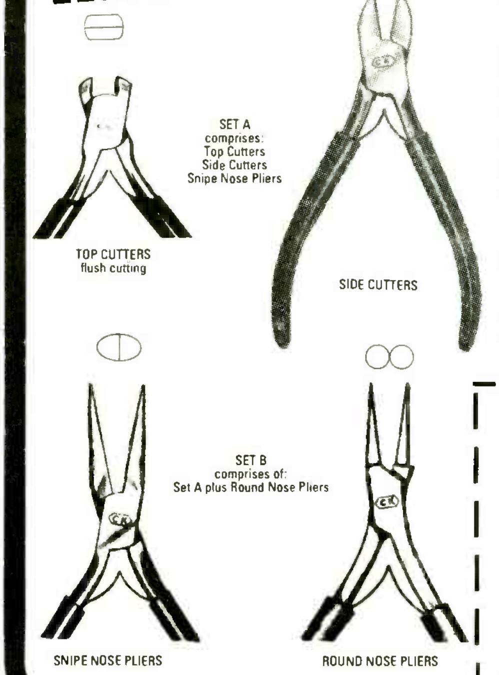
As a little test of the quality and the squareness and fit of the jaws we tried holding pieces of paper with the pliers and cutting the paper with the cutters – we were extremely impressed. Naturally we also tested them with wire and were equally pleased with the results.

We decided to offer readers the alternative of a set of the three most vital tools, comprising top cutters, side cutters and snipe nose pliers (smooth inside jaws). All are approximately 4¾″ long. In shops this set (Set A) would cost about £29.70, but our price to readers is **£19.50** incl VAT and UK p&p.

Our alternative choice is the above set plus a pair of round nose pliers which are extremely useful for shaping wires, etc. This set (Set B) comprising the four tools would normally cost £38 but we are offering it at only **£24.75** incl VAT and UK p&p.

We regret the tools are not available separately – only the sets as offered.

To order either of the above, use coupon or photocopy or on plain paper and send with crossed cheque/PO made out to Wireless World Offers. Send to Pliers Offer, 48 Beauchamp Place, London SW3 1NX. Allow up to 28 days for delivery, UK addresses only. Closing date July 31st 1984.84.
VAT receipt will be supplied if SAE is enclosed with order.



PRECISION BOX JOINTED PLIERS AND CUTTERS

Coupon to Wireless World Pliers Offer, 48 Beauchamp Place, London SW3 1NX

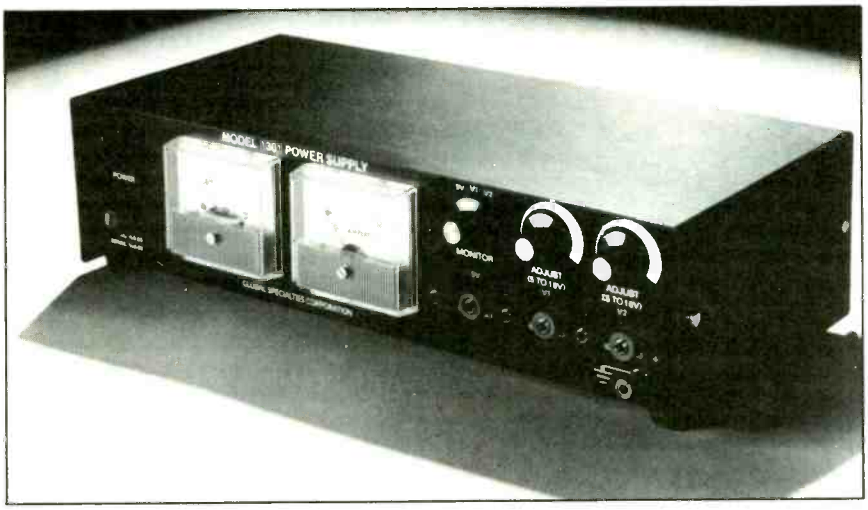
Please send me:

...........Pliers/Cutters Sets
...........Set A at £19.50
...........Set B at £24.75
....
for which I enclose total £..

NAME ....
(please print)
ADDRESS ....
....
....
....

Price includes postage, packing and VAT. Offer applies to UK only. Please allow 28 days for delivery. Registered No. 151537. Reg. Office: Quadrant House, Sutton, Surrey SM2 5AS. 83/199

Power at your fingertips!



Now, from GSC, a benchtop power supply that offers the same degree of price/performance excellence as the company's test & measurement products.

The new Model 1301 is a triple-output unit with a fixed 5V d.c. output and two independently variable 5-18V d.c. outputs – enough for all the common logic families and many other applications.

Front-panel meters provide continuous monitoring, and straightforward controls offers continuous variation and easy monitor selection.

The Model 1301 incorporates many sophisticated features as standard, such as built-in current-limiting protection and the ability to link the outputs and increase the voltage range. And it offers a high degree of line regulation – within 10mV on the 5V output and 30mV on the variable outputs – with equivalent performance on load regulation and ripple.

At only £159, the Model 1301 offers professional performance at a bargain price. To find out more, fill in the coupon. Today.

GLOBAL SPECIALTIES CORPORATION

G.S.C. (UK) Ltd. Dept. 7K9
Unit 1, Shire Hill Industrial Estate.
Saffron Walden. Essex CB11 3AQ
Telephone: Saffron Walden (0799) 21682

GSC (UK) Ltd. Dept 7K9 Unit 1, Shire Hill Industrial Estate. Saffron Walden, Essex CB11 3AQ

1301 Triple Power Supply **£187.45** PRICE INCLUDES P&P and VAT	Quantity Reqd.	

Name .... Address ....
....
I enclose Cheque/P.O. for £ .... or debit my Barclaycard/Access/American Express Card No. .... expire date ....

FOR IMMEDIATE ACTION – The G.S.C. 24 hour, 5 day a week service Telephone (0799) 21682 and give us your Barclaycard, Access, American Express number and your order will be in the post immediately

For FREE catalogue tick box ☐

CIRCLE 42 FOR FURTHER DETAILS.

COMPUTER WAREHOUSE

1000's OF
BARGAINS
FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished **DIABLO/DRE** series 30 2 5 Mb disk drives. **DEC RKO5, NOVA, TEXAS** compatible.

Front load. Free stand or rack mount	*£550.00*
Exchangeable type (via lid removal)	*£295.00*
me3029 PSU unit for 2 drives	*£125.00*
DIABLO/DRE 44-4000A/B 5+5 ex stock from	*£995.00*

1000's of spares for S30, 4000, 3200, HAWK ex stock.
Plus in house repair, refurbishing service.
Call for details or quotation.

HOT LINE DATA BASE

DISTEL©

THE **ORIGINAL FREE OF CHARGE** dial up data base. 1000's of stock items and one off bargains. **ON LINE NOW** – 300 baud, full duplex CCITT tones, 8 bit word, no parity.

01-679 1888

COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and −15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc. etc. Units are in good but used condition – supplied for 240v operation complete with full circuit and tech. man. **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high. Useable area 16"w 10.5"h 11.5"d.
Also available **LESS PSU**, with FANS etc. Internal dim. 19"w. 16"d. 10.5"h. ***£19.95***. Carriage & insurance £9.50.

EX STOCK INTEGRATED CIRCUITS

D8085AH-2	D8086	D8257-5
D8202	D8271	AM2764-3DC
74LS86	74LS112	74LS373
7407	2102-6	4116-3

CALL SALES OFFICE FOR PRICES

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference.
SD5A As recommended by ZX81 news letter, matchbox size up to 1000 watt load ***£5.95***
L2127 compact completely cased unit with 3 pin fitted socket. Up to 750 watts ***£9.99***

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
ETRI 99XUOI Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. **£9.95.**
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

SAVE £250

SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2

ONLY £199

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of ***ONLY £199.00*** + VAT Complete with full manual etc. Limited quantity –Hurry while stocks last.
Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.00 each. BBC graphics screen dump utility program £8.50.
Carriage and Ins. £10.00 + VAT

VIDEO MONITORS

5" CASED Superb little unit made by **HITACHI** in ergonimcally designed free standing case. Very high definition will display small but readable 132 columns wide! 12v DC opp. @ 800 ma, so ideal for mobile use. Supplied in AS NEW condition complete with data. Composite 75 ohm vid inp. Black & White CRT ***£45.00*** or Green CRT ***£55.00***
Carr & Ins £5.00.
12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. ***ONLY £45.00 PLUS £9.50 CARR.***
24" CASED Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition.
ONLY £55.00 PLUS £9.50 CARR & INS.

EPROM COPIERS

The amazing **SOFTY 2**. The 'Complete Toolkit' for writing, copying, modifying, and listing EPROMS of the 2516, 2716, 2532, 2732 range. Many other functions include integral keyboard, cassette interface, serial and parallel data i/o, UHF modulator.
ONLY £169.00 + PP £2.50
NEW 'GANG OF EIGHT' intelligent Z80 controlled gang bang programmer for ALL single 5V rail EPROMS. Copies up to 8, 27128 in typ. **ONLY 2 MINUTES!!** Internal LCD display and checking routines for **IDIOT PROOF** operation. **ONLY £395.00 + PP £3.00**
Data sheets on request.

GE TERMIPRINTER

A massive purchase of these desk top printer -terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY, electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width – up to 13.5" 120 column paper, upper – lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working ***£130.00*** or untested ***£85.00***, optional floor stand £12.50 Carr & Ins £10.00.

TELETYPE ASR33 I/O TERMINALS

FROM £195 + CAR. + VAT
Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry. RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order
Options: Floor stand ***£12.50*** + VAT
KSR33 with 20ma loop interface ***£125.00*** +
Sound proof enclosure ***£25.00*** + VAT

COLOUR MONITORS

NOVEX NC-1414-CL Fully cased brand new 14" colour monitor. Many exacting features such as **RGB TTL** and **PAL** composite video inputs, Internal speaker and audio amp, **"GREEN TEXT'** switch for high def text applications and matching **BBC** colour scheme make this monitor ideal for the most exacting user. Brand new and Fully Guaranteed only **£199.00 + £10.00 carr.**

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great **QWERTY**, full travel, chassis keyboard offer at fractions of their original costs.
ALPHAMERIC 7204/60 full **ASCII** 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" +5 & −12 DC. ***£39.50.***
DEC LA34 Uncoded keyboard with 67 quality, **GOLD**, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable – ideal micro conversions etc. pcb DIM 15" x 4.5" ***£24.95*** Carriage on keyboards £3.00.

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way 'D' skt. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.

MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex, **ANSWER** or **CALL** modes. **AUTO ANSWER.** Data i/o via standard **RS232** 25 way 'D' socket. Just 2 wire connection to comms line. Ideal networks etc. Complete with data, tested, ready to run at a **NEW SUPER LOW PRICE** of ***ONLY £65.00*** + VAT + Carr.
MODEM 20-1 Compact unit for use with **MICRONET**, **PRESTEL** or **TELECOM GOLD** etc. 2 wire direct connect. 75 baud transmit 1200 baud receive. Data i/o via RS232 'D' socket. Guaranteed working with data ***£49.95***
MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit. ***£130.00***
TRANSDATA 307A 300 baud acoustic coupler RS232 i/o **£95.00**

NEW DSL2123 Multi Standard modem selectable V21 300-300 bps, V23 75-1200, V23 1200-75 full duplex. Or 1200-1200 half duplex modes. Full auto answer via modem or CPU. LED status indicators. CALL or ANS modes Switchable **CCITT** or **BELL 103 & 202**. Housed in ABS case size only 2.5" x 8.5" x 9". *£286.00* + VAT
For further data or details on other EX STOCK modems contact sales office.

Carriage on all modems £10.00 + VAT.

SUPER DEAL? NO — SUPER STEAL!!

The FABULOUS 25CPS TEC Starwriter

BRAND NEW AT ONLY £499 + VAT

Save over £400

a fraction of its original cost.

Made to the very highest spec the **TEC Starwriter FP1500-25** features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLO/QUME command compatability and full control via CPM Wordstar etc.
Many other features include bi directional printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard RS232 serial interface with handshake.
Supplied absoluty **BRAND NEW** with 90 day guarantee and **FREE** daisy wheel and dust cover. Order **NOW** or contact sales office for more information.
Optional extras: RS232 data cable **£10.00**. Tech manual **£7.50**. Tractor feed **£140.00**. Spare daisy wheel **£3.00**. Carriage & Ins. (UK Mainland) **£10.00**.

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs., etc. etc. All devices guaranteed brand new full spec. with manufacturer's markings, fully guaranteed.
50+ ***£2.95*** 100+ ***£5.15.***
TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would nnormally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ ***£6.90*** 200+ ***£12.30*** 300+ ***£19.50***

66% DISCOUNT

ELECTRONIC
COMPONENTS
EQUIPMENT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's, P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads. we are packing all these items into the *"BARGAIN PARCEL OF A LIFETIME"*. Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay. Unbeatable value!! Sold by weight.

2.5kls ***£4.25*** + pp £1.25	5kls ***£5.90*** + £1.80
10kls ***£10.25*** + pp £2.25	20 kls ***£17.50*** + £4.75

DEC CORNER

MOSTEK CRT 80E Brand new dual eurocard, Z80 based VT100 PLUS emulator with graphics etc	***£499.00***
BA11-MB 3.5" Box, PSU, LTC	***£385.00***
DLV11-J 4 x EIA interface	***£310.00***
RK05-J 2.5 Mb disk drives	***£650.00***
PDP1105 Cpu, Ram, i/o, etc.	***£450.00***
RT11 ver. 3B doc kit	***£70.00***
LA36 Decwriter EIA or 20 ma	***£270.00***
KL8JA PDP 8 async i/o	***£175.00***
MI8E PDP 8 Bootstrap option	***£75.00***
DILOG DQ100 RK05 LSI 4 x RK05 disk controller	***£450.00***
MSC4804 (Equiv MSV11-L) 256k bytes ram card	***£499.00***
LAX34-AL LA34 tractor feed	***£85.00***

1000's of EX STOCK spares for DEC PDP8 PDP11 PDP15 & periperhals. Call for details. All types of Computer equipment and spares wanted for prompt **CASH PAYMENT**

ALL PRICES PLUS VAT

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value ***£2.00***. Minimum Credit Card order ***£10.00***. Minimum BONA FIDE account orders from Government depts., Schools, Universities and established companies ***£20.00*** Where post and packing not indicated please ADD £1.00. + VAT Warehouse open Mon-Fri 9.30 – 5.30. Sat. 10.15 – 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.

DISPLAY
-ELECTRONICS-

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 27924

BARCLAYCARD
VISA

CIRCLE 63 FOR FURTHER DETAILS.

Automatic speech recognition

By Tom Ivall

Speaking communication between man and machine is needed for many applications — in military use, where hands are otherwise occupied, where the communicator is disabled or where it is simply more convenient. Tom Ivall reports on two recent meetings.

Machines are needed to wreck a nice beach....... If you have read that sentence purely visually, as most people do, you will be somewhat puzzled. If, however, you heard it being read aloud, fairly quickly, you probably would have interpreted the last part of the continuous stream of sound as the entirely appropriate words ".... recognize speech."

This rather artificial example illustrates one of the characteristic problems in the automatic recognition of speech by electronic systems. Electronics can analyse the acoustic speech signal perfectly well in terms of amplitude, frequency, time and other sych parameters, but how does it translate the result into a correct message — either in printed words or merely as data for controlling a machine — when such ambiguities are possible?

According to J. S. Bridle of the Joint Speech Research Unit (JSRU), who supplied this example, aural ambiguity is the most difficult problem of all. Another is the problem of continuity. In normal speech the words run together into a continuous stream of sound, as shown by the spectrogram of the two words "go away" in Fig.1, so how does a machine find the linguistic and semantic boundaries? In any case, the mouth movements required by particular junctions between spoken words modify the sounds of the syllables on either side of these boundaries.

Then there is the problem of variability of pronounciation — for example, in utterances of the same word by different speakers, or in different rates of speaking, even by the same person. Finally, there is a big problem in the sheer complexity of the different levels of meaning in spoken language (e.g. if you say to a machine "Can you tell me the time?" you don't want it to just answer "Yes").

Mr Bridle was one of the speakers at a recent IERE colloquim on "Speech Input/Speech Output" held at the Royal Institution in London. This followed shortly after a similar London meeting, an IEE/IERE lecture on "Man-Machine Speech Interface" given by Dr J. Laver, a phonetician from Edinburgh University. Together these two meetings gave a useful picture of current activities and achievements in what is now called speech technology — mainly speech synthesis and speech recognition.

But why do we want this particular kind of man-machine interface? What is wrong with the established m.m.i. techniques using keyboards, v.d.u. screens, printers and the like? The most general answer seems to be that in some jobs the operator's hands and eyes are already heavily occupied, sometimes with multiple tasks. They should be kept as free as possible to concentrate on procedures that are more important than data input/output.

One group of speech interface applications is where technical solutions are being sought for very pressing reasons, such as helping the pilots of fighter aircraft to operate systems so that they can concentrate their main attention on tactics. Here, plenty of money is available. Dr Laver remarked, in a regretful tone, that "the military market constitutes the major driving force behind this technology."

A second, less pressing group of applications are the "hands busy" tasks in industry that require data entry — inspection, quality control, package sorting, office machinery, computerised map-making, handling very dirty materials — where operating a keyboard can be very inconvenient. Japanese banks have been using speech recognition for some years to help counter staff deal with customers' enquiries, and now a Japanese ship-buillding firm is trying it for engine control in a coal-carrying vessel.

Aids for the disabled, such as voice control of wheelchairs, are a socially useful group of applications (see, for example, April 1984 issues, News, p.59). Finally, there are those applications which are not really necessary in any urgent sense but exploit the wide availability of the ordinary telephone as a cheap form of speech input/output. Of course, this has a mass-market potential for the electronics manufacturers. New automated services now being tried out include telephone directory and train timetable enquiries, telephone banking, voice actuated dialling using keywords like "Mother", and voice actuation of telephone switchboards for disabled operators.

Much of the current commercial equipment for speech recog-

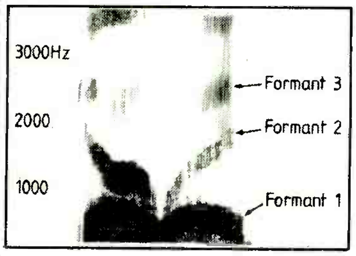


Fig.1. **Spectrogram of spoken phrase "go away", showing formants. In some speech recognizers, spectrum analysis by filter banks provides acoustic information which subsequently has to be translated into linguistic/semantic data. (Horizontal scale is time; recording density is proportional to acoustic energy.)**

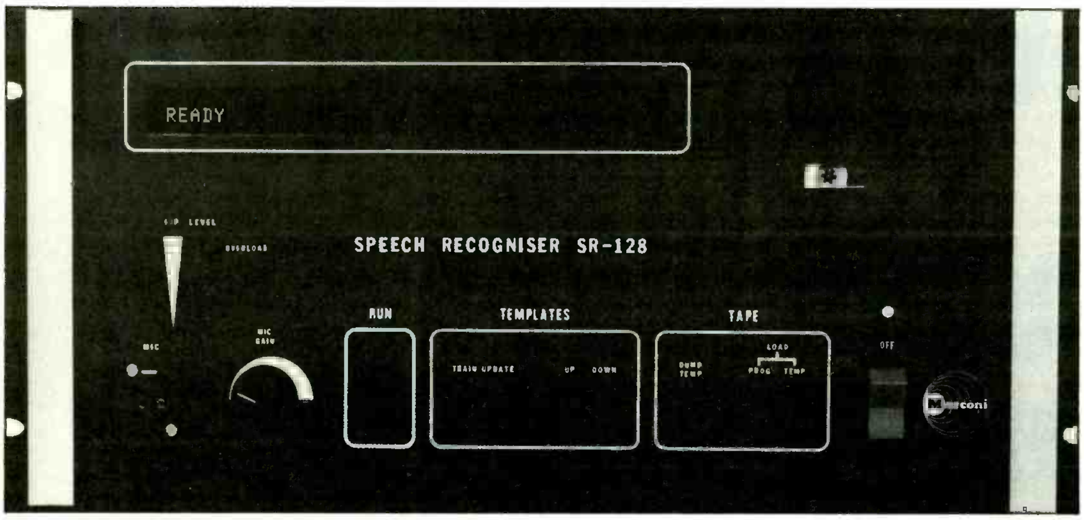


Fig.2. **The SR-128 connected-speech recognition system made by Marconi Space & Defence Systems uses a template-matching principle and has a maximum vocabulary of 240 words. Syntax can be applied to isolated keywords. Utterances can be up to 8s long and recognition response time is 50ms.**

nition is in the form of desk-top or stand-alone units, of about the size of the Marconi SR-128 Speech Recognizer shown in Fig.2. There are also i.c. chips and chip-sets which can be built into other equipment. These include what are basically general-purpose signal processor, which the user programs with speech recognition algorithms (e.g. Intel, Texas Instruments), and more specialized chip sets (e.g. NEC) designed specifically for speech recognition.

How, then, does this commercial equipment cope with the extremely difficult speech recognition problems outlined above? It achieves practical results, with reasonable accuracy at reasonable cost, by offering only limited capabilities. The range of spoken language parameters to which it can respond is deliberately restricted in the design.

Vocabulary is limited, to perhaps several hundred words rather than the several thousand desirable. Some recognizers will work only on isolated words, with pauses separating them from the preceding and following words. Most commercial recognizers are 'speaker dependent': they will only work with one particular voice, the one that has been used to 'train' them. The spoken words must be carefully enunciated and acoustic background noise must not be allowed to interfere — a real problem in aircraft cockpits, for example.

Thus the ambiguity problem discussed above is just side-stepped: the words can have only one prescribed meaning, or nothing at all. Overall the result, in the words of Dr J. N. Holmes of the JSRU, is that "communication with machines by speech is at present pathetically trivial compared with speech communication between humans." And Dr M. J. Underwood, of the Alvey Directorate, argued that available products with limited capabilities "are not all that easy to use", the difficulties arising from the fact that the systems do not necessarily match the users' jobs, skill or experience.

Dr Underwood was issuing a general warning against the "facile argument" that, because speech is man's most natural form of communication, spoken communcation with computers and other machines must be worth doing. And J. Paterson of Logica joined him in the view that the problems of matching systems to applications were now more pressing than the purely technological problems of equipment design. Mr Paterson felt that a major goal in this applications task was minimizing access or transaction time, which was influenced by both the type of transaction and the error rate.

Technology

Most speech recognizers start with a signal processing section, which analyses the acoustic waveform of the spoken words. This is followed by a digital information processing section, basically programmed logic, which makes decisions about the linguistic/semantic meanings of the acoustic parameters presented to it, on the basis of some algorithm.

Dr Laver referred to a distinction that is often made, between systems based on the principle of 'template matching' and systems that extract specific phonetic features from the acoustic information. The important point here is that template matching — trying each input acoustic pattern, typically a whole word, against a vocabulary of stored reference patterns — does not have to depend on any explicit theory of speech. The process would work just the same if the input and reference patterns were sound of dogs barking, whistles blowing or anything else that makes a noise. The basic simplicity of this template matching principle — and the fact that it can be used on continuous sequences of connected words as well as an isolated single words — makes it very attractive for use in commercial equipment. Its main drawbacks are that it tends to be speaker-dependent and limited in vocabulary. Dr Laver agreed with an American opinion that "template matching will not be able to attain human levels of performance."

The alternative principle, of extracting phonetic features, does, however, depend on explicit theories of speech. In general it uses phonemes — the smallest elements in speech sounds capable of indicating contrasts in meaning. Phonemes do not correspond simply to vowels and consonants. For example, the phonemes for 'p', 'i' and 't' in the word 'pit' are not the same phonemes as in other words using this vowel and these consonants, such as 'bit', 'pet' and 'pin'. The differences, mentioned by Dr Holmes as a particular problem in speech synthesis, are due to co-articulation: the sound of a driven vowel or consonant depends on the articulatory movements necessary to form the vowels and consonants immediately before or after it.

The use of phonemes, as against whole words, allows great flexibility and a high level of performance, but it also introduces considerable difficulties. Basically, how are phonemes identified from the extracted acoustic features? To begin with, only some of the information in th speech signal is relevant to the recognition process. Parameters that are in fact relevant can include peak values, frequency of zero crossings, times between prominent peaks, the sum of squares of waveform values over a period of time and so on.

Time varying patterns of local peaks in power spectra — the formants in Fig.1 — are important clues to recogizing phonemes, especially their dynamic properties. Various electronic techniques being used include spectrum and cepstrum analysis, Fast Fourier Transforms, autocorrelation, and autoregression or linear

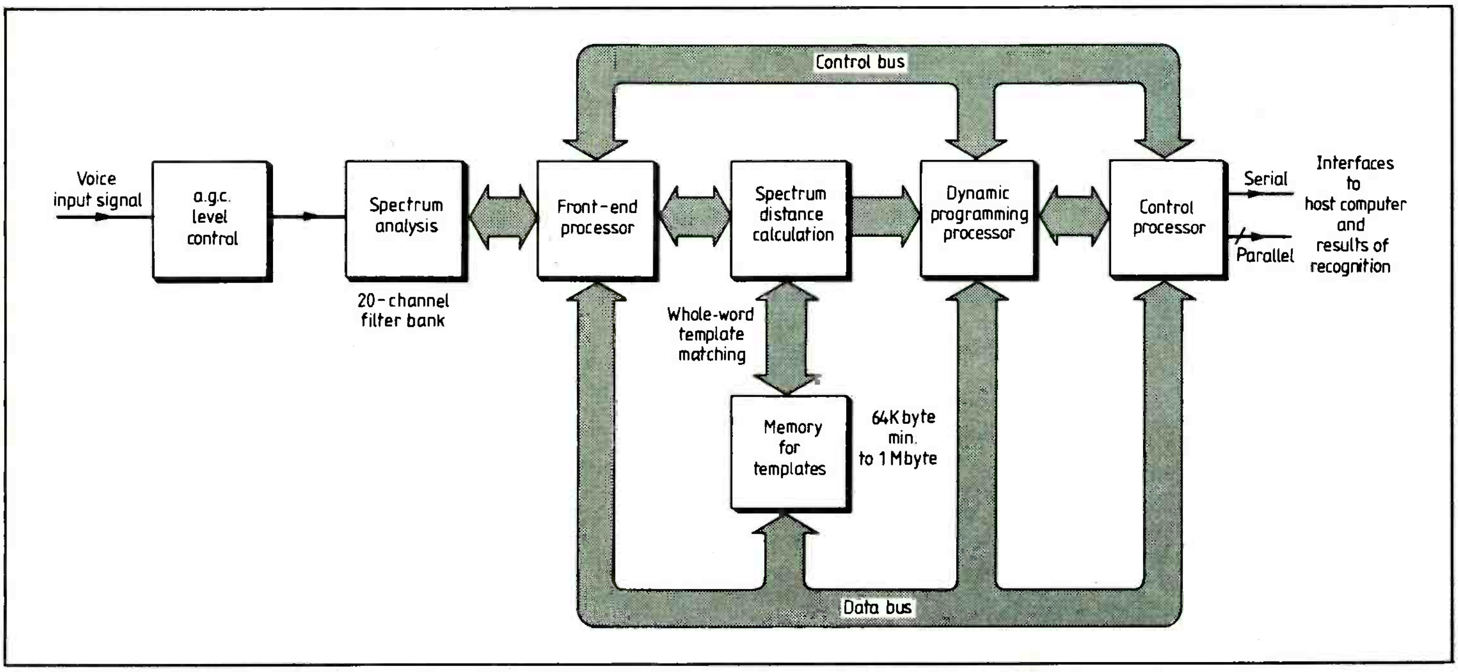


Fig.3. **This continuous-speech recognition system made by Logica is based on techniques developed at the JSRU. Using a template-matching dynamic programming algorithm, it has a vocabulary of 120 words expandable by extra storage to about 2000 words. Syntax and error correction strategies can be programmed in.**

prediction. (See, for example, recent issues of *IEEE Trans. on Acoustics, Speech and Signal Processing*.)

Several lecturers agreed that the information processing stage, following feature extraction, will need much more research on how to use artificial intelligence in this field. Dr Laver pointed out that the Japanese were employing multi-disciplinary methods involving signal processing, computer technology, phonetics, linguistics, artificial intelligence and ergonomics to achieve very ambitious goals in a 100M dollar project up to the end of 1993. This would involve parallel processing at speeds of 40 million instructions per second in 1986 and 500 m.i.p.s. by 1989.

As an example of what is needed, Dr S. J. Young described work at Manchester University aimed at finding better forms of man-machine diologue than those controlled by the rather rigid and artifical 'menu' type of interaction. He recommended a "data driven" dialogue control and described a prototype system in which knowledge necessary to run an intelligent and flexible dialogue is encoded in special kinds of data structures.

The two meetings, however, revealed rather more about the technology of current template-matching systems. These have achieved good results mainly through th use of a very powerful algorithm based on dynamic programming. J. Wilson demonstrated the Marconi SR-128 speech recognizer using this technique and J. S. Bridle exlained the broad principle. The Logica system shown in Fig.3 is based on dynamic programming and this algorithm is programmed into some i.c. chip sets.

In this method, matching between an input pattern and a stored reference pattern is achieved by an optimisation technique, while time-normalisation copes with one of the oldest problems in automatic speech recognition: the variability of speaking rate. This amounts to a non-linear variation of the timing of the input pattern for a word, or sequence of words, relative to the time-scale of the reference pattern. With the dynamic programming algorithm, the timing differences between the two patterns are eliminated by dynamically distorting the time-scale of one to obtain maximum co-incidence with the other.

Dynamic programming — not to be confused with any kind of computer programming — is a mathematical technique used in optimisation problems and is useful where time-dependence and non-linearities are involved. For example, the control problem of steering a vessel to reach a desired destination by the optimum path (shortest or quickest) can be seen as a multi-stage decision process, in which the steering has to be repeatedly re-decided along the route tc counteract the non-linearities introduced by currents, wind and other perturbations.

Inventory control in a factory is another example of a multi-stage decision process. The inventory of a particular item depends on the previous day's inventory, the production quantity decision in the factory, and the random demand from customers. In general at each stage of a multi-stage decision process the current state or result is a dunction of (a) the state at the previous stage, (b) any action made by a decision, and (c) any random event that occurs.

In the template-matching speech recognizer, the two patterns, input and reference, are typically spectrum analyses produced by filter banks. The Fig.3 system, for example, uses a bank of 20 bandpass filters. The information produced has the parameters shown in Fig.1: energy/frequency with time.

