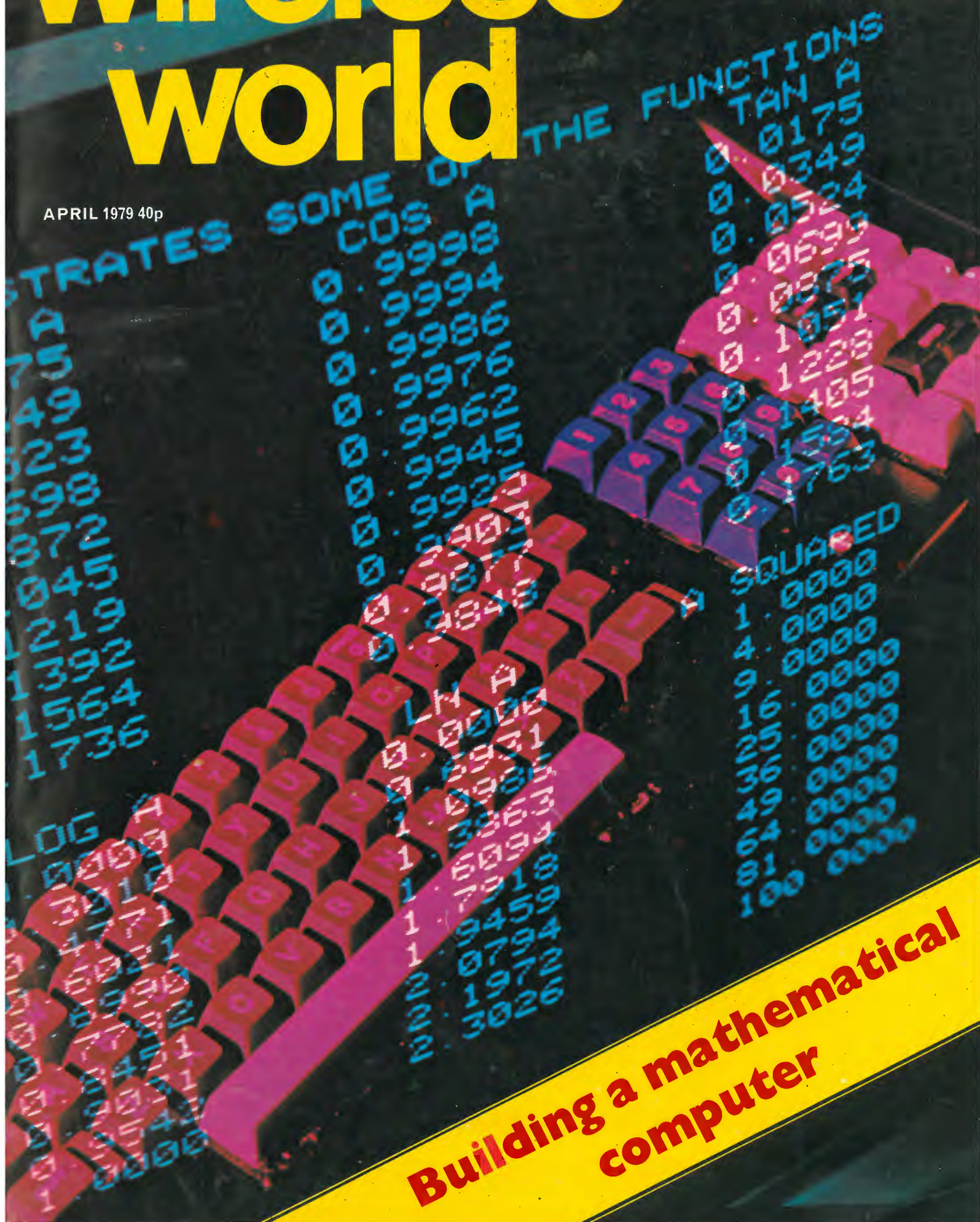


wireless world

Australia SA1.25
Canada \$1.75
Denmark Kr. 11.00
Germany Dm. 4.00
Greece Dr. 47.00
Holland Dfl. 4.50
Italy L. 1100
New Zealand SNZ 1.50
Norway Kr. 11.00 incl. moms.
Singapore M \$3.25
Spain Ptas. 80.00
U.S.A. \$1.65

APRIL 1979 40p



Building a mathematical computer

high quality

Multicore solder helps Europe's OTS-2 satellite orbit at 23,000 miles

OTS-2, a forerunner of a European communications satellite, was launched from Cape Canaveral on May 11th 1978.

Now orbiting the equator at a height of 23,000 miles, OTS-2 was built for the European Space Agency by the MESH consortium, led by British Aerospace Dynamics Group, Stevenage.

In building OTS-2, complete precision was called for. Which is why Ersin Multicore solders were used for many of the soldering operations.

Quite simply, Multicore solders have *that* kind of reputation. For quality, toughness and reliability. That's why so many electronics manufacturers won't use anything else.

Next time you need solder of any kind, aim as high as OTS-2... and use Multicore.

Full details of Ersin Multicore solders, solder chemicals and high purity-bar solders for automatic soldering from



Multicore Solders Ltd
Maylands Avenue
Hemel Hempstead Herts HP2 7EP
Tel: Hemel Hempstead 3636
Telex: 82363

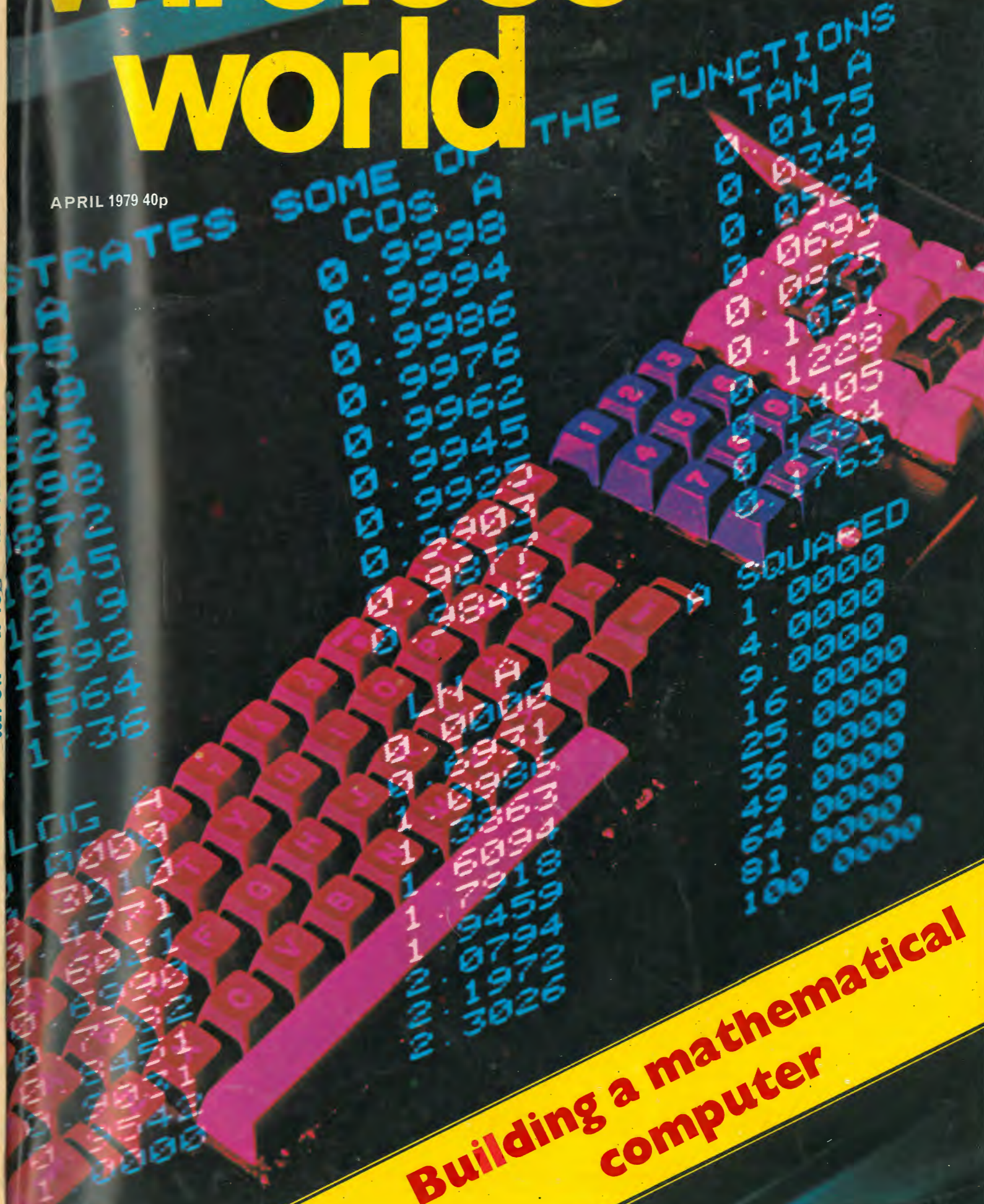


wireless world

APRIL 1979 40p

WIRELESS WORLD APRIL 1979 VOL 85 NO 1520

Australia SA1.25
Canada \$1.75
Denmark Kr. 11.00
Germany Dm. 4.00
Greece Dr. 47.00
Holland Dfl. 4.50
Italy L. 11.00
New Zealand \$NZ 1.50
Norway Kr. 11.00 incl. posts
Singapore M \$3.25
Spain Ptas. 80.00
U.S.A. \$1.65



Building a mathematical computer



A Synthesized Signal Generator from mi

£8,000? £6,000? £4,000? under £2,000?

Somehow some of our customers have been persuaded that our prices are as big as we are. Sometimes the biggest brains are the most cost-conscious brains. For example, our illustration shows a synthesized signal generator which costs £1,900*: the new 520MHz TF2015/1 Signal Generator with its associated Synchronizer. With this combination, synthesizer operation is obtainable without any degradation of generator signal purity, performance and versatility.

Leakage specification is lower than any other available VHF/UHF source and output accuracy at low levels beats all others in the price range.

Building on the enviable reputation of the TF2015 for performance, reliability and value, we have now introduced two new a.m./f.m. versions: the TF2015/1 for narrow band mobile radio testing and TF2015/2 for telemetry and other wideband applications. The U.K. price for TF2015/2 with Synchronizer is £2,150*. All have a frequency coverage of 10 to 520MHz with calibrated a.m. and f.m.

Tuning in 100Hz steps whilst under locked conditions provides a valuable facility for bandwidth measurements and channel stepping. Digital setting of frequency with direct readout means no waiting for counter gate times when you want high resolution, and no r.f. leakage from display holes.

*Special U.K. price

One in four

Only one in four of our customers tells us he needs the stability of a synthesizer. So the other three can save almost half the cost of the synthesizer combination by buying the analogue part alone. So, whether you require a synthesizer or a signal generator you can now obtain quality at ordinary prices.

Optional accessories include Pulse Modulator TF2169, i.f. probes for 'squelch killing', multiple calibration plates for units of output level, matching pads, attenuators, reverse power protection and carrying case.

Write or 'phone for full details:

mi MARCONI INSTRUMENTS

Marconi Instruments Limited · Longacres · St. Albans · Hertfordshire · England AL4 0JN · Tel: (0727) 59292 · Telex: 23350

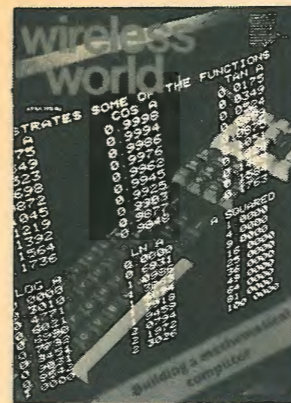
Marconi Electronics Inc · 100 Stonehurst Court · Northvale · New Jersey 07647 USA · Tel: (201) 767-7250 · Twx: 710-991-9752

Marconi Instruments · 32 avenue des Ecoles · 91600 Savigny-Sur-Orge · France · Tél: 996.03.86 · Télex: 600541.F

Marconi Messtechnik GmbH · 8000 München 21 Jörgstrasse 74 · West Germany · Tel: (089) 58 20 41 · Telex: 5 212642

A GEC-Marconi Electronics Company

WWW.MI FOR FURTHER DETAILS



Front cover shows the prototype keyboard of the scientific computer together with a display of trigonometric values. Part 1 of the constructional design starts in this issue.

IN OUR NEXT ISSUE

Converting between analogue and digital quantities — 1 is the first part of a series of articles on this topical subject, starting with a discussion of digital codes.

Acoustic breakthrough in record players. Measurements of the sensitivity of the pickup/arm/turtable combination to loudspeaker sound in various operating conditions.

Current issue price 40p, back issue (if available) 50p. at Retail and Trade Counter, Paris Garden, London SE1. Available on microfilm, please contact editor.

By post, current issue 55p, back issues (if available) 50p, order payments to Room CP34, Dorset House, London SE1 9LU.

Editorial & Advertising offices: Dorset House, Stamford Street, London SE1 9LU.

Telephones: Editorial 01-261 8620. Advertising 01-261 8339.

Telegrams/Telex: Wivorld Bispres 25137 BISPRS G. Cables. Ethaworld, London SE1.

Subscription rates: 1 year. £7.00 UK and \$23.40 overseas (\$24 USA and Canada).

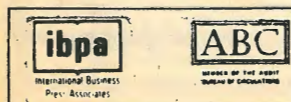
Student rate: 1 year, £3.50 UK and £4.50 overseas (\$11.70 USA and Canada).

Distribution: 40 Bowling Green Lane, London EC1R 0NE. Telephone 01-837 3636.

Subscriptions: Oakfield House, Perrymount Road, Haywards Heath, Sussex. RH16 3DH. Telephone 0444 59188. Please notify a change of address.

USA mailing agents: Expeditors of the Printed Word Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022. 2nd-class postage paid at New York.

© IPC Business Press Ltd, 1979
ISSN 0043 6062



wireless world

ELECTRONICS/TELEVISION/RADIO/AUDIO

APRIL 1979 Vol 85 No 1520

43 **Micromania**

44 **Scientific computer**
by J. H. Adams

48 **Literature received**

49 **Simplified distortion measurements**
by F. Butler

53 **Teletext remote control**
by R. T. Russell

56 **Books received**

57 **Digital data recording without f.s.k**
by B. T. Evans

62 **Circuit ideas**
Mosfet input power amp / Hexadecimal display / Noise-reduction system

64 **News of the month**

66 **Novatexts — Linear ramp generators**
by P. Williams

68 **Low-cost logic analyser**
by B. C. Adams

71 **Letters to the Editor**
Medium wave spurious / Computer buses / Birds' geomagnetic sense

77 **H.f. amateur-band frequency synthesizer — 2**
by M. Small

82 **Police communications**

83 **Motor speed controller**
by J. D. Stumbles

89 **World of amateur radio**

90 **Functional logic symbols**
by G. M. Whittaker

95 **New products**

WILMSLOW AUDIO

The firm for Speakers

HI-FI DRIVE UNITS



PA GROUP & DISCO UNITS



WILMSLOW AUDIO

KITS FOR MAGAZINE DESIGNS etc.

SPEAKER KITS



HD12 9D25	£6.00	Tannoy HPD 385A	£105.00
HD13 D34H	£12.00	Tannoy HPD 315A	£87.50
HD20 B25J4 25	£9.45	Tannoy HPD 385A	£105.00
HD20 B25H4	£11.98	Baker Group 25	£13.00
HD11 P25EBC	£5.56	Baker Group 35	£14.50
Baker Superb	£22.50	Baker Group 50/12	£21.00
Castle 8RS/DD	£12.35	Baker Group 50/15	£33.00
Chartwell CE205 8" bass, matched pairs only	£59.90	Celestion G12M	£13.50
Coles 4001	£6.25	Celestion G12H	£17.95
Coles 3000	£6.25	Celestion G18C	£41.95
Celestion HF1300 II	£8.25	Celestion G12/75	£22.50
Celestion HF2000	£9.95	(alum. dome)	£24.50
Dalesford D10 tweeter	£8.25	Celestion G12/75 (d/cone)	£22.50
Dalesford D30/110 5"	£10.95	Celestion G12M/50	£16.95
Dalesford D50/153 6 1/2"	£11.95	(cambric edge)	£32.50
Dalesford D50/200 8"	£11.95	Celestion G15/100	£13.50
Dalesford D70/250 10"	£24.95	(alum. dome)	£45.95
Dalesford D100/310 12"	£34.95	Celestion MH1000	£48.95
Decca London	£41.25	Celestion Powercell 12 / 100	£51.95
Decca CO/1000/8	£8.95	Celestion Powercell 15 / 100	£10.95
Decca DK30	£27.50	Celestion Powercell 15 / 125	£12.50
E.M.I. type 350 4 ohm	£9.25	Fane Pop 40	£12.50
E.M.I. 14A/770 14" x 9"	£16.95	Fane Pop 50H	£16.95
E.M.I. 8" x 5" d/c 10 watt	£3.95	Fane Pop 75	£19.95
Isophon KK10/8	£8.25	Fane Pop 65	£21.95
Isophon KK8/8	£7.50	Fane Pop 80	£35.95
Jordan Watts Module	£17.95	Fane Pop 100	£6.50
Jordan 50mm Unit	£22.50	Fane J44 horn	£13.75
Jordan CB Crossover	£22.50	Fane J104 horn	£9.75
KEF T27	£8.50	Fane J73 horn	£19.75
KEF B110	£10.95	Fane Guitar 80L	£19.95
KEF B200	£11.95	Fane Guitar 80B	£21.50
KEF B139	£24.95	Fane Disco 80	£19.50
KEF DN13	£4.95	Fane PABO	£29.95
KEF DN12	£7.25	Fane Bass 85	£42.95
KEF DN22 pair	£36.00	Fane Crescendo 12A	£44.95
Lowther PM6	£49.95	Fane Crescendo 12B	£54.95
Lowther PM6 MKI	£52.00	Fane Crescendo 15/100	£64.95
Lowther PM7	£86.50	Fane Crescendo 15/125	£75.95
Peerless DT10HFC	£9.75	Fane Crescendo 18	£45.95
Peerless K010DT	£8.95	Fane 920 II Horn	£2.50
Peerless K040MRF	£11.75	Fane HPX1/HPX2	£4.25
Radford BD25 II	£26.95	Goodmans 8PA	£19.75
Radford MD9	£14.50	Goodmans 12P	£22.50
Radford MD6	£19.50	Goodmans 12PD	£21.25
Radford FN8/FN831	£19.95	Goodmans 12PG	£45.50
Richard Allan CG8T	£9.95	Goodmans 18P	£20.50
Richard Allan CG12T Super	£22.45	Goodmans 50HX	£22.95
Richard Allan HP8B	£15.50	McKenzie C1280	£32.95
Richard Allan LP8B	£10.35	McKenzie GP15	£32.95
Richard Allan HP12B	£25.25	McKenzie TC15	£55.95
Richard Allan DT20	£7.25	McKenzie CG15 Bass	£8.50
Richard Allan DT30	£7.45	Motnrola Piezo Horn	£14.50
Seas HO86	£8.75	Richard Allan HD8T	£15.75
Shackman Electrostatic C/W polar network & X/O pair	£112.00	Richard Allan HD10T	£20.95
Tannoy HPD 295A	£78.00	Richard Allan HD12T	£36.95
Tannoy 315A	£87.50	Richard Allan HD15	£37.95
		Richard Allan HD15T	

Kits include drive units, crossovers, BAF/Long fibre wool, etc. for pair of speakers. Carriage £3.50

Practical HiFi & Audio PR09-TL (Rogers) £118.00
Felt panels for PR09-TL £5.50 + £1.50 p&p
HiFi Answers Monitor (Rogers) £129.00

HiFi News State of the Art (Atkinson) £161.00
Popular HiFi Mini Monitor (Colloms) £63.00
Popular HiFi Round Sound (Stephens) including complete cabinet kit £69.00
Popular HiFi (Jordan) £91.00

Practical HiFi & Audio Monitor (Giles) £119.00
Practical HiFi & Audio Triangle (Giles) £86.00
Practical HiFi & Audio BSC3 (Rogers) £60.00
Practical HiFi Mini Triangle (Giles) £99.00

HiFi News Miniline (Atkinson) £43.00
HiFi News Tabor (Jones) £51.95
HiFi News Tabor (with H4 bass units) £55.00
Wireless World T.L./KEF (Bailey) £112.00
Wireless World T.L./Radford (Bailey) £154.00

Seas Mini £17.90
Seas 203 £35.50
Seas 302 £43.90
Seas 303 £73.90
Seas 503 £119.90

Wharfedale Denton 2XP £26.95
Wharfedale Linton 3XP £41.95
Wharfedale Glendale 3XP £56.95

Richard Allan Maramba T.R.8 £61.50
Richard Allan Charisma T.R.12 £90.00
Richard Allan Super Triple £73.00
Richard Allan RAB £46.50
Richard Allan RA82 £74.00
Richard Allan RA82L £79.95

SMART BADGES FREE WITH ALL ABOVE KITS (TO GIVE THAT PROFESSIONAL TOUCH TO DIY SPEAKERS!)

Send 3 x 7p stamps for reprints/construction details of any of above designs.

CARRIAGE & INSURANCE	
Tweeters/Crossovers	40p each
Speakers up to 10"	75p each
Speakers 12"	£1.50 each
Speakers 15"	£2.50 each
Speakers 18"	£3.50 each
Speaker Kits	£2.50 pair
Mag. design kits	£3.50 pair

Prices per pair. Carriage £2.50.

Dalesford System 1 £52.90
Dalesford System 2 £55.75
Dalesford System 3 £101.75
Dalesford System 4 £108.00
Dalesford System 5 £139.00
Dalesford System 6 £93.00

Eagle SK210 £15.00
Eagle SK215 £29.00
Eagle SK320 £37.00
Eagle SK325 £67.00
Eagle SK335 £91.00

Kef Kit I £59.50
Lowther PM6 Kit £103.00
Lowther PM6 MKI Kit £173.00

Peerless 1060 £71.95
Peerless 1120 £139.00
Peerless 2050 £49.95
Peerless 2060 £65.95

Radford Studio 90 £154.00
Radford Monitor 270 £208.00
Radford Studio 270 £275.00
Radford Studio 360 £390.00
RamKit 50 (makes Ram 100) £69.95
Richard Allan Tango Twin Assembly £43.50

Richard Allan Maramba T.R.8 £61.50
Richard Allan Charisma T.R.12 £90.00

Richard Allan Super Triple £73.00
Richard Allan RAB £46.50
Richard Allan RA82 £74.00
Richard Allan RA82L £79.95

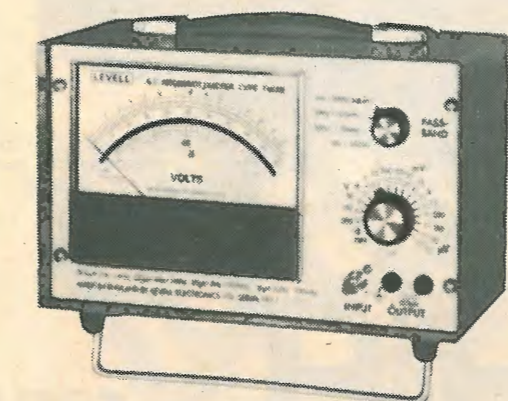
Seas Mini £17.90
Seas 203 £35.50
Seas 302 £43.90
Seas 303 £73.90
Seas 503 £119.90

Wharfedale Denton 2XP £26.95
Wharfedale Linton 3XP £41.95
Wharfedale Glendale 3XP £56.95

Everything in stock for the speaker constructor!
BAF, long fibre wool, foam, crossovers, felt panels, components, etc.
Large selection of grille fabrics.
(Send 15p in stamps for fabric samples)
(Prices correct at 1/1/79)



DON'T GAMBLE WITH PERFORMANCE BUY LEVELL VOLTMETERS



A.C. MICROVOLTMETERS

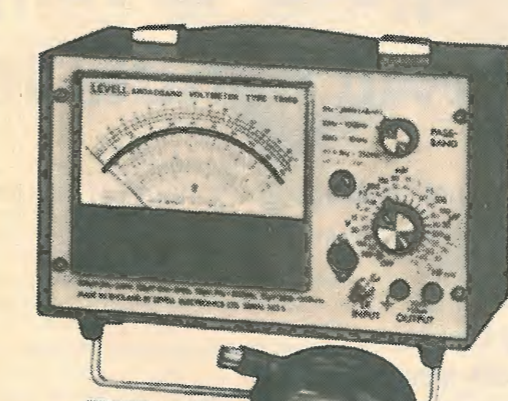
VOLTAGE & dB RANGES 15µV, 50µV, 150µV... 500V fsd.
Acc. ± 1% + 1% fsd + 1µV at 1kHz.
-100, -90... +50dB.
Scale -20dB / +6dB ref. 1mW / 600Ω.

RESPONSE ± 3dB from 1Hz to 3MHz,
± 0.3dB from 4Hz to 1MHz above 500µV.
TM3B filter switch: LF cut 10Hz,
HF cut 100KHz, 10KHz or 350Hz.

INPUT IMPEDANCE Above 50mV: 10MΩ < 20pF.
On 50µV to 50mV: > 5MΩ < 50pf.

AMPLIFIER OUTPUT 150mV at fsd.

type TM3A £110 type TM3B £120



BROADBAND VOLTMETERS

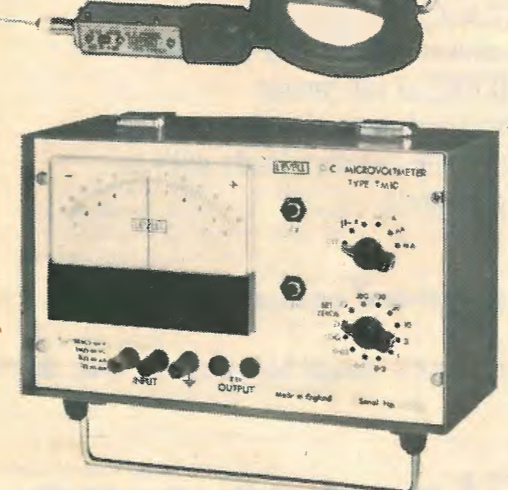
H.F. VOLTAGE & dB RANGES 1mV, 3mV, 10mV... 3V fsd.
Acc. ± 4% ± 1% fsd at 30MHz.
-50, -40... +20dB.
Scale -10dB / +3dB ref. 1mW / 50Ω.

H.F. RESPONSE ± 3dB from 300kHz to 400MHz.
± 0.7dB from 1MHz to 50MHz.

L.F. RANGES As TM3.

AMPLIFIER OUTPUT Square wave at 20Hz on H.F. with amplitude proportional to square of input.
As TM3 on L.F.

type TM6A £170 type TM6B £180



D.C. MICROVOLTMETERS

VOLTAGE RANGES 30µV, 100µV, 300µV... 300V.
Acc. ± 1% + 2% fsd + 1µV. CZ scale.

CURRENT RANGES 30pA, 100pA, 300pA... 300mA.
Acc. ± 2% + 2% fsd + 2pA. CZ scale.

LOG. RANGE ± 5µV at ± 10% fsd, + 5mV at ± 50% fsd,
± 500mV at fsd.

RECORDER OUTPUT ± 1V at fsd into > 1kΩ.

type TM10 £90

Fully details specification sheets are available on request for our complete range of portable instruments. Prices are ex-works, carriage, packing and VAT extra. Optional extras are leather cases and power units.

LEVELL ELECTRONICS LTD.

MOXON STREET, BARNET, HERTS., EN5 5SD.
TEL: 01-449 5028/440 8686

SWIFT OF WILMSLOW
The firm for Hi-Fi
5 Swan Street,
Wilmslow, Cheshire.

Send 15p stamp for free 38 page catalogue 'Choosing a Speaker'

Telephone: Speakers, Mail Order and Export:
0625 529599. Hi-Fi: 0625 526213
Lightning service on telephoned credit card orders!

WILMSLOW AUDIO
The firm for Speakers
Swan Works, Bank Square,
Wilmslow, Cheshire.

THINK OF A SHAPE



S 500D — dual channel up to 500W/RMS per channel DC-20 KHZ

Whatever it is, the **H||H** 'S' range of power amplifiers will handle it

The **H||H** 'S' range is designed to handle heavy industrial usage in the fields of vibrator driving, variable frequency power supplies and servo motor systems.

S 500D
Dual Channel
19" rack mount 3½" high
500w r.m.s. into 2.5 ohms per channel
900w r.m.s. in bridge mode
DC-20 KHZ at full power
0.005% harmonic distortion (typical) at 300w r.m.s. into 4 ohms at 1 KHZ
3KW dissipation from in-built force cooled dissipators

S 250D
Single Channel
19" rack mount 3½" high
500w r.m.s. into 2.5 ohms
Retro-convertible to dual channel
DC-20 KHZ at full power
Full short and open circuit protection
Drives totally reactive loads with no adverse effects

A complete range of matching transformers and peripheral equipment for closed loop, constant current and voltage use are available.
Alternative input and output termination to order. Rack case for bench use built to specifications. For complete data write or call.



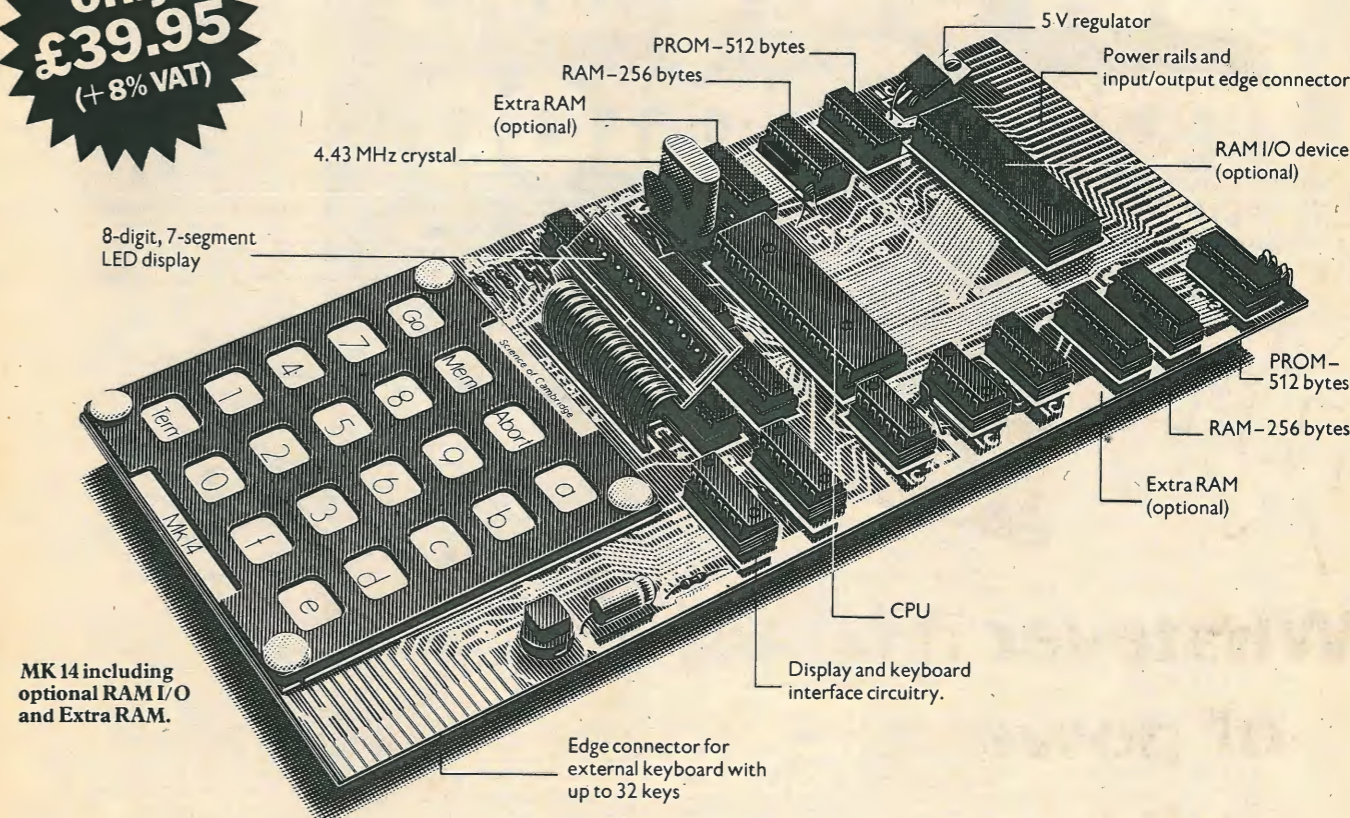
Kirkham Electronics

MILL HALL, MILL LANE, PULHAM MARKET, DISS, NORFOLK IP21 4XL
DIVISION OF K.R.S. LIMITED
TELEPHONE (037 976) 639/594

FRANCHISED COMMERCIAL AND INDUSTRIAL AGENTS FOR **H||H** ELECTRONIC
WW-029 FOR FURTHER DETAILS

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer - in kit form.

only
£39.95
(+ 8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory — and peripherals!

Optional extras include:

1. Extra RAM-256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module - which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool — and a training aid

As a computer, it handles operations of all types - from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid - providing an ideal introduction to computer technology.

SPECIFICATIONS

- Hexadecimal keyboard
- 8-digit, 7-segment LED display
- 8 x 512 PROM, containing monitor program and interface instructions
- 256 bytes of RAM
- 4 MHz crystal
- 5 V regulator
- Single 8 V power supply
- Space available for extra 256-byte RAM and 16 port I/O
- Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Please send me the following, plus details of other peripherals:

- MK 14 Standard Microcomputer Kit " £43.55 (inc 40p p&p.)
- Extra RAM " £3.88 (inc p&p.)
- RAM I/O device " £8.42 (inc p&p.)

I enclose cheque/money order/PO for £_____ (indicate total amount.)

Name _____

Address (please print) _____

Allow 21 days for delivery.

Science of Cambridge

ww/4

WW-007 FOR FURTHER DETAILS

More second user bargains from Carston

Top Quality Test Equipment at the keenest prices

Acoustic	Prices from £	Modulation Meters	Prices from £	Pulse Generators	Prices from £
BRUEL & KJAER		RADIOMETERS		E. H. RESEARCH	
2203 Precision sound level meter	400	AFM1 AM/FM modulation meter	205	G710 5V/50 Ω 30 Hz-50 MHz RT 5 ns	100
2204 Precision sound level meter	475	Oscilloscopes		132AL 50 V/50 Ω 5 Hz-3 MHz RT 12 ns	175
1613 Octave filter set couples directly to 2203 & 2204	250	ADVANCE	265	LYONS INSTRUMENTS	
CEL		OS1000 DC-15 MHz dual trace		PG2E 10 V/50 Ω 1 Hz-16 MHz RT 10 ns	130
112 LEQ meter-digital readout	575	HEWLETT PACKARD		PG23 10 V/50 Ω 1 Hz-10 MHz RT 5 ns	135
Bridges		184A + 1801A + 1822A DC-50 MHz system, T.B. and amplifier included, storage facility (storage de-rated please ask for details)	650	SYSTRON DONNER	
CAMBRIDGE		LANSCOPE		101 10 V/50 Ω 10 Hz-10 MHz RT 5 ns	95
43379 Decade resistance bridge	75	419A Display oscilloscope 4 trace	200	110B 10 V/50 Ω 5 Hz-50 MHz RT 4 ns	195
MUIRHEAD		PHILIPS		Recorders & Signal Conditioning Equipment	
D30A Wheatstone bridge test set	175	PM3232 DC-10 MHz dual trace	375	BRUNO WOELKE	
SULLIVAN		TEKTRONIX		ME102B Wow and flutter meter	120
T1098 Decade resistance bridge	190	3A74 4 channel amplifier for 560 series	285	ME102C Wow and flutter meter	150
WAYNE KERR		453A DC-60 MHz dual trace	750	BRUSH	
B221 Universal bridge	180	545B + CA DC-24 MHz dual trace system	350	260 Six channel 80 Hz response, ink writing	2400
B601Z RF bridge to 5 MHz	475	5103/D11 + 5A18 + 5L4 Spectrum analyser and storage system	1950	BRUEL & KJAER	
SR268 Source for B601Z		20 Hz-100 kHz		2305B Stylus Recorder includes 50 db pot	650
Cable Test Equipment		5103N/D13 + 5A18N + 5B12N Storage system 20 div/ms DC-2 MHz	675	HEWLETT PACKARD	
MARCONI		5103N/D15 + 5A18N + 5B12N Storage system 800 div/ms DC-2 MHz	595	7035B 8 1/2" x 11" 0.4 mV-4 V/cm	500
TF2091A/TF2092A White noise generator/receiver 300 channel system complete	550	5A21N DC-1 MHz differential	95	17502A Plug-in for 7100 series recorder temperature module	75
SIEMENS		7A13 DC-100 MHz differential comparator	350	METRAWATT	
3W518/3D335 Cable test oscillator and voltmeter 10 kHz-17 MHz	310	7B70 Dual time base with 7B71 delayed sweep (for 7000 series)	275	RA6 6 channel UV with conditioning amplifiers	695
STC		TELEQUIPMENT		NAGRA	
74226B Telephone cable test set	350	D54 DC-10 MHz dual trace	275	IVD Portable tape recorder	950
WANDEL AND GOLTERMAN		Oscilloscope Probes - Current		SE LABS	
TFPM43 Cable test voltmeter 10 kHz-14 MHz	90	TEKTRONIX		3006DLT 12 channels UV 6 inch chart	450
Counter Timers		P6021 AC current probe to 20 MHz	220	A1000 Galvo 600 Hz 0.34 mA/cm	30
HEWLETT PACKARD		P6022 AC current probe to 150 MHz	240	MICROMOVEMENTS	
5253B Converter plug-in to 512 MHz	380	Oscilloscope Probes - Voltage		M100 Galvo 60 Hz 2.5 μA/cm	25
5263A Time interval plug-in	60	HEWLETT PACKARD		M400 Galvo 300 Hz 50 μA/cm	25
MARCONI		1121A 500 MHz	90	M1000 Galvo 600 Hz 0.34 mA/cm	25
TF2414A DC-40 MHz 7 digits	170	TEKTRONIX		M1600 Galvo 1000 Hz 0.4 mA/cm	25
TF2422 Frequency divider to 300 MHz	50	P6032 Sampling probe kit	15	M8000 Galvo 5 kHz 15.5 mA/cm	25
RACAL		P6046 Differential probe DC-100 MHz	250	SMITHS	
9024 10 Hz-600 MHz 7 + 1 digits	325	Oscilloscope Cameras		RE520.20 2 pen potentiometric roll chart	385
9059 DC-560 MHz with battery pack	300	HEWLETT PACKARD		RE551.20 X-Y1 Y2 plotter A3 time base fitted	575
9835 DC-15 MHz 6 digits	175	195A Pack film polaroid	285	SIEMENS	
9837 DC-80 MHz 6 digits	245	198A Pack film polaroid	145	Oscillostore 4 channel digital storage system with UV recorder	3300
Function Generators		HEWLETT PACKARD		KOMP III 2 pen potentiometric roll chart	575
HEWLETT PACKARD		C30AR Roll film polaroid	130	Signal Sources & Generators	
3300A 0.01 Hz-100 kHz sine, square triangular	150	C31A Roll film polaroid	135	HEWLETT PACKARD	
3301 Auxiliary plug-in		Power Meters		200CD 5 Hz-600 kHz O/P 10 V RMS	75
Insulation Testers		HEWLETT PACKARD		608E 10 MHz-480 MHz AM	410
EDGCUMBE		432A/478A 10 MHz-1.2 GHz wideband with bolometer	350	0.1 μV-1 V/O/P	525
Metrohm Hi resistance test set	50	Power Supplies		8693/100 3.7-8.3 GHz 5 mW, sweeper plug-in	
Logic Analysers		DANA	5	LEVELL	
HEWLETT PACKARD		Battery Pack for use with 3800 series		TG150DM 1.5 Hz-150 kHz 2.5 V	45
1601L Logic state analyser 12 channel display	1050	FARNELL		MARCONI	
SPECTRUM DYNAMICS		TSV70 DC stab. variable 70 V/5 A	140	TF1370A 10 Hz-10 MHz 3 mV-3 V O/P	160
550 Universal programmer/verifier for ROMs	1550	HEWLETT PACKARD		TEXSCAN	
Mains Monitors		6265B DC stab. variable 40 V/3 A	195	VS40 1-300 MHz sweeper	450
AMPROBE		6267B DC stab. variable 40 V/10 A	215	VS80A 1-1000 MHz sweeper	650
LAV2X Mains voltage recorder	45	6269B DC stab. variable 40 V/50 A	350		
LAV3X Mains voltage recorder	45	SYSTRON DONNER			
LAV4X As LAV3X with suppressed zero	50	LNG 16-10 16 V/10 A variable	95		
GEC		Pressure & Displacement Transducers			
FB31A Surge monitor records mains spikes + filter	85	ELECTRO MECHANISMS			
RUSTRAK		LVDI DC linear variable ± 0.50 inches	25		
288 + CT Clamp-on AC recording ammeter	110	SCHAEVITZ			
Microwave		P700 Pressure sensor 250 psi	30		
HEWLETT PACKARD					
423A Crystal detector	65				
X382A Attenuator 'X' band	220				
788C Directional detector	145				

T.V. Test Equipment	Prices from £
MARCONI	
TF2909 Gray scale generator	350
Temperature & Humidity	
AMPROBE	
T8650 Recording thermometer	50
12"/hr chart speed	
COMARK	
1604BLU Analogue thermometer	55
0-100°C	
DARTRON	
82 Thermohygrograph	45
LEE-DICKENS	
HP5 Humidity probe	130
HUMIGUN Temp/humidity probe with meter	215
RAYTEK	
T1000 Infra-red thermoprobe	275
Voltmeters - Analogue	
AVO	
9 AC/DC/Ω	50
BRADLEY	
CT471C AC/DC/Ω/current multimeter	350
HEWLETT PACKARD	
427A AC/DC/Ω multimeter	295
3406A 10 kHz-1.2 GHz	395
KEITHLEY	
610B Electrometer recorder O/P	330
LINSTEAD	
M2B DC/AC 10 Hz-500 kHz	50
MARCONI	
TF2603 AC voltmeter to 1.5 GHz	375
NORMA	
U-Function Dual channel peak/RMS meter	495
PHILIPS	
PM2454B AC voltmeter to 12 MHz	300
PYE	
11320 Scalamp galvo 10 mV-300 V	10
Voltmeters - Digital	
ADVANCE	
DMM3 1999 FSD AC/DC/Ω/current	85
DANA	
5230 119999 FSD AC/DC	175
BOONTON	
93A 20 Hz-20 MHz true RMS	285
FLUKE	
8300A 119999 FSD DC only	150
8300A OP1 119999 AC/DC	185
HEWLETT PACKARD	
3474/2 9999 FSD AC/DC/Ω	215
SOLARTRON	
A200 19999 FSD DC only	200
A205 19999 FSD AC/DC/Ω	300
A215 199999 FSD AC/DC/Ω	475
LM1867 101999 FSD DC only	175
Wave Analysers	
HEWLETT PACKARD	
302A 20 Hz-50 kHz 75 db range	550

Redundant Test Equipment	Prices from £
Why not turn your under-utilized test equipment into cash? Ring us and we'll make you an offer.	
3006DLT 12 channels UV 6 inch chart	450
A1000 Galvo 600 Hz 0.34 mA/cm	30
MICROMOVEMENTS	
M100 Galvo 60 Hz 2.5 μA/cm	25
M400 Galvo 300 Hz 50 μA/cm	25
M1000 Galvo 600 Hz 0.34 mA/cm	25
M1600 Galvo 1000 Hz 0.4 mA/cm	25
M8000 Galvo 5 kHz 15.5 mA/cm	25
SMITHS	
RE520.20 2 pen potentiometric roll chart	385
RE551.20 X-Y1 Y2 plotter A3 time base fitted	575
SIEMENS	
Oscillostore 4 channel digital storage system with UV recorder	3300
KOMP III 2 pen potentiometric roll chart	575
HEWLETT PACKARD	
200CD 5 Hz-600 kHz O/P 10 V RMS	75
608E 10 MHz-480 MHz AM	410
0.1 μV-1 V/O/P	525
8693/100 3.7-8.3 GHz 5 mW, sweeper plug-in	
LEVELL	
TG150DM 1.5 Hz-150 kHz 2.5 V	45
MARCONI	
TF1370A 10 Hz-10 MHz 3 mV-3 V O/P	160
TEXSCAN	
VS40 1-300 MHz sweeper	450
VS80A 1-1000 MHz sweeper	650

Redundant Test Equipment
Why not turn your under-utilized test equipment into cash? Ring us and we'll make you an offer.

JUST AVAILABLE

Acoustic
Brue & Kjaer
1614 Third octave
filter **£1000**

Oscilloscopes
Dynamco
7200/02/12 DC-15 MHz
2 ONLY AS NEW **£295**

Hewlett Packard
1707B/20 DC-75 MHz
3 ONLY **£780**

Tequipment
D83/V4/S2A DC-50 MHz
2 ONLY **£450**

Contact David Kennedy or Kathy Goodman

01-267 4257

Carston Electronics Limited,
Shirley House, 27 Camden Road,
London NW1 9NR. Telex: 23920

Our catalogue even includes some popular car accessories at marvellous prices.

A vintage 160W per channel stereo tuner to build yourself. Full specification in our catalogue.

Speakers from 1 1/4 inch to 16 inch; megaphone, PA horns, crossovers etc. They're all in our catalogue. Send the coupon now!

Our catalogue describes a wide range of plugs and sockets, all at marvellous prices. See cat. pages 114 to 123 for details.

61-note touch-sensitive piano to build yourself. Full specification in our catalogue.

These are just some of the metal cases we stock. There are dozens of plastic ones to choose from as well. See pages 52 to 57 of our catalogue.

A digitally controlled stereo synthesiser the 5800B with more facilities than almost anything up to £3,000. Build it yourself for less than £700. Full specification in our catalogue.

A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.

Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 108 and 183 to 198 for details.

MAPLIN

ELECTRONIC SUPPLIES LTD

All mail to:-
P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155.

Shop: 284 London Road,
Westcliff-on-Sea, Essex.
(Closed on Monday).
Telephone: Southend (0702) 554155.

A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages - some in full colour - it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data. Our bi-monthly newsletter contains guaranteed prices, special offers and all the latest news from Maplin.

A superb range of microphones and accessories at really low prices. Take a look in our catalogue - send the coupon now!

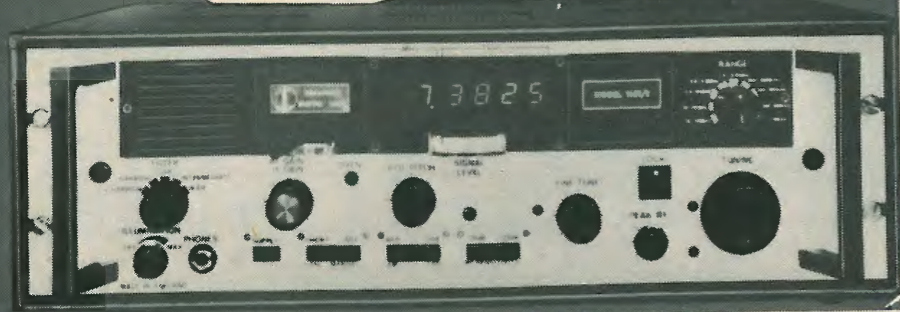
Post this coupon now for your copy of our 1979-80 catalogue price 75p.

Please send me a copy of your 280 page catalogue as soon as it is published (8th Jan. 1979). I enclose 75p but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 75p refunded immediately. If you live outside U.K. send £1 or ten International Reply Coupons.

NAME _____

ADDRESS _____

GRADE: Professional and Military
 FREQUENCY RANGE: 100KHz to 3MHz
 STABILITY: High - with digital lock
 COST: Modest
 MAKER: Eddystone, of course!
 1837/1838 SERIES



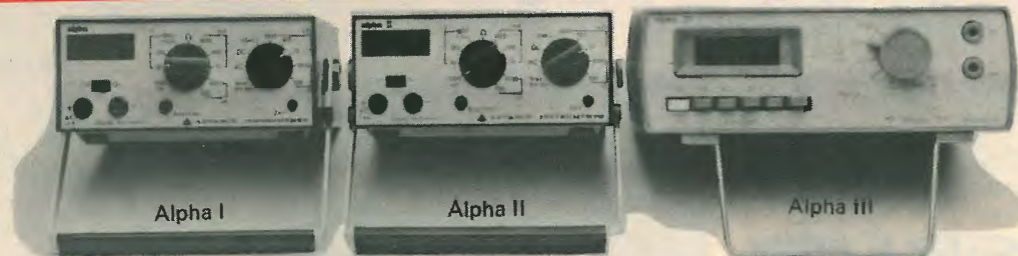
- Covers most general-purpose applications in professional and military communication including marine use (speech, telegraphy or f.s.k. teleprinter signals)
 - Manual tuning plus accurate digital frequency lock
 - High reliability and environmental performance
 - Complies fully with MPT specifications 1201, 1216, 1217, 1204
- Please ask for details

Eddystone Radio Limited

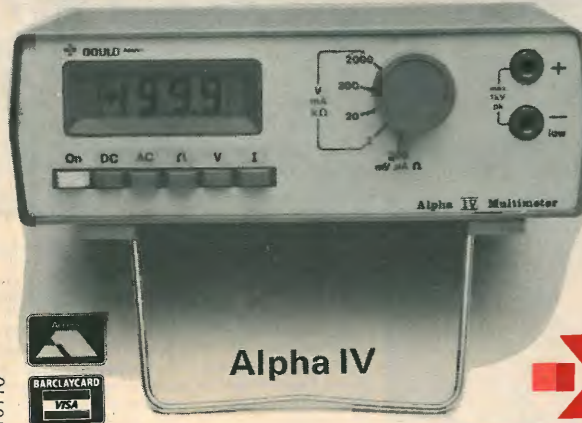
Member of Marconi Communication Systems Limited
 Alvechurch Road, Birmingham B31 3PP, England
 Telephone: 021-475 2231 Telex: 337081
 A GEC-Marconi Electronics Company



WW — 057 FOR FURTHER DETAILS



MULTIMETERS TO THE FORE



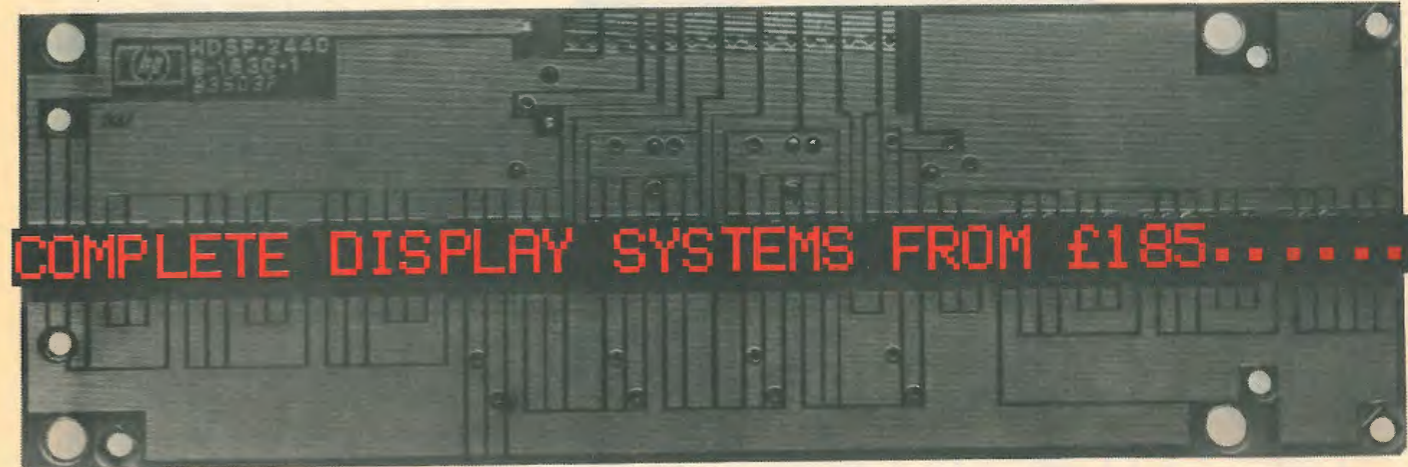
Gould Advance proudly present our new Alpha IV.
 The fourth generation of an outstanding multimeter, its price of £105 is so reasonable when compared to those of its competitors — in these inflationary times.
 While the improved spec and high reliability are a result of the experience we gained from the first three models.
 The Alpha IV measures a.c. and d.c. voltage and current, plus resistance — with a choice of 25 accurate measurement ranges. A '2000 Count' large, clear l.c.d. display.
 And true ease of use with its long life battery power facility.
 Plus a two-year guarantee (in common with all our instruments).
 May we send you the data, *forthwith*?



Gould Advance Limited,
 Roebuck Road, Hainault, Essex JG6 3UE.
 Telex: 263785.
TELEPHONE: 01-500 1000

WW — 081 FOR FURTHER DETAILS

**The Hewlett-Packard
 Solid State
 Alphanumeric Display System.**



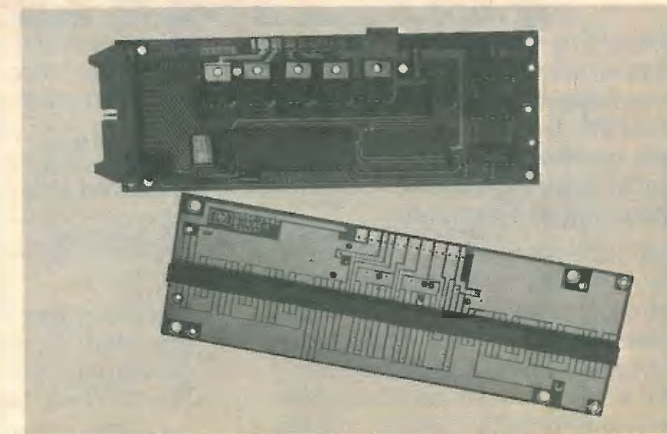
Is it trying to tell you something?

The new HDSP-2400 series is a breakthrough that provides a better product at a significantly lower price. With the high cost of engineering time there's no longer any advantage in producing your own systems when you can get them off-the-shelf from Crellon—and know that they'll work. First time and every time.

The HDSP-2400 series gives a completely supported 5 x 7 dot matrix display panel that frees the user's system from display maintenance and minimises the interaction normally required for this type of display.

There are two parts—an alphanumeric display controller with programmed microprocessor plus associated logic and a display panel, matched for luminous intensity.

Prices speak for themselves—display boards cost from £134.03 to £254.20 and control panels from £51.44 to £67.52 depending on the number of characters. These are one-off costs and there are considerable benefits for quantity orders.



- Main features are as follows:
- ★ Choice of 64,128, ASCII or user defined character set.
 - ★ Choice of 16,24,32 or 40 element display panel.
 - ★ Single 5.0 volt power supply.
 - ★ Easily interfaced to a keyboard or microprocessor.
 - ★ Multiple data entry formats—left, right or block entry.
 - ★ Editing features that include cursor, backspace, forwardspace, insert, delete and clear.
 - ★ TTL compatible.



HEWLETT PACKARD

For full data telephone or complete Reader Service Card.
 Crellon Electronics Ltd.,
 380 Bath Road, Slough, Berks. SL1 6JE.
 Tel: Burnham (06286) 4434. Telex 847571.

WW — 014 FOR FURTHER DETAILS

The Ultimate Multi-mate

It's easy to see why Philips PM 2517 digital multimeter is called The Ultimate Multi-mate.

No other DMM comes near its combination of laboratory performance and handy form - for such a handy price. Take a look at just a few of the many features it packs in.

Full 4-digit display giving higher resolution for 80% of measurements than 3½ digits.

LED or LCD readout at no extra cost.

Autoranging with manual override.



True RMS rather than "average" means you can measure non-sinewave AC signals more accurately.

Overload protection that's truly comprehensive.

The Ultimate Multi-mate is available from Wessex Electronics Ltd., 114 - 116 North Street, Downend, Bristol BS16 5SE. Tel: (0272) 571404; Rank Radio International, Watton Road, Ware, Herts. (Tel: Ware 3966); and Philips Service Centres ('phone 01-686-0505 for the address of your nearest branch). It can also be purchased from the U.K. marketing organisation -

Pye Unicam Ltd
Philips Electronic Instruments Dept
York Street, Cambridge, England CB1 2PX
Tel: Cambridge (0223) 58866 Telex: 817331

PHILIPS

**The no-compromise
4-digit instrument**

PHILIPS Test & Measuring Instruments

□ OSCILLOSCOPES 10 - 150 MHz □ DIGITAL & ANALOGUE MULTIMETERS □ CONVERSATIONAL DATA LOGGERS □ RECORDERS CHART & X - Y □ LF & RF OSCILLATORS □ MICROWAVE EQUIPMENT □ DC POWER SUPPLIES & AC STABILIZERS □ FREQUENCY COUNTERS & TIMERS □ TV STUDIO & TRANSMISSION INSTRUMENTATION □ PULSE GENERATORS □ AUDIO & VIDEO SERVICE EQUIPMENT
WW - 085 FOR FURTHER DETAILS

scope for recording

Recording transients using conventional recorders is unsatisfactory because the natural resonant frequency of pens and galvanometers may well distort the signal even if great care is taken with matching and damping.

An oscilloscope eliminates these problems but would normally only be capable of capturing one event, whether a storage CRT or digital storage techniques are used. A permanent record may be made using an external camera; a tedious procedure that involves a skilled operator.

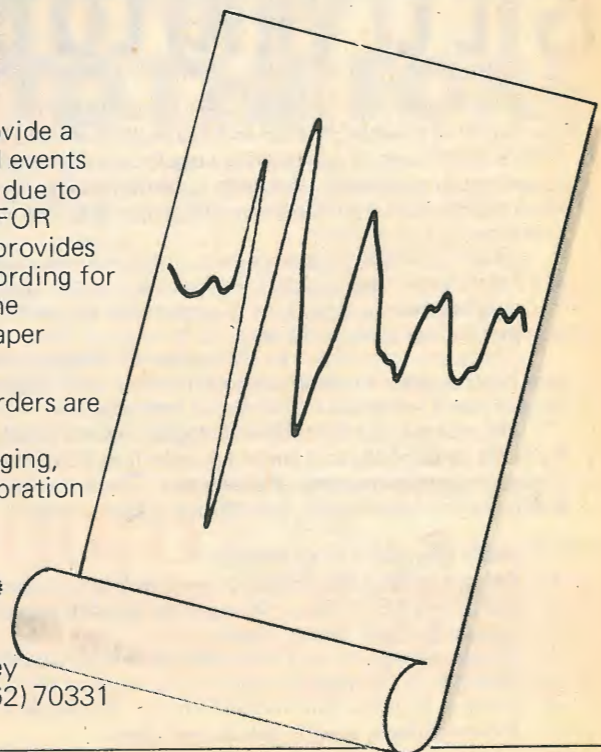
A Fibre Optic Recorder allows the unattended recording of a random series of transients fully automatically with paper advance between each event. Alternatively if the paper is

driven continuously to provide a strip chart recording, rapid events will be recorded faithfully due to the high efficiency of the FOR system. The Raster mode provides effectively continuous recording for long periods with good time resolution and excellent paper economy.

Medelec Fibre Optic Recorders are also used for research and development in Video Imaging, Digital Data, Noise and Vibration and many other fields.

medelec

MÉDELEC LIMITED
Manor Way, Woking, Surrey
Telephone: Woking (04862) 70331
Telex: 859141 Medlec G

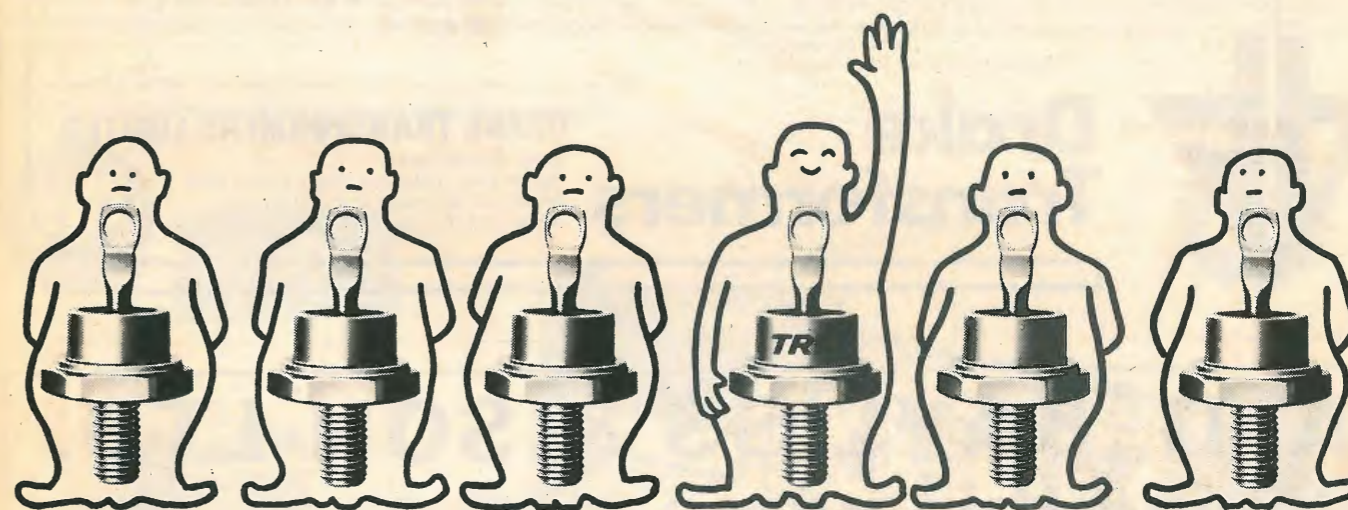


Transients

WW-059 FOR FURTHER DETAILS

OK, which of you Power Schottkys is ready to talk reliability and performance?