Analogue digital conversion produces two patterns of stored digital data, which are compared. In Fig.4 these two patterns, input (A) and reference (b), are shown in relation to each other as sequences of units called 'frames' (a_1, a_2 ... etc. and b_1, b_2 ... etc.). Each frame is a digital 'cross-section' of the spectrum analysis corresponding to a particular instant of time. If the A and B patterns were identical the curve relating them would be a straight line ($a = b$). In reality, the timing non-linearities make the curve a crooked one, such as the one shown, with its sequence of points, c_1, c_2 ... etc., indicating the timing differences between the patterns.

This curve is a function which maps the pattern A time-scale onto the pattern B time-scale — a 'time-scale distortion' function. The dynamic programming algo-

SPEECH RECOGNITION

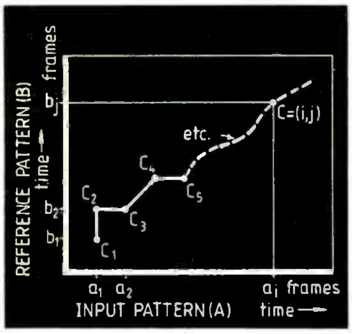


Fig.4. **In the dynamic programming algorithm for speech recognition, timing non-linearities in the input speech pattern relative to the reference (template) pattern are eliminated by distorting the time-scale of one relative to the other. In this graph, input and reference patterns consisting of spectrum analysis 'frames' are related to each other by a 'time-scale distortion' function.**

rithm finds the optimum path for the curve in this multi-stage process, from the many paths possible — that is, the best correspondence between the time-scales of patterns A and B. It does this by computing a 'score', which is the sum of th frame dissimilarities, called 'distances' (see Fig. 3), for the best way of aligning a given number of input frames with a given number of reference frames. This is computed for all the reference patterns (templates), and the score giving the smallest sum is defined as the optimum path and the best match. This smallest sum is the residual, time-normalized 'distance' value — what remains after the timing differences between the two patterns have been eliminated.

The same dynamic programming principle can be extended from single-word template matching to matching sequences of connected words as in continuous speech. The Logica system in Fig.3 has this ability, and J. Wilson of Marconi demonstrated the process in action on the SR-128 speech recognizer. An aid to correct recognition, built into both the Logica and Marconi systems, is the constraint of syntax — the normal order in which successive words are arranged in a given language. A set of word sequence rules is programmed into the recognizer and this reduced the number of word choices possible at any point in a phrase. This not only improves recognition accuracy but also reduced the amount of computation required.

Mr Bridle also presented some results of speech recognition research on isolated words being done by P. K. Moore of the Royal Signals and Radar Establishment. This work aims at producing better word models by using stochastic series called Markov chains*. Mr Bridle showed spectrograms of words which sound rather similar ("nine" and "five"; "league" and "leak") and therefore might be confused in automatic recognition systems. He said that the Markov modelling gave results in distinguishing between these than could be obtained by conventional comparison of the whole-word patterns.

There was much lively discussion on the question of whether speech synthesizers should be made to sound 'natural' or decidedly machine-like. Some of the demonstrations of synthesized speech were hardly distinguishable from human utterances, but one member of the audience declared roundly that he would always want to know whether he was speaking to a person or a machine. This was particularly important in large organizations where sometimes one never met face-to-face certain people one was dealing with! Another participant suggested that interactive speech interface systems should always use "jovial" sounding synthesized speech, while one-way announcement systems should have a "short and professional" manner.

Dr Laver felt that when man-machine speech interaction becomes commonplace we shall certainly have to consider the apparent 'personality' characteristics in synthesized voices. An unsuitable tone of voice could make a human operator react badly, depending on his particular life experience, and so be counter-productive. The jargon term 'user friendly' will certainly become much more pertinent than it is at present.

* Named after A. A. Markov who published in 1913 a statistical study of digraphs in Pushkin's poetic novel (subsequently Tchaikovsky's opera) *Eugene Onegin*.

LITERATURE RECEIVED

A company has been formed to offer a mail-order catalogue service for test and measuring instruments, with cables, connectors, kits and accessories. There is no minimum order and the catalogue is aimed at the small business and home constructor. Supercat Electronics Ltd, PO Box 201, St. Albans, Herts AL1 4EN. EWW 258

Over 1300 new products are included in the latest edition of the Verospeed catalogue, which in its 400 pages covers a total of 7500 products, telephone and computer connectors and cabling, keyboards, proximity and microswitches, a wide range of test equipment and many tools and accessories. Verospeed, Stansted Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY. EWW 259

Weir Electronics have published an introductory leaflet outlining the capabilities of their display division which specializes in the design and manufacture of data display monitors. Described is a wide range of monochrome and colour video display modules with brief performance specifications. Weir Display Division, Durban Road, Bognor Regis PO22 9RW. EWW 260

Texas Instruments has published a Master selection guide on its semiconductor ranges. The 114-page guide gives outline data and packaging information on all TI components including memories, logic arrays, digital products, linear products, telecommunications circuits, opto-electronics, and power and small signal devices. Included are details of TI's latest products. Copies are available free from any TI distributor or by phoning TI at Bedford (0234) 223000. EWW 250

The extensive Cube range of Eurocards, rack-mounted computers and peripherals has been described in detail with extensive illustrations specifications and technical information in a 150-page catalogue. Development systems based on Eurocards are a speciality of the company and they produce direct, and often enhanced replacements for the Acorn range. A new range of Delegate/Unicube modules are designed for industrial and laboratory control. There is also an extensive range of add-ons for the BBC microcomputer. Control Universal Ltd, Unit 2, Anderson's Court, Newnham Road, Cambridge CB3 9EZ. EWW 251

The specialist computer company, Unit C, has published a useful pocket-sized guide to its range of 68000 VME and Pascal-2 products. The guide describes the 68000 VME and Q-Bus hardware together with the Unix system III operating system and Pascal-2 supporting software. Development software is available for Unix/68000, DEC RSX/PDP or DEC VMS/VAX hosts. Stand-alone 68000 target support can also be provided by means of the pSOS real time executive. Unit C Ltd,
Dominion Way West,
Broadwater, Worthing,
West Sussex.
EWW 253

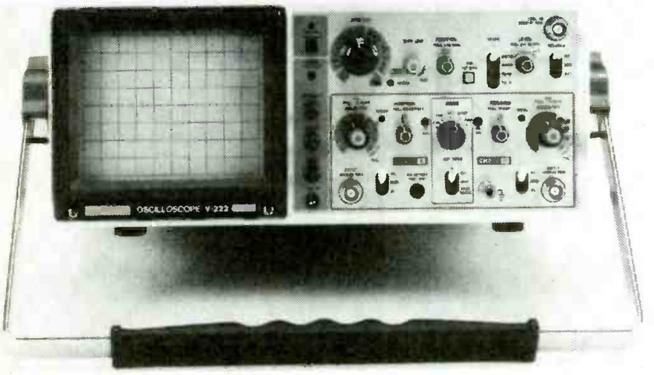
A catalogue lists software available for Torch computers, from Torch themselves and from other software houses. Over 140 programs are listed for the computers which are networked Unix and CP/M compatible operating systems. By purchasing the Torch add-on, the programs are also available to users of the BBC micro. Torch Computers Ltd, Abberley House, Great Shelford, Cambridge CB2 5LQ.
EWW 254

Ferranti Electronics has issued a colour brochure highlighting their new generation of power mosfets. The mosfets are suited to a wide range of switching and amplifying applications where high input impedance, high gain and fast switching is desired. The brochure gives basic mosfet information with the aid of clear diagrams, and there is a tabular selectors guide giving the range of devices on offer. Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancs OL9 8NP.
EWW 255

A 16-page colour brochure gives full technical details of the recently-introduced Gould 5110 intelligent 100MHz oscilloscope system. The 5110 automates many oscilloscope measurements and has a built-in IEEE interface for use in automatic test systems. It is controlled by a keyboard/menu system. Numerous application examples are given and the instrument's operating modes and controls are clearly illustrated. Gould Design and Test Systems Division, Roebuck Road, Hainault, Ilford, Essex IG6 3UE.
EWW 256

Hitachi Oscilloscopes

performance, reliability, value and immediate delivery!



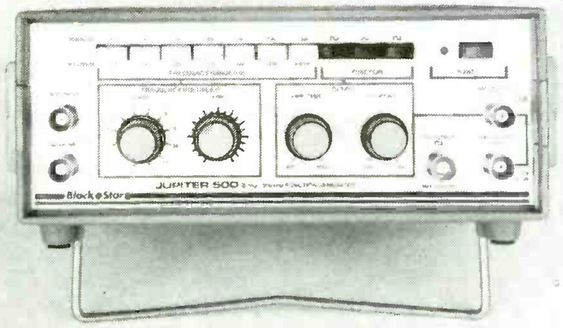
Hitachi Oscilloscopes provide the quality and performance that you'd expect from such a famous name, with a newly-extended range that represents the best value for money available anywhere.

V-212	20MHz Dual Trace	V-209	20MHz Mini-Portable
V-222	20MHz (illustrated)	V-509	50MHz Mini-Portable
V-203F	20MHz Sweep Delay	V-1050F	100MHz Quad Trace
V-353F	35MHz Sweep Delay	V-134	10MHz Tube Storage
V-422	40MHz Dual Trace	VC-6015	10MHz Digital
V-650F	60MHz Dual Timebase	VC-6041	40MHz Digital

Prices start at around £300 plus vat including 2 probes and 2 year warranty. We hold the range in stock for immediate delivery.

For colour brochure giving specifications and prices ring **(0480) 63570**
Thurlby-Reltech, 46 High Street, Solihull, W. Midlands, B91 3TB

CIRCLE 56 FOR FURTHER DETAILS.



FUNCTION GENERATOR 0.1Hz - 500kHz

- Sine, Square, Triangle, TTL output
- Typically 0.02Hz - 700kHz
- 7 switched ranges with coarse and fine frequency controls
- ± 30V output capability
- Accuracy typically 1% of range
- Variable DC offset
- External A.M. facility
- External sweep facility
- Short circuit protection all outputs

JUPITER 500 (inc. P & P and VAT) £128.80

Colour leaflet with specifications and prices available from:

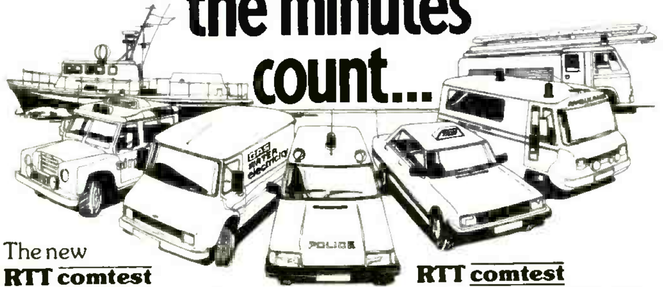
BLACK STAR LTD, (Dept. WW) 9A Crown Street, St.Ives,
Huntingdon, Cambs. PE17 4EB, England. Tel: (0480) 62440 Telex: 32339

Designed and manufactured in Britain

Black✱Star

CIRCLE 006 FOR FURTHER DETAILS.

In these testing times the minutes count...



The new **RTT comtest** ensures testing and calibrating to the highest specifications demanded by modern radio communications systems. Interactive instruments, semi automatic in operation, ensure faster, more efficient system testing, reduce servicing costs and downtime whilst improving communications quality and reliability.

RTT comtest is designed, manufactured and serviced by RTT, a Division of a major UK Electronics Group with 30 years experience of manufacturing to Government quality standards. New enhanceable features are continually being added which ensure the system never becomes outdated.

Features include: • 1.7 GHz version • Selcall / Pilot Tone Testing • 300W Power Meter • Sinad Meter • Full Duplex Testing • Fully protected • Small / Lightweight / Portable • 12V for field use • Automatic Tuning • Off Air and Adjacent Channel Power Measurement

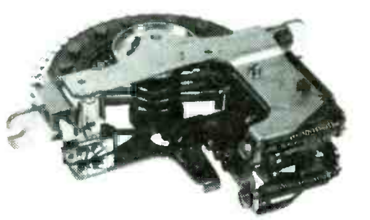
MADE IN GREAT BRITAIN

RTT comtest
Tomorrow's World - Today

RTT Division of Hanworth Enterprises Ltd, Enterprise House, Central Way, North Feltham Trading Estate, Feltham, Middx. TW14 0RX. Tel 01-844 1811.

CIRCLE 49 FOR FURTHER DETAILS.

UNISELECTORS TYPE 2 SERIES



Uniselectors are designed to meet the requirements for mechanisms having long life and dependability. They are approved by British Telecom and used extensively by them.
Uniselectors can be supplied with double-ended wipers giving two appearances of 25 points per revolution. 4, 6, 8, 10 and 12 level uniselectors can also be supplied with single-ended wipers, connected in adjacent pairs which give 2, 3, 4, 5 and 6 complete circuits of 50 points per revolution respectively. Wipers may be bridging or non-bridging and can be adjusted for position on bank contacts independently of mechanism adjustments.

Also in stock: Miniature Uniselectors, 3000 Type Relays, Carpenter Polarised Relays, High Speed Relays, Transformers, 2000 and 4000 Type Selector Mechanisms, etc.
As one of the few remaining suppliers of Strowger components in the U.K. we would welcome your enquiries and look forward to discussing your needs.

Cynpex Ltd
Telecommunication component factors
Unit 3, Argyle Way, Stevenage, Hertfordshire SG1 2AD
Telephone (0438) 352497/352326. Telex 825617

CIRCLE 44 FOR FURTHER DETAILS.

www.americanradiohistory.com

VIDEO TERMINAL BOARD

★ 80 characters × 24 lines ★

Requires ASCII encoded keyboard and monitor to make fully configurable intelligent terminal. Uses 6802 micro and 6845 controller. Program and character generator (7 × 9 matrix with descenders) in two 2716 EPROMs. Full scrolling at 9600 baud with 8 switch selectable rates. RS232 interface.

Bare board with 2 EPROMS and program listing — £48 plus VAT. Send for details or CWO to:

A M Electronics
Wood Farm, Leiston, Suffolk IP16 4HT
Tel: 0728 831131

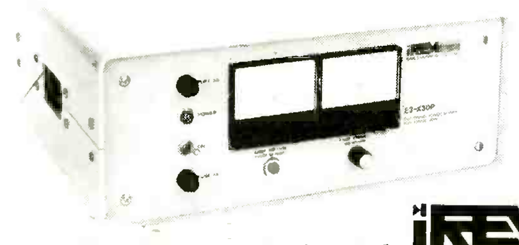
CIRCLE 33 FOR FURTHER DETAILS.

ELECTRONIC POWER UNITS

FOR XENON ARC AND MERCURY ARC LAMPS

UNITS AVAILABLE FOR LAMPS RANGING FROM 75 TO 6500 WATTS.

Lamp housings and lens systems manufactured as standard off the shelf models or to specific design.



K. T. Manners Design Ltd.

P.O. Box 936, London, W4 4NW Telephone: 01-994 7155. Telex: 28604

CIRCLE 57 FOR FURTHER DETAILS.

It's easy to complain about an advertisement. Once you know how.

One of the ways we keep a check on the advertising that appears in the press, on posters and in the cinema is by responding to consumers' complaints.

Any complaint sent to us is considered carefully and, if there's a case to answer, a full investigation is made.

If you think you've got good reason to complain about an advertisement, send off for a copy of our free leaflet.

It will tell you all you need to know to help us process your complaint as quickly as possible.

The Advertising Standards Authority.
If an advertisement is wrong, we're here to put it right.

ASA Ltd, Dept 1 Brook House,
Torrington Place, London WC1E 7HN

This space is donated in the interests of high standards of advertising.

PM COMPONENTS LTD

VALVE & COMPONENTS SPECIALISTS

INTEGRATED CIRCUITS

AN124	2.50
AN214Q	2.50
AN240P	2.80
AN612	2.15
AN7140	3.50
AN7145	3.50
AN7150	2.95
BA521	3.35
CA1352E	1.75
CA3086	0.46
ETT6016	2.50
HA1377	3.50
HA1156W	1.50
HA1339A	2.95
HA1551	2.95
LA1230	1.15
LA4102	2.95
LA4250	2.95
LA4400	4.15
LA4420	1.95
LA4422	2.50
LA4430	2.50
LC7120	3.25
LC7130	3.50
LC7131	5.50
LC7137	5.50
LM324N	0.45
LM380N	0.95
LM383T	2.95
M51513L	2.30
M51515L	2.95
M51521L	1.50
MB3712	2.00
MC1307P	1.00
MC1310P	1.50
MC1327	0.95
MC1327Q	0.95
MC1330P	0.76
MC1349P	1.20
MC1350P	0.95

MC1351P	1.50
MC1352P	1.25
MC1357	2.35
MC1358	1.58
MC1495	3.00
MC1496	1.25
MC145106P	7.95
MC1723	0.50
MC3357	2.75
ML231B	1.75
ML232B	2.50
MSM5807	6.75
PLL02A	5.75
SAA500A	3.50
SAA1025	7.25
SAA5010	6.35
SAS560S	1.75
SAS570S	1.75
SAS580	2.85
SL901B	4.85
SL917B	6.65
SL1310	1.80
SL1327	1.10
SL1327Q	1.10
SN76003N	1.95
SN76013N	1.95
SN76023N	1.95
SN76033N	1.95
SN76110N	0.89
SN76115N	1.25
SN76131N	1.30
SN76226DN	2.95
SN76227N	1.05
SN76533N	1.65
SN76544N	1.95
SN76570N	1.00
SN76650N	1.15
SN76660N	0.80
STK014	7.95

STK015	7.95
STK415	7.95
STK433	7.95
STK437	7.95
STK439	7.95
TA7061AP	3.95
TA7108P	1.00
TA7120P	1.65
TA7130P	1.50
TA7146	2.95
TA7176AP	2.95
TA7203	2.95
TA7204P	2.15
TA7205AP	1.50
TA7222AP	1.80
TA7227P	4.25
TA7310P	1.80
TA7313AP	2.95
TA7321P	2.25
TA7609P	3.15
TA7611AP	2.95
TAA550	0.25
TAA570	1.95
TAA621AXI	3.50
TAA661B	1.20
TAA700	1.70
TBA120B	0.95
TBA120C	1.15
TBA120T	1.05
TBA120U	1.00
TBA231	1.25
TBA395	1.50
TBA396	0.75
TBA440N	2.55
TBA480Q	1.25
TBA510	2.50
TBA510Q	2.50
TBA520	1.10
TBA520Q	1.10
TBA530	1.10
TBA530Q	1.10

TBA540	1.25
TBA540Q	1.35
TBA550Q	1.45
TBA560C	1.45
TBA560CQ	1.45
TBA570	1.00
TBA641A12	2.50
TBA651R	2.50
TBA720A	2.45
TBA750Q	2.65
TBA800	0.89
TBA810AS	1.65
TBA810P	1.65
TBA820M	0.75
TBA820Q	1.45
TBA890	2.50
TBA920	1.65
TBA950/2X	2.35
TBA970	2.95
TBA990	1.49
TBA1441	2.15
TCA270	1.10
TCA270SQ	1.10
TCA650	2.50
TCA800	2.15
TCA940	1.65
TDA440	2.20
TDA1001	1:95
TDA1004A	3.25
TDA1006A	2.50
TDA1010	2.15
TDA1035	2.50
TDA1037	1.95
TDA1170	1.95
TDA1190	2.15
TDA1270Q	3.95
TDA1327	1.70
TDA2002	1.95
TDA2020	2.45
TDA2030	2.80
TDA2522	1.95

TDA2523	1.95
TDA2524	1.95
TDA2530	1.95
TDA2532	1.95
TDA2540	1.25
TDA2541	2.15
TDA2560	2.15
TDA2571	2.95
TDA2581	2.25
TDA2593	2.95
TDA2600	5.50
TDA2610	2.50
TDA2611A	1.95
TDA2640	2.60
TDA2680A	2.75
TDA2690	2.45
TDA3560	5.50
UPC566H	2.95
UPC575C2	2.75
UPC1025H	2.50
UPC1028H	1.95
UPC1032H	1.50
UPC1156H	2.75
UPC1158H	0.75
UPC1167C2	1.15
UPC1181H	1.25
UPC1182H	2.95
UPC1185H	3.95
UPC1191V	1.50
UPC1350C	2.95
UPC1353C	2.45
UPC1365C	3.95
UPC2002H	1.95
555	0.35
556	0.42
723	0.50
741	0.35
747	0.50
748	0.35
7808	0.60

SEMICONDUCTORS

AAY12	0.25
AC127	0.20
AC128	0.28
AC128K	0.32
AC141	0.28
AC141K	0.34
AC142K	0.30
AC176	0.22
AC176K	0.31
AC187	0.25
AC187K	0.28
AC188	0.25
AC188K	0.37
AD142	0.79
AD143	0.82
AD149	0.70
AD161	0.39
AD162	0.39
AD161/2	0.90
AF114	1.50
AF124	0.65
AF125	0.35
AF126	0.32
AF127	0.40
AF139	0.40
AF178	1.95
AF239	0.42
AU106	3.25
AU110	2.00
BC107A	0.11
BC107B	0.11
BC108	0.10
BC108A	0.11
BC108B	0.12
BC109	0.10
BC109B	0.12
BC109C	0.12
BC114	0.11
BC116A	0.15
BC117	0.19
BC119	0.24
BC125	0.25
BC139	0.20
BC140	0.31
BC141	0.25
BC142	0.21
BC143	0.24
BC147	0.09
BC147B	0.09
BC148A	0.09
BC148B	0.09
BC149	0.09
BC157	0.12
BC158	0.09
BC159	0.09
BC160	0.28
BC161	0.28
BC170B	0.15
BC171	0.09
BC171A	0.10
BC171B	0.10
BC172	0.10
BC172B	0.10
BC172C	0.10
BC173B	0.10
BC174	0.09
BC174A	0.09
BC177	0.15
BC178	0.15
BC182	0.10

BC182LB	0.10
BC183	0.10
BC183L	0.09
BC184LB	0.09
BC204	0.10
BC207B	0.13
BC208B	0.13
BC212	0.09
BC212L	0.09
BC212LA	0.09
BC213	0.09
BC213L	0.09
BC214	0.09
BC214C	0.09
BC214L	0.09
BC237B	0.09
BC238	0.09
BC239	0.12
BC251A	0.12
BC252A	0.15
BC258	0.25
BC258A	0.39
BC284	0.30
BC300	0.30
BC301	0.30
BC303	0.26
BC307B	0.09
BC327	0.10
BC328	0.10
BC337	0.10
BC338	0.09
BC347A	0.13
BC461	0.35
BC478	0.20
BC527	0.20
BC547	0.10
BC548	0.10
BC549A	0.08
BC550	0.08
BC557	0.08
BC557B	0.08
BC558	0.10
BCY33A	1.60
BD115	0.30
BD116	0.60
BD124P	0.59
BD131	0.32
BD132	0.35
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.32
BD138	0.30
BD139	0.32
BD140	0.30
BD144	1.10
BD159	0.65
BD160	1.50
BD166	0.55
BD179	0.72
BD182	0.70
BD201	0.83
BD202	0.65
BD203	0.78
BD204	0.70
BD222	0.46
BD223	0.48
BD225	0.48
BC232	0.35
BD233	0.35

BD234	0.35
BD236	0.45
BD237	0.40
BD238	0.40
BD241	0.40
BD242	0.50
BD246	0.60
BD376	0.32
BD410	0.55
BD434	0.55
BD437	0.50
BD438	0.60
BD506	0.50
BD508	0.40
BD520	0.65
BD538	0.65
BD597	0.75
BD697	1.10
BD698	1.10
BD707	0.80
BDX32	1.50
BDY57	1.65
BF115	0.35
BF119	0.65
BF127	0.24
BF154	0.12
BF158	0.22
BF160	0.27
BF167	0.24
BF173	0.22
BF177	0.38
BF178	0.26
BF179	0.34
BF180	0.29
BF181	0.29
BF182	0.29
BF183	0.29
BF184	0.28
BF185	0.28
BF194	0.11
BF195	0.11
BF196	0.11
BF197	0.11
BF198	0.16
BF199	0.14
BF200	0.40
BF241	0.15
BF245	0.30
BF256/LC	0.28
BF257	0.28
BF258	0.28
BF259	0.28
BF271	0.26
BF273	0.13
BF336	0.34
BF337	0.29
BF338	0.32
BF355	0.37
BF362	0.38
BF363	0.38
BF371	0.20
BF394	0.19
BF422	0.32
BF457	0.32
BF458	0.36
BF459	0.36
BF467	0.68
BF595	0.23
BF597	0.25
BFR39	0.23
BFR40	0.23
BFR41	0.28

BFR81	0.25
BFR88	0.30
BFR90	1.50
BFR91	1.75
BFT42	0.28
BFT43	0.28
BFW92	0.85
BFX29	0.30
BFX84	0.26
BFX85	0.32
BFX86	0.30
BFX88	0.25
BFY50	0.21
BFY51	0.21
BFY52	0.25
BFY90	0.77
BLY48	1.75
BR100	0.26
BR101	0.49
BRC4443	0.85
BT100A/02	0.75
BT106	1.49
BT116	1.20
BT119	2.35
BT120	1.65
BU105	1.22
BU108	1.69
BU124	1.25
BU125	1.25
BU126	1.60
BU204	1.55
BU205	1.30
BU208	1.39
BU208A	1.52
BU208D	1.85
BU326	1.20
BU407	1.24
BU500	2.25
BU526	1.90
BUY69B	1.70
MJ3000	1.98
MJE340	0.40
MJE520	0.48
MPSA13	0.29
MPSA92	0.30
MRF450A	12.50
MRF453	17.50
MRF454	23.50
MRF475	2.50
MRF477	10.00
OC23	1.50
OC42	0.55
OC44	0.75
OC45	0.55
OC70	0.45
OC71	0.55
OC81	0.50
R2008B	1.70
R2010B	1.70
R2322	0.58
R2323	0.66
R2540	2.48
RCA16334	0.90
RCA16335	0.80
SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.42
TIP32C	0.42
TIP33B	0.75

TIP34B	0.75
TIP41A	0.45
TIP41C	0.45
TIP42C	0.47
TIP47	0.65
TIP120	0.60
TIP125	0.65
TIP142	1.75
TIP146	2.75
TIP161	2.95
TIP2955	0.80
TIP3055	0.55
TIS91	0.20
TV106/2	1.50
2N2219	0.28
2N2905	0.40
2N3053	0.40
2N3054	0.59
2N3055	0.52
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3705	0.12
2N3706	0.12
2N3708	0.12
2N3773	1.95
2N3792	1.35
2N4427	1.50
2N4444	1.15
2N5294	0.42
2N5296	0.48
2N5298	0.60
2N5496	0.65
2SA715	0.60
2SC495	0.80
2SC496	0.80
2SC1096	0.80
2SC1106	2.50
2SC1172Y	2.20
2SC1173	1.15
2SC1306	1.00
2SC1307	1.50
2SC1364	0.50
2SC1449	0.80
2SC1678	1.25
2SC1909	1.95
2SC1945	2.65
2SC1953	0.95
2SC1957	0.80
2SC1969	1.95
2SC2028	1,15
2SC2029	1.95
2SC2078	1.45
2SC2091	0.85
2SC2098	2.50
2SC2166	1.95
2SC2314	0.80
2SC2371	0.36
2SD234	0.50
3N211	1.95
3SK45	0.70
3SK88	0.55

DIODES

AA119	0.08
BA115	0.13
BA145	0.16
BA148	0.17
BA154	0.06
BA155	0.13
BA156	0.15
BA157	0.30
BAX13	0.04
BAX16	0.06
BB105B	0.30
BT151	0.79
BY126	0.10
BY127	0.11
BY133	0.15
BY164	0.45
BY176	1.20
BY179	0.63
BY182	0.55
BY184	0.35

BY199	0.40
BY206	0.14
BY208-800	0.33
BY210-800	0.33
BY223	0.90
BY298-400	0.22
BY299-800	0.22
BYX10	0.20
BYX36-150R	0.20
BYX38-600R	0.60
BYX55-600	0.30
BYX71-600	1.10
BZY95C30	0.35
OA47	0.09
OA90	0.05
OA91	0.06
OA95	0.06
OA202	0.10
IN914	0.04
IN4001	0.04
IN4002	0.04
IN4003	0.04

IN4004	0.05
IN4005	0.05
IN4006	0.06
IN4007	0.06
IN4148	0.02
IN4448	0.10
IN5401	0.12
IN5402	0.14
IN5403	0.12
IN5404	0.12
IN5405	0.13
IN5406	0.13
IN5407	0.16
IN5408	0.16
ITT44	0.04
ITT923	0.15
ITT2002	0.10

74LS SERIES
Prices available on request

CRT TUBES

A selection available. Prices on request.

3BPI	£13.50	D10-210GH	£45
DG7-32	£42	DH7-91	£59
DP7-6	£35	DP7-11	£35
SE4DP7	£45	95447	£135
M17-151GVR	£220		

TV SPARES

We now have available from stock a range of popular TV spares including: line output transformers, tuners, triplers, etc

PRICE LIST AVAILABLE

PHONE
0474 813225
3 LINES

P. M. COMPONENTS LTD

SELECTRON HOUSE, WROTHAM ROAD
MEOPHAM GREEN, MEOPHAM, KENT DAI3OQY

TELEX
966371
PM COMP

A SELECTION FROM OUR STOCK OF BRANDED VALVES

A1714	18.50
A1998	11.50
A2087	11.50
A2134	14.95
A2293	6.50
A2521	21.00
A2599	37.50
A2900	11.50
A3042	24.00
A3283	24.00
AC/HL/DD	4.00
AC/THI	4.00
ACT22	59.75
AC/VP2	4.00
AC/S2 PEN	8.50
AH221	39.00
AH238	39.00
AL60	6.00
AN1	14.00
ARP12	0.70
ARP34	1.25
ARP35	2.00
BL63	2.00
BS450	67.00
BS810	55.00
BS814	55.00
CIK	16.00
C3JA	16.00
C1108	54.95
C1112G	70.00
C1134	32.00
C1148A	115.00
C1149/1	130.00
C1150/1	135.00
C1534	32.00
CCA	2.60
CC3L	0.90
CL33	2.00
CV Nos Prices on request	
D63	1.20
DAF91	0.70
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	12.00
DCX4-5000	25.00
DET16	28.50
DET18	28.50
DET24	39.00
DET25	22.00
DET29	
DF91	0.70
DF92	0.60
DF96	0.65
DF97	1.00
DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	1.00
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	1.50
DL93	1.10
DL94	2.50
DL96	2.50
DLS10	13.50
DLS16	10.00
DM70	1.95
DM160	2.75
DY51	1.50
DY86/87	0.65
DY802	0.72
E80CC	8.50
E80CF	11.00
E80F	13.50
E80L	11.50
E81CC	3.50
E81L	12.00
E82CC	3.50
E83CC	3.50
E83F	5.50
E86C	9.50
E88C	7.95
E88CC	3.50
E90CC	8.50
E90F	7.95
E91H	4.50
E92CC	3.95
E99F	6.99
E130L	19.95
E180CC	6.50
E182CC	9.00
E180F	6.50
E186F	8.50
E280F	19.50
E283CC	10.00
E288CC	13.50
E810F	18.50
E1148	1.00
E1524	6.95
EA50	1.00
EA76	1.95
EA79	1.95
EAA91	0.60
EABC80	0.70
EAC91	2.50
EAF42	1.20
EAF801	3.50
EB34	1.50
EB41	3.95
EB91	0.60
EBC33	2.50
EBC41	1.95
EBC81	1.50
EBC90	0.90
EBC91	0.90
EBF33	2.50
EBF80	0.65
EBF83	0.65
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	2.50
EBL21	2.00
EC52	0.75
EC70	1.75
EC80	9.50
EC81	7.95
EC86	1.00
EC88	1.00
EC90	1.10
EC91	5.50
EC92	1.25
EC93	1.50
EC95	7.00
EC97	1.10
EC8010	12.00
ECC32	3.50
ECC33	3.50
ECC35	3.50
ECC81	1.15
ECC82	0.55
ECC82 Philips	1.50
ECC83	0.65
ECC83 Brimar/ Mullard	1.35
ECC83 Philips	1.95
ECC84	0.50
ECC85	0.60
ECC86	2.75
ECC88	0.85
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.60
ECC807	2.50
ECC2000	12.00
ECF80	0.85
ECF82	0.85
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.00
ECF805	2.50
ECF806	10.25
ECH3	2.50
ECH4	3.00
ECH35	2.15
ECH42	1.00
ECH81	0.65
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	2.50
ECL84	0.74
ECL85	0.69
ECL86	0.80
ECL805	0.69
EF37A	2.00
EF39	1.10
EF41	3.50
EF42	3.50
EF50	2.50
EF55	4.95
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.55
EF83	3.50
EF85	0.50
EF86	1.25
EF86 Special quality	2.50
EF89	0.85
EF91	1.50
EF92	2.50
EF93	0.95
EF94	0.95
EF95	1.00
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF730	1.80
EF731	3.50
EF732	3.50
EF800	11.00
EF805S	13.50
EF806S	14.50
EF812	0.65
EFL200	1.50
EH90	0.72
EK90	0.72
EL32	0.95
EL33	4.00
EL34	2.25
EL34 Philips	3.50
EL36	1.50
EL37	9.00
EL38	6.00
EL41	3.50
EL42	2.00
EL81	6.95
EL82	0.58
EL84	0.75
EL85	4.50
EL86	0.85
EL90	1.50
EL91	6.00
EL95	0.70
EL153	12.15
EL183E	3.50
EL183P	3.50
EL360	7.95
EL500	1.40
EL504	1.40
EL509	5.25
EL519	6.95
EL802	3.65
EL821	8.50
EL822	12.95
EM1	9.00
EM4	9.00
EM80	0.70
EM81	0.70
EM84	1.65
EM85	3.95
EM87	2.50
EN10	8.00
EN32	13.50
EN91	1.10
EN92	4.50
ESU872	25.00
EY51	0.80
EY81	1.50
EY83	1.50
EY84	5.95
EY86/87	0.50
EY88	0.55
EY91	5.50
EY500A	1.50
EY802	0.70
EZ35	0.75
EZ40	2.75
EZ41	2.75
EZ80	0.60
EZ81	0.60
EZ90	1.35
F6064	2.95
FW4/800	2.95
G1/371K	30.00
G55/1K	9.00
G180/2M	9.00
G240/2D	9.00
G400/1K	14.00
GC10B	17.50
GC10D	17.50
GC10/4B	17.50
GC10/4E	17.50
GC12/4B	17.50
GD86W	6.00
GDT120M	5.00
GE10	9.00
GN4	6.00
GN10	15.00
GR10G	4.00
GR10J	4.00
GS10C	16.50
GS10H	12.00
GS12D	12.00
GT1C	14.00
GT1C S/S	13.00
GTE175M	8.00
GTR150W	1.00
GU20	35.00
GXU1	13.50
GXU3	24.00
GXU50SS	14.50
GY501	1.20
GY802	1.00
GZ30	1.00
GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ37	4.50
HAA91	1.00
HABC80	0.90
HBC90	0.75
HBC91	0.80
HF93	0.75
HF94	1.50
HK90	1.05
HL2K	3.50
HL23DD	4.00
HL41	3.50
HL41DD	3.50
HL42DD	3.50
HL90	0.70
HL92	1.50
HL133/DD	3.50
HR2	4.00
HY90	1.00
HVR2	3.00
JP9-7A	60.00
K391A	95.00
K3118	85.00
KR6/3	45.00
KT8C	7.00
KT33C	3.50
KT36	2.00
KT44	4.00
KT45	4.00
KT61	4.00
KT63	2.00
KT66 OSRAM	10.50
KT66 USA	7.15
KT66 GEC	14.95
KT77 Gold Lion	9.50
KT81	7.00
KT88 USA	9.00
KT88 Gold Lion	15.95
KT67	9.00
KTW61	2.50
KTW62	2.50
KTW63	2.00
KTZ63	2.50
L63	1.50
L102/2K	6.95
L120/2K	12.00
LS9B	6.95
M502A	60.00
M508	85.00
M537A	60.00
M5143	155.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	5.50
M8161	6.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50
M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
M8225	3.50
ME1401	29.50
ME1402	29.50
ME1501	14.00
MH4	3.50
MHLD6	4.00
ML4	4.50
MS4B	5.50
MU14	1.50
N37	12.50
N78	9.85
OA2	0.85
OA2WA	1.50
OA3	2.50
OB2	0.85
OB2WA	1.25
OC2	2.50
OC3	1.50
OD3	1.70
OM4	1.00
OM5B	3.00
OM6	1.75
ORP43	2.50
ORP50	3.95
P61	2.50
P41	2.50
PABC80	0.50
PC86	0.75
PC88	0.75
PC92	3.50
PC97	1.10
PC800	1.10
PC900	1.25
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.80
PCF201	1.80
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL84	0.85
PCL85	0.80
PCL86	0.85
PCL200	1.60
PCL800	0.80
PCL805	0.90
PD500	3.50
PD510	3.65
PEN4DD	2.00
PEN25	2.00
PEN4ODD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	1.25
PL21	2.50
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.78
PL88	1.00
PL95	1.75
PL302	1.00
PL345	12.50
PL500	1.10
PL504	1.15
PL508	1.95
PL509	4.85
PL519	4.95
PL802	5.95
PL802T	3.50
PL820	2.95
PL5557	29.50
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
Q13-110BA	47.50
QB3-300	30.50
QEO3-10	3.50
QEO8-200	145.00
QF40	65.00
QP25	1.00
QQEO3-12	6.50
QQEO3-20	27.00
QQEO6-40	39.50
QQVO2-6	16.50
QQVO3-10	5.50
QQVO3-20	18.50
QQVO3-20B	32.00
QQVO6-40A	19.50
QQVO7-50	63.50
QQZO3-20	42.50
QQZO6-40A	45.25
QS72/20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/45	7.00
QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QS1218	5.00
QU37	9.50
QU37	11.50
QVO3-12	4.95
QVO5-25	1.75
QVO6-20	29.50
QVO8-100	145.00
QY3-125	49.50
QY4-250	65.00
QY4-400	71.95
R10	4.00
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1169	55.00
RG1-125	4.95
RG1-240A	14.50
RG3-250A	3.50
RG3-1250A	52.50
RK2K25	62.50
RG4-1000	10.00
RK-20A	12.00
RL16	1.50
RPL16	12.00
RPY13	2.50
RPY43	2.50
RPY82	2.50
RR3-250	37.00
RR3-1250	65.00
RS613	45.00
RS685	54.95
RS688	52.15
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	5.95
S130P	5.95
SC1/800	5.00
SC1/1200	5.00
SC1/2000	9.00
SD6000M	45.00
SP2	1.50
SP41	5.00
SP42	3.00
SS501	35.00
ST11	1.50
STV280/40	11.95
STV280/80	19.95
SU42	4.95
TB2.5/3000	60.00
TB2-300	45.00
TD1-100A	25.00
TD03-10D	35.00
TD03-10E	28.00
TDO3-10F	28.00
TD3-12	4.00
TP25	1.50
TSP4	7.00
TT11	1.50
TT15	34.95
TY2-125A	60.00
TY4-400	70.00
TY7-6000A	365.00
TY8-600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	0.65
U251	1.00
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	1.75
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	1.20
UCH42	1.35
UCH81	0.65
UF85	1.20
UF41	1.15
UF42	1.15
UF80	0.80
UF89	2.50
UL41	3.50
UL84	0.85
UU5	2.50
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V240C/2K	225.00
V241C/1K	195.00
V246A/2K	315.00
V339	3.50
VLS631	10.95
VP4B	4.50
VP133	2.00
VR75/30	3.00
VR101	2.00
VR105/30	1.50
VR150/30	1.15
VT52	2.50
VU29	4.50
VU39	1.50
W77	5.00
W729	1.00
W739	1.50
X24	1.00
X66L	4.95
X76M	1.95
XC24	1.50
XC25	0.50
XFW47	1.50
XFW50	1.50
XG2-6400	35.00
XG5-500	22.50
XL1-5V	1.50
XL628FT	7.50
XNP12	2.50
XP1002	29.00
XR1-1600A	49.50
XR1-3200A	79.50
XR1-6400A	99.50
Y63	1.50
Y65	6.95
Y602	12.00
YD1100	75.00
YJ1060	265.00
YL1020	29.00
YL1070	115.00
YL1071	109.00
Z77	1.20
Z302C	12.00
Z359	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z803U	18.95
ZA1000	12.50
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1001	5.00
ZM1005	8.00
ZM1020	8.95
ZM1021	8.00
ZM1023	7.95
ZM1041	14.00
ZM1050	14.00
ZM1082	9.00
ZM1084	10.00
ZM1177	9.00
ZM1202	55.00
ZM1263	4.00
ZM1612	3.00
1AC6	1.20
1B3GT	1.95
1B5	2.50
1B22	10.00
1B24	14.95
1B35A	29.50
1C1	1.20
1C5GT	1.00
1D5	1.00
1FD1	0.90
1G3GT	1.00
1L4	0.60
1L6	1.50
1LA6	1.00
1N5GT	2.50
1S2	0.55
1T4	0.70
1U5	1.00
1X2B	1.40
2B7	1.50
2C21	1.00
2C39A	23.50
2C39BA	39.50
2C40	37.00
2C40A	55.00
2C42	29.50
2C51	0.75
2C53	32.00
2CY5	1.50
2D21	0.95
2D21W	2.50
2E26	7.95
2J42	93.00
2K25	24.95
2K26	95.00
3A/107B	12.00
3A/108A	9.00
3A/109B	11.00
3A/110B	12.00
3A/141K	11.50
3A/147J	7.50
3A/167M	10.00
3A2	3.95
3A3A	3.95
3A4	1.10
3AL5	0.95
3AT2	3.35
3AW2	3.35
3B2	3.00
3B7	4.50
3B26	24.00
3B28	12.00
3C4	1.00
3C45	24.00
3CN3A	2.50
3CS6	0.95
3CX3	2.50
3CY5	1.50
3D6	4.50
3D21A	29.50
3D22	19.50
3W4GT	2.50
4B551B	115.00
4-65A	59.00
4-250A	65.00
4BQ7A	1.75
4C27	25.00
4C28	25.00
4CX250B I.T.T.	37.50
4CX250B EIMAC	58.00
4CX250B surplus ex-government	12.50
4CX250B tested ex-equipment	6.00
4CX350A	71.50
4D26	75.00
4GS7	2.25
4GV7	2.25
4J52	75.00
4JC6A	2.95
4X150A	25.00
5A152M	9.00
5A163K	10.00
5A170K	6.25
5A-180M	9.00
5A-206K	10.00
5AM8	2.15
5AN8	1.20
5AR4	2.00
5AU4	1.50
5B.110M	10.00
5B-254M	14.50
5B-255M	19.50
5B-256M	9.00
5B-257M	9.00
5B-258M	14.50
5C22	40.00
5R4GB	2.80
5R4GY	2.80
5T4	5.95
5U4G	1.95
5U4GB	2.50
5V4G	1.25
5Y3GT	1.95
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A8G	1.50
6AB8	0.66
6AC7	2.00
6AF4A	2.50
6AF9	4.15
6AG5	1.50
6AG7	1.95
6AH6	1.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.00
6AK6	2.00
6AL5	0.60
6AM4	3.25
6AM5	6.00
6AM6	1.50
6AN5	3.95
6AN8A	2.95
6AQ5	1.50
6AQ8	0.85
6AR8	3.95
6AS5	1.50
6AS6	1.50
6AS7G	7.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.95
6AV6	0.75
6AW8A	2.95
6B8G	1.50
6BA6	0.95
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.50
6BD6	1.00
6BE6	0.72
6BF5	1.60
6BG6G	3.00
6BH6	1.95
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	2.75
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BL8	0.65
6BR5	0.70
6BR7	4.95
6BR8	2.15
6BR8A	2.15
6BS7	5.50
6BS8	2.50
6BW4	1.50
6BW6	5.35
6BW7	1.50
6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.50
6BZ7	2.95
6C4	1.10
6C5	1.95
6C6	2.50
6C8G	1.50
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	4.50
6CB6	1.95
6CD6GA	4.50
6CF6	1.50
6CH6	10.35
6CL6	3.50
6CL8A	2.00
6CM5	1.60
6CS6	0.75
6CW4	7.25
6CY5	1.00
6DC6	2.95
6DK6	1.15
6DQ5	3.35
6DQ6B	2.50
6EA8	2.50
6EB8	1.75
6EU8	1.75
6EW6	1.50
6F1	2.00
6F6G	2.00
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F21	2.50
6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F32	1.25
6F33	17.00
6FG5	1.95
6GH8A	0.80
6GK5	1.50
6GK6	2.00
6GV7	2.50
6GW6	2.50
6H3N	1.10
6H6	1.35
6H6GT	1.20
6J4	1.10
6J4WA	3.15
6J5	1.95
6J5GT	1.50
6J6	0.65
6JB6A	3.95
6JE6C	4.95
6JS6C	4.95
6J7	4.15
6K7G	0.70
6K8Y	3.95
6KD6	5.50
6L1	2.50
6L19	3.95
6L6GC	2.95
6L6GC(GE)	3.95
6L6GT	1.15
6L7G	0.75
6LD20	0.60
6LF6	4.50
6LQ6	4.95
6N7	2.50
6N7GT	1.50
6P15	1.50
6P25	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6S4A	1.50
6S7	1.10
6SA7GT	1.00
6SC7	1.50
6SG7	1.20
6SH7	1.20
6SJ7GT	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.85
6SN7GT	0.95
6SQ7	0.80
6SS7	1.95
6U4GT	1.75
6U5G	1.50
6U8	0.85
6U8A	1.50
6V6GT	0.85
6X2N	1.00
6X4	0.96
6X5GT	0.55
6X5GTY	1.00
6X8A	2.25
7A7	2.00
7AD7	1.75
7B7	2.50
7C5	3.00
7C6	2.50
7J7	3.50
7Q7	2.00
7V7	4.15
7Y4	1.95
8B8	2.50
8FQ7	1.95
10D2	1.25
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E2	16.50
11E3	55.00
12AG8	1.50
12AL5	1.00
12AT6	0.65
12AT7	1.15
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AY7	3.95
12AZ7A	1.95
12B4A	3.50
12BA6	1.50
12BE6	1.05
12BH7A	2.50
12BL6	1.75
12BY7A	2.75
12CX6	1.20
12E1	17.95
12E14	28.00
12GN7	3.95
12HG7	4.50
12HG7A	4.50
12J7GT	0.70
12K5	1.00
12K7GT	0.60
12K8	1.10
12Q7GT	0.50
12SA7GT	1.00
12SG7	4.75
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
12SQ7GT	1.50
13D3	3.20
13D7	3.20
13DR7	2.95
13E1	115.00
14S7	1.00
17EW8	0.95
17JZ8	2.75
18D3	1.60
19G3	17.00
19H4	23.95
19H5	33.50
19Q6	9.00
20A2	10.50
20D1	0.70
20D4	1.75
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.05
20P5	1.15
21LU8	2.50
24B1	39.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30C17	0.40
30C18	1.4[illegible]
30F5	0.95
30FL1	1.00
30FL2	1.35
30FL12	0.95
30FL13	1.10
30FL14	1.25
30L1	0.45
30L15	0.60
30L17	0.60
30P4MR	1.00
30P12	1.00
30P18	0.60
30P19	1.00
30PL1	2.50
30PL13	0.60
30PL14	1.75
33A/158M	19.50
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
47	6.00
50C5	0.95
50CD6G	1.15
50JY6	2.95
52KU	2.00
61SPT	4.50
75B1	2.50
75C1	2.95
84	3.00
85A1	6.50
85A2	1.50
90AV	10.00
90C1	2.70
90CG	13.50
91AG	9.00
92AG	12.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	6.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
274A	15.00
307	5.00
328A	15.00
388A	17.50
425A5	8.00
431U	2.00
572B	35.00
705A	8.00
708A	8.00
715A	6.00
715C	45.00
725A	275.00
803	14.95
805	39.00
807	1.60
810	55.00
811A	12.95
813	18.50
813 USA	59.50
833A	115.00
866A	3.50
872A	19.00
873	60.00
884	5.50
930	9.95
954	1.00
955	1.00
958A	1.00
1299A	0.60
1619	2.50
1625	3.00
1626	3.00
2050W	9.50
2050	7.00
3545	4.00
4313C	4.00
4328D	9.00
5642	9.50
5651	2.50
5654	1.95
5663	1.95
5670	3.25
5672	4.50
5675	23.50
5687	4.50
5692	3.50
5696	3.50
5704	3.50
5718	6.50
5725	2.50
5726	2.50
5727	2.50
5749	2.50
5750	2.00
5751	3.50
5763	4.95
5814A	3.25
5840	3.50
5842	11.00
5879	3.90
5894	39.50
5899	4.50
5963	2.00
5965	2.25
5993	8.00
6005	1.95
6012	16.00
6021	3.95
6057	2.50
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	4.75
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146B	7.50
6157	2.50
6201	6.95
6211	2.50
6267	1.50
6350	2.00
6360	5.50
6386	14.50
6545	8.50
6550A	8.00
6870	11.50
6883B	9.95
6973	3.75
7025	2.50
7027A	4.65
7032	2.00
7059	2.50
7189	2.50
7193	7.50
7199	5.95
7247	2.00
7360	9.50
7475	5.00
7551	5.75
7558	11.50
7586	11.50
7587	26.95
7591A	5.50
7609	47.00
7868	3.95
8012	15.00
8042	45.00
8136	1.00
8245	107.50
8298A	4.95
8417	5.95
9001	0.90
9006	0.90
18042	10.00
18045	10.00

WIREWOUND RESISTORS

PREFERRED VALUES

4 Watt	4R7-1K8	0.15
	2K2-6K8	0.18
	10K	0.24
7 Watt	R47-4K7	0.18
	5K6-12K	0.19
	15K-22K	0.20
11 Watt	1R-10K	0.20
	15K-22K	0.24
17 Watt	1R-10K	0.26
	15K-22K	0.28

WW-2

BASES ETC.

B7G	0.15
B7G Skirted	0.30
B8G	0.70
B9A	0.20
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.14
14 Pin DIL	0.15
14 Pin DIL/Q	0.30
16 Pin DIL	0.17
OCTAL	0.35
CANS	0.27
B9A PCB	0.15
B5	0.75
B9G	0.38

ZENER DIODES

BZX61 0.15

6V2 7V5 8V2 9V1 10V 11V 12V 13V 15V 16V 18V 20V 22V 24V 27V 30V 33V 36V 39V 47V 51V 56V 68V 75V

BZY88 0.07

2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 20V 24V 27V 30V

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45
VA1097	0.25

BATTERIES

7V Power Mike batteries
TR175 £1.40 ea
other prices on request

CALLERS WELCOME

★ ENTRANCE ON A227
50 YDS SOUTH OF MEOPHAM GREEN

CAR PARKING AVAILABLE

OPEN MONDAY TO FRIDAY 9a.m.-5.30p.m.

★ 24 HOUR ANSWERPHONE SERVICE ★
ACCESS AND BARCLAYCARD ORDERS WELCOME
★ MANY OTHER ITEMS AVAILABLE ★

UK ORDERS P&P 50p PLEASE ADD V.A.T. AT 15%

EXPORT ORDERS WELCOME. CARRIAGE/POST AT COST

CIRCLE 35 FOR FURTHER DETAILS.

01-452 1500 TECHNOMATIC LTD 01-450 6597

BBC Micro Computer System

OFFICIAL DEALER

Please phone for availability

ALL PRICES EXCLUDE VAT.

Please add carriage 50p unless indicated as follows:

(a) £7 (b) £2.50 (c) £1.50 (d) £1.00

ACORN COMPUTER SYSTEMS

BBC Model B	£348.00a
BBC Model B + Econet	£389.00a
BBC Model B + DFS	£429.00a
BBC Model B + DFS + Econnet	£470.00a
Acorn Electron	£175.00a
BBC Teletext Receiver	£195.00a

UPGRADE KITS

A to B Upgrade Kit	£75.00d
Installation	£15.00
DFS Kit	£95.00d
Installation	£15.00
Econet Kit	£55.00d
Installation	£25.00
Speech Kit	£47.00d
Installation	£10.00

BBC FIRMWARE

1.2 Operating System	£7.50d
Basic II Rom	£32.00d
View Word Processsor Rom	£52.00c
Wordwise W/P Rom	£34.00c
Beebpen W/P Rom	£38.00c
BCPL ROM + Disc	£87.00b
Disc Doctor Utility Rom	£28.00c
Termi Emulator Rom	£28.00c
ULTRACALC Rom (BBC Publications)	£65.00c
Gremlin debug Rom	£28.00c
Computer Concepts Graphics Rom	£28.00c
EXMON	£20.00d
TOOL KIT	£20.00d
Printmaster Rom	£30.00c
Communicator Rom	£59.00c

BBC COMPATIBLE 5.25" DISC DRIVES:

(All include cables, manual + format disc)

100K (40 Track)	£140.00a
100K (40 Track) with psu	£165.00a
200K (40/80 Track)	£175.00a
200K (80 Track) with psu	£210.00a
400K (80 Track DS)	£195.00a
400K (80 TDS) with psu	£225.00a
2×100K (40 Track) with psu	£320.00a
2×200K (40/80 Track) with psu	£400.00a
2×400K (80 Track DS) with psu	£420.00a
3" Hitachi 100K Drive	£160.00c
Accessories:	
40/80 Track Switching Module	£30.00c

Single Disc Cable		£6.00d
Double Disc Cable		£8.50d
Discs/Pkt of 10	WABASH	3M
40T SS/SD	£14.00	£16.00c
40T DS/DD	—	£22.00c
80T SS/DD	£24.00	£26.00c
80T DS/DD	£26.00	£30.00c
Life Time Warranty on 3M Discs		
3" Double Sided Disc		Each £4.50c
FLOPPICLENE Drive Head Cleaning Kit		£14.50c
Disc Library Case		£2.50d
Disc File Case 30/40		£8.00c
Disc Lockable Case 30/40		£15.00c
Disc Lockable Case 60/70		£27.00b

SOFTWARE

ACORN/MERLE BUSINESS SOFTWARE
GEMINI Leisure — Full Range
ACORNSOFT — Full Range
ACORN LANGUAGES including BCPL, LISP
FORTH with Manuals
BBCSOFT — Full Range
PROGRAM POWER — Full Range
ACORNSOFT (Electron) — Full Range
BEEBUGSOFT — Full Range

TORCH Z80 DISC PACK

The proven upgrade for the BBC Micro. Comprising 2 × 400K disc drive, Z80 processor with 64K of memory, and a CP/M compatible operating system, it opens up the vast range of CP/M software, including advanced languages, scientific and business applications. The system is supplied complete with the PERFECT software range including PERFECT WRITER, PERFECT SPELLER, PERFECT CALC, and PERFECT FILE. Full TORCHNET software is also supplied allowing access to information, and communication, between up to 254 upgraded BBCs.

NEW TORCH Z80 PACK PRICE £699.
SOFTWARE PACKAGE INCLUDES Z80 BASIC

Phone for details about the 20Mbyte Hard Disc Pack, and the 68000 Hard Disc Pack with UNIX Operating System.
NOW AVAILABLE — The TORCH Z80 SECOND PROCESSOR CARD — for those who already have suitable disc drives. The card is supplied with all the free software, as detailed above, presenting a very attractive package. **£299.**

ACORN IEEE INTERFACE

A full implementation of the IEEE-488 standard, providing computer control of compatible scientific & technical equipment, at a lower price than other systems. Typical applications are in experimental work in academic and industrial laboratories. The interface can support a network of up to 14 other compatible devices, and would typically link several items of test equipment allowing them to run with the optimum of efficiency. The IEEE Filing System ROM is supplied. **£282.**

BOOKS

We have a large selection of books on the BBC and other titles. Please ask for details. No VAT on books.

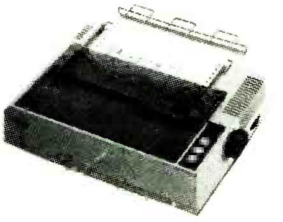
★ ★ ATTENTION ★ ★
All prices in this double page spread are subject to change without notice.

'TIME-WARP' REAL-TIME-CLOCK/CALENDAR

A low cost unit that opens up the total range of Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, continuous display of 'on-screen' time and date information automatic document dating, precise timing & control in scientific applications, recreational use in games etc — its uses are endless and are simply limited by one's imagination. Simply plugs into the user port — no specialist installation required — No ROMS. Supplied with extensive applications software.
Please phone for details. £29.00 + £2.50 carriage.

PRINTERS

EPSON FX-80	£350.00a
EPSON RX-80 FT	£250.00a
EPSON FX-100	£450.00a
EPSON DX-100	£460.00a
Printer Sharer + Cable Set	£88.00c
SEIKOSHA GP 100A	£160.00a
JUKI 6 100 Daisy wheel	£350.00a
MCP40 Col. Printer/Plotter	£120.00a
Grafpad Graphics Tablet	£125c



ACCESSORIES

Parallel Printer Lead	£10.00d
Serial Printer Lead	£8.00d
Epson Serial Interface 2K 8148	£60.00c
Epson Serial Interface 8143	£50.00c
NEC Serial Interface	£42.00c
Epson Paper Roll Holder	£17.00c
FX-80 Tractor Attachment	£37.00c
PAPER Fanfold 2000 sheets	£13.50b
Ribbon MX80/RX80/FX80	£6.50c

MONITORS

Microvitec 1431 14" RGB Std Res	£195.00a
Microvitec 1431 PS 14" RGB/PAL + Sound	£225.00a
Microvitec 1451 14" RGB Med Res	£229.00a
Microvitec 1441 14" RGB Hi Res	£420.00a
Microvitec 2031 20" RGB Std Res	£287.00a
KAGA Vision I 12" RGB Med Res	£230.00a
KAGA Vision II Hi Res	£260.00a
KAGA Vision III 12" RGB Super Hi Res	£358.00a
KAGA 12" Green Hi Res	£106.00a
SANYO DM8112CX 12" Green Hi Res	£99.00a
KAGA RGB Lead	£6.50d
BNC Green Screen Monitor Lead	£3.50d

CASSETTE RECORDERS

SANYO DR 101 Data Recorder	£34.00b
Datex Slim Line	£24.00c
BBC Tape Recorder	£28.50b
Cassette Lead	£3.00d
HOBBIT Floppy Tape	£135.00b
HOBBIT Zero Memory Option	£25.00d
Computer Grade C-12 cassette	£0.50d
Computer Grade Cassette 10 off	£4.50c
Phillips Mini-data cassette	£3.00d

EPROM PROGRAMMER:

A fully self-contained mains-powered eprom programmer housed in an attractive finished case. It is able to program 2716, 2732/32A, 2764 & 27128's in a single pass. It is supplied with vastly superior software when compared to any currently available similar programmer. In addition to normal eprom programming, you are now able to load your favourite basic programs onto eprom.

- **Menu Driven Software provides user friendly options for programming the eprom with:**
  - **a) Basic programs.**
  - **b) Ram resident programs.**
  - **c) Any other program.**
- **Programmer can read, blank-check, program & verify at any address/addresses on the Eprom.**
- **Personality selection is simplified by a single rotary switch.**
- **Programming voltage selector switch.**
- **Full Editor with ASCII Disassembler, allowing direct modification of memory data in HEX or ASCII.**
- **Continuous display of time left for completion of proramming.**
- **Continuous display of current addresses as they are being programmed.**

The programmer comes complete with cables, software & operating manual.
£89 + £2.50 carriage. Software on disc £2 extra.

SMARTMOUTH:

The original 'infinite speech'. Still the best.
A ready built totally self contained speech synthesiser unit, attractively packaged with built-in speaker, AUX output socket etc. — no installation problems! It allows the creation of any English word, with both ease and simplicity, while, at the same time being very economical in memory usage. You can easily add speech to most existing programs. Due to its remarkable infinite vocabulary, its uses spread throughout the whole spectrum of computer applications — these include industrial, commercial, educational, scientific, recreational etc. No specialist installation — no need to open your computer, simply plugs into the user port — and due to the simple software, no ROMS are needed. SMARTMOUTH is supplied with demo and development programs on cassette, and full software instructions. **£37 + £2.50 carriage.**

EPROM ERASERS

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 + £2 p&p.**
UV1 as above but without the timer. **£47 + £2 p&p.**

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

No. of ways

	9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Hoods	90p	85p	90p	100p

IDC 15-way plug 340p. Socket 400p
IDC 25-way plug 385p. Socket 450p

TEXTOOL ZIF

SOCKETS
28-pin £8.00
24-pin £5.75
40-pin £9.75

DIL SWITCHES

4-way 70p
6-way 100p
8-way 130p
10-way 150p

JUMPER LEADS

24" Ribbon Cable with Headers

	14-pin	16-pin	24-pin	40-pin
1 end	145p	165p	240p	350p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with Sockets

	20-pin	26-pin	34-pin	40-pin
1 end	160p	200p	280p	300p
2 ends	290p	370p	480p	525p

Ribbon Cable with D. Conn.