(now be honest)



Reliability

TRW supplied its first customer with Power Schottky devices in 1972 and he's still buying. His return rate is still nil. He knows that he doesn't have to worry about them failing in low voltage, high current switching power supply applications. He knows that when he gets a shipment he can use them without any worries. Hundreds of other customers have had the same experience.

Performance

The SD-51 in the DO-5 package has the best overall performance around for switching power supplies with 5.0V @ 60 amps. ($V_F = 0.6V @ 60A$, P.I.V. - 45V and $T_j = 150^\circ C$.) For 5.0V @ 30 amps the SD-41 in the DO-4 package can cut system size and cost. And both will reduce your need for heat exchangers and cooling devices.

And that's straight talk. If you'd like help with your low voltage, high current switching power supply designs just call MCP Electronics on 01-902 5941.



MCP Electronics Ltd.
Alpert, Wembley, Middx.
Tel: 01-902 5941

WW 4 79

MCP Electronics Ltd.
Alpert, Wembley, Middx.
Tel: 01-902 5941

Please send me further information on TRW's Power Schottky Diodes.

Name _____

Company _____

Address _____

Tel. _____

TRW POWER SEMICONDUCTORS

WW - 065 FOR FURTHER DETAILS



there are Transformers and . . .

We have been established for over twenty years and are proud of the reputation earned for the design and manufacture of high quality transformers, and other wound components.

Our design team is available to give their personal attention to customers' technical requirements.

Development and pre-production samples can be supplied by our prompt prototype service.



Drake Transformers

DRAKE TRANSFORMERS LIMITED

South Green Works
Kennel Lane, Billericay, Essex CM11 2SP
Telephone Billericay (02774) 51155
Telex 99426 (prefix message DRAKE)

WW-019 FOR FURTHER DETAILS

A. D. BAYLISS & SON LTD.

Behind this name there's a lot of real POWER!

Illustrated right is a TITAN DRILL

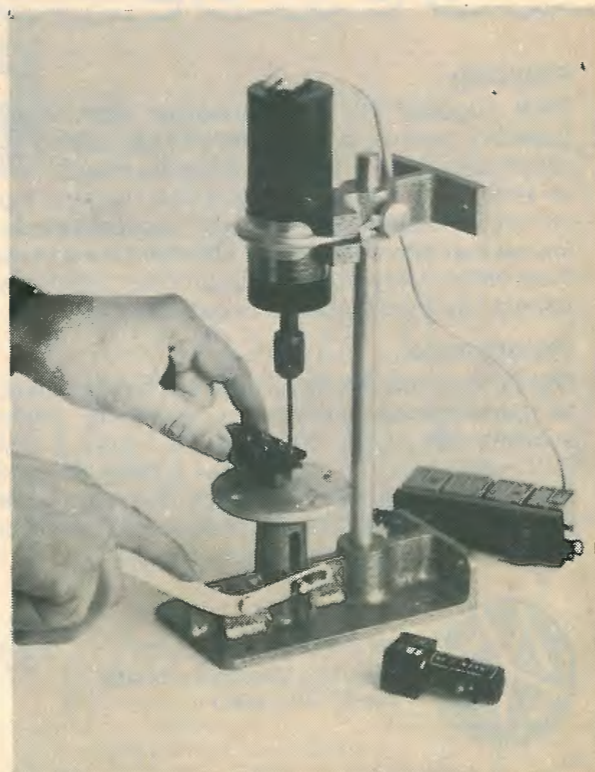
Mounted in a multi-purpose stand. This drill is a powerful tool running on 12v DC at approx. 9000 rpm with a torque of 350 gm. cm. Chuck capacity 3.00 m/m. The multi-purpose stand is robustly constructed of steel and aluminium. The base and bracket are finished in hammer blue. Also available for use in the stand is the RELIANT DRILL which is a smaller version of the Titan. Approx. speed 9000 rpm, 12v DC, torque 35 gm. cm. Capacity 2.4 m/m.

- | | |
|----------------------------------|-----------------------------|
| TITAN DRILL & STAND | £21.45 |
| TITAN DRILL ONLY | + 8% VAT = £23.17 + £1 P&P |
| RELIANT DRILL & STAND | £9.79 |
| RELIANT DRILL ONLY | + 8% VAT = £10.57 + 35p P&P |
| TITAN MINI DRILL KIT | £18.44 |
| Drill Plus 20 Tools | + 8% VAT = £19.92 + £1 P&P |
| RELIANT MINI DRILL KIT | £6.34 |
| Drill Plus 20 Tools | + 8% VAT = £6.85 + 35p P&P |
| TITAN MINI DRILL KIT | £16.25 |
| Drill Plus 20 Tools | + 8% VAT = £17.55 + 50p P&P |
| RELIANT MINI DRILL KIT | £13.20 |
| Drill Plus 20 Tools | + 8% VAT = £14.26 + 50p P&P |
| TRANSFORMER UNIT | £9.40 |
| | + 8% VAT = £10.15 + 75p P&P |

These are examples of the extensive range of power tools designed to meet the needs of development engineers, laboratory workers, model makers and others requiring small precision production aids. To back up the power tools, Expo offer a comprehensive selection of Drills, Grinding Points and other tools. SEND STAMP for full details to main distributors.

A. D. BAYLISS & SON LTD., Pfera Works, Redmarley, Glos. GL19 3JU

Stockists: Richards Electric, Gloucester; Hoopers of Ledbury; Hobbs of Ledbury; D&D Models, Hereford; Bertella, Gloucester; J. Power Services & Co. Ltd., Worcester



Put Fluke to the Test

A Digital Multimeter on 14 days approval

If you've ever wanted to challenge the claim of a leading instrument manufacturer then here is your chance.

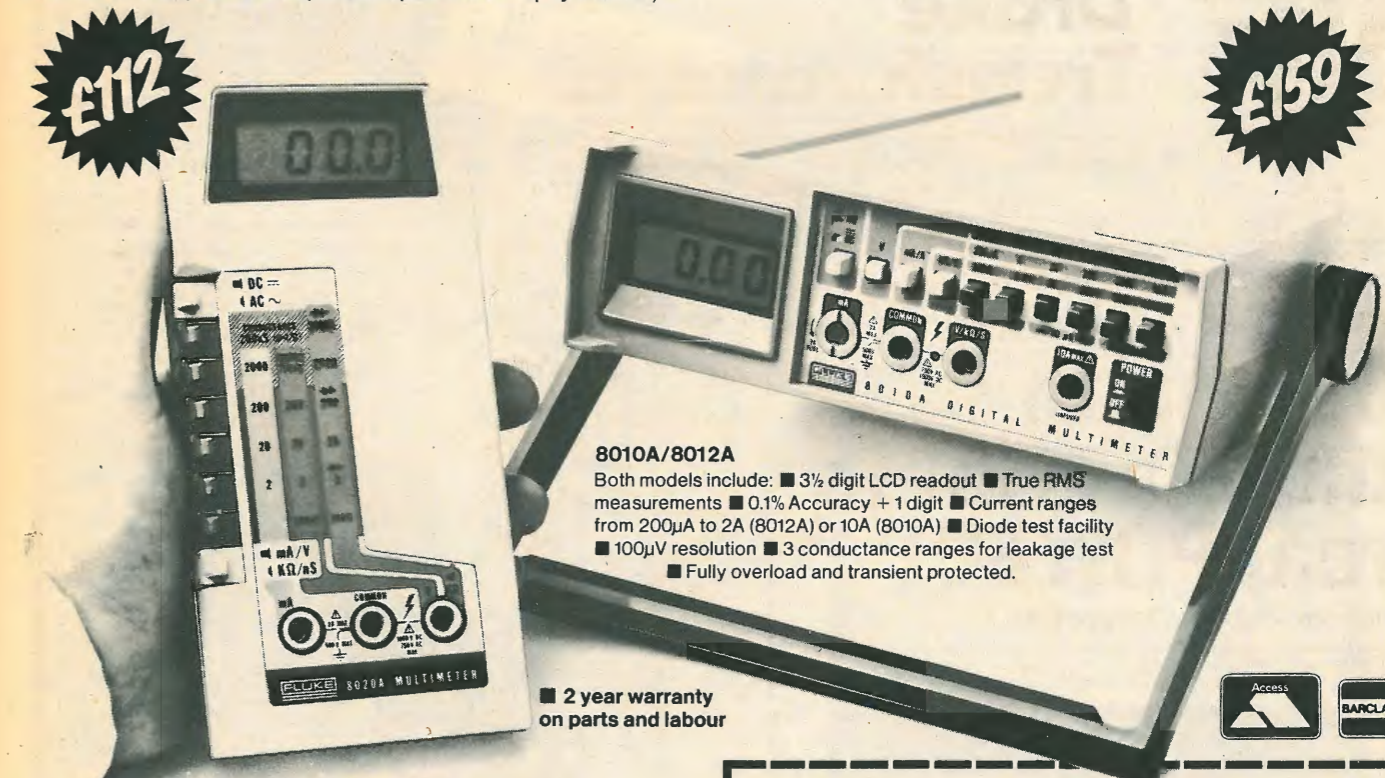
Fluke are so confident that you will appreciate the fine qualities of their multimeters that we would invite you to put them through their paces.

Simply select either the handheld or bench models at the special low price, complete and clip the coupon. We then pay the VAT,

postage & packing and despatch the instrument on 14 days approval.

If during the 14 day period you're not completely satisfied with its performance, return it to us and your money will be refunded.

Are you going to put us to the test?



FLUKE 8020A HANDYMETER

- Large easy to read 3 1/2 digit LCD display.
- 26 measurement ranges for AC/DC volts, amps, ohms and conductance.
- 0.25% VDC accuracy over 1 year.
- High power and low power ohms capability.
- Measures to 10,000 MΩ using two conductance ranges.
- Fully protected to 250V on all ranges.
- Protected against transients up to 6KV for 10 μsecs.

8010A/8012A

- Both models include: ■ 3 1/2 digit LCD readout ■ True RMS measurements ■ 0.1% Accuracy + 1 digit ■ Current ranges from 200μA to 2A (8012A) or 10A (8010A) ■ Diode test facility ■ 100μV resolution ■ 3 conductance ranges for leakage test ■ Fully overload and transient protected.

■ 2 year warranty on parts and labour

To: Fluke International Corporation, Colonial Way, Watford, Herts WD2 4TT. C

Please send me: 8020A DMM(s) at £112.00 8012A DMM(s) at £199.00
 8010A DMM(s) at £159.00 Short Form Catalogue—FREE
 All prices are fully inclusive.

I enclose my cheque/postal order for £ _____ or please debit my Access/Barclaycard

No _____ Signature _____

Name _____ (BLOCK LETTERS PLEASE)

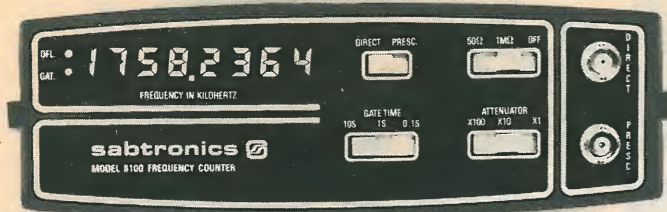
Address _____

THIS OFFER MUST CLOSE 30th SEPTEMBER 1979. ALLOW 2 WEEKS FOR DELIVERY.
 Offer applies to U.K. Mainland and Channel Isles. For Northern Ireland & Eire contact EURO ELECTRONIC INSTRUMENTS, 32 Brews Hill, Navan, County Meath, EIRE. *Official company orders, duly authorised, will be accepted with corresponding credit arrangements if required.



Fluke International Corporation
 Colonial Way, Watford, Herts. WD2 4TT
 Telephone: (0923) 40511 Telex: 934583

WW — 066 FOR FURTHER PROOFS



Model 8100 Frequency counter
Kit £ 69.95
assembled tested: £ 84.95
(plus p.p. £ 3.50 and VAT at 8%)

The Winners

These two products are our best sellers!

The two products shown above from Sabtronics are our best selling products. Both these products compare with similar equipment selling for at least £ 150.00. Is there more to these products than value? Let's take a closer look.

The Frequency Counter Model 8100

It employs LSI Technology, has the performance and characteristics you demand, guaranteed frequency range of 20 Hz to 100 MHz; selectable hi/lo impedance; superior sensitivity; selectable resolution and selectable attenuation. Plus an accurate time base with excellent stability. An 8 digit LED Display features floating decimal point, leading zero suppression and overflow indicator.

Brief specifications:
Frequency Range: 20 Hz to 100 MHz guaranteed, (10 Hz to 130 MHz typical) - Sensitivity: 10 mV RMS,

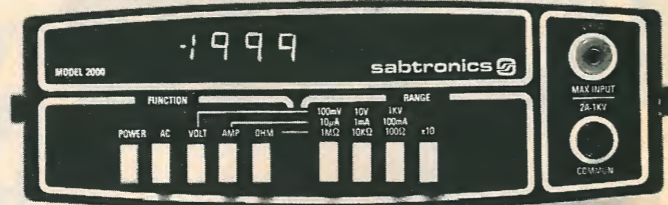
20 Hz to 50 MHz (5 mV typical); 15 mV RMS, 50 MHz to 100 MHz (10 mV typical) - Selectable impedance: 1 MΩ/25 pF or 50Ω - Attenuation: X1, X10 or X100 - Accuracy: ± 1 Hz plus time base accuracy - Aging Rate: ± 5 ppm/yr - Temperature Stability: ± 10 ppm, 0° to 50° C - Resolution: 0.1 Hz, 1 Hz, 10 Hz selectable - Display: 8-digit LED, floating DP, overflow indicator - Overload Protection - Power Requirement: 9-15 VDC. Optional prescaler will be available from around March 1979.

The DMM Model 2000

The model 2000 is all solid-state, incorporating a single LSI circuit and high quality components. It has five functions and a total of 28 ranges. Input overload protection, auto polarity and auto zero are provided on all ranges and a basic DCV accuracy of 0.1% ± 1 digit.

sabtronics

Model 2000 3½ Digit DMM
Kit £ 49.95
assembled: £ 69.95
(plus p.p. £ 3.00 and VAT at 8%)



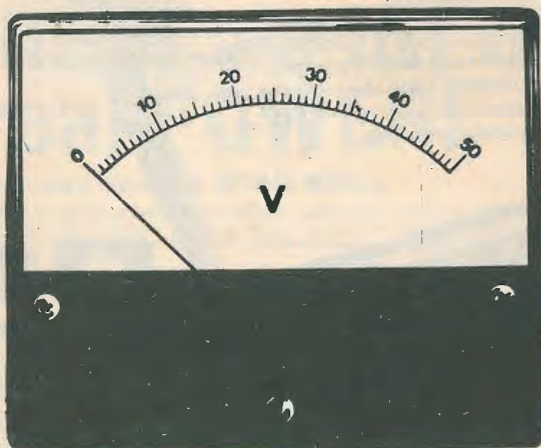
Brief specifications:

DC volts in 5 ranges: 100 μV to 1 kV - AC volts in 5 ranges: 100 μV to 1 kV - DC current in 6 ranges: 100 nA to 2A - AC current in 6 ranges: 100 nA to 2A - Resistance: 0.1Ω to 20 MΩ in 6 ranges - AC frequency response: 40 Hz to 50 kHz - Display: 0.36" (9.1 mm) 7-segment LED - Input impedance: 10 MΩ - Size: 8" W x 6.5" D x 3" H (203 x 165 x 76 mm) - Power requirement: 4 "C" cells (not included).

Order yours now! Write to:
Timwood Ltd.
Prospect Road, Cowes,
Isle of Wight, England Telex 86892.
Send payment with your order.

WW-039 FOR FURTHER DETAILS

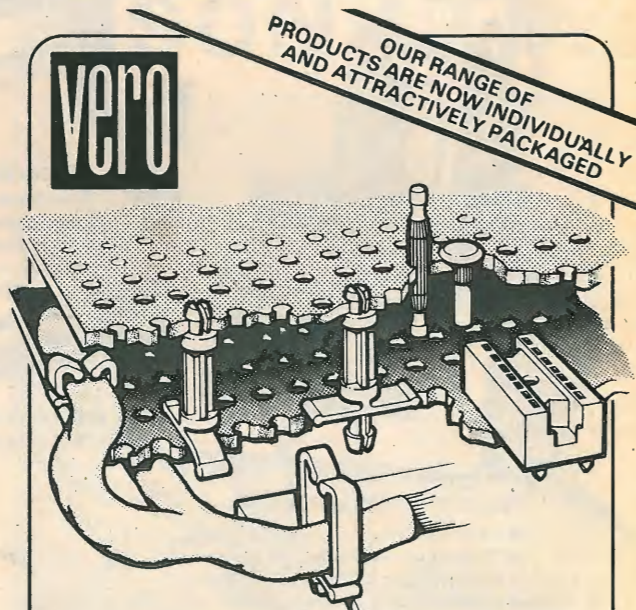
METER PROBLEMS?



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 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW-025 FOR FURTHER DETAILS



OUR RANGE OF PRODUCTS ARE NOW INDIVIDUALLY AND ATTRACTIVELY PACKAGED

Our new catalogue lists circuit board accessories for all your projects - DIP sockets, pins, stand-offs, cable clips, hand tools. And we've got circuit boards, module systems, cases and boxes - everything you need to give your equipment the quality you demand. Send 25p to cover postage and packing, and the catalogue's yours.

VERO ELECTRONICS LTD. RETAIL DEPT.
Industrial Estate, Chandlers Ford, Hants. SO5 3ZR
Telephone Chandlers Ford (04215) 2956

WW - 009 FOR FURTHER DETAILS

The Ultimate Multi-mate

It's easy to see why Philips PM 2517 digital multimeter is called The Ultimate Multi-mate. No other DMM comes anywhere near its

combination of laboratory performance and handy form - for such a handy price. Take a look at some of the features it packs in.

Full 4-digit display giving higher resolution than 3½ digits for 80% of measurements. Parameter readout, too.

Small and sturdy construction makes this DMM ideal for bench or field work.

Choice of LED or LCD display - choose the one that suits you, the price is the same. Mains unit supplied free with LED version.

Ergonomic design allows it to work in any position without fuss or fumble.

Autorangeing with manual override. Average auto response time less than two seconds.

True RMS rather than "average" detection. The Ultimate Multi-mate measures non-sinewave AC signals more accurately.

High accuracy - necessary to make full use of those four digits. An impressive 0.2% of reading ± 0.05% of scale on d.c. volts.

Current to 10A via a separate input is standard, not optional, on the PM 2517.

Overload protection that is so comprehensive you have to try very hard to do any damage, even with mains and TV booster voltages.



Low-cost temperature option makes possible measurement from -60 to +200°C.

Data hold option means that in tricky situations you can "freeze" measurements for increased operator safety and convenience.

Built to international standards - you name them and the PM 2517 meets them. But what else would you expect from an international company like Philips?

The no-compromise 4-digit instrument

The Ultimate Multi-mate is available from Wessex Electronics Ltd., 114 - 116 North Street, Downend, Bristol BS16 5SE Tel: (0272) 571404; Rank Radio International, Watton Road, Ware, Herts. (Tel: Ware 3966) and Philips Service Centres (phone 01-686-0505 for the address of your nearest branch).

It can also be purchased from the U.K. marketing organisation -

Pye Unicam Ltd
Philips Electronic Instruments Dept
York Street, Cambridge, England CB1 2PP
Tel: Cambridge (0223) 68866 Telex: 817331



Test & Measuring Instruments

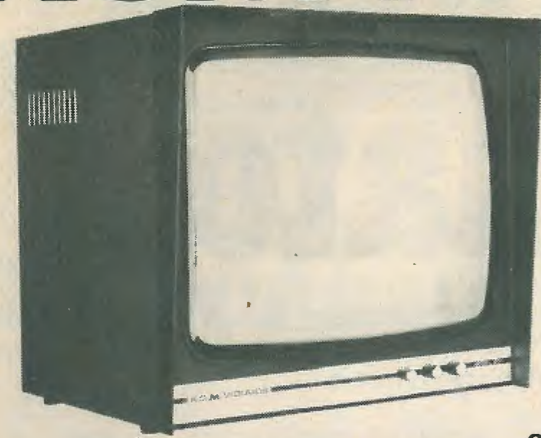
PHILIPS

□ OSCILLOSCOPES 10 - 150 MHz □ DIGITAL & ANALOGUE MULTIMETERS □ CONVERSATIONAL DATA LOGGERS □ RECORDERS CHART & X-Y □ LF & HF OSCILLATORS □ MICROWAVE EQUIPMENT □ DC POWER SUPPLIES & AC STABILIZERS □ FREQUENCY COUNTERS & TIMERS □ TV STUDIO & TRANSMISSION INSTRUMENTATION □ PULSE GENERATORS □ AUDIO & VIDEO SERVICE EQUIPMENT

WW - 061 FOR FURTHER DETAILS

KGM TV MONITORS

the big choice



Type 224 – the ruggedized monitor for those really demanding situations – extremes of weather, temperature, vibration and frequent change of site.

Standard KGM monitors range from 12" – 24". Our long experience of CCTV enables us to meet almost any special requirement.

VDU's – visual display units have also been supplied in large numbers to suit customers' requirements. Tell us your needs and we will gladly quote.

Send for your data sheets on the full range of CCTV monitors and cameras designed and manufactured by KGM. KGM also supply an extensive range of ancillaries and distribution units.



Clock Tower Road, Isleworth, Middlesex TW7 6DU
Tel: 01-568 0151. Telex: 934120

WW-031 FOR FURTHER DETAILS

PRODUCTION TESTING

POWER UNITS
Now available with 3 OUTPUTS



Type 250VRU/30/25

- OUTPUT 1: 0-30v, 25A DC
- OUTPUT 2: 0-70v, 10A AC
- OUTPUT 3: 0-250v, 4A AC

ALL Continuously Variable



VALRADIO LIMITED, BROWELLS LANE, FELTHAM MIDDLESEX TW13 7EN
Telephone: 01-890 4242/4837

WW-035 FOR FURTHER DETAILS

FOR POWER SEMICONDUCTORS



INTERNATIONAL RECTIFIER

- Diodes Thyristors
- Fuses for protecting Semiconductors
- Power Transistors Potted Bridges
- Solid State Relays
- Silicon Stacks Surge Suppressors

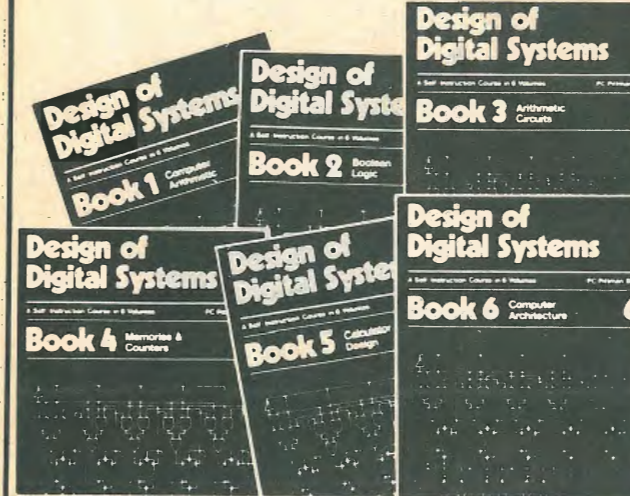
IN A HURRY!

070-681 4931

HARMSWORTH, TOWNLEY & CO. LTD.
HAREHILL TODMORDEN LANCS OL14 5JY
Phone: 070 681 2601 and 070 681 5246
Telex 635 091 Albion G Attn: HARMSWORTH

Understanding Digital Electronics

New teach-yourself courses



In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and petrol consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

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

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.

The six volumes of **Design of Digital Systems** cost only: **£8.10** + 90p post & packing

And the four volumes of **Digital Computer Logic and Electronics** cost only: **£4.60** + £1 post & packing

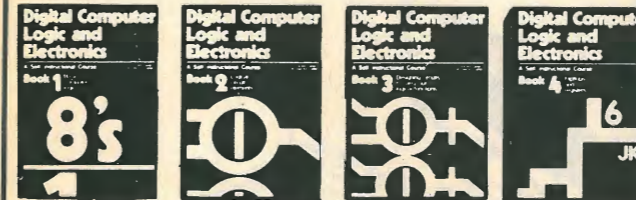
But if you buy both courses, the total cost is only: £12.00 + £1 post & packing

Price includes surface mail anywhere in the world – Airmail extra.

Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes – each A4 size – are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

- Book 1** Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
- Book 2** OR and AND functions; logic gates. NOT, exclusive OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
- Book 3** Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
- Book 4** Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
- Book 5** Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
- Book 6** Central processing unit (CPU); memory organisation; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes – each A4 size – and serves as an introduction to the subject of digital electronics. Everyone can learn from it – designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

CAMBRIDGE LEARNING ENTERPRISES, UNIT 37, RIVERMILL SITE, FREEPOST, ST. IVES, HUNTINGDON, CAMBS. PE17 4BR, ENGLAND TELEPHONE: ST. IVES (0480) 67446

PROPRIETORS: DAYRIDGE LTD. REG. OFFICE: RIVERMILL LODGE, ST. IVES REGD. IN ENGLAND No. 1328762

Flow Charts & Algorithms

HELP YOU PRESENT safety procedures, government legislation, office procedures, teaching materials and computer programs by means of YES and NO answers to questions.

THE ALGORITHM WRITER'S GUIDE explains how to define the questions, put them in the best order and draw the flow chart, with numerous examples shown. All that students require is an aptitude for logical thought. Size A5, 130 pages. This book is a MUST for those with things to say.

£2.95 + 45p post & packing by surface mail anywhere in the world. Airmail extra.

GUARANTEE
If you are not entirely satisfied your money will be refunded.
Please allow 21 days for delivery

Cambridge Learning Enterprises, Unit 37, Rivermill Site
Freeport, St. Ives, Huntingdon, Cambs. PE17 4BR
England

- Please send me the following books
-sets Digital Computer Logic & Electronics @ £5.50, p&p included
 -sets Design of Digital Systems @ £9.00, p&p included
 -Combined sets @ £13.00, p&p included
 -The Algorithm Writer's Guide @ £3.40, p&p included

Name

Address

I enclose a cheque/PO payable to Cambridge Learning Enterprises for £.....

Please charge my Access/Barclaycard/Visa/Eurocard/Mastercharge/Interbank account number

Signature

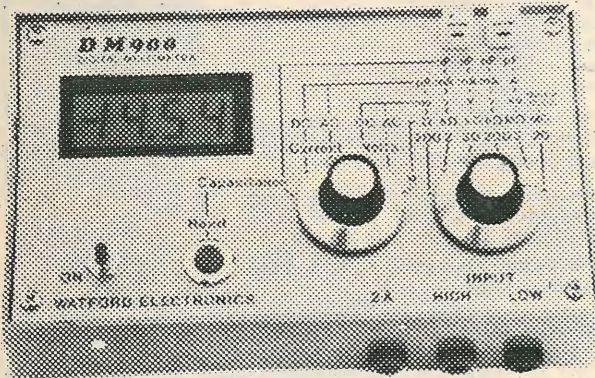
Telephone orders from credit card holders accepted on 0480-67446 (ansafone). Overseas customers should send a bank draft in sterling drawn on a London Bank.

WW37

WATFORD ELECTRONICS

33 CARDIFF ROAD, WATFORD, HERTS, ENGLAND
Tel. Watford 40588/9.

DM 900



THERE ARE 900 REASONS FOR BUYING THIS MULTIMETER (with direct reading capacitance range)

Its 900 cubic centimetres are packed with up to the minute technology offering a low cost yet accurate method of measuring voltage, current, resistance and capacitance too, on a total of 30 RANGES. The WATFORD ELECTRONICS DM900 uses latest MOS Integrated Circuits which drive a 3½ digit Liquid Crystal Display for extremely low power consumption.

Specifications:

- DC VOLTS 5 ranges 200mV to 1KV } Zin
- AC VOLTS 5 ranges 200mV to 1KV } > 10MΩ
- DC CURRENT 5 ranges 200μA to 2A
- AC CURRENT 5 ranges 200μA to 2A
- RESISTANCE 6 ranges 200Ω to 20MΩ
- DIODE Voltage Drop 100nA to 10mA
- CAPACITANCE 4 ranges 2nF to 2μF
- Accuracy on all ranges better than 1%
- 0.5" 3½ digit LCD Display
- Single 9V (PP3) Power Supply
- Sampling Rate > 2 per second
- Display Test Facility
- Battery Test Facility
- Movable Decimal Point
- Isolated Floating Ground
- Dual Slope A/D Conversion
- Critical Input Protection
- Overrange Indication
- Polarity Indication
- True Auto Zero
- 30 Ranges
- Overall size: 160 x 95 x 60mm
- Colour: Grey (standard) Black Orange (optional)

The DM900 incorporates dual slope A/D conversion; true auto zero; polarity and overrange indication; battery and display test facilities. Its input impedance of over 10MΩ allows voltage measurements in high impedance circuits without distorting circuit operation.

The DM900 is small and robust. It measures only 160 x 95 x 60mm and is housed in an ABS case which will fit in your coat pocket or briefcase.

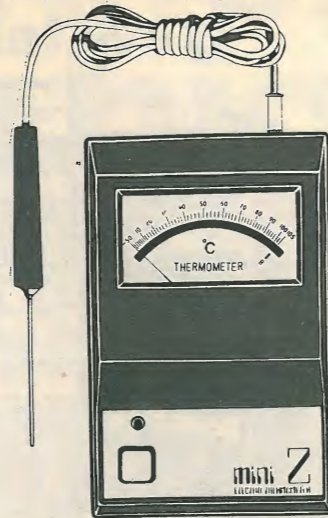
The DM900 has been specially designed for Watford Electronics and is available in kit form or ready built.

Special Offer: £78.50 plus VAT (p&p insured add 80p)

Also available in Kit form for the Enthusiast at **£54.50 plus VAT plus 80p** (probes and carrying case £3.00 extra).

WW-049 FOR FURTHER DETAILS

ELECTRONIC INDUSTRIAL THERMOMETER



THE MODERN WAY TO MEASURE TEMPERATURE

A Thermometer designed to operate as an Electronic Test Meter. Will measure temperature of Air, Metals, Liquids, Machinery, etc., etc. Just plug-in the Probe, and read the temperature on the large open scale meter. Supplied with carrying case, Probe and internal 1½ volt standard size battery.

Model "Mini-Z 1" measures from -40° C to +70° C. Price £30.00
Model "Mini-Z 2" measures from -5° C to +105° C. Price £30.00
Model "Mini-Z Hi" measures from +100° C to 500° C. Price £33.00
(VAT 8% EXTRA)

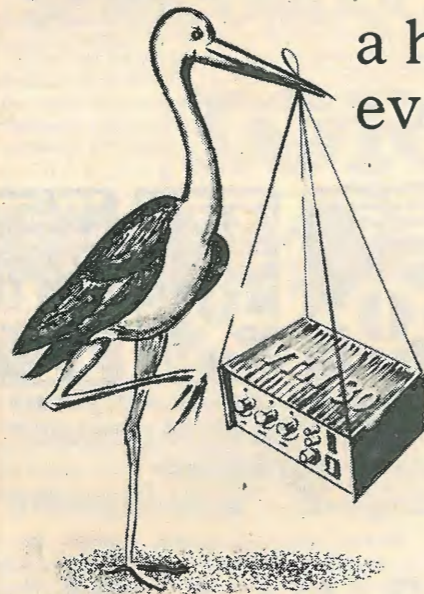
Write for further details to

HARRIS ELECTRONICS (LONDON)
138 GRAY'S INN ROAD, LONDON, WC1X 8AX
(Phone 01-837 7937)

WW-025 FOR FURTHER DETAILS

VORTEXION

a happy event . . .

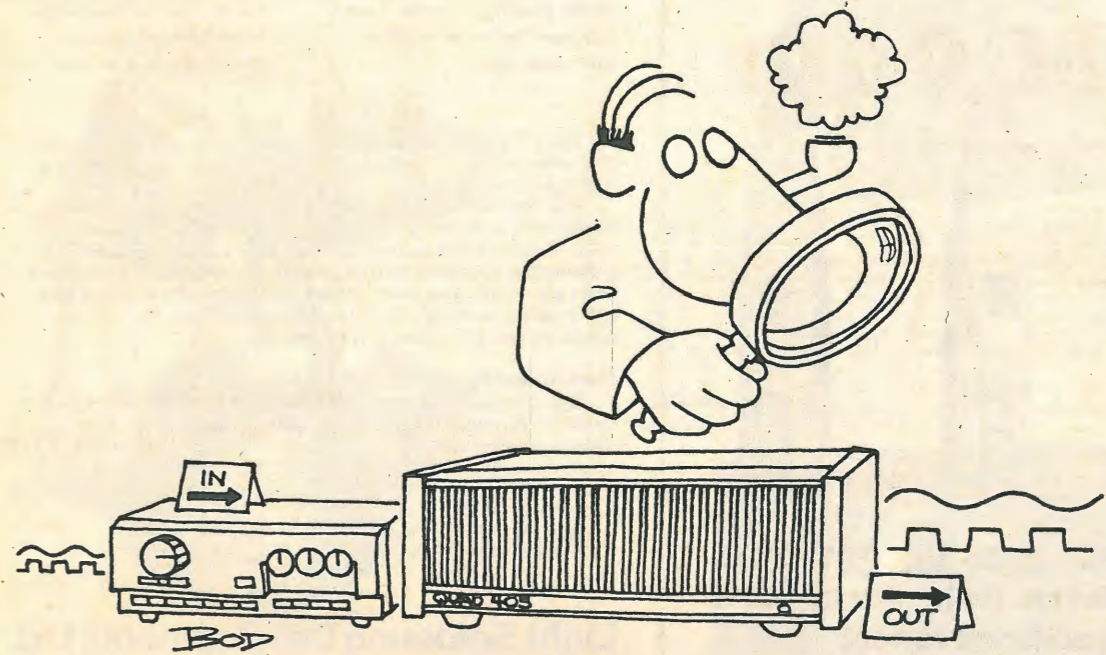


. . . a new addition to our family of amplifiers. The VTN 30. The new baby weighs in at 30 watts, and has a maximum of 3 inputs.

The other members of the Vortexion family are the system 2000, 50/70 watt and CP50 mains/battery amplifiers. Contact Jennifer Hall — VORTEXION DIVISION. Clarke & Smith Manufacturing Co. Ltd., Melbourne Works, Melbourne Road, Wallington, Surrey. Tel. 01-669 4411 Ext. 38.

Telex Casint G 22574; Telegrams: Electronic Wallington.

WW-034 FOR FURTHER DETAILS



"Comparisons are odorous"

We are often asked by audio enthusiasts how our amplifier compares with so and so's product, and they are surprised when we reply "we don't know, we have never tried."

It is not that we are unwilling to learn from other people's mistakes, it is simply that at Quad we recognise only one standard for comparison, namely the original.

What we wish to know is how the output of the equipment under investigation compares with the original signal fed into it.

Over the years we have developed experimental techniques which enable us to investigate the audible contribution of a piece of equipment to a music signal, and as a result we can say with complete confidence that a Quad 405* contributes absolutely no audible degradation to the signal fed through it, and that's as close to the original as you need to get.

For further details on the full range of QUAD products write to:

The Acoustical Manufacturing Co. Ltd.,
Huntingdon, Cambs. PE18 7DB.
Telephone: (0480) 52561.

*or 303 or 33. When operated within specified input and output levels and at specified loads.

QUAD

for the closest approach to the original sound
QUAD is a registered Trade Mark



WW-070 FOR FURTHER DETAILS



LITESOLD C35 CORDLESS SOLDERING IRON



Convenient — solders anywhere
Quick heating — under 7 secs.
Leakage free — no earthing
Twin spotlights

Complete safety
Up to 350 joints/charge
Interchangeable tips
Recharges in 8 hours.

The LITESOLD C35 cordless rechargeable iron is indispensable where an electrical supply is not available or a connecting lead is inconvenient.

The iron recharges completely in 8 hours from its mains power unit, and cannot be overcharged. The built-in nickel cadmium batteries give operating temperature within 7 seconds of pressing the operating button, which is fitted with a safety lock. Twin spot lights give clear, shadowless illumination of the work and an additional light in the body shuts when the iron is operating and also when it is on charge.

Prices Including Postage, Packing and V.A.T.

C35 Cordless Iron complete with mains power unit, standard tip C35D for work up to 2.5 sq.mm. detachable light fittings, cleaning sponge and miniature screw driver for tip changing £21.61.

As above but including spare tip C35F for fine joints up to 1.5 sq.mm. and broad tip C35G for work up to 6 sq.mm. £24.43.

Spare tip C35D (Standard)	£1.97
Spare tip C35F (Fine)	£2.20
Spare tip C35G (Broad)	£2.32

Light Soldering Developments Ltd.

97-99 Gloucester Road, Croydon, Surrey CRO 2DN, England.
Telephone 01-689-0574 Telex 8811945

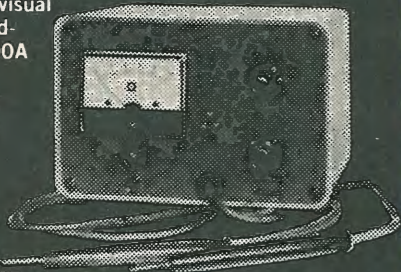
WW — 103 FOR FURTHER DETAILS

Cut out the magnifying-glass!

You don't need a magnifying-glass to find short-circuits on PCBs, backplanes, and wiring harnesses. You need the ToneOhm 400A.

In just a few seconds, a unique audio tone guides the hand-held probe to pin-point the fault — even if it's a microscopic whisker of solder. There's visual confirmation by meter read-out, too. The ToneOhm 400A gives automatic testing a new dimension at very low cost (£98 + VAT); and as a stand-alone instrument it stands alone.

Evaluate the ToneOhm 400A at your leisure. Simply send the coupon.



Omnitest Ltd.
119 Old Xchurch Rd.,
Bournemouth,
Dorset BH1 1EP.

Please send me ___ ToneOhm 400As.

I enclose £ _____
(£107.29 each, incl. £7.84 VAT and £1.45 P & P.)

Name _____

Address _____

To: Omnitest Ltd., 119 Old Christchurch
Road, Bournemouth, Dorset BH1 1EP.

WW — 038 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:—

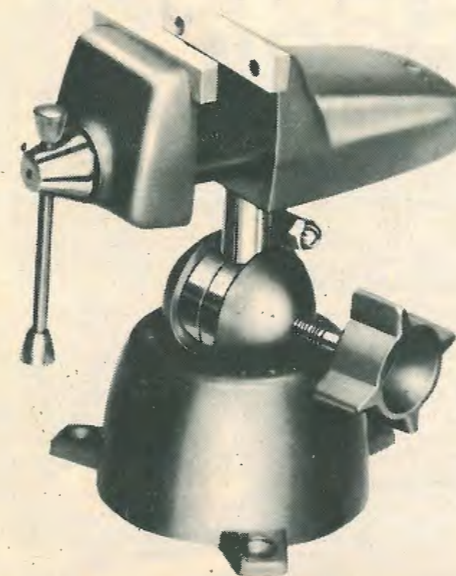
1. Only 100% pure, natural diamond grains are utilised.
 2. Blades are treated with hard chrome to reinforce the setting of the diamond grains, to obviate loosening or breakaway during use. This process also prevents clogging of the diamonded surface by residues resulting from use.
 3. All diamonded 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.

WW—075 FOR FURTHER DETAILS

New from GREENWOOD



PANAVISE®

a precision vice,
that rotates a full
360 degrees—tilts
180 degrees from
vertical to horizontal,
and offers a choice
of 3 bases, 3 heads,
a bench clamp and
a PCB holder.

We think it's like no other vice you've ever used. Its head rotates a full 360 degrees — and tilts 180 degrees from vertical to horizontal.

One conventional knob locks work in any desired position, firmly yet gently. You can choose a standard, low profile or vacuum base — a standard, low profile or wide opening head — a bench clamp mounting base — a printed circuit board holder and of course replacement jaws and pads if ever you need them. Panavise is more than just a vice — it's a system.

Greenwood Electronics

Greenwood Electronics, Portman Road, Reading, RG3 1NE
Telephone 0734-595844 Telex 845059

Obtainable also from our distributors:

Electroplan Ltd
P.O. Box 19, Orchard Road,
Royston, Herts SG8 5HH.

West Hyde Developments Ltd
Unit 9, Park Street Industrial Estate,
Aylesbury, Bucks HP20 1ET.

Toolrange Ltd
Upton Road, Reading RG3 4JA.
Special Products Distributors Ltd
81, Piccadilly, London, W1.
ITT Electronic Services
Edinburgh Way, Harlow,
Essex CM20 2DF.

WW—073 FOR FURTHER DETAILS

NEC

RADIO
AMATEUR
COMMUNICATION
EQUIPMENT

CQ-P-2200E
137-150 Mhz

2 meter FM 12 channel portable/mobile 1/3 watt transceiver



Features: battery cartridge system, all 12 channels X-tal fitted, 1750 Hz tone-call system, AXC or RIT switchable, highly efficient squelch, high (3 watts) low (1 watt) output power switchable, lambda 1/4 or 5/8 telescopic antenna selectable. Provisions for: external power 13.5 V DC, external antenna, earphone, external speaker. NEW: Professional plug-in moduls construction, with all units shielded, selected high quality parts secure long life. Range: up to 50 KM. direct, up to several hundreds of kilometers over repeaters. Universality: mobile or portable (with the snip of a finger). High sensitivity: 0.2 uV for 20 db S/N.

CQ-R-700 6 band general coverage receiver with ultra high sensitivity (0.1 uV for 170 KHz-30.0 Mhz 15 db S/N on 30 Mhz)



Features: VFO patent allows perfect frequency read-off and tune-in with ease. Selectivity selectable wide/narrow. Modes: SSB (USB/LSB), CW or AM. facility. Modern electronic layout. A true solution for all searching a reliable mean for short range or continuous long haul reception.

CQ-LINE 300 - 3000 watts HF-LINE. Modes: USB/LSB. CW. AM. RTTY (FSK). FAX in 1.6 - 30.0 Mhz full digital readout.



In many thousands of applications the CQ-LINE has proven their reliability and sturdiness. Its versatility and high power make the CQ-LINE a true partner for long distance communication. Even with simple antenna from home or car, world-wide contacts are no problem.

UK: please contact our distributor Messrs. William Munro, Invergordon, High Street 100, telef.: 349-852351-4 Telex: 75265.

CEC SOLE DISTRIBUTOR EUROPE OF **NEC**
RADIO AMATEUR AND CB EQUIPMENT
VIA VALDANI, 1, CH 6830 CHIASSO/SWITZERLAND,
TELEF. 091/448464, TELEX 64077 CEC CH.

WW—027 FOR FURTHER DETAILS

LOWE ELECTRONICS LTD.

119 CAVENDISH ROAD, MATLOCK, DERBYSHIRE
TEL. 0629 2430 OR 2817. TELEX 377482 LOWLEC G



NEW MODEL
CS1577
30 MHz/2mV

CS1577
130mm DUAL TRACE
TRIGGERED SWEEP
OSCILLOSCOPE

£480 + 8%

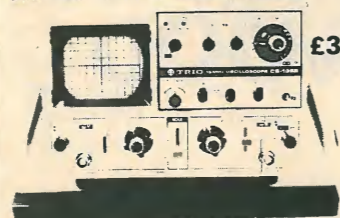
PRICE INCLUDES TWO X10
FULL BANDWIDTH PROBES

- * 130 mm mesh PDA
- * DC - 30 MHz
- * 2 mV sensitivity
- * Signal delay
- * Auto level triggering
- * Display modes CH1, CH2, DUAL, ADD, X-Y
- * Single shot with variable hold off

SPECIFICATION

Bandwidth: DC - 30 MHz (3 dB) 40 MHz (6 dB)
Sensitivity: 2 mV/cm - 10V/cm
Input R.C.: 1 M ohm 22 pF
Risettime: 11.7 nS
Overshoot: less than 3%
Sweep time: 100 nS/cm - 0.5S/cm
better than 3%
Linearity: 1 KHz 100 mV square wave
Calibrator:
Trigger bandwidth: DC - 40 MHz
Trace rotation: Electrical
Phosphor: P31
Power: AC 1 0 0 / 1 2 0 // 220/240V 50/60 Hz 40W
Dimensions: 260mm x 190mm x 375mm
Weight: 10 Kg

**CS1352 DUAL TRACE 15
MHz/2mV PORTABLE**



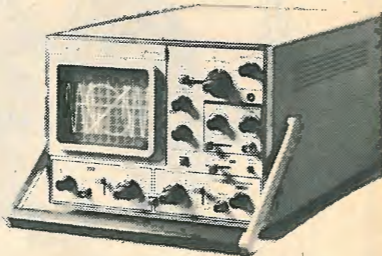
£350 + 8%

The CS1352 oscilloscope offers you not only dual trace, 15MHz bandwidth operation at sensitivities down to 2mV/cm but also use from 100-240 Vac mains and portable operation using the optional rechargeable battery pack. Automatic charging is carried out when the CS1352 is plugged into a mains supply. Now you can have top performance both on the bench and out in the field — and at an affordable price.



CS1575 DUAL TRACE 4 FUNCTION

The CS1575 is a unique tool for the audio engineer. It features the normal facility of dual trace display with sensitivity to 1 mV/cm but not only can it display the input signals on two channels, it can **simultaneously** display the phase angle between them and measure the phase angle referenced to a zero phase calibration display. In addition to these unique features, you also have independent triggering from each channel to give stable displays even with widely differing input frequencies.



£278 + 8%

Absolutely indispensable to the professional audio engineer, the CS1575 is now in use all over the world. See it in action or send for complete details.

**TRIO
OSCILLOSCOPES**

The Trio range of oscilloscopes offer top quality at moderate cost. The brief specifications show the performance features which have made these oscilloscopes firm favourites in all parts of the world, with bandwidths to 30 MHz and sensitivities down to 1mV/cm on 130 mm screens. Prices are very realistic and we try to ensure that delivery is ex-stock at all times — quite a change these days.

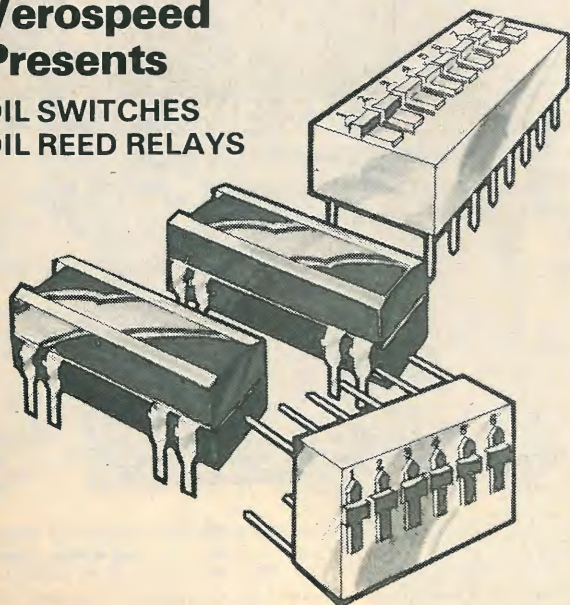
FOR FULL DETAILS ON THESE AND OTHER MODELS, CONTACT THE SOLE AGENTS, LOWE ELECTRONICS

WW — 092 FOR FURTHER DETAILS

BY RETURN

**Verospeed
Presents**

DIL SWITCHES
DIL REED RELAYS



For these and many other lines on the Verospeed hotline contact

Verospeed,
Barton Park Industrial Estate,
Eastleigh, Hampshire SO5 5RR
Tel: (0703) 618525

WW — 102 FOR FURTHER DETAILS

**1/2 watt ATTENUATORS
TERMINATIONS
IMPEDANCE
TRANSFORMERS**

MANUFACTURED BY ELCOM SYSTEMS INC.



LOW COST FAST DELIVERIES
FROM

Aspen Electronics Limited

Communications Equipment and Components
2 KILDARE CLOSE, EASTCOTE, RUISLIP, MIDDLESEX HA4 9UR
Telephone: 01-868 1188. Telex: 8812727

**THE BRIDGE BETWEEN
MANUFACTURERS & USERS
OF MICROELECTRONICS**

MICROSYSTEMS '79

West Centre Hotel,
Lillie Road, Fulham,
London, SW6
January 31 to
February 2

09.30-18.00 hrs each day



Now in its second great year, Microsystems is a combined conference and exhibition aimed at alerting industrialists and businessmen to the meaning of the microelectronic revolution.

Learn how to develop and use successfully the new micro-processor-based technologies. Hear a score of experts describe their design experiences and the latest products and development aids.
Find out what new skills are needed, what costs are incurred and how to maintain and test microprocessor-based systems.
Join the expanding group of small business and personal computing

enthusiasts, and listen to their experience and advice.
Talk to over 60 leading firms who will show, in the exhibition, new products and ideas for the solution of business and technical problems.
The Exhibition is free. The Conference costs £55 + VAT for each of the first two, professional days (£95 + VAT for a two-day ticket), and £7 + VAT for the final, personal computing, day.

Microsystems is sponsored by 'Computer Weekly', 'Microprocessors', 'Data Processing', 'Electronics Weekly', 'Systems International', 'Electron', 'Electrical Times', 'Electrical Review' and 'Wireless World' and is organised for them by Iiffe Promotions Ltd, Dorset House, Stamford Street, London, SE1 9LU.

USE THIS COUPON TO BOOK FOR MICROSYSTEMS

To: Microsystems, Room 821, Dorset House, Stamford Street, London, SE1 9LU.

Please send me: Conference details and registration forms A free exhibition ticket (Tick as required)

Name

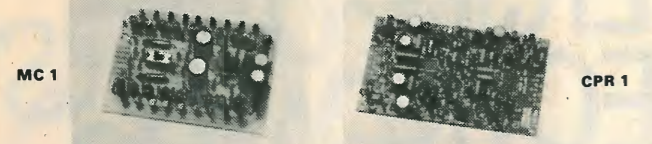
Address

WW

TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

STEREO PRE-AMPLIFIERS



CPR 1 — THE ADVANCED PRE-AMPLIFIER. The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion < 0.05% at 30dB overload 20kHz.

Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/μs; T.H.D. 20Hz—20kHz<0.08% at any level.

F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138x80x20mm. Supply to be ± 15 volts.

MC 1 — PRE-AMPLIFIER. Suitable for nearly all moving-coil cartridges. Sensitivity 70/170μV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3.5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

XO2:XO3 — ACTIVE CROSSOVERS. XO2 — two way, XO3 — three way. Slope 24dB/octave. Crossover points set to order within 10%.

REG 1 — POWER SUPPLY. The regulator module, REG 1 provides 15.0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS. It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification. T.H.D. typically 0.1% any power 1kHz 8 ohms. T.I.D. insignificant, slew rate limit 25V/μs; signal to noise ratio 110dB; frequency response 10Hz-35kHz, — 3dB, stability unconditional, protection drives any load safely; sensitivity 775mV (250mV or 100mV on request), size 120x80-25mm.

POWER SUPPLIES. We produce suitable power supply which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT. The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up services enables a novice to build it with confidence in a few hours.



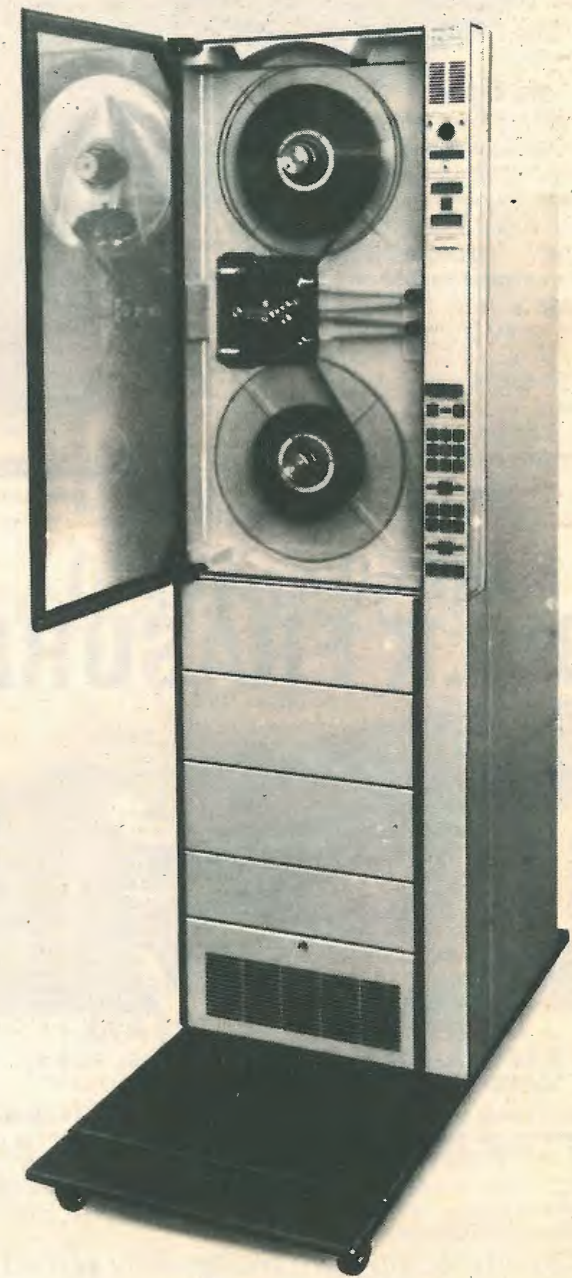
POWER AMPLIFIER MODULES	£16.30	POWER AMP KIT	£32.40
CE 608 60W/8 ohms 35-0.35v	£19.22	PRE-AMPS	
CE 1004 100W/4 ohms 35-0.35v	£23.22	These are available in two versions —	
CE 1008 100W/8 ohms 45.0.45v	£20.12	one uses standard components, and	
CE 1704 170W/4 ohms 45.0.45v	£22.68	the other (the S) uses MO resistors	
CE 1708 170W/8 ohms 60.0-60v	£31.90	where necessary and tantalum capaci-	
		tors	
TOROIDAL POWER SUPPLIES	£14.47	CPR1	£29.49
CPS1 for 2xCE 608 or 1xCE 1004	£16.82	MC1	£18.50
CPS2 for 2xCE 1004 or 2/4xCE 608	£15.31	CPRIS	£39.98
CPS3 for 2xCE 1008 or 1xCE 1704	£22.68	MC1S	£29.49
CPS4 for 1xCE 1008	£23.98		
CPS5 for 1xCE 1708		ACTIVE CROSSOVERS	
CPS6 for 2xCE 1704 or 2xCE 1708		XO2	£14.83
		XO3	£23.06
HEATSINKS	£1.30	POWER SUPPLY	
Light duty 50mm 2 C/W	£2.20	REG1	£6.75
Medium power 100mm 1.4 C/W	£2.85	TR6	£1.75
Disc/group 150mm 1-1 C/W	£18.50		
Fan 80mm, state 120 or 240v		BRIDGE DRIVER, BD1	
Fan mounted on two drilled 100mm heatsinks	£29.16	Obtain up to 340W using 2x170W	
2x4 C/W 65 max. with two 170W		amps and this module.	
modules	£1.38	BD1	£5.40
THERMAL CUT-OUT, 70 C			

CRIMSON ELEKTRIK

1A STAMFORD STREET, LEICESTER LE1 6MLL. Tel. (0533) 537722
U.K. — please allow up to 21 days for delivery

All prices shown are UK only and include VAT and post. COD 90p extra. £100 limit. Export is no problem, please write for specific quote. Send large SAE or 3 International Reply Coupons for detailed information. Distributor: Minic Teleprodukter, Box 12035, S-750 12 Uppsala 12, Sweden.

Bell & Howell. Sets a new performance standard in motor tape drives.



System 80 is designed, developed and built by Bell & Howell. Featuring a new dual-capstan, dual-motor tape drive, System 80 outperforms the competition. Real spectral purity and a low flutter specification are both achieved over a wide speed range. At 120i.p.s. System 80 brings you a capstan servo bandwidth of 1000Hz, a time-base error of a mere 200 nanoseconds, and a flutter figure of only 0.80% peak-to-peak.

Backed by the worldwide network of Bell & Howell companies and associates, System 80 is just one of the Company's comprehensive range of Datatape products for laboratory, military and industrial applications. Each one available with a wide selection of amplifiers, interfaces and accessories.

System 80 is supported by a team of specialist Sales Engineers throughout the U.K. plus qualified Applications and Service Engineers working from well equipped laboratories at Basingstoke.

For more information, contact:
Electronics & Instruments Division, Bell & Howell Limited,
FREEPOST, Basingstoke, RG22 4BR.
or telephone Basingstoke (0256) 20244.

Bell & Howell.
The symbol for
superior technology

BELL & HOWELL
Information systems. For work, education and entertainment.

WW — 083 FOR FURTHER DETAILS

MHz electronics

2111 WEST CAMELBACK SUITE B PHOENIX, ARIZONA USA (602) 242-3037

Type	Price	Type	Price	Type	Price
2N1561	\$15.00	2N5637	\$20.70	HEPS3006	\$19.90
2N1562	15.00	2N5641	4.60	HEPS3007	24.95
2N1692	15.00	2N5643	27.70	HEPS3010	11.34
2N1693	15.00	2N5764	27.00	HEPS5026	2.56
2N2857JAN	2.45	2N5862	50.00	MMCH918	1.00
2N2876	12.35	2N5913	3.25	MMT72	.61
2N2880	25.00	2N5922	10.00	MMT74	.94
2N2927	7.00	2N5942	49.50	MMT2857	1.43
2N2947	17.25	2N5943	1.75	MMT3960A	6.25
2N2948	15.50	2N5944	7.50	PT1865	3.00
2N2949	3.90	2N5945	10.90	PT4571A	1.50
2N2950	5.00	2N5946	13.20	PT8659	10.72
2N3287	4.30	2N6080	5.45	PT9784	24.30
2N3300	1.05	2N6081	8.60	PT9790	41.70
2N3302	1.05	2N6082	9.90	PT9847	26.40
2N3307	10.50	2N6083	11.80	JO4030	15.60
2N3309	3.90	2N6084	13.20	40281	10.90
2N3375	7.00	2N6094	5.75	40282	11.90
2N3553	1.80	2N6095	10.35	40290	2.48
2N3818	6.00	2N6096	19.35	TA7994	50.00
2N3824	3.20	2N6097	28.00		
2N3866	1.09	2N6136	18.70	FET,s	
2N3866JAN	4.14	2N6166	36.80	40673	1.39 or 10/10.00
2N3866JANTX	4.85	2N6439	43.45	3N123	1.35 or 10/10.00
2N3924	4.00	MM1500	32.20	2N5248	.60 or 10/ 4.50
2N3925	6.00	MM1550	10.00	MPF102	.45 or 10/ 3.50
2N3927	11.50	MM1552	50.00	MEM631	.63 or 10/ 5.30
2N3950	26.25	MM1553	56.50		
2N3961	6.60	MM1601	5.50	TERMS :	
2N4072	1.70	MM1602	7.50	All CHECKS and MONEY ORDERS ARE	
2N4073	2.00	MM1607	8.65	IN US FUNDS !!!	
2N4135	2.00	MM1620	17.50	ALL ORDERS SENT AIRMAIL DAY	
2N4427	1.24	MM1661	15.00	Please include \$2.50 Minimum for	
2N4430	20.00	MM1669	17.50	postage.	
2N4440	8.60	MM1943	3.00	ALL PRICES IN US DOLLARS.	
2N4957	6.30	MM2605	3.00	ALL PARTS PRIME/GUARANTEED.	
2N4958	4.35	MM2608	5.00	BANK AMERICARD/VISA/MASTERCARD	
2N4959	2.12	MM8002	2.05	Your Number;	
2N4976	19.00	MM8006	2.12	Exp. Date	
2N5070	13.80	MMF245	31.05	Your Signature	
2N5090	6.90	MRF304	43.45		
2N5108	3.90	MRF501	.49	IC,s	
2N5109	1.55	MRF504	6.95	MC1550C	1.50
2N5160	3.34	MRF509	4.90	MC1590C	6.50
2N5177	20.00	MRF511	8.60	MC4024P	3.27
2N5179	.68	MRF646	20.70	TMS4024	10.00
2N5184	2.00	MRF5177	20.70		
2N5216	47.50	MRFB004	1.90	Crystal Filters. Tyco 001-19880 same as 2194F	
2N5589	4.60	HEP76/S3014	4.95	10.7MHZ Narrow Band Crystal Filter	
2N5590	6.30	HEPS3002	11.30	3 db bandwidth 15khz minimum 20 db bandwidth 60khz minimum	
2N5591	10.35	HEPS3003	29.88	Ultimate 50 db : Insertion loss 1.0db Max. Ripple 1.0db Max. Cr. 0+ - 5pf. Rt. 3600 Ohms.	
		HEPS3005	9.55	Now Only \$ 5.95	

WW—037 FOR FURTHER DETAILS

IT'S SURPRISING HOW MANY PEOPLE MAKE COMPUTERS TO FIT OUR MEDIA

Our Disks

3M is the world's leading magnetic disk manufacturer. 3M can supply quality media, including disk packs, disk cartridges and data modules, for virtually every type of computer. They've all got the unique Crashguard Binder Formulation, which resists head impact damage, and virtually eliminates oxide build-up on the read/write heads.