25-way Male 500p Female 550p

RS 232 JUMPERS

(25-way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female-Female	£10.00
24" Male-Male	£9.50
24" Male-Female	£9.50

DIL HEADERS

	Solder Type	IDC Type
14pin	40p	100p
16pin	50p	110p
24pin	100p	150p
40pin	200p	225p

AMPHENOL CONNECTORS

	Solder	IDC
36-way plug Centronics	£5.25	£5.25
36-way socket Centronics	£5.50	£5.50
24-way plug IEEE	£5.00	£4.75
24-way socket IEEE	£5.00	£4.75

PCB Mtg Skt Ang pin
24-way £6.00. 36-way £6.50

RIBBON CABLE

(Grey/meter)

10-way	40p
16-way	60p
20-way	85p
26-way	120p
34-way	160p
40-way	180p
50-way	200p
64-way	280p

EURO CONNECTORS

	Plug	Skt.
DIN 41617		
21-way	160p	165p
31-way	170p	170p
DIN 41612		
2×32-way St. Pin	230p	275p
2×32-way Ang. Pin	275p	320p
3×32-way St. Pin	260p	300p
3×32-way Ang. Pin	375p	400p
1 DC Skt	A + B 275p	A + C 350p

For 2 x 32-way please specify spacing (A + B, A + C)

TEST CLIPS

14-pin 375p
16-pin 400p
40-pin £10.30

EDGE CONNECTORS

	0.1"	0.156"
2x6-way (Commodore)	—	300p
2x10 way (Commodore)	150	—
2×12-way (Vic 20)	—	350p
2×18-way	—	140p
2×23-way (ZX81)	175p	220p
2×25-way	225p	220p
2×28-way (Spectrum)	200p	—
2x36-way	250p	—
1×43-way	260p	—
2x22-way	190p	—
2×43-way	395p	—
1×77-way	400p	500p
2x50-way (S100conn)	600p	—

74 SERIES

7400	POA100p
7401	60p
7402	100p
7403	60p
7404	POA100p
7405	60p
7406	POAp
7407	POAp
7408	100p
7409	60p
7410	100p
7411	60p
7412	50p
7413	75p
7414	90p
7416	POA200p
7417	POA200p
7420	60p
7421	100p
7422	60p
7423	60p
7425	75p
7426	60p
7427	60p
7428	60p
7430	60p
7432	POAp
7433	60p
7437	60p
7438	100p
7439	50p
7440	60p
7441	120p
7442A	75p
7444	120p
7445	160p
7446A	120p
7447A	120p
7448	120p
7450	60p
7451	60p
7453	60p
7454	60p
7460	75p
7470	75p
7472	75p
7473	75p
7474	100p
7475	100p
7476	80p
7480	80p
7481	220p
7483A	120p
7484A	250p
7485	120p
7466	70p
7469	300p
7490A	75p
7491	70p
7492A	90p
7493A	75p
7494	150p
7495A	90p
7496	100p
7497	250p
74100	220p
74107	75p
74109	75p
74110	90p
74111	55p
74116	220p
74118	200p
74119	300p
74120	180p
74121	90p
74122	100p
74123	150p
74125	100p
74126	100p
74128	120p
74132	100p
74136	90p
74141	180p
74142	450p
74143	480p
74144	480p
74145	140p
74147	225p
74148	180p
74150	225p
74151A	100p
74153	100p
74154	250p
74155	100p
74156	110p
74157	110p
74159	320p
74160	120p
74161	75p
74162	90p
74163	90p
74164	90p
74165	100p
74166	120p
74167	400p
74170	250p
74172	750p
74173	180p
74174	120p
74175	120p
74176	150p
74177	150p
74178	250p
74179	250p
74180	150p
74181	380p
74182	200p
74184	300p
74185A	300p
74190	140p
74191	140p
74192	140p
74193	140p
74194	140p
74195	100p
74196	140p
74197	140p
74198	250p
74199	250p
74221	150p
74251	150p
74259	250p
74265	100p
74273	270p
74276	350p
74278	370p
74279	150p
74283	170p
74285	350p
74290	140p
74293	140p
74298	225p
74351	225p
74365A	100p
74366A	100p
74367A	100p
74368A	100p
74376	200p
74390	225p
74393	225p
74490	300p

74LS SERIES

74LS00	POA100p
74LS01	60p
74LS02	POA100p
74LS03	60p
74LS04	POA100p
74LS05	70p
74LS08	100p
74LS09	60p
74LS10	100p
74LS11	70p
74LS12	60p
74LS13	75p
74LS14	120p
74LS15	60p
74LS20	60p
74LS21	60p
74LS22	70p
74LS26	70p
74LS27	70p
74LS28	70p
74LS30	60p
74LS32	POA100p
74LS33	60p
74LS37	60p
74LS38	100p
74LS40	60p
74LS42	100p
74LS47	140p
74LS48	140p
74LS51	60p
74LS54	60p
74LS55	60p
74LS73A	75p
74LS74A	100p
74LS75	90p
74LS76A	75p
74LS83A	120p
74LS85	150p
74LS86	75p
74LS90	90p
74LS91	110p
74LS92	100p
74LS93	90p
74LS95B	100p
74LS96	160p
74LS107	75p
74LS109	75p
74LS112	90p
74LS113	75p
74LS114	75p
74LS122	100p
74LS123	200p
74LS124/629	300p
74LS125	90p
74LS126	90p
74LS132	90p
74LS133	90p
74LS136	75p
74LS138	120p
74LS139	120p
74LS145	150p
74LS147	220p
74LS148	220p
74LS151	100p
74LS153	100p
74LS154	300p
74LS155	140p
74LS156	125p
74LS157	100p
74LS158	100p
74LS160A	140p
74LS161A	140p
74LS162A	140p
74LS163A	140p
74LS164	140p
74LS165A	160p
74LS166A	250p
74LS168	200p
74LS169	200p
74LS170	220p
74LS173A	120p
74LS174	120p
74LS175	120p
74LS181	250p
74LS183	270p
74LS190	130p
74LS191	130p
74LS192	130p
74LS193	130p
74LS194A	130p
74LS195A	130p
74LS196	130p
74LS197	130p
74LS221	140p
74LS240	250p
74LS241	250p
74LS242	140p
74LS243	140p
74LS244	300p
74LS245	350p
74LS247	120p
74LS248	120p
74LS249	120p
74LS251	100p
74LS253	100p
74LS256	200p
74LS257A	120p
74LS258A	100p
74LS259	200p
74LS260	90p
74LS261	120p
74LS266	100p
74LS273	240p
74LS275	175p
74LS279	120p
74LS280	240p
74LS283	120p
74LS290	110p
74LS292	900p
74LS293	120p
74LS295	140p
74LS297	900p
74LS298	150p
74LS299	250p
74LS321	300p
74LS324/624	350p
74LS348	250p
74LS352	150p
74LS353	150p
74LS356	220p
74LS363	180p
74LS364	180p
74LS365	100p
74LS366	100p
74LS367	100p
74LS368	100p
74LS373	POA300p
74LS374	POA300p
74LS375	100p
74LS377	180p
74LS378	150p
74LS379	140p
74LS390	140p
74LS393	200p
74LS395A	140p
74LS399	210p
74LS445	180p
74LS465	220p
74LS467	220p
74LS490	170p
74LS540	200p
74LS541	200p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS626	350p
74LS628	350p
74LS629	300p
74LS640	250p
74LS640	1300p
74LS641	250p
74LS642	1300p
74LS643	250p
74LS643	1300p
74LS644	350p
74LS645	350p
74LS645	400p
74LS668	120p
74LS669	150p
74LS670	225p
74LS682	650p
74LS684	650p
74LS687	550p

74S SERIES

74S00	100p
74S02	100p
74S04	120p
74S05	100p
74S08	100p
74S10	100p
74S11	100p
74S20	100p
74S22	100p
74S30	100p
74S332	180p
74S37	180p
74S51	150p
74S74	120p
74S85	450p
74S86	180p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	120p
74S133	100p
74S138	180p
74S139	180p
74S140	100p
74S151	200p
74S153	200p
74S157	300p
74S158	300p
74S163	400p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	400p
74S195	400p
74S196	350p
74S200	450p
74S201	320p
74S225	650p
74S240	250p
74S241	300p
74S244	400p
74S251	300p
74S257	300p
74S258	300p
74S260	100p
74S261	300p
74S262	850p
74S283	300p
74S287	225p
74S288	180p
74S289	225p
74S299	650p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S571	300p
74S573	500p

4000 CMOS

4000	30p
4001	30p
4002	30p
4006	90p
4007	30p
4008	90p
4009	60p
4010	60p
4011	30p
4012	30p
4013	60p
4014	80p
4015	80p
4016	50p
4017	75p
4018	75p
4019	60p
4020	90p
4021	80p
4022	80p
4023	50p
4024	50p
4025	30p
4026	100p
4027	50p
4028	60p
4029	90p
4030	45p
4031	160p
4032	80p
4033	160p
4034	200p
4035	80p
4036	270p
4037	150p
4038	80p
4039	250p
4040	80p
4041	60p
4042	75p
4043	75p
4044	75p
4046	90p
4047	85p
4048	60p
4049	48p
4050	48p
4051	80p
4052	80p
4053	80p
4054	90p
4055	90p
4056	100p
4059	450p
4060	90p
4063	90p
4066	45p
4067	290p
4068	30p
4069	30p
4070	30p
4071	30p
4072	30p
4073	30p
4075	30p
4076	90p
4077	30p
4078	30p
4081	30p
4082	30p
4085	60p
4086	70p
4089	125p
4093	48p
4094	100p
4095	90p
4096	90p
4097	290p
4098	90p
4099	90p
4501	40p
4502	60p
4503	60p
4504	90p
4505	400p
4506	120p
4507	45p
4508	160p
4510	75p
4511	75p
4512	75p
4513	140p
4514	130p
4515	130p
4516	75p
4517	200p
4518	75p
4519	75p
4520	75p
4521	125p
4522	90p
4526	90p
4527	90p
4528	75p
4529	90p
4531	75p
4532	80p
4534	400p
4536	220p
4538	90p
4539	90p
4541	90p
4543	100p
4551	250p
4553	220p
4555	60p
4556	70p
4557	250p
4560	120p
4566	200p
4568	300p
4569	200p
4572	50p
4583	75p
4584	48p
4585	65p
4724	150p
14411	900p
14412	850p
14416	300p
14419	300p
14490	550p
14495	450p
14500	700p
14599	350p
22100	350p
22101	700p
22102	700p
40014	48p
40085	90p
40097	60p
40098	60p
40100	120p
40101	120p
40102	140p
40103	170p
40104	120p

COUNTERS

74C925	£4
74C926	£5
74C928	£6
72168	£22
ZN1040	670p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AN103	200p
AY1-5050	99p
AY3-1270	750p
AY3-1350	350p
AY3-8910	400p
AY3-8912	500p
CA3019A	100p
CA3028A	150p
CA3046	70p
CA3059	350p
CA3060	350p
CA3080E	80p
CA3086	60p
CA3089E	250p
CA3090AQ	375p
CA3130E	90p
CA3130T	110p
CA3140E	60p
CA3140T	110p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	120p
CA3280G	225p
D7002	600p
DAC0800	200p
DAC0808	200p
DG308	300p
HA1366	190p
HA1388	250p
ICL7106	700p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM72168	2400p
ICM7217	900p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	325p
LC7137	350p
LF347	150p
LF351	60p
LF353	100p
LF355	100p
LF356F	100p
LF357	130p
LF13331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308CN	75p
LM310	120p
LM311	70p
LM318	150p
LM319	160p
LM324	50p
LM334Z	90p
LM335Z	140p
LM339	40p
LM348	65p
LM358P	60p
LM377	225p
LM380	75p
LM381AN	180p
LM382	180p
LM386	90p
LM387	120p
LM389	180p
LM391	180p
LM392N	60p
LM393	100p
LM394CH	350p
LM709	50p
LM710	50p
LM711	70p
LM725C	300p
LM733	75p
LM741	20p
LM747	70p
LM748	40p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	500p
LM1889	350p
LM2917	250p
LM3302	75p
LM3900	50p
LM3909	120p
LM3911	160p
LM3914	350p
LM3915	350p
LM3916	350p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	130p
MC1458	40p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	200p
MC3401	50p
MC3403	65p
MF10CN	360p
MK50240	900p
MK50398	790p
ML920	500p
MM6221A	300p
NE531	150p
NE544	190p
NE555	22p
NE556	50p
NE564	400p
NE565	150p
NE566	150p
NE567	140p
NE570	400p
NE571	400p
NE592	75p
NE5532P	200p
NE5533	160p
NE5534P	120p
NE5534AP	200p
PLL02A	500p
RC4136	60p
S566B	300p
SAA1900	£16
SAD1024A	1150p
SFF96364	800p
SN76477	600p
SN76489	400p
SN76495	400p
SP0256AL2	800p
TA7120	150p
TA7130	160p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TDA1004A	500p
TDA1010	250p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2002	325p
TDA2003	325p
TDA2004	300p
TDA2006	350p
TDA2020	320p
TDA2030	250p
TDA2541	400p
TDA3560	990p
TDA7000	350p
TL061CP	50p
TL062	75p
TL064	110p
TL071	45p
TL072	60p
TL074	110p
TL081	45p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
TL430C	120p
UA1003-3	935p
UA2240	120p
UAA170	200p
UCN4801A	350p
ULN2001A	130p
ULN2002A	130p
ULN2003A	130p
ULN2004A	130p
ULN2068	350p
ULN2802	250p
ULN2803	250p
ULN2804	250p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	350p
XR210	400p
XR2206	400p
XR2211	575p
XR2240	120p
ZN414	80p
ZN419C	190p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E	210p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	200p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		−ve	
5V	7805	50p	7905	45p
6V	7806	60p	7906	45p
8V	7808	60p	7908	50p
12V	7812	50p	7912	45p
15V	7815	50p	7915	45p
18V	7818	60p	7918	50p
24V	7824	60p	7924	45p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

LM309K 1A 5V	140p	78P05	900p
LM317K T03	250p	78H12	850p
LM317T	150p	78HGKC	600p
LM337T	225p	78HO5KC	650p
LM323K 3A 5V	450p	78GUIC	225p
LM350T	350p	79GUIC	250p
LM723N	50p	79HGKC	700p
TL494	300p	ICL 7660	250p
TL497	300p	LM305AH	250p
78S40	250p	SG3524	300p

OPTO-ELECTRONICS

2N5777	48p
OCP71	180p
ORP12	120p
ORP60	120p
ORP61	120p
TIL32	55p
TIL78	55p
TIL31A	120p
TIL81	120p
TIL100	75p

OPTO-ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
MOC3020	150p
ILQ74	180p
TIL111	70p
TIL112	70p
TIL113	70p
TIL116	70p
6N137	400p
FND357	120p
MAN72	140p
MAN74	140p
MAN4640	200p
MAN8910	250p
TIC729	140p
TIC730	140p
NSB5881	570p
TIL311	600p
TIL321/3	130p
TIL330	140p
7750/60	200p
Bargraph	225p

LEDS

0.125″

TIL209 Red	10p
TIL211 Gr	12p
TIL212 Yel	15p

0.2″

TIL220 Red	10p
TIL222 Gr	12p
TIL228 Yel	15p
Rectangular LEDs (R,G,Y	30p

DISPLAYS

DL704	140p
DL707 Red	140p

TRANSISTORS

AD161/2	45p
BC107/8	18p
BC109C	20p
BC169C	16p
BC172	18p
BC177/8	30p
BC179	30p
BC182/3	15p
BC184	16p
BC187	30p
BC212/3	16p
BC214	18p
BC237	16p
BC327	16p
BC337	16p
BC338	16p
BC461	40p
BC477/8	36p
BC516/7	50p
BC547B	20p
BC548C	12p
BC549C	16p
BC557B	14p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	40p
BF256B	50p
BF257/8	40p
BF337	30p
BFR39	32p
BFR40/1	32p
BFR79	32p
BFR80/1	32p
BFR96	180p
BFX29	45p
BFX30	45p
BFX84/5	30p
BFX86/7	30p
BFX88	40p
BFX89	180p
BFY50	30p
BFY51/2	40p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	30p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	150p
MJE3055	120p
MPF102	40p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	30p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TI41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP55	180p
TIP120	75p
TIP121	75p
TIP122	80p
TIP125	75p
TIP126	80p
TIP142	120p
TIP147	120p
TIP2955	90p
TIP3055	70p
TIS93	30p
VN10KM	50p
VN66AF	90p
VN88AF	100p
ZTX108	16p
ZTX300	18p
ZTX452	45p
ZTX500	20p
ZTX502	20p
ZTX504	22p
ZTX552	55p
ZTX652	60p
ZTX752	70p
2N697	35p
2N698	45p
2N706A	36p
2N708	36p
2N918	45p
2N930	30p
2N1131/2	50p
2N1613	36p
2N1711	36p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	30p
2N2484	30p
2N2645	50p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	12p
2N3053	40p
2N3054	60p
2N3055	55p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	16p
2N3704/5	16p
2N3706/7	16p
2N3708	16p
2N3773	200p
2N3819	40p
2N3823	30p
2N3866	120p
2N3902	700p
2N3904	22p
2N3905	22p
2N3906	24p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	120p
2N4871	50p
2N5087	30p
2N5089	30p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	80p
2N5485	36p
2N5875	250p
2N5883	375p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
22N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2076	160p
2SC2335	200p
2SC2612	200p
3N128	200p
3N140	200p
3N141	200p
3N201	200p
3N204	200p
40290	250p

DIODES

BY127	12p
BYX36300	20p
OA47	10p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/2	12p
1N5403/4	14p
1N5404/5	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

DIL SWITCHES

4-way	90p
8-way	120p
6-way	105p
10-way	150p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p
TIC 206D	60p
TIC 226D	75p
TIC 246D	110p

THYRISTORS

3A 400V	45p
8A 600V	180p
12A 400V	160p
16A 100V	180p
16A 400V	220p
C106D	45p
MCR101	36p
2N3525	130p
2N4444	180p
2N5060	30p
2N5061	32p
2N5064	35p

PCB MOUNTING RELAYS

6 or 12V DC
Coil SPDT 2A
24V DC 160p

6 or 12V DC
Coil DPDT 5A
24V DC
240V AC 200p

6 or 12V DC
Coil SPDT 10A
24V DC
240V AC 225p

ZENERS

2.7V-33V
400mW 9p
1W 15p

WW-5

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	400p
6502A	650p
6800	290p
6802	300p
6809	650p
68B09	£12
6809E	£12
68B09E	£16
6800L8	£48
8035	550p
8039	550p
8080A	350p
8085A	1800p
8086	£22
8088	2200p
8748	3600p
TMS1601	£12
TMS9980	1200p
TMS9995	£12
WD55	1450p
Z8	£24
Z80	300p
Z80A	400p
Z80B	950p
8288	£11
8755A	1800p
9901	£3
9902	£3
TMS9901	350p
TMS9902	350p
Z80P10	300p
Z80AP10	350p
Z80CTC	300p
Z80ACTC	350p
Z80ADART	850p
Z80ADMA	£10
Z80SI 0/1/2	£9

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	650p
6551	650p
6821	200p
68B21	250p
6829	£12.50
6840	375p
68B40	600p
6850	200p
68B50	250p
6852	250p
6854	850p
68B54	1200p
6875	750p
8154	950p
8155	1100p
8156	750p
8205	225p
8212	300p
8216	200p
8224	200p
8226	250p
8228	250p
8243	1400p
8250	1400p
8251A	1800p
8253C-5	1800p
8255AC-5	1900p
8256	£36
8257C-5	750p
8259C-5	750p
8279	750p
8284	600p

MEMORIES

2102	250p
2107B	500p
2111A-35	400p
2114-2L	500p
2114-4L	400p
2147	450p
4027-3	300p
4116-15	200p
4116-20	175p
4118-3	500p
4164-2	450p
4164-15	500p
4416-15	500p
4532-20	250p
4816AP-3	475p
5101/5501	450p
5516	1000p
6116P-3	850p
6116LP-3	950p
6264-15	3500p
6514-45	650p
6810	180p
474S189	225p
74S201	350p
74S289	225p
93415	600p
93425	600p
93L422	950p
X2210	TBA

ROMs/PROMs

74S188	180p
74S287	200p
74S288	180p
74S387	225p
74S473	475p

EPROMs

2532	450p
2532-30	700p
2564	700p
2708	400p
2716	350p
2732	450p
2732A-2	900p
2732A-35	550p
2764-25	900p
27128-25	2500p
27128-30	2200p

CRT CONTROLLER

CRT6545	900p
CRT5027	£18
CRT5037	£18
EF9365	£36
EF9366	£36
MC6845	650p
MC6845SP	750p
MC6847	650p
P8275	£27
SFF96364	£8
TMS9918	300p
TMS9927	£18
TMS9928	£20
TMS9929	£16

INTERFACE ICs

AD558CJ	775p
AD561J	£20
AM25S10	350p
AM25LS2521	350p
AM26LS31	160p
AM26LS32	160p
D7002	600p
DAC80	£28
DM8131	325p
DP8304	300p
DS3691	350p
DS8830	140p
DS8831	150p
DS8832	150p
DS8833	225p
DS8836	150p
DS8838	225p
DS8880	170p
LF13201	450p
MC1488	100p
MC1489	100p
MC3418	950p
MC3446	250p
MC3459	450p
MC3470	650p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14412	750p
75107	90p
75110/12	160p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75159	220p
75365	150p
75451/2	72p
75453/4	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/6	90p
8T97/8	90p
81LS95	220p
81LS96	220p
81LS97	220p
81LS98	220p
88LS120	400p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E	600p
ZN428E-8	450p

DISC CONTROL ICs

8271	£45
8272	£20
FD1771	£20
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
TMS9909	£12
WD2793	4200p
WD2797	4200p
WD1691	1500p
WD2143	800p

CHARACTER GENERATORS

RO3-2513	
U.C	750p
L.C.	700p
DM86S64	£12
MC66760	750p

KEYBOARD ENCODER

AY 5 2376	1150p
74C922	480p
74C923N	500p

BAUD RATE GENERATORS

MC14411	900p
COM8116	800p
4702B	750p

UARTs

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	360p
TR1602	300p

ZIF SKTS

(TEXTOOL)

24 pin	575p
28 pin	800p
40 pin	975p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

CRYSTALS

32.768KHz	100p
100KHZ	400p
200KHZ	400p
Freq in MHz	
1.0	325p
1.8432	300p
2.00	250p
2.45760(L)	210p
2.45760(S)	275p
2.5	250p
2.662	250p
3.276	150p
3.5795	120p
4.0	150p
4.194	200p
4.43	125p
4.608	250p
4.9152	250p
5.0	175p
6.0	150p
6.144	175p
7.0	150p
7.168	175p
8.0	175p
8.867	175p
10 0	175p
10.50	250p
10.70	200p
11.0	300p
12.0	150p
14.0	175p
14.316	175p
14.756	250p
15.0	200p
16.0	200p
18.0	200p
18.432	150p
19.969	150p
20.0	450p
24.0	300p
48.0	175p
116	300p
PX0 1000	1200p

REAL TIME CLOCK

MC6818P	550p
MM58174AN	800p
MSM5832RS	350p

TELETEXT DECODER

SAA5020	600p
SAA5030	700p
SAA5041	£16
SAA5050	900p

LOW PROFILE SOCKETS BY TI

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TI

8 pin	30p	18 pin	50p	24 pin	75p
14 pin	42p	20 pin	66p	28 pin	100p
16 pin	45p	22 pin	75p	40 pin	130p

TECHNOMATIC LTD

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
(Tel: 01-452 1500, 01-450 6597. Telex: 922800)
305 EDGWARE ROAD, LONDON W2

PLEASE ADD 50p p&p & 15% VAT

(Export: no VAT, p&p at Cost)

Orders from Government Depts. & Colleges etc. welcome.

Detailed Price List on request.
Stock items are normally by return of post.

NEW LIGHT ON MULTIMETER

An optional feature of the new Philips PM 2518 Multimeter is a low-power electroluminescent strip which acts as a back light for the large l.c.d. The display is automatically illuminated when the ambient light level is too low. This enables the use of the meter in dark and awkward places such as testing equipment on site and in photographic darkrooms. The backlight also switches itself off automatically if no reading has been taken for 30s. With the back light illuminated, the meter still has a battery life of some 200 hours.

The meter uses a microporcessor linked to other i.cs internally by the Philips/Intel I^2C (inter integrated circuit) bus. An I^2C adaptor will be offered as an option which will allow users of the meters to carry out maintenance and calibration tests with the meter interfaced to a computer.

Facilities offered by the meter are claimed to match those of many bench multimeters. It is autoranging and offers a basic d.c. accuracy to within 0.1%. Alternating voltage and current measurements are true r.m.s. Voltage measurements are up to 1kV and (with a special high current probe) current measurements are up to 30A. Resistance range is between 1kΩ and 100MΩ with a resolution in the 1kΩ range of 100mΩ. There is also a diode test facility, a dB scale, a bleeper output for continuity testing which also acts as a warning if any range is exceeded. Temperature readings between —60 and 200°C are possible with an optical temperature probe. There is very little bandwidth (10Hz to 100kHz) for a.c. measurement which combined with the true r.m.s. reading is very suitable for audio measurement. Bandwidth may be increased further with h.f. probes, up to 1GHz. Safety test leads are provided which are unaffected by, for example, burning with a soldering iron. A wide range of optional accessories are available including the various probes mentioned above. The basic costs £165; with back light it comes to £199. Pye Unicam Ltd, York Street, Cambridge CB1 2PX.
EWW 210

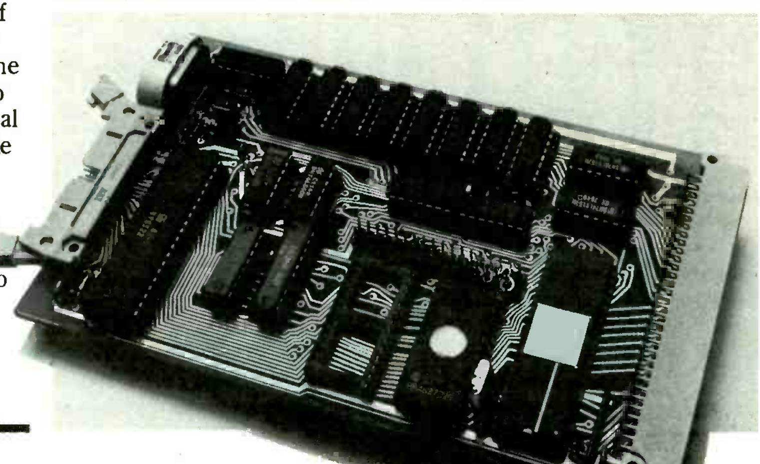
EPROM ERASERS

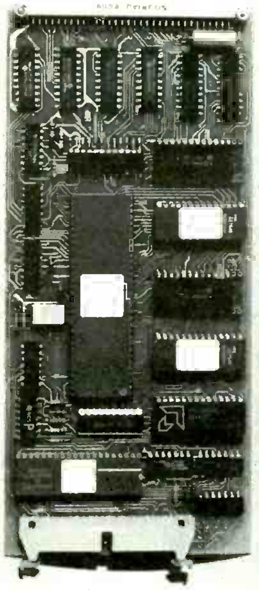
Three new low-cost eprom erasers have been designed for use in the laboratory, classroom and by the hobbyist. All three versions use a simple drawer construction for easy access. The drawer is lined with high-density anti-static foam to hold (depending on the model) 20 or 40 devices to be erased at one time. A low-power light source has been selected to keep the unit cool while emitting the correct level to the eproms. The tube is fully enclosed. Unit 82 for 20 devices costs £31.25, 84 takes 40 devices and costs £44.95 and for a further £10, Unit 84T may be purchased and this includes a timeswitch to prevent over-cooking the chips. Time is variable between 10 and 30 minutes. An l.e.d. indicates when the unit is working. J. P. Designs, 37 Oyster Row, Cambridge CB5 8LJ.
EWW 211

INDUSTRIAL CONTROLLER

A single board computer based around a 6809 processor has been especially produced to suit the needs of the engineer and process designer. The 6809 has a wealth of readily available software and programs may be developed quite easily for a particular application. This single Eurocard may be interfaced with the Acorn/BBC computer, which may then be used as a development system for the software that will run on the controller. The system may be used to write programs in the control language PL9, or any of a number of languages including BCPL, Pascal, C or assembler. The use of the board is very flexible and the memory map of the system can be redefined to any preferred configuration. The control board can address up to 64K of read/write memory, ideal for applications where real-time data storage is required. The board incorporates battery back-up circuitry and there are two sockets for eight-bit memories such as eproms up to 16K, or 8K c.mos or n.mos read/write memories.

Thus its capabilities range from a device with 32K of rom and 32K of ram or just 4K of rom and 56K of ram or in a minimal configuration of 4K rom and 2K of ram. So superfluous functions may be removed, thus cutting the cost of the controller card. The on-board versatile interface adaptor provides two 8-bit parallel t.t.l.-level i/o ports with protocol control lines and there are a pair of interval timers for real-time interrupts. The v.i.a. communicates with the outside world through a 26-way connector. Microprocessor control, data and address lines are available through a 64-way edge connector and not only will this connect to a host computer but may also be used to connect other cards such as extra digital i/o, a-to-d and d-to-a converters, opto-isolated mains switches and any other Acorn-bus compatible circuits. The board may also be used as a second processor for the Acorn/BBC computer by way of an interface board and may then be used to run Flex software. The basic price for the 6809 board is £229, another £20 will get you the 6809-to-BBC interface, software on floppy disc to link the BBC and 6809 is £10 and also on disc is an unconfigured Flex with assembler and editor and full operational manual for £130. Cambridge Microprocessor Systems Ltd, 11 St. Margarets Road, Girton, Cambridge CB3 0LT.
EWW 212





BUILD A 16-BIT CONTROLLER

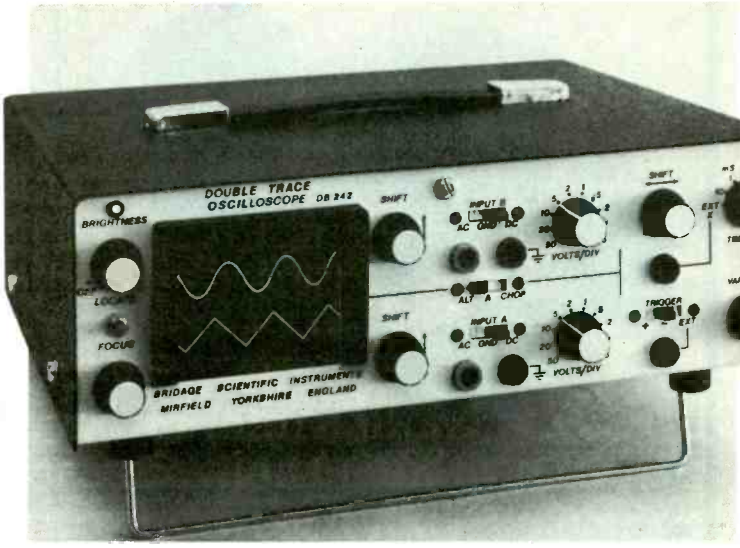
A microcomputer dual-processor controller card is built around the Motorola 68000 and 68701 processors. It feature on-card eprom (up to 32Kbytes) and ram (16Kbytes), a real-time clock, serial RS232 interface and a parallel printer port. The card is designed to the G64 bus specification and comes on an extended Eurocard. This card may be combined with a 256Kbyte memory card and a dual-density disc controller to form the SAT-16 computer system. The control system gives four selectable data transmission rates, an on-card self test that is carried out each time there is a power reset, direct memory access operation and is easily expandable. Interfacing to the G64 bus is provided by tri-state buffers, data transfers are asynchronous for off-card memory and on-card resources but synchronous for peripherals. Any existing eight-bit peripheral which is G64 compatible may be used directly with the Sat-16 card.