Our Tapes

3M made the very first computer tape. Our Scotch computer tapes like Scotch 700 tape are designed and tested to give you better performance - especially on high-speed drives. Textured backing minimises cinching and damaged edges, reduces static attraction and surface damage, and maintains uniform signal output for the entire tape length.

Scotch 701 tape does the same, but with 33% more tape on the same size reel.

And if you have a D.E.C. computer using 3/4" tape, ask about Scotch 481 tape.

**Post this coupon now to Data Recording Products,
3M United Kingdom Ltd., FREEPOST, Bracknell, Berkshire RG12 1BR.**

We are interested in

Disk packs/modules Computer tapes

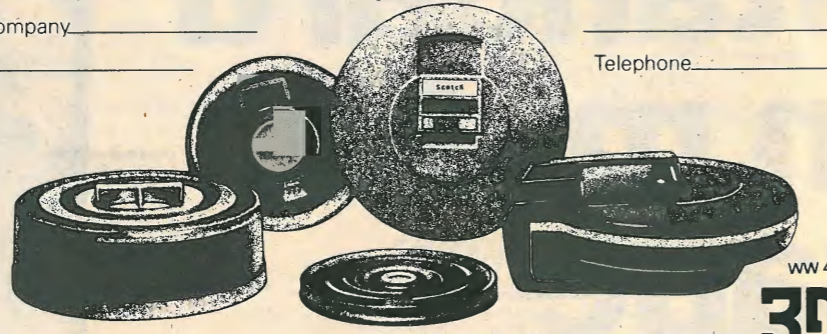
Disk cartridges Diskettes

Please specify other items _____

Name _____ Address _____

Position _____

Company _____ Telephone _____

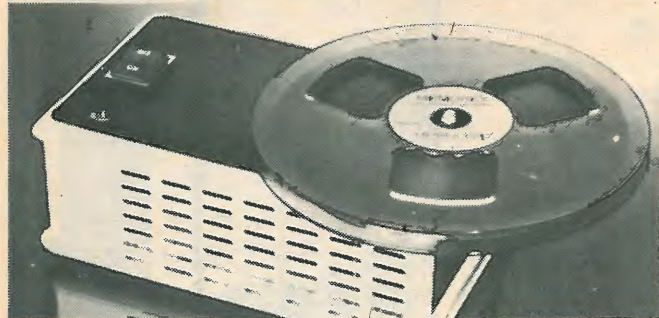


WW 4/79
3M

3M, Scotch and Crashguard are trademarks.

WW-079 FOR FURTHER DETAILS

VIDEO or AUDIO BULK ERASURE



LR71 MAX REEL-SIZE 11 1/2" VIDEO AND AUDIO

LR70 MAX REEL SIZE 8 1/2" AUDIO ONLY

LR70/71 bulk tape erasers are simple to operate and will erase cassettes, cartridges and reels of tape up to a maximum reel size of 11 1/2" and tape width of 1", quickly and efficiently.

LR70/71 bulk erasers are currently used in Broadcast Companies, Recording Studios, Government Departments, Educational Establishments and the Computer Industry.

Quality equipment moderately priced



LEEVERS-RICH EQUIPMENT LIMITED
319 Trinity Road, Wandsworth
London SW18 3SL
01 874-9054 Telex 923455

WW - 024 FOR FURTHER DETAILS

EXPORT ENQUIRIES INVITED!

pocket-sized
500 MHz FREQUENCY COUNTER
(CM 7044)
for UHF/VHF or CB mobile radio

- * ± 2ppm accuracy (0.0002%)
- * Overload protected
- * Built-in Ni-Cad battery pack
- * Exceptional value

Frequency Ranges (Switched)
(a) 10MHz - 50MHz
(b) 40 MHz - 500 MHz

Sensitivity
50 MHz range, 30 mV
500 MHz range, 50 mV

Display
7 digit, 7 segment LED display

Dimensions
4.75" x 2.6" x 1.25"
(121 x 67 x 32mm)



Labgear Labgear Limited Abbey Walk
Cambridge CB1 2RQ England
Telephone: 0223 66521 (7 lines) Telex: 81105 LAB
Telegrams: Labgear, Cambridge

WW - 100 FOR FURTHER DETAILS

The 935



full-function DMM
from
Data Precision

HANDY · VERSATILE · TOUGH · PRECISE

HANDY - easy to hold, to carry, to use, to read. Always at hand to make difficult measurements easy.

VERSATILE - all the functions and ranges you need... 29 in all: volts and amps, a.c. and d.c., switchable Hi and Lo ohms.

TOUGH - built to take the rough and tumble of field service and survive normally disastrous overloads the 935 will stay in cal.

PRECISE - basic 0.1% d.c. accuracy - better than many bench models!

VISIBLE - big, clear, high contrast 3 1/2 digit LCD display, readable anywhere. 1/2" characters.

EXPANDABLE - accessories extend measurements to 1000A, 40kV, r.f. at 700MHz or temperature from -60 to +150°C.

INEXPENSIVE - the 935 has the lowest price tag of any high performance hand-held DMM at £99 U.K. mainland delivered exc. VAT It uses a low cost PP9 battery which can give up to 200 hours use.

Get the leaflet now and see why your next multimeter should be a Data Precision 935!

sole U.K. agent

Contact:



Farnell International

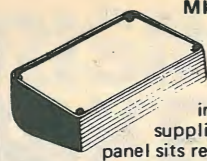
WETHERBY · WEST YORKSHIRE LS22 4DH · TEL: 0937 63541 · TELEX 557294 FARIST G OR LONDON OFFICE - TEL: 01 864 7433

WW - 088 FOR FURTHER DETAILS

BIMENCLOSURES

ALL METAL BIMCASES

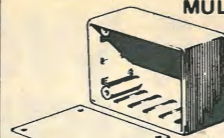
Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.
BIM 3000 (250x167.5x68.5mm) £14.58



MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.
BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05

MULTI PURPOSE BIMBOXES



Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.
BIM 4003 (85x56x28.5mm) £1.18
BIM 4004 (111x71x41.5mm) £1.62
BIM 4005 (161x96x52.5mm) £2.19

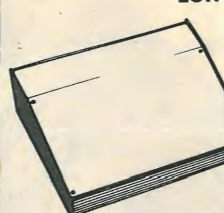
ALL METAL BIMCONSOLES



All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non-slip rubber feet. Ventilation slots in base and rear panel for excellent cooling. See latest catalogue for new styles and sizes

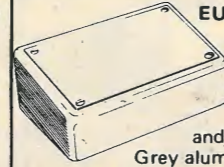
15° Sloping Panel		30° Sloping Panel	
BIM7151 (102x140x51 [28] mm)	BIM7301 (102x140x76 [28] mm)	£10.67	
BIM7152 (165x140x51 [28] mm)	BIM7302 (165x140x76 [28] mm)	£11.44	
BIM7153 (165x216x51 [28] mm)	BIM7303 (165x183x102 [28] mm)	£12.61	
BIM7154 (165x211x76 [33] mm)	BIM7304 (254x140x76 [28] mm)	£13.82	
BIM7155 (254x211x76 [33] mm)	BIM7305 (254x183x102 [28] mm)	£15.36	
BIM7156 (254x287x76 [33] mm)	BIM7306 (254x259x102 [28] mm)	£16.67	
BIM7157 (356x211x76 [33] mm)	BIM7307 (356x183x102 [28] mm)	£17.58	
BIM7158 (356x287x76 [33] mm)	BIM7308 (356x259x102 [28] mm)	£18.55	

LOW PROFILE BIMCONSOLES



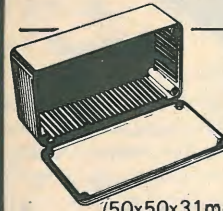
Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.
BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.37
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.08
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.12

EUROCARD BIMCONSOLES



Orange, Blue, Black or Grey ABS body accepts full or 1/2 size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.
BIM 8005 (169x127x70 [45] mm) £4.12
BIM 8007 (243x187x103 [66] mm) £6.10

ABS & DIECAST BIMBOXES



6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammetone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast		Hammetone	Natural
(50x50x31mm)	N/A		BIM5001/11	TBA	£1.02	
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12		£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13		£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14		£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15		£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16		£3.94	£3.33

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

BIMTOOLS + BIMACCESSORIES



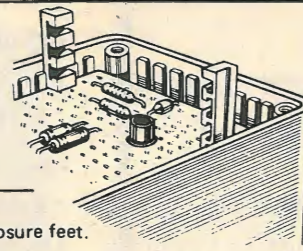
MAINS BIMDRILLS

Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks. Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with integral on/off switch £10.53
Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14

BIMDAPTORS

Allows pcb's to be flat mounted sandwich fashion in BIMBOXES, BIMCONSOLES, and all other enclosures having 1.5mm wide vertical guide slots. One plastic BIMDAPTOR on each corner of pcb(s) enables assembly to be simply slid into place. 54mm long, 10 slots on 5mm spacing and can be simply snapped off to length. £1.08 per pack of 25.



BIMFEET

11mm dia. 3mm high, grey rubber self-adhesive enclosure feet. £0.77 per pack of 24

12 VOLT BIMDRILLS

2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia. £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia. £13.60

Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 - £15.12, Major Kit 1 - £19.44. Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains-12V dc adaptor. Mini Kit 2 - £34.02, Major Kit 2 - £39.42. Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 - £45.36, Major Kit 3 - £50.76.

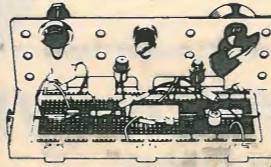
BIMPUMPS

2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.
BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80

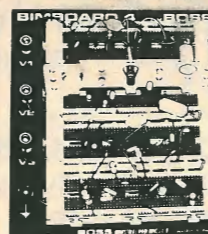
BIMIRONS

Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05
Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook. £4.43

BIMBOARDS



DIL COMPATIBLE BIMBOARDS



Accept all sizes (4-50 pin) of DIL IC packages as well as resistors, diodes, capacitors and LEDs. Integral Bus Strips up each side for power lines and Component Support Bracket for holding lamps, switches and fuses etc. Available as single or multiple

units, the latter mounted on 1.5mm thick black aluminium back plate which stand on non slip rubber feet and have 4 screw terminals for incoming power.

BIMBOARD 1 has 550 sockets, multiple units utilising 2, 3 and 4 BIMBOARDS incorporate 1100, 1650 and 2200 sockets, all on 2.5mm (0.1") matrix.

- BIMBOARD 1 £ 8.83
- BIMBOARD 2 £21.01
- BIMBOARD 3 £29.84
- BIMBOARD 4 £38.79

DESIGNER PROTOTYPING SYSTEM

1, 2, or 3 BIMBOARDS mounted on BIM 6007 BIMCONSOLE with Integral Power Supply (±5 to ±15Vdc @ 100mA and fixed +5Vdc @ 1A) All O/P's fully isolated. Short circuit and fast fold back protection. Power rails brought out to cable clamps that accept stripped wire or 4mm plug.

- DESIGNER 1 £55.62
- DESIGNER 2 £61.02
- DESIGNER 3 £66.42

...and now No.3!

This third book in Wireless World's popular series will be welcomed by all concerned with designing, using and understanding electronic circuits. It comprises information previously included in the third ten sets of Wireless World's highly successful Circards — regularly published cards giving selected and tested circuits, descriptions of circuit operation, component values and ranges, circuit limitations, modifications, performance data and graphs. The book follows on from Circuit Designs Nos. 1 and 2. It is magazine size in hard cover and contains ten sets of Circards plus additional information and an explanatory introduction. Like its predecessors, it may soon be difficult to obtain, so you are advised to order your copy without delay.

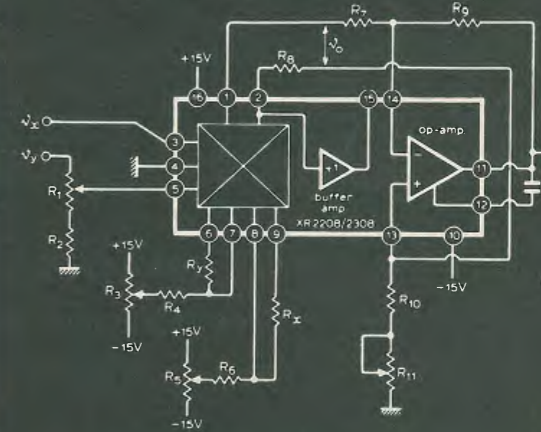
- Voltage to frequency converters.
- Amplitude modulators.
- Reference Circuits.
- Voltage regulators.
- RC oscillators — part 1.
- RC oscillators — part 2.
- C.M.O.S. — part 1.
- C.M.O.S. — part 2.
- Analogue multipliers.
- R.m.s./log./ power law circuits.

circuit designs

3

Collected Circards

PWilliams/JCarruthers/JHEvans/JKinsler



A WIRELESS WORLD PUBLICATION

A book from

wireless world

General Sales Department, IPC Business Press Ltd., Room CP34, Dorset House, Stamford Street, London SE1 9LU.

ORDER FORM

To: General Sales Department, IPC Business Press Limited, Room CP34, Dorset House, Stamford Street, London SE1 9LU.

Please send me.....copy's of Circuit Designs — Number 3 at £14.50 each inclusive. I enclose remittance value £..... (cheques payable to IPC Business Press Ltd.)

NAME.....
(please print)
ADDRESS.....

Company registered in England and a subsidiary of Reed International Ltd. Registered No. 677128. Regd. office: Dorset House, Stamford Street, London SE1 9LU.

ambit international

PARTS FOR CURRENT PW PROJECTS ... FROM AMBIT INTERNATIONAL

VHF FM monitor RX: A complete kit of parts for this project, which we firmly believe will be an established "standard" for years to come. The kit includes a 5 channel switched crystal oscillator added to the board end, using diode switching. Uses cheaper 3rd OT crystals, employing original oscillator as x3 stage. Price depends on filter selected (we have various types) and whether or not chip capacitors are required. More notes on the kit from our own lab. £25-£35 kit.

VMOS POWER TRANSISTORS FOR PW WINTON £9.95 pair * 2SK133/J48

FULL KITS FOR THE PW SANDBANKS METAL LOCATOR (should be ex stock)

FULL KITS FOR THE PW DORCHESTER

Radio ICs	
TDA1062	HF/VHF tunerhead 1.95
TDA1083	One chip AM/FM rx 1.95
TDA1090	One chip HiFi am/fm 3.35
TDA1220	One chip am/fm rx 1.75
HA1197W	HiFi AM tuner IC 1.40
CA3123E	AM tuner IC 1.40
TBA651	AM tuner IC 1.81
CA3089E	Famous FM IF system 1.94
CA3189E	As 3089+ deviation mute 2.75
HA1137W	Improved S/N 3089 2.20
TBA120	limiting amp+detector 0.75
TBA120S	high gain 1.00
MC1350P	agc'd IF preamp 1.20
MC1330P	synch AM/video detector 1.35
KB4406	Cascade IF preamp 0.65
uA753	limiting FM preamp 1.95

Discrete devices: more than ever:	
BF960	800MHz/2.8dB nf mosfet 1.60*
BF961	200MHz/2.0dB nf 0.80*
40822	FM RF amp 0.43*
40823	FM mixer 0.51*
40673	Famous MOSFET 0.55*
2S349/2sK133	120V/100W MOSPOWER output devices 10.50*

LEDS: the best value today	
Red	3mm 5mm 2.5x5mm 0.14 0.14 0.17
Green	0.18 0.16 0.20
Yellow	0.18 0.15 0.20
Orange	0.22 0.29 0.24

100 off mix, 25% discount. All are AEG first grade types - absolutely no junk, 5mm clips for panel mounting 0.03 each

Misc. ICs for radio/audio applications

U237B	5 LED bargraph driver 0.80*
SD6000	DMOS RF/Mixer pair 3.75
KB4412	Bal mixers, IF stage 2.55
KB4413	AM/SSB det. squelch, agc 2.75
KB4417	mic processor 2.55
MC3357	best thing in NBFM yet 3.12
MC1496P	popular double bal mixer 1.25

Multiplex decoders + noise blanker	
MC1310P	popular PLL decoder 2.20
uA758	buffered 1310 2.20
CA3090AQ	RCA PLL decoder 3.25
HA1196	improved PLL decoder with stereo preamps 3.95
HA11223	19kHz pilot cancel, low distortion, high S/N as HA11223 with remote 4.35
KB4437	VCO kill facility 4.55
KB4438	stereo MUTING preamp for post decoder mute 2.22
KB4423	impulse noise blanker 2.53

TERMS etc: CWO please, VAT on Ambit items is generally 12%, except where marked (*). Catalogue part 1:45p, part 2:50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays.

At last, DIY HiFi which looks as if it isn't.

That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb. A small pic here would be an insult, so send an SAE for details on the kit that looks as if it isn't. It's something else.....

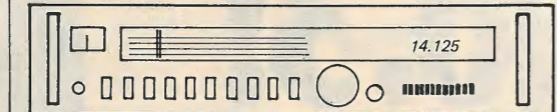
- * Exceptionally high performance - exceptionally straightforward assembly
- * Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- * Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- * Matching both the style and design concepts of the MkIII HiFi FM tuner
- * Hitachi VMOS power fets - characterized especially for HiFi applications
- * Power output readily multiplied by the addition of further MOSFETs
- * VU meters on the preamp - not simply dancing according to vol level
- * Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester-LW, MW, SW, & FM stereo tuner

THE DIGITAL DORCHESTER ALL BAND TUNER



With styling and dimensions to fit in with the rest of AMBIT's new range of tuner & audio equipment.

When the new range of OKI digital frequency display ICs was announced, the original prototype of the Dorchester had been made - but since so many of you wanted to use the OKI frequency counter display system with the Dorchester, we quickly designed a unit to incorporate the necessary facilities. The Digital Dorchester is designed in 19 inch form, and forms a perfect match for the other units in the range. If you don't want to go to the expense of the full Ambit DFM1 module, with AM/FM/Time/Timer, then the MA1023 clock module can be used instead.

The Dorchester has been described in PW Dec., Jan. and Feb. issues - but for those of you who may have missed it - it is an All Band broadcast tuner, covering LW/MW/SW and FM stereo in 6 switched ranges. Construction is very straightforward, with all the switching being PCB mounted - and the revolutionary TDA1090 IC used for AM/FM.

The electronics for the radio section of the Dorchester remain unchanged at £33.00, with 12.5% VAT. The hardware package, of case, meter, PSU now costs £33.00 + 8% with the MA1023 available for an extra £5 only. For the fully digital version, with Ambit DFM1, the price is £56.50 + 8% VAT.

2 Gresham Road, Brentwood, Essex.

WW-011 FOR FURTHER DETAILS

OSTS CD4000 CMOS

Since AMBIT introduced the "One Stop Technology Shop" to our service, we have been pleased to see just how many users of electronic components appreciate our guarantee to supply goods only from BS9000 approved sources. More than ever, professional and amateur electronics engineers cannot afford to waste time on anything less than perfect pedigree products.

SEE THE AMBIT AD TOO!

Micromarket PRICES SLASHED

4000	17p	4059	563p	4522	149p	8216	1.95	2114	£10	7400	'N'	'LSN'	'N'	'LSN'	'N'	'LSN'	'N'	'LSN'	LSN					
4001	17p	4060	115p	4527	157p	8224	3.50	2708	£10.55	7401	13	20	7455	35	24	74126	57	44	74185	134	74377	124		
4002	17p	4063	109p	4528	107p	8228	4.78			7402	13	20	7460	17		74128	74		74188	275	74378	93		
4006	109p	4066	53p	4529	141p					7403	14	20	7463	37		74132	73		74190	115	74379	130		
4007	18p	4067	400p	4530	90p	6820P	6.50			7404	14	20	7470	28		74133	28		74191	105	74386	37		
4008	80p	4068	25p	4531	141p	6850P	2.75			7405	18	26	7473	32		74136	40		74192	105	74390	140		
4009	58p	4069	20p	4532	125p	6852	3.65			7406	38		7474	27	38	74138	60		74193	105	74395	139		
4010	58p	4070	20p	4534	614p					7406	38		7475	38	40	74141	56		74195	95	74398	180		
4011	17p	4071	20p	4536	380p					7408	17	24	7476	37		74142	265		74196	99	74399	150		
4012	17p	4072	20p	4538	150p					7409	17	24	7478	37		74143	312		74197	85	74445	92		
4013	55p	4073	20p	4539	110p					7410	15	24	7480	48		74144	312		74198	150	74447	90		
4016	52p	4075	20p	4541	141p					7411	20	24	7481	86		74145	65		74199	160	74480	140		
4017	80p	4076	90p	4543	174p					7412	17	24	7482	69		74147	175		74248		74488	110		
4018	80p	4077	20p	4549	399p					7413	30	52	7483A	30		74148	109		74249	93	74670	249		
4019	60p	4078	20p	4553	440p					7414	51	130	7484	97		74150	99		74251	90				
4020	93p	4081	20p	4554	155p					7415	20	24	7485	104	99	74151	64	84	74253	105	MISCELLANY			
4021	82p	4082	20p	4556	77p					7416	30		7486	205	40	74153	64	54	74257	108	NE555	30p		
4022	90p	4085	82p	4557	386p					7417	30		7489	30	90	74154	65	110	74258	153	NE558	78p		
4023	17p	4086	82p	4558	117p					7420	16	24	7490	33	90	74155	54	110	74259	158	ICM7217	950p		
4024	76p	4089	150p	4559	388p					7421	29	24	7491	76	110	74156	80	110	74260	153	ICM7208	1495p		
4025	17p	4093	50p	4560	218p					7422	24	24	7492	38	78	74157	67	55	74261	353	ICL7106CP			
4026	180p	4094	190p	4561	65p					7423	27	27	7493	32	99	74158	60	60	74262	60	ICL7106P			
4027	85p	4096	105p	4562	530p					7425	27	27	7494	78		74159	210		74273	124	955p			
4028	72p	4097	372p	4566	159p					7426	36	27	7495A	65	99	74160	82	130	74275	312	LCD DVM KIT			
4029	100p	4098	110p	4568	281p					7427	27	29	7496	58	120	74161	92	78	74279	52	LCD DVM IC			
4030	58p	4099	122p	4569	303p					7428	35	32	7497	185		74162	92	130	74283	120	2480			
4031	250p	4160	90p	4572	25p					7430	17	24	74100	119		74163	92	78	74290	90	3% digit LCD			
4032	100p	4161	90p	4580	600p					7432	25	24	74104	63		74164	104		74293	95	display 1150p			
4033	145p	4162	90p	4581	319p					7433	40	32	74105	62		74165	105		74295	120	ICL7107 LED			
4034	200p	4163	90p	4582	164p					7437	40	24	74107	32	38	74166			74298	100	DVM kit 2065p			
4035	120p	4174	104p	4583	84p					7438	33	24	74109	63	38	74167	20		74324	157	ICM7216 - 8 digit			
4036	250p	4175	95p	4584	63p					7440	17	24	74110	54		74168			74325	242	10MHz DFM/			
4037	100p	4194	95p	4585	100p					7441	74	74	74111	68		74169		200	74326	247	timer £19.82			
4038	105p	4501	23p							7442	70	99	74112	88		74170	230	200	74327	237	(for LED C.cath)			
4039	250p	4502	91p							7443	115		74113	38	38	74172	625		74352	100	SCALAR ICs			
4040	83p	4503	69p							7444	112		74114	38	38	74173	170		74353	100	8629 150MHz			
4041	90p	4506	51p							7445	94		74116	198		74174	87	120	74362	715	divide by 100			
4042	85p	4507	55p	CA3130E	84p	LM339N	66p	5082	7650 red CA	7446	82		74118	83		74175	87	110	74365	49	420p			
4043	85p	4508	248p	CA3130T	90p	LM348N	186p	5082	7653 red CC	7447	82		74119	119		74176	75		74366	49	95H90DC 780p			
4044	80p	4510	99p	CA3140E	35p	LM3900N	60p	5082	7660 yellow CA	7448	56	99	74120	115		74177	78		74367	43	11C90DC 1400p			
4045	150p	4511	149p	CA3140T	72p	709HC	105 64p	5082	7670 green CA	7449	57	99	74121	25		74180	85		74368	49	by 100 or 10			
4046	130p	4512	96p	CA3160E	90p	709PC	dil 36p	5082	7670 green CA	7450	17		74122	46		74181	165	350	74373	77	For 120/60MHz			
4047	95p	4513	206p	CA3160T	99p	710HC	105 65p	5082	7673 green CC	7451	17	24	74123	48		74182	160		74374	77				
4048	60p	4514	260p	Op amps		710PC	dil 59p	0.3" Standard HP		7453	17		74124	38		74183		210	74375	60				
4049	55p	4515	300p	LM307AH	67p	723CN	65p	0.3" Standard HP		7454	17	24	74125	38	44	74184	135							
4050	55p	4516	125p	LM307AN	30p	741CH	105 66p	0.5" Fairchild																
4051	65p	4517	382p	LM308H	121p	741CN	8dil 27p	5082	7740 red CC															
4052	65p	4518	103p	LM308N	97p	747CN	70p																	
4053	65p	4519	57p	LM318H	279p	748CN	36p																	
4054	120p	4520	109p	LM318T	279p	NES31T	12cp																	

TPA SERIES D

— PROVEN POWER

Only the best designs stand the test of time. The reliable power of the TPA Series D has been a consistent choice of professional audio engineers.



- 19" x 3 1/2" rack mounting
- Load sensing output protection circuits
- Stable into loads of any impedance characteristic
- Available with a range of connectors and line transformers
- TPA 100 D incorporates plug-in PCB's and power transistors
- AM 8/12 fits loudspeakers enclosures for monitor purposes
- Conservative power rating 25,50 and 100W RMS. Full power at 15 ohms
- At 8 ohms power rating of 45,80 and 170W RMS
- Designed to operate in ambient temperatures in -25°C $+50^{\circ}\text{C}$ range

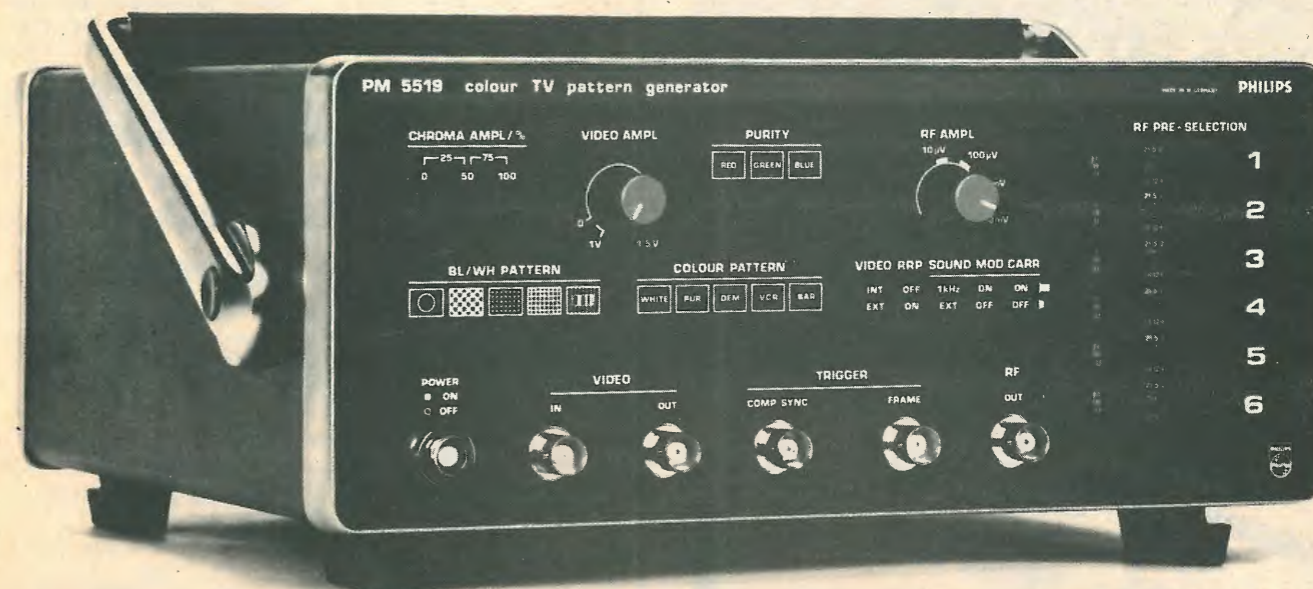
For further information please contact



VIKING WAY BAR HILL
CAMBRIDGE CB3 8EL
TEL: CRAFTS HILL (0954) 81140
TELEX: 817515 HH ELEC G
PROFESSIONAL
AUDIO ELECTRONICS

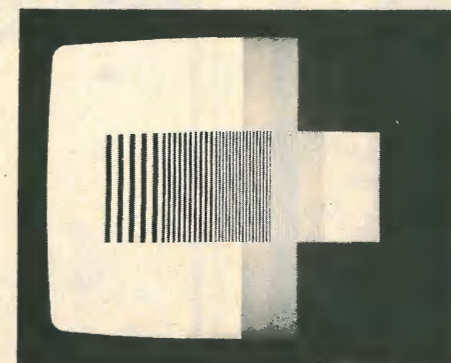
WW — 093 FOR FURTHER DETAILS

The professionals' colour pattern generator



Over 20 patterns to CCIR or RTMA standards

- Full RF coverage: TV IF, Band I-III-IV and V.
- Electronic tuning and choice of six preset channels.
- Synchronisation according to TV standard, also obtainable as composite and frame sync.
- Adjustable Video, calibrated chroma/burst and variable RF amplitude.
- Internal/external video and sound modulation.



Linearstaircase signal with 8 identical steps combined with definition pattern of 5 vertical bars at 0.8 - 1.8 - 2.8 - 3.8 and 4.8 MHz.

This pattern generator is the finest available for precise measurement and alignment work on video equipment including domestic TV receivers, VCR's, VTR's, VLP's, closed circuit and cable TV installations. Service technicians, video development engineers, TV broadcast staff and lecturers will all appreciate the quality and ease of use of this compact but very versatile pattern generator. More than 20 patterns are available on six channels frequencies using instant touch-button selection. The RF, video and trigger outputs are superior to many other portable generators and closely resemble those transmitted from your local TV station.

Find out more about the PM 5519 and the rest of the Philips audio and video service equipment range by requesting our new Service Brochure.



Test & Measuring
Instruments



Pye Unicam Ltd
Philips Electronic Instruments Dept
York Street, Cambridge, England CB1 2PX
Tel: Cambridge (0223) 58866 Telex: 817331

PHILIPS

□ OSCILLOSCOPES 10 - 150 MHz □ DIGITAL & ANALOGUE MULTIMETERS □ CONVERSATIONAL DATA LOGGERS □ RECORDERS CHART & X - Y □ LF & RF OSCILLATORS □ MICROWAVE EQUIPMENT
□ DC POWER SUPPLIES & AC STABILIZERS □ FREQUENCY COUNTERS & TIMERS □ TV STUDIO & TRANSMISSION INSTRUMENTATION □ PULSE GENERATORS □ AUDIO & VIDEO SERVICE EQUIPMENT

WW — 086 FOR FURTHER DETAILS



Clip and Save

Clip-on Thermalloy "Slip Clip" heat sinks and save assembly time, board space, and heat sinks costs. They require no mounting hardware, PC board drilling, or adhesives, and clamp firmly to the device for maximum heat transfer. "Slip Clips" are available for TO-202, TO-220, TO-126, Motorola case 90 and most other popular case styles.

Thermalloy
Number one in Semiconductor Accessories



Plastic Power Coolers

New low profile heat sinks save board space. The 6073B requires only 750" board space and is just 375" tall - the right heat sink for 500" centreline PC board applications. Cools SCR's and transistors in TO-220, Motorola Case 70 and Case 90 packages. Dissipates 21° C/watt in natural convection. Available in Black Anodized and Pre-Black Anodized finish.

Thermalloy
Number one in Semiconductor Accessories

Full data and Free sample on request.



MCP Electronics Limited
Station Wharf Alperton Wembley Middx.
Telephone: 01-902 5941

WW - 077 FOR FURTHER DETAILS

AURA SOUNDS

THE WERSI SPECIALISTS
announce the opening of their

NORTHERN SHOWROOM

at 17 UPPER CHARTER ARCADE, BARNSELY

FOR

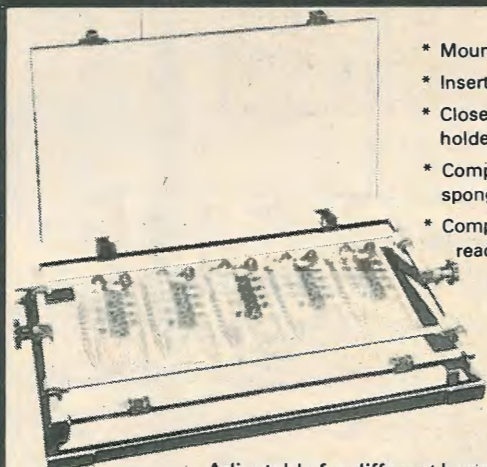
WERSI ORGANS D.I.Y. KITS LPs

Catalogues and Price Lists—£1.00 from

AURA SOUNDS

Copthorne Bank, Crawley, W. Sussex
Telephone: 0342 713338

TURNOVER PCB ASSEMBLY HOLDERS



- * Mount PCB
- * Insert components
- * Close lid and turn holder over
- * Components held by sponge lid
- * Components legs ready for cutting, clenching and soldering

Adjustable for different board sizes.
Three sizes available for maximum board areas:
270 x 220, 500 x 220, 750 x 220 mm

Antistatic models available
Component lead preforming equipment also available
Demonstrations and catalogues on request

ERASER INTERNATIONAL LTD.

3 HAMPTON COURT PARADE EAST MOLESEY
SURREY KT8 9HB ENGLAND
Telephone: 01-9798141/2 Telex: 928698

WW - 015 FOR FURTHER DETAILS

RADFORD

AUDIO MEASURING INSTRUMENTS

Oscillators

LDO3. Low Distortion Oscillator £300.00
LDO3B. Low Distortion Oscillator, balanced output £400.00

Distortion Measuring Sets

DMS3. Distortion Measuring Set, manual nulling £250.00
DMS4. Distortion Measuring Set, auto-nulling £350.00

Voltmeters

HSV1. Audio Microvoltmeter, average responding £175.00
HSV2. Audio Microvoltmeter, true r.m.s. reading £225.00

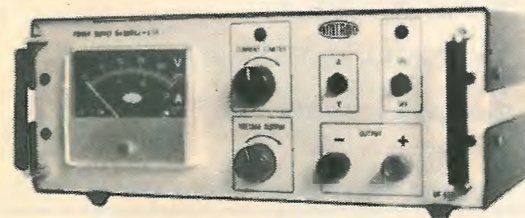
Noisemeters (psophometers)

ANM1. Audio Noisemeter and Microvoltmeter, average responding £200.00
ANM2. Audio Noisemeter and Microvoltmeter, true r.m.s. reading £250.00
ANM3. Audio Noisemeter and Microvoltmeter, true r.m.s. and quasi-peak responding £300.00

Descriptive leaflets available on request.

RADFORD LABORATORY INSTRUMENTS LTD.
4 High Street, Nailsea, Bristol BS19 1BW
Tel. 02755-6637

7 HUGHENDEN ROAD, HASTINGS, SUSSEX TN34 3TG
Telephone: HASTINGS (0424) 436004



UK677 KIT

Stabilized Power Supply
Variable Voltage 0-20v = 2.5 amp
Variable Current Limiting
LED Current Limit Indicator
Calibrated Metering for Current and Voltage
Load Regulation 0.15%
Ripple < 1mV
Input Voltage 115-220-250 v A.C. 50-60 Hz
All Aluminium Cabinet

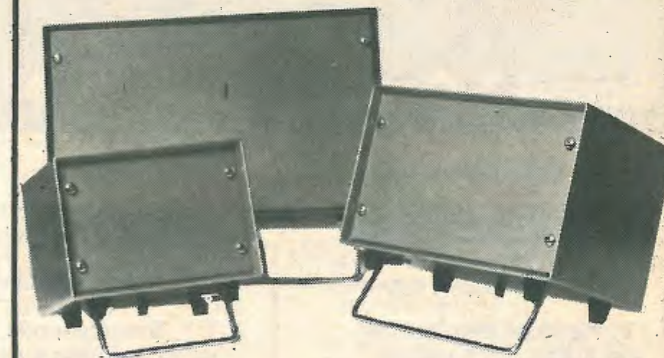
£36.73 + VAT

Trade and Export Enquiries Welcomed

WW-087 FOR FURTHER DETAILS

OLSON

MINICASES



Type	Overall Dimension			Case no vents	Case with vents	Chrome leg
	Width	Height	Depth			
21	6 1/2"	4 1/2"	4 1/2"	—	5.88	1.15
22	8 1/2"	5 1/2"	5 1/2"	—	6.50	1.15
23	10 1/2"	6 1/2"	6 1/2"	—	7.70	1.30
24	12 1/2"	7 1/2"	7 1/2"	—	8.45	1.30
25A	6 1/2"	4 1/2"	4 1/2"	5.60	6.20	1.30
25B	6 1/2"	4 1/2"	6 1/4"	6.00	6.60	1.30
26A	8 3/4"	5 3/4"	6 1/4"	7.90	8.50	1.30
26B	8 3/4"	5 3/4"	8 1/4"	8.25	8.85	1.30
27A	12 1/4"	7 1/2"	5 1/2"	8.65	9.35	1.30
27B	12 1/4"	7 1/2"	8"	9.35	10.05	1.30
28A	14"	10 1/2"	6 1/2"	10.20	10.90	—
28B	14"	10 1/2"	8 1/2"	11.15	11.85	—
29A	10"	4"	6"	7.15	7.75	1.30
29B	10"	4"	8"	7.53	8.13	1.30
30A	12"	5"	6"	7.80	8.50	1.30
30B	12"	5"	8"	8.15	8.85	1.30
31A	14"	6"	6"	8.50	9.20	1.30
31B	14"	6"	8"	8.93	9.63	1.30
61	15 1/2"	7 1/2"	9 1/2"	—	13.00	—
62	17 1/2"	8 1/2"	9 1/2"	—	15.00	—
63	16 1/2"	9 1/2"	9 1/2"	—	15.00	—
64	15 1/2"	7 1/2"	12 1/2"	—	15.00	—
65	17 1/2"	8 1/2"	12 1/2"	—	17.15	—
66	16 1/2"	9 1/2"	12 1/2"	—	17.15	—

Postage & VAT extra

INSTANT TRUNKING SYSTEM!

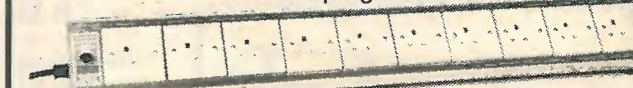


Ready to use. Internal wiring suitable for 30 amp

TR6 — 6 sockets switched £21.50
TR9 — 9 sockets switched £25.50
P&P £1.85 +VAT

PORTABLE POWER DISTRIBUTION FOR INSTANT MAINS!

NEW! 10 sockets switched
in sloping box



Type 13A/10SW £27.50. P&P £1.85 + VAT

COMPLETE WITH 6FT. CABLE AND 13 AMP FUSED PLUG

4 sockets 13A £12.15
6 sockets 13A £14.30
4 sockets 13A switched £13.75
6 sockets 13A switched £15.95

ALL DISTRIBUTION PANELS ARE FITTED WITH MK SOCKETS & PLUG
Send for details of complete range+postage 85p each+8% V.A.T.
OLSON ELECTRONICS LTD., FACTORY NO. 8, 5-7 LONG ST., LONDON E2 8JH
TEL: 01-739 2343

WW-082 FOR FURTHER DETAILS



Design, manufacture & installation
 Audix Limited
 Station Road, Wenden
 Saffron Walden
 Essex CB11 4LG
 Tel: Saffron Walden (0799) 40888
 Telex: 817444

Sound & Communications systems

Please send me details

- Sound reinforcement/public address equipment
- Theatre sound equipment
- Hospital distribution and nurse call systems
- Intercom systems, commercial & industrial
- Hotel entertainment systems
- Simultaneous interpretation and conference systems

Name _____
 Address _____



Build any Project - Fast and Easy

It's the new deal for project builders from Lektrokit! A complete new range of breadboarding and testing devices. At prices anyone can afford. For any project anyone could want to build - from one-chip simplicity to 1,000-chip complexity.

It's fast and easy project building, too. You simply push components in and pull them out. No soldering, no de-soldering, no chance of heat damage. You can make design changes instantly, keeping full leads on components.

In fact, with Lektrokit, you can build a project as fast as you used to sketch a layout. And a lot more easily.

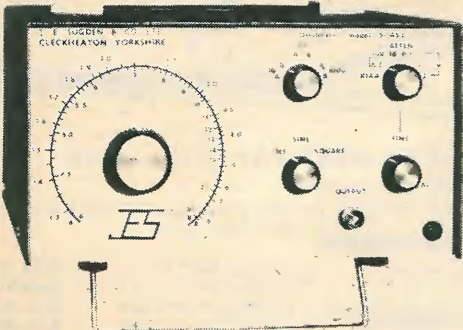
LEKTROKIT completes the circuit

See Lektrokit at one of the Lektrokit dealers near you. There's bound to be one they're springing up everywhere. Send for the name of your nearest - plus FREE full-colour catalogue - to:

Lektrokit Ltd., Sutton Industrial Park,
 Earley, Reading, Berks RG6 1AZ
 Telephone 0734 669 116

WW - 060 FOR FURTHER DETAILS

JES AUDIO INSTRUMENTATION



Illustrated the Si453 Audio Oscillator
SPECIAL FEATURES:

- ★ very low distortion content—less than 0.03%
- ★ an output conforming to RIAA recording characteristic
- ★ battery operation for no ripple or hum loop
- ★ square wave output of fast rise time

£70.00

also available

Si451 Millivoltmeter

- ★ 20 ranges also with variable control permitting easy reading of relative frequency response

£70.00

Si452 Distortion Measuring Unit

- ★ low cost distortion measurement down to 0.01% with comprehensive facilities including L.F. cut switch, etc.

£56.00

ALL PRICES PLUS VAT

J. E. SUGDEN & CO. LTD., CARR STREET, CLECKHEATON, W. YORKS. BD19 5LA.

Tel. 0274-872501

WW - 023 FOR FURTHER DETAILS



MODEL 756 FULL ASCII KEYBOARD LOW COST!
 Fully Assembled

- 756 KEYBOARD**
- * Intended for professional micro-processor applications.
 - * This one Keyboard will meet most present and future requirements.
 - * Full 128-character ASCII 8-bit code Tri-mode MOS encoding.
 - * Applications notes for auto repeat, numeric pad, serial output.
 - * Upper and lower case characters generated by keyboard with latching shift-lock.
 - * Selectable polarity.
 - * Size 305 X 140 X 32mm (12 1/4 X 5 1/2 X 1 1/4 in)
 - * MOS/DTL/TTL compatible outputs.
 - * New guaranteed OEM grade components.
 - * Needs +5 and -12V supply
- * Board has space for small low cost DC/DC converter so that entire unit operates off single 5V rail.

NUMERIC KEYPAD

£49.90 + VAT

Also available:
 Numeric keypad — interfaces with 756 £7.50
 DC to DC converter to give -12V £5.00
 (Mounts direct on 756 P.C.)
 Plastic enclosure type 701 £10.75
 Gold plated edge connector type 756/con £1.95

Generous Quantity Discounts Available
 U.K. orders add 8% VAT on order total.
 All U.K. enquiries to
CITADEL PRODUCTS LTD.
 50 High St., Edgware, Middx. HA8 7EP
 Tel.: 01-951 1848

- * Alpha lock.
- * Extra loose keys available.
- * Supplied complete with full technical data.
- * Rugged mil. spec. G-10 PCB with plated through holes.
- * 2-key roll-over
- * DC level and pulse strobe signal for easy interface to any 8-bit input port microprocessor system, video display or terminal board. Strobe pulse width 1 ms.
- * User selection of positive or negative logic data and strobe output.



Carter Associates
 P.O. Box 11262 VLAEBERG
 South Africa postal code 8018

WW-028 FOR FURTHER DETAILS

QUARTZ CRYSTALS - FAST!

AEL

AEL CRYSTALS LIMITED
 Gatwick House, Horley, Surrey, England RH6 9SU
 Telephone: Horley (02934) 5353 Telex: 87116 (Aerocon Horley)
 Cables: Aerocon Telex Horley

WW - 056 FOR FURTHER DETAILS

carbon film RESISTORS
 ON BANDOLIERS OR PREFORMED 12.5mm AT NO EXTRA COST

Z & I AERO SERVICES LTD.
 42-44A-46 Westbourne Grove
 London W2 5SF
 Tel. 01-727 5641 Telex 261306

WW-053 FOR FURTHER DETAILS

THE MOST COST EFFECTIVE FREQUENCY COUNTERS
 ALL COUNTERS SUBJECTED TO 500-HOUR SOAK TEST AND CRYSTAL AGEING

OFF/AIR FREQUENCY STANDARD TYPE 103
 10MHz, 1MHz
 Stability 1 part 10⁸ £108

FREQUENCY COUNTER TYPE 801B
 CRYSTAL OVEN STABILITY 3 PARTS 10⁹
 401A 50MHz 6 Digit £150
 701A 80MHz 8 Digit £210
 901M 520MHz 8 Digit £395
 1001M 1.2GHz 8 Digit £670
 Start/Stop versions Plus £18

LED COUNTERS
 302 50MHz. 5 digit £108
 All standard counters in centre column now available as the 02 Series with LEDs. STABILITY 5 PARTS 10⁷

RCS ELECTRONICS, 6 WOLSEY ROAD, ASHFORD, MIDDX. ASHFORD 53661

SUPPLIERS TO: Ministry of Defence, G.P.O., B.B.C., Government Depts., Crystal Manufacturers and Electronic Laboratories world-wide for 18 years.

WW - 099 FOR FURTHER DETAILS

Revolutionary manually operated portable **CUT-BEND MACHINE**

- High capacity production: up to 40,000 pcs/hr
- Low capital investment
- New, fully adjustable pitch and leg length
- Pitch size is transposed directly from board to machine
- Neat and compact size
- Any adjustment can be made in seconds



You can produce 20,000 cut-bends whilst others are setting-up their machines!

PLEASE SEND ME MORE DETAILS AND PRICE

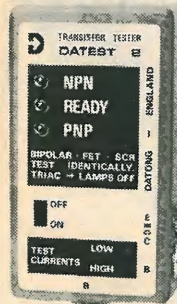
NAME

ADDRESS

POST THIS COUPON NOW TO: **WW**
ADCOLA PRODUCTS LTD, ADCOLA HOUSE, GAUDEN ROAD,
LONDON, SW4 6LH Tel 01-622 0291/3 Telex 21851 ADCOLA

WW-018 FOR FURTHER DETAILS

NEW TESTER



Designed for fast **in-circuit** testing, new **DATEST 2** tests transistors, FETs, SCRs and Triacs even when shunted by resistors **as low as 20 ohms**. It will usually test every device in even a DC coupled AF power amp. or in a colour TV (except line o/p) **while still in circuit**.

Automatic NPN/PNP indication, foolproof three-LED display, and unique test-probes allow a very high rate of testing even by unskilled users.

Other features include long battery life, low battery warning, rugged die-cast case, reliable six-IC circuit. Best news of all. **DATEST 2** is affordable and available from stock.

Full data sheet free on request.

ONLY £39.50
 + VAT (8%)
 WITH PROBES

DATONG ELECTRONICS LIMITED
 Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE
 Telephone: Pudsey (0532) 552461

WW-052 FOR FURTHER DETAILS

Cables
Cords
Connectors

we have a wide range at our fingertips

FUTURE FILM DEVELOPMENTS
 36/38 Lexington Street, London W1R 3HR
 Telephone 01-437 1892/3 • Telex 21624ALOFFD G

WW - 051 FOR FURTHER DETAILS

8-digit universal counter-timer

new

This amazingly versatile new module will count:

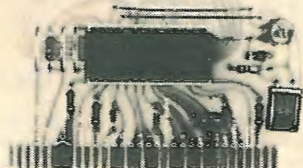
- FREQUENCY from 0.1Hz to 10MHz (150MHz with prescaler)
- PERIOD from 0.5 micro seconds to 100ms (resolution of 0.1 micro sec)
- TIME INTERVALS with a 0.1 micro second gate
- FREQUENCY RATIO between two inputs
- 8-DIGIT TOTALISING counts up to 100 million events

Full details of this and many other brand new digital display products are given in New Product Bulletin No 3

STOP PRESS - £10 OFF
NOW ONLY £44.95
 + £4.49 P&P + VAT. Total £49.44

Counter timer £54.95 6.49
 150MHz Prescaler 11.95 1.19
 Mounting Bezel 3.95 0.39

12345678



LASCAR ELECTRONICS LTD., P.O. BOX 12, SECOND AVENUE,
BILLERICAY, ESSEX Tel: Billericay (02774) 3394

WW - 062 FOR FURTHER DETAILS

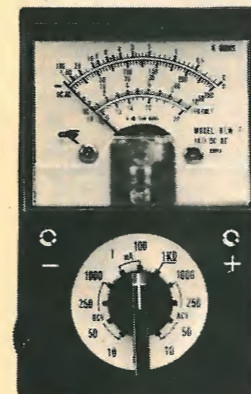
NOT EVERY CABLE HAS A LABEL



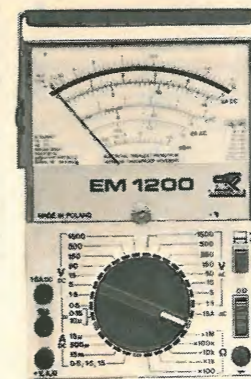
Everyone who works with electricity needs to know at some time or other what's going on inside the cable he's handling. What voltage. What current. What resistance. Not knowing the answers, or worse still having inaccurate answers, can make life difficult, even terminal.

Eagle Test Equipment gives the right answers

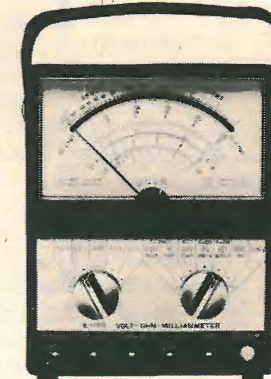
The range covers general multimeters, high voltage probes, clamp meters, insulation testers. Here are just four. Send the coupon for details of all the rest.



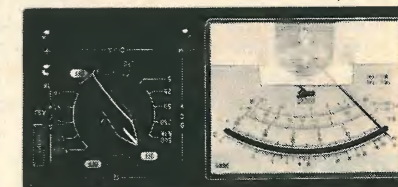
KEW 7 Multimeter
 1000 OPV. DC volts up to 1000, DC amps up to 100 mA. AC volts up to 1000. Resistance up to 150 Kohms. Pocket size. "Off" damping. Complete with leads & battery. R.R.P. £6.95 ex. VAT.



EM 1200 Multimeter
 100,000 OPV. Taut band movement. Overload protection. Reversible DC polarity. AC amps: 15, AC volts to 1500. DC amps up to 15, DC volts to 1500. Resistance up to 200 megohms. R.R.P. £49.95 ex. VAT.



K1400 Multimeter
 20,000 OPV. DC and AC volts up to 5000. DC and AC amps up to 10. Resistance up to 20 megohms. "Off" damping. Overload protection. R.R.P. £79.35 ex. VAT.



EM10, 20 & 30 Multimeters
 10, 20 & 30,000 OPV. All with antiparallax mirror scale. DC volts to 1000 (1200 for EM30). DC amps to 250 mA (600 for EM30). AC volts to 1000 (1200 for EM30). Resistance up to 6.5 and 60 megohms respectively. R.R.P.'s EM10 £13.50 EM20 £17.25, EM30 £20.75 ex. VAT.

Test Equipment: EAGLE



Please send me details of your complete range of Test Equipment.

Name _____ Company _____

Address _____

EAGLE INTERNATIONAL Precision Centre, Heather Park Drive, Wembley, Middlesex HA0 1SU.

WW4

WW-080 FOR FURTHER DETAILS



PHILIPS

AIWA	D 555	▲	AH 985	▲	TANDBERG	
AD 1250	○	D 560	▲	AH 988	▲	TCD 320
AD 6350	▲	D 580	▲	AH 989	▲	TCD 340A
AD 6400	▲	D 850	○	AH 993	▲	TEAC
AD 6550	▲	D 900	○	AH 994	○	A 103/6/7/8/9
AD 6600	▲	TRQ247	●	PIONEER	▲	A 300
AD 6800	▲	TRQ299	●	CTF 700	▲	A 303
AD 6900	○	ITT		CTF 900	▲	TECHNICS
AKAI	ST 65	●	CTF 1000	○	M 22	
GXC702D MkII	▲	ST 720	●	CT 500	▲	M 33
GXC704D	▲	HIFI8021	▲	CT 606	▲	M 56
GXC706D	▲	JVC		PYE	▲	M 85
GXC709D	▲	CD 1635 MkII	○	1605	▲	RSM 75
GXC725D	○	CD 1770	○	3537	▲	RS 631
GXC730D	▲	KD 55	▲	6000	▲	RS 641
CS34D	▲	KD 65	□	SANSUI	▲	RS 673
AMSTRAD	KD 85	□	SC 1100	▲	RS 640USD	
7050	■	KD 720	▲	SC 1110	▲	TRIO
7060	■	KDA3/5/8	□	SC 2002	○	KX 530
7070	■	NAKAMICHI		SC 2100	▲	KX 830
EX700	●	DT 350	▲	SC 2110	▲	KX 1030
B&O	NATIONAL PANASONIC		SC 3000	○	TOSHIBA	
Beocord 1900	▲	RQ 312DS	▲	SC 3100	▲	PCD 15
Beocord 5000	▲	RQ 2106	●	SC 3110	▲	PC 230/D
DUAL	RS 612US	▲	SC 5100	▲	PC 335	
C809	○	PHILIPS		SANYO	▲	PC 530
C819	○	N2213	●	M 2522	●	PC 3030
GRUNDIG	N 2215	●	RD 4028	□	PC 4020	
CN 830	○	N 2228	●	RD 4260	○	PC 4030
CN 930	▲	N 2233	●	RD 5150	▲	PC 5060
CN 1000	○	N 2234	●	RD 5300-2	□	PC 5460
CNF250	■	N 2501	○	RD 5500	○	PC 6030
CNF300	■	N 2511	○	RD 5600	▲	UHER
CNF350	■	N 2515	○	SONY	○	CR 240
HARMAN KARDON	N 2520	○	TC 158SD	□	CG 310	
HK 1500	▲	N 2521	□	TCK 7A/8B	□	CG 340
HK 2500	▲	N 2534	□	TCK 1	○	CG 362
HK 3500	○	N 2538	□	TCU 2	○	YAMAHA
HITACHI	N2541	□	TCK 4	□	TC 520	
D 220	▲	N 2543	□	TCK 5	○	TC 511S
D 440	□	AH 970	■	TCK 6	□	
D 550	▲	AH 979	▲	TCK 60	□	

Philips present a biased guide to cassettes.

Naturally we feel that our cassette tapes are the best. After all, we invented the compact cassette. But this has not led to complacency. There are now five Philips cassettes available from your audio dealer, and the chart above shows which one is best suited to each cassette deck.

But don't take our word for it. Try a Philips cassette in your machine, and draw your own conclusions.



Simply years ahead



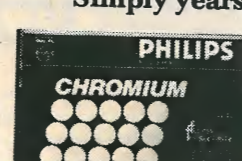
● Low noise tape. Balanced output and response.



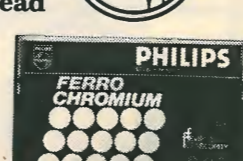
■ High output. Low noise. Suitable for machines with low bias settings.



▲ High output. Low noise. Suitable for machines with higher bias settings.



○ Chromium Dioxide coating. Improved high frequency reproduction.



□ Combines the best characteristics of Ferric and Chromium Dioxide tape coating.

WW-067 FOR FURTHER DETAILS

wireless world

Micro mania

Editor:
TOM IVALL, M.I.E.R.E.

Deputy Editor:
PHILIP DARRINGTON
Phone 01-261 8435

Technical Editor:
GEOFFREY SHORTER, B.Sc.
Phone 01-261 8443

Projects Editor:
MIKE SAGIN
Phone: 01-261 8429

Communications Editor:
RAY ASHMORE, B.Sc., G8KYY
Phone 01-261 8043

Drawing Office Manager:
ROGER GOODMAN

Production:
ALAN KERR

Advertisement Controller:
G. BENTON ROWELL

Advertisement Manager:
BOB NIBBS
Phone 01-261 8622

DAVID DISLEY
Phone 01-261 8037

Classified Manager:
BRIAN DURRANT
Phone 01-261 8508 or 01-261 8423

BARRY LEARY (Classified Advertisements)
Phone 01-261 8508

JOHN GIBBON (Make-up and copy)
Phone 01-261 8353

Publishing Director:
GORDON HENDERSON

The government's plans to encourage microelectronics, announced last year, are most welcome. Not only are they helping the development and manufacture of integrated semiconductor devices within the UK electronics industry to the tune of £70 million spread over five years; they are also encouraging the whole of British industry to apply microprocessors to plants in the UK to make them more efficient and to the design of new products to make them more competitive than earlier ones on world markets (initial support £15 million). In all this they are backed up

enthusiastically by the semiconductor chip manufacturers and the organizers of private courses and conferences on microelectronics.

On the face of it this is all good news. The campaign does, however, carry with it all the dangers of over-selling that we saw in industrial electronics in the 1950s and in computers in the early 1960s. When some people discovered the limitations of what they had bought — maybe in performance, reliability or suitability to their needs — their disappointment led to an over-reaction against the new technology and the net effect was a setback for electronics and computers. A more considered approach by the campaigners would have had better results.

At the moment microelectronics is being presented as a brand-new technology which has suddenly arrived out of nowhere, when of course it is simply electronics in modern dress and qualitatively can do no more than the old-fashioned electronics with valves and discrete transistors could do, namely the transmission and processing of information. The microprocessor is being presented as a miraculous invention which by itself can transform British industry overnight if only people will use it. That it needs software which is becoming increasingly complicated and expensive to provide, that it will probably need storage, interfaces and other supporting electronics, and that

the design problems and cost of the electrical or mechanical system within which it must function will probably exceed those of the electronics hardware many, many times, all these facts and other difficulties such as labour relations are not being given proper weight in the propaganda. From what he has gathered so far, a typical factory manager might well think he only has to send the works electrician on a fortnight's course to get boned up on these microelectronics gadgets for the firm to leap dramatically into the technological age in one bound and astonish its rivals with its efficiency.

As we know, higher productivity is brought about by technical changes in methods of manufacture, but these are taking place on a broad front and include a variety of things such as better organization of work and the use of new materials. Productivity is improved not only through the reduction of labour input for a given product output but also by increasing the utilisation of capital equipment and reducing the wastage of raw materials. A recent American study on the prospects for "intelligent electronics" in industry has shown that since about 95% of the time that material spends in a factory it is idle either in stores or in transit, much more can be gained by properly organizing the overall manufacturing process than by applying electronic automation systems to individual machines on which the material remains for only 5% of the time.

This is not to denigrate the benefits that electronics — sorry, microelectronics — can bring to industry. But it will be better served when it is clearly defined to the layman as essentially an information processing technique and firmly put in perspective along with developments in other engineering fields — electrical, mechanical, chemical, hydraulic and so on — which it complements but does not displace. In this way expectations will not be raised too high nor dashed to the ground too soon.

A scientific computer — 1

Powerful design uses two microprocessors and BURP, a new high level language

by J. H. Adams, M.Sc.

This series of articles describe a complete scientific computer which is based on two microprocessors. Unlike conventional mini and microcomputers which rely on large and expensive memories for complex subroutines, the present design uses a Z80 to handle the general processing and leaves the "number crunching" to a MM57109 microprocessor. This second device contains all of the algorithms necessary to execute standard mathematical functions. The basic design uses 8K of memory although this can be easily expanded to 32K.

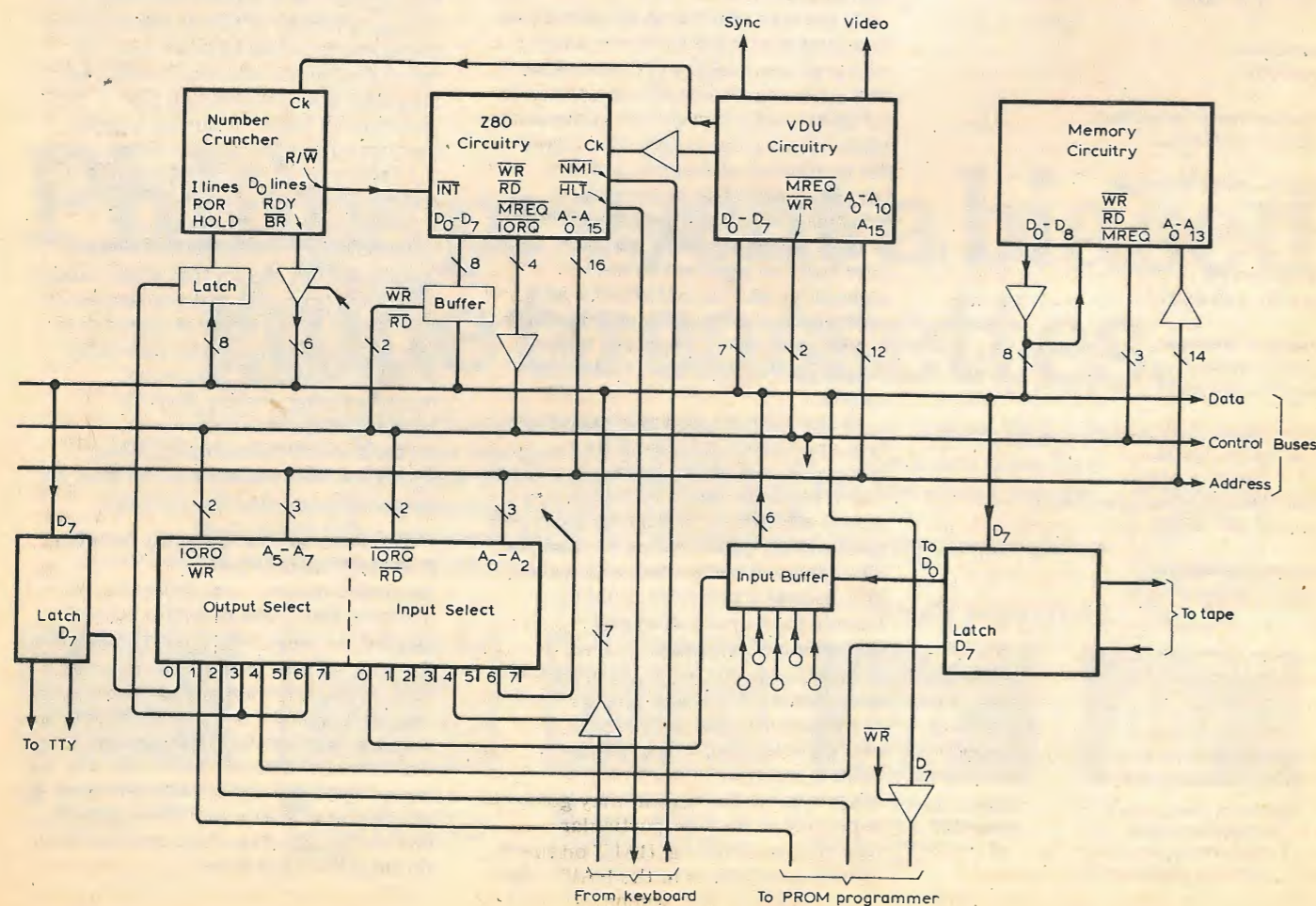
The series will also describe tests and diagnoses, together with the computer's operation, both in machine code and the high level language BURP. Games, mathematical and financial programmes will also be given, and the series will conclude with several options including graphics and symbolic displays, graph plotting and an e.p.r.o.m. programmer.

A COMPUTER, to quote the dictionary, is an "apparatus for making calculations or controlling operations that are expressible in numerical or logical terms". With the advent of the microprocessor it has become possible to build low cost computers but, as industry has demanded, the majority of these devices are designed with the controlling-operations aspect of computing as their particular forte. Therefore, as numerical calculators, they are rather limited, and this has led to many disappointed owners of development kits who find their idea of microcomputers and that of the kit manufacturers are poles apart.

To meet the needs of such buyers, i.e. a system that can do sums and communicate in a language based upon English, various versions of the language BASIC (Beginner's All-purpose Symbolic Instruction Code, a programming language devised in 1964 by the

Americans Kemeny and Kurtz) have been produced, ranging from Integer Basic, the mathematical applications of which are limited to computer games and the like, to quite complex versions which are able to handle floating point numbers and to perform several mathematical and trigonometrical operations on those numbers. These operating systems need computers with large memories, not for running large pro-

Fig. 1. Block diagram of computer. Control and data buses are buffered as they leave the Z80, while buffering for the address bus is in the memory circuitry. Five buffered serial inputs and one buffered output are available for external add-on circuitry, together with three output and five input select signals which may be used to latch data off or buffer it on to the data bus.



Specification

Commands available

LOAD Loads program lines into memory.
 ADD Adds program lines to those already in memory.
 DEL n Deletes program line n.
 RUN n Runs from program line n.
 MOD* Converts Print statements to Write and vice-versa. (For use with second output device.)
 LIST n Lists from program line n.
 DUMP n Lists on second output device.

Statements available

Input, Print, Write, For, Next, Goto or Go, If, Then, Gosub, Return, Top Erase, Halt, Let.
 Write is the print command for a second output device, such as a teleprinter.
 Top clears the top line of the v.d.u. and sets this as the next printing position.
 Erase is similar to Top, except that the whole screen is cleared.
 Halt stops execution until any key, except FS or RS is depressed.

Mathematical capability

Calculates to 8 figures plus 2 exponent digits.

Functions

+, -, *, square, square root, log, 10^x . In (nat log), e^x , sin, cos, tan, \sin^{-1} , \cos^{-1} , \tan^{-1} , y^x , $1/x$, π , degree to radian conversion and vice-versa.

Variables 26, denoted by A to Z.

Range 10^{-99} to 9×10^{99} .

Program lines Up to 254, or the limit of the read/write memory.

Print capability

Automatic switching to scientific mode on results greater than 10^9 or less than 10^{-4} .

Printed figures may be tabulated or close-packed, to any number of decimal places from 0 to 7.

Automatic rounding occurs on results abbreviated in this way.

Alphanumeric data may be interposed with printed variables.

Input/output

Input via ASCII encoded keyboard.

Output via v.d.u. of 32 lines, 64 char/line. Separate video and sync signals to 625 standard.

Optional output to teleprinter.

300 baud f.s.k. input/output, using tones of about 1200Hz and 2400Hz, for the storage and retrieval of data via a tape recorder.

grams, but for storing the mass of information required to instruct the logic oriented microprocessor on how to behave as a number oriented device.

The aim of this project was to produce a computer with extended mathematical capabilities and avoid the need for such heavy investments in memory i.c.s. This has been achieved by using two processors, the Z80 standard microprocessor which takes the dominant role as the processor of data moving around the system, and the MM57109, a number-oriented processor which handles the calculations. The Z80 has been well covered in this and other journals, but the MM57109 may be less familiar. This device appears to be a not entirely successful transplant of a scientific calculator chip into the world of data buses and memories. It can perform most of the standard scientific calculator functions and, in common with many such devices, it uses a sequence for instructions known as Reverse Polish Notation. This system differs considerably from the standard algebraic notation, and is based upon the logical idea that the instructions to be performed or, in the case of a calculator, keys to be pressed, should be listed in the order which they are to be performed. For example, consider the calculation $c = \sqrt{(3^2 + 4^2)}$. The first operator following the equals sign is the last operation to be carried out and yet the last, brackets, is not the first. The actual order of execution is in fact quite complex, and the more complex the expression to be solved, the worse things become. The algebraic sequence would actually be 3, sq, +, memory recall, =, root. In algebraic BASIC, the computer line would be: LET C = (3↑2 + 4↑2) 0.5 where ↑ means raised to the power of.

However, a simple RP calculator would execute the operations in the

sequence which the operator would follow, ie, 3, sq, store, 4, sq, recall, +, root. In practice this is even simpler because calculators and the MM57109 have a stack of registers, each capable of holding a number. In the MM57109, this stack consists of four registers called X, Y, Z and T for top. Data enters and leaves via the X register, but may be pushed up into the stack either for temporary storage, or to take part in a two number operation involving the contents of the X and Y registers (e.g. YX which calculates the Y number to the Xth power). There are specific instructions which move or exchange the contents of the stack registers to facilitate calculations; however, the system ensures that in normal use of the language, numbers are pushed or entered into the stack as and when necessary. As RP is a step-by-step system, no brackets are required, and in the expression originally considered the RP BASIC version of the computer line would be

LET C = 3 SQ 4 SQ = ROOT

Some other examples of calculations and the stack operations are given in table 1. In my view, having used both types of notation, the Reverse Polish wins every time. For this reason a new language was formed for the computer Basic Using Reverse Polish or BURP.

Hardware

The block diagram of the computer in Fig. 1 follows standard microcomputer techniques, with an eight wire data bus, a sixteen wire address bus and a four wire control bus which interconnect the various elements of the computer. The majority of lines in this design are active low, ie, for an i.c. output, they go to the low state when the particular output label is occurring, e.g. HALT on the Z80 goes low when it is in the HALT condition, WR goes low whenever the Z80 wants to write some information into

the memory. With an input, that input must go low for the input label to occur, e.g. INT needs to go low for the Z80 to be interrupted. An active low label is identified by a bar over it.

To describe the operation of the c.p.u. shown in Fig. 2, it will be helpful if some aspects of microprocessor operation are discussed. The Z80 can execute a repertoire of 158 groups of instructions, of which there are about 600 in total, and these instructions are read in through the data bus of the system as 8-bit words or bytes. The reading in, or writing out of bytes from or to memory locations or input/output devices is controlled by the four processor output lines RD, WR, MREQ, IORQ. For example, a low RD and a low MREQ output from the Z80 indicates that it wants to read in a byte from a memory location, whereas a low WR and IORQ means that it is writing a byte out along the data bus to an output device, such as a teleprinter. The address of the memory location, which is stored in a 16-bit register within the Z80, known as the program counter, or code number of the input/output device, is simultaneously sent out onto a second 16-line bus by the Z80. External circuitry selects which memory location or device is coupled to the data bus for that particular Z80 operation. When pin 26 RESET, of the Z80 is taken to 0V, the program counter is cleared, and when pin 26 returns to 5V, the Z80 begins by reading in the data byte in memory location 0, executing it as an instruction, increasing the program counter by one, and reading in the next byte from memory and so on. Thus, the memory will contain lists of instructions to be executed sequentially, interspersed with bytes of data which are required by some of them. The Z80 will then work its way through these lists or programs.

The instructions cover such operations as LOADS, which move bytes

between registers within the Z80 or the memory. Logical and arithmetic functions, usually on the contents of the A register of the Z80. JUMPS, which, by feeding two new 8-bit bytes into the program counter register, cause the sequence of instruction execution to jump to a different point in the program. And CALLS, which are similar to jumps except that the old program counter contents are kept in a last-in first-out store in the read/write memory of the system, to be restored to the program counter on execution of the Z80 instruction RETURN. Calls are particularly useful whenever a certain block of instructions need to be used at several points in a program. If the instructions are written once in a program with a return instruction at the end, the block may be called at any point during the rest of the program. Such blocks are known as subroutines.

One feature of most microprocessors, including the Z80, is that CALL instructions may also be forced into the instruction sequence by activating

either of the pins \bar{NMI} or \bar{INT} . The subroutines called by these interrupts are executed immediately after the instruction in progress, and, as with most CALLS, once the subroutine has been completed, instruction execution recommences at the point where the sequence was originally interrupted. These interrupts are generally used by other devices that want to communicate with the Z80 and, in this case, the \bar{NMI} interrupt is initiated by the strobe pulse from the keyboard and hence by the depression of any key. The keyboard subroutine reads in and acts upon the keyboard data before returning control to the main program as shown in Fig. 3. This is just one method of using the keyboard and another common approach is the polling system where, as part of the main program, the Z80 reads in the strobe pulse as part of a byte, then tests to see if the strobe is active and jumps back to the read operation if it is not. When it is active, the Z80 reads in the keyboard data byte. This method requires six bytes of in-

structions and memory locations, or at least a three byte CALL instruction to a read-the-keyboard subroutine whenever a byte of keyboard data is required.

In contrast, an interrupt driven system only requires the one-byte HALT instruction to be executed whenever a byte of keyboard data is needed. The only method for the processor to get out of the HALT state, once the instruction has been executed, is by operation of the reset button or by an interrupt, the Z80 waits for the interrupt which directs it into the subroutine for the keyboard. The interrupt system which was chosen, saves on memory space and the subroutine contains an extra section which will reset the entire system if the processor is not in the HALT state. If it is necessary to interrupt, for example, a program under development which has a fault, this can be achieved by pressing any key. The HALT command is also available in the high level language where it will also stop program execution until a key is pressed.

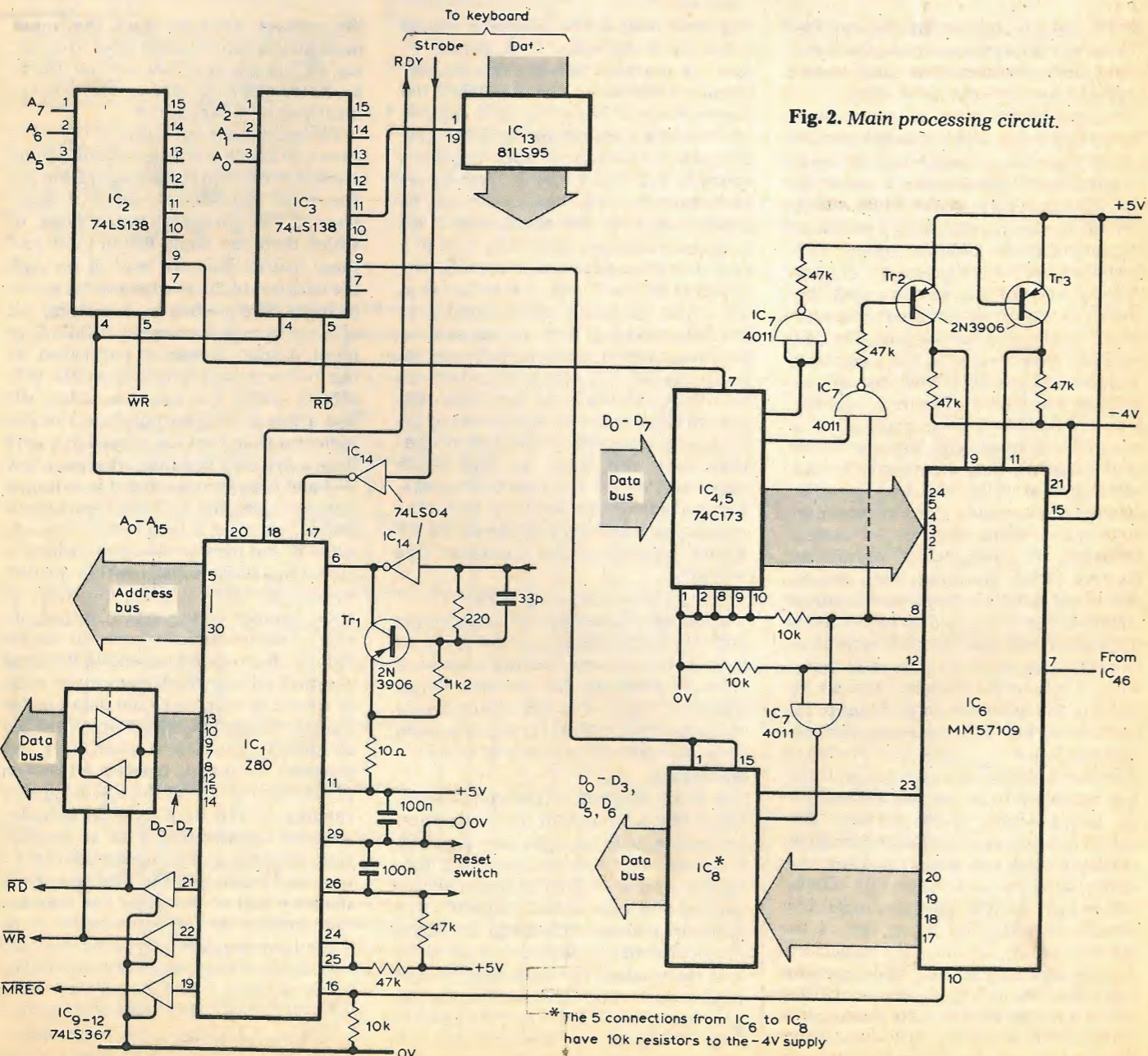


Fig. 2. Main processing circuit.

The \bar{NMI} input (non-maskable interrupt) operates under all conditions and just calls to a fixed address in the memory. The other interrupt input, \bar{INT} , can be enabled or disabled by instructions within the program being executed. This particular interrupt line comes from the MM57109 R/W output and indicates that the 57109 wants to send b.c.d. data to the Z80. This output can do some peculiar things during the initial reset of the processor; therefore, during this period, it is essential that the \bar{INT} input is disabled. This is automatically done by the Z80 whenever it receives the reset signal. The interrupt can be programmed to respond in one of three ways, but in this system its response is similar to that of the \bar{NMI} input, i.e., a CALL to a particular memory address.

Operation of the MM57109 is most easily understood by reference to the simplified diagram in Fig. 4. The device has open drain outputs which require external pull-down resistors, and some non-t.t.l. compatible inputs, but these have been left out of the diagram. The 57109 has a 6-bit input word into which 70 instructions, mostly of single bytes, have been encoded. The two relevant control lines are the RDY output and the HOLD input. RDY indicates that the device is ready to receive an instruction. If the HOLD input is low, RDY will go low after 16 μ s, and the current instruction on the input lines will be executed. If the HOLD is high, RDY remains high and the operation of the 57109 is suspended until HOLD goes low. In this system, RDY is sensed, and HOLD is controlled by the Z80. The typical sequence used by the Z80 when it wants the 57109 to execute an instruction is shown in Fig. 5.

Although this sequence is adequate for the execution of most instructions, the 57109 has been designed to operate as a separate microprocessor and will therefore sometimes produce RDY pulses during the execution of certain instructions. These pulses are intended to cue memory counters etc. As the HOLD is on during the execution of instructions, these RDY pulses must be suppressed otherwise the Z80 may think that it's time for another instruction to be sent to the 57109 latch. Fortunately, in such cases the output ISEL at pin 12 goes low, and this is used to gate the RDY signal to, and the HOLD signals from, the Z80 via IC₇.

The data read in by the Z80 via the tri-state buffer, IC₈, consists of the modified RDY signal together with the four DO (digit output) lines which carry the b.c.d. data from the 57109 X register, and the BR line on pin 23. This line pulses low whenever one of the seven tests that the 57109 can perform proves to be true. Pin 10, R/W, goes low whenever b.c.d. data bytes are waiting to be read in by the Z80. During the execution of an OUT instruction, twelve such pulses occur which signal the two

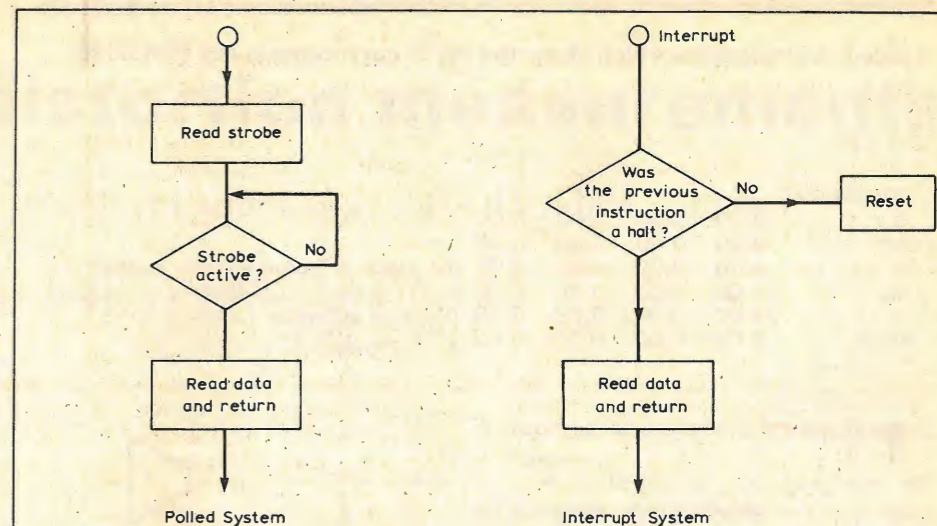


Fig. 3. Polled and interrupt keyboard systems.

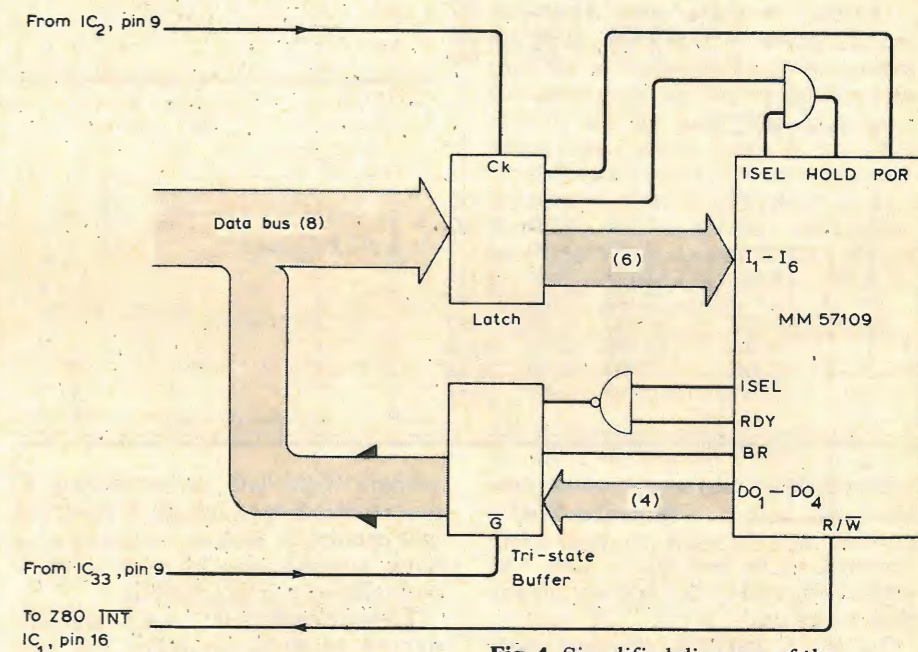


Fig. 4. Simplified diagram of the MM57109 logic. The microprocessor also has open drain outputs which require external pull-down resistors.

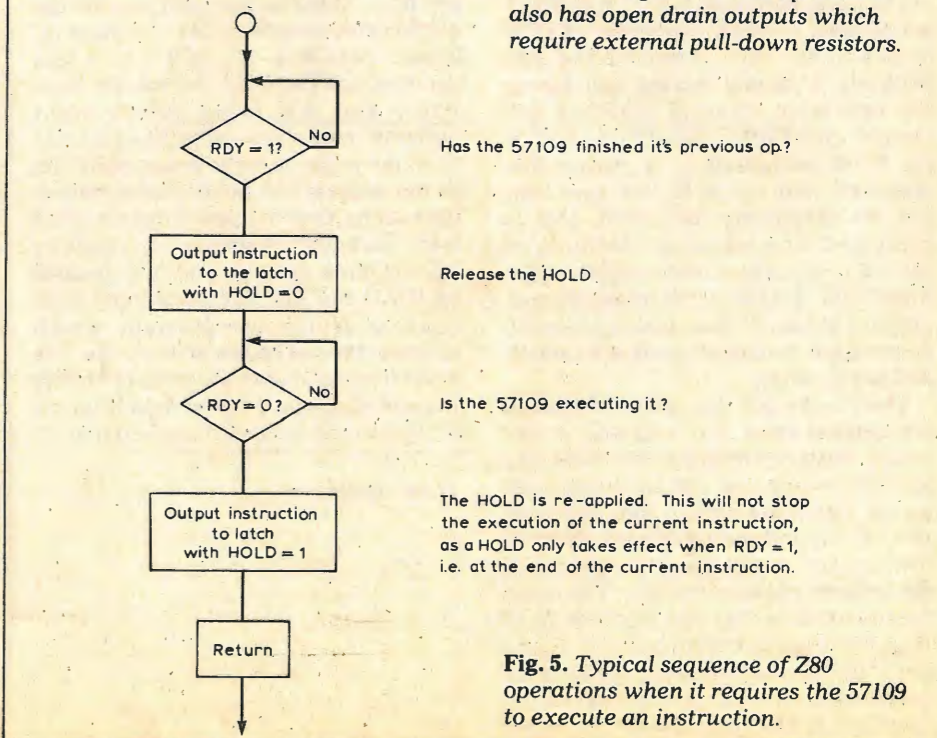


Fig. 5. Typical sequence of Z80 operations when it requires the 57109 to execute an instruction.

Table 1. Calculations which show the stack operations in the MM57109.

COMMAND	X	Y	Z	T	
$\sqrt{3^2+4^2}$					
3	3.00	0.00	0.00	0.00	
SQ	9.00	0.00	0.00	0.00	
4	4.00	9.00	0.00	0.00	the stack is automatically pushed, i.e.
SQ	16.00	9.00	0.00	0.00	X→Y, Y→Z, Z→T, T lost
+	25.00	0.00	0.00	0.00	the stack collapses, i.e. 0→T, T→Z
ROOT	5.00	0.00	0.00	0.00	Z→Y, result in X.

$$\frac{(6+9)}{(4-1)}$$

6	6.00	0.00	0.00	0.00
9	9.00	6.00	0.00	0.00
+	15.00	0.00	0.00	0.00
4	4.00	15.00	0.00	0.00
1	1.00	4.00	15.00	0.00
-	3.00	15.00	0.00	0.00
/	5.00	0.00	0.00	0.00

$$\sin(1 + \sqrt{5^3 - 4})$$

5	5.00	0.00	0.00	0.00	
3	3.00	5.00	0.00	0.00	
YX	125.00	0.00	0.00	0.00	Y to the Xth power
4	4.00	125.00	0.00	0.00	
-	121.00	0.00	0.00	0.00	
ROOT	11.00	0.00	0.00	0.00	
1	1.00	11.00	0.00	0.00	
+	12.00	0.00	0.00	0.00	
SIN	0.2079116	0.00	0.00	0.00	

exponent digits, a byte representing the signs, one byte for the decimal point position, and the eight mantissa digits' readiness to be sent to the Z80. The interrupt caused by this line has already been described.

The HOLD and POR (power on reset) lines on pins 9 and 11 respectively, are not t.t.l. compatible and Tr_2 , Tr_3 in Fig. 2 act as level shifters. Operation of POR occurs under the control of the Z80 whenever a reset is applied, and during the operation internal registers are cleared and various conditions within the 57109 initialised. It is during this operation that the R/W line goes low, but, as previously described, this is prevented from causing interrupts to the Z80. For further information on the MM57109, National Semiconductor produce a data booklet which gives full operational details of each instruction and pin function.

The clocks for the microprocessors are derived from IC_{30} and IC_{46} in the visual display circuitry. To meet the specified swing and rise times required by the Z80, a rise time of 30ns to a level of 4.4V, Tr_1 and the associated circuitry form an active pull-up on the output of the Schottky inverter in IC_{14} . The clock for the 57109 is obtained from pin 12 of IC_{46} . With the link from pin 1 of IC_{46} to pin 12 of IC_{29} , the frequency of this clock is 400kHz, which is the maximum specified in the data sheet. The other

position of the link, to pin 14 of IC_{29} , doubles this frequency and, if the 57109 will operate at 800kHz as tested ones have, a worthwhile increase in computing speed can be achieved.

Tri-state buffers IC_9 to IC_{12} are connected to form an eight-line bus transceiver, and buffer the system control lines. These buffers also provide the extra drive required for the heavily loaded data bus. IC_2 is a 3 to 8-line decoder, activated by the control lines IORQ and WR. This allows eight different output devices to be addressed from the codes that the lower eight bits of the address bus holds during output operations. One of these output devices is the latch $IC_{4.5}$. A similar job is done by IC_3 for input devices, and it is enabled by IORQ and RD. The three input lines to these devices are different, which spreads the load on the address bus. The input devices shown are tristate buffers IC_8 and IC_{13} , which buffer data from the 57109 and the keyboard respectively. □

To be continued

Literature Received

Digital optical tachometer is described by Compact Instruments Ltd in colour leaflet, available from Binary House, Park Road, Barnet, Herts EN5 5SA.

WW 401

Camera tubes. Plumbicon and Newvicon from Mullard are on colourful, but not very informative, wall-chart which can be obtained from Department C1H, Mullard Ltd, Mullard House, Torrington Place, London WC1E 8HD.

WW 402

A range of alphanumeric printers is subject of brochure recently sent to us by Syntest, 169 Millham Street, Marlborough, Mass. 01752, U.S.A.

WW 403

General and specific information on stepping motors is given by Moore Reed in their 50-page catalogue, which can be had from Moore Reed and Company Ltd, Walworth, Andover, Hants SP10 5AB.

WW 404

Computer card recorders for analogue or other information are made by Houston Instrument and described in a brochure from Louis Arnold, Houston Instrument, One Houston Square, Austin, Texas 72753, U.S.A.

WW 405

Brief descriptions of test and measuring instruments marketed by Lyons Instruments in product guide, not sent to us but available from L.I. at Ware Road, Hoddesdon, Herts EN11 9DX

WW 406

Audio test instruments produced by Bang and Olufsen shortly described in recent brochure, obtainable from Eastbrook Road, Gloucester GL4 7DE.

WW 407

Health and safety recommendations for Bakelite materials in two publications: TIS B212 for impregnated materials; TIS B211 for industrial laminates. Copies from Bakelite UK Ltd, Sales Office, Tuition House, St. George's Road, Wimbledon, London SW19 4DS.

WW 408

Sound reinforcement systems made by Millbank, described by Royal Institute of British Architects in a product data sheet, is available from Millbank Electronics Group, Uckfield, Sussex TN22 1PS.

WW 409

Company magazine of Rohde and Schwarz for end of 1978 deals with range of r.f. test gear and television techniques. Includes description of standard stereo decoder. In English. Rohde und Schwarz, Postfach 80 1469, D-8000 Munich 80, Fed. Rep. Germany.

WW 410

Catalogue of voltage and current stabilizers is produced by Techmation Ltd. Units are made by Kepco and use switching techniques, ferroresonance and ordinary feedback methods. Techmation Ltd, 58 Edgware Way, Edgware, Middx.

WW 411

Simplified distortion measurements

Method using audio amplifier under test as a low distortion oscillator

by F. Butler, O.B.E., B.Sc., F.I.E.E., F.I.E.R.E.

The need for an external signal source is avoided by using the amplifier under test as a low distortion oscillator, coupling the output back to the input through a limiter and LC frequency selective network. The author concludes with a review of three common methods of measurement and discusses possible sources of error which become important at distortion levels of about -80dB.

TO MAKE accurate measurements of the distortion products of an audio-frequency power amplifier calls for a test signal source in which the total harmonic distortion is about an order of magnitude lower than that of the equipment under test.

In *Wireless World* for February 1975, Letters, p. 68, T. Magchielse described one way of achieving this performance and gave a condensed account of a highly accurate but rather expensive technique for distortion measurement. His work inspired the present contribution which in essence describes a method of converting the amplifier under test into a low-distortion oscillator by coupling the output back to the input through an amplitude-limiter and a frequency-selective network, thus avoiding the necessity for an external signal source. The rest of the article is taken up with a critical review of three common methods of distortion measurement, together with some discussion of possible sources of error which become important at distortion levels around -80 dB.

This amplifier-feedback technique is of course widely used in the design of many types of audio signal generators of which a common example is the Wien bridge or parallel-T circuit. Frequency-setting is by RC networks and amplitude-limiting by thermistors or filament lamps.

At first glance the Wien network seems ideal for the purpose. It is easily tunable over a wide band; it is of high impedance, causing little loading of the maintaining amplifier and simple range-switching permits coverage from sub-audio to video frequencies.

Closer examination of the properties of the network shows it to be far from ideal. The theory given in the appendix brings out its major defects. First, its selectivity is poor since its effective Q-factor is only 1/3 as against figures

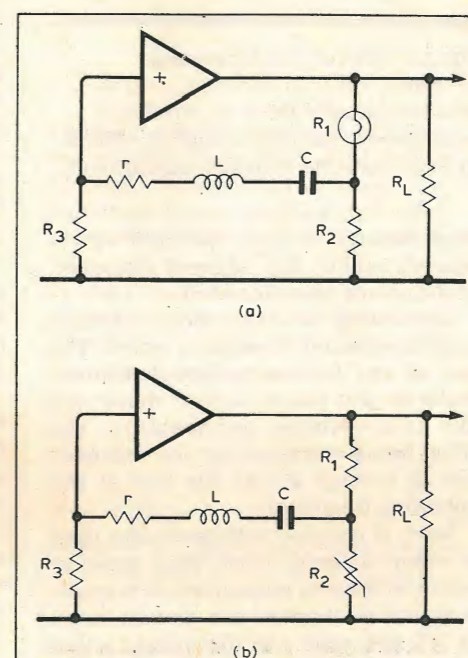
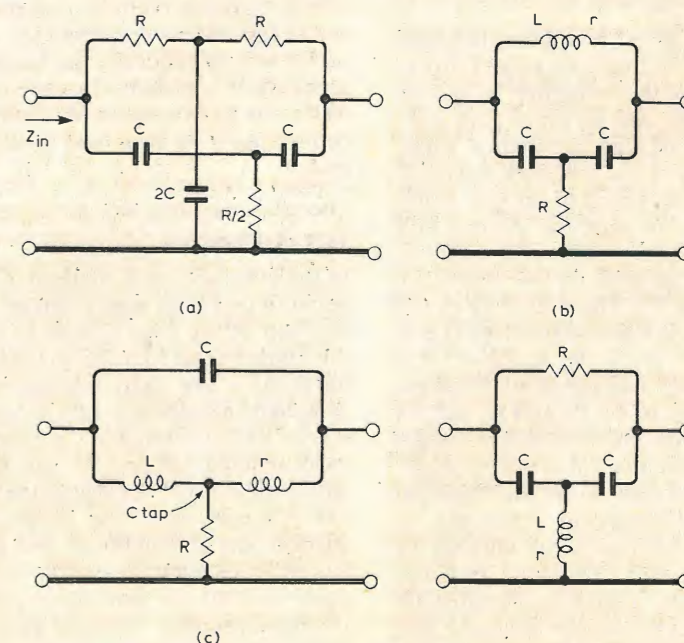


Fig. 1. Series-tuned LC oscillators: (a) parallel-T; (b) bridged-T with centre-tapped coil; (c) bridged-T lamp control; (d) bridged-T with shunt coil.



Parameter at Null	(a)	(b)	(c)	(d)
ω	$1/RC$	$\sqrt{2/LC}$	$\sqrt{1/LC}$	$\sqrt{1/2LC}$
Z_{in}	$R(1-j)/2$	$2R$	$2R$	$R/2$
Q-Factor	$1/4$	$2R/\omega L$ or ωCR	$R/\omega L$ or ωCR	$2\omega L/R$ or $1/\omega CR$

between 10 and several hundreds for LC circuits.

At 1kHz centre frequency the 3dB points lie at about 300Hz and 3.3kHz. Along with this the phase changes only slowly with frequency, reaching ± 45 degrees at the 3dB points. One consequence is that a small change in amplifier phase shift, however caused, calls for a relatively large frequency change to maintain the overall loop gain at unity and the total phase shift zero. There is one saving grace in that such oscillators are easily locked to an external source. Against this the frequency stability is poor in the face of variable loading of the output or in the event of supply voltage changes. Buffer amplifiers are essential.

Worse is to come. The maintaining

Fig. 2. Typical notch networks: (a) parallel-T; (b) bridged-T; (c) bridged-T with centre-tapped coil; (d) bridged-T with shunt coil.

amplifier, of gain $\times 3$, must necessarily generate some harmonic output. This is transferred to the input through the feedback network where it is once more amplified by this same factor 3. As already stated the network loss is $\frac{1}{2}$ at the centre frequency. At the second harmonic it has only dropped to 0.298 with a lagging phase angle of 26.57 degrees. At the third harmonic the corresponding figures are 0.249 and 41.63 degrees. In these respects the parallel-T network is even worse since its Q-factor is only $\frac{1}{4}$.

Clearly some better arrangement is required, and the solution is to use LC circuits in the feedback path. At audio frequencies such circuits are not conveniently tunable over wide ranges but several spot frequencies can easily be selected by switched L or C. Plots of distortion versus frequency or output power represent smooth monotonic functions so that checks at a few well-chosen frequencies reveal most of what one needs to know about the amplifier under test.

LC feedback oscillators

Most audio amplifiers give an output which is in phase with the input and the overall voltage gain commonly lies between $\times 10$ and $\times 100$. With amplifiers of more than 2W output an ideal feedback network is a series-tuned LC circuit with amplitude control by means of a filament lamp, which is cheap, effective and virtually noise-free. Below this power level, thermistor control may be preferred. The principles are shown in Figs. 1 (a) and 1 (b). At still lower output powers, field effect transistors can be used as voltage-controlled resistors.

The design of LC oscillators is based on the following considerations, assuming that the amplifier is of low impedance and that its input gain control, if any, is of high impedance. First, the selectivity of the feedback network is determined by the Q of the coil when embedded in the network. At one end the LC circuit sees a resistance equal to R_1 and R_2 in parallel. At the other, the termination is R_3 . The actual Q of the coil alone is $\omega L/r$ but its effective Q is in fact $\omega L/(r + R_3 + R_1 R_2/(R_1 + R_2))$. High selectivity thus calls for the lowest possible values of R_1 , R_2 and R_3 but, as shown in the appendix, these low values increase the attenuation of the network. It is preferable, then, to set the amplifier gain near its maximum value and to choose resistors just large enough to sustain oscillation. To avoid possible damage to the amplifier, reasonable resistor values should be selected and the input gain control slowly increased from zero until oscillation starts and then remains sinusoidal. Low resistor values result in the maximum possible attenuation of harmonics through the network. This attenuation can easily be made to exceed 40dB but, as will appear in later practical circuits, quite

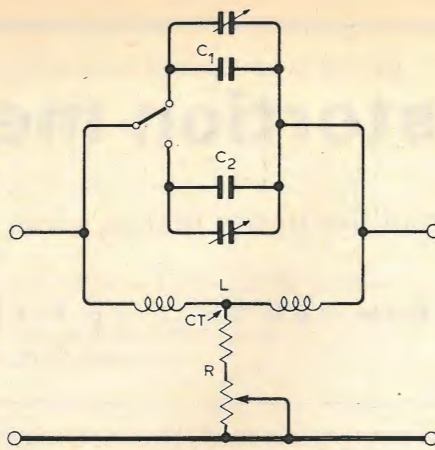


Fig. 3. Practical notch network: $L = 50\text{mH}$ total (air cored); $C_1 = 0.5\mu\text{F}$ plus trimmer for 1kHz; $C_2 = 0.005\mu\text{F}$ plus trimmer for 10kHz; and $R = 1200\Omega$ to $25k\Omega$, variable with fine adjustment.

large departures from optimum values scarcely add to the inherent distortion of the power amplifier itself.

Continuing with the choice of components, the coil must be air-cored. The use of any ferrite or ferromagnetic material will cause serious distortion due to non-linear permeability, the effect being worsened by the resonant rise of voltage across the coil at the operating frequency.

Next, if rectifier voltmeters are used to monitor signal levels, they must be removed before a measurement is made. A typical multimeter can give as much as 0.5 per cent t.h. distortion when connected across a 600-ohm line.

Ideally the coil should be screened to avoid pick-up from power lines or power supplies but unless it is placed in a large high-conductivity non-magnetic shield the effective inductance and Q-factor will be reduced, the latter quite seriously. It is probably better to place it well away from sources of interference, connecting it up by a long twisted-pair lead.

Test procedures

In the standard t.h.d. method, a notch-network or a high-pass filter, or a combination of the two, is used to suppress the fundamental frequency. Ideally, the harmonics are then measured by a wide-band amplifier of known gain and a true r.m.s. voltmeter. In practice, a mean-reading instrument can be used with little error if the distortion is very low. Though useful for testing a production run of amplifiers, the method has obvious limitations. To measure down to 0.001 per cent distortion on a 1V signal requires 100dB of gain to get 1V output of harmonic. Noise is a problem and the method gives no clue to the composition of the harmonic spectrum. Because they combine on an r.m.s. basis the voltmeter reading is almost unaffected by low-level products.

The most commonly used notch net-

work is the RC parallel-T which is a 3-terminal form of the Wien bridge. In its passive form it suffers from all the disadvantages of the regular bridge. Instead of a very narrow notch in an otherwise flat pass-band, the second harmonic is down about 9dB below the zero-loss datum. The third is attenuated by about 5dB. The results, displayed on an oscilloscope or measured by voltmeter, are meaningless. The transmission of an active notch circuit can be made much nearer the ideal but, by definition, this uses an amplifier of which the distortion must be much lower than that being measured, a state of affairs quite difficult to reach because the amplifier operates under rather exacting conditions.

Passive bridged-T LC circuits as shown in Figs. 2 (b), (c) and (d) are much to be preferred, provided one is satisfied to work at a few spot frequencies. As before, air-cored coils must be used. Fortunately the Q is not very critical. Even if it is as low as 3, Terman, (Radio Engineers' Handbook), states that the second harmonic is attenuated by only 0.5dB, though calculations give a figure nearer 0.8dB.

A few of the more important properties of the various networks are also listed in Fig. 2. In some cases, close approximations to the true values are given since the exact mathematical expressions are so cumbersome. The worst errors are of the order of 1 per cent. The choice of a preferred network will be considered later.

Wave analyser methods

Wave analysers are calibrated selective voltmeters, usually working on the superheterodyne principle. In use they are tuned successively to the fundamental and to each harmonic of the distorted input signal. Internal or external attenuators are adjusted to give a standard reading on the output voltmeter. Distortion figures are then derived directly in terms of the relative settings of the attenuators. Some possible sources of error are:

- (i) Non-linearity of the input amplifier.
- (ii) Intermodulation and spurious signal generation in amplifiers, filters or mixers.
- (iii) Inadequate adjacent-channel selectivity.
- (iv) Ground loop effects at high attenuator settings.

Such sources of error become important when measuring distortion levels around 0.001 per cent. The t.h.d. of the input amplifier is seldom better than -85dB referred to the fundamental. This is clearly not good enough when attempting to measure levels at 100dB down. Spurious signals of various sorts may appear at levels between -70, and -90 dB, also causing problems. Adjacent channel responses may be as low as -90dB; still not good enough for ultra-low distortion measurement.

All these difficulties may be circum-

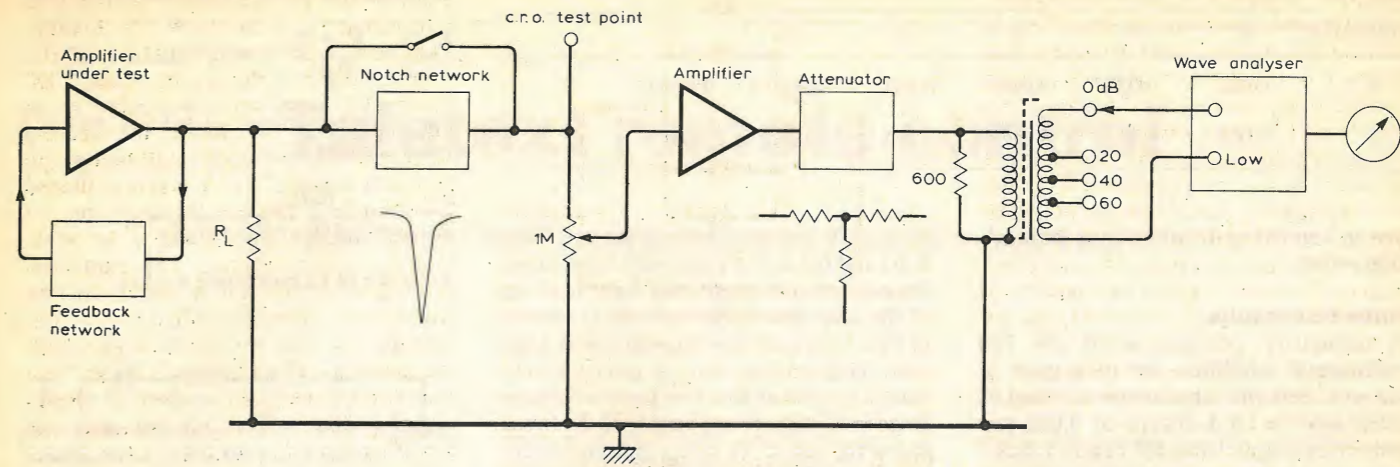


Fig. 4. Equipment layout for distortion measurement: amplifier under test; oscillator feedback network and amplitude limiter; passive LCR notch network with short circuiting switch; unity-gain amplifier (f.e.t. input, low Z_o , 5V r.m.s. output across 600Ω); attenuator, 80dB variable, 600Ω; transformer attenuator (0, 20, 40 and 60dB taps); wave analyser.

vented by placing a notch network, ahead of the analyser and by using an isolated transformer or transformer attenuator after the notch circuit to break any possible ground loops.

In measurements to be quoted later, screened transformers have been used as fixed attenuators at 0, 20, 40 and 60 dB loss, their performance being checked against a 600-ohm resistive attenuator. Here the use of magnetic cores is admissible since the attenuator is used after the fundamental has been suppressed. Any spurious product then causes only a negligible increase of an already low distortion figure. Using this technique it becomes possible to get exactly repeatable results down to 0.001 per cent or to 0.0001 per cent, (-120dB), using wide-band low-noise amplifiers in front of the analyser.

Phase-sensitive synchronous detectors

Here the complex signal to be analysed is applied to one of the two inputs of an analogue multiplier or to a suitable balanced modulator. A square-wave switching signal is fed to the second input and tuned successively to the fundamental and to the harmonics of the test signal. When the switching signal is locked to the component under investigation, sum and difference frequencies appear at the multiplier output. The difference signal is of zero frequency, (d.c.), and has an amplitude proportional to that of the test harmonic. A low-pass filter removes all unwanted a.c. components including noise. This is probably the ideal method of distortion measurement and, though very expensive, such instruments are offered by several manufacturers. Since they use input amplifiers, p.s.d.s suffer from the same defects as wave analysers so that when measuring very low distortion levels it is advisable to make use of a notch network as before.

Some practical tests

For these a range of transistor amplifiers with power outputs between 50mW and 40W were used. In one case a quasi-complementary amplifier was built to a Mullard design for which distortion figures had been published

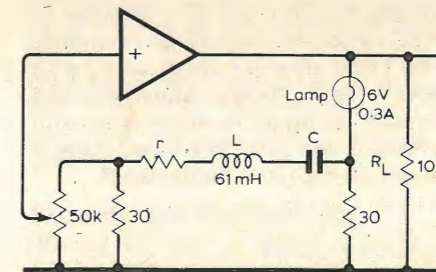


Fig. 5. Typical oscillator-amplifier: 6W amplifier, $\times 40$ maximum gain; 6V 0.3A filament lamp; $C = 0.4\mu\text{F}$ for 1kHz and 4000pF for 10kHz.

and which could be checked against results obtained independently. In all cases, brief tests of t.h.d. were made by the standard method in order to get an idea of the distortion figures to expect. Wave analyser tests were then made with much more elaborate equipment, most of which, including filters, notch circuits, transformer attenuators, audio oscillators, voltmeters and wave analysers had to be specially built because of the very high cost of professional equipment.

Fig. 4 is a block diagram of the system used while Fig. 5 gives a particular example of a small 6W amplifier-oscillator with its amplitude-limiter and selective feedback network set to operate at 1kHz or at 10kHz by changing the capacitor.

The test procedure is as follows. Connect a resistive load to the amplifier to give the required output power, allowing for the load presented by the feedback network. Start up the oscillator and adjust the input to notch net-

work to such a level that the amplifier D is never overloaded. About 4V is acceptable in the present case. Then tune or trim the notch network to the oscillator frequency and vary the phasing resistor until the deepest possible null is reached, best checked at this stage by an oscilloscope connected to the point shown in Fig. 4.

Switch on the wave analyser, set it to low gain and place both external attenuators at 0dB. Tune to the fundamental, readjust the notch network for the best null and increase the analyser gain to give full scale deflection on the output voltmeter. This represents the notched fundamental residue. Now tune the analyser to the second harmonic and note the corresponding output voltage. If it exceeds f.s.d., reduce the analyser gain, leaving the external attenuators still on 0dB. We now have to compare this harmonic level with the true fundamental amplitude. To do so, set both external attenuators at maximum loss, close the short-circuiting switch across the notch circuit so that the fundamental is applied to the analyser through attenuators only. Re-tune the instrument to the fundamental and set the attenuators to give the same output reading as that observed for the selected harmonic. The attenuator readings then give the amount by which that particular distortion level is below the fundamental amplitude. Repeat for the third and any required higher harmonics.

The accuracy is high because it depends only on that of the external attenuators. The 600-ohm resistive unit will probably be good to over 100kHz but unless well made, the transformer could be in error. In the present case, two windings, each of 1000 turns, were wound on a Mumetal core $\frac{1}{2} \times \frac{1}{2}$ inch cross section. The outer winding was tapped at 1, 10 and 100 turns to give 60, 40 and 20dB loss. An earthed interwinding screen of copper foil was used, insulated in such a way as to prevent the formation of a single-turn short-circuited loop. With a 600-ohm load across the untapped primary and when fed from a 600-ohm source the tapped output on any setting was flat to around 50kHz. The transformer proved effec-

Comparison of two amplifiers, A and B

Harmonic	2	3	4	5	6	7
A	0.022	0.033	0.0009	0.0011	0.00015	0.00025
B	0.062	0.023	0.0094	0.001	0.0052	0.001

tive in removing troublesome ground-loop errors.

Some test results

A carefully compensated μ A 709 operational amplifier, set to a gain of $\times 3$ and used with thermistor control at 1kHz gave a t.h.d. figure of 0.002 per cent. The output was 3V r.m.s., loaded only by the feedback network and the notch-circuit input impedance. Its worst failing was the noise level, clearly detectable on the oscilloscope. This feature characterised all the i.c. circuits tested. Next tested was a pre-amplifier built to a design by H. P. Walker but using unselected components and non-preferred transistors. Nevertheless, at 3V r.m.s. output and set to a flat gain of $\times 10$ at 1kHz this gave a figure of 0.011 per cent which would probably have been halved if built to the original specification. With a low source impedance the noise level was the lowest recorded in any of the tests.

At the same test frequency, 1kHz, and when set to a gain $\times 100$, a Fairchild μ A 716 gave 0.11 per cent, well within limits quoted by the manufacturer.

More detailed figures, again obtained at 1kHz, are given for two amplifiers in the table above. Type A is a complementary Class B unit with an f.e.t. input stage, built for use as a capacitance-tuned Wien bridge oscillator. The unit B is a modified version of a Mullard quasi-complementary 15W design, run with a reduced supply voltage giving 7W maximum output. Its total harmonic distortion, the r.m.s. sum of the components listed in the table, agreed exactly with figures published by the company but with an 8-ohm load instead of 10 ohms actually used in the present test.

Measurements at 10kHz followed the general trend of those at 1kHz, the actual distortion figure being up to two or three times that at the lower frequency. In some i.c. amplifiers, heavily compensated, the 10kHz figures were actually lower because of the shunting effect of compensating capacitors.

As regards the choice of notch networks, the passive parallel-T may be used for wave analyser measurements provided that its transmission losses away from the notch are taken into account. To do this add 9, 5, 3.3 and 2.3dB respectively to the measured 2nd, 3rd, 4th and 5th harmonic distortion figures. The errors involved in this are considered to be significantly lower than if an active network is used, incorporating as it does an amplifier with an unknown distortion spectrum. Of the

bridged-T circuits, those shown in Figs. 2 (b) and (c) are of relatively high input impedance and cause only light loading of the amplifier under test. That shown in Fig. 2 (d) is of low impedance at high test frequencies but is particularly suited for use at low frequencies where large inductances are required. In these cases the effective coil resistances are also very large so that the test amplifier is again lightly loaded. Coils up to 5H with d.c. resistances up to 1000-ohms have been used successfully. For quick experimental tests such coils can be obtained by slipping the wound bobbins off the laminated cores of redundant chokes or l.f. transformers.

Two further points may be mentioned in conclusion. First, it is simple to apply quartz crystal control to the feedback amplifier. Three-terminal crystals generating flexural mode vibrations at low frequencies may be used in the feedback network and such units have been found to work well at 5 and 15kHz.

In the second place, it is possible to use LC circuits in the parallel-resonance mode. These are particularly useful with phase-reversing power amplifiers and they can be made to work well with low-gain units provided these have a medium-to-high input impedance.

Appendix

1. Properties of the Wien network

If $n = \omega CR$,

$$\frac{e}{E} = \frac{1}{3 + j(n - \frac{1}{n})}$$

When $\omega CR = 1$, $e/E = 1/3$; $\phi = 0$

At the second harmonic,

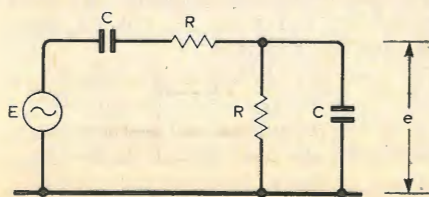
$$n = 2; e/E = 2/15 (2 - j)$$

Attenuation = $2/15 \sqrt{5}$; $\tan \phi = -1/2$

Loss = 0.298; phase angle = 26.57 deg.

At the third harmonic the corresponding figures are 0.249 and 41.63 degrees.

Assuming a centre frequency of 1kHz the 3dB points lie at 3.303 and 0.303kHz with phase angles ± 45 degrees. $Q = 1/3$.



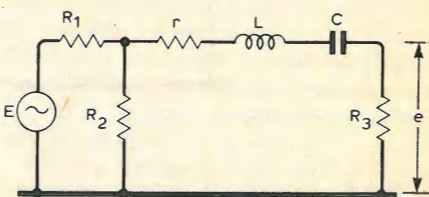
2. Properties of RLC feedback network

$$\frac{E}{e} = \frac{R_1 + \frac{R_1 + R_2}{R_3}}{r + R_3 + j(\omega L - 1/\omega C)}$$

At series resonance $\omega L = 1/\omega C$ and the network loss is:

$$\frac{e}{E} = \frac{R_2 R_3}{(r + R_3)(R_1 + R_2) + R_1 R_2}$$

Q factor of Lr coil alone = $\omega L/r$



When embedded in the network:

$$Q_1 = \frac{\omega L}{r + R_3 + R_1 R_2 / (R_1 + R_2)}$$

Assuming r stays constant over an appreciable frequency range, the attenuation of any harmonic n below that of the fundamental is:

$$\text{Loss} = Q_1 (n - 1/n)$$

Even with poor coils and low gain power amplifiers, harmonic attenuation below the fundamental level at the network output will seldom be less than 20dB and may easily exceed 40dB with good coils and high-gain amplifiers.

Acoustics conferences

The Spring Conference of the Institute of Acoustics is to be held at the Institute of Sound and Vibration Research, Southampton University, April 8-11. There will be sessions on psychoacoustics, sound power determination, building vibration, and sound generated by impact, as well as others organized by specialist groups. Contact: Professor J. B. Large, ISVR, The University, Southampton.

Forthcoming meetings include "Planning and noise control for industrial developments" at County Hall, London, April 26; "Acoustic test facilities and recent work on test methods" at British Gypsum Ltd, Loughborough, May 3; "Noise nuisance" at County Hall, London, May 31; "Source location and active control of noise", Cambridge University, June 28-29; "Speech production modelling" at Leeds University, August 2; "Non-linear acoustics" Bath University, September 10-11; and "Non-physical aspects of noise and noise criteria" at Portsmouth Polytechnic, October 5. Details from the Institute of Acoustics, 47 Belgrave Square, London SW1X 8QX (tel: 01-235 6111).

Teletext remote control

Ultrasonic link for page, time and function selection

by R. T. Russell

A number of articles on the updating and modification of the *Wireless World* teletext decoder have appeared since the original, pioneering, series of articles by J. F. Daniels in 1976¹. A decoder which has had these modifications carried out should have a performance which in most respects matches that of any other teletext decoder on the market, including those using i.s.i. integrated circuits. There is, however, one facility lacking on the *W.W.* decoder which is provided on nearly all other decoders, and that is remote control.

Whilst the front-panel controls of the decoder are adequate for experimentation and demonstration purposes, they leave something to be desired when the decoder is installed in a domestic environment. A means of remote control is therefore desirable.

A NUMBER of possible ways to provide this feature present themselves. The simplest is probably to remove the page-selection thumbwheel switches and essential function switches (e.g., Clear) to a separate box, connected to the decoder by means of a multiway cable. This, however, makes a fairly bulky item; the cable is of necessity thick and something of a hazard if trailed across the floor. In addition, the capacitance of the cable could deform the fast pulses fed to the thumbwheel switches, possibly resulting in unreliable operation. Another important aspect is the electrical safety of such an installation, since the decoder circuitry is connected to the live television chassis. This having been said, such a scheme is practical and probably the cheapest to implement.

The problem of the bulkiness of the remote unit can be solved by replacing the thumbwheels and other function switches by a small calculator-style keypad. The difficulty with this is that whereas the thumbwheel switches are "self indicating" (i.e. the page number selected is displayed directly on the switches) there is no equivalent indication with a pushbutton keypad. One solution to this would be to incorporate a page-number display into the remote unit, perhaps by means of a small seven-segment display. An alternative solution, adopted in this design, is to indicate the page number as part of the text display on the tv screen. A convenient place for it is the top left hand

corner of the page where there is a space of eight characters preceding the service name (CEEFAX or ORACLE).

The problem of the heavy multiway cable can be partially overcome by multiplexing the data into a serial format, thereby allowing the use of a thin two core cable. However, this does not reduce the safety hazard which might even be aggravated by the unsuitability of the insulation on a thin cable not intended for mains use.

The ideal solution to these problems is to use a cordless arrangement to eliminate the trailing lead and with it any safety hazard. Naturally the price of such a solution is complexity and expense, and for those who want to avoid the cost of the ultrasonic link the rest of the circuitry to be described is compatible with a wired system using a two core cable. This could easily be upgraded to the cordless system at a later date.

Transmission characteristics

Having decided to adopt a cordless system, the next choice to be made was of the transmission medium to use (e.g., ultrasound, radio signals, light) and the method of modulation to enable it to carry the desired information. It was decided to use an ultrasonic link, because this has been the choice of most set manufacturers for their remote control systems and it does not require any sort of licence. Piezo-electric ultrasonic transducers for operation at around 40kHz are readily available and these are used in this design.

The choice of a suitable method of modulation was more difficult. A frequently adopted method is to allocate a different ultrasonic frequency to each of the control functions provided and to use a frequency-sensitive detector in the receiver to separate the functions. In the simpler versions, the frequency generation and detection are done using conventional tuned circuits, but in the more complex systems, with a large number of commands, purpose-

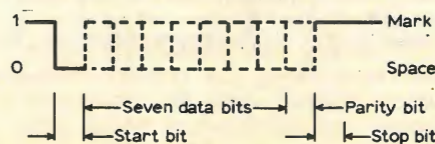


Fig. 1. Format of serial data. Duration of each bit is 10ms.

made integrated circuits, usually carry out these functions.

Although this is a well tried and proven system, it has a number of disadvantages in the present application. Firstly, sixteen different functions are required for teletext remote control alone in present case, and the number is even larger if provision is made for remote channel-change, etc. Although this number of separate frequencies is possible, without using specialised i.c.s, the transmitter and receiver circuits would be quite complex, whether analogue or digital techniques were adopted. Secondly, the bandwidth of the piezoelectric type of transducer is probably insufficient for such a system, since the different frequencies cannot be very close together, and this would necessitate using capacitive transducers which need a large driving voltage and d.c. polarization.

For, these reasons, the multi-frequency approach was rejected and an alternative system devised, which uses a two stage modulation process. Firstly, the control functions to be transmitted are encoded into a serial data stream of 1s and 0s and secondly, the serial data is used to modulate the ultrasonic carrier in a binary fashion. The most obvious method of modulation is simple on-off keying, with the carrier on for logic 1 and off for logic 0. Such a system was tried but was found to be sensitive to short-term reflections from walls and objects in the room. Whilst this problem could be partly overcome by an a.g.c. system in the receiver, with suitable time constants, it was found better to use frequency-shift keying instead, the signal having a constant amplitude to mask reflections. In common with other f.m. systems, this allows the use of a high-gain limiting amplifier in the receiver, which renders it insensitive to the large signal-level fluctuations which can be experienced.