The 68701 contains software programmed within it that provides the user with the normal communications dialogue with its co-processor the 68000 and a number of user commands. The software is installed within the 68701 at manufacture but may be modified, although a 68701 programmer is needed for this.

The system is aimed at giving would-be 16-bit users a system at a reasonable cost which can be for single-board applications or expanded as required.

Built and tested the c.p.u. card costs £299; in kit form its £280, and a starter kit which includes the bare p.c.b., p.a.l. devices, 68701, i/o software and full documentation is £150. Built modules, kit or bare boards are available for the RS232/printer adaptor, a six-slot back board and a bus terminator board. Satellite Services Ltd, 9 King Street, Sileby, Leics LE12 7LZ.
EWW 230

LOW-COST OSCILLOSCOPE



This general purpose, dual-trace oscilloscope costs £225 and is made by Bridage, in Skipton, N. Yorkshire. The DB242 has been specially developed to cater to the needs of educational and industrial laboratories, and test and service bays. Small in size and portable, the oscilloscope is also suitable for radio, tv and hi-fi maintenance. Ease and speed of use have been considered important in producing an instrument which the makers claim is easy to understand and yet versatile. The display has a medium-persistance phosphor on a 60 by 50mm screen which has a calibrated graticule. There is a trace location button and an auto brightline triggering system. Sensitivity can be varied from 50mV/cm in independant switched sequences for each channel. Sweep speeds can be varied from 1μs/cm to 0.2s/cm using a calibrated switch. The scope complies with British and EEC safety standards and has been made with safety in mind. A cheaper single-trace version with the same general specification costs £195. Bridage Scientific Instruments Ltd, 63 High Street, Skipton, North Yorks. BD23 1EF.
EWW 231

LOGIC ANALYSER FOR HOME MICRO

An add-on unit which turns the Acorn/BBC computer into a logic analyser is available. The Hawk 3210S is controlled from the computer's keyboard and provides 32 t.t.l. or variable threshold input channels. The computer with disc drives, monitor and printer is used to provide diagnostic processing, display, recording and hard copy facilities. Once data has been recorded on disc it can be processed by the computer as the requires.

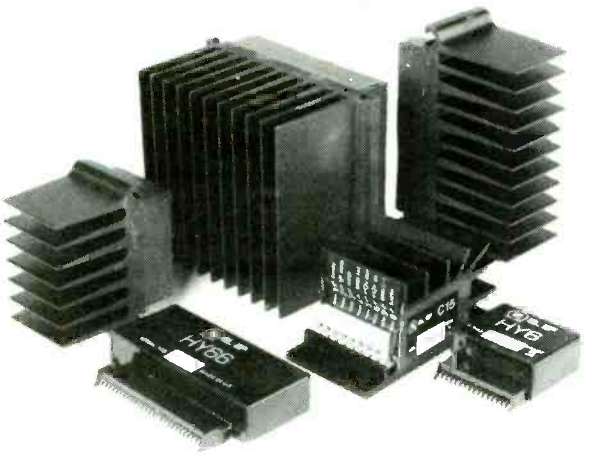
Each channel captures 1024 samples, including any glitches, timed by an internal clock programmed to run at 10MHz, or by an external clock. Triggers may be programmed in binary, octal, hex, decimal or ASCII for each channel and pre or post triggering can be varied by up to 1024 samples delay.

In timing mode the system can display 16 out of the 32 channels concurrently for comparison, while in parallel mode all 32 channels can be displayed in the chosen format. Glitches are detectable to 30MHz and their display is optional, as an overlay to other data. The unit is menu driven, with on-screen prompts and a 'help' display page. Most programming selections are made by a single key input.

Another version of the unit is available for use with Apple II and IIe computers. Hawk Electronic Test Equipment, Bircholt Park Industrial Estate, Maidstone, Kent ME15 9XT.
EWW 232

AMPLIFIERS

WHY ILP? Years of experience in audio, unique designs, world wide sales and outlets, reliable delivery and friendly service........



BIPOLAR MODULES

Ideal for Hi Fi, Full load line protection integral Heatsink, slew rate 15v/µs

Distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
HY30	15	4-8	**£8.95**
HY60	30	4-8	**£9.95**
HY6060	30 + 30	4-8	**£19.45**
HY124	60	4	**£20.95**
HY128	60	8	**£20.95**
HY244	120	4	**£26.95**
HY248	120	8	**£26.95**
HY364	180	4	**£39.95**
HY368	180	8	**£39.95**

MOSFET MODULES

Ideal for Disco's, public address and applications with complex loads (line transformers etc.). Integral Heatsink slew rate 20v/µs distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
MOS128	60	4-8	**£30.45**
MOS248	120	4-8	**£39.95**
MOS364	180	4	**£45.95**

PREAMPLIFIER MODULES

All modules are supplied with in line connectors but require potentiometers, switches etc. If used with our power amps they are powered from the appropriate Power Supply.

Type	Application	Functions	Price
HY6	Mono Pre Amp	Full Hi Fi facilities	**£7.95**
HY66	Stereo Pre-Amp	Full Hi Fi facilites	**£4.95**
HY73	Guitar Pre-Amp	Two Guitars plus Microphone	**£15.95**
HY78	Stereo Pre-Amp	As HY66 less tone controls	**£14.95**

MOUNTING BOARDS: For ease of construction we recommend the B6 for HY6 **£0.95** B66 for HY66-78 **£1.45**.

POWER SUPPLY UNITS

Type	For Use With	Price
PSU212	1 or 2 HY30	£11.95
PSU412	1 or 2 HY60, 1 HY6060, 1 HY124	£13.95
PSU422	1 HY128	£15.95
PSU432	1 MOS128	£16.95
PSU512	2 HY128, 1 HY244	£17.45
PSU522	2 HY124	£17.45
PSU532	2 MOS128	£17.95
PSU542	1 HY248	£17.95
PSU552	1 MOS248	£19.95
PSU712	2 HY244	£21.95
PSU722	2 HY248	£22.95
PSU732	1 HY364	£22.95
PSU742	1 HY368	£24.45
PSU752	2 MOS248, 1 MOS368	£17.95

All the above are for 240v operation.

FOR FREE DATA PACK PLEASE WRITE TO OUR SALES DEPT.

Post to: ILP Electronics Ltd., Dept. 6
Graham Bell House, Roper Close,
Canterbury, Kent. CT2 7EP
Tel: (0227) 54778 Telex: 965780

VISA

ILP

CIRCLE 65 FOR FURTHER DETAILS.

Happy Memories

Part type	1 off	25-99	100 up
4116 200ns	1.25	1.15	1.10
4164 200ns	4.95	4.40	4.20
2016 150ns	4.75	4.25	4.05
6116 150ns Low power	Call	Call	Call
6264 150ns	Call	Call	Call
2716 450ns 5 volt	3.85	3.45	3.30
2732 450ns Intel type	4.20	3.75	3.60
2532 450ns Texas type	3.85	3.45	3.30
2764 250ns	Call	Call	Call
27128 300ns	Call	Call	Call

Z80A-CPU	£2.99	Z80A-P10	£2.99	Z80A-CTC	£2.99
6522 PIA	£3.70	7805 reg	£0.50	7812 reg	£0.50

Low profile IC sockets:										
	Pins	8	14	16	18	20	22	24	28	40
	Pence	12	13	14	16	18	22	24	27	38

Soft-sectored floppy discs per 10 in plastic library case:
5 inch SSSD £17.00 5 inch SSDD £19.25 5 inch DSDD £21.00
5 inch SSQD £23.95 5 inch DSQD £26.35

74LS series TTL, large stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or phone for list

Please add 50p post & packing to orders under £15 and VAT to total
Access & Visa welcome. 24 hr phone service on (054 422) 618
Government & Educational orders welcome, £15 minimum
Trade accounts operated, 'phone or write for details

HAPPY MEMORIES (WW)
Gladestry, Kington
Herefordshire HR5 3NY
Tel: (054 422) 618 or 628

---

pantechnic

THE POWERFET SPECIALISTS

OEM USERS

Pantechnic present the most adaptable high-powered amplifier ever.

FET SYSTEM AMP

Features:
- ● HIGH POWER up to 1.2kW (single ended)
- ● LOW VOLUME. 1/15 Cubic foot inc. Heatsink
- ● VERSATILE. Delivers more than 1kW into ½ to 8 ohms

OR 2 × 600W into 2 to 8Ω
OR 4 × 300W into 2 to 4Ω (200W into 8Ω)
OR { 1 × 600W into 2 to 8Ω
1 × 300W into 2 to 4Ω
1 × 150W into 4 to 8Ω
Etc., etc.

Having been closely involved in a wide variety of OEM applications of their amp boards. Pantechnic became aware of numerous implementation problems often left untackled by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.
By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatsink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The **SYSTEM** Amp offers 1.2kW of power in a space of 180mm x 102mm × 77mm, excluding PSU and Fan.
The basis of this considerable advance is the PANTECH 74 Heat Exchanger, designed and manufactured by us. By eliminating the laminar air flow found in conventional, extruded heatsinks, heat transfer to the environment is greatly enhanced.
The flexibility of the 1.2kW amp stems from its division into 4 potentially separate amplifiers of 300W each (downrateable with cost savings to 150W). These can be paralleled, increasing current capability or seriesed (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented
As ever Pantechnic offer a full range of customising options including DC coupling, ultra-high slew, etc. Contact Phil Rimmer on 01-361 8715 with your particular application problem.
P.S. Specs, as ever, are exemplary.

A wide range of other amplifiers and other modules available.

Price and Delivery
PANTECHNIC (Dept. WW6)
132 HIGH ROAD,
NEW SOUTHGATE,
LONDON N11 1PG

Technical Enquiries
contact
Phil Rimmer
on
01-361 8715

CIRCLE 58 FOR FURTHER DETAILS.

www.americanradiohistory.com

6VA MINIATURE TX 240V AC Input 12-0-12V Output P.C. Mounting + Internal thermal overload protection. £25 for 10 + VAT £115 for 50 + VAT, £210 for 100 + VAT, £950 for 500 + VAT. Sample sent for £3 + 75p P and P (£4.30 inc. vat).

MINIATURE SKELETON Preset horizontal mounting 220R @ O.1W 5.1MM × 10.2MM pitch, £35 for 1,000 + VAT.

BERG LOW PROFILE 14-PIN DUAL IN-LINE IC SOCKET manufactured from glass filled polyester to UL94V-0. £7 for 100, £31 for 500, £56 for 1000, £256 for 5,000, £460 for 10,000 £2,100 for 50,000, £3,700 for 100,000. Sample 10 sent for £1.20 + 30p P and P (£1.72 inc. VAT)

BERG LOW PROFILE 16 PIN DUAL IN-LINE IC SOCKET as above £8 per 100, £36 for 500, £65 for 1,000, £295 for 5,000, £530 for 10,000, £2,390 for 50,000, £4,300 for 100,000. Sample 10 sent for £1.40 + 30p p&p (£1.96 inc VAT).

215MA 32mm QUICK BLOW GLASS FUSE £5 for 100, £48 for 1,000.

TO3 HEATSINK. Efficient space saving to 03 Heatsink. Suitable for onboard mounting. Flat surfaces ensure high thermal conductivity. Predrilled to accept any standard TO3 device. Height 12mm, width 36mm, length 47mm black anodised finish. £20 for 100 + VAT, £150 for 1,000 + VAT, sample 10 sent for £2.50 + VAT and p&p.

HIGH POWER SILICON BRIDGE RECTIFIER. 25 amp 600V single hole fixing 250 (¼") push on connector terminals, manufactured by I.R. £20 for 10, £90 for 50, £175 for 100, £800 for 500, £1,450 for 1,000. Special quotations for larger quantities. Sample sent for £2.50 + 25p p&p (£3.16 inc VAT).

METAL FILM RESISTOR TYPE FZ4. Manufactured by C.G.S. semi precision with a standard tolerance of ±2% and a temperature co-efficient of better than 100 ppm/oc. We have a full range in stock from 100R to IMO. All bondoliered. £2.50 per 1,000 any one value.

ZENER DIODES manufactured by Thompson C.F. all bandoliered. BZX79 CI8 — BZX79C20 — BZX83 — C20, £12 for 1,000 of one type, £15 per 1,000 assorted. Sample 100 sent for £3 + 25p p&p (£3.74 inc. VAT).

STEREO CASSETTE FRONT LOADING REPLAY MECHANISM for in-car entertainment complete with motor and pre-amplifier. Manufactured in UK under licence of Staar S.A. £45 for 10 + VAT £205 for 50 + VAT £375 for 100 + VAT. Sample for £5 + £1.50 p&p (£7.48 inc VAT).

TERMS C.W.O. Please add 5% to all orders for carriage plus 15% VAT. Export enquiries welcome. We find it impossible to advertise all we stock. Please telephone or write for further enquiries. Personal callers always welcome.

ELECTRONIC EQUIPMENT CO.

SPRINGFIELD HOUSE
TYSSEN STREET, LONDON, E.8
TELEPHONE: 01-249 5217
TELEX: 9853906 EECO.G

CIRCLE 52 FOR FURTHER DETAILS.

Tiny BASIC Eurocard Computers using the ***INS 8073 plus***

FULL RANGE OF INTERFACES

£185 BUYS PROCESSOR CARD WITH 48 io, 2K ram, RS232, EPROM PROGRAMMER, CLOCK FUNCTION, WATCHDOG etc

ALL SYSTEMS AUTO-START & RE-START FOR RELIABILITY

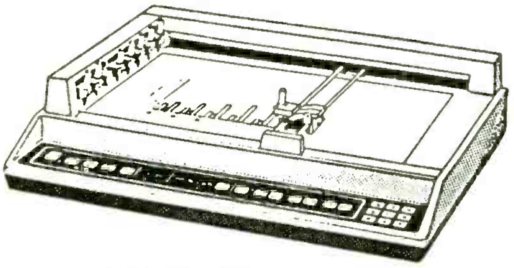
mim

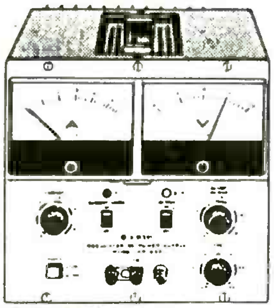
Broadway
Dukinfield
Cheshire
SK16 4UU

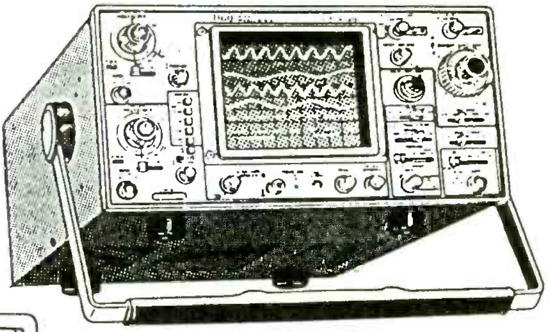
Tel: 061-339 6028

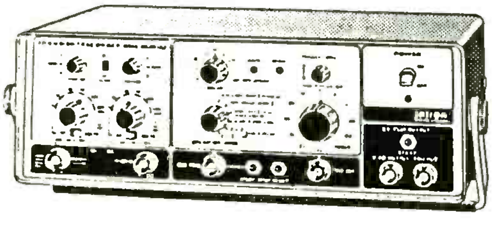
CIRCLE 64 FOR FURTHER DETAILS.

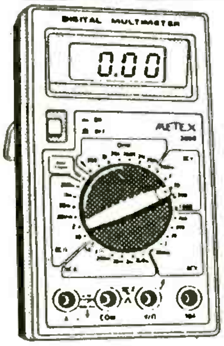
Total Test and Measurement Capability **hi!**

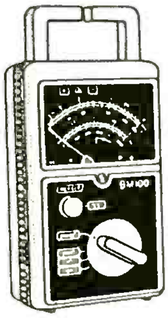


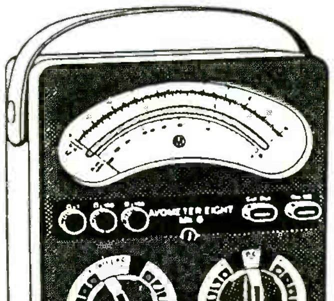












hi!

House of Instruments Ltd.
Clifton Chambers, 62 High Street,
Saffron Walden, Essex CB10 1EE
Telephone: (0799) 24922 Telex: 818750

AMERICAN EXPRESS Access VISA

CIRCLE 39 FOR FURTHER DETAILS.

www.americanradiohistory.com

reprints

If you are interested in a particular article/special Feature or advertisement published in this issue of

WIRELESS WORLD

why not take advantage of our reprint service.

Reprints can be secured at reasonable cost to your own specifications providing an attractive and valuable addition to your promotional material. *(Minimum order 250.)*

For further details contact Michael Rogers, Electrical-Electronic Press. Phone 01-661 3457 or simply complete and return the form below.

To Michael Rogers, Reprints Department:
Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS

I am interested in .... copies of the article/advertisement headed .... featured in

WIRELESS WORLD

on page(s) .... in the issue dated ....

Please send me full details of your reprint service by return of post.

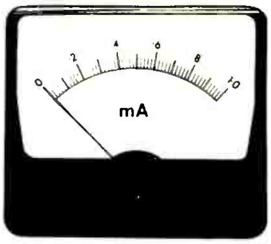
Name ....

Company ....

Address ....

.... Tel. No. ....

METER PROBLEMS?



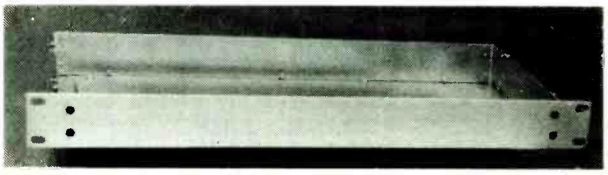
137 Standard Ranges in a variety of sizes and stylings available for 10-14 days delivery. Other Ranges and special scales can be made to order.

Full Information from:

HARRIS ELECTRONICS (London)
138 GRAY'S INN ROAD, W.C.1 **Phone: 01-837 7937**
Telex: 892301 HARTRO G

CIRCLE 007 FOR FURTHER DETAILS.

RACKMOUNT CASES



19"Self Assembly Rack Mounting Case with lift off Covers. Front Panel 10 gauge, Brushed Anodised Aluminium, Case 18 gauge, Plated Steel with Removeable Rear & Side Panels. In 1U & 2U Types, a Subplate Chassis is Mounted to Bottom Cover. In 3U Type the Subplate is located on two Rails Mounted Between The Side Plates.

1U (1¾) height, 230m depth............. £27.00
2U (3½) height, 308m depth............. £32.00
3U (5¼) height, 230m depth............. £39.00

Width Behind Front Panel 437m (All Types).

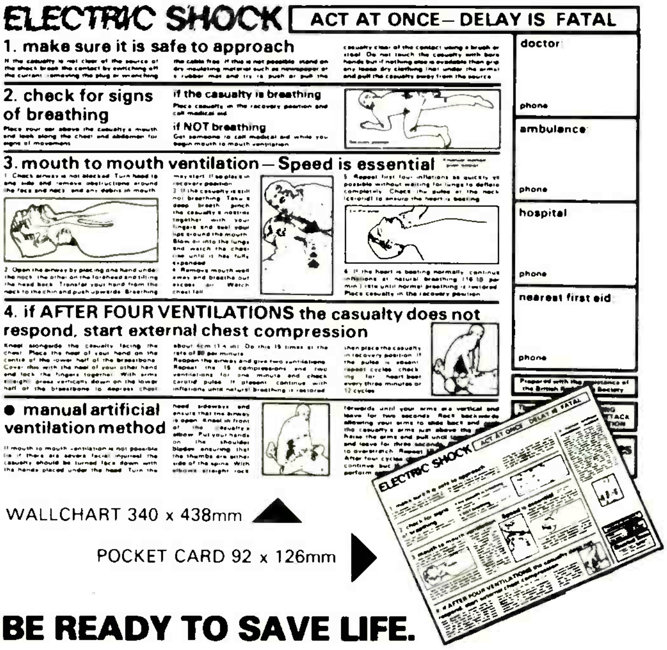
All Prices include Postage & V.A.T. Cheques, Postal Orders Payable to:-

J. D. R. Sheetmetal, 131 Grenfell Road, Maidenhead, Berks. SL6 1EX. Maidenhead 29450.

CIRCLE 011 FOR FURTHER DETAILS.

ELECTRIC SHOCK

NEW AIDS TO RECOVERY



ELECTRIC SHOCK ACT AT ONCE – DELAY IS FATAL

1. make sure it is safe to approach

2. check for signs of breathing

if the casualty is breathing

if NOT breathing

3. mouth to mouth ventilation – Speed is essential

4. if AFTER FOUR VENTILATIONS the casualty does not respond, start external chest compression

● manual artificial ventilation method

doctor

phone

ambulance

phone

hospital

phone

nearest first aid

phone

WALLCHART 340 x 438mm ▲

POCKET CARD 92 x 126mm ▶

BE READY TO SAVE LIFE.
SOMEONE MIGHT SAVE YOU.

ELECTRICAL TIMES' FIRST AID CHARTS

To the Cashier, Business Press International Ltd., Sales and Distribution, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS, England. Tel: 01-661 8438.

Please send me:

... pocket cards at 70p each

... paper charts at £1.00 each

... card charts at £2.00 each

... plastic charts at £3.00 each

I enclose cheque/money order for £......
payable to
BUSINESS PRESS INTERNATIONAL LTD

Name ______________________

Address ____________________

____

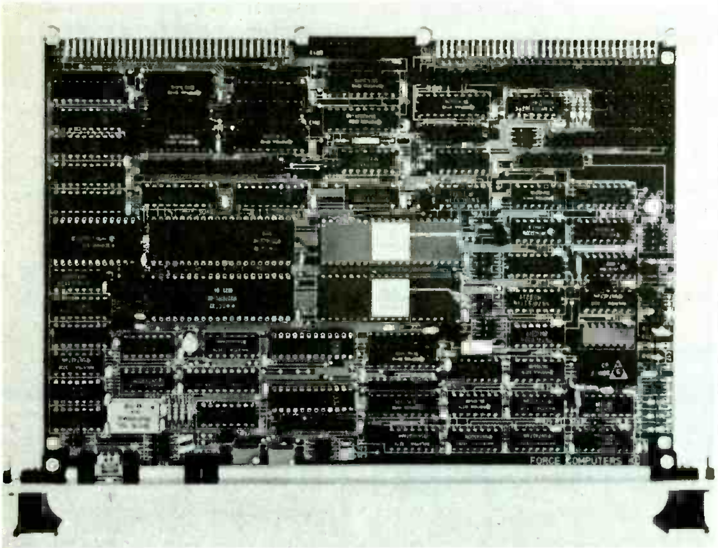
____

Co. Reg. No. 151537. Reg. Office: Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS.

WINCHESTER/ FLOPPY DISC CONTROLLER

Compatible with the VME bus, the Force disc drive controller features user-programmable d.m.a. channels, up to 16Kbytes of dual-port ram, and double Eurocard sized p.c.b. with DIN 41612 connectors.

The board is capable of supporting up to four floppy-disc drives and up to three hard-disc 5¼in drives. It generates interrupts with user-selectable interrupt levels, and auto interrupt vectors. The SYS68K/WFC-1, allows a programmable sector size up to 1Kbyte, and provides automatic track formatting for hard discs. The data transfer rate is up to 5Mbit/s. Available from Microsystem Services, PO Box 37, Lincoln Road, Cressex Industrial Estate, High Wycombe, Bucks. HP12 3XJ.
EWW 213



SWITCHING MULTIPLEXER FOR NETWORKS

A solution to the problems of interconnecting dispersed multi-terminal data processors is offered by Babynet, a switching multipoint multiplexer. It combines switching (port selection and contention) with multipoint multiplexing. The switching capability allows dynamic mapping of connections between remote terminals to a computer. Remote ports can be permanently mapped to a particular computer port, mapped on terminal connection to one of a predetermined group of computer ports, or routed to one port of a user specified group. All port groups are designated by alphanumeric strings so that the terminal user could specify, for example, 'PDP11', 'VAX' or 'Accounting' on connection. This allows a large number of terminals to use a small number of computer ports, and also allows one terminal to be connected to a number of computer systems.

The mulitplexer used a single communications line with its own polling method called 'Adaptive Polling Technique'. With APT, Babynet continually monitors remote station activity and polls active stations at a much higher rate than inactive ones. This results in a faster response time for terminal users.

Babynet is an expandable system with three functions (master, master expansion and node) all in the same piece of hardware. All units start as two channels and may be upgraded in increments of three channels. A master can have up to 22 ports and up to eight nodes, each with eight ports.

The configuration of each Babynet is a simple matter of pushing the right buttons on the front panel. A control console may also be used, if needed. Each Babynet also capable of self-testing, terminal testing and diagnostic fuctions. The system is transparent to the user; no systems or applications programming is necessary. It works not only with v.d.u. terminals but also with virtually any asynchronous RS232 device including printers and bar-code readers. Error detection and correction is built in to the system and is completely automatic. The Babynet system is designed for unattended operation. Start-up is completely automatic and preprogrammed configurations are retained even when the power is off. Network Products Ltd, 387 Sykes Road, Slough Trading Estate, Slough, Berks.
EWW 215

VIDEO SYNCHRONIZER FOR THE BEEB

A device to synchronize the RGB output of the Acorn/BBC computer to a video signal allows it to be used as a low cost alternative to professional tv caption and graphics generators. The Beeb-Lock is housed in a small case and is connected to the computer's p.c.b. with a few simple connections. The unit includes a PAL colour encoder and colour genlock system to convert the RGB output from the computer into a synchronous PAL colour signal which can be combined with a video signal through a vision mixer. One version, BL.2K, includes a mix/key circuit and provides a complete system for those users who require a basic title and caption insertion or fade facility. Another model, BL.3 is fitted with a Micropal board instead of the PAL encoder. This decodes the reference video signal into RGB components prior to combining them with the RGB output taken directly from the computer. The final output is a linear RGB signal which can be displayed directly on a colour monitor.

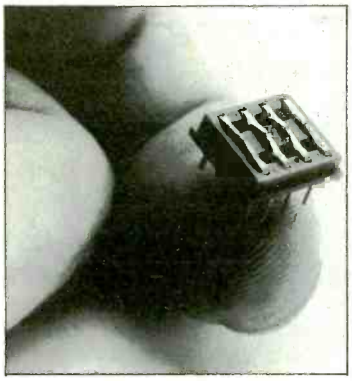
A future enhancement, available toward the end of the year, is to be a colour mapping board which will be able to select eight colours from several million variations. This makes possible the selection of several shades of the same colour for use in shadow and modelling effects.

The price of the basic Beeb-Lock, which is powered from the computer's auxilliary socket, is £193 An enhanced version. BL.2 may be expanded by the addition of optional p.c.bs and includes a mains power supply for £240. Models BL.2K and BL.3 mentioned above are £330 and £260 respectively. Two-channel video mixers are available from the same designer/manufacturers: Video Electronics Ltd, Wigan Road, Atherton, Manchester M29 0RH.
EWW 214

MINIATURE SOCKET

The high-profile version of the Harwin sub-miniature socket is designed to give a maximum protrusion below a p.c.b. of less than 1mm, This means that the socket's tail will be untouched by any conventional lead cropping process. Inside the socket is a four-leaf beryllium copper contact designed to accept the leg of any standard i.c. Use of the socket allows high density packing of i.cs and offers lower than average insertion/withdrawal force. Harwin Engineers SA. Fitzherberts Road, Farlington, Portsmouth, Hants PO6 1RT
EWW 216

D.I.L. LINKS



Programmable links offer a low-cost alternative to d.i.p. switches for many applications where frequent changes are not necessary. The Series 680 programmable headers from Aries can be operated by simply severink the links between pins. One style of header can be used to program connections between both adjacent and opposite pins. It has a plain cover through which opposite links may be broken. A hand tool is available for small production runs or an arbour press for bulk programming. The headers may also be bought pre-programmed. Aries Electronics Ltd, Alfred House, 127 Oatlands Drive, Weybridge, Surrey KT13 9LB.

WW 227

BORROW AN OSCILLOSCOPE

If you have sudden need of an oscilloscope, perhaps for prototype testing, you can hire one from Microlease. For example they now have the latest Nicolet 3091 portable digital oscilloscope which uses 12-bit digitizing and is claimed to be ten times more accurate than analogue instruments. It may be used for field calibration, fault diagnosis, or transient analysis, in mechanical, electrical, acoustical and biological applications. It may be linked to a computer by way of an RS232 interface, and to plotters and chart recorders for waveform printouts. Weekly rental is from £70, including bubble memory cassette. Microlease plc, Forbes House, Whitefriars Estate, Tudor Road, Harrow, Middlesex HA3 5SS.
WW 226

WIREWRAP TOOL

This bit and sleeve combination is able to cut off excess wire for cable, wire harness or reel, strip the proper length of insulation, and wrap the correct number of turns onto the terminal. This eliminates the need for pre-cutting or pre-stripping the wire. Used in the same way as conventional wire wrapping tool bits and sleeves, the CSW sets are available for 0.50, 0.40 and 0.25mm wire and a wide range of terminal sizes. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA. WW 229

Extending their horizons from the purely photographic to other images, Kodak have produced a home video system. The core element is a video camera/recorder (Camcorder) which uses 8mm wide tape in cassettes about the same size as audio compact cassettes and lasting for 60 minutes for PAL signals or 90 minutes with NTSC. The Camcorder is no larger than an average amateur movie camera and weighs 2.4kg, yet a similar quality to the average video cassette recorder is claimed. This has been achieved, says Kodak, through the use of cobalt-nickel metal tapes, amorphous metal recording heads in the helical scan recorder and the development of a new 0.3in (85mm) Newvicon tube. For display on a domestic tv, the Camcorder fits into a 'cradle' which provides the electronics and also acts as a battery charger for the camera. The camera has all the moving parts and so acts as the heart of the system. The cradle may be fitted optionally with a tuner/timer for the recording of programmes off-air. Soon to be launched in the US, the UK version may be available towards the end of the year.

ANTI-STATIC CARPET SPRAY

An anti-static aerosol spray, ASP 40, has been designed for use on carpets and/or video screens in static-sensitive environments. A walk across a carpet can generate a charge of up to 10 000V, according to the spray manufacturers. This can damage electronic components or cause data glitches in computer equipment. A single canister of the spray can treat up to 20 square metres of carpet. The treatment lasts for two to three months and during this time the carpet has the additional property of being dirt repelling. A video screen will remain clean and static-free for six to eaight weeks. £4.20 for a single can, £3.90 each for a pack of six. Technotrend Ltd, The Town House, Chobham, Surrey GU24 6AF.
WW 228

If you would like more information on any of the items featured here, enter the appropriate WW reference number(s) on the reply-paid card bound in this issue. Overseas cards require a stamp.

AMAZED FUSED LOGIC

A software package for designing integrated fused logic from Mullard is called AMAZE, which stands for automated map and zap entry. Another acronym involved is BLAST for Boolean logic and state transfer, the first package within Amaze which also includes a device programmer interface and a simulator.

Blast allows the designer to assign pin mnemonics and functions, and to write Boolean equations which are compiled into programming table. Data entry is by way of a menu screen display and the data is checked for consistency and legality before progress to subsequent screens is allowed. Complex functions are reduced to a sum of products by a resident logic processing program.

The DPI (device programmer interface) can download compiled program tables in selected formats. It can also 'upload' the tables from existing devices for editing and simulation.

The simulator can be run manually or automatically. In manual mode the operator can assign input vector and then observe the resulting output; in automatic mode the simulator creates a test vector file for production testing of the programmed device.

The first release of AMAZE contains the Blast and DPI modules for 82S153 and 82S159 devices and is suitable for use on VAX, VM53.2 or later computers. Personal computer versions will be released later in the year along with the rest of the integrated fuse logic range including the simulator module. Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.

EWW 222

MEASUREMENT AND CONTROL INTERFACE

A complete interface system in a single compact package can provide a link between any GPIB controller and the sensors and actuators of laboratory and process automation systems. A single p.c. motherboard accepts plug in modules which may be configured to provide conditioning and conversion for any combination of analogue and digital input or output signals. Functions currently available include digital input and output; pulse, event and up/down counting; frequency measurement; real-time clock; and thermocouple, strain gauge and real-time display inputs.

Fully compatible with IEEE488 and IEC625-1 specifications, the Di-An DMS550 is designed to operate with eight-bit binary characters and enables the transmission and receipt of GPIB data at a maximum rate of 250kHz. Available from STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF.

EWW 223

HEAR AUNTIE FROM ANYWHERE

Specifically designed for the reception of the BBC World Service, the Liniplex F1 h.f. receiver has nine fixed crystal-controlled channels tuned to the frequencies most used by the BBC in various locations around the world. The 5 to 26.5MHz band is also tunable for reception of other s.w. stations. Crystals may be easily changed if a different frequency is required on any of the pre-set channels.

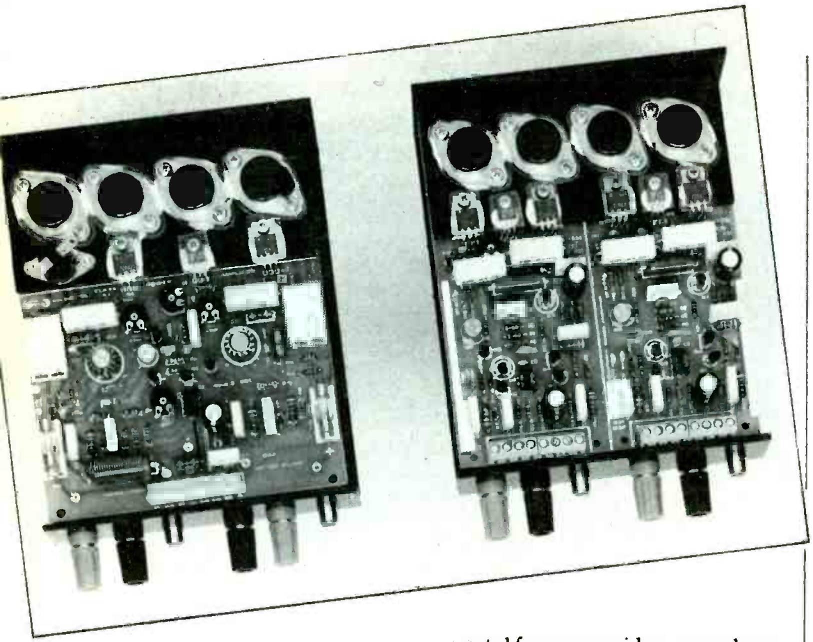
The receiver incorporates a patented a.m. phase-locked demodulator which uses a phase-error signal to control a voltage-controlled oscillator and the set stays tuned even during a temporary loss of a pilot carrier signal. This is especially useful in areas of multi-path reception and also helps cut out distortion caused by fading signals. Double or single sideband reception is possible and upper, lower or both sidebands may be selected at will. This facility offers the choice of least interference from transmitters at adjacent frequencies. The ability to use a balanced antenna indoors also helps to reduce local interference. Despite its die-cast aluminium case, which is strong and offers electromagnetic shielding, the Liniplex F1 weighs only 1.85kg and is small enough to be slipped into a briefcase. Phase Track Ltd, 132 Queens Road, Reading, Berks RG1 4DG.

EWW 224

FAST PROMS

Two 2048byte, edge-triggered, D-type registered proms are claimed to be 20% faster than comparable devices. These bipolar devices consume half the power of a standard prom with an external register. The RA1681 and RA1681A are available with synchronous or asynchronous operation and have maximum clock-to-output response times of 20 and 15ns respectively. They feature a flexible initialization sheme which offers a start-up and time-out sequencing of 16 programmable words to provide controlled systems start-up.

The proms are designed to hold microprogrammable control storage, state sequencers, next-address generation and mapping other proms in a wide range of computer systems. The synchronous devices may be used when multiple registered proms are bussed together to provide increased word length. Asynchronous versions are used when multiple gates are not in use or when the outputs are to be gated on to a data bus. The devices are available with a variety of access modes, refresh modes and set-up modes. Both types includes two externally controlled modes, one access and one refresh. The two auto-access modes of 1681A operate in 130ns, worst case and thus eliminate the wait states usually encountered in fast microprocessor systems. Monolithic Memories Ltd, 1 Queens Road, Farnborough, Hants GU14 6DJ.
EWW 225



BENCH POWER AMPS

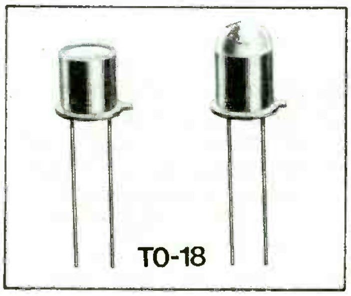
Two power amplifiers, a 200W stereo and a 300W mono, are presented in open frame form for o.e.m. and hobby use. S200 the stereo module consists of two completely independent amplifiers which may be operated with separate power supplies, and at different frequencies. The amplifiers may be used for bench testing of equipment and one example has been the amplification of outputs from accelerometers in vibration analysis. With bench use in mind, all connections use screws so that different power supplies or inputs and outputs may be quickly connected. The open metal frame provides a very large external heatsink.

Both the S200 and the M300 amplifiers although rated at their maximum powers may, of course be used at lower power ratings by reducing power supply voltages. In addition the M300 includes preset potentiometers to adjust the gain, allowing ratings to be set precisely. S200 costs £48.50 and M300, £43.50. There is in addition an amplifier drive board which is a complete amplifier without the output power transistors. These may be selected to build amplifiers designs from 60 to 250W into 8Ωor 100 to 300W into 4Ω . This module, D100,costs £23.50.XTR Electronics, 335 Holdenhurst Road, Bournemouth, Dorset BH8 8BT.
EWW 217

Ge DIODES IDEAL FOR FIBRE OPTICS

A spectral response between 0.5 and 1.8µm, peaking at 1.5µm is claimed to be the ideal wavelength for maximum efficiency in a fibre optical cable and is the wavelength of greatest sensitivity of some new germanium light-receiving diodes. They are available in a TO-18 package with an active receiving diameter of 1mm and a choice of window or lens. Responsivity is up to 0.7A /W, rise time is as low as 10ns and 'dark' current is only 5µA.

The GM5 photodiode may be used in photovoltaic or photoconductive modes and applications include optical communicatons, optical power measurement, fibre attenuation measurements, laser burn-in monitoring etc. as well as spectrophotometers and pyrometers. US prices are approximately $75 each for small quantities. A GM8 photodiode, with a 5mm active diameter in a T0-8 package, costs $130. Germanium Power Devices Corp. PO Box 3065, Shawsheen Village Station, Andover, MA 01810 USA.
EWW 218



SOLID-STATE RELAYS

Housed in standard 14 and 16-pin d.i.l. packages, the range of MSI solid-state relays use thick-film hybrid circuits to combine the handling of high power in a physically small volume. There are three d.c. relays and seven a.c. types with a wide choice of current and voltage ratings, optical or transformer isolation and synchronous or zero-voltage switching.

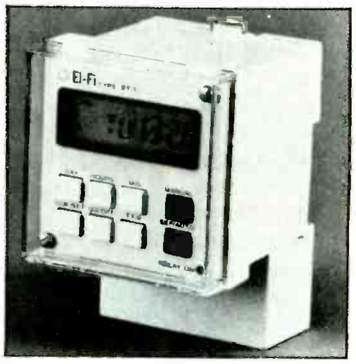
One of the range is the E24E-2H which has 1A current rating and is housed in a 16-pin package. Input/output isolation is 400Vr.m.s. and the use of anti-parallel s.c.rs in the power switch ensures enhanced rise time, surge current and thermal characteristics. The device switches at zero volts and requires an input signal of 8mA at 5V. The output switch has a peak voltage rating of 600V and is therefore safe to use with 240V a.c. supplies. Others in the range include the E40-1 which will switch a.c. or d.c. up to 80mA at 60V; E41-2H is rated 1A and has a triac output up to 600V; E43-1 for d.c. switching of 500mA, 60V and the E43-2 also for d.c. at 200mA, 250V. The use of ceramic sealed packages ensures that they are hermetically sealed. They are good conductors of heat and maintain a good safety margin on junction operating temperatures. Elyon Electronics Ltd, 23 Croydon Road, Reigate, Surrey. RH2 0LY.
EWW 219

68008 EMULATOR

An addition to the MICE-II range of in-circuit emulators is one for the M68008 processor. It may be used as a stand-alone program development/debugging system or in conjunction with a target computer to allow off-line debugging. The MICE system in such a master-slave configuration can be used to evaluate a number of different processors easily by a simple change of a 'personality' card in the unit. The system can be extended to include several work stations and a Multi-MICE unit can be used to emulate a multiprocessor system. The emulator allows the user to run the target system in real time, eliminating wait states and using none of the host's memory space. MICE software allow the inclusion of two breakpoints, includes a resident assembler/disassembler, a real-time forward trace for up to 2048 cycles, instruction step or cycle step through a program. There is 32K of emulator memory, expandable in 32K sections. The system as designed to be easy to use and has 23 commands common to all the emulators regardless of the target processor. It is portable and lightweight, permitting on-site testing. ARS Microsystems Ltd, Doman Road, Camberley, Surrey GU15 3DF.
EWW 220

DIGITAL TIMESWITCH

A digital electronic time switch can provide up to 84 separate on or off settings in a week — 12 settings for each day. The program may be set for each individual day or a group of up to six setting may be repeated automatically every day. The current time is shown on a display which can also indicate the status of any function or program. A built in battery can retain the program. A built in battery can retain the program and clock time during a power failure and the battery is automatically recharged when the power is restored. The program may be easily overidden at any time without affecting the memory and operation will revert to the program when the next switch-time is reached. Applications include the switching of heating or air conditioning plant, or manufacturing processes up to a rating of 220V, 10A a.c. Highland Electronics Ltd, 8 Old Steine, Brighton East Sussex BN1 1EJ.
EWW 221



Appointments

Advertisments accepted up to 12 noon Tuesday, June 5, for July issue
subject to space available.

DISPLAYED APPOINTMENTS VACANT: £17 per single col. centimetre (min. 3cm).
LINE advertisments (run on): £3.50 per line, minimum £25 (prepayable).
BOX NUMBERS: £5 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS).
PHONE: LUCY O'SULLIVAN, 01 661 3033 (DIRECT LINE)

Cheques and Postal Orders payable to BUSINESS PRESS INTERNATIONAL LTD. and crossed.

---

ecm

ALWAYS AHEAD WITH THE BEST!

£7,000-£22,000

- ★ **Where does your interest lie:** Graphics; Comms; Robotics; Simulation; Image and Signal Processing; Medical; Automation; Avionics; Sonar; Acoustics; Weapons; Radar; Opto and Laser?
- ★ **Experienced in:** Microprocessor Hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?
- ★ **There are hundreds of opportunities in:** Design; Test; Sales and Service for Technicians; Engineers and Managers
- ★ **For free professional guidance:** Call 076 384 676 (till 8pm most evenings) or send your C.V. (no stamp needed) to:

ELECTRONIC COMPUTER AND MANAGEMENT SERVICES LIMITED
Freepost, Barkway, Royston, Herts SG8 8BR

1926

An experienced Test Engineer required for safety testing laboratory in London SW2 area.

The successful candidate will be fully conversant with BS 415 1979 and have a good knowledge of other standards relating to domestic electronic equipment.

Excellent working conditions and rates of pay for an engineer with the relevant experience.

If interested in the above post, please contact:

Bill Jeanes - Technical Director
Tech-Semco Limited
Telephone No: 01 733 5588

(2605)

ILP ELECTRONICS LTD.

ILP have been established in the modular audio amplifier market for over ten years. In order to enlarge this product range we require a

LOUDSPEAKER DESIGN ENGINEER

The candidate will preferably be educated to degree standard and have had several years experience in the field. The successful applicant will be required to design a range of chassis loudspeakers for music and P.A. applications.

Salary negotiable.

Apply with full C.V. to:
Mrs. Yvonne Johnson, Personnel Manager,
ILP Electronics Limited, Graham Bell House,
Roper Close, Canterbury, Kent. CT2 7EP.

(2593)

ILP ELECTRONICS LTD.

EXETER HEALTH AUTHORITY

Royal Devon and Exeter Hospital (Wonford), Barrack Road, Exeter EX2 5DW.

MEDICAL PHYSICS TECHNICIAN (ELECTRONICS) GRADE III

(£6132 - £7926 pa)

Applications are invited from suitably qualified and experienced persons for the above post in the Physics department. The successful applicant will work with two other technicians responsible for the development and maintenance of equipment used in the fields of radiation physics, radiotherapy, nuclear medicine, ultrasound imaging and pathology. Experience of, and interest in, the applications of microprocessors will be particularly valuable.

Job Description and application form from the Administration Department, tel Exeter (0392) 77883 ext 2007.
Closing date for applications I June.

(2589)

Bloomsbury Health Authority
DEPARTMENT OF MEDICAL PHYSICS AND BIOENGINEERING UNIVERSITY COLLEGE HOSPITAL, LONDON
ELECTRONIC SERVICE ENGINEER (MPT III)

Applications are invited from experienced service engineers for the post of Medical Physics Technician in the Department's Electro-medical Unit. The work, under the direction of the physicist in charge, includes servicing of a wide range of monitoring equipment. Acceptance testing and equipment calibration is also carried out. The applicant must be prepared to work in a clinical environment; contact with patients may be necessary.

Appointment, according to qualifications and experience:

Medical Physics Technician III £6,132 - £7,926 plus £1,042 London Weighting.

Further details and job description from Mr C Hemsley, 01 636 5152.

AN EQUAL OPPORTUNITIES EMPLOYER

(2590)

Appointments

CUT THIS OUT!

Clip this advert and you can stop hunting for your next appointment. We have a wide selection of the best appointments in Digital, Analogue, RF, Microwave, Microprocessor, Computer, Data Comms and Medical Electronics and we're here to serve *your* interests.

Call us now for posts in Design, Sales, Applications or Field Service, at all levels from £6,000-£16,000.

Technomark
Engineering & Technical Recruitment
11 Westbourne Grove, London W2. Tel 01-229 9239

(1935)

Inner London Education Authority

LONDON COLLEGE OF FURNITURE,
41 Commercial Road, E1 1LA. Tel No: 247 1953

WORKSHOP TECHNICIAN GRADE 5

Department of Musical Instrument Technology

Electronics Technician required to work as part of a team providing a comprehensive technical support service to the College. The postholder will be responsible for maintaining and organising workshop facilities involving electronics for the Music Industry including Audio and Computer Music Equipment.

Applicants should have at least HNC, HND, Advanced City & Guilds or equivalent qualifications in appropriate subjects and a minimum of eight years experience (including training period).

Salary scale £6279 to £7332 plus £1220 London Weighting.

Application forms and further details are available from the Senior Adminstrative Officer at the above address. Completed application forms should be returned to EO/Estab 3a Room 255a County Hall London SE1 7PB within 14 days of the appearance of this advertisement.

ILEA IS AN EQUAL OPPORTUNITIES EMPLOYER (2582)

TELECOMMS TECHNICIANS

If you lead your industry the way we lead ours, let's meet.

As one of the world's most successful and progressive oil and gas exploration and production companies, we make the highest demands of all the services and systems we use in our day-to-day business: particularly telecommunications.

Developments at our on-shore terminal on the Norfolk coast mean we now need to add a Supervisor and a small number of Technicians to the team responsible for maintaining our full range of advanced telecomms systems: including MF/HF/VHF/UHF radio, broadband microwave radio, multiplex to 36 channels, voice frequency telegraphy, speech and duplex; public address systems, telephone equipment - electro-mechanical digital and stored programme-controlled, intercoms, teleprinters, VDUs, line printers, facsimile machines; modems up to 9.6k bits, statistical multiplexors and programmable systems controllers.

If you pride yourself on having an exceptional level of expertise on one or more of these, are aged 30+, qualified at least to ONC standard - and ideally have had experience in our industry - we offer a competitive salary and benefits package, including relocation, excellent prospects and the security of a future with an organisation of world class.

For more information about these opportunities, please contact our Recruitment Consultant:

Michael Platten at PER,
Norfolk Tower, Surrey Street,
Norwich. NR1 3PA.

(2606)

PER Professional & Executive Recruitment

CAPITAL APPOINTMENTS LTD

THE UK's No. 1 ELECTRONICS AGENCY

ELECTRONICS ENGINEERS

If your career is stagnating, if you are unemployed, or just starting your career in the most dynamic industry this country has to offer, then Capital Appointments can help. Our client companies have immediate and long term requirements throughout the UK for most categories of staff including:
TECHNICAL MANAGEMENT, DESIGN, SOFTWARE, TEST, FIELD SERVICE, SALES, ETC.
with salaries from £6,000 to £16,000 p.a.

Ours is a FREE SERVICE for applicants and you are assured of complete confidentiality.
For immediate attention to your career requirements, complete the form below now and post to:
CAPITAL APPOINTMENTS LTD, 76 WILLOUGHBY LANE LONDON N17 0SF
If you would prefer to telephone us to discuss your situation in more detail, one of our consultants will be pleased to help.

TELEPHONE: 01-808 3050 CUT FORM AND RETURN

✂ - ✂

CONFIDENTIAL

NAME .... ADDRESS ....

....

Tel. (Home): .... (Office): ....

Date of Birth: .... Place of Birth: .... Nationality now: ....

If not British, is a Work Permit required? ....

Marital Status: .... Car Driver: .... Car Owner: ....

Type of Position required: .... Approx. Salary level ....

Please indicate areas in which you are prepared to work:

Cent. London		S. Coast		E. Midlands	
S.E. London		West Country		W. Midlands	
S.W. London		N.E. England		E. Anglia	
N.E. London		N.W. England		Wales	
N.W. London		Scotland		Overseas	

Home Counties: N.W.	N.E.	S.W.	S.E.

Are you a houseowner? Are you willing to relocate?

Are you prepared to travel – In UK? Overseas?

State of health:

Notice Period required:	Availability for Interview:

EDUCATION:
Secondary School Qualifications: ....
College or University Qualifications: ....
Any Professional Membership: ....

CAREER HISTORY

From/To	Company	Job Title/Description	Salary

Please indicate any Companies you do not wish us to contact.

If you wish to detail further aspects of your experience or job requirements, please continue on a separate sheet.

(2450)

UNIVERSITY OF BIRMINGHAM
DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Postdoctoral Research Fellowship

Applications are invited for the above post which is funded by the MOD. The work is concerned with signal handling in high frequency receivers using digital techniques for filtering and demodulation. There are prospects for a wide range of work and also collaboration with other establishments. Both theoretical and practical skills are required and an ability to direct and to liase with other staff will be important.

The post is tenable for up to one year from the soonest possible date.

The salary is on the Research Fellow 1A scale £7,190-£11,615 plus superannuation. For further particulars phone 021-472 1301 ext. 2559, quoting reference S3.

No formal application form. Three copies of application, including full Curriculum Vitae and naming three referees to Assistant Registrar, (Science and Engineering), P O Box 363, BIRMINGHAM, B15 2TT by 4 June 1984. (2578)

DO YOU REALY WANT TO BE A SMALL COG IN A BIG MACHINE?

You want to move into a position of responsibility, are capable of using your own initiative and can handle pressure, so join us as Engineering Supervisor and get into technical management.

If you are over 22 and an electronic engineer, phone Joyce now on 01-607 0991 and find out about us.

HALDA LTD
The Incentive Group. (2600)

B/T.E.C. H.N.C. in Electronics & Communications Engineering

A one year full time course leading to the above award. Specialist subjects: Radiocommunications, Radar & Microprocessors.

For details write or phone: W. Halton,
Department of Maritime Studies,
Lowestoft College of Further Education,
St. Peters Street, LOWESTOFT, Suffolk
Tel: 83521 Ext. 256. *(2579)*

BORED ?

Then change your job!

1) Technical Support Engineer
Service and design of office automation systems. £10,000 + car. Berks/Bucks.

2) Design Engineer
Image processing/broadcast systems. Hardware and software involvement. Berks/Bucks/Hants.

3) Repair Engineer
Computer peripherals/A.T.E. Field support. c.£9,000 Berks/Bucks.

4) Senior Test Engineer
R. S. Techniques + digital and analogue. Hardware experience. £12,000 Hants/Middx.

Hundreds of other Electronic and Computer vacancies to £12,500

Phone or write:

Roger Howard, C.Eng., M.I.E.E., M.I.E.R.E.

CLIVEDEN CONSULTANTS
92 The Broadway, Bracknell, Berkshire
Tel: 0344 489489

(1640)

CLIVEDEN

When replying to classified advertisements, readers are recommended to take steps to protect their interests before sending money

(2519)

RESEARCH INSTITUTE
University of Petroleum and Minerals
DHAHRAN, SAUDI ARABIA

Needs Digital Electronics Repair Technicians for expansion of the facility for instrument repair, maintenance and calibration.

Candidates' background should include:–

- ★ Bachelors or associate degree or equivalent military/Technical training.
- ★ Minimum 4 years' hands-on digital experience on micro-mini computers, peripherals, data acquisition systems, micro-processor controlled test instruments.
- ★ Trouble-shooting and repair capability to component level (experience with current model minis, micros and GPIB a big advantage).

Salary is competitive, benefits include annual repatriation, housing and transportation allowances.

Candidates possessing the above requirements should only apply to the following address within one week of the release of this advertisement furnishing details resume of their educational qualifications and experience, attaching copies of their degrees and transcripts, giving names and addresses of four referees, including their present employer, if possible, and the present position held.

Mr. Ali A. Jaman, Director General,
Financial and Admin. Affairs,
Research Institute – University
of Petroleum and Minerals, P.O.
Box 7177, Dammam – 31462,
Saudi Arabia.

2546

"Who'll hustle up the first engineering job offer for you?"

Will Raj, our DP Director, when he scans the Register on his 10-megabyte computer? Will Richard, Graeme, John, Sandra, Robert of our job-search force hear about it on the phone? Will Keith, our Regional Director, discover it in a face to face chat with an employer?

The minute your profile form arrives at Lansdowne all these people and more will be actively searching for vacancies that suit you. Searching day in, day out.

In just 3 days, one Lansdowne job-seeker was approached by 27 employers. That's because the brief Lansdowne profile form tells employers just what they need to know to pick you out for a job offer. But no more than that.

Over 12 years introducing job-seekers to employers we've trimmed and honed the questions we ask you into a lean fighting form employers welcome and use. That's why every day employers add new vacancies to Lansdowne Appointments Register in 283 different job categories.

We could have one in there for you right now. And if you think it will cost you to find out, think again.

The Lansdowne service is absolutely free to job-seekers.

NOW SHORTLISTING
Analogue · Digital · R.F. Microwave · Radio · TV · Computing · Telecommunications
01-743 6321 (24 hours)

Lansdowne
Appointments Register

To Stuart Tait,
Lansdowne Appointments Register,
Park House, 207-211 The Vale,
London W3 7QB.

Please send me a Lansdowne Appointments Register job-finding pack.

NAME ____________________

JOB TITLE ____________________

ADDRESS ____________________

____

4C0516CWW

All posts are open to men and women and our service is completely confidential for companies and job-seekers.

SATELLITE TVRO ELECTRONICS

The expansion of our Development operation has created the requirement for an additional Engineer to work on the design and production development of a new range of satellite television receiving equipment for both professional and consumer applications.

Suitable candidates would preferably hold a relevant degree or HND and have several years experience in commercial product design and development. More important, they should be able to demonstrate aptitude and flair, a genuine interest in the technology of RF, logic and baseband circuitry, and the ability to work without supervision.

Satellite TV Antenna Systems Limited is a small and highly professional British Company with strong prospects of fast growth in this emerging technology and is located in new facilities in Wales.

Salary and benefits are negotiable.

Applications in writing please together with a current C.V.

Mr. P.M. Gray, Managing Director,
Satellite TV Antenna Systems Ltd.,
10 Market Square, STAINES TW18 4RH, Middx.

(2587)

TEST PLANNING TRIALS SUPPORT INTEGRATION & TEST

Are you ready for a commitment to Engineering Excellence?

STC Defence Systems has one of the most impressive growth records in the international defence market. In the short space of 3 years we have more than doubled in size — in both turnover and manpower. Major development projects currently in hand are the direct result of solving technical problems through a commitment to engineering excellence. Increased activity in a wide range of advanced technology fields, such as specialist communications equipment, guidance and control systems and general data communications systems is continuing our record of expansion and has now created the following positions for experienced Electronics Professionals at our Basildon location:

Test Planning

Senior Engineers (up to £13k pa)

We're looking for Senior Engineers to plan a major role in the preparation and planning of test programmes. Working closely with prototype manufacturers and external suppliers, you'll develop stringent test specifications and schedules — from single modules through to complete systems. You'll be involved in extensive customer contact and maintain close liaison with internal trials support teams. The positions call for the highest standards of professionalism. A degree or HNC level qualification is essential, coupled with at least 4 years' relevant experience in an electronics environment or technical support role.

Trials Support

We are looking for Engineers at all levels to play a key role in conducting acceptance trials pre- and post-product handover, providing a complete testing service to Project Leaders and other Departments as required.

Senior Engineer (£12-£13k pa)

You should be qualified to degree level or equivalent with around 5-7 years' experience in operational test or in the evaluation of electronic equipment in an operational environment.

Engineer (£8-£9k pa)

Aged 23 years +, you'll be qualified to at least HNC level with at least 3 years' relevant experience, possibly gained in an installation or commissioning role with a major user or supplier of electronic equipment.

Systems Integration & Test

We're looking for people from Section Head to Engineer level to be responsible for the integration of the hardware and software elements of complex high technology systems. You will be involved in producing proposals on software simulation and hardware modelling to meet stringent product requirements for harsh environments and for identifying and conducting test programmes.

Section Head (£13-£14k pa)

Qualified to degree level or equivalent, you should have 5-7 years' proven experience including a sound background in both hardware and software.

Senior Engineers (£12-£13k pa)

Aged 25 years + you'll be qualified to degree/HNC level with around 3 years' sound relevant experience.

We would like to discuss all these key positions with Engineers who are looking for their next challenge in Electronics. Necessary personal qualities include the ability to work to deadlines and under pressures, with the minimum of supervision. Working with STC Defence Systems will bring you exceptional opportunity to grow within a young, dynamic environment and share in the company's success. Very competitive salaries are offered together with an attractive range of benefits including an exceptional relocation package where appropriate.

Please send your c.v. to our consultant, John Faith at Cambridge Recruitment Consultants, 1a Rose Crescent, Cambridge CB2 3LL, quoting reference TP/TS/TC or telephone Cambridge (0223) 311316 for an application form. These positions are open to both men and women.

STC TELECOMMUNICATIONS

STC

SENIOR PROJECT MANAGEMENT & DESIGN OPPORTUNITIES IN

ADVANCED BROADCAST TECHNOLOGY TV STUDIO AUDIO & VIDEO SYSTEMS TO £18000

Dedication to engineering excellence and technical innovation has established our client as one of the world's leaders in the design, development and manufacture of TV Studio equipments and systems for a wide range of applications within the broadcast industry. Continued expansion and total commitment to an exciting and dynamic development programme has created unique career opportunities for a small number of engineering professionals to play major roles in the conception, design and development of new broadcast systems or equipment for the future. This will require an interest and awareness of the latest technologies and state-of-the-art in one or more of the following areas:

- **HIGH SPEED DIGITAL PROCESSING AND WIDE BAND ANALOGUE TECHNIQUES IN AUDIO AND VIDEO APPLICATIONS**
- **MICROPROCESSOR INTERFACING & CONTROL TECHNOLOGY**
- **DECODERS AND SYNCHRONISERS**
- **NEW DIGITAL TV PROCESSING EQUIPMENT, VIDEO DISTRIBUTION**

If you are well qualified technically with extensive relevant project management or design experience within the professional broadcast, studio equipment or closely related communications systems industry fields, this is an opportunity to attain the highest level of professionalism and responsibility.

Our clients offer top negotiable salaries and benefits including generous relocation in the Home Counties, excellent technical facilities and a green fields working environment second to none.

For an informal and confidential discussion please call Alan Newman on (0494) 30517 or write to him in the strictest confidence quoting ref. no. 8/84.

Daton Recruitment Limited
23 Easton Street, High Wycombe Buckinghamshire HP11 1NY

daton
Recruitment

The SNV Group

Soundcraft Network Video Ltd.