Because of the narrow transducer bandwidths, the maximum modulation rate is limited to only a few hundred bits per second but, since this rate permits a maximum of ten commands per second (faster than one can press the keys), the theoretical system capacity is more than adequate. The method adopted consists of coding each command as a seven bit number, appending synchronizing bits to it and transmitting the whole as a serial signal, at 100,

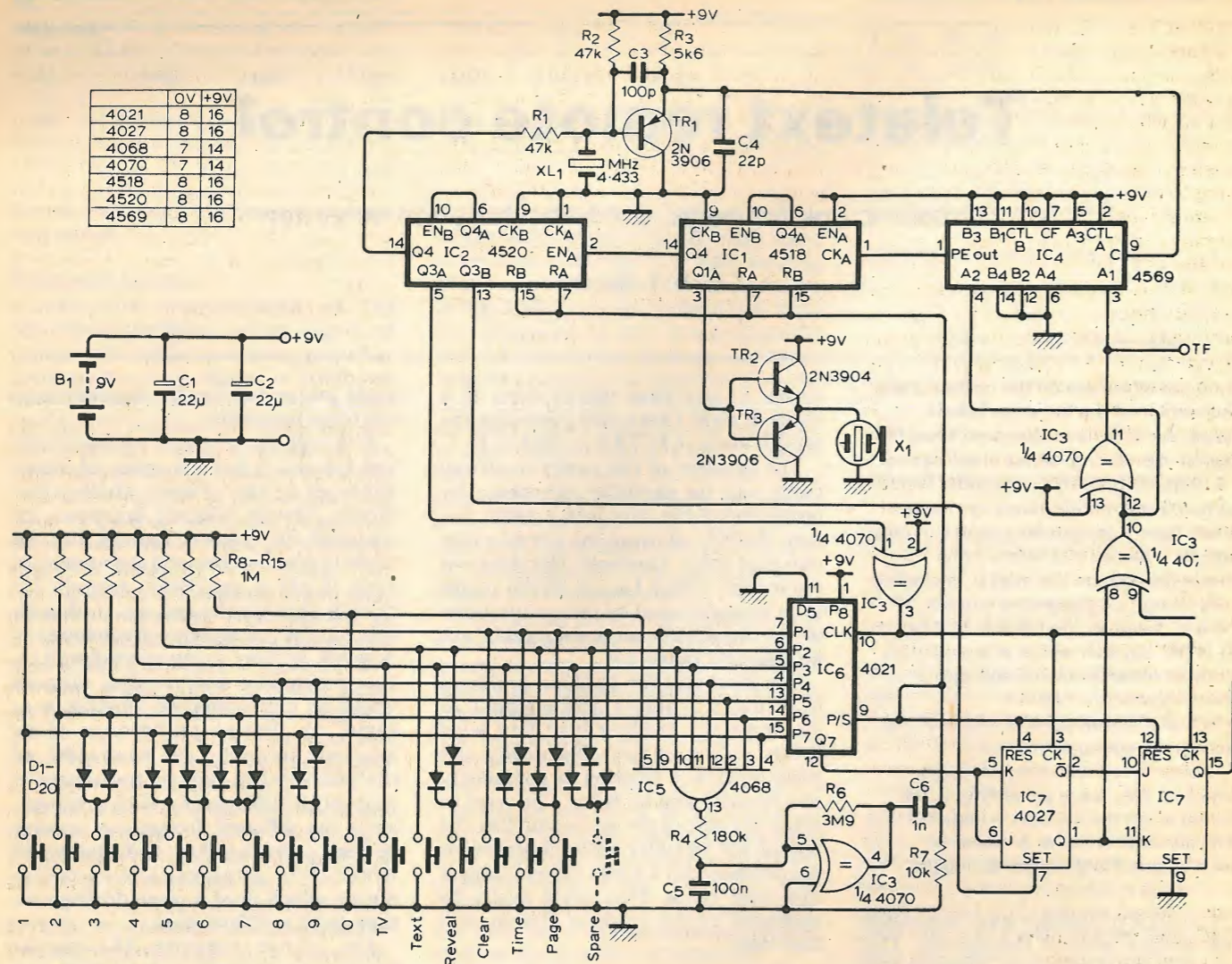


Fig. 2. Circuit of keypad and ultrasonic transmitter.

bits per second. Although only sixteen commands are implemented, the system could be expanded to a maximum of 128 functions, with additional circuitry in the decoder. It could, for example, be used to transmit alphanumeric data at up to 10 characters per second.

Data format

The serial data format is shown in Fig. 1 and is the same as that adopted for computer terminals, teleprinters and the like. In the quiescent condition, when no data is being transmitted, the signal rests in the logic 1 or MARK condition. When a command is sent the serial data begin with a logic 0 start bit followed by the seven data bits. After the last data bit, a "parity bit" is inserted. In this case odd parity is used, which means that the parity bit is chosen so that the total number of ones in the seven data bits plus the parity bit is always odd. This allows a measure of error detection when the signal is received. After the parity bit is a "stop bit" to identify the end of the data. If another command is to follow, the new start bit may follow immediately after the previous stop bit, but otherwise the signal remains in the quiescent "stop" condition. Whilst this code may seem complex it is in fact not difficult to generate and because of its common use

there are inexpensive integrated circuits available especially designed to decode it.

It is the use of this serial format which allows, if desired, the ultrasonic link to be bypassed and the serial data sent directly to the decoder along a cable.

Compatibility. This remote control system is suitable for all versions of the *Wireless World* decoder and is not dependent on any or all of the previously published modifications having been carried out. It is basically an add-on unit requiring no changes to the original boards or inter-board wiring and therefore can be added with the minimum of disruption, although its performance may be enhanced by a small modification to the original circuitry which will be detailed later.

The remote control splits naturally into three parts; the remote push-button keypad unit, the ultrasonic receiver and the interface board with the teletext decoder. These three sections will be dealt with in turn.

Ultrasonic transmitter

The circuit of the ultrasonic transmitter/keypad unit is shown in Fig. 2. It performs the function of encoding the different keys, generating the serial data signal, and from it a frequency-shift keyed signal to drive the ultrasonic transducer. It is battery powered and uses c.m.o.s. logic to reduce power consumption to a minimum: the quiescent current consumption is so low that no on-off switch is required. The circuitry is crystal controlled and uses a standard colour-subcarrier crystal, resulting in high stability and the absence of any adjustments.

The sixteen keys on the keypad are each encoded into a 7-bit binary word using the diode-matrix D₁-D₁₇. A seventeenth, spare, function may be incorporated with the addition of three diodes, D₁₈-D₂₀. The codes generated are shown in Table 1 and it should be noted that the transmitted data is inverted with respect to the outputs of the diode matrix itself. The encoding system was chosen to minimise the total number of diodes.

The seven data bits are fed to the parallel inputs of a shift-register, IC₆, and also to the inputs of a NAND-gate, IC₅. When no key is pressed these bits

4021	0V	+9V
4027	8	16
4068	7	14
4070	7	14
4518	8	16
4520	8	16
4569	8	16

are all at logic 1 by virtue of the pull-up resistors R₈-R₁₄. The "0" key is fed only to R₁₅ and the NAND gate, since it is encoded as all zeroes (all ones at the shift register inputs). When any key is pressed, one or more inputs of IC₅ are pulled to logic 0, the NAND gate output going to logic 1. This signal is fed via an RC integrating network (R₄, C₅) to a Schmitt trigger circuit, comprising (3,4) and the associated resistors. The function of this circuit is to suppress the contact-bounce inherent in a mechanical switch. The positive-going edge at IC₃, pin 4 is differentiated by C₆, R₇ to generate a narrow strobe pulse. This pulse performs two functions: it resets the circuit to the correct initial conditions and also parallel-loads IC₆ with the 7-bit data present at its inputs.

By virtue of being reset by the strobe pulse, pin 14 of the binary divider IC₂ goes to logic 0 and turns on the crystal oscillator Tr₁ (since the power consumption of c.m.o.s. is a function of clock frequency, the oscillator is turned off when not in use). The oscillator, running at 4.43 MHz, clocks the high-speed divider IC₄ which is configured to divide the frequency by either 55 or 56. The signal at IC₄ pin 1, at about 80kHz, is further divided by 100 in IC₁ to give a signal of 800 Hz at IC₂ pin 2. This is divided down to 100 Hz, which appears at IC₂, pin 5, and after inversion in (3,3) this signal clocks the shift-register IC₆, so that the seven data bits appear serially at its output pin 12. The function of IC₇, and the exclusive-OR gate (3,10) is to generate the odd-parity bit and to append the start and stop bits as pre-

viously mentioned. The serial data produced at (3,10) are fed to IC₄, along with an inverted signal from (3,11), so that the division ratio is set to 55 for logic 0 and 56 for logic 1. This results in a square-wave at IC₁, pin 3 of 40.31 kHz for logic 0 and 39.59 kHz for logic 1. This signal drives the ultrasonic transducer

Table 1. Binary codes corresponding to the 17 keys.

0	0000000
1	0000001
2	0000010
3	0000011
4	0000100
5	0000101
6	0000110
7	0000111
8	0001000
9	0001001
TV	0010000
TEXT	0100000
REVEAL	0110000
CLEAR	1000000
TIME	1010000
PAGE	1100000
Spare	1110000

via Tr₂ and Tr₃. Shortly after the data bits have been sent IC₂, pin 14 goes to logic 1, turning off the oscillator and the ultrasonic output.

The battery used is a 9V type, which should last several months in normal use. The transmitter will fail to operate when the battery voltage drops below that needed for IC₄ to divide correctly at 4.43 MHz. This will depend on the particular sample of IC₄, but is typically 6 volts.

Construction of transmitter. By using a miniature 16-key keypad the transmitter, including the ultrasonic transducer and battery, will fit into a small handheld unit. The printed-circuit layout shown does not include the diode matrix which, in the prototype, was mounted directly on the keypad connections. Copper strip board is a suitable alternative. The transducer must, of course, have an unobstructed "view" from the end of the unit normally pointing away from the user. The prototype was built into a small die-cast box with the keypad mounted on the lid.

For those wishing to use the "wired" system, Tr₂, Tr₃ and the ultrasonic transducer should be omitted and the circuit of Fig. 3 substituted.

Ultrasonic receiver

The circuit of the receiver is shown in Fig. 4. The function of this unit is to receive the ultrasonic signal, demodulate it and feed the resulting serial data to the decoder. It is intended that it be mounted inside the tv cabinet.

The ultrasonic transducer X₁ receives the signal from the transmitter and feeds it to the limiting amplifier consist-

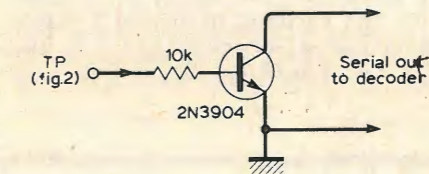
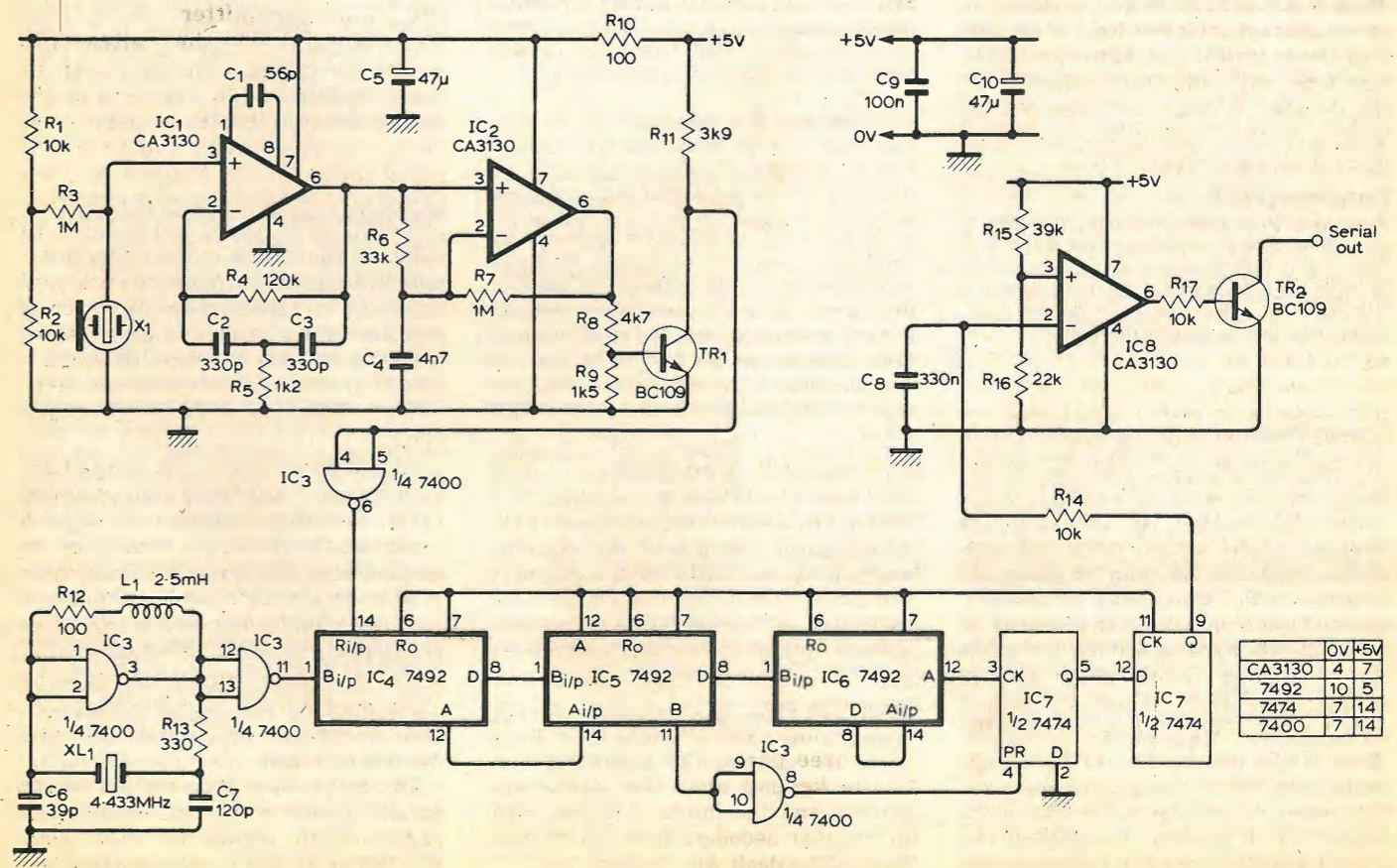


Fig. 3. Output circuit if cable used instead of ultrasound.

Fig. 4. Ultrasonic receiver.



	0V	+5V
CA3130	4	7
7492	10	5
7474	7	14
7400	7	14

ting of IC₁ and IC₂. The natural selectivity of the transducer is supplemented by the feedback network connected around IC₁ which gives it a band-pass response centred on 40 kHz and a Q of 5. Because of the decoupling effect of C₄, the negative feedback around IC₂ is significant only at low frequencies and there is sufficient gain to give a clipped square-wave output with a normal signal from the ultrasonic transmitter. This 40 kHz square-wave is matched to t.t.l. levels by Tr₁ and buffered by NAND gate (3,6).

The dividers IC₄, IC₅ and IC₆ each consist of separate divide-by-2 and divide-by-6 sections. The 40 kHz signal at IC₄, pin 14 is divided by two in IC₄ and again in IC₅. The output at IC₅, pin 12 is fed to the reset inputs of both IC₄ and IC₅ so that, rather than being a 10 kHz square wave as might be expected, it consists of narrow positive-going pulses at a 20 kHz repetition rate. The duration of the pulses corresponds to the propagation delay from the reset to output of IC₅, and is only 30 nanoseconds or so.

Gates (3,3) and (3,11), along with the associated components, make up a crystal oscillator running at the PAL colour subcarrier frequency, 4.43 MHz approximately. This signal is divided by 6 in IC₄, by 6 again in IC₅ and by 12 in

IC₆. This results in IC₆, pin 12 going high 216 cycles, or 48.7 microseconds, after the reset pulse occurs. This signal clocks IC₇, pin 5 to logic 0. Six clock pulses, or 1.4 μ s, later, IC₅, pin 11 goes to logic 1 and, via (3,8), presets (7,5) to a 1. Therefore IC₇, pin 5 is at logic 0 during the period 48.7 to 50.1 microseconds after each reset pulse. When the following reset pulse occurs in this "window" it will impose a logic 0 onto IC₇, pin 9. This condition corresponds to an input frequency range of approximately 40 to 41 kHz. This encompasses the logic 0 frequency of 40.3 kHz but not the logic 1 frequency of 39.6 kHz. By this means a demodulated serial data signal is present at IC₇, pin 9. The presence of noise and interfering signals results in some spurious pulses at this point, so these are filtered out by the RC network R₁₄, C₈ and the data signal squared-up by IC₈. Tr₂ provides the serial output with sufficient current drive capability to feed the decoder circuitry.

Receiver construction. The amplifiers IC₁ and IC₂ together have a gain in excess of 80 dB, so care must be taken with the layout of components and earthing to ensure a stable system. It is recommended that the author's board layout be adopted.

This board will fit inside a standard die-cast box if interference from (or to) the rest of the television circuitry is experienced, although this was not found necessary with the prototype. The five-volt supply should be taken from a point having adequate decoupling so as not to introduce interfering signals into the receiver by this route. No setting-up adjustments are required.

For best results the ultrasonic transducer should be mounted in the front of the television cabinet in such a position as not to restrict its natural beam-width of approximately 60 degrees. Being of metal construction it should be mounted behind a protective insulating grille to prevent it being touched. Such a grille should be chosen to have a low attenuation to ultrasound at 40 kHz. The transducer should be connected to the receiver circuit board by a short length of screened microphone cable and should not be grounded other than via this cable. □

Reference

1. Daniels, J. F. "Wireless World teletext decoder". *Wireless World*, November 1975 to June 1976.

Printed circuit layouts can be supplied from this office. Please send a stamped, addressed envelope.

BOOKS RECEIVED

One more in the monumental series of compilations from D.A.T.A. Inc., the updated **Diode D.A.T.A. Book**, is now available. In nearly 800 pages, this first issue of the 1979 two-issue series contains electrical, mechanical and environmental information on over 50,000 types of diode, from 156 makers throughout the world. All types of diode are covered, with supplements on US Mil specifications, outline drawings and manufacturers addresses. This book is one of a set of similar publications which takes in the whole field of semiconductor devices. It costs £48.75 for one year — two issues — and is offered on a 30-day trial. The UK agents are London Information (Rowse Muir) Ltd, Index House, Ascot, Berks SL5 7EU.

System Design with Microprocessors, by D. Zissos. It seems that workers in virtually every sector of science and industry are recognizing the need to study and apply computers, particularly microprocessors and microcomputers. In this book, Professor Zissos, who has the chair of Computer Science at the University of Calgary, employs his non-pedagogic approach to allow workers in widely different disciplines to understand the methods by which these newly-fashionable devices can be made to work to the best advantage. There is virtually no reference to "electronics" — the discussion is of logic systems only, the first chapter being an introduction to logic design, based on a previous book, which was also the inspiration for a series of articles in this journal during 1977-8. Several chapters pro-

vide extended problems, with their solutions — in this type of book a very useful feature. References are provided, but are somewhat repetitive and fairly limited. Academic Press Inc. (London) Ltd, 24-28 Oval Road, London NW1 7DX, Pp. 202, £6.50 in paper back.

Understanding Hi-fi Specifications, by John Earl, is an attempt to explain the language used by reviewers of audio equipment in the magazines. Since the author is one of these gentlemen, he ought to be in a good position to do this: it may be asked, though, why the language continues to be used in consumer magazines if it is so evidently in need of elucidation. Since the more incomprehensible the reviews become, the more abstruse these explanations will have to be, and one can envisage a position where only the review writer will know what he is talking about.

The book is an honest try at clarification, but it does seem that a little more care would have been a good idea. For example, it is unlikely that anyone who doesn't understand the expression "output level" will be greatly assisted by the sight of the quantity 200nWb/m, even though it is also spelt out (wrongly). The publishers are Fountain Press, 14 St James Road, Watford, Herts, and the price is £2.95 in limp back.

Radio and Television Servicing, 1977-78 Models is the latest of a very long line of similar volumes, which are probably familiar to most servicing technicians. A representative choice of equipment is covered, each section with a circuit diagram and servicing notes. The compiler has included audio sys-

tems as well as television and portable radio receivers, and any servicing information published by the makers during the year is included in a separate section. R. N. Wainwright edited the collection, which costs £10.50. The publishers are Macdonald and Jane's Publishers Ltd, Paulton House, 8 Shepherdess Walk, London N1 7LW.

Modern Instrumentation Tape Recording is a small, though densely-packed handbook intended to help the user of this equipment to select and apply it intelligently. It assumes no knowledge of magnetic recording, beginning as it does with a chapter on the physics of recording on tape, although the reader is treated as an intelligent being and is not "written down" to. In the second chapter, the concepts of direct, f.m. and digital recording techniques are introduced and are then allotted a chapter each, the treatment being exceptionally clear. Tape transports and heads are then discussed in two chapters, which are followed by a section on the selection of an instrument for specific work. A particularly useful chapter indicates possible malfunctions and their prevention or cure and a chapter is devoted to the various standards of format and calibration that exist, with particular reference to the IRIG set of standards. Finally, a section describes some typical applications of the instrument. The book is written by the staff of the Engineering Department of EMI Technology Inc. It is obtainable from SE Labs (EMI) Ltd, North Feltham Trading Estate, Feltham, Middlesex TW14 0TD.

Digital data recording without f.s.k.

Simple interface for audio recorders uses differentiation

by Brian T. Evans, B.Sc., Ph.D., M.I.E.E., M.B.E.S.
St Bartholomew's Hospital, Department of Medical Electronics

Contrary to current belief digital data can be quite easily recorded on unmodified audio reel-to-reel or cassette tape recorders. This can be done via a simple interface unit, and the unit described in this article has been in use for more than five years at St Bartholomew's Hospital, London, for recording a stream of digital numbers corresponding to the inter-beat interval of patients' heart rate. In the hospital system this recorded data is statistically analysed by a minicomputer some time later by replaying the audio data tape at two or four times the initial recording speed through one of the computer's input ports.

IT IS MORE usual to record slow speed digital data onto cassette tape by the use of frequency shift keying. However, our main requirement was that the method of recording and recovering the data from tape should be independent of the tape speed. In this way data originally recorded at low speed could be transcribed into the computer at any convenient higher speed without the need to adjust the interface unit.

Domestic audio tape recorders are usually 'flat' from about 100Hz to 6,000Hz or more. If a digital square wave at, for example, a repetition frequency of a few hundred hertz is first recorded onto audio tape and then examined on an oscilloscope, on replay it is seen to be considerably distorted and, at first sight, useless. However, similar distortion (differentiation) would occur if the square wave were passed through an RC high pass filter whose -3dB frequency was chosen to be the same as the measured overall tape record-replay low frequency -3dB point.

Experiment will show, however, that this overall record-replay low frequency roll-off varies both with tape speed and type of recorder. Let us therefore take a pessimistic view and choose an RC low frequency -3dB point higher than experienced on even poor machines. Let us take a figure of 170Hz, equivalent to an RC time constant of 1ms.

If we now repeat our experimental recordings using the output of the 170Hz RC filter as the signal source it can be seen that whatever tape speed is chosen there is very little difference on replay when compared to the initial differentiated square wave. Even if we

replay the tape at higher speed there is little change in wave shape. Thus a suitable differentiated square wave will retain its shape over a wide range of tape speeds and speed-ups. A suitable simple circuit is shown in Fig. 1.

We next require a method of reforming the differentiated pulses to their original 'square' shape. This is not as simple as it first appears since the digital information is not really a 50 : 50 square wave but an unknown run of marks and spaces.

Perhaps the best known source of serial digital data is that produced by and for v.d.us and teleprinters and serve as the example for this design. However, any serial digital data may be recorded,

via the interface, whatever the length of marks and spaces.

When no information is being transmitted from a v.d.u. the output line assumes a 'marking' condition, either defined as the flow of current or the continuous generation of digital 'ones'. It is convention to prefix each serial data word with a 'start' bit represented by either a digital 0 or the interruption of line current. Then follows typically eight data bits and a parity check bit that can be used for later error detection. The next data word cannot be sent until there has been a halt in transmission of one or two bit lengths (the 'stop' bits). We may take two examples. In the first serial word all the data and parity

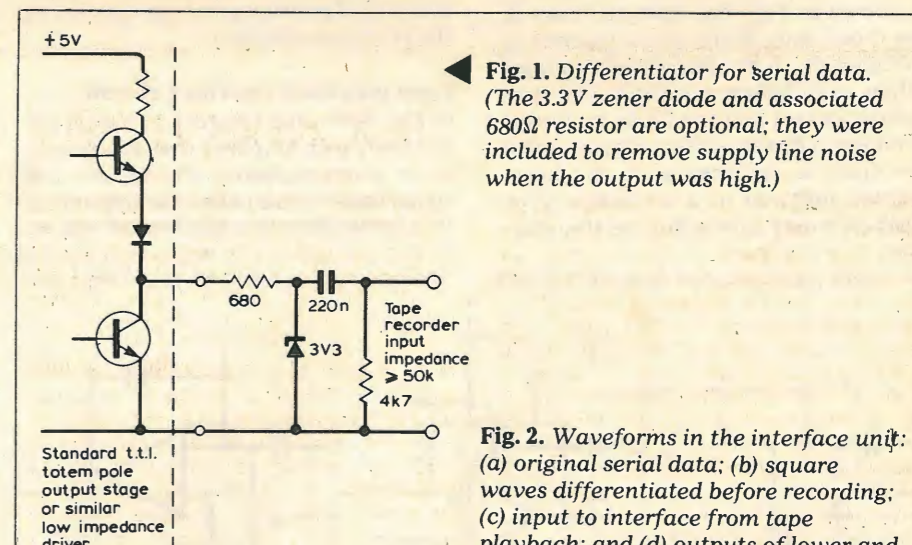


Fig. 1. Differentiator for serial data. (The 3.3V zener diode and associated 680 Ω resistor are optional; they were included to remove supply line noise when the output was high.)

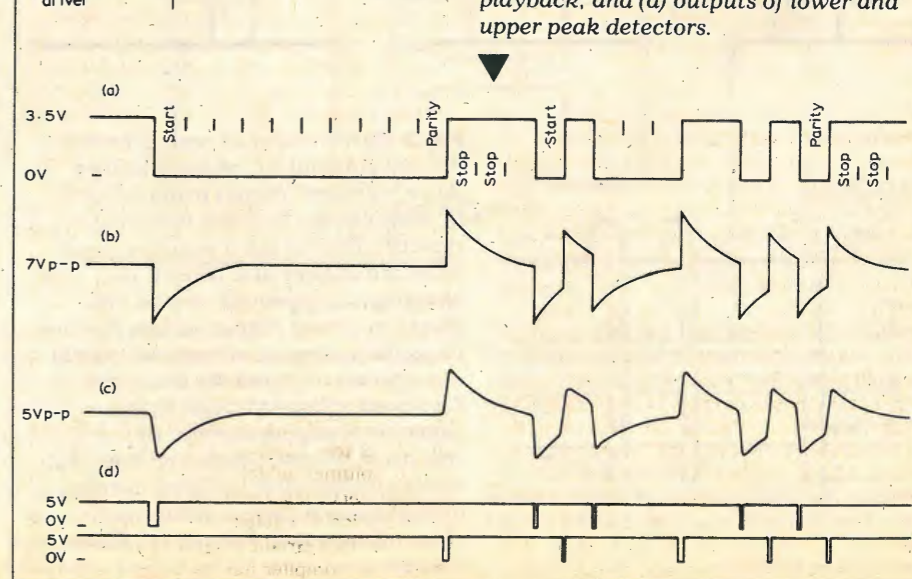


Fig. 2. Waveforms in the interface unit: (a) original serial data; (b) square waves differentiated before recording; (c) input to interface from tape playback; and (d) outputs of lower and upper peak detectors.

bits are set to 0, in the second there is a more typical random pattern of 1s and 0s. If the data has resulted from the manual depression of keys on the v.d.u. there may be a relatively long marking period between successive key strokes and hence data words.

These two data word examples, both prior to and after differentiation, are shown in Fig. 2(a) and (b). It can be seen that the absolute height of each differentiated edge depends on the run of bits before it. Because of this effect it is not possible to reshape the differentiated bits by means of a Schmitt trigger since there is no means of optimally setting the trigger level for changing bit height. The problem is exacerbated by the lack of high frequency response of the replayed tape which serves to increase the rise time of the edges of the recorded waveform. This is illustrated in Fig. 2(c). The only remaining relatively undistorted reference point is the top of each 'spike' and it is the timing of these turning points that must be determined in order to reconstitute the original serial data stream. To accomplish this we require a peak detector.

Peak detector

If a pulsatile waveform is applied to the input of the conventional d.c. restorer, as shown in Fig. 3(a), current flows in the diode only while the capacitor is charging up to the input peak voltage. When the capacitor is fully charged, current ceases and the diode no longer conducts. The same effect is produced if the diode is replaced with the base-emitter junction of a transistor (Fig. 3(b)). We may now estimate the mag-

nitude of the capacitor's charging current by measuring the voltage drop across the collector resistor as shown in Fig. 3(f). This voltage drop falls to zero once the input capacitor is fully charged. This, of course, occurs at the top of the input voltage pulse. However, it is interesting to note that charging current first starts to flow at some point near the bottom of the pulse once the magnitude of this new pulse exceeds the stored voltage remaining across the capacitor. This latter voltage is a function of the d.c. restorer's RC time constant and the immediate past history of the magnitude and timing of previous voltage pulses.

One practical improvement to this circuit is the substitution of an operational amplifier and discrete diode for the transistor configuration (Fig. 3(c)). (Another practical transistor version is employed in the clock frequency doubler circuit described later.) The op-amp circuit provides a constant negative-going voltage pulse during capacitor charging that can be used to drive t.t.l. directly. Circuit operation is improved if a small voltage bias is applied to the non-inverting op-amp input. This avoids spurious outputs when no input signals are applied. This circuit has become a standard building block at Barts, including use as a peak detector of physiological signals such as the electrocardiogram.

Tape playback interface circuit

In Fig. 4 the tape recorder output is fed to a unity gain amplifier that acts purely as an inverting buffer. From there the signal follows two paths; the first direct to a peak detector, the second via an

inverter and identical peak detector. Typical waveforms are shown in Fig. 2(c) and (d). The negative-going output of each peak detector is fed to the set and reset inputs of the bistable formed from two cross connected Nand gates. At first sight it would appear that the 'squared' output of this bistable is the reconstituted digital data (Fig. 5(c)). This is not quite true since set and reset are initiated at the start of diode conduction in the peak detectors. We need to delay the operation of the bistable to the end of the peak detector's diode conduction period so that the transitions of the digital output coincide with the peaks of the input waveform rather than occurring indefinitely early.

To achieve this delay the t.t.l. compatible peak detector outputs are also summed in a 7400 Nand gate (now a Nor gate under negative logic) and inverted in a further 7400 gate (Fig. 5(d)). In this way the trailing edge from either peak detector, virtually coinciding with the peak of the input voltage, clocks the 7474 'D'-type flip flop. This procedure delays the S-R bistable transitions to the correct points in time so that the Q output of the D flip-flop now provides the correct reconstituted data (Fig. 5(e)).

In practice both Q and Q-bar outputs are made available via a switch as the recording process may introduce an even or odd number of analogue inversions of the signal.

Optional clock track recording

Although two separate transmit and receive clock oscillators may be employed to feed the parallel-serial and serial-parallel converters that are used to generate and receive the serial data stream, it was thought convenient to add a separate clock track to the stereo tape recorder. The availability of such a signal permits complete freedom in the initial choice of tape speed and final tape speed-up without the need to adjust the interface.

In the original design, parallel-serial and serial-parallel conversions were performed in u.a.r.t. (universal asynchronous receiver transmitter) chips that require a clock input at 16 times the intended serial data rate. Fortunately, since this signal is frequency divided within the chip, the mark space ratio of the clock signal is not critical. The original design specified a serial data recording rate of 750 bits/s thus requiring a 12kHz oscillator for the u.a.r.t. transmitter. Experiments showed, not unexpectedly, that at the lowest tape speed of 4.75cm/s the reproduction of a 12kHz signal was less than perfect. However, when a 6kHz recorded signal was replayed at a 4x speed up (19cm/s) a surprisingly clean 24kHz sine wave was displayed on the oscilloscope.

So, if the transmit clock signal is frequency divided prior to recording is there a simple method of frequency

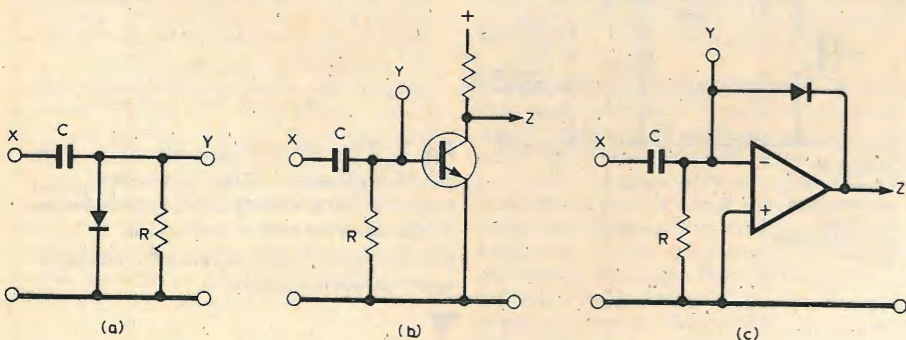


Fig. 3. Development of peak detector: (a) conventional d.c. restorer using a diode; 'restored' output available at Y; (b) base-emitter junction of transistor replaces diode of (a); a negative input pulse is available at Z while C is charging; (c) improved version that gives a constant output voltage for any capacitor charging current; (d) typical input pulses at X and the discharge of C's stored voltage through R; (e) capacitor charging current; (f) transistor collector output voltage at Z, related to capacitor charging current; and (g) op-amp output voltage at Z showing improved rise and fall times over (f).

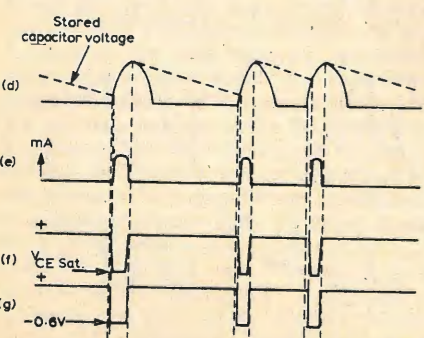
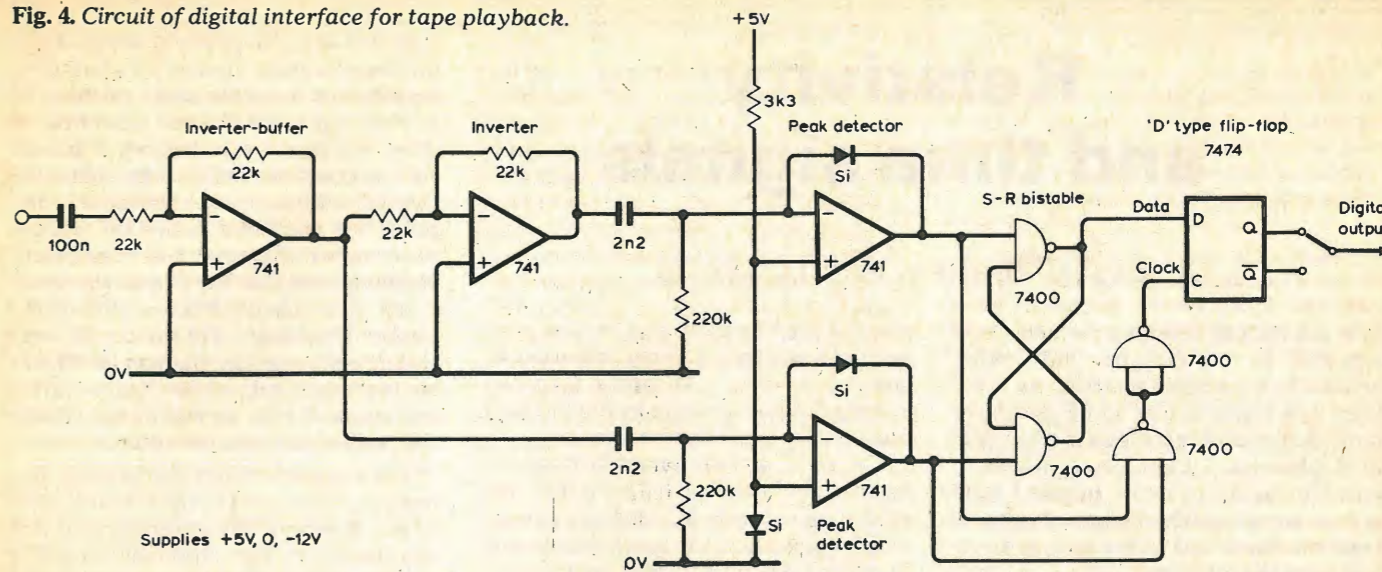


Fig. 4. Circuit of digital interface for tape playback.



doubling on replay, preferably independent of frequency? The circuit described below operates from sine or square wave input signals over a range wider than 1 to 30kHz and is also not critical of input amplitude. It produces a short output pulse on each occasion the input waveform passes through zero, viz, twice per input cycle.

Clock frequency doubler

In Fig. 6 the unity gain inverting buffer amplifier feeds separate buffer and inverting amplifiers so that identical out-of-phase tape clock signals are presented to a two-diode gate. The output of this gate will always follow the more negative of its two input signals (see Fig. 7(d)). There is thus an abrupt change or turning point in the gate's output as first one then the other, complementary clock signal is tracked. These abrupt changes (or spikes) are detected in the subsequent simple transistor peak detector. The substitution of a reverse diode in place of the conventional resistor across the base-emitter transistor junction permits the peak detector to operate over a wider range of both input voltage and frequency.

The inclusion of the buffer amplifier is not essential if the circuit is to be used on input frequencies below about 5kHz. It is only introduced to counter the short time delay of the parallel inverting amplifier path that results from the well-known voltage slew rate limitation of the 741 amplifier. The alternate use of 748 operational amplifiers using discrete 22pF compensating capacitors permitted trouble-free operation beyond 50kHz input frequency.

Setting up

Some form of error monitoring is required, the simplest being the connection of the parity error line of the serial-parallel digital receiver to a light emitting diode.

Data replay level

A playback output level of less than 1.4V p-p will fail to trigger the peak detectors and the output will remain

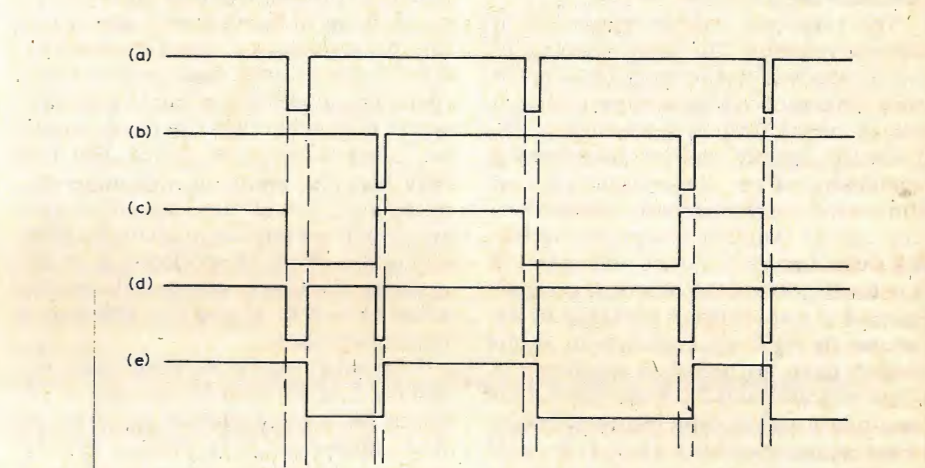
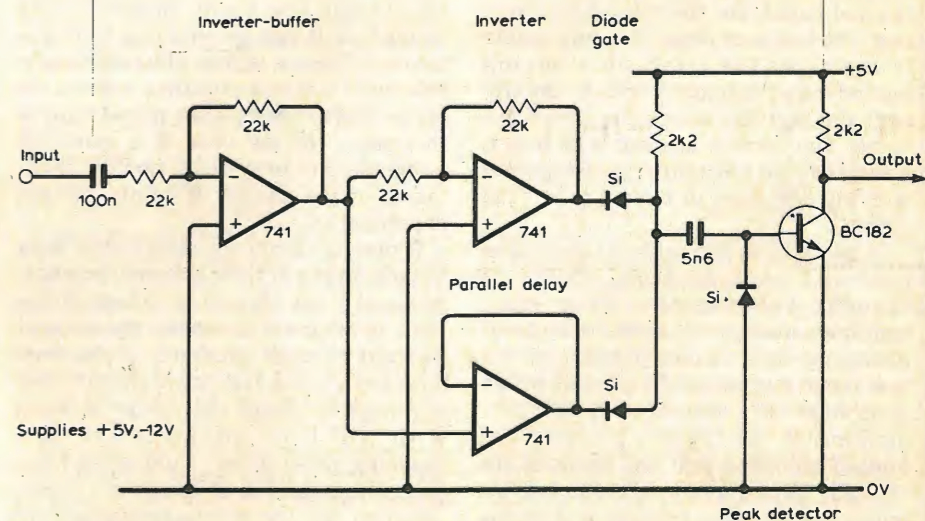


Fig. 5. Waveforms in the playback interface of Fig. 4: (a) output of lower peak detector; (b) output of upper peak detector; (c) output of S-R bistable; (d) clock input; and (e) Q output of 7474.

Fig. 6. Circuit of frequency doubler.



permanently high or low. Levels in excess of 8V p-p will experience clipping in the buffer and inverting analogue amplifier and will thus destroy the true turning points of the waveform. Such clipping will markedly increase the error rate.

In practice an error trough exists for replayed signals in the range 3-6V p-p whereas outside these limits error rate

rapidly increases. It is easy to determine the edges of the trough and to set the level control midway between these limits.

Clock track option

Below a similar replay level of about 1.4V p-p the frequency doubler will not

Relativity and time signals

Dr Essen replies to his critics

MY ARTICLE "Relativity and time signals" in the October 1978 issue aroused considerable interest. As there were too many letters to be published individually and there was a good deal of duplication I have been invited to write a composite reply. In this I shall try to bring out the points of general interest since our joint aim is to illuminate the problem.

The response was disappointing in several respects. The main purpose of my article was to encourage interest in new theories of electromagnetism which might lead to a method of exploiting cosmic energy, thus saving civilisation from catastrophic decay. Only two correspondents referred to this aspect. Another disappointing feature was that little notice was taken of my description of the practical comparison of clocks. Writers continue to describe thought experiments in terms which have no practical significance. They still use t and t' for the times of the stationary and moving clocks although I have pointed out that four dial readings are obtained. Einstein, in effect, used four at first by adding qualifying phrases to t and t' and his mistake was to omit the qualifying phrase in his thought experiment. He read the wrong dial. This can be checked most simply by reading his original paper, but there is no evidence that this has been done. It is impossible to arrive at the truth by studying second-hand accounts which usually omit the sections where the errors are made. The serious student will find it helpful to read Einstein's paper together with my criticisms in reference 2 of the article.

In my reply to Dr Griffiths (December letters) I expressed my dislike of thought experiments. Their only legitimate use is to illustrate some point of theory: they cannot possibly give a new result and especially a result which contradicts the assumptions and predictions of the theory. Einstein has himself admitted that the result of his thought experiment contradicted his initial assumptions (reference 3 of the article) and it must therefore be wrong. Relativists seem unable to accept the logic of this statement. Although no further argument is necessary I have drawn attention to the precise nature of the mistake in Einstein's account and, for my own satisfaction, in all other accounts published before my criticisms. Thought experiments continue to

convince the unwary, and several have been recommended to my attention by correspondents. Like other forms of science fiction they may be fun but they must not be mistaken for science.

The error is made by performing the experiment incorrectly. This is followed by the logical error of accepting a result which contradicts the assumptions; and in many cases by a further logical error of ascribing to the thought experiment the characteristics of a real experiment. If a clock is actually made to travel in a round trip acceleration must be applied and it is possible that the result would be changed in consequence. But the only way the result of a thought experiment could be modified by acceleration would be to include a term giving the effect of acceleration in the analysis. If no such term is included the result cannot be in any way influenced by accelerations.

A number of correspondents, including J. H. Fremlin, P. Dobbins, P. M. Smith, M. A. Michaelis, W. A. Edelstein, R. J. Sherwood, A. S. Bennett and M. Brown fall into this error. A. M. New states that Einstein's experiment is not a logical application of the theory. This is true and in order to draw any conclusion from it the assumption must be made that accelerations have no effect; and this assumption is made implicitly. He accepts the result, however, and states that it can be obtained from the General Theory, just as Einstein does in reference 3. It is a pity that there is, as far as I know, no English translation of this paper. In my view it is complete nonsense and provides a further illustration of the danger of using thought experiments.

Professors Jennison and Fremlin refer to talks I gave at their universities years ago and I am pleased to acknowledge their willingness to debate the subject in front of their students. I welcome Jennison's partial agreement and although he states that there is much with which he disagrees the outstanding differences could arise from the contradictions in Einstein's paper. The two specific points mentioned are readily explained.

In Jennison's view, which is shared by a number of other correspondents, the whole series of transmitted pulses is received. This is true if time dilation is the result of a change in the units of measurement, which is one interpretation of Einstein's postulates as explained in reference 2, and also if it is

regarded as a real physical effect as it is in the Lorentz theory, but if it is regarded as a symmetrical effect as in Einstein's prediction, then I can find no other explanation than a loss of pulses. He also questions my statement that the Doppler effect is not mentioned in the prediction but if he consults the original paper he will find that I have quoted it correctly, and that the Doppler formula is not given until a later section of the paper. Einstein's definition of time which eliminates the Doppler effect was an ingenious but unnecessary device and I used it only so that I could quote the prediction in his own words.

The suggestion that the Doppler formula could be used as the starting point of the theory is an interesting and reasonable one. The classical formulae usually given distinguish between a moving source and moving observer, but according to the postulate of relativity it is immaterial which is regarded as moving. The formulae must therefore be made the same, which is what Einstein does. P. D. Edgley and M. Readdie also use the full Doppler formula.

Fremlin claims that he refuted my arguments (see letter in this issue); but my recollection is that he ignored them and repeated Einstein's thought experiment in a more elaborate form, as he does in his present letter.

J. Blecker raises an important point when he asks why I distinguish between the Lorentz transformations and the special theory of relativity since they are practically equivalent. My answer is that they become equivalent only after Einstein has drawn the wrong conclusion from his paradox thought experiment. Lorentz offered no explanation of his time dilation assumption: Einstein tried to explain it in terms of time and space measurements. I think his explanation is wrong and that a true explanation should be found.

T. Theocharis suggests that history has shown the futility of drawing attention to the mistakes in the relativity theory, but I think it is our duty to keep on trying, especially as I do not think any previous critic has shown exactly where the mistake occurs in the thought experiment. He expresses the view that the theory will die only if and when the aether-drift is observed. Although I am in full agreement with the importance of experiment in general, in this particular case it is my view that the theory is rendered invalid by its own internal contradictions. Moreover, most of the experiments that one can think of involve accelerations and cannot provide a direct check of the effect of uniform relative motion.

G. Machiels recounts a story concerning his work as a "Schlepen" — a kind of sheriff — in his home town. He found that large sums of money and materials were being stolen and prepared a case

against the suspects. The case was not brought to court and the corruption continued for another five years before the same suspects were charged and imprisoned in another district. He discovered that the prosecutor had not brought his case because he had been told that it was prepared by a man who must be mad because he had published a book "The end of the Einstein era," which criticised the relativity theory. He offers to send me a copy if I can read Flemish. Although I cannot read Flemish the language difficulty should not prevent the interchange of scientific ideas and if he cares to send a copy I shall do my best with it.

W. Theimer has sent a book "Die Relativitätstheorie" published by A. Francke, A. G. Verlag, Bern 1977, which appears to be a comprehensive and clearly written criticism of the theory. He is trying, so far without success, to publish an English version in the UK or the USA. E. W. Silvertooth agrees that relativity is wrong and supports his conclusion from a consideration of the Doppler equation. He refers to discrepancies obtained in satellite experiments but this is outside my field of experience and I cannot make any useful comment.

M. L. Michaelis sent a long philosophical discussion on logic and understanding in science. Much of what he writes is reasonable, but I do not accept his distinction between logic and commonsense. He admits that students must not expect to understand relativity by using their commonsense and also that many textbook accounts are unsatisfactory. In view of his stress on the importance of logic it is strange that he ignores the lack of logic shown by Einstein and relativists in their conduct and interpretation of thought experiments.

A number of writers insist that Einstein's theory has been proved by experiment, but the experiments they mention involve accelerations which are not considered in the theory. It is shown in reference 2 that the so-called theory consists merely of a number of contradictory assumptions and experiments can only indicate which if any of these assumptions is correct.

S. H. Rutherford asks what does Einstein mean by the expression clocks running slow. I do not know what was in Einstein's mind but I have tried to interpret his statements in such a way as to make sense in practical timekeeping. A short answer to some questions he asks about the measurement of time is that it consists of the counting of the number of repetitions of some periodic event. The number is recorded on a dial and the combination of periodic event and dial is called a clock. It is thus difficult to distinguish between the two.

J. de Rivas asks whether there is evidence of time jumps in caesium

clocks. I expect there is, but the examples he quotes are probably changes of rate of about 1 part in 10^{12} which would give a time change of $1\mu\text{s}$ in 10 days. This is a reasonable performance for clocks of that era. It is not a change in the frequency of the spectral line but of the mechanism for using it.

P. Hirschmann writes from "a state of confused time orientation" and concludes from some rather hypothetical considerations that if Einstein were right time could be made to stand still. He is relieved to find that this is unlikely to happen. R. V. Harvey supports my "crusade" and regards the article as a stimulating challenge to students. My hope is that it will also stimulate thought among our mature scientists.

Finally I would like to say a word in favour of my critics. I realise how difficult it is to doubt the validity of a theory which is accepted by many eminent scientists and receives the continuous public adulation from the media and from distinguished people even though most of these are not in a position to judge for themselves. I had one great advantage. I knew from my practical experience of comparing clocks that Einstein's thought experiments were incorrectly carried out.

L. Essen.

Register of research

The recent ACARD report on industrial innovation urged the Government to stimulate firms to make more use of the research facilities available in university departments. A new way in which we can find out what actual research is going on at the moment in such places is a register of current projects now being published by the British Library. Entitled "Research in British Universities, Polytechnics and Colleges" and issued in three volumes, it contains information from over 3000 departments in every university and polytechnic and a number of colleges in the UK.

Volume 1, available early in 1979, covers the physical sciences and includes sections on electrical engineering and electronics, mathematics, biophysics, materials technology, information science and other fields of interest to electronic engineers. The book lists research work in progress, with names of investigators for each project or area, duration of the work and sponsoring bodies. Names and addresses of heads of departments are given, and there is also a name index and a detailed keyword index. The volume is available at £15 (or 30 dollars) per copy from The British Library, Boston Spa, Wetherby, West Yorks LS23 7BQ (tel: Boston Spa (0937) 843434).

The other two volumes, No. 2 on the biological sciences and No. 3 on the social sciences, will be issued later. All three will appear annually, and the whole register will also be available later through the British Library Automated Information Service (BLAISE).

● The ACARD report mentioned above criticizes the academic world for having too long ignored the field of manufacturing, although it could in fact make an important and useful contributions. "The Government

Up to the time when Dr Essen wrote the above reply the following people had sent us letters in response to his October 1978 article. We thank them for their interest and are sorry that we have not been able to publish all the contributions in our correspondence columns.—Ed.

T. Barnes, Witham, Essex; A. S. Bennett, Bedford Inst. of Oceanography, Dartmouth, Canada; J. Blecker, Geneva, Switzerland; M. Brown, Aberdeen; S. K. Chatterjee, St Andrews, Fife; P. Dobbins, Maiden Newton, Dorchester; W. A. Edelstein, Univ. of Aberdeen; P. D. Edgley, Handbridge, Chester; J. H. Fremlin, Univ. of Birmingham; A. Jones, Alderney, Channel Isles; R. C. Jennison, Univ. of Kent at Canterbury; R. V. Harvey, Reigate Heath, Surrey; G. F. Filbey, Poly. of the South Bank; D. Griffiths, Imp. Coll. of Science and Tech.; P. Hirschmann, Haifa, Israel; B. L. Kershaw, Birmingham; G. Machiels, Diepenbeek, Belgium; M. L. Michaelis, Mainz/Rhein, G.F.R.; A. M. New, Fishponds, Bristol; M. Readdie, Trinity Hall, Univ. of Cambridge; J. de Rivaz, Porthtowan, Truro, Cornwall; S. H. Rutherford, Aylesbury, Bucks; E. W. Silvertooth, Flintridge, California, USA; P. M. Smith, Swansea; R. J. Sherwood, Erdington, Birmingham; T. Theocharis, Imp. Coll. of Science and Tech.

should stimulate firms without access to research facilities to use university departments by offering incentives, such as special tax relief, for such expenditure. It should also review and evaluate the relative merits of the various schemes for university/industry collaboration, such as Wolfson Industrial Units and the appointment of industrial liaison officers; the UGC might then be encouraged to transfer extra funds to those judged a success."

Electronics courses. Two universities are running flexibly organized courses on the latest technology in electronics. "An introduction to modern digital systems" at Leeds University, 2-6 April and 17-21 September, is broad and introductory and intended not so much for specialists as for a wide range of participants from education, the public services and general industry. The course and its laboratory activities can be tailored to individual needs. (Contact: Director of Special Courses, Dept. of Adult Education and Extramural Studies, The University, Leeds LS2 9JT). Nottingham University are offering a modular course on "Modern electronics," starting in October 1979, in which participants can select those modules appropriate to their work interests. An M.Sc. can be obtained after two years of part-time study. There are ten modules, encompassing computer hardware and software, control theory, microprocessors, signal processing, communications, solid-state devices, computer aided design, power electronics and information systems. (Contact: Mr R. V. Arnfield, Industrial and Business Liaison Office, University of Nottingham, University Park, Nottingham NG2 2RD).

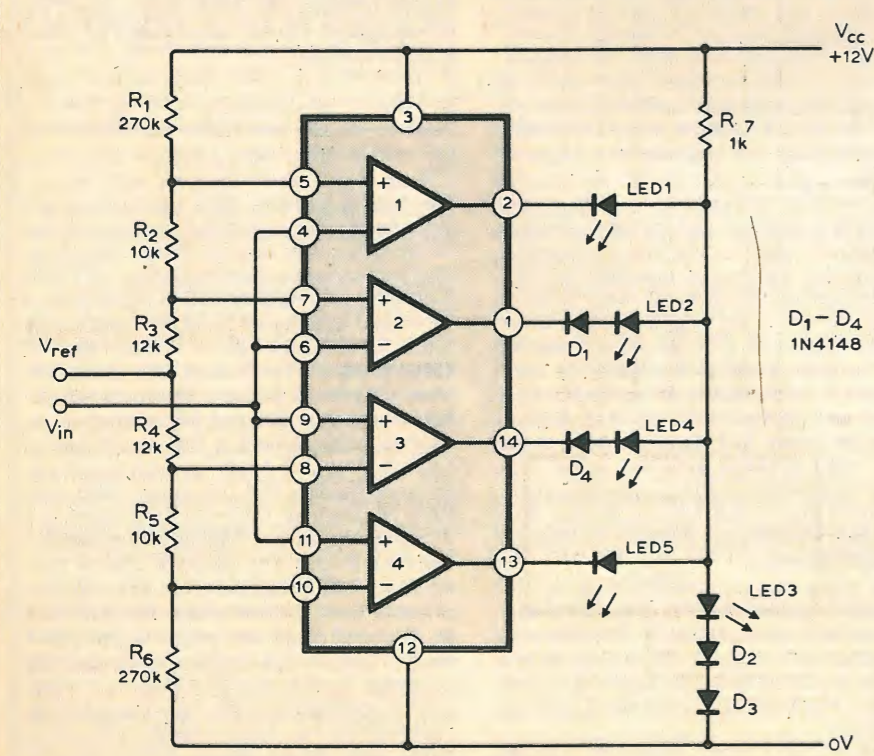
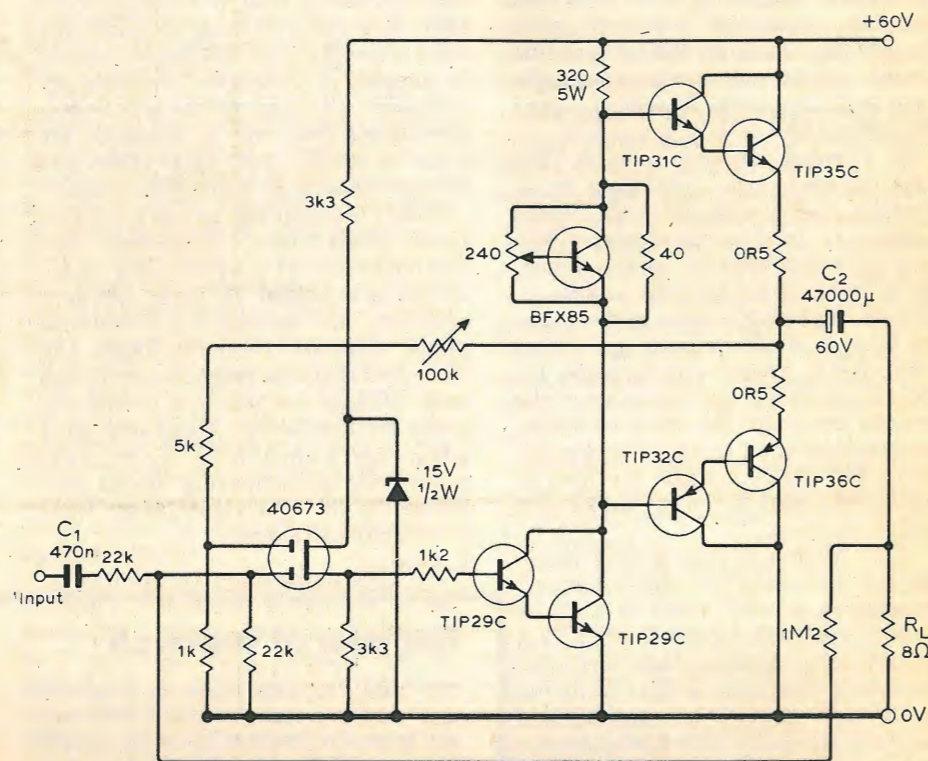
CIRCUIT IDEAS

Power amplifier uses m.o.s.f.e.t. input

The normal longtail pair circuit is avoided in this design which offers a high input-impedance by using a m.o.s.f.e.t. input. The -3dB point is set by C_1 and C_2 , and d.c. feedback is applied via the 100k Ω variable resistor. Quiescent current is set by the 240 Ω potentiometer, and is adjusted for minimum crossover distortion.

In operation, the amplifier has proved to be very stable, and will provide up to 50W r.m.s.

A. R. van Wijgerden
Coventry



L.e.d. tuning meter

Due to their low cost and availability, l.e.d. displays are becoming popular as replacements for conventional meters. This design replaces a f.m. tuning meter with a line of five l.e.d.s, and uses a single MC3302 i.c., which contains four comparators with open-collector outputs. When off-tune, V_{in} from the discriminator equals V_{ref} , all of the comparator outputs are high, and LED₃ is illuminated. Tuning towards a station causes V_{in} to swing more positive than V_{ref} , which drives comparator outputs 1 and 2 low but only LED₁ turns on. As V_{in} increases further, output 1 goes high, turning LED₁ off and LED₂ on. The on-tune condition turns LED₃ on again when V_{in} is within $\pm 0.25V$ of V_{ref} . Comparators 3 and 4, with LED₄ and LED₅ behave similarly when V_{in} is less than V_{ref} ; therefore the display acts like a centre-off moving-coil movement.

For correct operation, V_{ref} must be around 6V, otherwise R_1 and R_6 must be altered. Also, V_{ref} must have a low impedance source, so buffering may be required.