THE SNV GROUP
The Very Best in Video

SALES MANAGER

(SNV London)

Challenging opportunity in the fastest growing video communications company in the U.K. Based in Charlotte Street, the successful applicant will have a proven record of sales and managerial success in the professional video world and will be seeking responsibility and involvement in SNV's expansion. Car, attractive salary and benefits.

FACILITIES and HIRE TECHNICIAN

(SNV North East)

All rounder required to provide a fully integrated Facility and Hire service to our clients in the North East. Good understanding of video equipment as well as an ability to edit. (Might suit an experienced AV technician or corporate 'one man band'.) Progress to full time editor envisaged as department expands. Good salary and use of company vehicle.

TECHNICAL ENGINEERING MANAGER~Facilities

(SNV London)

Responsible for the day to day operation of the edit suites and technical areas at our Charlotte Street premises; the successful applicant will have practical 'hands on' engineering knowledge of VTR's (including 1", BVU and LB), editing control systems and broadcast cameras, and will be capable of supervising and training staff as well as handling future planning and development. Working closely with the Facilities and Hire Manager and reporting to the National Facilities Director, this is a challenging position with good potential for personal development. Salary by negotiation.

VIDEO EDITOR

(SNV London)

Top notch personality required, with proven editing ability, to take charge of Edit Suite 1, our computer assisted multi-machine suite. (This position might suit a really good 'Number Two' looking for a break!) Good salary, plus bonus geared to success.

REGIONAL FACILITY/HIRE MANAGERS

With the expansion of our Facility and Hire departments throughout the UK, applications are invited from experienced managers seeking to broaden their careers by becoming involved in developing and promoting video facilities to a wider market. The SNV Group has offices in every part of the country and provides a co-ordinated and comprehensive nationwide service. Successful applicants will enjoy a challenging and responsible position and will play a key role in SNV's expansion. Company car. Salary by negotiation.

BENCH and FIELD ENGINEERS

(SNV London, South, West, North and North East)

Due to an ever increasing number of varied commercial and industrial contracts, the SNV Group requires yet more Engineers, with at least 5 years practical video experience to carry out bench and field servicing. Must be conversant with client requirements. Salary based on experience. Performance bonus. Company vehicle available for field use.

Applications in writing, with C.V. please to
The National Facilities Director, The SNV Group,
c/o SNV London, 50-54 Charlotte Street, London W1P 1LW.

Salaries will conform to the Company Staff Grading system, currently under review. Company BUPA scheme.

Appointments

Electronics Engineers £9561 Communications Design in High Tech Country

At H.M. Government Communications Centre we're using the very latest ideas in electronics technology to design and develop sophisticated communications systems and installations for special Government needs at home and overseas.

With full technical support facilities on hand, it's an environment where you can see your ideas progress from initial concepts through prototype construction, tests and evaluation, to the pre-production phase, with a chance to influence every stage. Working conditions are pleasant, the surroundings are attractive, and the career prospects are excellent.

Ideally we're looking for men and women who have studied electronics to degree level or equivalent and have had some experience of design, whether obtained at work or through hobby activities. Appointments will be made as Higher Scientific Officer (£7149-£9561) or Scientific Officer (£5682-£7765) according to qualifications and experience.

For further details please write to the address given below. As our careful selection process takes some time, it would be particularly helpful if you could detail your qualifications, your personal fields of interest and practical experience, and describe the type of of working environment most suited to your career plans.

The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.

(2448)

COMMUNICATIONS ENGINEERS AND TECHNICIANS

Join the UK's leading communications system house where recent success has created the following opportunities. Can you meet these needs!

Systems and Project Engineers

Engineers who have a broad experience of single channel, microwave and multiplex equipments and understand the parameters of these systems.

Vacancies exist both at Great Yarmouth and Aberdeen with opportunities for occasional overseas travel. You will be involved in the design and planning of complete communications systems, as well as their implementation.

We offer an attractive salary, four weeks holiday, pension scheme and BUPA membership. Assistance with relocation given if necessary.

Engineers and Technicians for UK and Overseas

For on-going projects in the UK and overseas, we require engineers and technicians able to install and maintain a wide range of communications equipment from microwave and multiplex, to VHF, HF and UHF systems and probably some PABX knowledge.

Whether you are working in the North Sea or Middle East you can expect to receive a competitive salary plus allowances and attractive work/leave cycles.

We also have vacancies for radio operators, qualified to M.R.G.C., preferably with oil related experience.

**Please apply in wiriting to: R. D. Elliott, Group Personnel Director, Inspectorate EaE Group Limited,
284/5 Southtown Road, Great Yarmouth,
Norfolk NR31 0JB**

Inspectorate EaE
Worldwide Quality Services

(2603)

ELECTRONICS ENGINEERS for MARINE SYSTEMS

Hunting Surveys & Consultants Limited requires Electronics Engineers to work on both the theoretical and practical aspects of Marine Survey Instrumentation Systems.

They must be qualified to degree level with a broad electronics experience but having an emphasis on digital circuitry, computing and microprocessing techniques. Software experience will be necessary.

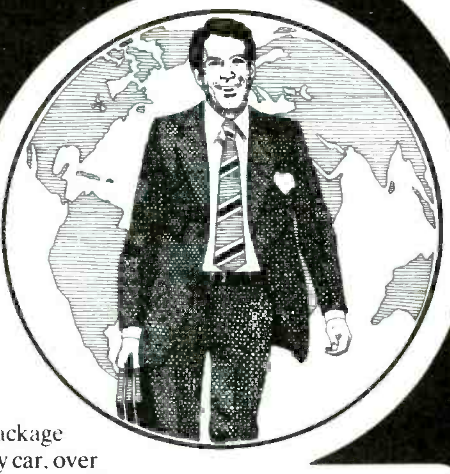
Applicants (preferred age 23-30) will need to be physically fit and prepared to undertake periods of operational work in the North Sea and Overseas. Engineers appointed must be capable of working with minimum supervision to take overall responsibility for initial circuit design, prototype building and testing, board layouts, circuit diagrams and documentation. This work often involves the production of working prototypes to be used in the field within days.

If you believe that you are suitably qualified and could be happy working under these demanding but stimulating conditions, please apply in writing to:—

Hunting

The Personnel Manager
HUNTING SURVEYS & CONSULTANTS LTD
Elstree Way, Borehamwood, Herts WD6 1SB.

Regional Sales Manager (Export)



Racal Dana Instruments Ltd. is a major manufacturer of sophisticated electronic test and measurement instrumentation for the radio communications and ATE industries.

The potential for expansion in the export markets for our products means that we need to recruit a Regional Sales Manager to realise this targeted increase in exports.

Applicants must have a technical qualification in electronics with a background in the radio communications industry. We also require a minimum of two years experience of technical selling in either the U.K. or export markets with a track record that testifies to the ability to achieve targets in a highly competitive industry. A second language (French or Spanish) would be an advantage.

We offer an attractive salary package including company car, over five weeks annual leave, staff pension and free life assurance scheme. Assistance with relocation is available in appropriate cases.

This is an excellent opportunity for an ambitious professional to develop his/her career in export selling.

If you have the drive and enthusiasm to join Britain's fastest growing electronics group then please contact:-
The Personnel Officer,
Racal Dana Instruments Ltd., Duke Street, Windsor, Berks. Tel:- Windsor (07535) 68101

RACAL-DANA **RACAL**

World leaders in electronics

EAST HAM COLLEGE OF TECHNOLOGY

High St. South London, E6 4ER.

Principal: K.R. Bishop, B.Sc. (Econ.) FRSA

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

LECTURERS I IN ELECTRONIC/ELECTRICAL ENGINEERING

Applications are invited from those holding appropriate qualifications, preferably with industrial experience, to teach to BTEC HND level in one or more of the following areas:

1. Electronics and Electrical Power.
2. Microprocessors and their applications.
3. Software Engineering.

Salary within the range: £5,649 - £9,735 plus £987 p.a. London Allowance.

Application forms and further details may be obtained by writing to the Vice-Principal enclosing a self-addressed envelope. Completed forms should be returned within 14 days of the appearance of this advertisment.

An equal opportunity Employer.

(2575)

LONDON BOROUGH OF NEWHAM

ELECTRONICS TECHNICIAN

The Electronics and Computer Services Dapartment of Inco's Refinery in North West London is concerned with the construction and installation of process control equipment, and the maintenance of bought-in hardware.

A vacancy now exists for a suitably qualified person with demonstrable practical and logical ability to assist with the work of the department.

Salary will be based on experience at **c. £8,000**. In addition, an excellent benefits package is available to the successful candidate.

Please write or telephone for an application form to:
Mr. Jeff Parkin, Refinery Engineer,
Inco Europe Limited Bashley Road, London NW10 6SN.
(Tel: 01-965 6031 Ext.41)

INCO
INCO EUROPE LIMITED

LOOKING FOR NEW HORIZONS?

Your experience and qualifications could take you to one of the more pleasant Middle East countries where vacancies currently exist for:-

Fully trained ELECTRONIC TECHNICIANS

With a minimum of five years experience in servicing, maintenance and repair, including defect diagnosis, of various types of military ground based electronic equipment. These unaccompanied posts include free accommodation, medical care and free air travel to the UK for frequent leave periods. Attractive salary with bonus and allowances normally free of UK Tax. For further information write to:- **Company Personnel Manager, Airwork Limited, Bournemouth - Hurn Airport, Christchurch, Dorset BH23 6EB.**

Airwork Limited

1983

PRINCIPLE DESIGN ENG. to £17.5K
PRINCIPLE QUALITY ENG. to £15K

Analogue/Digital Technology **S.E. England**

A world leader in the innovative design of future electronic equipment is offering you an opportunity to meet the challenge of stretching the capability of present technology and its principles to resolve the most exacting Signal Processing and Analogue circuit design requirements for future systems development.

You will be part of a professional team of engineers, managers, systems analysts and modelling consultants. You will help to maintain our client's position as world leader in their field by successfully dealing with a continuous influx of new projects. These future developments will offer you considerable opportunities to exercise your personal initiative, innovative, technical and managerial skills from the product's conception through to customer acceptance. As a candidate you will have a degree in electronics and **experience in one or more of the following:**

DIGITAL SIGNAL PROCESSING, SPREAD SPECTRUM TECHNIQUES, COMMUNICATIONS PROCESSING, WIDEBAND ANALOGUE CIRCUIT TECHNIQUES with LSI, VLSI and HYBRID DESIGN TECHNIQUES.

Our client also requires:

DESIGN AND DEVELOPMENT ENGINEERS
SYSTEMS and SCIENTIFIC ANALYSTS
SYSTEMS MODELLING CONSULTANT
PROJECT MANAGEMENT

(and opportunities also exist for candidates with HNC/H.Tech qualifications or graduates yet to gain experience.)

These important positions present a major opportunity for the professional engineer set to establish himself in future electronic circuit and systems design and development. Our client provides the most modern accommodation and engineering facilities including the latest VAX System, an attractive salary package, full company benefits, five weeks holiday and generous relocation package to S.E. England.

To find out more and to obtain an early interview please telephone **Ken Jacobsen** in complete confidence on Hemel Hempstead (0442) 47311 during office hours or one of our duty consultants on Hemel Hempstead (0442) 212650 evenings or weekends. Alternatively write to him at the address below.

Executive Recruitment Services
THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS COMPUTING AND DEFENCE INDUSTRIES
25-33 Bridge Street, Hemel Hempstead, Herts., HP1 1EG.

ELECTROSONIC

SYSTEMS AND DESIGN ENGINEERS
£8K — £12K PLUS CAR

ELECTROSONIC, a well established International Company with subsidiaries in Europe and America, designs, manufactures and commissions a wide range of control systems for the entertainment and commercial markets.

Although the Company's main strengths lie in the areas of audio, lighting and associated control systems, much of its work is best categorised as 'imagineering' with the only thing more diverse than its client list, being the range of technologies and solutions used to solve their porblems.

A project Engineer/Manager is required to augment the existing special projects team. The successful candidate should have experience in one or more of the above fields, as well as an in-depth knowledge of video systems.

The position carries the benefit of a Comapny car, participation in the Company's pension and bonus schemes and offers the opportunity for overseas travel.

A Development Engineer is also required to augment a multi-disciplined team of audio, lighting, control hardware and software Engineers. Our preference is for an Engineer with a video design background, but with a willingness to expand his/her experience by carrying our work in some of the other fields listed. The successful candidate will be an experienced Development Engineer possessing the drive necessary to contribute to both the specification and implementation of the designs for both special project solutions and standard products.

Applications in writing to:

R.L.C. STINTON C.ENG. M.I.E.E.
Director of engineering
Electrosonic Ltd.,
815 Woolwich Road, London SE7 8LT

(2592)

Brompton Hospital

Medical Physics Technician III

Electronics

A vacancy exists for a technician with hospital experience to join the team of technicians in the Department of Medical Electronics. The Department provides a comprehensive maintenance and development service to two busy cardiothoracic hospitals. The technician will be based initially at the Brompton Hospital, SW3, but he/she must be willing to also work at London Chest Hospital, E2.

For further information contact Mr. P. Butler, Chief Technician 01-980 4433 Ext. 340.

For a job description and application form contact Mrs J Walton, Assistant Personnel Manager, Brompton Hospital, Fulham Road, London SW3 6HP. Tel: 01-352 8121 Ext. 4357. (2577)

ARTICLES FOR SALE

TEKTRONIX OSCILLOSCOPES. Many types including storage and curve tracer mainframes. Plug-ins, most types including spectrum analyzer and calibration units. Good condition. Repair and re-calibration facilities. Tektronix spares, manuals, probes, camera trolleys. Components. Other test equipment. Texas silent 700 printer. Tel. 01-868 4221 2604

VALVES, PROJECTOR Lamps, 6000 types, list 75p, world wide export. Cox Radio (Sussex) Ltd., The Parade, East Wittering, Sussex. Phone (024 366) 2023. (1991)

WAVEGUIDE, Flanges and Dishes. All standard sizes and alloys (new material only) from stock. Special sizes to order. Call Earth Stations, 01-228 7876, 22 Howie Street, London SW11 4AR. (2099)

BRIDGES waveform/transistor analysers. Calibrators, Standards. Millivoltmeters. Dynamometers. KW meters. Oscilloscopes. Recorders. Signal generators — sweep, low distortion, true RMS, audio, FM, deviation. Tel. 040 376236. (1627)

Electronic Engineers –
What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £5000-£15000.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL
PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.

TJB

Tel: 0892 39388
(24 Hour Answering Service)

Please send me a TJB Appointments Registration form:

Name . . . .

Address . . . .

. . . .

(861)

Have you a flair for Electronics?
c.£11,000

Schlumberger Cambridge Research, part of a highly successful multinational organisation, is a research centre recently established to investigate topics of central importance to Schlumberger's oilfield drilling and production services.

Expansion of our research activities has created posts for two Electronics specialists. Both positions offer opportunity to work with first-class equipment including a major flow loop facility and a wellbore simulator in an exceptionally modern working environment. The job details and requirements are as follows:-

Fluid Mechanics

Projects in this Department include the development of flow measurement techniques and a general instrumentation system. We require someone with a thorough knowledge of both digital and analog circuits and preferably possessing experience on microprocessors for on-line data acquisition and analysis.

Wellbore Physics

The post here offers the opportunity to exercise practical skills in electronics (especially digital electronics), measurement, the construction of prototype instruments and interfacing instrumentation with computer hardware, both in the laboratory and on a large-scale wellbore simulator, hence, a flair for software application is desirable.

Both appointments require an honours degree/HNC in electronics or electrical and electronic engineering preferably supported by 2-5 years' experience in a research or R & D environment.

Salary is negotiable around £11,000 p.a. and the general conditions of service are excellent including a non-contributory pension scheme and considerable scope for career development exists with Schlumberger, which has very wide interests in instrumentation, measurement, control and other areas of electronics.

Please send your curriculum vitae, quoting reference RA/FLM/WBP to: Mrs. Jacqueline Barr, Personnel Manager, Schlumberger Cambridge Research, P.O. Box 153, Cambridge CB2 3BE. Telephone 0223 315576.

Schlumberger

SCHLUMBERGER CAMBRIDGE RESEARCH

ARTICLES FOR SALE

20 MHz protable oscilloscope, re-chargeable batteries, internal charger, mains operation etc., **£175.** Avo Universal Bridge, Component Comparator **£75.** Single to 3-phase converter. Binocular microscope **£145.** Centrifuge **£49.** FM/AM generator. Wow/flutter meter. New set of binocular microscope lenses including wide-field oculars, one-twelth objective etc., **£75.** PCM Generator, IC Tester. Master and general purpose pressure guages. Pressure transducers. Autocontrol pressure switches. Fly-press **£49.** Compressor **£35.** Vacuum pump **£35.** Optic-fibre light source **£35.** 16mm film reader **£45.** Micrigen overhead projector **£39.** 4-phase signal generator. Philips GM 5545 Amplitude & Phase adaptor **£25.** Foster Electromagnetic motor Control Unit **£25.** Record Clip-on Tester with chart recorder **£65.** Creed 444 Teleprinter **£75**

040-376236.

(2016)

LINSLEY HOOD DESIGNS

Audio Signal Generator Kit Model 113	£26.45
Audio Signal Generator Kit Model 149	£36.80
P.C.Bd. for 75 watt amp.	£2.30
P.C.Bd. for 100watt Mosfet	£4.00

P/P extra
S.A.E. for leaflets

TELERADIO ELECTRONICS
325 Fore Street, London N9 0PE

(1762)

RACAL COMMUNICATION RECEIVERS

500Kc s to 30Mc s IN 30 BANDS 1Mc s WIDE **RA17 MK11** £100 **RA17L** £150 **RA117E** £225 NEW METAL LOUVERED CASES FOR ABOVE £25 EACH ALL RECEIVERS ARE AIR TESTED AND CALIBRATED IN OUR WORKSHOP SUPPLIED WITH MANUAL AND DUST COVER IN FAIR USED CONDITION **RACAL SYNTHESISERS** (DECADE FREQUENCY GENERATOR) **MA350B** SOLID STATE FOR USE WITH MA79 RA117 RA217 RA1217, ETC, £100 to £150 MA250 1 6Mc s TO 31 6Mc s £100 to £150 **MA259G PRECISION FREQUENCY STANDARD** 5Mc s 100Khz £100 to £150 **EDDYSTONE RECEIVER TYPE EC964 7K** SOLID STATE SINGLE CHANNEL SSB MAINS OR BATTERY POWERED 1 6 to 27 5Mc s AND 400 535Khz £100 WITH MANUAL **REDIFON SSB RECEIVER TYPE R499** SOLID STATE 10 FIXED CHANNELS RANGE 1 5 TO 30Mc s AND 255Khz TO 525Khz POWER MAINS OR BATTERY COMPLETE WITH ISB ADAPTOR ARU10A £100 WITH MANUAL **REDIFON TT10 OR TT11 AUDIO TELEPRINTER CONVERTOR** SOLID STATE TESTED WITH CIRCUIT £25 **CREED TYPE 75 TELEPRINTER** 50 AND 75 BAUDS FOR USE WITH ABOVE CONVERTOR £25

OSCILLOSCOPES

CT436 DUAL BEAM OSCILLOSCOPES 6Mc s £45 **TEKTRONIX 647A** 100Mc s DUAL TRACE SOLID STATE £350 WITH MANUAL **MARCONI TF995 SIGNAL GENERATORS** FROM 2Mc s OR 1 5Mc s TO 220Mc s AM FM A2M, £80 A3, £80 A5, £150 WITH MANUALS **TF2606 DIFFERENTIAL DC VOLT METER** 0 TO 1100 volts £100 **TF2002 AM SIGNAL GENERATOR** 10Kc s TO 72Mc s £300 **TF2002AS** FM AND AM SIGNAL GENERATOR 10Kc s TO 72Mc s £600 **TF2170B DIGITAL SYNCHRONIZER** FOR ABOVE £350 **TF1066B 6 FM AM SIGNAL GENERATOR** 10Mc s TO 470Mc s £300 **TF1245 CIRCUIT MAGNIFICATION METER** AND TF1246 OSCILLATOR £200 **H P SIGNAL GENERATORS 620B** 7 TO 11 GIGS £150 **608** 10 420Mc s £70 612A 450 1200Mc/s £200 **MARCONI AF WATT METER CT44 ND1** ABSORPTION 200 MICROWATTS TO 6 WATTS IN 10 RANGES SWITCHED 2150 Ohms £45 **TF893A AF WATT METER** 1 MILLIWATT TO 10 WATTS 2 5 Ohms TO 20K Ohms IN 48 STEPS £65 **THYRISTOR TEST SET CT558** VOLTAGES UP TO 2KV £100 **TEKTRONIX 4002A GRAPHIC COMPUTER TERMINAL WITH JOYSTICK** £400 **TEKTRONIX 4601 HARD COPY UNIT** FOR USE WITH ABOVE £150 BOTH UNITS FOR £500 **RACAL DIGITAL COUNTERS**, TYPE 801M 125Mc s £50 **RACAL 836 COUNTER** 35Mc s £50

V A T AND CARRIAGE ON ABOVE ITEMS EXTRA

ALL ITEMS ARE BOUGHT DIRECT FROM H M GOVERNMENT, BEING SURPLUS EQUIPMENT PRICE IS EX WORKS S A E FOR ALL ENQUIRIES PHONE FOR APPOINTMENT FOR DEMONSTRATION OF ANY ITEM

JOHN'S RADIO
WHITEHALL WORKS, 84 WHITEHALL ROAD EAST
BIRKENSHAW, BRADFORD BD11 2ER
TEL (0274) 684007

WANTED REDUNDANT TEST EQUIPMENT RECEIVING AND TRANSMITTING EQUIPMENT VALVES PLUGS AND SOCKETS SYNCHROS, ETC (848)

SETTING UP A RADIO STATION?

Professional quality VHF/FM broadcast transmitters and repeater links available. 25-250 watts, all solid state, continuously rated. Mono/Stereo versions. High stability PLL/Xtal references. Competitively priced ie 100 watt model, with integral mains power supply – £280. Fully guaranteed.

Cyberscan International,
3 Eastcote View, Pinner,
Middx HA5 1AT. Tel: 01-866 3300

(2557)

MORSE READING PROGS. Work on clean signals without hardware interface. ZX81 1K UNEXPANDED MEMORY. Translated code with word and line spaces for easy reading Automatic scroll action. £7 incl.
SPECTRUM 16/48K. Scroll action with 10-page scrolling memory, instantly accessible page by page. £8 incl. All types variable speeds. Feed signal direct into EAR socket. Pinehurst Data Studios, 69 Pinehurst Park, West Moors, WIMBORNE, Dorset. BH22 0BP. (2532)

Technical Manager

Medical Electronics

To £15K **Oxfordshire**

With the retirement of its Technical Director due within the next two years our client, a market leader in the manufacture, development and marketing of electronic physiotherapy equipment, is seeking to recruit an experienced Technical Manager.

Reporting initially to the Technical Director and later direct to the Managing Director your role will embrace all aspects of the technical development of new and existing products from inception through manufacture to after sales service. In addition to total responsibility for the day to day running of the Design and Development department you, as the company's technical specialist, will be responsible for providing technical advice to customers and sales engineers and technical support to the manufacturing and sales/service engineering functions.

To fully succeed and develop this role candidates should:-

- be aged 30-45
- be qualified to degree level in electronics
- have design and development experience with RF equipment, power amplifiers or similar equipment using mainly digital techniques.

In addition the ability to manage in a technical setting and communicate effectively both within the company and to customers at all levels is essential.

In addition to the salary the company offers a package of benefits including relocation assistance in appropriate cases. For the right person there is the prospect of promotion to Technical Director on retirement of the current post holder.

For an initial and confidential discussion please call Newbury (0635) 48709 or write in strict confidence quoting ref: 949/MM to:-

Larkfield Personnel Selection,
Mill Reef House, 9-14 Cheap Street,
Newbury, Berkshire RG14 5DD.

LPS

Senior RF Engineer

The modern communications complex of Marconi at Browns Lane Portsmouth requires an experienced professional Senior Engineer to develop new VHF/UHF receivers and micro processor based communications systems.

This involves directing the technical work of engineers in a project team who will be working on the design, development and evaluation of R.F. circuits, particularly power amplifiers at UHF and HF, high gain amplifiers, R.F. filters and Front End Receivers in VHF and UHF.

The essential qualifications are a degree in electronics, plus at least five years related experience.

We offer excellent salaries and conditions of employment.

Telephone or write for an application form, quoting Ref. BL 171 to Jack Burnie, Marconi, Browns Lane, The Airport, Portsmouth. Telephone Portsmouth 674019. (All posts are open to men and women).

Marconi

ARTICLES FOR SALE

COMPONENT SCOOP PURCHASE

ONE MILLION C280 MULLARD PHILIPS POLYESTER CAPACITORS. Ideal for the trade or manufacturing. 0.01 to 0.47 mfd. 100v wkg. Assorted values £10 per 1,000 lot., p.p. £1. 1,000 of one value £12.50, p.p. £1. 5,000 assorted £42, p.p. £2. Please add VAT. MAINS TRANSFORMERS. Famous manufacturer. TYPE 1. Midget clamped type. Input 200-250v. 250 c.s. Output 250-0-250 60 m.a. 6.3v at 2 amps, £2.50 each, p.p. £1.50. Ten transformers £17.50, carriage £4. TYPE 2. Mains input. Output 35V at 1¼ amp. Price £2.25 each, carriage £1.50. Ten for £16, carriage £6. Larger discounts for larger quantities. Ten thousand valves, 1925 to 1975, modern and obsolete types. Send 60p (refundable). VERSATILE BENCH POWER SUPPLY UNITS. Contains high quality transformer made to exacting specifications giving one 20v output and one 20-0-20v output. D.C. output fused at 3 amps but will easily give 5 amps. Input AC 110 250v 50 c.s. Bridge rectification. Contained on metal chassis with robust compact case size 7x5x4. Easily modified to give 40v and 60v. Makes ideal variable power supply. Usual cost around £60. Our price as new with circuit £8.50 each, p.p. £3. Two units £20 post free. XENON FLASHER UNITS. Complete panel with dual flash rate (slow/fast). 12v to 18v D.C. Includes tube, base, fuseholder, 10 metres of connecting wire. Full instructions and guarantee. As used on police vehicles. Ideal for boats and cars. Should be £40 each. Our price £12 each, p.p. £1.50. Two units £23 post free. Ideal emergency beacons for boats and cars.

DEPT. WW, MYERS ELECTRONIC DEVICES
12/14 Harper Street, Leeds LS2 7EA. Tel: 452045

T.V. PATTERN GENERATORS

Black and white Generator
4 patterns and Grey scale UHF output **£18.50**

Colour Bar Generator
11 patterns plus sound. UHF & VIDEO output **£75.90**

Colour Bar also available with R.G.B. output.

Prices include P&P & VAT

SAE FOR FURTHER DETAILS OF THESE PRODUCTS.

C.M.J. ELECTRONICS
Unit 8 16 Union Mill St,
Horseley Fields, Wolverhampton
Tel: (0902) 871563 WV1 3DN

(2595)

FOUNDATIONS OF WIRELESS AND ELECTRONICS

10th ed. M.G. Scroggie Price £10.00

WORLD RADIO TV HANDBOOK 1984 by J.M. Frost Price £12.00

A GUIDE TO PRINTED CIRCUIT BOARD DESIGN by C. Hamilton Price £7.85

MICROELECTRONICS: A PRACTICAL INTRODUCTION by R.A. Sparkes Price £9.00

1984 THE RADIO AMATEUR'S HANDBOOK 1984 by A.R.R.L Price £12.50

THE ARRL ANTENNA BOOK by A.R.R.L. Price: £7.50

VLSI TECHNOLOGY by Sze .... Price £10.90

FUNDAMENTALS OF MODERN DIGITAL SYSTEMS by B.R. Bannister Price: £9.00

AN INTRO. TO OPTICAL FIBRES by A.H. Cherin Price: £9.00

INSIDE THE IBM PC by P. Norton Price: £19.00

★ *ALL PRICES INCLUDE POSTAGE* ★

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST
of British and American
Technical Books

19-21 PRAED STREET
LONDON W2 1NP
Telephone: **01-402 9176**
Closed Saturday 1 p.m.
Please allow 14 days for
reply or delivery

(2245)

VIDEO ENGINEER
(SERVICE)

Required to work in our young progressive company, based in West London. the applicant should possess a good working knowledge of current video technology (or willing to adapt from another electronics background). He or she will have responsibility for the servicing and maintenance of our specialist product range inc: Character Generators, T.B.C.'s, Vision Mixers and C.S.O. Systems. Salary negotiable upon experience and ability.

Please contact Fred Smith at:

POLARVIDEO

2-5 Powis Mews, London W11. Telephone 01-727 1111

(2601)

TELE-CINE LTD.

have a number of immediate vacancies for:

VTR AND TELECINE OPERATORS/ENGINEERS

Essential requirements include a suitable technical qualification, (HNC, Higher Tec, or equivalent), and some experience working in a broadcast television environment. Applicants will ideally be in their mid to late twenties and should be capable of motivating both themselves and others when working with a small operational group within an interesting shift system. Salaries are negotiable and will be commensurate with experience. For full details, please write, enclosing full c.v. to

J Rowland
Tele-Cine Ltd.,
109/110 Bolsover Street, London W1P 7HF

(2573)

ENGINEERING OPPORTUNITIES

Bell & Howell, recognised as an international leader in audio visual and video equipment have, since the creation of the new Bell & Howell Television Division, experienced significant success which will assure our future throughout the 80's and beyond, in the highly competitive world of broadcast level equipment.

A major factor in our success has been the contribution made by our Engineering Team. This success leads us to recruit further experienced engineers.

Broadcast Engineers:

To provide technical support to our Sales Team and advise and assist our dealers and end users. This will involve working both in-house and on client sites throughout the U.K.—a company car will be provided!

You will be aged 25+ and should have HND/HNC in electronics engineering and have 2/3 years experience of broadcast level equipment.

Professional Video Engineers:

To service a wide range of video equipment up to broadcast level hardware at our workshop in Alperton, Middlesex. Aged 25+, male or female, and likely to be qualified to HND/HNC in electrical or electronics engineering, with at least 3 years experience in a similar or related environment.

You should also be able to demonstrate good communications skills since a part of your role will be assisting our customers with technical queries.

In both cases you will be joining small but efficient and highly professional teams. You will be self motivated as well as possess good written and oral skills and have the ability to work within an ever changing technical environment.

In return both these positions carry an excellent salary with a realistic benefits package and the opportunity to advance your career within a new division of a large and progressive company.

To apply for these exciting opportunities write or telephone for an application form to: Jennifer Cockings, Personnel Manager, Bell & Howell Ltd., Alperton House, Bridgewater Road, Wembley, Middlesex. HA0 1EG. Telephone: 01-902 8812.