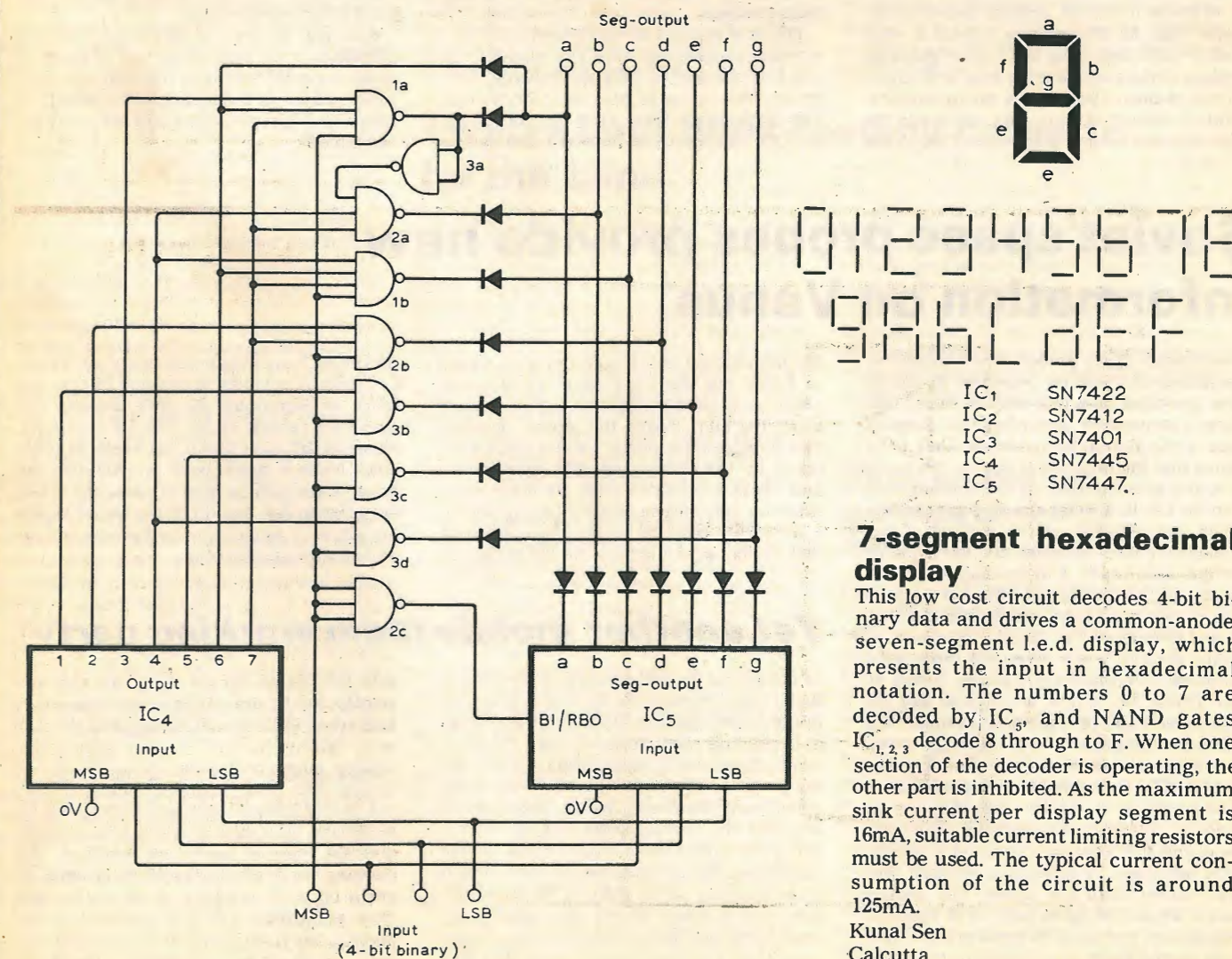
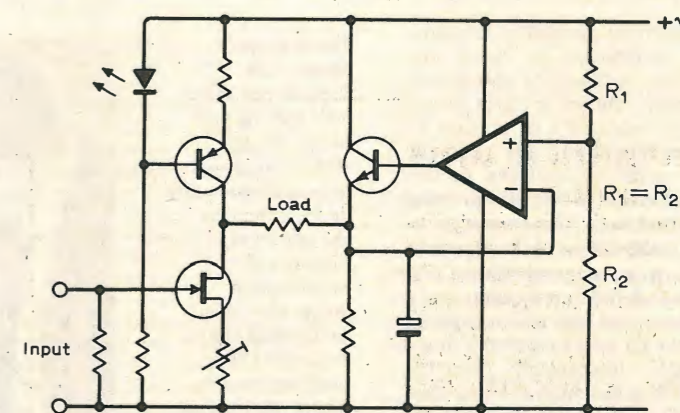
T. P. Hopkins
Haywards Heath
West Sussex

Directly coupled class A headphone amplifier

In this headphone amplifier a constant current source for the drain load allows maximum gain to be achieved. The circuitry to the right provides the necessary centre tapped supply from a single rail, and is not required if a centre tapped power supply is used.

The variable resistor is adjusted so that no current flows through the load under no-signal conditions. Circuit values depend on the supply voltage and headphone impedance which can vary from 8 Ω to 2k Ω .

G. Nye
Reigate
Surrey



7-segment hexadecimal display

This low cost circuit decodes 4-bit binary data and drives a common-anode, seven-segment l.e.d. display, which presents the input in hexadecimal notation. The numbers 0 to 7 are decoded by IC₅, and NAND gates IC_{1,2,3} decode 8 through to F. When one section of the decoder is operating, the other part is inhibited. As the maximum sink current per display segment is 16mA, suitable current limiting resistors must be used. The typical current consumption of the circuit is around 125mA.

Kunal Sen
Calcutta
India

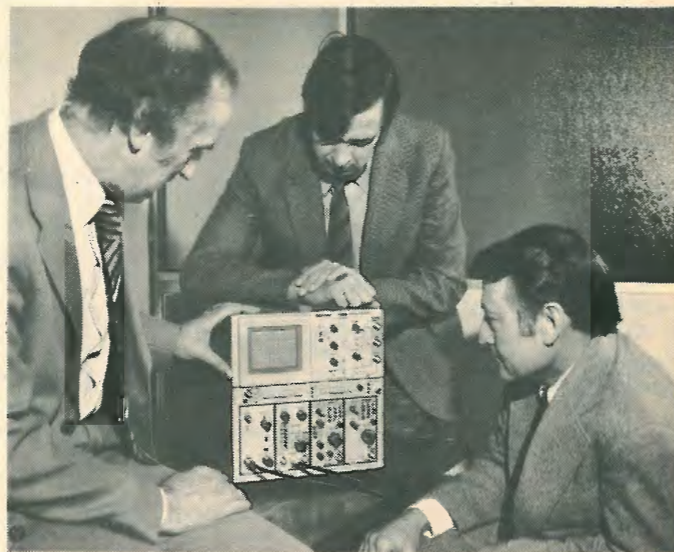
NEWS OF THE MONTH

First general-purpose 1GHz scope

Five years ago, Tektronix decided to develop a general-purpose oscilloscope to break the magic 1GHz barrier. Although a specialized instrument already offered a 1GHz bandwidth, its vertical sensitivity of around 10 V/cm and a sweep rate of only 2ns/cm made it impractical for many applications. As this performance was close to the limit, using conventional components, three main developments were undertaken. A new, wide-bandwidth c.r.t. was designed with a distributed horizontal deflection system, and a meshless scan expansion lens which expands the electron beam 4½ times vertically and 4 times horizontally, substantially reducing the tube length. A microchannel-plate electron multiplier gives a high writing speed and enables fast transients to be photographed with an average-speed camera and ordinary film. The microchannel-plate, which is a secondary emission device behind the c.r.t., also removes the problem of "blooming" when the beam intensity is high by limiting the brightness just as the plate's electron amplifier becomes saturated.

To overcome the problems of high-frequency amplification Tektronix developed an in-house linear i.c. process called SHIII (super high 3). The process combines very shallow diffusions with ion implantation to produce devices with a unity gain at 6½GHz. To complement these i.c.s a micro-stripline printed circuit layout was designed to accommodate each package. The third

The Tektronix Model 7104 oscilloscope seen here has the high sensitivity of 10mV/cm in real time at frequencies up to 1GHz, and the ability to display sub nano-second single-shot events in ambient light. Inspecting the oscilloscope are (left to right) Keith Retallick - sales manager, Derek Smith - marketing development manager, and Ed Morrison - managing director.



specialised design was the interconnection system which uses metallized elastomer contacts to reduce reflection losses and mismatching.

The final product of this expensive development programme was the model 7104 which is compatible with the existing Tektronix 7000 series of plug-in instruments. This oscilloscope offers a rise time of 350 ps, an X/Y bandwidth of 350MHz, full sweep

triggering up to 1.5GHz, a photographic writing speed of 20cm/ns, and a trace which is claimed to be 1,000 times brighter than usual for one-shot events.

Although the price of between £11,000 and £15,000 puts the instrument out of range of many budgets, Tektronix feel that the development spin-off and intangible benefits from pioneering this specialized area are worth the investment.

Soviet space probes provide new information on Venus

Two Russian space probes which landed on the surface of Venus on December 21 and 25 have provided new information about the planet's atmosphere, according to a January issue of the journal *Soviet News*. They have shown that the ratio of the isotope Argon 36 to Argon 40 is from 200 to 300 times greater than on Earth. Special gas chromatographs which were landed on the surface of the planet have also recorded the presence of carbon monoxide. Chromatographs are usually fairly bulky instruments, but the ones used in this experiment weighed only about 2lb and were known as "Sigma" probes.

The probes were released from two automatic interplanetary stations, Venus 11 and Venus 12, which were launched on September 9 and 14 respectively as part of a continuing programme investigating Venus. The equipment on the space vehicles was developed by Soviet and French scientists.

Although Venus 11 was launched before Venus 12, the latter reached the vicinity of the planet first because it was on a shorter flight path, and its probe was released four days earlier than the other. The probes landed about 500 miles apart and reported atmospheric pressures 88 times greater than those on the Earth, and temperatures in the region of 445° to 460°C, says the journal.

The information from the probes was relayed to Earth via the interplanetary stations which continued in flight in orbits centred about the Sun. During the probes' descent, nine samples of the planet's atmosphere were taken by the chromatograph instruments and these confirmed that its main constituents were carbon dioxide and nitrogen.

An earlier issue of *Soviet News* reported that cosmonauts Vladimir Kovalyonok and

Alexander Ivanchenkov, on board the Salyut 6 - Soyuz 31 complex, completed 100 days in space on September 23, 1978, beating the previous record of 96. The cosmonauts, whose health took four to six weeks to settle down while in space, were investigating the ozone layer using a special telescope. They also carried out experiments related to the formation of semiconductor crystals in conditions of weightlessness.

Yet another mobile radio working party

At the annual general meeting of the Mobile Radio Users' Association, held on January 18, it was agreed that the Association would set up a working party, together with the Electronic Engineering Association, to discuss the problems of channel loading within the mobile radio frequency bands. Both parties felt that the present policy of the Home Office on mobile radio would cause severe difficulties, especially in the Greater London area. Secretary of the MRUA, Mr Ron London, told *Wireless World* that what most worried the two parties was the Home Office view that a system which permitted 80% channel loading during busy hours was feasible.

The MRUA did not think that this was possible at the present time since members had heard 70% channel loading and this had been "pretty chaotic." In due course this loading might be feasible, when users are familiar with heavy channel loading, he said, but to implement it fairly suddenly would be a mistake, particularly when a number of different types of user were involved. The working party would therefore attempt to come up with evidence to show that 80% channel loading was not practical at the present time. Mr London hoped that the party would report its findings to the Home Office within the next few months.

CB letter to the PM

On January 12, James Bryant, the president of the Citizens' Band Association, sent a letter to the Prime Minister, The Rt. Hon. Mr Jim Callaghan, pointing out the rapid growth of the illegal use of citizens' band radio in this country, and urging him to legalize high-performance v.h.f. c.b. before the pressure of illegal use compels the legislation of the American system in this country. The adoption of the American system would lead to a flood of Japanese equipment into this country, while v.h.f. c.b. radios could be manufactured in Britain. "Four British manufacturers are already prepared to manufacture such sets should c.b. be legalized," he wrote.

In his opening sentence Mr Bryant asked the Prime Minister to reconsider his government's opposition to the introduction of citizens' band radio in this country. Great Britain and Eire, he said, were the only countries left in Europe which did not allow private citizens some form of short range radio communication.

Most of Mr Bryant's letter dealt with the main arguments which had been put forward against c.b. and comments which he had to make on these objections. These arguments are now quite well known and many of his comments reflect what are now common views amongst the pro-c.b. fraternity, views that have already been discussed in *Wireless World*. However, a few of his comments are still worthy of note here.

About the argument that the administration required to control c.b. would be prohibitively complex, Mr Bryant made the point that modern silicon-chip technology made it not only possible but simple to fit every c.b. set sold, at the factory, with a unique identifying signal which could not be tampered with without the resources of a microelectronics factory and without which the c.b. set would not transmit. The extra cost of this advice would be under 50p, he said, and it would reduce the administrative costs of a c.b. service to a low level, and also increase the impracticality of criminal or anti-social use of c.b.

In the letter Mr Bryant claimed that there were many MHz of available frequency spectrum in the v.h.f. and u.h.f. regions which, though allocated were unused. The 220 to 240MHz range, for example, had unused sectors — some never used since 1944. There was also space around 900MHz, and possible space in the near future where the v.h.f. tv channels are now. Very little spectrum was needed for c.b.; according to Mr Bryant, 0.5 to 1MHz would be ample and even 200kHz could provide a reasonable service. He believed that, given political will, the spectrum space could be found.

Mr Bryant stressed that the American 27MHz a.m. standard, as used in most of the countries having c.b., was unsuitable for a small, densely-populated country like Britain, and he reminded the Prime Minister that the NEC, BREMA and the EEA were all agreed on this.

In describing the present seriousness of illegal c.b. in Britain Mr Bryant said that the Citizens' Band Association had estimated that there were now about 15,000 illegal users in this country and that their number was growing by about 1000 every month.* If the growth in illegal operators continued the Government would be forced, as happened in Australia, to legalize what was already being done. There would then be no possibility of

introducing a more complex system, or automatic identification, and the Government would be forced to legalize an American-style system, with all its problems. Britain would also miss out on the 'golden opportunity' of leading the world into a new generation of c.b. radio.

* Wondering how any individual or association could possibly estimate the number of illegal operators with any accuracy at all, *Wireless World* asked James Bryant exactly how this was done. His answer was that people go out to the main cities where c.b. operation is known to take place, such as London, Bristol, Birmingham, Manchester and Liverpool, and listen. From this, he said, one can estimate the number and check it against the number of sets which the Association knows have been brought into this country. The latter figure, according to Mr Bryant, is at least 10,000, but there is equipment, legitimately manufactured for the 10-metre amateur service, which is also being used for c.b. *Wireless World* still finds it very difficult to see how these figures can be arrived at. While we know exactly how many radio amateurs there are in this country, we cannot see any way in which this number could be obtained from any amount of listening because the number of amateurs operating at a particular time depends upon so many factors. Indeed, one would expect that the problem is even greater with illegal c.b. operation because the operators, surely, would endeavour, to some extent at least, to keep their identities and locations secret. This would not help the listener who is trying to count the number of people operating at that time. Having said this, *Wireless World* does agree with most of what James Bryant has said in the remainder of his letter.

When asked which four British manufacturers were prepared to manufacture c.b. sets, Mr Bryant said that, for their own commercial protection, they had requested that their names be kept secret.

Twelve hour book-reading cassette for the blind

The Foundation for Audio Research and Services for Blind People has achieved one of its major objectives — the storage of 12 hours' reading on a C90 cassette similar in design to a standard compact cassette. To accomplish this they employed specially-modified cassette recorders which made use of four recording tracks in the mono track order 1, 4, 3, 2, at a tape speed of 1.2cm/s. The significance of this achievement is that it will enable audio books to appear on the shelves of public libraries alongside printed editions, and be available in bookshops at comparable prices.

Mr Arthur Wilson, the honorary director of the Foundation, said at a press conference in November that, apart from people with visual and physical handicaps, there were millions of people who could not or did not take advantage of printed books but who would read audio books. Remploy Ltd, which provided employment for seriously disabled people, had undertaken to manufacture equipment by which these audio books could be read. Mr Wilson concluded his speech with an appeal; first, for general support for the project in principle, and secondly, for financial help to enable the project to proceed as quickly as possible. A sum of £50,000, required to translate the laboratory versions of the cassettes into prototypes, was quoted as the appeal figure in a draft of the conference report. The Foundation's HASLAF award for 1978 was then presented to Mr Malcolm Watford of Hemel Hempstead in recognition of his work in designing

Conferences and Exhibitions

After two successful conferences at Montreux in 1975 and 1977, the 3rd Electromagnetic Compatibility (E.M.C.) Symposium and Exhibition, planned for May 1 to 3 this year, is to be held in Rotterdam, Holland.

The 22nd Salon International des Composants Electroniques is to be held from April 2 to 7 this year at the Porte de Versailles, Paris. It will be an exhibition of components and electronic sub-assemblies, measuring instruments, and materials and products for the electronics industry. A conference will also be held between these dates.

Communications 80 will be held from April 14 to 18, 1980, at the National Exhibition Centre in Birmingham, England. With an exhibition area of 18,000 square metres, it is expected to be the largest yet held. The international exposition is again being organised by Tony Davies Communications.

A call for papers has been made by the IEE for the 5th European Solid State Circuits Conference (ESSCIRC 79) which is to be held at the University of Southampton from September 18 to 21 this year. Abstracts should be submitted by May 2. Further details from the Institution of Electrical Engineers (IEE) Conference Department, Savoy Place, London WC2R 0BL.

A new exhibition for the amateur, hobbyist and small professional buyer is to be held at Alexandra Palace, London, from June 28 to 30 this year. The Great British Electronics Bazaar, as it is to be called, is being organized by the Evan Steadman Communications Group, Saffron Walden, Essex.

modifications which had already transformed the lives of many blind and partially-sighted people now using equipment supplied by the Foundation.

Technical information which has been released about the equipment so far gives a wow-and-flutter figure of less than 0.1% and a frequency response of at least 6kHz, despite the slow running speed.

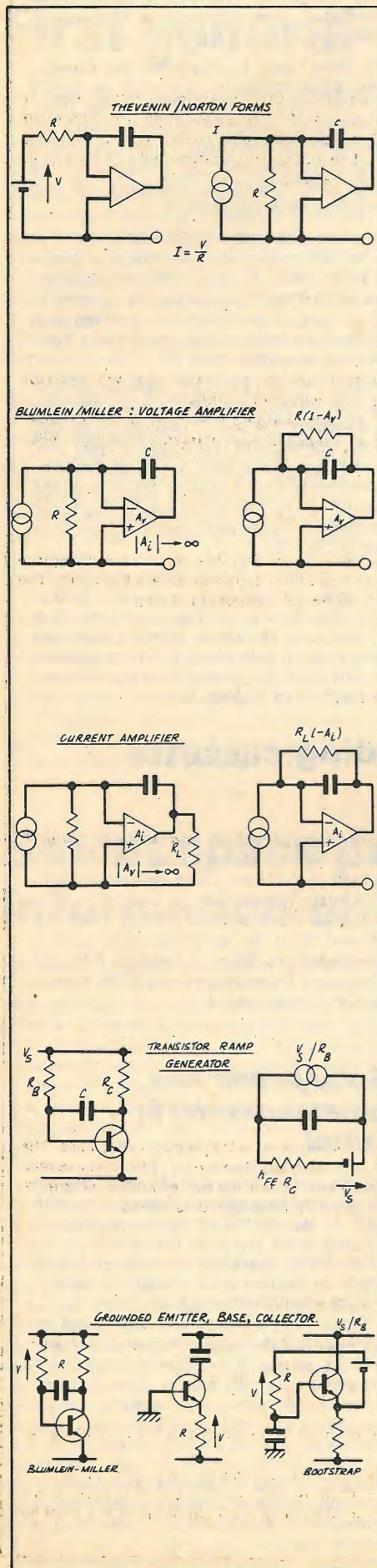
Solar power has great potential in Israel

Experts in Israel say that the Dead Sea has the potential for supplying their country with 150% of its electricity needs. Already, a two-acre solar pond on the shores of the Dead Sea is providing enough energy to satisfy the heating and cooling requirements of a 200 room hotel being built there.

The solar pond idea was conceived by Professor H. Tabor, of the Hebrew University in Israel. Energy in the form of hot water is extracted from the bottom of a specially layered pond without making waves, which could disturb the build up of heat. Each layer consists of water of a different salinity. The hot water is then passed through heat exchangers so that the heat produced may be used with turbines driving electrical power generators or directly for air conditioning or other systems.

Novatexts — 2

by Peter Williams



It is now necessary to investigate in more detail the imperfections and sources of error in ramp generators. The discharge part of the cycle is left till later, and the results obtained are equally applicable to triangular wave and sawtooth generators, as to the generation of any waveform having a nominally linear region. The first step is to apply the circuit theorem to the input section comprising the voltage generator in series with a resistor. This is identically equivalent to a current generator in parallel with the same resistor provided that $I = V/R$. This allows of a different interpretation of the effect of finite voltage gain. The higher that gain, the lower the voltage appearing across the equivalent parallel resistor, and hence the smaller the error current. As the voltage gain becomes infinite so the error current in the equivalent resistor reduces to zero and the circuit behaves as if the current generator were perfect. The circuit only functions correctly for an inverting amplifier — if non-inverting, the regenerative feedback through the capacitor leads to oscillation.

It is simpler and also more practical to consider the effects of finite voltage and current gain separately. At least for first-order terms the effects are additive, while in important practical cases only one error at a time is significant. For finite voltage gains the Blumlein/Miller effect provides a good way of evaluating the error. An impedance Z placed across an amplifier of gain A_v results in a current flow at the input equivalent to an impedance $Z/(1-A_v)$ placed in parallel with the input (a second impedance across the output required to complete the equivalence has no practical effect if $|A_v| \rightarrow \infty$ as in the case assumed here). This places a capacitance of $C(1-A_v)$ in parallel with R at the input showing the new time-constant to be $(1-A_v)\tau$; with A_v negative and $|A_v|$ very large the time constant is correspondingly large. The inverse transformation can be even more useful. The resistor across the input is replaced by one across the feedback capacitor to provide the same input current. Its value is found to be $R(1-A_v)$, and the final effect is that of a very high value of leakage resistance: the charging current still depends on R , while the current error corresponds to $R(1-A_v) \gg R$.

The advantage of the previous interpretation becomes clearer when the errors due to finite current-gain are investigated. In this case we assume an infinite voltage gain so that only one error at a time is under investigation. Hence there is zero voltage drop across the amplifier input terminals and in the Norton equivalent form the generator shunt-resistance, shown in broken lines, introduces no error. The load resistance draws a current that results in a proportional current flow into the amplifier input terminals. This current increases linearly with the output voltages and has the same effect as a resistor placed directly across the capacitor. The value of the equivalent resistor is found to be $-AR_L$ where A is negative, and $|A| \gg 1$ is the ideal condition. Again this allows the resistance determining the error in the slope to be large while the load resistance is small. This form of error is dominant in single-transistor ramp-generators, widely used for simple time-base circuits. The effect of finite voltage gains is apparent in ramp generators using field-effect transistors.

One particular form is considered first to show the application of the theory introduced above. Two other forms, also well-known, are then shown to be of the same family corresponding to a simple shift in ground-point. A capacitor is placed between base and collector of a bipolar transistor with resistors from each point to the supply line (positive for a n-p-n transistor). The transistor is assumed to have $V_{BE} = \text{constant}$ corresponding to a high voltage gain, and this may be further simplified to $V_{BE} = 0$ since typically $V_C \gg V_{BE}$. The current in R_B is fixed and the majority of it charges the capacitor with a small portion flowing in the transistor base to sustain the required output. Initially the input is shorted, the output is at V_S and the capacitor is fully charged. Hence the voltage across R_C is zero and when the short is removed $I_B \rightarrow 0$. The inverting gain results in a negative-going ramp, increasing the voltage across R_C and the collector and base currents. Thus while the change in output voltage produces a change in slope attributable to a shunt resistance $h_{FE}R_C$ (where $h_{FE} = -A$) a voltage V_S has to be added in series with it to account for the fact that for $V_C = V_S$ $V_{RC} = 0$ and vice-versa.

Three apparently different ramp generators appear in the technical literature: the Blumlein/Miller integrator, the constant-current circuit and the bootstrap circuit. These differ greatly in detail but form a closed family with all essential points in common. The active device has three terminals any one of which may be grounded. In one mode (grounded emitter, source, cathode) the stage inverts and the magnitudes of both voltage and current gain are $\gg 1$. In the second mode (grounded base, gate, grid) the stage is non-inverting with approximately unity current gain. In the third mode (grounded collector, drain, anode) the stage is non-inverting with approximately unity voltage gain. The capacitor is placed between base and collector or the equivalent locations for f.e.t.s and valves, with a resistor and voltage bias in series between base and emitter. The bias voltage may be provided directly by the supply, by a separate but grounded bias voltage or by a floating battery. Thus the circuits differ in convenience but are internally similar. Each forces a constant current to flow in a capacitor generating a linear ramp.

Linear ramp generators

THEORY

The voltage generator can be replaced by the current generator provided each provides the same open-circuit voltage and short-circuit current. Let the current generator have a resistor R in parallel.

$$\begin{aligned} V/R &= I \text{ short-circuit current} \\ V &= IR' \text{ open-circuit current} \\ \text{Result holds for } R' &= R \end{aligned}$$

The Blumlein-Miller effect postulates the replacement of a feedback impedance by input and output terminating impedances that draw the same currents from source and output as does the feedback impedance and are hence equivalent to it. Commonly the impedance across the output can be ignored: with a high-gain amplifier it is almost equal to the feedback impedance while the output impedance is low. Similarly an impedance across the input can be replaced by a feedback impedance of appropriate value.

Let i, i' be currents drawn from the source in the two cases

$$\begin{aligned} i &= v/r \\ i' &= (v - A_v v)/R' \\ \text{For } i &= i' \\ v/R &= v(1 - A_v)/R' \\ R' &= (1 - A_v)R \\ \text{For } A_v & \text{ large and negative} \\ R_1 & \gg R \text{ and the time constant is} \\ \tau' &= RC(1 - A_v) = (1 - A_v)\tau \\ \tau &= |A_v|\tau \end{aligned}$$

This is identical with the value obtained by the usual Blumlein-Miller calculation where C is replaced by $C(1 - A_v)$ across the input. To complete the equivalence the current flowing in the notional feedback resistance has to be cancelled by a resistance across the output carrying an equal and opposite current. In the high-gain case the voltage is large and the resistance correspondingly so. For op-amp circuits the loading effect is negligible and only input/feedback equivalence need be observed.

For $|A_v| \rightarrow \infty$ the input voltage $\rightarrow 0$, a true virtual earth that prevents the source resistance from contributing to the non-linearity. The current gain is A_v and is negative for negative feedback.

$$\begin{aligned} \text{Load current } &= V_o/R_L \\ \text{Input current } &= \frac{V_o}{A_v R_L} \end{aligned}$$

Replace R_L by resistor R' between input and output. This resistor is to divert the same current away from the capacitor as did the amplifier input, the gain of the amplifier now being considered infinite.

$$\begin{aligned} \text{Current in } R' &= -\frac{V_o}{R'} \\ \frac{V_o}{A_v R_L} &= -\frac{V_o}{R'} \end{aligned}$$

and $R' \rightarrow \infty$ for A_v large and negative.

$$\begin{aligned} \text{For } V_{BE} & \rightarrow 0, \text{ charging current is } V_S/R_B \\ \text{Initial conditions } & V_C = V_S \\ & \text{and } I_{RC} = 0 \\ & I_B = 0 \\ & h_{FE} = A_v \\ \text{Error current} &= \frac{V_S - V_C}{h_{FE} R_C} \end{aligned}$$

This current has an initial value of zero ($V_S = V_C$) and a maximum value of $\frac{V_S}{h_{FE} R_C}$ for $V_C = 0$.

$$\therefore \text{Max\% error is } \frac{V_S}{h_{FE} R_C} \bigg/ \frac{V_S}{R_B} = \frac{R_B}{h_{FE} R_C}$$

EXAMPLES

1. An amplifier has a voltage gain of -500 and negligible input current. It is used as a ramp generator with a 10nF feedback capacitor. The drive current is obtained from a 10V source through a $10\text{k}\Omega$ resistor. What is the approximate time to complete a 20V ramp? Estimate the % change in slope from beginning to end of the ramp.

$$\begin{aligned} \text{Input current} & \approx 1\text{mA} \\ \frac{\Delta V_c}{\Delta t} &= \frac{10^{-3}}{10^{-8}} \\ \Delta t &= \frac{20 \cdot 10^{-8}}{10^{-3}} = 2 \cdot 10^{-4}\text{s} \\ \Delta t & \approx 200\mu\text{s} \end{aligned}$$

Circuit is equivalent to perfect current generator but with resistor $10\text{k}\Omega[1 - (-500)]$ in parallel with capacitor $\approx 5\text{M}\Omega$.
 \therefore With $V_c = 20\text{V}$, $I_r \approx 4\mu\text{A}$. Thus the charging current is $(1 - 0.004)\text{mA}$. But $dV_c/dt \propto I_c$ i.e. the slope is reduced by four parts in a 1000 or 0.4%.

2. Repeat the previous question using the Blumlein-Miller effect to replace the feedback capacitor by an equivalent capacitor across the input. The results can be obtained by expanding the exponential term.

$$\begin{aligned} V_o &= AV \\ V &= V_1(1 - \exp -t/\tau) \\ V_o &= -500 \cdot 10 \cdot (1 - \exp -t/\tau) \\ \frac{dV_o}{dt} &= \frac{-5000}{\tau} \cdot \exp -t/\tau \\ \tau & \approx 10^4 \cdot 10^{-8} [1 - (-500)] \\ & \approx 5 \cdot 10^{-2}\text{s} \end{aligned}$$

For $\Delta V_o = 20\text{V}$ and the relatively high gain, ΔV is small compared with V , i.e. $t \ll \tau$
 $\exp -t/\tau \approx 1 - t/\tau$
 $\frac{dV_o}{dt} \approx \frac{-5000}{\tau} (1 - t/\tau)$ and $V_o \approx \frac{5000t}{\tau}$
 i.e. the fractional change in slope is
 $\approx \frac{t}{\tau} = \frac{20}{5000} = 0.4\%$

3. An amplifier having $|A_v| \rightarrow \infty$ and $A_v = -100$ feeds a $5\text{k}\Omega$ load. The feedback capacitance is $1\mu\text{F}$ and the input is an e.m.f. of 5V in series with $1\text{k}\Omega$. Determine (i) the initial slope of the output waveform (ii) the % change in slope at an output of -10V if the load is removed.

$$\begin{aligned} \text{The initial slope } \frac{dV_o}{dt} &= \frac{-dV_c}{dt} = \frac{I}{C} \\ &= \frac{-5 \cdot 10^{-3}}{10^{-6}} = -5,000\text{V/s} \end{aligned}$$

$$\begin{aligned} \text{When the output is } -10\text{V, load current is } -2\text{mA.} \\ \therefore \text{input current is } \approx \frac{-2 \cdot 10^{-3}}{A_v} = \frac{-2 \cdot 10^{-3}}{-100} = 20\mu\text{A} \end{aligned}$$

On removing load, the slope changes in proportion to the current i.e. $\approx 20\mu\text{A}$ is 5mA or 0.4%.
 Alternatively take the load resistor as equivalent to a resistor of value $R_L (-A_v)$ across capacitors i.e. $500\text{k}\Omega$. At 10V out the current is again $20\mu\text{A}$ reducing the charging current and hence the magnitude of the slope by 0.4%

Low-cost logic analyser — 2

Construction and application

by B. C. Adams

THE LOGIC ANALYSER may be built into any suitable instrument case, preferably with a tilt-up stand as shown in the photograph, the prototype incorporating a separate front panel and removable chassis for ease of servicing. The circuitry was wired on strip-board using self-fluxing, insulated copper wire, and the l.e.d.s were mounted on 0.1in pitch Veroboard about 1/4in clear of the board. By drilling 3/16 in diameter holes in the front panel with the same pitch as the l.e.d.s, the display can be mounted behind the panel without the need for individual l.e.d. mounting clips and wiring. The display matrix for the sample channel can also be mounted on Veroboard and supported behind a rectangular slot, cut in the front panel and covered with a tinted plastic screen.

The data inputs use 2mm connectors mounted directly beneath each respective indicator, and an extra socket is used for the 0V connection. Trigger input, sample channel and external input use BNC sockets, which allow the use of existing oscilloscope coaxial leads and screen interference signals. Slide switches are used for the selection of positive or negative waveform edges and the external input, and miniature thumbwheel switches preset the hexadecimal comparator and delay sec-

tions. The threshold control potentiometer should be linear to within $\pm 5\%$ so that approximate calibration via the front panel can be achieved.

All wiring between input sockets, comparators, data latch and sample channel sections should be as short as possible, and the trigger input should be connected to the D type latch via coaxial cable.

The power supply shown in Fig. 8 uses regulator i.c.s to give +5V at 2A, +12V at 200mA, and -5V at 100mA. Supply leads to the comparators must be as short as possible to reduce unwanted inductances which can cause the comparators to oscillate. Leads should also be decoupled with 0.1 μ F low voltage ceramic capacitors between the +12V to 0V to -5V rails for each comparator, and a 10 μ F 35V tantalum capacitor for every six comparators. The t.t.l. supply must also be decoupled with one ceramic 0.1 μ F capacitor every three packages.

Applications

The following section describes some typical applications for the logic analyser. Unless a storage oscilloscope is available it is very difficult to view a one-shot event or series of events. The sample channel can store the logic signals if data information rather than

signal parameters such as rise time are needed. To detect and store a single pulse, the sample channel is linked with the external trigger input and connected to the signal point. The trigger threshold and sample channel threshold are set for the logic family in use, and trigger edge setting is made, dependent on whether the input signal is normally low or high and whether the trigger delay is being used. Typical waveforms that can be stored are shown in Fig. 9. After the correct edge of the input pulse has occurred, the trigger inhibits the sample channel and the pulse is displayed. By using the delay mode, the display will also store the state of the input signal after the trigger signal has occurred. The period of the pulse may be calculated by counting the number of sample clock periods that have switched the input. Each l.e.d. position represents the input logic state at the time of one sample clock edge: therefore, if the pulse is shown high for 22 l.e.d. positions and low for the remaining 10, the pulse period is 22 times the sample clock period. It should be noted that there can be an error of ± 1 sample clock period on each displayed transition of the input signal, and pulses of a shorter duration than the sample clock period may be missed. It is often necessary to design inter-

face circuitry for a mechanical contact and a logic system. With such circuitry the approximate period of any contact bounce may be required and this can be measured by connecting the contact to the logic analyser, and using the sample channel to store the bounce waveform. By using the delay mode, the display will show the bounce signal after the initial trigger edge has been received. The sample channel can also be used to display serial data from synchronous or asynchronous systems. By using the output clock of a teleprinter as the sample clock of the analyser, ASCII codes can be stored and displayed.

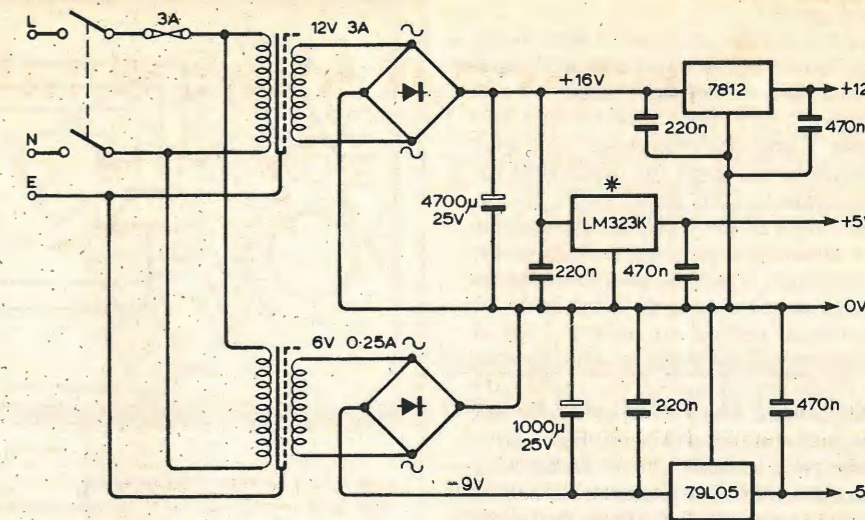


Fig. 8. Power supply.

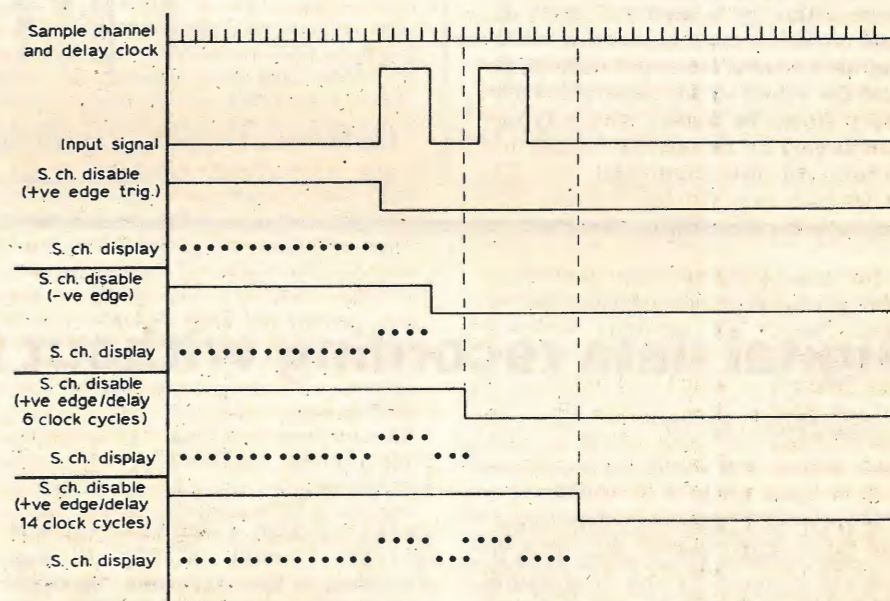
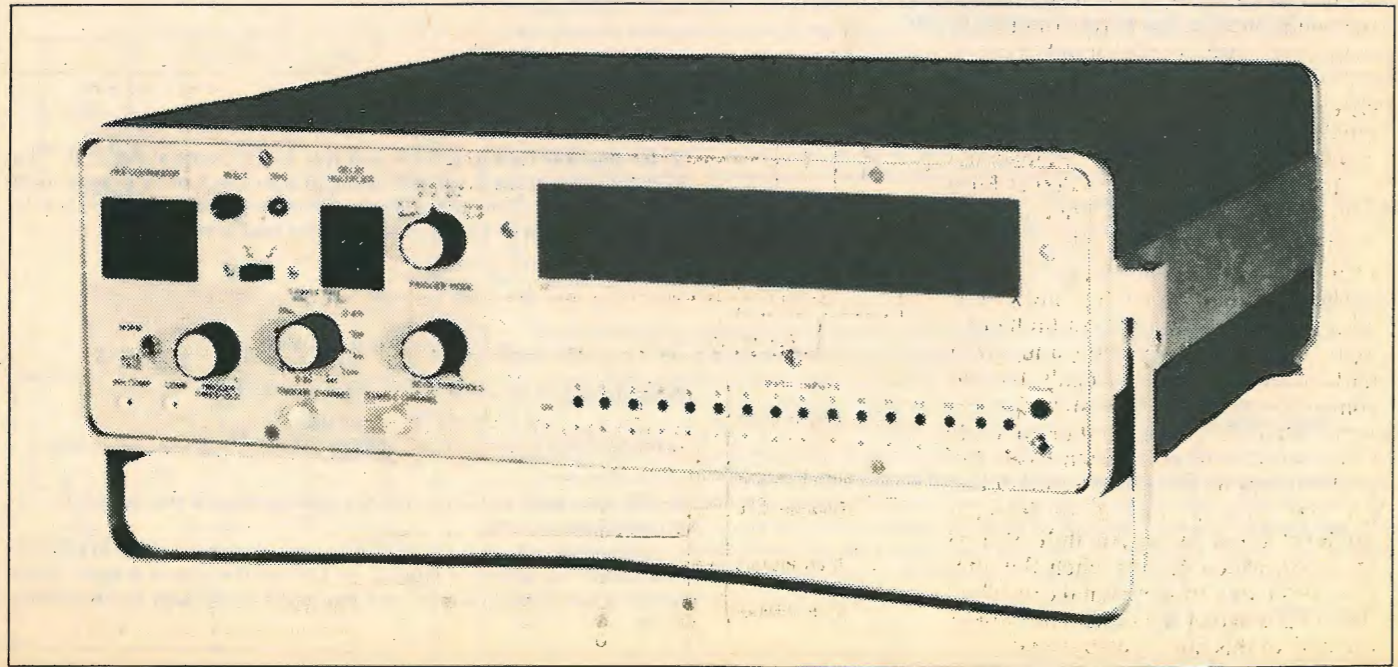


Fig. 9. Typical sample channel displays.



A similar system can be used for checking memory contents against the number of write pulses received by the memory. In addition, the hexadecimal comparator can be used to detect false codes produced by the memory, and the sample channel can record the state of a memory control line.

The problem of detecting and evaluating random or intermittent faults in a logic system is a common and often difficult one. This is especially true in complex systems such as microprocessors, where a large number of logic codes are produced. In such cases the analyser can be left on-line to monitor the logic system, and set to detect a predetermined fault. An indicator is provided, which flashes when the analyser receives a trigger signal caused by the occurrence of the fault. The data at the time of this fault is also stored.

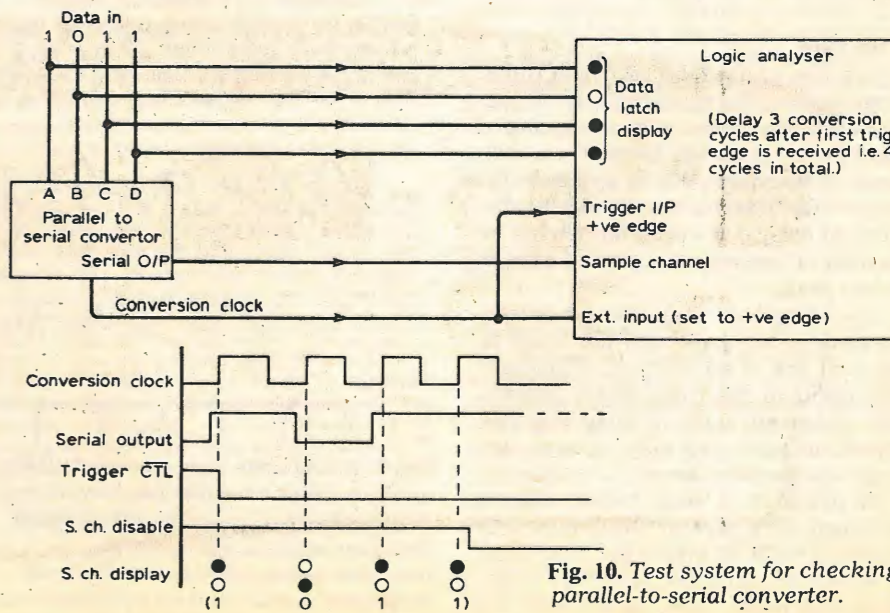


Fig. 10. Test system for checking a parallel-to-serial converter.

Conclusion

Since I built the analyser it has more than repaid the initial investment, and has enabled me to solve many more diagnostic problems than I had intended. Using the equipment has also given me some ideas for improving its performance. One suggestion is the replacement of the clock oscillator by a more accurate crystal type. It must be remembered, however, that the sample channel always has a possible error of one clock period on every stored transition, and the delay counter can be one clock period out at the end of its timing period. The l.e.d. display for the sample channel could be replaced by a single row of indicators, and the number of sample channels increased, each with its own trigger-control selection to provide signal or data phase relationships. This would also permit the simultaneous storage of triggered and delay triggered waveforms. The data latch section could be expanded so that it stores, for example, 16 bytes clocked into the store by a separate input. It would not be necessary to display all 16 bytes at the same time, but each byte could be selected for display. This facility would be useful for verifying truth tables or recording blocks of machine code instructions etc. □

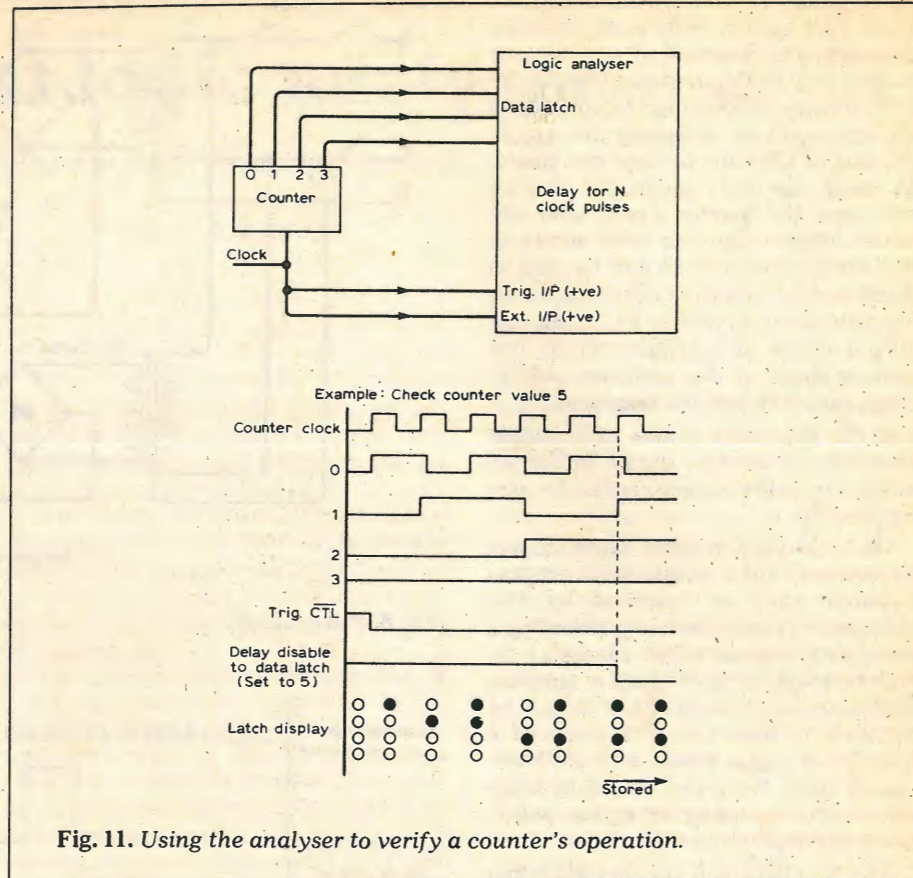


Fig. 11. Using the analyser to verify a counter's operation.

Digital data recording without f.s.k.

continued from page 59

work at all. Any signal above this minimum will operate the doubler even if severely clipped in the preceding buffers/inverters. However, for reliable high frequency operation it is best to operate the operational amplifiers within their linear region.

Error rate

Errors are caused by imperfections (drop-outs) in the recording tape. If the tape drop-out time is as long or longer than the bit duration then errors will occur. If the drop-out is appreciably shorter than this the system will only be prone to error if the drop-out occurs in the interval between the onset of a pulse and its peak.

Tape drop-outs that occur between the peak of one pulse and the onset of the next are of no concern. Drop-outs that occur in the rising pulse interval may either advance or delay the true transition time and may or may not result in a received error.

In practice it was found that a recorded data rate of 750 bits/s produced 15 to 20 bit errors per 1800ft reel of 3M's 2106 ¼in audio tape. The recording was made at 4.75cm/s and the errors determined at a four-times speed

up (19cm/s) on a Sony stereo tape recorder (model TC252). It was reassuring to see that using the clock track option no errors resulted from the

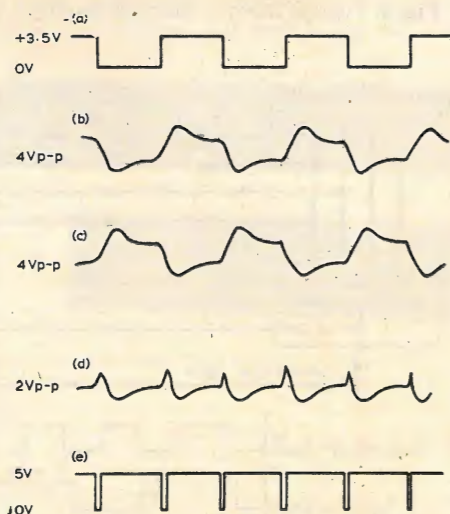


Fig. 7. Waveforms in frequency doubler of Fig. 6: (a) original 6kHz square wave clock signal; (b) typical playback signal fed to upper diode; (c) inverted playback signal fed to lower diode; (d) diode gate output; and (e) collector output.

deliberate slowing of the playback speed by injudicious finger pressure on the tape supply reel.

Expressed more conventionally, error rate was about 1 in 5×10^5 recorded bits. The total storage capacity of a single track of an 1800ft reel is about 750K 8-bit bytes in which each byte is assumed to be formatted with start, stop and parity error bits.

Errors can be dealt with in two ways: (1) The played back information in error may be ignored. (2) The information may be monitored by means of a separate playback head as recording is taking place. If an error is detected the last block of information can be rewritten.

In the Barts heartbeat interval data logging system it was thought that the occasional loss of a data word could be tolerated without seriously jeopardising the statistical results. The receiving computer's software notes that an individual word is in error and deletes it from the statistical calculations.

However, if it is essential to ensure that each and every data word is correct then it would be necessary to adopt the second, more complicated, approach. □

RELATIVITY AND TIME SIGNALS

I would like to comment on the article by Essen on relativity and time signals in your issue of October 1978. I would like first to say that Dr Essen is quite incorrect in saying that "No one has attempted to refute my arguments." A number of refutations have been provided, over more than two decades, including for example a letter written by myself in *Nature* in 1957 of which I enclose a reprint. Furthermore, Dr Essen came himself to this Department in November 1968 and he and I debated the problem with an audience of students. During this debate I gave a detailed and calculated refutation of his thesis. The problem is not that there has been no answer to his arguments, but that he has failed to understand the answers which have been repeatedly given.

In each case the main discussion was concerned with the "twin paradox"; according to Einstein's theory of one pair of twins who remains on earth will have aged more by the time they meet than one who travels fast to a distant point and then returns. Dr Essen's statement that the Einstein theory implies that more ticks are transmitted than received by either Traveller or Stay-at-home, each of which has with him a clock ticking at a standard rate, is nonsense. One of the ways of refuting Dr Essen's arguments is to show that if Traveller goes at very high speed from earth to a distant point, turns round in a short period and returns at the same high speed, his clock will in fact have ticked fewer times than has the clock on earth which is operating throughout Traveller's journey. The fact that all ticks emitted by each individual are received by the other is the solid evidence for the asymmetry of ageing. There is of course no *a priori* reason for assuming symmetry of results; one twin has never accelerated and the other has suffered a major acceleration on starting and a major deceleration and re-acceleration at the goal. The asymmetry is clearly shown by an extreme example. If Traveller moved at such a speed that he took only an hour longer to reach Sirius (a distance of 12 light years from Earth) than a beam of light would have, Stay-at-home will observe his recession not just for 12 years + 1 hour but for an hour more than 24 years since Stay-at-home will see Traveller's arrival and deceleration 12 years, in earth time, after it actually occurred. Stay-at-home will watch Traveller's return from a distance of 12 light years for a period of only one hour since Traveller will arrive at earth only an hour behind the light emitted from Sirius at the time of his turnaround. If Traveller is broadcasting the ticks of his clock during his outward journey these will be returning to earth at a very much slower rate owing both to the Doppler effect and to the relativistic differences of the rate of the clocks. This slow rate will be observed by Stay-at-home for 24 years and an hour. During Traveller's return the rate of receipt of ticks on earth will be enormously greater but this very much greater rate will be observed for only one hour.

The observations of Stay-at-home's clock by Traveller, however, are quite different. From Traveller's point of view the amount of slowing down of the ticks from Stay-at-home's clock during the earth's recession from him will be identical with the slowing down observed by Stay-at-home during Traveller's recession. On Traveller's return, similarly, when he sees the earth approaching him rapidly Stay-at-home's



clock will appear to him speeded up by just the same amount as Traveller's clock had appeared to be speeded up as seen by Stay-at-home.

Now, whatever the time may be which is recorded by Traveller on his outward journey*, i.e., the time that it appears for him for Sirius to reach him, exactly the same time period will be recorded by Traveller for the earth to reach him on the return journey since at the moment of his deceleration when he is stationary with respect to Sirius and to earth, the distance away from earth will clearly appear to him identical with the apparent distance of Sirius from earth just before he started.

Accordingly, while Stay-at-home saw a slow tick rate for a very long time and a fast tick rate for a very short time Traveller sees the slow ticks and the fast ticks from earth for equal times and the total number of ticks received will therefore be very much greater. For ticks we can read heart-beats, and accordingly Stay-at-home and his clock must have aged more than for Traveller and his clock. It is easy using Einstein's equations to work out exactly both these times and the total number of ticks in each case but even without this it is evident that the experiences of the twins are not symmetrical and that there is no reason at all to suppose that they should have aged by equal amounts.

Finally, it should be pointed out that we have found experimentally that a fast moving particle which in the laboratory frame moves away at high speed and then returns will appear to age very slowly. π mesons that revolve in a big accelerator at speeds approaching that of light do, on the average, survive for a very much larger number of rotations and do show a half-life for decay very much longer than do similar mesons which remain more or less stationary in the laboratory. It is thus quite certain that

*38 hours. This time is easily calculated. All parties to the controversy - so far as I know - accept that objects moving fast with respect to an observer will appear to that observer to be reduced in length along the direction of motion - the Fitzgerald-Lorentz contraction. The amount of this is: $\sqrt{(1-v^2/c^2)}$ so that the case under consideration where $v=c(1-1/(12 \times 365 \times 24))$ or $v=9.5 \times 10^6$ c, the contraction is to $\sqrt{(1.9 \times 10^{-5})}$ or 0.0044, times the original length. Accordingly, while Traveller is in transit, the dimensions of the Universe along the earth-Sirius line is reduced by this amount and to him the earth-Sirius distance is only 0.0044×12 light years, or 38 light hours. Accordingly, Sirius which is approaching him at nearly the speed of light, will reach him in about 38 hours and earth will require a similar period to return to him after his retardation and re-acceleration.

the universe does not give a symmetrical answer to the twin paradox whatever Einstein or Essen may theoretically predict. Since I find no difficulty in calculating the increased half-life of the π mesons by using exactly the same Einsteinian formula as I would have in finding the age difference of the twins, I am also convinced that Einstein's theory is correct and Essen's theory is wrong. J. H. Fremlin (Professor) Department of Physics University of Birmingham

MEDIUM WAVE SPURIAE

After the medium-wave frequency changes on 23rd November 1978 I noticed an "extra" BBC Radio 1 signal on 729kHz; careful listening revealed that Radio 2 was in the background, obviously indicating an intermodulation product of some sort. A further spurious signal was discovered on 963kHz consisting of Radio's 1 and 3. The prime suspect was of course the receiver, but after various checks with attenuators and retuning, trying another receiver and getting other people to try with their own receivers in different locations, it seemed likely they were transmitted spuriae. This impression is reinforced by the fact that the two frequencies can be explained by simple intermodulation of the Brookmans Park transmitters:

$$729\text{kHz} = 2 \times 909\text{kHz} (R2) - 1089\text{kHz} (R1)$$

$$\text{and}$$

$$963\text{kHz} = 2 \times 1089\text{kHz} (R1) - 1215\text{kHz} (R3)$$

A telephone call to the BBC Engineering Information Department on 28th November indicated that they were well aware of these problems and that other people had reported them. I was told the problem stemmed from the fact the transmitters and aerial arrays were all new and that these unwanted interactions would be resolved as soon as possible. While I appreciate there may be considerable practical difficulties in curing this effect the fact remains that over two months later the spuriae are still being radiated. A second telephone enquiry to the BBC (E.I.D.) in mid-January revealed a very different attitude. While they were aware of the situation they had not been notified of it by any "official" body and until they were it was unlikely that anything would be done. This seems a somewhat regrettable attitude for two reasons. Firstly the signal on 729kHz especially is quite strong and the medium-wave band is sufficiently congested without spuriae of this magnitude. Secondly the BBC has always set extremely high engineering standards which are the envy of the world and it seems sad they should fail so noticeably in their country's own capital.

Roland C. Pearson
Benfleet
Essex

The BBC comments:

The changes we made on November 23rd involved the commissioning of many new transmitters and aerial systems. At stations where several programmes are radiated at high power, it is not always easy to avoid combinations of this kind. We are now engaged in a tidying-up and fine tuning operation at all of our transmitting stations, in the course of which these two spurious emissions will be eliminated - or at least reduced to an acceptable level.

AN OVERSIGHT IN COSMOLOGY?

I ask you to accept *a priori* two things: that the red shift can be explained in the system to be proposed and that the frequency spectrum of light is quantized; there is some experimental evidence as to the latter. If light is quantized in this way then there is a limited number of frequencies in any electromagnetic spectrum.

My question concerns Oblens's paradox which is said, by some, to mark the origin of modern cosmology. Oblens asked: Why is the sky dark at night? He had already shown by good reasoning that it should not be dark at all. *Mathematically* the sky could be represented as a continuous shell of incandescent matter whose temperature, as near as makes no odds, was that of the sun. *Ergo* the Earth would soon be as hot as the sun. The obvious contradiction stood unanswered for about a century and a half.

The astronomer Hubble observed the red shift, which cosmologists then combined with the Doppler effect and drew the neat conclusion that the sky is dark at night because the universe is expanding!

I suggest that this particular piece of elegant simplicity was possible only because there had been an oversight which indeed persists to this day. The law of averages has been disregarded. It can be shown that the size of Oblens's sphere is at least 10^{20} light years in radius. On a sphere of such size there will be a near infinite number of point sources of radiation in any small solid angle of the sphere that is observed. Practically, the solid angle is determined by the limits of the observing instrument.

It follows, dare I say, as night follows day (?), that an observer will see none of the light. Due to the law of averages the radiation will arrive in balanced phase/antiphase relationship at the detector and, even though there is about 5×10^4 kW/metre² at the Earth's surface, it will be neither seen nor felt.

My question is: Has there or has there not been an oversight in this problem? If there has then the universe is not expanding and certain readjustments to our concepts are long overdue.

Alex Jones
Swanage
Dorset

COMPUTER BUSES

Ian Witten's article on computer buses (February issue) is right to point out certain key factors when designing a bus system. For example, t.t.l. totem pole gates cannot be connected together in a wired AND function for the precise reasons he states.

Then he discusses two alternatives, tri-state and open collector. He dismisses the latter because of alleged slowness. This is not true. Any switching edge which appears slow is due to the quality of the interconnection, it is not an inherent property of the transistor circuit. I have achieved switching speeds of about 6-8ns, with the positive edge being slightly faster than the negative. Additionally, crosstalk calculations need to take into account the transmitting element, the receiving element and the interconnections.

The possibility of excessive current as shown in the totem pole configuration also

applies to tri-state if two enables happen to be true at the same time.

For a comprehensive explanation of open collector bus driving see the June 1978 issue of *Wireless World*, p. 61.
M. F. Davidson
CAM Consultants
St Albans
Herts

The author replies:

Malcolm Davidson raises the interesting question, to what extent should a bus be treated as a transmission line? If really high switching speeds are required, then of course the transmission line approach is mandatory, and if the line is properly terminated at both ends, open-collector gates can indeed be fast. However, one great attraction of a bus structure for interconnection of computer subsystems is the flexibility it offers for reconfiguration by inserting or removing modules, or extending the bus without adverse effect on the rest of the system — and this rules out the possibility of exactly matched termination. Fortunately, most commercial microcomputers are slow enough to allow one to get away with this! Under conditions of incorrect line termination tri-state devices give more robust and reliable performance than open-collector.

He is quite right to point out that two tri-state gates driving the same bus line should not be enabled at the same time. This means that some lines cannot be tri-state driven. The "bus request" signal illustrates this — one cannot guarantee that bus requests will not occur simultaneously. In practice, computer buses usually have some tri-state and some open-collector lines, tri-state being used when the protocol guarantees that no two devices can simultaneously drive the line. This means, of course, that failure of a device to observe the protocol may result not only in logical breakdown of communication along the bus, but in physical breakdown as well — due to multiple gates driving the line. As Mr Davidson notes in the article he cites, this is a considerable disadvantage of tri-state driving.

Ian H. Witten

MILITARY ELECTRONICS

Many readers of *Wireless World* will have paused to think about the issues raised in the January leader, "The death delivery business". Some may have wondered how they personally could become less involved in production for military use, or how to break the vicious circle of "organic intercourse" between electronics firms and the military. Obviously there are no easy answers, but there are sources of information and support for people who would like to consider these issues more deeply.

The Campaign Against Arms Trade was set up by several peace and internationalist groups in 1974, to work for an end to British involvement in the arms trade and for the conversion of British military industry to peaceful, socially useful production. It distributes a wide range of books and pamphlets, and has produced a wide range of factsheets, leaflets, and campaigning materials. It is in close touch with shop stewards and others who are putting forward alternatives to military production in their companies, and with individuals who have

chosen not to work on military products. We would be pleased to hear from *Wireless World* readers who would like more information.

Sandy Merritt
Campaign Against Arms Trade
5 Caledonian Road, Kings Cross
London N1 9DX

In your January editorial you quoted J. K. Galbraith as saying "no faith sustains this (military) competition". May I suggest that at least some of those whom you claim "are not really aware of what they are doing" are in fact sustained by the insight that however many things there are that we don't know there are some things we do know? They assume that some questions are closed and that our survival as a nation depends on acting bravely on those assumptions, the most crucial of which is that our military capability keeps the Soviet Union from doing to us what it did and is doing to Poland, E. Germany, Latvia, Estonia, Hungary, Czechoslovakia and Cambodia.

D. J. Richardson
Stotfold
Hitchin
Herts

STATUS OF ENGINEERS

Mr Wilson's letter in the February issue contains, I believe, a clue to the lowly status of the British professional engineer. Our more affluent professional brothers — accountants, doctors, solicitors *et al.* — have never tolerated the unqualified dabbler in their midst, and have often joined battle to rid themselves of these pests.

While it might be argued that the use of technical jargon, euphemisms and "buzz" words and the worship of complicated techniques serves no useful purpose, I would like to suggest that such methods have served to "repel boarders" from the aforementioned professions since their inception.

The logical, fair-minded engineer of today sits on the lower rung of the rewards ladder clad in his dungarees, clutching his oily spanner — for such is the public image of him — peering myopically upward. The view at these higher altitudes is fine: a procession of "T" registration automobiles driven by doctors, lawyers and accountants clad in Savile Row suitings — a procession to which John Public rushes to doff his hat and offer his open wallet.

These opulent gentry have no need of a trade union; they have welded themselves into neat respectable units ideally suited to make money out of their skills. These professional gentlemen have secured the unassailable right to "do their thing" to the exclusion of all other persons. Unqualified is unclean!

Surely there's a lesson to be learnt here. Surely the engineering profession must exclude the unqualified dabbler from its ranks. The C.Eng. label is a joke compared to the respected M.D., F.C.A., and F.R.C.S.

This may seem irresponsible, unfair, grasping, etc., etc., but ... who wants to drive a '74 banger, dress at Oxfam, and pay their legal and medical fees on the old never-never?

M. C. Heard
Hullbridge
Essex

OSCILLOSCOPE WAVEFORM STORE

R. H. Fastner's excellent design for an "Add-on oscilloscope waveform store" (Nov., Dec. 1978 issues) has an in-built handicap. The store uses 16 shift registers whose total cost, if a supplier can be found, approaches £100. Contrary to the statements near the beginning of the article it is not difficult to replace these shift registers with r.a.ms and some extra chips at a total cost of less than £20. We have a p.c.b. design which uses readily available 2102 static r.a.ms. The board is used in place of Mr Fastner's shift register board. The 5V supply current is increased by about 120mA and the -8V supply is no longer needed. No other changes are necessary. It may be possible to arrange for a supply of p.c.bs (and components) if interested parties write to me.

J. Ward
Department of Physics
University of Oxford
Clarendon Laboratory
Parks Road
Oxford

FURTHER USE OF RADIONAVIGATION SYSTEMS

THE modulating waveforms for the VOR (VHF OmniRange) and ILS (Instrument Landing System) signals can be generated digitally, using sources such as the Wavetek Model 175. The information from both waveforms can be recovered by means of the discrete Fourier transform. The quantization error associated with these techniques has been determined with simulations run on a Commodore 2001-8 computer. Mean and peak error and standard deviation of error were computed for more than 100 independent sample timing offsets. The results are summarized here.

For 1024 samples with 256 levels (8 bits) of resolution, the standard deviation of VOR error is 0.012 degrees (0.0024 dots, on many cockpit displays). Localizer error is 42 millionths of a d.d.m. (difference in depth of modulation) (0.00054 dots), and glideslope error is 84 millionths of a d.d.m. (0.00096 dots). The error in general is inversely proportional to R times the square root of S, where R is the number of levels of resolution and S is the number of samples. Peak error is approximately three times the standard deviation and mean error is less than the standard deviation, for both VOR and ILS signals.

The Nyquist sampling theorem requires 11 samples of the ILS modulation and about 700 samples for VOR. However, both include voice and Morse identification in practice. A VOR/ILS demodulator that took 1024 samples would reject these modulation frequencies. It appears possible to build an inexpensive 1024-sample 8-bit demodulator that would make nearly 30 readings per second with some new microprocessors. One could build a single receiver that would recover full ILS data up to 15 times per second, by storing and resetting a.g.c. voltage digitally. The same receiver could scan up to 30 VOR channels per second while

indicating one or more bearings plus the number of usable signals available.

These techniques are applicable to the monitoring of VOR and ILS transmitters. If Fourier demodulation were to be used in both monitors and receivers, the VOR and ILS systems could become cost-effective backups or alternatives to the Global Positioning System (GPS) and Microwave Landing System (MLS).
Robert G. Huenemann
San Bruno
California, USA

SCIENCE AND THE ELECTRON

Your editorial in the February issue on the nature of truth falls, in its last sentence, into an inexplicably common fallacy when it says, "We still don't know, for example, whether the electron is a particle or a packet of waves." (My emphasis.) That it is not the duty of science to answer such questions is best illustrated by a simpler example:

"Is it true that the planets revolve around the sun in ellipses?" Of course.

"Is it therefore untrue that the sun and the other planets revolve around the earth in complex paths which may be calculated to any required accuracy by considering wheels revolving within other wheels?" Of course not.

I can calculate the trajectory of a rocket to the moon no less accurately using the latter hypothesis, and someone looking at our solar system for the first time could equally well believe either hypothesis depending on whether their view fell firstly on the sun or on a planet.

Similarly with particulate or wave electrons and with all other mathematical fictions. We may decide, at times, to obey Occam's Razor and accept the simplest hypothesis but we should not call this the "true" hypothesis.

C. W. Hobbs
Apeldoorn
Netherlands

The word "science" is derived from the Latin *scientia*, meaning knowledge. — Ed.

BIRDS' GEOMAGNETIC SENSE

I. A. Seath's spinal cord model (December 1978 letters) shares some objections to the flapping wing model, but suffers others alone. Taking first the latter: a magnetic sense of heading has been demonstrated by Wiltschko, Keaton, Walcott, Emlen, Fromme, Bookman, Southern and others in the robin, gull, swallow, pigeon and bunting.

Bringing the spinal cord model into concordance with this fact seems to need: (1) A neural discrimination of 1 part in 10^7 (the change in induction due to the alteration in dip across a 1m cage) to provide a north-south orientation. (2) Some means of providing east-west orientation. (3) A means to judge air-speed to at least the accuracy given in (1). (4) A means to judge wind speed to the same precision. The last two are requisite to direction-finding on the wing.

A. M. Roberts published a theoretical critique of this model¹ which attracted several responses^{2,3}. To summarize, briefly, his view: an unchanging electric field due to electromagnetic induction is sensible only by reference to external factors in relative motion to the bird, e.g. leakage currents through the surrounding air.

It is not obvious to me that the neural logic needed to decode, for example, a 10° (electrical) signal change for a 20° (compass) bearing change is complex.

Turning to some shared objections, I note: (a) the noise due to muscular activity; (b) thermal noise; (c) electrostatic induction arising from rolling motion in the atmospheric electric field; (d) piezo-electric voltage from feather quill strain; and (e) tribo-electric voltage on feathers.

It transpires, however, that Ad. J. Kalmijn⁴ (Woods Hole) working with sharks, skates and rays, which in a sense are ideal animals for geomagnetic sense experiments, has given unequivocal demonstrations of their sensitivity to fields, induced magnetically, of values down to $1 \mu V \cdot m^{-1}$.

Although it is true that they exhibit dedicated receptors, the Lorenzian ampullae they too suffer from two important factors cited as shared objections above, viz. (a) and (b). The remaining factors are believed to be confined to the surface of birds.

I come to the same view as Kalmijn: sensory perception of the electric field depends upon the imbalance between the induced electric field and the charge movement which tends to neutralize it but which depends upon tissue conductivity for its occurrence. Where an insulated conductor exists within the animal, a p.d. as high as the modulus of the electric field strength is available across this insulation barrier for some time constant.

B. Whatcott
Addlestone
Surrey

References

1. A. M. Roberts, *Physics Education*, 1977, 12, pp. 221-3.
2. P. Lorrain, *ibid*, 1978, 13, pp. 203-4.
3. B. Whatcott, *ibid*, 1978, 13, pp. 397-8.
4. Ad. J. Kalmijn, "Animal Migration, Navigation and Homing". Springer-Verlag, Berlin 1978, pp. 347-353.

VIDEO RECORDERS FOR MICROCOMPUTERS

I have been very much aware of the explosive evolution of microcomputers and their accompanying peripherals. One of the available devices, the video recorder, I think has been left out, in spite of its great capabilities in access time and bulk storage.

In addition the technique of video recording (with the use of a closed loop cartridge and helical scan) could give rise to the evolution of a new generation of peripherals.

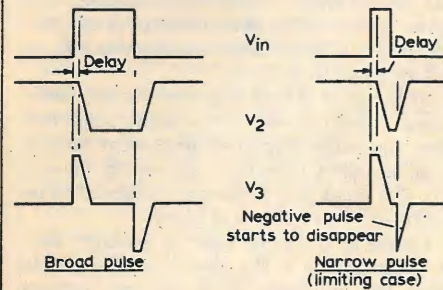
Has anyone given any thought to this interface?

Lazazos Labzianidis
Athens
Greece

HIGH FREQUENCY DIFFERENTIATOR

With reference to Mr Andrew E. Romer's comments (Letters, December 1978) concerning the "High frequency differentiation" described by S. Cussons (Circuit Ideas, August 1978), I should like to point out that the operation of Mr Cussons's circuit does not merely depend on the direct mathematics of the circuit elements.

In practice all operational amplifiers introduce some delay between a change in the input and a corresponding change in the output. In the example of Mr Cussons's circuit, the output of the "low pass filter", V_2 , will be also a delayed as well as filtered version of V_{in} . Mr Romer does correctly point out that his own circuit is mathematically equivalent to that of Mr Cussons, assuming perfect operational amplifiers in each case.



The inherent finite delay would allow the value of C, the feedback capacitance, to be reduced, giving better high frequency performance. At high frequencies the circuit generates pulses at the leading and trailing edges of the given narrow input pulse.

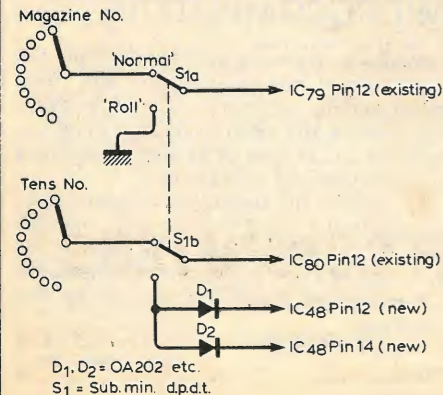
Lastly, the circuit can perform up to 5MHz (as long as the input signal is not too great) because the LM381 amplifiers are only slew-rate limited, a gain-bandwidth product of 15MHz being possible for small signals.

The waveforms which should relate to Mr Cussons circuit are shown here.

Roger Green
Postgraduate School of Electrical Eng.
University of Bradford.

WW TELETEXT DECODER — MODIFICATIONS

As will have been appreciated, the present "roll-mode" facility possessed by the Wireless World teletext decoder is of little use, due to the rapid scan rate. In fact, the later teletext kits have omitted the "roll-mode" for this reason. However, the teletext pages have been arranged in the form of a book and the



ability to "browse" through the pages is a desirable feature.

The accompanying simple modification (see circuit) enables the user to display every page whose units number agrees with that of the "page-units" selector. This provision allows the user to sequence through the entire magazine whilst giving, in most cases, adequate time to obtain the page number and an idea of the contents.

It is suggested that the present "roll-mode" switch be replaced with the double switch (S₁) and the diodes may be mounted on the terminals of this switch.

A. J. Jameson
IBA Mounteagle Transmitting Station
Conon-Bridge
Ross & Cromarty

ENGINEERS, PUT ON NEW HATS

With regard to recent correspondence about the standing of engineers, might I make the following points? Engineers' salaries have now fallen so far behind that they are unlikely to ever catch up again, rate of growth being limited by the constraints imposed by pay policies designed for the good of society as a whole. Lack of growth in British industry (and one should not confuse growth with conglomeration — the former is a creative process, the latter merely acquisitive), lack of growth will necessarily limit the rate of occurrence of promotional opportunities.

Possible solutions are: (a) Becoming a contract engineer or technician. This has been common practice for technical writers and draughtsmen for some time. (b) Becoming a consultant. This is the common mode of operation for many doctors, accountants, architects, etc. Why not engineers? (c) Becoming an entrepreneur. Having worked in both the UK and US I know how much the entrepreneurial spirit has helped to create not just new facets of technology, but even complete "micro-cultures", such as Silicon Valley. And the interesting point is that those entrepreneurs were engineers — perhaps not so different from the reader.

Indeed, as a significant proportion of them are British, it is likely that they too were readers of that renowned institution, *Wireless World!*

A. Macrae
Sociotics
Aberdeen

REVISE PREFERRED VALUES?

We've inherited a legacy of awkward component values from the days when accuracy was rare and expensive, but now that tolerances of 5% and even 1% are becoming inexpensive and common so that it becomes meaningful to combine values for intermediates, I would urge a revision of the scales of preferred values. I would suggest the scales below, displayed to the right of the present scales, as the best compromise.

The great advantage of such a revised system is that, in the E24 series, all the integers, 1, 2, 3, 4, 5, 6, 7, 8, 9 (and their decades) are present, which simplifies arithmetic and also allows easy switching. The second advantage is that even down to the E6

Present values	Suggested values
10	10
11	11
12	12
13	13
14	14
15	15
16	16
18	18
20	20
22	22
24	24
27	27
30	30
33	33
36	36
39	39
43	45
47	50
51	55
56	60
62	65
68	70
75	75
82	80
91	90
100	100

series, the key values of 1, 2, 5 appear which, like weights in a box for a balance, can be added to form any value from 1 to 9.

There are demerits of course. In the E6 series, the greatest ratio is 1.67 instead of the present 1.50 (optimum 1.47); in the E12 series, the greatest ratio is 1.33 instead of the present 1.25 (optimum 1.21); the E24 series, however, is little affected, the greatest ratio being 1.14 which is slightly better than the present 1.15 (optimum 1.10).

The scales suggested also preserve the many-factored numbers 6, 12, 24.

Tony Kelly
Llanwrda
Dyfed

CITIZENS' BAND IN THE USA

The citizens' band situation here in the USA, particularly in the vicinities of large cities, is nothing short of disastrous. Naturally, with only 5 watts and no facilities for adequate tuning of sets or installation of good aerials, it is difficult to transmit much farther than 10 miles at most, which is what it was intended for. Naturally the Yanks with an almost unlimited amount of dollars at their disposal — even the lowest of the low (income wise) — can afford to finagle their power up above the legal.

Naturally the FCC has countered the linear amplifier problem by making them illegal to purchase but not before millions of factory wired pre-amps have got onto the market. It is the same with marijuana exactly. It is now legal to possess x number of ounces but illegal to sell it, yet 'everyone' seems to possess it (marijuana) except for those who are still considered God fearing, and we seem to be in the dejected minority.

The population explosion takes its toll in more ways than protein scarcity — example, the crowded radio spectrum.

I am certain I can command 'quite a following of so called 'old-timers' who came by their licences the hard way and by no means want what they toiled perilously hard for given away to the undeserving.

John Teale KA6CRB
La fayette
California, USA

8K ON BOARD MEMORY!
5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

2 KEYBOARDS!
56 Key alphanumeric keyboard PLUS 16 Key HEX PAD.

GRAPHICS!
64 character graphics option.

MEMORY MAPPED high resolution Visual Display Circuitry with its own 2K memory to give 32 lines of 64 characters.

2 MICROPROCESSORS!
Z80 the powerful CPU with 158 instructions including all 78 of the 8080.

MM57109 Number cruncher. Functions include +, -, *, /, squares, roots, logs, exponentials, trig functions, inverse, etc. Range 10⁹⁹ — 9 × 10⁹⁹

2K BASIC (reverse Polish notation) resident in EPROM.

1K MONITOR resident in EPROM.

KANSAS CITY tape interface.

SINGLE BOARD DESIGN!
Even keyboards and power supply circuitry on board!

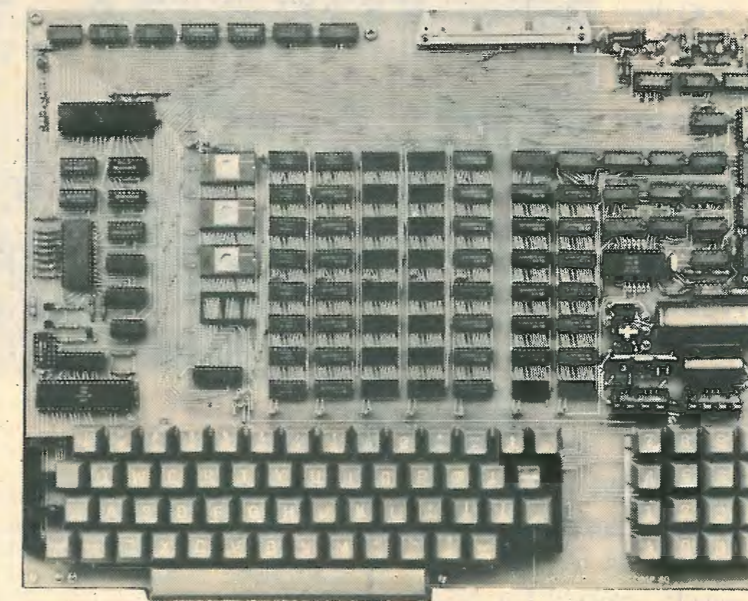


Cabinet Size 19.0" x 15.7" x 3.3" Television by courtesy of Rumbelows Ltd., price £58.62

POWERTRAN COMP 80

COMPLETE KIT only £275 + VAT

The kit for this outstandingly practical design by John Adams being published in a series of articles in *Wireless World* really is complete! Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2-keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.



PCB size 16.0" x 12.5"

Kit also available as separate packs; e.g. PCB, Keyboards, Cabinet, etc.

Value Added Tax not included in prices

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until May 31, 1979, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.

U.K. ORDERS: Subject to 8% surcharge for VAT. NO charge is made for carriage*. Or current rate if charged.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

UK Carriage FREE

POWERTRAN COMPUTERS

(a division of POWERTRAN ELECTRONICS)

PORTWAY INDUSTRIAL ESTATE
ANDOVER HANTS SP10 3NN

ANDOVER
(0264) 64455



To get Tokyo, dial this number.

Knowing the frequency of a particular station is one thing. But finding it with the aid of a mechanical pointer can be a bit of an electronic lucky dip.

Panasonic, however, have just made success a certainty. We've incorporated a direct frequency readout facility on our range of portable shortwave radios.

It gives you an exact visual indication of the frequency you've tuned to, right down to the last kHz.

So whether you're going for Tokyo or Turkey, with Panasonic you'll certainly know when you're there.

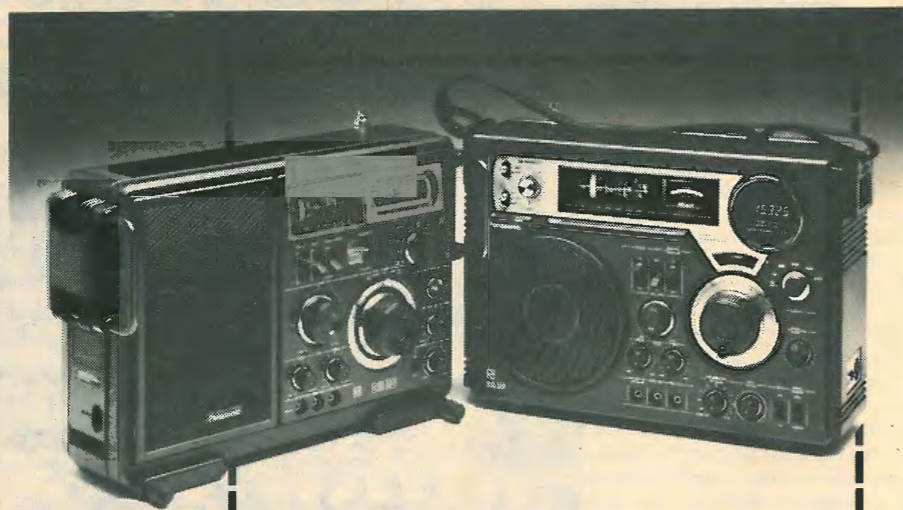
And when you are, we have even more features designed to improve your reception.

Our super-portable DR26 model, for example, gives you a pre-selector tuning control, and all three models feature infinitely variable BFO pitch control for SSB and a switch to narrow the band width when powerful local stations intrude.

The DR49 you see above, gives you still more: 8 short-wave bands in addition to the FM, MW and LW bands, RF gain control, aerial trimmer and sophisticated

circuitry specifically designed to improve sensitivity, stability and selectivity.

For more details and specifications on all of these radios, just complete the coupon below. Or better still, dial our number—it's Slough 27516.



For free colour brochures, send this coupon to: National Panasonic Sales Promotion Dept., 107-109 Whitby Road, Slough, Berkshire SL1 3DR. Telephone: Slough 27516

Name _____

Address _____

National Panasonic
Just slightly ahead of our time.

WW4

THE PANASONIC DR SERIES: DR 26 £189.95, DR 28 £219.95, DR 49 £388.95. RECOMMENDED RETAIL PRICES CORRECT AT TIME OF GOING TO PRESS, INC. VAT.

WW — 068 FOR FURTHER DETAILS

H.f. amateur band frequency synthesizer — 2

Circuit description, construction and commissioning

By M. Small, B.Tech (G4DVI)

THE SYNTHESISER, shown in block form in Fig. 7, consists of two major parts: a phase-locked loop and an interpolation oscillator and mixer. The phase-locked loop is capable of producing frequencies at 500 kHz intervals over a frequency range which is greater than 3 to 1, the actual range used being from 7.0 MHz to 23.0 MHz. The output of the phase-locked loop is fed into a mixer, where it is combined with a signal from the interpolation oscillator to provide continuous coverage from 1.5 MHz to 28.5 MHz in selectable 500 kHz bands. For amateur use only six of these bands are needed.

Reference oscillator

The reference-frequency oscillator in Fig. 8 is the key component which determines the frequency stability of the phase-locked loop. The oscillator circuit is taken from a design by L. Nelson-Jones in reference 3, although the oven, also described in this article, was not used. The use of such an oven would give rise to an order of magnitude improvement in the stability obtainable. The oscillator uses a quartz crystal to produce a 1MHz, t.t.l.-compatible, square-wave output. This is divided by 20 by one half of a 7474 and a 7490 to produce the 50kHz reference frequency. It would be theoretically possible to use

a 500kHz reference frequency to obtain 500kHz frequency steps, but then the programmable frequency divider would have to operate at the full v.c.o. frequency — difficult without using schottky t.t.l. It would limit the maximum usable frequency to less than 1/2 of that obtained by the current design, which is 50 MHz.

Voltage-controlled oscillator

The voltage-controlled oscillator, shown in Fig. 9, uses a Motorola MC 1648 i.c. and an MV 1401 hyper-abrupt junction tuning diode. This combination gives a tuning range which approaches 4 to 1 and is usable to a frequency of well over 50 MHz. In fact, the oscillator MC 1648 can operate up to 200 MHz. It provides four key attributes:

- low peak-to-peak a.c. on the tuning diode (500 mV),
- automatic gain control of oscillations and output essential for such a wide tuning swing,
- availability of both sinusoidal and logic-compatible outputs,
- high spectral purity close to the carrier by the use of a LC tank circuit. This is not usually the case with RC oscillators.

The i.c. is from the e.c.l. family and produces e.c.l.-compatible output

levels. However, it is quite acceptable to operate it on a 5V rather than —5.2 V power rail with no degradation of performances. The output is translated to t.t.l. levels by single-transistor stage and the 74S00 gate acts as a buffer. A sinusoidal signal is taken from the tank circuit, which is buffered and used as the output.

The MV 1401 hyper-abrupt junction tuning diode provides a guaranteed capacitance ratio of 15 to 1 for a 10 volt reverse-bias voltage swing. The typical swing is said to be greater than 25 to 1. Whilst this component is fairly expensive, reasonably cheap diode pairs intended for a.m. radio tuning are becoming available (MVAM2), and these would serve equally well with appropriate minor circuit modifications.

The output from the v.c.o. is pre-scaled by the 74196 high-speed divide-by-10 circuit in Fig. 8 before input to the programmable divider. This extends the frequency range of the system upwards to 50 MHz, or beyond 100 MHz if an e.c.l. device were to be used.

Programmable divider

The programmable divider of Fig. 8 is fairly conventional, consisting of two stages using 74192 synchronous up/down counters in the count-down mode. It is unfortunate that, with these

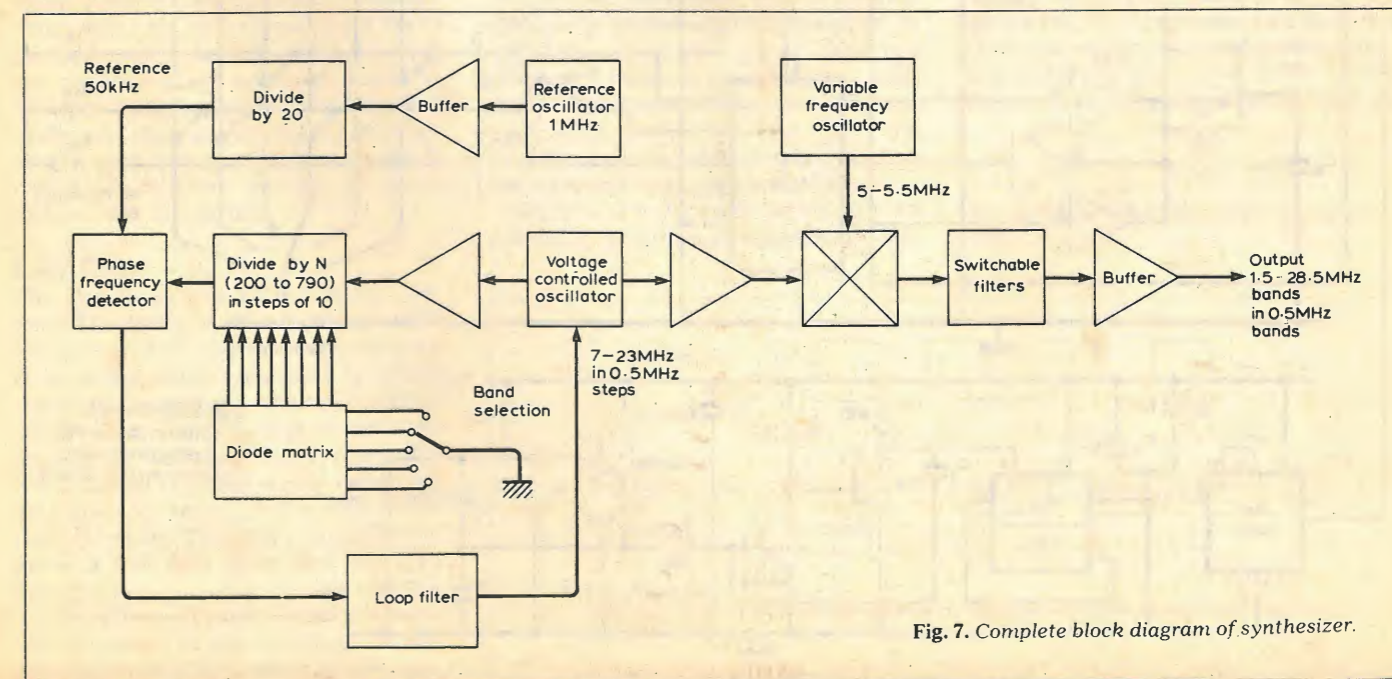


Fig. 7. Complete block diagram of synthesizer.

devices, the carry/borrow pulse is formed directly from the state of the counter and the incoming clocks. This makes these signals unsuitable for use directly as a "load preset data" signal. The circuit operates as follows, assuming that preset data has just been loaded. Each input pulse causes the counters to decrement until the logic of the 7405s connected to the outputs detects that a count of 2 has been reached. This causes the D input of the 7474 to be set high so that the next input pulse sets this state (count now -1). The inverse output from this state going low causes the preset data to be loaded into the 74192s and disables their clock. Since the 74192 outputs are no longer set to 2, the D input to the 7474 is again low. Hence the next input pulse unsets this state (count now equal 0) and releases the counters, which commence decrementing on the subsequent clock. The Q output from the 7474 is taken as the output of the programmable divider and fed to the phase detector.

A diode matrix is used to select the division ratio of the programmable divider with a single-pole, 6-way switch.

To allow the selection to be by a remote connection to earth, the output from the diode matrix is inverted by a set of SN 7404 gates before being connected to the programmable dividers.

Phase detector

The phase detector in Fig. 9 is the Motorola MC 4044, which has the advantages that it is both a phase and frequency detector, and that a complete system including filter amplifier is available in the one package. It is essential that a phase frequency detector is used in this application, since the frequency range covered exceeds 2 to 1 and straightforward phase detectors can register zero phase error on harmonics. The MC 4044 also gives an output which is independent of the duty cycle of the two input wave forms. The phase detector consists of two parts, a phase frequency detector and a diode-pump arrangement. The former produces two logic outputs indicating 'go up' and 'go down' and the latter serves to invert one of these and combine the two in analogue form. The operation of the phase detector can be seen from the

following state-transition table.

Current state	Next state after transition		Output
	R	V	
A	0	0	Up
B	0	1	Up
C (start)	0	1	—
D	1	1	—
E	1	1	—
F	1	0	Down
G	1	0	Down
H	1	0	Down

This shows that the MC 4044 has the eight internal states A to H. States A and B are entered when the variable frequency is detected to be less than the reference frequency, states C to F accommodate differing duty cycles between otherwise synchronized variable and reference frequencies and finally, states G and H are entered when the variable frequency exceeds the reference.

The table shows what subsequent state the MC 4044 will adopt after a transition on its inputs of the reference signal R and the variable signal V, given that its current state is known. An example of its use is shown in Fig. 10.

Band	PLL frequency	N
3.5MHz	7.5MHz	15
7.0 "	11.0 "	22
14.0 "	18.0 "	36
21.0 "	7.0 "	14
28.0 "	14.0 "	28
28.5 "	14.5 "	29

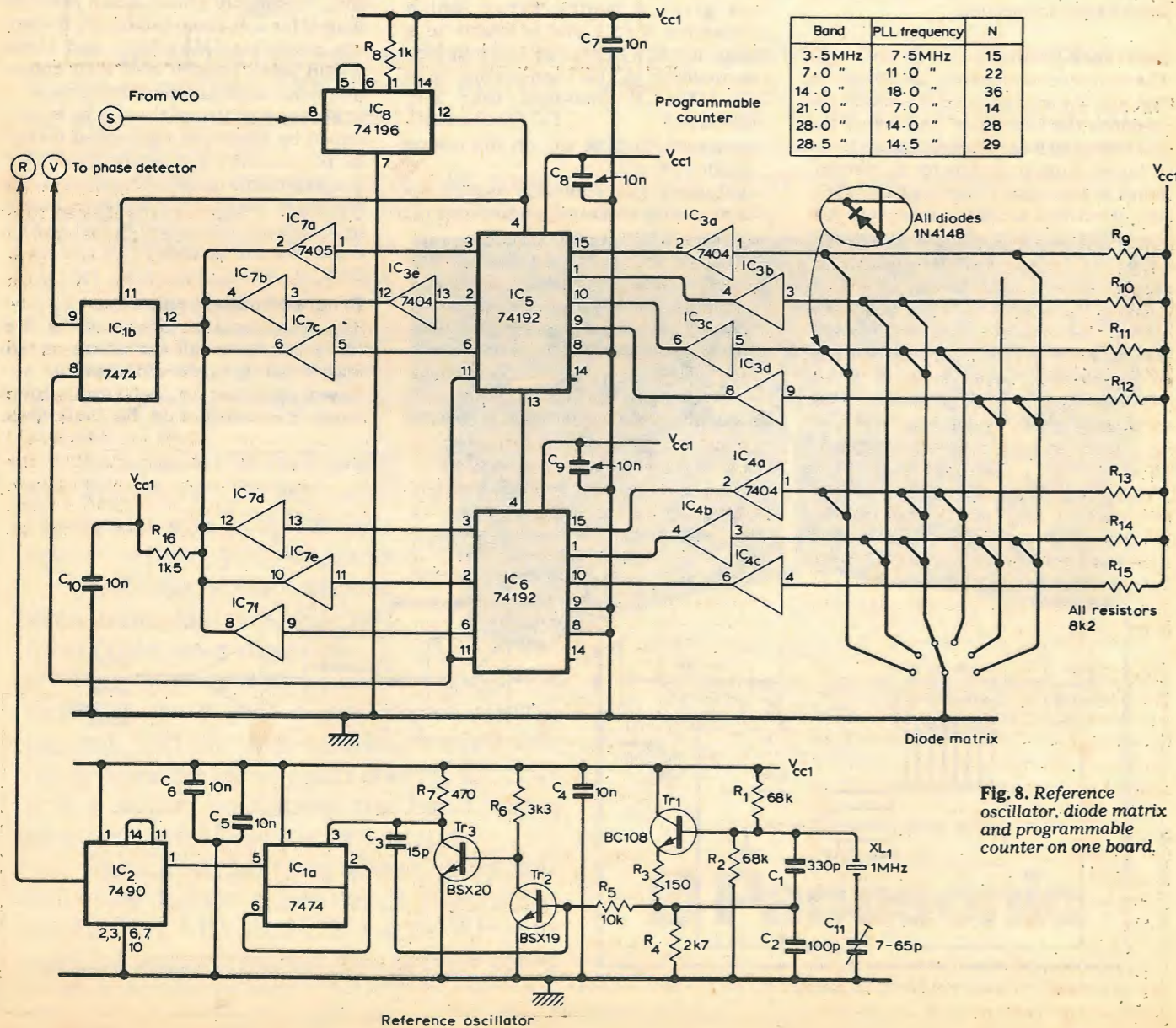


Fig. 8. Reference oscillator, diode matrix and programmable counter on one board.

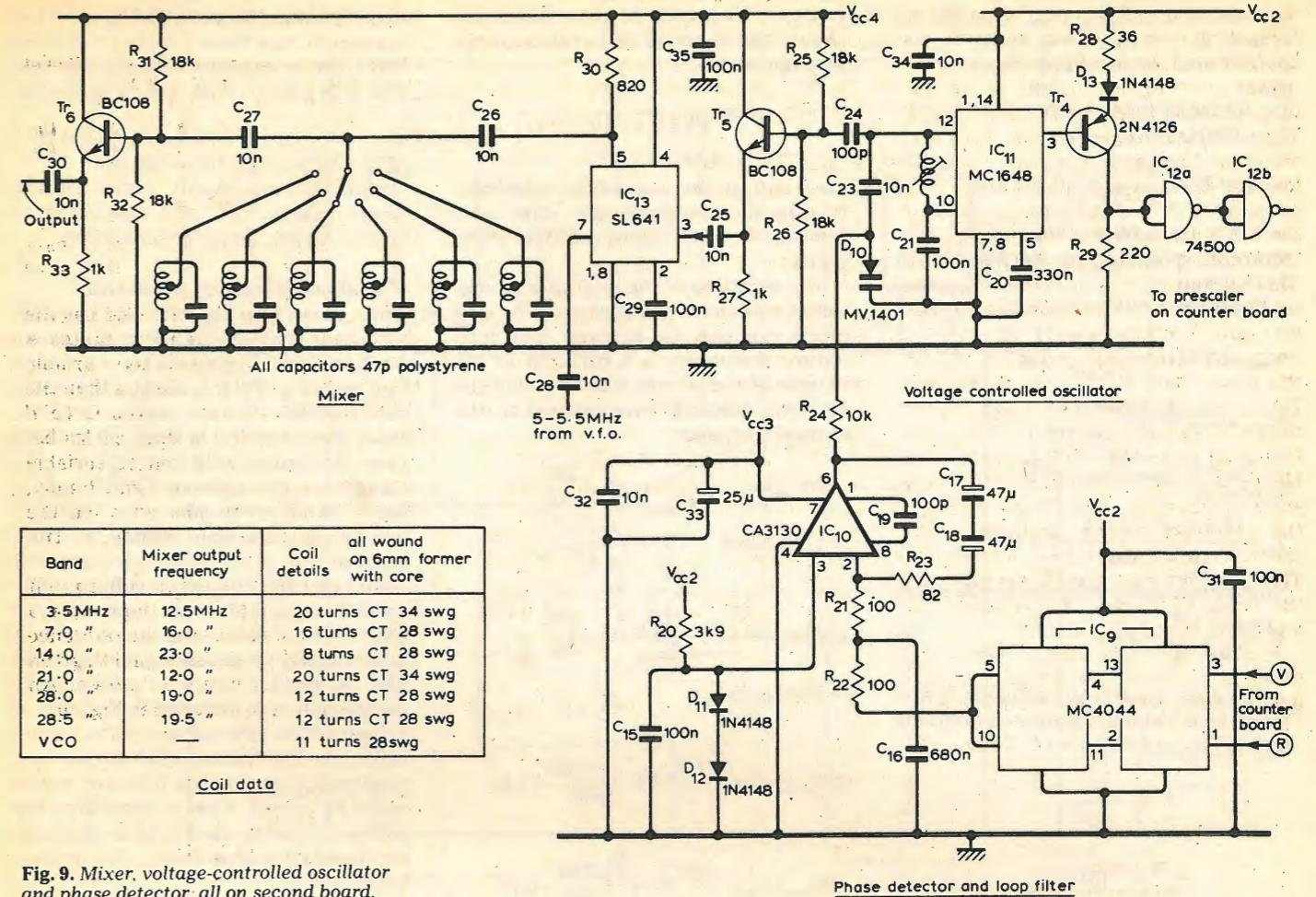


Fig. 9. Mixer, voltage-controlled oscillator and phase detector, all on second board.

Band	Mixer output frequency	Coil details
3.5MHz	12.5MHz	20 turns CT 34 swg
7.0 "	16.0 "	16 turns CT 28 swg
14.0 "	23.0 "	8 turns CT 28 swg
21.0 "	12.0 "	20 turns CT 34 swg
28.0 "	19.0 "	12 turns CT 28 swg
28.5 "	19.5 "	12 turns CT 28 swg
VCO	—	11 turns 28swg

Coil data

In this example the phase detector is assumed to start in state C. The first transitions of R and V going to one are simultaneous and the device adopts state E. Since the device attempts to synchronize negative-going transitions of R and V, when R goes to zero and V remains high, the device adopts state B "go up", indicating that it has detected that V is lagging R. It remains in this state until V also goes low, when it again takes up state C, giving no output. Thus the "go up" signal lasts for a period equal to the difference between the negative going edges of R and V. This process is repeated on subsequent cycles but the "go up" signal lasts for longer each time as the frequencies V and R are different and so the phase difference is increasing.

Loop filter

The loop filter uses a CA 3130 f.e.t. op. amp. This has the advantage that both the inputs and outputs can operate very close to the power rails and a balanced supply is not required. The built-in filter amplifier on the MC 4044 is not used because the voltage swing required for the varicap (10 volts) would cause the maximum V_{cc} rating of this component to be exceeded. The filter comprises two parts, a low pass filter and the loop integrator.

As has been discussed previously, the characteristics of the loop filter largely determine the performance. In this case,

two performance criteria were to be met: first, that in-band spurious outputs (reference feedthrough) should be suppressed by at least 60 dB and second, that the transient response time should be unnoticeable by the operator. This latter aim can be met providing the time is less than about 0.1s.

The design of a filter to meet these requirements is an iterative process. The lock-up time requirement is usually in conflict with that for reference-frequency feedthrough suppression. In this case it is also clear that the frequency range is so great that most steps will exceed the maximum phase error limit of the MC 4044. Thus the Laplace analysis will not usually define the transient response characteristics.

So, for a starting point, let us take the reference feedthrough suppression. If it

is necessary to have an additional low-pass section to obtain the desired suppression, this section should have a turnover frequency of at least one tenth of the reference frequency, to obtain reasonable benefit, and should also be 10 times the natural frequency of the loop, so as to have minimal unwanted effect on the loop phase margin.

Let us say that if $f_{ref} = 50$ kHz, a loop natural frequency of 150 Hz would well satisfy the above conditions. This would give us $\omega_n \sim 10^3$ rads/sec. and since the transient response for reasonable damping factors is $5/\omega_n$, $t_l = 5/10^3 \sim 5$ ms. Hence, the time constant T_1 can be

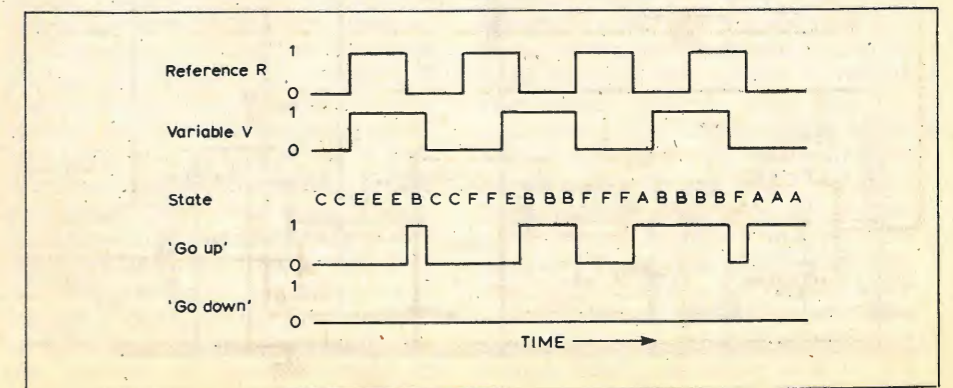


Fig. 10. Example of use of state-transition table.

calculated: $T_1 = K_p K_v / N \omega_n^2$. For this we require K_v and K_p . The quantity K_v was determined from experiments which gave:

$$f_{vco} = 23 \text{ MHz for } V_c \sim 10\text{V}$$

$$f_{vco} = 7 \text{ MHz for } V_c \sim 1\text{V}$$

$$\text{so } K_v = 2\pi \times \frac{23-7}{(10-1)} \times 10^6$$

$= 11.2 \times 10^6 \text{ rads/sec/volt}$.
Motorola specify K_p for the MC 4044 at 0.111 V/rad.

The divider ratio $N = \omega / \omega_{ref}$.

$$N_{min} \text{ at } 7 \text{ MHz} = \frac{7 \times 10^6}{5 \times 10^4} = 140.$$

$$N_{max} \text{ at } 23 \text{ MHz} = \frac{23 \times 10^6}{5 \times 10^4} = 460.$$

$$\text{So } N_{av} = \sqrt{N_{min} \cdot N_{max}} = 250.$$

Therefore

$$T_1 = \frac{11.2 \times 10^6 \times 0.111}{(10^3)^2 \times 250} = 5 \times 10^{-3} \text{ s.}$$

Now a reasonable value for $C = 25 \mu\text{F}$, so

$$R_1 = \frac{5 \times 10^6}{25 \times 10^3} = 200\Omega.$$

The next stage is to calculate T_2 and for this we require to propose a damping factor. Let us define $\zeta = 1.0$. Then

$$R_2 = \frac{2}{\omega_n C}$$

$$= \frac{2 \times 10^6}{10^3 \times 25}$$

$$= 82\Omega$$

Now the typical reference frequency suppression can be determined.

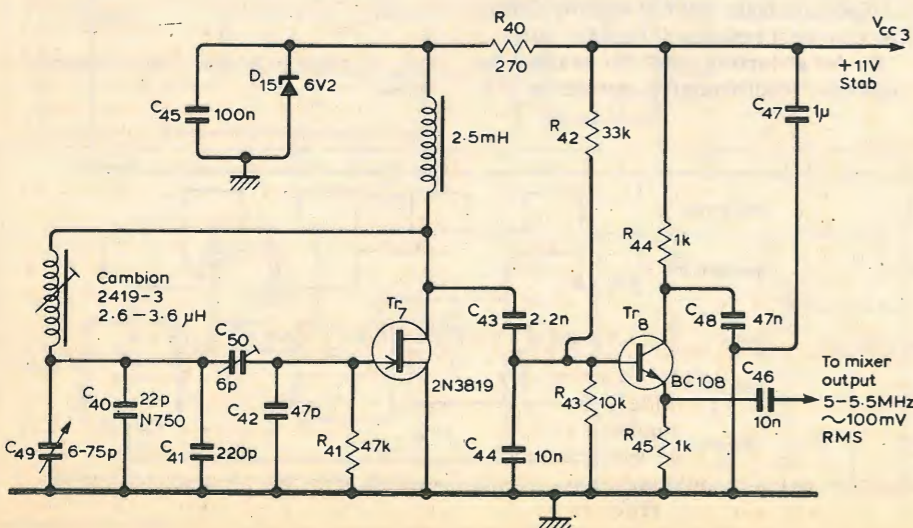
$$\text{Sidebands} = 20 \log_{10}$$

$$\left(\frac{1}{2} \times \frac{82 \times 0.1 \times 11.2 \times 10^6}{10^6 \times 2 \times \pi \times 5 \times 10^4} \right) \text{ dB}$$

$$= 70 \text{ dB.}$$

To ensure that this is bettered, an additional low-pass filter may be added by dividing R_1 into two sections and connecting a capacitor from this point to earth. If the filter so formed has a

Fig. 11. Variable frequency interpolation oscillator.



turnover frequency of about 5kHz this should add about 20 dB to this suppression figure.

$$C_1 = \frac{4}{2 \times \pi \times 5 \times 10^3 \times 200}$$

$$\sim 0.68 \mu\text{F.}$$

The total suppression of the reference-frequency feedthrough will now typically be 90 dB below the level of the carrier.

The variation of the loop characteristics at maximum and minimum division ratios can now be checked. The loop natural frequency is a function of the inverse of the square root of N and the damping factor is proportional to the natural frequency.

$$\omega_n(N_{min}) = \omega_n \sqrt{\frac{N_{av}}{N_{min}}} = 10^3 \sqrt{\frac{250}{140}}$$

$$= 1350 \text{ rad/s.}$$

$$\omega_n(N_{max}) = \omega_n \sqrt{\frac{N_{av}}{N_{max}}} = 10^3 \sqrt{\frac{250}{460}}$$

$$= 750 \text{ rad/s.}$$

$$\zeta(N_{min}) = \zeta \times \frac{\omega_n(N_{min})}{\omega_n} = \frac{1 \times 1350}{1000} = 1.35.$$

$$\zeta(N_{max}) = \zeta \times \frac{\omega_n(N_{max})}{\omega_n} = \frac{1 \times 750}{1000} = 0.75.$$

This illustrates how the settling time will increase as the division ratio gets larger. As N increases, the loop natural frequency and the damping factor reduce. This causes the loop to settle more slowly and in a more oscillatory manner.

The maximum frequency step which can be made within the $\pm 2\pi$ radians limit of the MC 4044 can now be checked. The time T can be determined with reference to the normalized time domain response plots. This can be taken to be $T = t_1/5 \approx 1 \text{ ms}$. so $f_{ref} \cdot T = 5 \times 10^4 \times 1/10^3 = 50$.

So the maximum step is about $\pm 4\%$. This corresponds to 280kHz at 7 MHz

and 920 kHz at 23 MHz. The time for the maximum step from 7 MHz to 23 MHz can thus be calculated, assuming that this $\pm 2\pi$ radians limit will be exceeded.

$$t_c = \frac{2 \times \pi \times 200 \times 25 \times 16 \times 10^6}{(0.35 \times 10^6 \times 11.2 \times 10^6)} = 130 \text{ ms.}$$

This is reasonably close to the original target of 1/10 s, and has been confirmed by computer simulation.

Variable-frequency oscillator

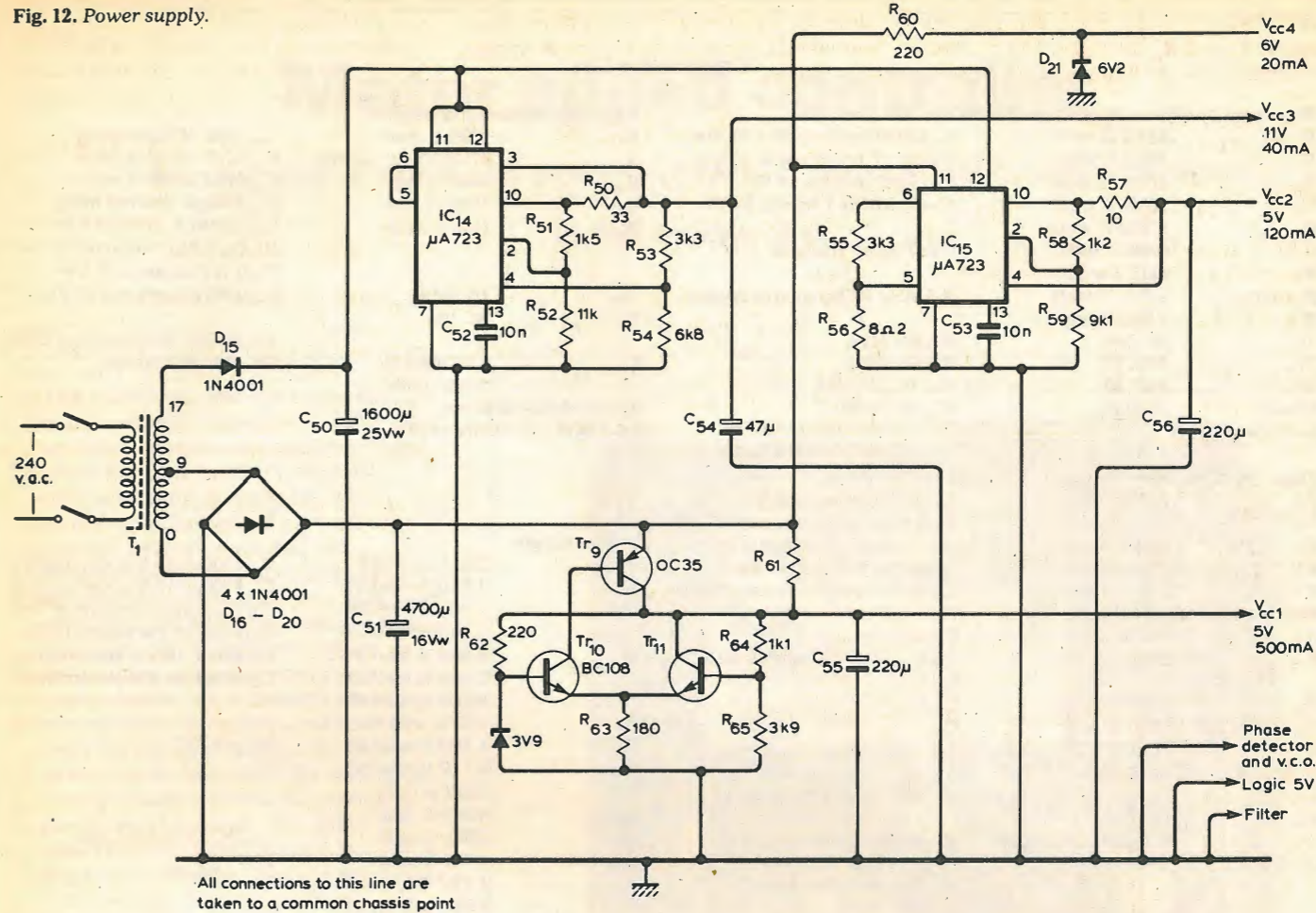
This covers 5 to 5.5 MHz and provides an output of about 100 mV rms. It uses a Vackar circuit incorporating a junction f.e.t. as in Fig. 11. It is adequately stable for reception of s.s.b. signals and the short term stability is better than 50Hz over 15 minutes. The coil used was by Cambion (type number 2419-3) and is made of silver-plated wire, tension wound on a ceramic former. A more modest coil could be constructed but would sacrifice frequency stability. The variable capacitor is the Jackson Type U101 6-75 pF s.l.c. law, which gives a substantially linear calibration over 500 kHz. A small amount of temperature compensation is included in the form of a 22 pF N750 capacitor across the tuning capacitor. The oscillator is buffered by a single transistor emitter follower, which takes its output from a capacitive tap across the tuned circuit, thus reducing the loading and defining the output amplitude.

Heterodyne mixer

The mixer, shown in Fig. 8, combines the output from the phase-locked loop with the signal from the v.f.o. By this means, continuous coverage is obtained from 1.5 to 28.5 MHz in 500 kHz bands. The only disadvantage with this arrangement is that the tuning of the bands from 1.5 to 12 MHz is reversed from that for those from 12 to 28.5 MHz.

The circuit uses a Plessey SL 641 double-balanced mixer, which provides adequate suppression of both v.f.o. and phase-lock loop feed through. The required sideband is selected by means of a tuned circuit. The Q of this is defined by the 820-ohm resistor across it, to ensure at least 500 kHz bandwidth for each band. The calculated suppression of all unwanted mixer components exceeds 30 dB, the best obtainable from a single tuned circuit. This is quite adequate for out-of-band components when used as the local oscillator in a superhet since there is effectively extra suppression provided by the r.f. tuned circuits. In addition, the conversion efficiency of the receiver mixer drops off rapidly for small oscillator levels. A more general method of achieving this selection would be to use a series of bandpass filters with their pass bands carefully chosen to exclude major unwanted products. It is possible that a greater degree of suppression could be achieved if these filters were more complex. The output from the mixer is buffered by a single-transistor emitter follower.

Fig. 12. Power supply.



Power supply

The power supply in Fig. 12 provides four voltage rails, two at 5 volts, one at 6 volts and one at 11 volts. The unit uses a standard charger transformer giving 0, 9 and 17 volts a.c. Stabilization is by i.c. and discrete component regulators. This reflects component availability at the time of construction, but there is no reason why standard three-terminal regulators could not be used. The most significant detail of its construction concerns the earthing arrangements, which are essential to ensure isolation between the rails. Each regulator has a single earth point and these in turn are all connected to a common earth point, the earth-return rail for each supply from the logic also being returned to this common point. In this way, the earth return currents of each supply are isolated from those of all others.

Two individually stabilized power rails are provided, one to supply the phase detector and v.c.o., and the other the rest of the logic. These separate supplies, together with the earthing arrangements mentioned above, are essential to prevent power supply noise generated by the counters from modulating the output signal.

Construction

The unit was constructed on three pieces of 0.1in Veroboard and was incorporated into the author's amateur band transceiver. One board of 2 1/2in x

5in contained the power supply components except for the transformer, another of the same size containing the phase detector, loop filter, v.c.o. buffer and heterodyne mixer. The final board of 3 1/2in x 5in contained the reference oscillator and dividers, together with the prescaler programmable divider and diode matrix. The coils and transformer were mounted on a chassis which also formed an enclosing screen. These parts occupied a space 7in x 4 1/2in x 4 1/2in. The v.f.o. had previously been built in a diecast box which was located outside this volume.

The order of construction that the author would recommend is as follows. First build up the power supply to give at least 5 volts at 500 mA. Then construct the reference oscillator to provide a convenient source of pulses with which to check subsequent circuit groups. The reference oscillator divider comes next and can be tested using an oscilloscope to monitor the output or alternatively, if one is not available, a frequency counter or general coverage receiver with the latter receiving a suitably attenuated version of the 50 kHz reference frequency, harmonics should be received throughout the h.f. spectrum. Now assemble the prescaler and the programmable divider, which is most conveniently tested using a frequency meter, taking the reference oscillator as input and confirming that the correct output frequency is

obtained for various division ratios. It is now necessary, if this has not already been done, to commission the 11 volt and second 5 volt supplies. The v.c.o. level charger and output buffer should next be constructed, again being commissioned in conjunction with the programmable divider and a frequency meter. It is useful at this stage to confirm the range of the oscillator by feeding the varicap diode from a suitable high-impedance, variable-voltage source.

The phase detector comes next, being commissioned with the 50 kHz reference. If this is fed to both pins 3 and 1, i.e. no phase error, the output at pins 5 and 10 should be about 1.5 volts. If this feed is made only to pin 1, leaving pin 3 open circuit, the output should fall to 0.8 volts, i.e. go up. Conversely feeding only pin 3 the output should rise to 2.2 volts.

Next the loop filter can be assembled, bearing in mind that the CA 3130 is a m.o.s. device and that care should be taken to avoid damage due to voltage transients during soldering or capacitive charge effects during handling. With this the loop can now be closed and, with any luck, frequency lock obtained. Checks on the output wave form can be made with a spectrum analyser, if one is available, or failing that, a general-coverage receiver with an "S" meter. The reference feed through may be detected as low level signals 50kHz on either side of the

Components List

Reference oscillator, programmable divider and prescaler

R ₁ , R ₂	68kΩ ½ watt	C ₁ 330 pF polystyrene 30 Vw
R ₃	150kΩ ½ watt	C ₂ 100 pF polystyrene 30 Vw
R ₄	2.7kΩ ½ watt	C ₃ 15 pF ceramic 30 Vw
R ₅	10kΩ ½ watt	C ₄ , C ₁₀ 0.01µF ceramic 30 Vw
R ₆	3.3kΩ ½ watt	CT ₁ 7-65 pF trimmer
R ₇	470Ω ½ watt	X ₁ 1MHz HC6U quartz crystal
R ₈	1kΩ ½ watt	Tr ₇ 2N 3819
R ₉ to R ₁₅	8.2kΩ ½ watt	Tr ₈ BC 108
R ₁₆	1.5kΩ ½ watt	D ₁₅ 6.2V 400mW zener diode
Tr ₁	BC 108	2.5mH choke Repanco
Tr ₂	BSX 19	2.6-3.6µH coil Cambion 2419-3.
Tr ₃	BSX 20	
Diodes	1N4148	
in diode matrix.		

Variable-frequency oscillator

R ₄₀	270kΩ ½ watt	C ₄₀ 22pF N750 ceramic
R ₄₁	47kΩ 2 watt carbon	C ₄₁ 22pF silvered mica
R ₄₂	33kΩ ½ watt	C ₄₂ 47pF silvered mica
R ₄₃	10kΩ ½ watt	C ₄₃ 2200pF silvered mica
R ₄₄ , R ₄₅	1kΩ ½ watt	C ₄₄ 10000pF silvered mica
		C ₄₅ C ₄₆ 0.01µF ceramic 30 Vw
		C ₄₇ 0.1µF ceramic 30 Vw
		C ₄₈ 0.047µF ceramic 30 Vw
		Vc ₁ 6-75pF Jackson type U101
		CT ₂ 3-30pF trimmer

Phase detector, loop filter v.c.o. and heterodyne mixer

R ₂₀	3.9kΩ ½ watt	C ₁₅ 0.1µF ceramic 30 Vw
R ₂₁ , R ₂₂	100Ω ½ watt	C ₁₆ 0.68µF polycarbonate 30 Vw
R ₂₃	82Ω ½ watt	C ₁₇ , C ₁₈ 47µF electrolytic 25 Vw
R ₂₄	10kΩ ½ watt	C ₁₉ 100pF ceramic 30 Vw
R ₂₅ , R ₂₆	18kΩ ½ watt	C ₂₀ 0.33µF polycarbonate 30 Vw
R ₂₇	1kΩ ½ watt	C ₂₁ 0.1µF ceramic 30 Vw
R ₂₈	36Ω ½ watt	C ₂₂ , C ₂₅
R ₂₉	220Ω ½ watt	C ₂₆ , C ₂₇ 0.01µF ceramic 30 Vw
		C ₂₈ , C ₃₀
R ₃₀	820Ω ½ watt	C ₃₁ , C ₃₂
R ₃₁ , R ₃₂	18kΩ ½ watt	C ₃₄
R ₃₃	1kΩ	C ₂₄ 100pF silvered mica
Tr ₄	2 N4126	C ₂₉ 0.1µF ceramic 30 Vw
Tr ₅	BC 108	C ₃₃ 25µF electrolytic 25 Vw
Tr ₆	BC 108	
D ₁₀	MV 1401 Motorola	IC ₉ MC4044 Motorola
D ₁₁ , D ₁₂ , D ₁₃	1N4148	IC ₁₀ CA 3130 RCA
		IC ₁₁ MC 1648 Motorola
		IC ₁₂ SN 74500
		IC ₁₃ SL 641 Plessey

Power supply

R ₅₀	33Ω ½ watt 5%	C ₅₀ 1000µF 25 Vw electrolytic
R ₅₁	1.5kΩ ½ watt 5%	C ₅₁ 4700µF 16 Vw electrolytic
R ₅₂	11kΩ ½ watt 5%	C ₅₂ , C ₅₃ 0.01µF ceramic 30 Vw
R ₅₃	3.3kΩ ½ watt 5%	C ₅₄ 47µF 25 Vw electrolytic
R ₅₄	6.8kΩ ½ watt 5%	C ₅₅ 220µF 16 Vw electrolytic
R ₅₅	3.3kΩ ½ watt 5%	C ₅₆ 220µF 16 Vw electrolytic
R ₅₆	8.2kΩ ½ watt 5%	
R ₅₇	10Ω ½ watt 5%	IC ₁₄ µA 723
R ₅₈	1.2kΩ ½ watt 5%	IC ₁₅ ..
R ₅₉	9.1kΩ ½ watt 5%	
R ₆₀	220Ω ½ watt	Tr ₉ OC 35 on heat sink
R ₆₁	470Ω ½ watt	Tr ₁₀ BC 108
R ₆₂	220Ω ½ watt	Tr ₁₁
R ₆₃	180Ω ½ watt	
R ₆₄	1.1kΩ ½ watt 5%	D ₁₅ , D ₂₀ IN 4001
R ₆₅	3.9kΩ ½ watt 5%	D ₂₁ 6.2V, 400mW zener
T ₁	0-9-17 volt 1 amp charger transformer	

Coils and tuning capacitors see circuit diagram inset.

wanted signal. Finally the v.f.o. and heterodyne mixer can be built and the mixer output coils peaked, using an r.f. volt meter, in the centre of their respective bands. □

References

- Crystal oven and frequency standard. L. Nelson-Jones. *Wireless World* June 1970 pp. 269-273.
- 10-80 Metre Amateur Transceiver. D. Bowman. *Wireless World* June, July, Aug, Sept 1972.