BELL & HOWELL
AV & VIDEO DIVISION

ARTICLES FOR SALE

TO MANUFACTURERS, WHOLESALERS BULK BUYERS. ETC.

LARGE QUANTITIES OF RADIO. TV AND ELECTRONIC COMPONENTS FOR DISPOSAL

SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc.

ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES, SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, etc.

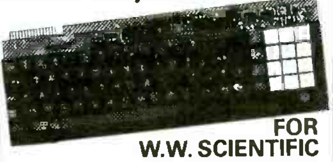
ALL AT KNOCKOUT PRICES – Come and pay us a visit ALADDIN'S CAVE

TELEPHONE: 445 0749/445 2713

R.HENSON LTD.
21 Lodge Lane, North Finchley, London, N.12
(5 minutes from Tally Ho Corner)

(1613)

ASCII Keyboards



FOR W.W. SCIENTIFIC COMPUTER.

- Upper & Lower Case plus Control
- Low Power Consumption
- Shift & Alpha Lock
- Autorepeat (Model 777)
- Parallel Data Output
- Metal Mounting Frame
- Suitable for Tuscan, Tangerine etc.

Model	KB756A	56 key	£44.50
	KB710	Numeric Pad	£ 7.50
	KB771	72 key	£57.50
	KB777	77 key	£65.00

Accessories available include:-

Metal Case	£15.95
Edge Connector	£ 2.25
DC to DC Convertor	£ 5.50

(for operation off single 5V supply)

U.K. Orders add 15% VAT on order total
Orders under £50 add £2.00 p&p plus VAT
Orders over £50 add £3.50 p&p plus VAT
Overseas orders add £6.50 to cover part cost postage and documentation.

FULL DATA SHEETS ON REQUEST (2594)

Citadel Products Ltd
Dept. WW 50 High Street Edgware
Middlesex HA8 7EP Tel: 01-951 1848

ENCAPSULATING EQUIPMENT FOR coils, transformers, components, degassing silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment, low cost, used and new. Also for CRT regunning metallising. Research & Development. Barratts, Mayo Road, Croydon CR0 2QP. 01-684 9917. (9678)

Townley Times

FREE Mail Order newspaper of Bargains. Relays; Diodes; Thyristors; Capacitors; Resistors; Bridge Rectifiers; Cable Straps; High Speed Fuses and Mechanical Components.

Harehill, Todmorden, Lancs. OL14 5JY
Tel. Todmorden (STD 070 681) 4931

(2530)

LARGE QUANTITY of Electrolytic capacitors resistors and some surplus pabx material available for disposal please contact John Palmer International Services Limited 1A Albert Street Slough Berks SL1 2BH (2576)

SHEETMETAL FOLDERS 18⅝ x 18G, Vice or Bench model. £38. Leaflet, 01-890 7838 Anytime. (2569)

PCB HAND ASSEMBLY —any quantity. Highest quality at sensible prices. **INTERESTED? Phone 01-274 3070** (2570)

COMMUNICATION RECEIVERS

RACAL 500KC/S TO 30MC/S IN 30 BANDS 1MC/S WIDE – **RA17 MKII** £100 • **RA17L** £150 • **RA117E** £225 • **NEW METAL LOUVRED CASES FOR ABOVE** £25. ALL RECEIVERS ARE AIR TESTED AND CALIBRATED IN OUR WORKSHOP, SUPPLIED WITH DUST COVER – OPERATION INSTRUCTIONS – CIRCUIT – IN FAIR USED CONDITION • **RACAL SYNTHESISERS** (DECADE FREQUENCY GENERATORS) **MA350B** SOLID STATE FOR USE WITH – MA79 – RA117 – RA217 – RA1218, ETC. – £100 TO £150 • **MA250** – 1.6MC/S TO 31.6MC/S £100 • **MA1350** – FOR USE WITH RA17 RECEIVER – £100 TO £150 • **MA259G** – **PRECISION FREQUENCY STANDARD** – 5MC/S – 1MC/S – 100KHZ – £100 TO £150 • **PANORAMIC ADAPTOR RA66** £150 • **RA137 LF CONVERTOR** – 10 TO 980KC/S – £75 **RA218 INDEPENDENT SSB UNIT** – £50 – **RA153 AND RA253 TWIN-CHANNEL RECEIVER** – 1 TO 30 MC/S – THIS IS VIRTUALLY TWO RA117s IN ONE CASE £150 TO £200 • **RA1218 SOLID STATE RECEIVER** WITH ELECTRONIC FREQUENCY DISPLAY TO 10HZ – FREQUENCY 1 TO 30MC/S – £500 • **RA6217** – **RECEIVER** SOLID STATE – COMPLETE WITH SEPARATE SYNTHESISER – INCLUDES FM – A VERY HIGH-GAIN, SENSITIVE AND EXTREMELY STABLE RECEIVER – NORTH AMERICAN RACAL MADE £400 • **RA337 LF CONVERTOR** 3 TO 980KHZ FOR USE WITH SOLID STATE RECEIVERS – £150 • **EDDYSTONE COMMUNICATION RECEIVERS** – **EC958** – SOLID STATE – HIGH STABILITY – 10KHZ TO 30MC/S £350 TO £400 – **EC964 7K** – **SOLID STATE** – SINGLE CHANNEL – SSB – MAINS OR BATTERY – 1.6 TO 27.5MC/S AND 400 TO 535KHZ £100 WITH MANUAL • **REDIFON SSB RECEIVER** – **R499** – SOLID STATE – 10 FIXED CHANNELS – RANGE 1.5 TO 30MC/S AND 255KHZ TO 525KHZ – MAINS OR BATTERY – COMPLETE WITH ISB ADAPTOR ARU10A – £100 WITH MANUAL • **CREED 75 TELEPRINTERS** – FITTED TAPE PUNCH AND GEARBOX FOR 50 AND 75 BAUDS – 110VOLT AC SUPPLY – IN ORIGINAL TRANSPORT TRAY SEALED IN POLYTHENE – LIKE NEW – £15 EA. • **REDIFON TT11 AUDIO TELEPRINTER CONVERTOR RECEIVER** SOLID STATE – SUPPLY 110 OR 240 AC – MADE FOR USE WITH ABOVE TELEPRINTER ENABLING PRINT-OUT OF MESSAGES RECEIVED FROM AUDIO OUTPUT OF COMMUNICATION RECEIVER – £15 WITH CIRCUIT TESTED. **REDIFON TT10 CONVERTOR** AS ABOVE BUT INCLUDES TRANSMIT FACILITIES – £20 • **OSCILLOSCOPES** – STOCKS ALWAYS CHANGING – **SELAB'S 111** SOLID STATE – 25MC/S £175 • **COSSOR COU150** – 35MC/S £200 • **TELEQUIPMENT D75** – 50MC/S £300 • **TEKTRONIX 465** – 100MC/S £1000 • **SOLARTRON CD1740** – 50MC/S £300 • **FM RECORDER SANGHMD SABRE 111** 14 CHANNELS £350 • **TRANSTEL MATRIX PRINTERS** – **AF11R** – 5-LEVEL BAUDOT CODE – UP TO 300 BAUDS – FOR PRINT-OUT ON PLAIN TELEPRINTER PAPER £50 TO £100 • **TRANSTEL AH11R** AS ABOVE BUT ALSO 8-LEVEL ASC11 (CCITT NO 2 AND CCITT NO 5) LIKE NEW £200 • **ARMY FIELD TELEPHONE SETS, TYPE F – L AND J** – LARGE QUANTITY IN STOCK £6 TO £15 DEPENDING ON TYPE AND QUANTITY • **G.P.O. TYPE 26 HAND GENERATORS** – LARGE QUANTITY AVAILABLE P.O.R. • **DON 10 TELEPHONE CABLE** HALF-MILE CANVAS CONTAINERS – £20 • **NIGHT VIEWING INFRA-RED AFV PERISCOPES** – TWIN EYEPIECE – 24-VOLT DC SUPPLY – £100 EA. – ORIGINAL COST TO GOVERNMENT OVER £11,000 EA. • **STATIC INVERTORS** – 12 OR 24-VOLT INPUT – 240-VOLT AC SINEWAVE OUTPUT – VARIOUS WATTAGES P.O.R. • **XY PLOTTERS AND PEN RECORDERS** VARIOUS – P.O.R. • **FERROGRAPH SERIES 7 TAPE RECORDERS** – MONO £100 – STEREO £150 • **LOW-NOISE AMPLIFIERS** – 500MC/S TO 40G/CS IN VARIOUS RANGES MADE BY WATKINS JOHNSON, 110- OR 240-VOLT MAINS INPUT £25 TO £50 • **SIGNAL GENERATORS** VARIOUS – TF995/A3 £80 • TF995/A5 £120 • TF144H £100 • TF1060/2 £75 • HP606A AND B – £100 – B £150 • HP608 £100 • HP614A £100 • HP618B £100 • HP620A £100 • **TELONIC SM 2000 SWEEP GENERATORS** L3 AND L5 PLUG-INS 4 TO 75MC/S £60 • **TELONIC SWEEP GENERATORS 2003** – 850 TO 2150MC/S £275 • **MARCONI TF2212 XY SCOPE** £150 • **TF1313 BRIDGE** £100 • **TF791 DEVIATION METER** £100 • **TF893A POWER METER** £50 • **TF1245 AND 1246 CIRCUIT MAGNIFICATION METER** £150 • **BOX OF PLUG-IN STANDARDS FOR TF1245** £100 • **AERIAL MAST ASSEMBLY 30FT. HIGH** COMPLETE WITH 16FT WHIP AERIAL TO MOUNT ON TOP – GUYROPES – INSULATORS – BASE AND SPIKES, ETC – IN HEAVY-DUTY CARRYING BAG – NEW – £30 • **RACAL FREQUENCY COUNTERS** TYPE 801 AND 836 £50 EA. • **TEKTRONIX PLUG-INS** – 1A1 £50, 1A2 £40, 1A4 £100, M £50.

All items are bought direct from H.M. Government, being surplus equipment; price is ex-works. S.A.E. for enquiries. Phone for appointment for demonstration of any item. V.A.T. AND CARRIAGE EXTRA

EXPORT TRADE AND QUANTITY DISCOUNTS GIVEN
JOHN'S RADIO
WHITEHALL WORKS, 84 WHITEHALL ROAD EAST
BIRKENSHAW, BRADFORD BD11 2ER
TEL: (0274) 684007

WANTED: REDUNDANT TEST EQUIPMENT – RECEIVING AND TRANSMITTING EQUIPMENT – VALVES, PLUGS – SOCKETS – SYNCHROS, ETC.

(848)

Appointments

Technical Training Professional Broadcast Equipment

As an essential part of a comprehensive service to the Broadcasting industry, the training Department of Sony Broadcast Ltd provides in-depth product courses on an extensive range of professional broadcast Video and Audio equipment. Two excellent opportunities have now arisen on our lecturing staff who are responsible for conceiving and conducting theoretical and practical courses.

Lecturer – Digital Audio Products

We are at the forefront of the Digital Audio revolution and our products include a Multi-track Digital Recorder, Digital Mastering System and a professional Compact Disc Player. In addition to lecturing on Audio products the successful applicant will also have an opportunity to become involved with our Video equipment.

Video Products

Our world renowned range of professional video equipment includes cameras, C-format and U-matic Video tape recorders, Betacam systems, Time Base Correctors and a range of computerised editor systems.

Applicants for both positions should ideally be educated to degree level or equivalent in electronics and should have a sound understanding of the theory and practice of analogue and digital techniques, together with an appreciation of Video and Audio principles. Experience should have been gained in the broadcast, computer or telecommunications industry.

The ability to communicate knowledge clearly and concisely on both theoretical and practical levels is essential.

Training on our range of products will be given where appropriate. Some overseas travel will be involved and we offer attractive salaries together with first class conditions of employment, and relocation assistance will be given where appropriate.

If you are interested, please contact Mike Jones, Senior Personnel Officer, Sony Broadcast Limited, City Wall House, Basing View, Basingstoke, Hampshire, RG21 2LA. Telephone (0256) 55011.

SONY®
Broadcast

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
Hampshire RG21 2LA
United Kingdom
Telephone (0256) 55 0 11

WANTED

BRACE DALE LTD
RADIO Centre

SURPLUS
ELECTRONIC
EQUIPMENT/COMPONENTS
TOP PRICES PAID
Tel: Shrewsbury (0743) 245078
Anytime (2572)

WANTED
SURPLUS ELECTRONIC COMPONENTS AND EQUIPMENT
We also welcome the opportunity to quote for complete factory clearance
B. BAMBER ELECTRONICS
5 STATION ROAD, LITTLEPORT, CAMBS.
Phone: Ely (0353) 860185
(2483)

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap and quantity. Prompt service and cash. Member of A.R.R.A.

M & B RADIO
86 Bishopsgate Street
Leeds LS1 4BB
0532 435649
(9956)

VERBGATE LTD.

We buy large and small parcels of surplus I/C, transistors, capacitors and related electronic stock. Immediate settlement

Tel: 01-208 0766
Telex: 8814998
(2478)

SURPLUS

We offer good prices for test equipment, components, redundant computers, PCB's connectors. Immediate settlement.

TIMEBASE
94 Alfriston Gardens
Sholling, Southampton SO2 8FU
Telephone: (0703) 431 323
(1832)

CAPACITY AVAILABLE

TW ELECTRONICS LTD
THE PCB ASSEMBLERS

More and more companies are investigating the advantages of using a professional subcontractor. Such an undertaking requires certain assurances.

TW are able to satisfy all of them – quality, competitive pricing, firm delivey and close co-operation with the customer.

Assembled boards at 100% inspected before flow soldering and reinspected after automatic cropping and cleaning.

Every batch of completed boards is issued with a signed certificate of conformity and quality – our final assurance.

For further details, contact us at our new works:

Blenheim Industrial Park
Bury St. Edmunds
Suffolk IP33 3UT
Telephone: 0284 3931 (1466)

FREE PROTOTYPE of the finest quality with EVERY P.C.B. artwork designed by us. Competitive hourly rates, and high standard of work. Halstead Designs Limited. Tel: Halstead (0787) 477408. (2126)

SERVICES

DESIGN AND CONSULTANCY of microprocessor, digital and analogue equipment. Complete service from feasibility and design to prototype and commissioning. Advice on test and design of dedicated test equipment or ATE. DPM Electronics, 24 Timbermans View, Basildon, Essex. Tel. 0268 558831. (2295)

TURN YOUR SURPLUS i.cs transistors etc. into cash, immediate settlement. We also welcome the opportunity to quote for complete factory clearance. Contact COLES-HARDING & CO, 103 South Brink, Wisbech, Cambs. 0945 584188. (9509)

PROFESSIONAL DESIGN SERVICE. Analogue/RF circuit/System design. Specialising in microwave amplifier, oscillator and network design. MOTOROLA 6805/6809 series microprocessor design/development capability. All work carried out to a high standard by competent professional engineers. **Trontech Electronics Design Services,** 81 Finchampstead Rd, Wokingham, Berkshire. Tel: 0734 790103 (2439)

SCOPES
repaired and recalibrated
All makes, all models
Scopex, Safgan Older TEK & TQ
MENDASCOPE LTD.
Otter House, Weston Underwood
Olney, Bucks MK46 5JS
BEDFORD (0234) 712445

To book
CLASSIFIED
ADVERTISEMENT
SPACE

Phone
Lucy O'Sullivan
NOW
on
01- 661 3033

Last date for July Issue
June 5th

SERVICES

ANALOG COMPUTERS LIMITED
CAPACITY NOW AVAILABLE FOR:
chartpak stockist

Design & Development, Complete Artwork Service, Camera Work, Prototype thru to Production PCB Manufacture/Assy.

5 Cork Street, Eccles, Maidstone, Kent, ME20 7HG
TELEPHONE (0622) 79987 TELEX 965633
(2348)

CIRCOLEC
THE COMPLETE ELECTRONIC SERVICE

Artwork, Circuit Design, PCB Assembly, Test & Repair Service, Q.A. Consultancy, Prototypes, Final Assembly. Full PCB Flow Soldering Service.
Quality workmanship by professionals at economic prices.
Please telephone **01-646 5686** for advice or further details.

TAMWORTH MANOR
302-310 COMMONSIDE EAST, MITCHAM
(1391)

DESIGN SERVICES. Electro.. design development and production service available for digital and analogue instruments. RF Transmitters and receivers, telemetery and con rol systems. 20 years' experience. R.C.S. Electronics, Wolsey Road, Ashford, Middlesex. Phone Mr Falkner 53661. (8341

DESIGN AND DEVELOPMENT. ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/small batch production. – **Adenmore Limited,** 27 Longshot Estate, Bracknell, Berks. Tel: Bracknell (0344) 52023. (656)

P.C.B.s & PANEL LABELS to your requirements. Design – Prototypes – Production. G. N. SLEE CUSTOM PRODUCTS, 78 Derry Grove, Thurnscoe, Rotherham, Yorks. S63 0TP. Telephone: (0709) 895265. (2401

SMALL BATCH PCBs, produced from your artwork. also DIALS, PANELS, LABELS. Camera work undertaken. FAST TURNAROUND. Details: Winston Promotions, 9 Hatton Place, London EC1N 8RU. Tel. 01-405 4127/0960. (9797)

When replying to classified advertisements, readers are recommended to take steps to protect their interests before sending money
(2519)

EQUIPMENT
REPAIR AND CALIBRATION

FAST, EFFICIENT SERVICE
CONFORMANCE TO NATIONAL STANDARDS

Scopecal
(0932) 245670

A division of:
PROTOTYPE DEVELOPMENT SYSTEMS LTD
Enterprise House, 44-46 Terrace Road
Walton-on-Thames, Surrey KT12 2SD

FOR THE BEST PCB SERVICE AVAILABLE

★ **Circuit Design & Development**
Digital and Analogue

★ **Artwork Layout**
Work of the highest standard by experienced draughtsmen. No minimum charge.

★ **Board Manufacture**
Prototype to semi-production, excellent rates. 24-hour prototype service from filmwork.

★ **Wiring & Assembly**
PCB assembly, wiring and cable forming by qualified staff.

★ **Test**
Full test facilities available.

One or all services available, no order too small. Please telephone Chelmsford (0245) 357935, or write to HCR Electronics, The Industrial Unit, Parker Road, Chelmsford.
HCR
(1169)

ENGINEERING SERVICES, Design/Development, testing of analogue digital systems. Full software/hardware STD Bus/Z80 system design and support available. Contact Nigel Golding on Dartford 23740 or Orpington 25792 and discuss your requirements. (2586)

Thamescity Limited

Electronic (Analog and Digital), electro pneumatic and control systems, R. & D. facilities for long or short run assembly and test to your design or ours at our new Maidstone facility.

5, Cork Street,
Eccles,
Maidstone,
Kent.
Tel. 0622 70497
Telex: 8954665
(2281)

- Layout
- Artwork
- Fast service
- Competitive

pcb design
0386-832152
Williams P.C.B. Artwork, 49 Westbourne, Honeybourne, Evesham, Worcs. WR11 5QT.

CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

To "Wireless World" Classified Advertisement Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

- Rate £3.50 PER LINE. Average six words per line. Minimum £25 (prepayable)
- Name and address to be included in charge if used in advertisement
- Box No. Allow two words plus £5
- Cheques, etc., payable to "IPC Business Press Ltd." and cross "& Co."

NAME ....

ADDRESS ....

....

....

			REMITTANCE VALUE .... ENCLOSED		

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION .... NUMBER OF INSERTIONS ....

COMPUTER APPRECIATION
16 Walton Street, Oxford OX1 2HQ -
Tel: Oxford (0865) 55163

PDP 11/03 SYSTEM comprising LSI11/2 processor with EIS/FIS, 64Kb memory, PERTEC Model 3000 20 megabyte hard disc drive (fully compatible with RK05), DILOG Model DQ100 disc drive controller, HAZELTINE Model 1552 VDU (24 × 80, VT 52 compatible), LEAR SIEGLER Model 200 180cps bidirectional matrix printer. With RT-11 operating system including BASIC etc. & 6 front loading disc cartridges. **£1950.00**
PERTEC Model PCC2000 COMPUTER/WORD PROCESSING SYSTEM. Comprising, 64byte 8085 based processor with green 24 × 80 display, detached keyboard with nemeric & function keypads, twin 8" double or single density floppy disc drives (IBM compatible), RS232 & Centronics interfaces, NEC Model 5500 Spinwriter (55cps daisy wheel printer). Spftware included in the price — CP/M, WORDSTAR, BASIC DATASTAR etc. BRAND NEW **£1250.00**
DICOLL LSI11 SYSTEM comprising, processor with 64kbytes, BALL backplane × PSU (DEC manufactured), DLV11J quad serial interface, dual PERTEC double density floppy disc drives. Contained in compact, attractive portable box. Software includes RT-11 many interesting bits & pieces **£950.00**
DEC Model PDT-100 SYSTEM. Compact unit incorporating LSI11/2 chip set, 64kbyte memory, three RS232 interfaces, twin 8" floppy disc drives. BRAND NEW **£985.00**
OLYMPIA BOSS MICROCOMPUTER. Small Z80 based business system with 80 col. screen, 64kbyte memory, twin 51/4 floppy disc drives, HONEYWELL Model L32 120cps matrix printer **£850.00**
TRANSAM 'TUSCAN' S100 MICROCOMPUTER. NEC D780 (Z80) based machine with 64kbytes of static RAM, twin 5 ' /4" floppy disc drives, NEC green phosphor monitor, RS232 & 8 bit parallel interfaces. S100 software includes CP/M etc. MANUFACTURED 1983 .... **£950.00**
PHILIPS P2000 MICROCOMPUTER. Z80 based machine with 48 kbytes, keyboard with function keypad, integral digital cassette tape drive, Shugart-compatible floppy disc interface, RS232 interface, twin external ROM slot **£195.00**
PHILIPS Model 2123 (EPSON) matrix printer for above. 9 x 9 matrix 80cps bidirectional, 96+ characters **£150.00**
KALLE INFOTEC Model 7 WORD PROCESSOR. Screen based dedicated WP with single 5 1/4" floppy disc drive & QUME Sprint 5 daisy wheel printer (55 cps) with single sheet feeder. ALMOST AS NEW **£950.00**
VISUAL Model 200 VDU. 24 × 80, 9600 Baud etc. with slow scrolling. Externally accessible switches configure for VT52, ADM3A, ADDS520 or HAZELTINE 1500 compatibility. Currently listed at £850. .... **£250.00**
PHILIPS Model P2121 daisy wheel printer (TEC 'Starwriter'). RS232 interface, DIABLO Compatibility, 25 cps bidirectional printing. In good ex-demo condition **£299.00**
CBM Model 8027 daisy wheel printer (Olympia 'Scripta') for PET. 25cps, IEEE interface. BRAND NEW **£350.00**
CBM Model 8024 high speed matrix printer (Tally 1200) for PET. IEEE interface. BRAND NEW **£350.00**
CENTRONICS Model 152.2 matrix printer. 150cps, bidirectional, logic seeking, 66,132,216 column format. Centronics parallel interface **£250.00**
MANNESMANN/TALLY Model M80MC matrix printer. With microprocessor control, 200cps bidirectional printing with U/L case, self test. Compact but heavy duty machine. BRAND NEW & BOXED **£195.00**
CENTRONICS Model 730-2 matrix printer **£95.00**
CENTRONICS Model 702 matrix printer. 132col. 165cps. bidirectional printing with self test. In good ex-demo condition **£285.00**
CENTRONICS Model 779 matrix printer. Similar to above but 80 col **£125.00**
HITACHI metal cased monitor. 12" screen, NEW **£65.00**
DEC boxes & power supplies. Various models available (BA11MF, SB11AA, BA11LX) all with 22 bit addressing or easily modified & with various optional processors etc .... **P.O.A.**
ITT Model 3510 TELEFAX Facsimile transmitter/receiver. Microprocessor controlled (8085) CCITT Group 2 machine for transmitting documents over an ordinary phone line. BRAND NEW & BOXED. .... **£350.00, or £600.00 per pair**
IBM Golfball printer with Z80 controlled IEEE interface for PET. 15cps & takes standard range of heads. (Complete with head) **£150.00**
TEKTRONIX Model T932A 35MHz double beam portable oscilloscope. **£350.00**
TEKTRONIX Model 4601 hard copy unit for 400 series graphics terminals. **£95.00**
TEKTRONIX Model 611 graphics storage display. For use with any DAC computer output **£150.00**
FACIT Model 4020 high speed paper tape reader. Parallel TTL interface. **£225.00**

Please note: • VAT & Carriage extra on all items • Visitors by appointment, please. • Technical manuals are available from us for many items stocked.

CIRCLE 47 FOR FURTHER DETAILS.

ELECTRONICS &
Wireless world

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 91-103

OVERSEAS ADVERTISEMENT AGENTS
France & Belgium: Norbert Hellin, 50 Rue de Chemin Veat, F-9100, Boulogne, Paris.

Hungary: Ms Edit, Bajusz, Hungexpo Advertising Agency, Budapest XIV, Varosliget.
Telephone: 225 008 – Telex: Budapest 22-4525
INTFOIRE

Italy: Sig C. Epis, Etas-Kompass, S.p.a. – Servizio Estero, Via Mantegna 6, 20154 Milan.
Telephone: 347051 – Telex: 37342 Kompass.

Japan: Mr. Inatsuki, Trade Media – IBPA (Japan), B.212. Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106. Telephone: (03) 585 0581.

United States of America: Jay Feinnan, Business Press International Ltd, 205 East 42nd Street, *New York*, NY 10017 – Telephone (212) 867-2080 – Telex: 238327.
Jack Farley Jnr., The Farley Co., Suite 1584, 35 East Walker Drive, *Chicago*, Illionois 60601 – Telephone (312) 63074.
Victor A. Jauch, Elmatex International, P.O. Box 34607, *Los Angeles*, Calif. 90034, USA – Telephone (213) 821-8581 – Telex: 18-1059.
Jack Mantel, The Farley Co., Suite 650, Ranna Building, *Cleveland*, Ohio 4415 – Telephone (216) 621 1919.
Ray Rickles, Ray Rickles & Co., P.O. Box 2028, *Miami Beach*, Florida 33140 – Telephone (305) 532 7301.
Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., *Atlanta*, Georgia 30305. Telephone (404) 237 7432.
Mike Loughlin Business Press International, 15055, Memorial Ste 119, *Houston*, Texas 77079 – Telephone (713) 783 8673.

Canada: Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 – Telephone (416) 364 2269.
* Also subscription agents.

Printed in Great Britain by Index Printers Ltd., Oldhill, Dunstable, and typeset by Legendary Characters, South Street, Lancing, for the proprietors, Business Press International, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. © Business Press International 1984. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd., Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd.: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th Floor, 111 Eighth Avenue, New York, N.Y. 10011.

www.americanradiohistory.com

THE NEW ANTEX TCSU-D

temperature control digital soldering unit

has joined the Antex range advancing the science of soldering

With the New Antex TCSU-D High-Value, high-performance unit. Its simple design incorporates an LED display and a unique ULA integrated circuit, custom-built for Antex by Ferranti.

Tight temperature control can be maintained by setting the station — then removing the knob, preventing any further alteration, for laboratory, for workshop, for production-line. Joins the most sophisticated range of soldering equipment. Irons, bit, stands, units and accessories — each at the forefront of soldering technology. It's just one more advanced from Antex.

For the very latest in the science of soldering send for a catalogue now.

Please send literature and price list to:

Name ________________

Address ________________

____

Telephone ________________

Excluding V.A.T. (15%) and Postage & Packing

Made in England.

Our products are widely distributed by wholesalers and retailers throughout the U.K. Please try your local dealer.

WW6

. . . and keep up to date with the science of soldering from ANTEX

TCSU1 Soldering Station
For safe 24 volt temperature-controlled miniature soldering iron, variable tip temperature 65-430°C, antistatic earth connection, with XSTC or CSTC iron.
R.R.P £59.50

ST4 Stand
R.R.P. £1.90

Model C
— 15 Watts
Stainless steel shaft only.
240 and 115 volts
R.R.P. £5.60
50 and 24 volts
R.R.P. £5.80

Model CS

Model XS

SK5 Soldering Kit
Contains model CS230 iron and the ST4 stand
R.R.P. £8.00

SK6 Soldering Kit
Contains model XS230 iron and the ST4 stand
R.R.P. £8.10

SK5-BP and **SK6-BP**
Soldering Kits
Fitted with safety plugs
SK5-BP kit R.R.P. £10.10
SK6-BP kit R.R.P. £10.10

TCSU-D
temperature control digital

TCSU-D temperature control digital soldering unit.
● Temperature range — ambient to 495°C. ● Bit temperature maintained to ± 5°C. ● Zero crossing switching ● Detachable sponge-tray and includes the world-famous ANTEX Iron. R.R.P. £69.95

Model XS
— 25 Watts
Available for 240 and 115 volts
R.R.P. £5.90
50, 24 and 12 volts
R.R.P. £6.10

Model XS-BP
— 25 Watts
Fitted with safety plug 240 volts
R.R.P. £7.90

Model CS
— 17 Watts
Available for 240 and 115 volts
R.R.P. £5.80
50, 24 and 12 volts
R.R.P. £6.00

Model CS-BP
— 17 Watts
Fitted with safety plug 240 volts
R.R.P. £7.80

A N T E X

ANTEX (Electronics) Ltd.,
Mayflower House, Plymouth, Devon. Telephone: 0752 667377 Telex: 45296

CIRCLE 002 FOR FURTHER INFORMATION

P8000 – THE PRODUCTION PROGRAMMER THAT HANDLES ALL NMOS EPROMS

NEW PRODUCT

2704
2708
2716(3)
2508
2758A
2758B
2516
2716
48016
2532
2732
2732A
68732-0
68732-1
68766
68764
2764
2564
MK2764
25128
27128

- Checks, Programs, Compares up to 8 devices simultaneously
- Handles all NMOS EPROMS up to projected 128K designs with no personality modules or characterisers – See list
- Easy to use, menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
- Constant display of device type, mode and fault codings
- Individual socket LED indicators for EPROM status
- Comprehensive EPROM integrity checks – Illegal bit check, data and address shorts, constant power line monitoring
- Full safeguard protection on all sockets
- Automatic machine self-test routine
- RS232C interface supplied as standard
- Powered down sockets
- Cost effective price – £695 + VAT
- Available from stock

Write or phone for more details

DISTRIBUTORS REQUIRED ● EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

Tel: Plymouth (0752) 332961
Telex: 42513

Unit E, Huxley Close, Newnham Industrial Estate, Plymouth PL7 4JN

CIRCLE 003 FOR FURTHER INFORMATION