Police communications aided by microcomputer

A recent demonstration of a police communications headquarters in Leicestershire which has been converted to microcomputer control may well indicate new trends in Post Office/Home Office/police relations.

The "Consort 2" computer-based network is a development by Burndept Electronics of Erith and Biggleswade. As reported in our March 1979 issue, the company was previously a part of the Ever-Ready (Berrec) Group, and is now partly under the control of the National Enterprise Board, which holds 51% of the equity. The new system replaces a v.h.f. communications centre which was functional but, according to a police spokesman, "out-dated," consisting of a manually-switched exchange in contact with mobiles and handportable units on the beat.

Although by no means revolutionary in concept, the new process has some unusual features, not the least of which is the facility

it provides to the driver of a patrol car or other observer to check in a few seconds the name, address and age of the owner of any car. This is effected by means of a direct link through the carrier-operated main station to the national police computer in Swansea. While such a facility could conceivably be used to harass a motorist, its usefulness as an instant check on stolen cars must be undisputed.

Briefly, the system comprises a v.h.f./u.h.f. linked switching exchange with facilities for monitoring, independent selection, and talk-through (via a main station), linking mobiles to base and to each other. It is also possible to patch in to local PAX/PABX lines, rendering the telephone network open to use by the police.

Even though a Leicestershire chief inspector suggested that the Post Office is reticent where the provision of a personal telephone

service for the copper on the beat is concerned, the official Post Office line is that as the telephone service is free to everyone else, it must also be free to the police.

With the recent changes which have taken place in Post Office regulations, permitting, interface of private mobile radio with the telephone network, specifically to Air Call Ltd, Burndept has unquestionably struck while the iron is hot. Linking a microprocessor to a basic switching circuit is hardly a systems breakthrough, but the Home Office, which selects and checks equipment for the police (and pays for it from the public purse) is clearly satisfied with the result since it has already equipped both Northampton and Nottingham as well as Leicester with the "Consort 2." A further 11 systems have been ordered by the Home Office for other police forces, at an approximate cost of £100,000 for each installation.

Motor speed controller

Inexpensive home-made alternative to £20 commercial model controllers

by J. D. Stumbles, B.Sc.

This motor controller is a cheap and effective home-made alternative to £20 commercial devices performing much the same function. The total component cost is under £5. It is considerably lighter and more efficient in terms of battery power than the servo-operated rheostats of the past. It also has some unique features of especial value to model boat enthusiasts. Because the motor control transistor derives its base current ultimately from the receiver power supply, it is impossible to set the boat off with the receiver switched off. Also, it is possible to set up the controller so that the off position of the transmitter control is biased toward the reverse speed end of its travel. This allows full speed to be achieved forward, but only a low speed in reverse. This not only looks more realistic, but also avoids the propeller unscrewing itself in mid-pond!

A FELLOW RADIO-CONTROL boat enthusiast wanted a device to control the electric motor in one of his scale boats. Ideally he wanted proportional speed control in forward and reverse, from one channel of his "digital" radio control outfit.

The modulation in these digital systems is similar to that described by M. F. Bessant in his multi-channel control system (*Wireless World*, October 1973). A number of width-modulated pulses of 1 to 2ms duration are sequentially transmitted, with a synchronization pulse for the decoder. The repetition period of this train of pulses is typically 15 to 20ms. The system used by Bessant and others is shown in Fig. 1 (a), with a slightly older variant at (b). In the last-mentioned system the sync pulse is longer than the control pulses, and the cycle repetition rate is usually independent of the widths of the control pulses; in the modern system the cycle time can vary over a wide range, depending on the settings of the controls.

The frames of pulses are transmitted

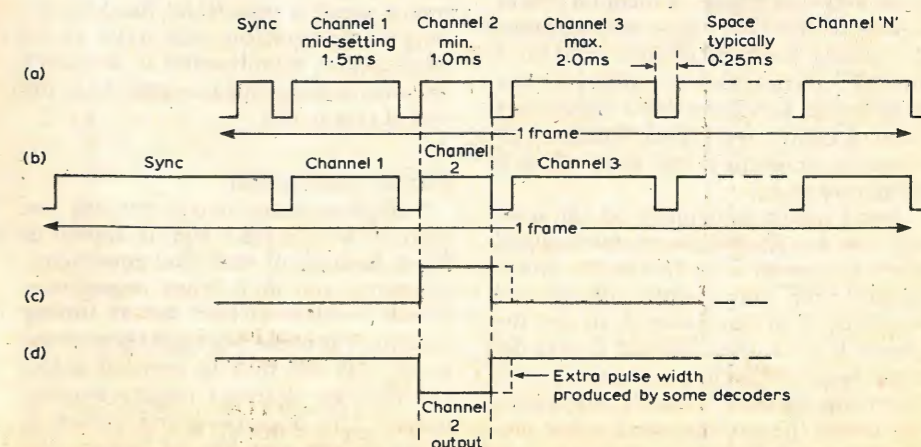
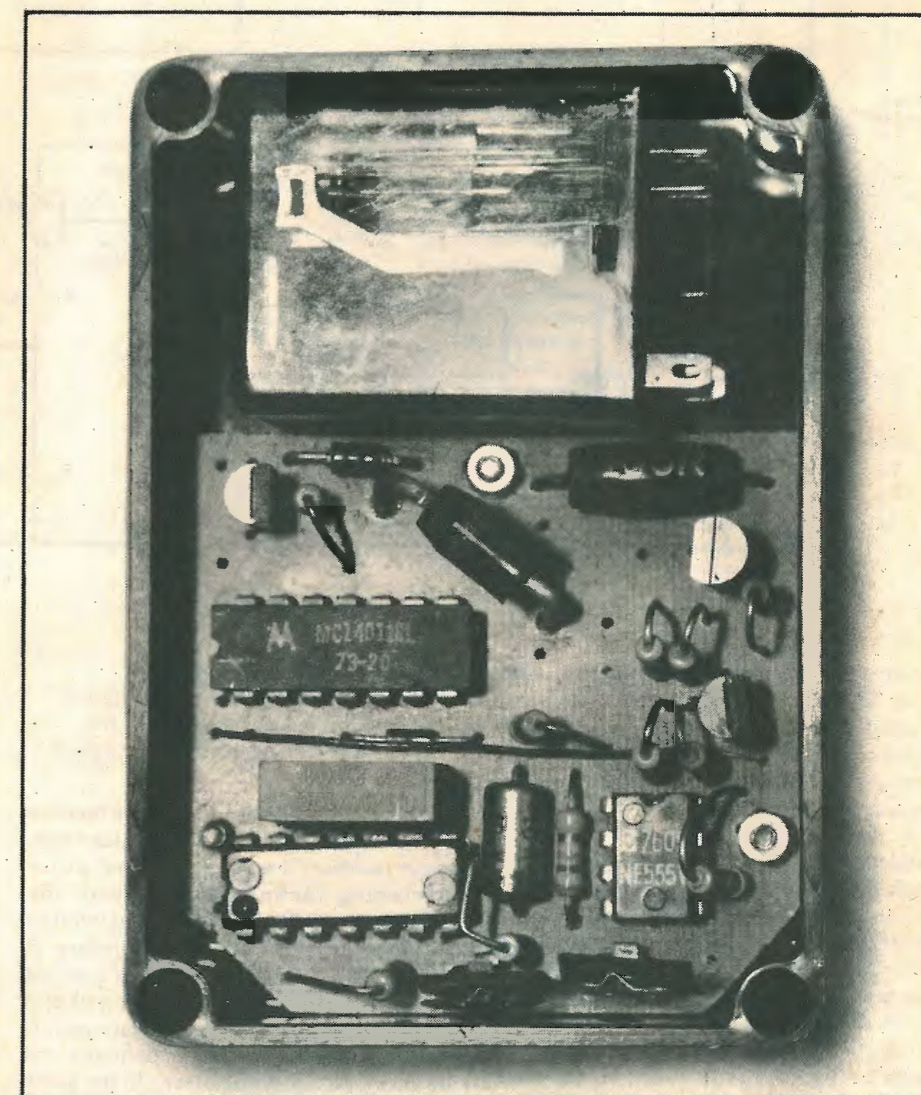


Fig. 1. Examples of modulation systems used in digital radio control are M. F. Bessant's multichannel system using short sync pulse (a) system using long sync pulse used in some radio control outfits (b), while (c) & (d) show outputs from different decoders for given channel.

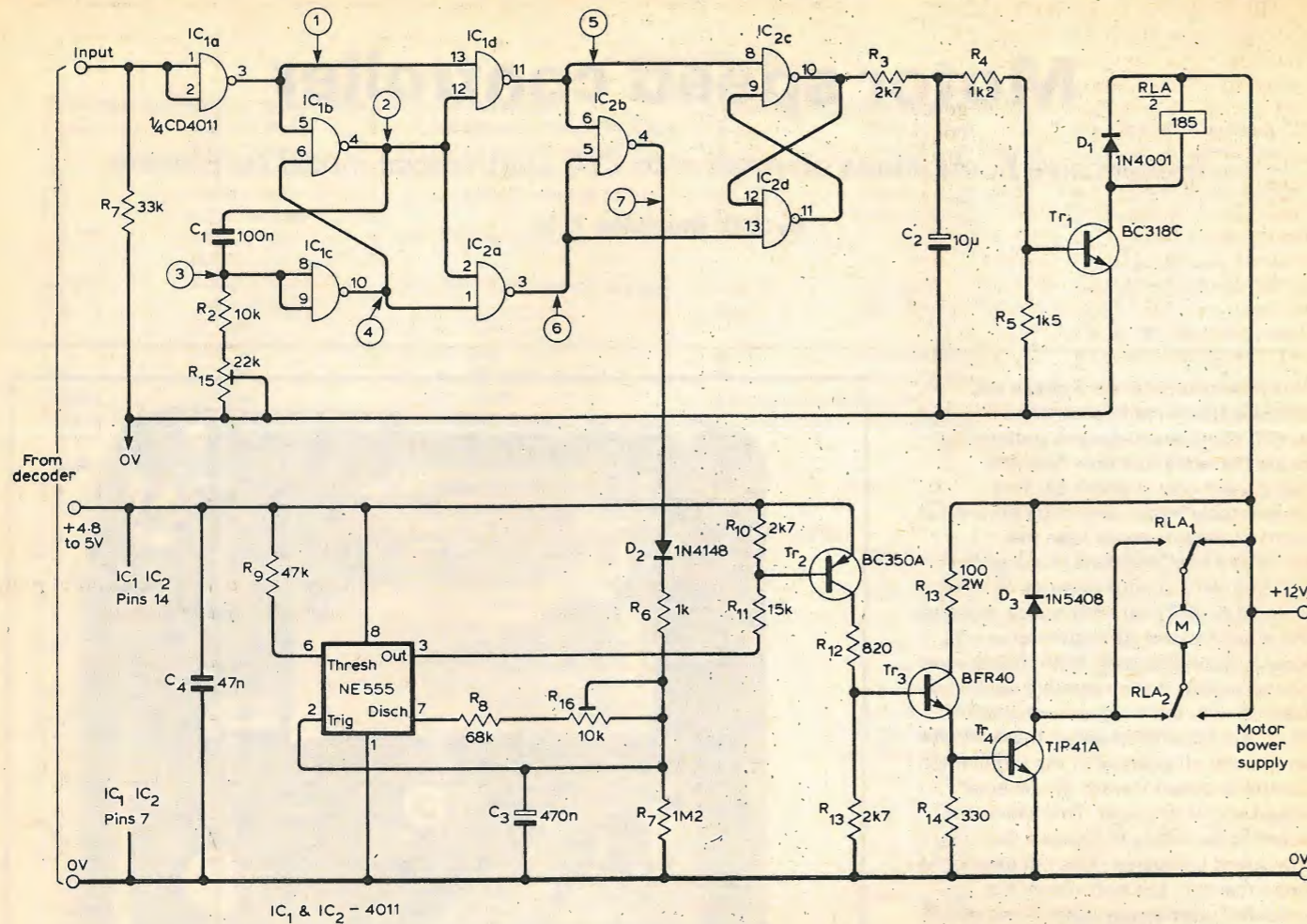


Fig. 2. Circuit of the c.m.o.s. motor-speed controller that is lighter and consumes less power than the "servo-operated rheostats of the past."

over a suitable data link (a 27MHz carrier for model radio control) and decoded at the other end. The decoder splits up the pulse train, presenting pulses for each channel at the appropriate channel output, as in Fig. 1 (c) or (d). In some decoders the "space" is added to the width of the output pulses, although this appears merely as a fixed offset, which can be allowed for in setting up the servo or motor controller. The polarity of the output pulses also varies from one system to another.

In deciding on a suitable method of controlling the motor, the obvious approach was some form of variable mark-space switched control, using a power transistor. As the motor only drew about two amps, when stalled, from a 12-volt supply, a medium power device of the TIP41 type was suitable. To obtain forward/reverse control a bridge circuit was considered, but rejected as the three extra transistors (two of them p-n-p types) would not be cheaper, or occupy less space than a miniature relay.

Some motor controllers on the market use a standard electromechanical servo to operate a control on the motor control unit. This seemed clumsy, and wasteful of an expensive servo and the power it consumes. Instead it was decided to use the width-modulated pulses from the decoder, suitably processed, to control the variable mark-space motor drive waveform.

The system chosen to do this has the advantage of simplicity. Its disadvantage is that, because of the pulse stretching technique employed, the motor speed is inversely proportional to the overall frame length. Therefore in systems such as Fig. 1 (a) there is slight interaction between other channels and motor speed. Since in most systems it is unlikely that all the other controls will be at their extreme positions in the same direction simultaneously, the effect is hardly noticeable. In systems where motor speed is important, fixed frame-length modulation will have to be employed. A modification to Bessant's encoder to allow this is suggested at the end of this article.

Circuit description

Complementary m.o.s. devices are used in the complete circuit, shown in Fig. 2, because of their low power consumption and high input impedance, which facilitates their use as timing circuits. The incoming signal is inverted by IC1 (a) and may be omitted where the decoder delivers negative-going pulses. The negative-going pulses at point 1 (see also Fig. 3) trigger the

monostable circuit made up of IC1 (b) & (c). In the discussion that follows assumes that the input pulses are of 1 to 2ms duration, and the frame repetition period is 15ms. The normal output pulse-width of the monostable is adjusted to 1.5ms by R₁₃.

Operation of the circuit with pulse widths shorter than, equal to, and longer than, 1.5ms is shown in Fig. 3. For short pulses the output of IC1 (b), point 2, is a constant 1.5ms positive-going pulse. This is compared with the input in NAND gate IC1 (d), whose output is a negative-going pulse of length equal to the difference between input and reference 1.5ms pulses. When the input pulse is longer than 1.5ms the output of IC1 (c), point 4, is a fixed 1.5ms negative pulse, whilst the output of IC1 (b) reproduces the input pulse. NAND gate IC2 (a) produces a difference-pulse.

The lower part of the circuit in Fig. 1 (a) consists of the pulse-stretching and driver/output circuits. The operation of the pulse stretcher is shown in Fig. 4. When the input pulses are very short, as in (a), the charge put on C₃ through D₂ and R₆ is so small that the bleed resistor R₇ keeps the voltage on C₃ below the trigger point of the 555 IC. This is connected as a comparator, with the threshold input held high by R₉. The comparator works in an inverting sense, so its output is high when the voltage on pin 2 is below the internal reference of

1/3 V_{cc}. In this state Tr₂, Tr₃ and Tr₄ are off and no power is applied to the motor.

As longer input pulses are applied, C₃ begins to charge above the trigger point, so the comparator output goes low. Resistors R₈ and R₁₆ are now connected to ground through pin 7, discharging C₃ until its voltage is below the trigger point once more. During this time the drive transistors are on and the motor is driven. Fig. 4 (c) shows the operation of the circuit when the difference pulses are half of their maximum length, 0.25ms. The pulse stretcher drives the motor for half the frame period, 7.5ms, thus giving half-speed control. When the difference pulses are at maximum length, 0.5ms, the voltage on C₃ never drops below the trigger point, so there can be a slight dead-band at full-speed setting.

The forward/reverse function is determined by the R-S flip-flop IC2 (c) and (d). Figures 1 & 2 show that pulses occur at point 5 only for inputs shorter than 1.5ms, and at point 6 only for longer inputs. The flip-flop therefore latches on whichever of these signals is present, and gives a steady signal to drive Tr₁, the relay drive transistor. Inclusion of the network C₂, R₃ and R₄ avoids the relay switching over briefly for a couple of frames, in the presence of radio interference. This is obviously unnecessary if a noise-free data-link is used.

Since the relay switches over at the centre dead point of the speed control, i.e. when the motor is off, the relay contacts can safely be used to pass considerably more than their rated direct switching currents. Thus in the prototype, one of the popular miniature 12V relays with a 185 ohm coil and nominal 2 A contacts is used to pass the full rated current of Tr₄ (i.e. 6A) and could be used for much more.

The drive current into Tr₄, about 100mA and set by R₁₃, has been chosen for a mid-range gain selection for this device of about 4A collector current.

Modifications and extensions

To use the controller for much higher currents, Tr₄ could be used as a driver for a larger n-p-n silicon power transistor in the Darlington configuration or for a hefty p-n-p germanium device. In the last-mentioned case it is essential to provide a low-value base-emitter resistor, to ensure the device turns off, even when hot. For currents much over 10 amps a larger relay should be used, although Tr₁ may have to be replaced with a Darlington pair to drive a lower resistance coil. To minimize interference - it would be wise to place these high-

(a) Short input pulse (1ms) (b) Mid-range input pulse (1.5ms) (c) Long input pulse (2ms)

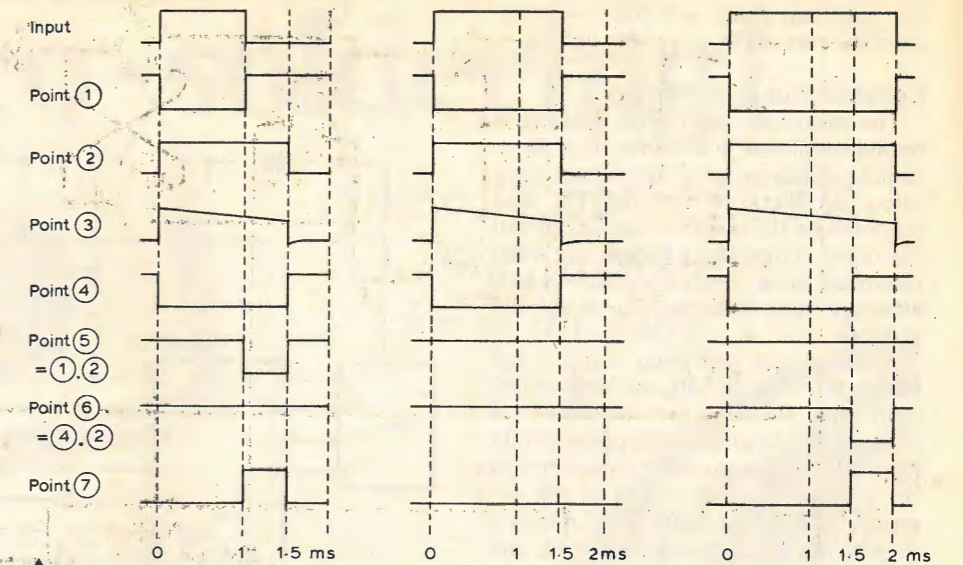


Fig. 3. Operation of the monostable and pulse-difference circuits with short input pulse of 1ms (a), mid-range input pulse of 1.5ms (b), and long input pulse of 2ms (c).

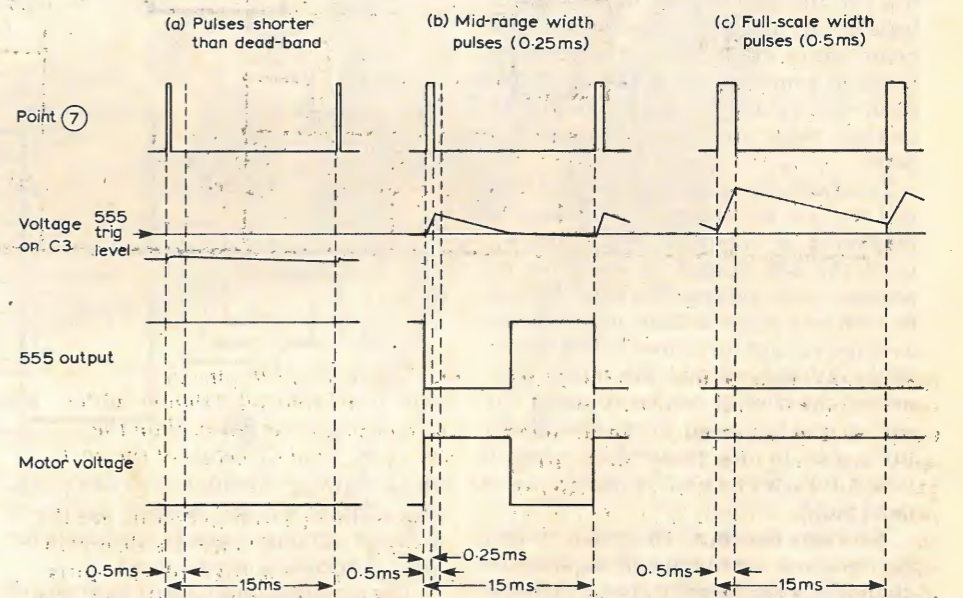


Fig. 4. Operation of the pulse-stretching circuit with pulses shorter than dead-band (a), mid-range width pulses (b) and full-scale width pulses (c). Time is scale distorted for clarity.

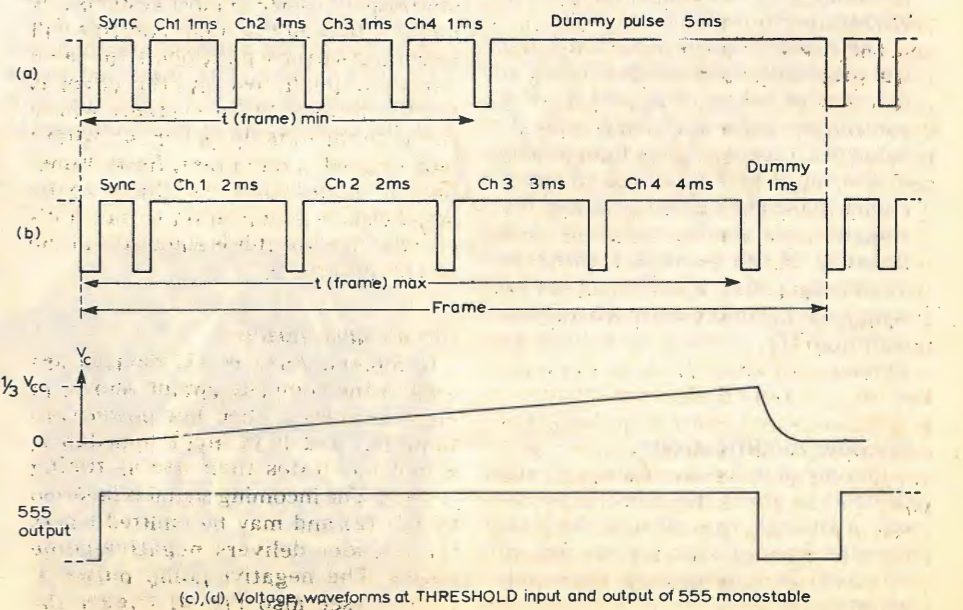


Fig. 5. Insertion of dummy pulse into frame equalizes frame lengths. Example shows four-channel system with controls at shortest pulse-width setting (a), and at longest pulse-width setting (b). (c), (d), Voltage waveforms at THRESHOLD input and output of 555 monostable

current components – output transistor, catching diode and relay – away from the rest of the controller circuit.

Construction & setting-up

The prototype was constructed in a miniature plastic box, about 70 × 48 × 25mm, with a piece of aluminium doubling as heatsink and lid. Tr₄ was mounted on the inside of this lid, and all the other components except the relay mounted on a printed circuit board, although strip-board would be equally suitable.

If the circuit has been constructed correctly it can be aligned without instruments, although a multimeter or a c.m.o.s. – compatible logic probe would help. With the controller connected to the correct channel output of the decoder, and the encoder/transmitter's control for that channel centred, the monostable/pulse-difference circuits can be checked and aligned. Adjust R₁₅ until no pulses appear at the output of IC2 (b): this can be seen on a scope or logic probe, or the direct voltage at this point can be measured on the sensitive range of a multimeter. If 12V is applied then the relay should be heard to change back and forth around this point.

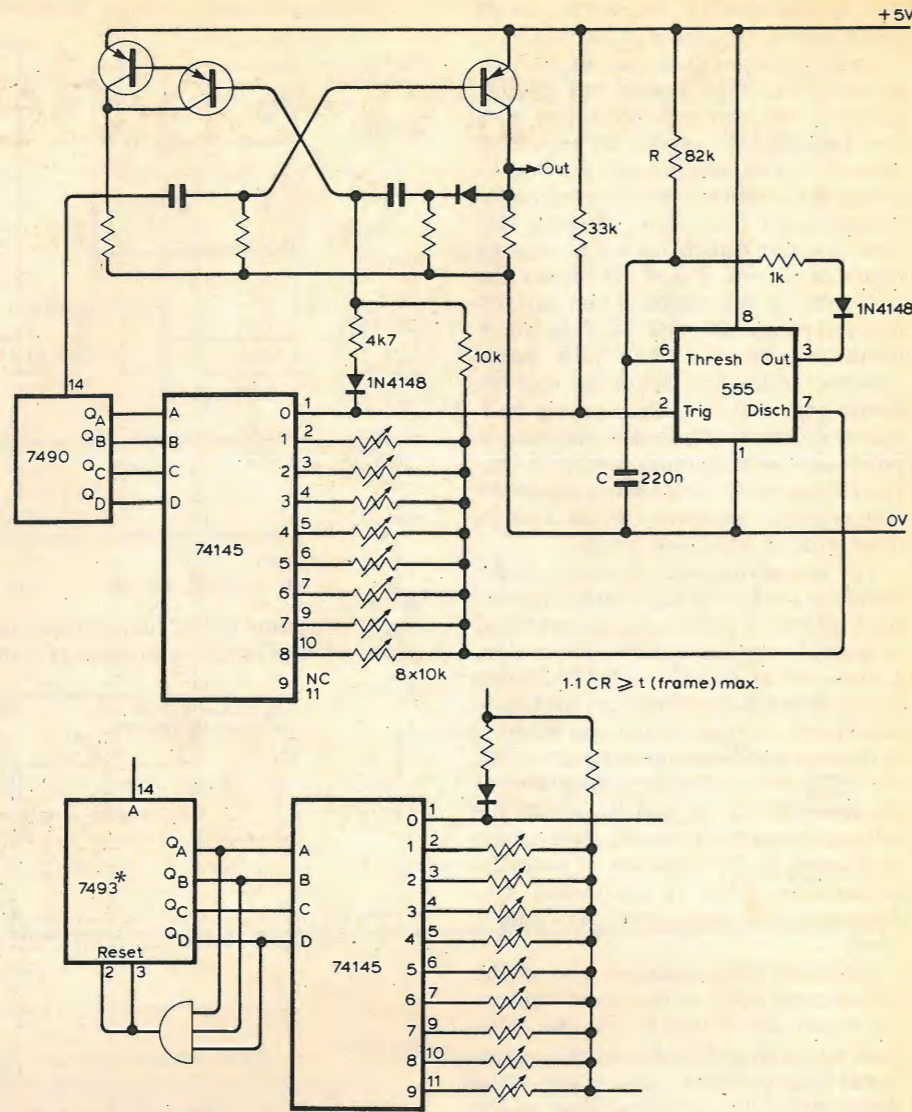
To adjust the pulse-stretch ratio control R₁₆, set the transmitter control to maximum or minimum and adjust R₁₆ until the 555 output is low with no positive-going pulses. This can similarly be seen on a scope or logic probe, or the average voltage measured with a meter. With 12V applied and the motor connected the control can be adjusted "by ear" to give full speed. There should be a little play in the transmitter control whilst full speed is still obtained, i.e. a dead-band.

If for any reason a full stretch cannot be obtained, the value of R₆ may be changed. Note however that it is below its design value of about 1.6kohm, the remaining resistance being accounted for by the output resistance of the unbuffered c.m.o.s. gate. This effect could possibly be reduced if an emitter-follower were used in place of D₂.

The relative values of R₆ and R₇ control the width of the off dead-band, and the relative values of R₆ and R₈ + R₁₆ control the pulse-stretching ratio. The value of C₃ is not critical, but should be in the range of 0.22 to 2.2 μF. Larger values make the system response more sluggish, and smaller values spoil the linearity of the pulse-stretching law. Transistors may also be substituted with any common-sense alternatives, although Tr₁ should be a high-gain device.

Encoder modifications

It is possible for the settings of other controls to affect the speed of the motor, although the off and forward/reverse changeover points are not affected. In applications where this variation is likely to be unacceptable



the following modifications are suggested, based on the Bessant design of encoder although equally applicable for similar encoders using c.m.o.s.

The modifications consist basically of inserting a dummy pulse into the frame, to equalize the length of the frame whatever the setting of all the controls. This dummy pulse has a minimum length of 1ms to avoid causing malfunction of the decoder, which is designed to accept pulses of less than 1ms as sync pulses. The modified pulse streams are shown in Fig. 5: in (a) with all the controls are at minimum, and in



Fig. 6. Modifications to Bessant's of October 1973 issue give constant frame length by using existing counter and sacrificing one control channel (top), or by retaining nine-channel capability with count-to-eleven circuit (below). *74293 is recommended but has different pin connections than 7490.

(b) at maximum. The dummy pulse is generated by the extra components in the Bessant encoder of Fig. 6 (a). This implementation sacrifices one channel, but if this is unacceptable then the variation in Fig. 6 (a) overcomes this problem by replacing the decade counter of the original circuit with a divide-by-eleven counter. When the counter reaches binary 1010 (decimal 10) the decoder produces no output. In Fig. 6 (a) the output for a count of decimal 9 is disconnected. In either case, when this end-state is reached the output of the multivibrator stays high until the monostable (555 timer) goes low, when the discharge terminal of the 555 grounds the common timing line. After a further 1ms the multivibrator goes low and the normal pulse sequence re-starts. The period of the monostable is set for just longer than the maximum normal frame length of the encoder. □

Micro*-soldering!

Antex TCSU1 & CTC
... the perfect kit
for miniature
work

*CTC. No.7/010
Tip size: 0.5mm-.02

Heat to any level between 145°-400° (with accuracy of 2%)

Model CX - 17 watts
...a miniature iron with the elements enclosed first in a ceramic shaft, then in a stainless steel. Virtually leak-free. Only 7 1/2" long. Fitted with a 3/32" bit £4.37 inclusive of VAT and P.&P. Range of 5 other bits available from 1/8" down to 3/64".

Model X25 - 25 watts
A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at £4.37 inclusive of VAT and P.&P. Range of 4 other bits available.



Model SK3 Kit
Contains both the model CX230 soldering iron and the stand ST3. Priced at £6.21 inclusive of VAT and P.&P. It makes an excellent present for the radio amateur, modelmaker or hobbyist.



Model SK4 Kit
With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home. Priced at £6.21 inclusive of VAT and P.&P.

Model SK1 Kit
This kit contains a 15 watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet, 'How to solder'. Priced at £6.48 inclusive of VAT and P.&P.

Model MLX Kit
The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price £4.83 inclusive of VAT and P.&P.

Finger-tip accuracy combined with strict control of temperature set anywhere between 145 and 400°C. Negligible leakage current. Earthed and protected by 'fail-safe' circuit. Operates at 24 volts.

TCSU1 station complete with soldering iron (XTC or CTC) £36, plus VAT to industry. Our multi purpose range of soldering irons are all made in England and fully guaranteed. They are stocked by many wholesalers and retailers in the U.K. but if unobtainable locally we will supply direct.



Electronics Ltd.

Mayflower House, Armada Way, Plymouth, Devon Tel: 0752 67377/8 Telex: 45296

Please send the following ...

Please send the ANTEX colour brochure

I enclose cheque/PO/Giro No. 258 1000

Name

Address

Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 075267377

Functional logic symbols

Recommendations for a simplified method of representing complex digital circuits

by G. M. Whittaker, B.Sc. Ferranti Ltd, Edinburgh

The intelligibility of circuit diagrams can be greatly improved both by good overall layout and by concise, precise representation of the function performed by analogue and digital integrated circuits, for which a rigorously developed standard symbology is essential. Different categories of functional complexity of i.c.s are defined, a variety of ways of representing i.c.s is identified, and the preferred notation for each i.c. category is outlined. A unified system using these notations is outlined and examples of functional i.c. symbols are given.

TIME AND EFFORT could be saved, and errors of interpretation reduced, in the interpretation of digital circuit diagrams, if the symbol of each i.c. were to show as simply and precisely as possible the functional relationship between its inputs and outputs. It is this that IEC 117-15(1) and its direct derivatives including BS3939², should do. That they fail is demonstrated by the fact that PANAVIA, after initially specifying it in its entirety, have dropped the IEC notation for all i.c.s more complex than logic gates.

Since IEC 117-15 and its derivatives are currently being revised to form a new standard, it is timely that engineers should examine the matter of functional i.c. symbols carefully to ensure that the new standard is fully developed to meet the needs of all categories of integrated circuits.

The purpose of the work reported here³ is to develop the current IEC symbology as embodied in BS3939 to the point where it can be used for drawing precise functional circuit diagrams of all digital i.c.s. There are similar arguments for the adoption of functional symbols for analogue i.c.s.

Functional i.c. symbols

In contrast to the precise representation of simple logic gates and analogue operational amplifiers, the more complex i.c.s are commonly represented on circuit diagrams as blank boxes with pin numbers, and in data books in a complex manner which may be difficult to interpret. Examination of i.c. data books shows that different manufacturers use diverse methods of presenting data about functionally similar i.c.s. This diversity is increased in equipment

manufacturers' circuit diagrams since a number of standards exist for graphical symbols for logic integrated circuits. Many problems have been caused by the publication of under-developed standards in the form of IEC 117-15 and its derivatives, which are unusable as they stand. They conflict with the JEDEC⁴ symbols used widely in i.c. manufacturers' reference manuals, and employed by engineers and technicians throughout large sectors of industry. However, the JEDEC system cannot be used as the basis for functional symbols for i.c.s more complex than logic gates and flip-flops.

The Approach

The report on functional logic symbols³, while following BS3939 to the letter where possible, introduces a concise dependency notation representing multi-line addressing inputs and outputs, representation of tri-state logic clarified rules for logic polarity indicators, and appendices showing a variety of i.c.s and giving guidance on the drawing of circuit diagrams. These rules have evolved in the light of experience in the documentation of a digital computer, and of comments on both the original draft of BS3939 and a preliminary edition of the report. They are currently being applied in the preparation of a UK Service publication.

Circuit Type	Single Function		Multi-Function
	Simple	Complex	
digital simultaneous	Gates inverter buffer AND gate OR gate linear gate	Simultaneous DICE (Arrays of gates) decoder/demux function gen. full adder ROM shift network b.c.d.-to-7 seg decoder	Simultaneous Multi-Function Digital (arrays of DICE) a.l.u.
notation:	qualifying symbol or dependency	dependency	pin name arrays of DICE
digital sequential	Multivibrators SR, JK, T, D. Bistables monostable. astable.	sequential DICE (arrays of gates and bistables) latch counter frequency divider shift register RAM	sequential Multi-function digital (arrays of DICE) microprocessor p.i.a.
notation:	dependency	dependency	pin name arrays of DICE

It is thought that those who already understand and use digital logic could learn to read functional logic symbols and find their way round the revised standard in about a day using a properly structured course either of programmed learning or of formal instruction.

Though the interpretation of the functional logic symbols is relatively easily learned, the origination of the best possible symbol for a complex logic element from currently available data demands a knowledge of the rules. Thus, in the short term, the publication of a set of standard symbols for all available digital i.c.s is necessary, leading eventually to the adoption of these symbols in manufacturers' data, so that the originators of circuit diagrams can quickly select the appropriate symbol of an i.c. for use in any application. Otherwise this system will continue to be unacceptable to industry.

Categories of i.c.

Digital i.c.s are categorised in terms of hardware complexity, the unit being the gate or gate equivalent circuit.

- Small-scale integration (s.s.i.) contains no more than 11 gates per i.c.
- Medium-scale integration (m.s.i.) contains between 12 and 99 gates per i.c.
- Large-scale integration (l.s.i.) contains between 100 and 1000 gates per i.c.

Circuit Type	Single Function		Multi-Function
	Simple	Complex	
analogue simultaneous	ACE comparator op. amp. voltage ref. current ref. inverting amplifier normal amplifier	ACE multiplier function gen.	Arrays of ACE voltage regulator
notation:	shaped symbols	qualified symbols	arrays of ACE
analogue sequential	integrator differentiator	gated integrator track/hold.	
notation:	qualified symbols	qualified symbols	
converters		d.a.c.	a.d.c.
notation:		qualified symbols	qualified symbols

— Very-large-scale integration (v.l.s.i.) contains over 1000 gates per i.c. However, the type of functional symbol used for an i.c. in ref. 3 depends on the functional complexity of the i.c. which may not correspond to hardware complexity. Functional complexity may be defined in terms of single-function and multi-function circuits, with the additional sub-divisions of simultaneous function and sequential function, as shown in tables 1 and 2.

Single-function circuits. Any circuit or i.c. which can be described by a single mathematical operation, logic function table (truth table) or logic state transition table is defined as a single function circuit.

Single-function digital circuits may be represented precisely and concisely using functional logic symbols and the dependency notation. Typical simple single-function logic elements are logic gates and flip flops. Complex single-function logic circuits composed of arrays of logic gates and flip-flops, such as b.c.d. to decimal decoders, counters, shift registers and memory devices, are referred to in ref. 3 as digital computing elements (DICE). A single-function analogue circuit is one which can be fully described by a single block denoting a mathematical operation, referred to as an analogue computing element (ACE).

Multi-function circuits. Highly-complex i.c.s may be represented in two ways: precisely, as a circuit composed of single-function computing elements showing the exact function, or more concisely as a block with signal names which act as aide-memoires and refer to the precise diagram. The choice of symbol for an i.c. depends on the space available, the complexity of the precise diagram, and the level of information one needs.

Dependency notation

The key to functional symbols for single-function digital computing elements is the use of a fully-developed dependency notation that allows the interaction between the control signals, data inputs and data outputs to be shown precisely.

The dependency notation indicates the relationship between signals by means of both a letter placed adjacent to the affecting input which indicates the type of dependency, and an identifier which is both a suffix to the dependency indicator and is also placed adjacent to the affected signal. The following dependencies are defined: **gating dependency**; Gx gates the data on the signal labelled x; **Activate dependency**; Gx holds the output labelled x in its active state **clocking dependency**; Cx clocks the sequential elements inputs prefixed by x.

The **clocking dependency** is qualified by +, which is an edge trigger (1 negative-going) denoted in function tables by +, and by -, a pulse trigger for master/slave flip-flops denoted in function tables by -.

Inhibit is indicated by —| When an inhibit stands at its logic 1 state, it holds all outputs in that part of a digital two-state or linear element in the 0 state if normal or the 1 state of negated.

Isolate is shown by —| When an isolate stands at its logic 1 state, it holds all outputs in that part of a digital tri-state or linear element in the open-circuit Z state.

Enable appears as —| or —| and is more precisely referred to as negated inhibit or negated isolate, as appropriate.

Negation and polarity indicators. In IEC 117-15 and BS3939-21 a subtle differentiation is made between the logic negation indicator — which is used to annotate those signals which are active in the logic-0 state, and the polarity or active-low indicator ▽ which is

One important benefit of the dependency notation is that symbols using it correctly are readily identifiable without further explanation and therefore the system is independent of language.

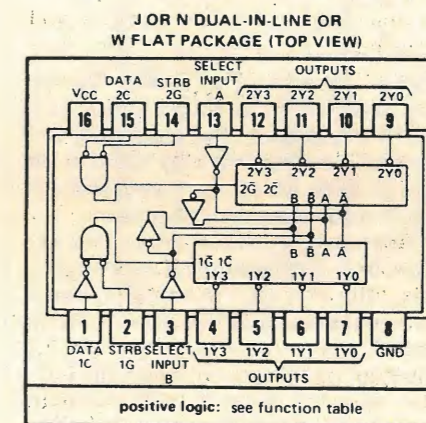


Fig. 1. SN54155 digital integrated circuit as shown in the manufacturer's data.

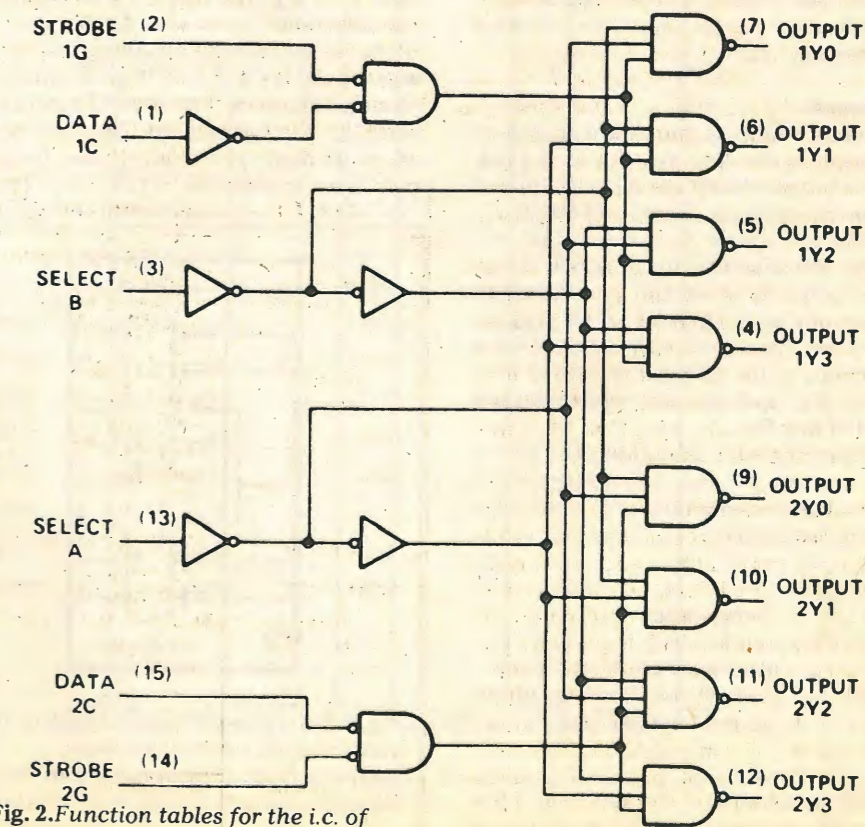


Fig. 2. Function tables for the i.c. of Fig. 1.

FUNCTION TABLES
2-LINE-TO-4-LINE DECODER
OR 1-LINE-TO-4-LINE DEMULTIPLEXER

INPUTS				OUTPUTS			
SELECT	STROBE	DATA		1Y0	1Y1	1Y2	1Y3
B	A	1G	1C				
X	X	H	X	H	H	H	H
L	L	L	H	L	H	H	H
L	H	L	H	H	L	H	H
H	L	L	H	H	H	L	H
H	H	L	H	H	H	H	L
X	X	X	L	H	H	H	H

INPUTS				OUTPUTS			
SELECT	STROBE	DATA		2Y0	2Y1	2Y2	2Y3
B	A	2G	2C				
X	X	H	X	H	H	H	H
L	L	L	L	L	H	H	H
L	H	L	L	H	L	H	H
H	L	L	L	H	H	L	H
H	H	L	L	H	H	H	L
X	X	X	H	H	H	H	H

used to annotate signals which are active in the low-voltage state. In this paper, reference is made to the negative logic indicator, and logic-0 or 1 states are referred to in the text. However, the Dutch have understandably decided to drop the concept of logic states and use only the active-low indicator, referring to low or high-voltage states — a measure which other countries may well adopt, with resulting simplification of their standards.

Pin name notation. For use in multi-function i.c.s, pin name abbreviations or initials must be short but memorable and preferably standardized. Manufacturers' pin names, where they already exist in data sheets, should be followed where practical.

Examples

Various practical circuits are shown to illustrate some key aspects of the advanced dependency notation as applied to functional logic symbols of DICE.

Manufacturer's diagrams of an SN 54155⁴ are shown in Fig. 1, applications of which are shown in the function tables of Fig. 2. Three of these applications are illustrated in functional logic diagrams of the element in Figs. 3 to 5, while Fig. 6 shows the negative-logic dual of Fig. 5.

Figure 3 shows the 54155 dual 2-to-4-line decoder in its basic form in positive logic. The manufacturers pin names are shown bracketed.

Pin	Dependency
2, 14, 15	inhibit
1	enable (negated inhibit)
3, 13	binary-coded address inputs (activate dependency)

The A (activate) dependency indicates that enabled outputs are activated

when a addressed. Their inhibit dependency de-activates all outputs from that part of the symbol. The outputs are all negated, meaning that they stand at the logic-0 state when activated and the logic 1 state when de-activated.

Figure 4 shows the i.c. connected as a 3-to-8-line encoder with positive logic in force. The BIN/OCT block is optional, the function being self evident from the symbol.

In Fig. 5 is the symbol when the i.c. is used as a 1-to-8-line demultiplexer in positive logic. Here the addressing input gates data onto the addressed output. The G dependency is therefore applicable. The outputs are shown negated since they are high (logic-1 state) when not addressed.

The negative-logic dual of the i.c., when used as a 1-to-8-line demultiplexer, is shown in Fig. 6. Note that the labels on the outputs are changed because 'all high' on the addressing input pins now represents octal zero. The

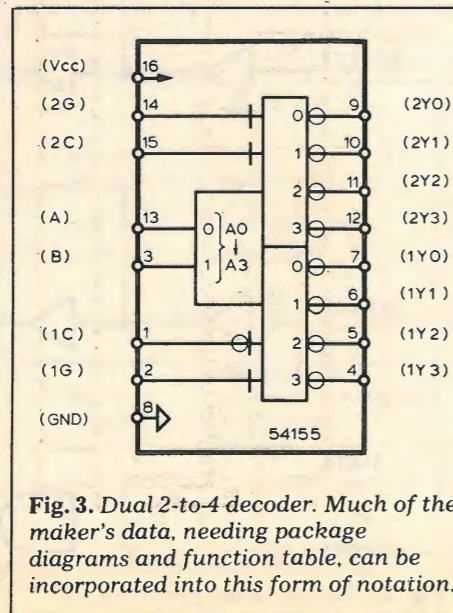


Fig. 3. Dual 2-to-4 decoder. Much of the maker's data, needing package diagrams and function table, can be incorporated into this form of notation.

FUNCTION TABLE
3-LINE-TO-8-LINE DECODER
OR 1-LINE-TO-8-LINE DEMULTIPLEXER

INPUTS				OUTPUTS							
SELECT	STROBE	OR DATA		(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C†	B	A	G‡	2Y0	2Y1	2Y2	2Y3	1Y0	1Y1	1Y2	1Y3
X	X	X	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H
L	H	L	L	H	H	L	H	H	H	H	H
L	H	H	L	H	H	H	L	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	L	H	H
H	H	L	L	H	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	H	L

†C = inputs 1C and 2C connected together
‡G = inputs 1G and 2G connected together
H = high level, L = low level, X = irrelevant

negative-logic form is the simplest form of the symbol, and illustrates the point that most logic systems are more conveniently represented in terms of negative logic than positive logic.

Part of an array of eight 1K × 1 bit r.a.ms is shown in Fig. 7. The information in one symbol need not be repeated in the others, saving drawing time and space. The precise operation of the circuit is readily discernible from this diagram, whereas prolonged study of the data sheet was necessary to find out precisely how it works — an exercise which illustrates the importance of publishing such symbols for all originators of diagrams to copy.

Timing diagrams

Precise signal flow through digital circuits, including details of clock pulse edges or levels which cause certain actions, can be presented by means of timing diagrams, as shown by Fig. 8, in which the step by step execution of a

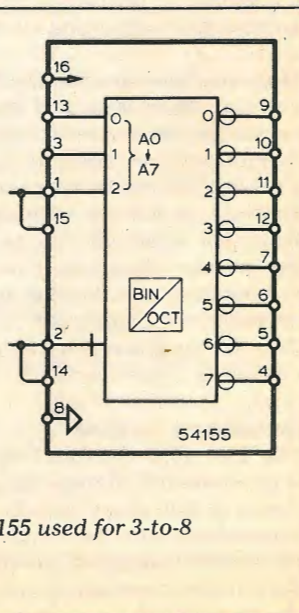


Fig. 4. SN54155 used for 3-to-8 decoding.

program instruction by a mini-computer can be seen. The operation of the circuit at each step is described by the text blocks at the top of the diagram.

The page is usually divided by vertical dotted lines, which represent clock-pulse edges. The circuit and signals contained between these lines shows the circuit configuration, signal values, etc, during that clock pulse. Sequential elements that are triggered by the clock-pulse edge are represented with the line passing through them, the clocking signal being positioned on the dashed line. The state after the clock edge is written to the right. A signal line that crosses a clock edge is not affected by that edge.

The same techniques have been used to draw the block diagram of the computer's control and display panel, showing the computer as a single block, and illustrating the sequence of operation of that peripheral in a much more helpful manner than a plain block diagram giving no sequential information.

The combination of functional symbols with timing diagrams forms a powerful technique, which can even be used for documenting the clock-pulse by clock-pulse operation of minicomputer or microprocessor based systems, the interpretation of these diagrams being easily learned. However, the originators of such drawings must be trained in the techniques.

There is a real danger that the revised IEC standard system of functional logic symbols for digital computing elements will become even more complex than the existing standard. It is vital that rules that are difficult to understand are simplified or replaced, rather than expanded, but for political reasons it is easier to add new rules than to amend or simplify existing rules.

Argument about the shape of AND/OR/INVERT gates is unimportant compared with the vital issue of producing intelligible blocks for digital computing elements, for which purpose rectangular gates seem preferable as in Fig. 7, and have advantages for computer graphics. While recognising slight advantages of shaped gates in some circumstances, it must be accepted that they are a lost cause as far as the IEC standard is concerned.

There is a real danger that the new IEC standard for logic symbols will continue to express simple concepts in a complex and long-winded manner, similar to the current standards.

It is essential that experienced users of digital circuit diagrams, all of whom will sooner or later be affected by the new standard, interest themselves in and contribute constructively to the development and simplification, if

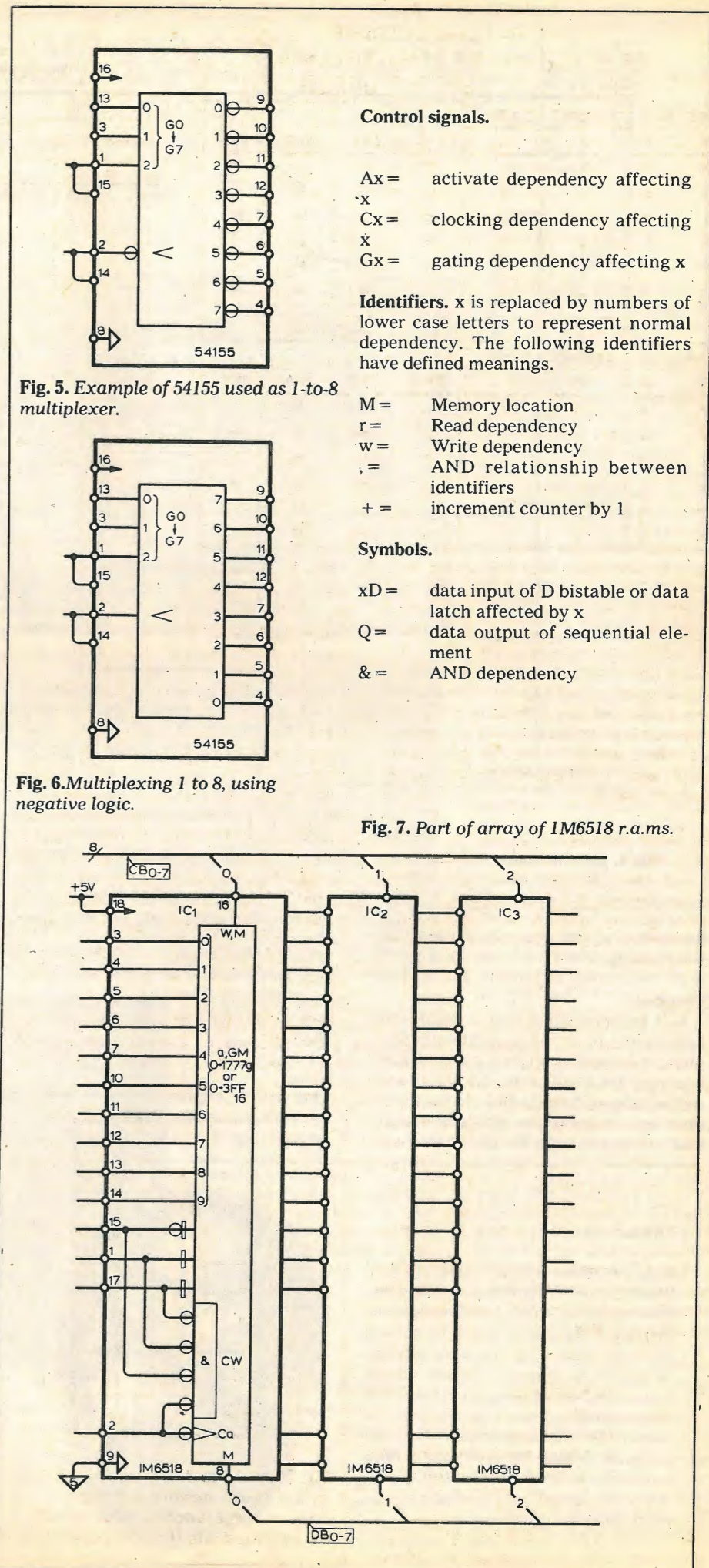


Fig. 5. Example of 54155 used as 1-to-8 multiplexer.

Fig. 6. Multiplexing 1 to 8, using negative logic.

Fig. 7. Part of array of 1M6518 r.a.ms.

Control signals.

- Ax = activate dependency affecting x
- Cx = clocking dependency affecting x
- Gx = gating dependency affecting x

Identifiers. x is replaced by numbers of lower case letters to represent normal dependency. The following identifiers have defined meanings.

- M = Memory location
- r = Read dependency
- w = Write dependency
- , = AND relationship between identifiers
- + = increment counter by 1

Symbols.

- xD = data input of D bistable or data latch affected by x
- Q = data output of sequential element
- & = AND dependency

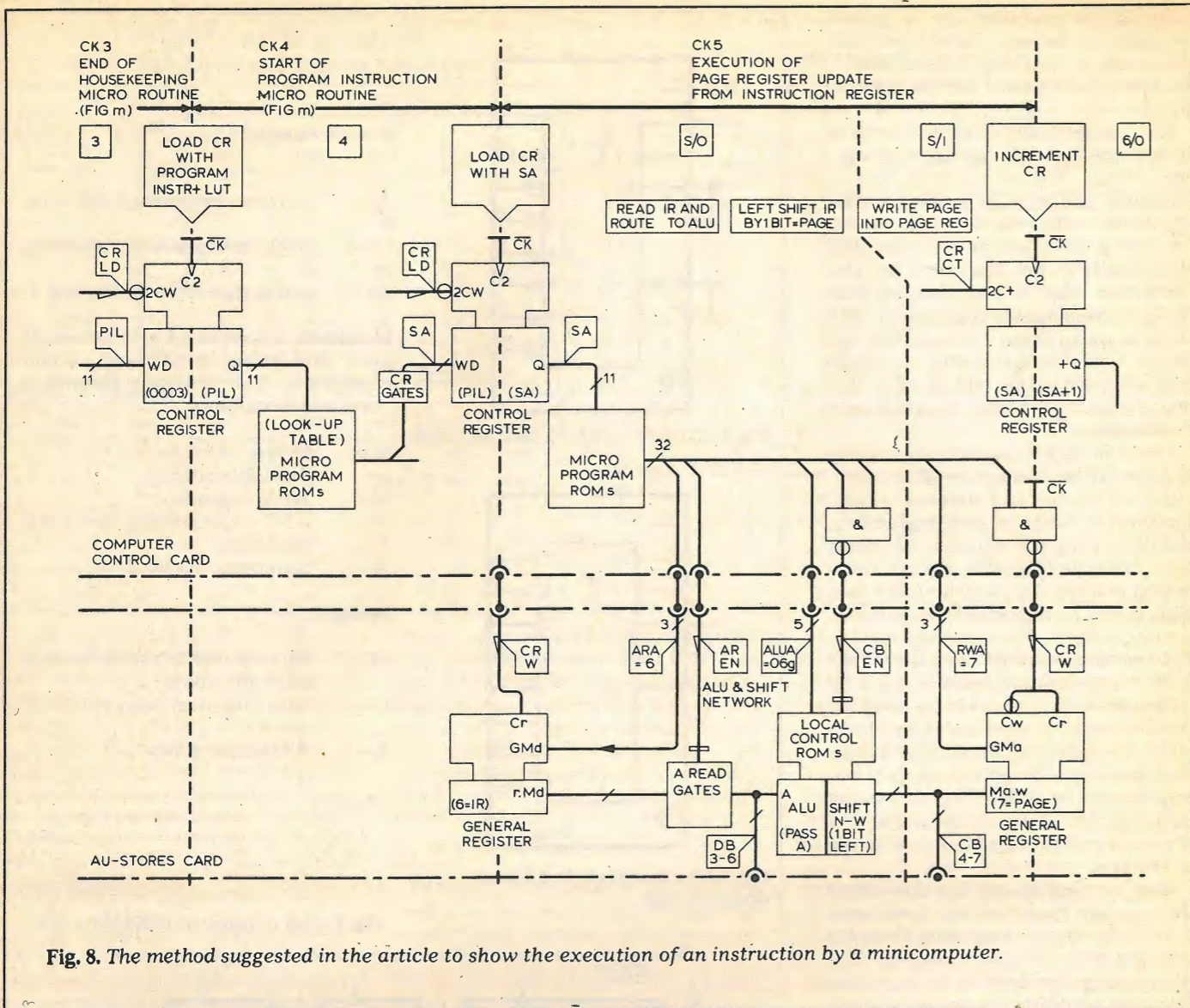


Fig. 8. The method suggested in the article to show the execution of an instruction by a minicomputer.

necessary, of the new standard within the existing framework, as soon as its draft becomes available for public comment.

It is recommended that a team with experience of modern digital techniques, documentation and programmed learning be formed to draw up and publish the standard symbols for available logic elements; to validate, amend and where possible simplify the rules

and definitions so that they are no more complex than necessary to describe the available i.c.s; and to devise a course of programmed learning for use in industry, further education and the Services.

Notes

This article expresses the opinions of the author only and does not necessarily represent the policy of the BS Logic

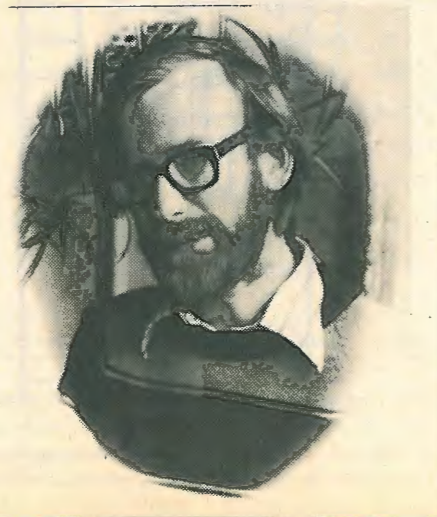
Symbols sub-committee to which he was appointed after it was written. Some symbols used in this article are additional to BS3939, where this has been found necessary for the sake of accuracy and clarity. While they are not necessarily identical to the symbols that will be incorporated in the forthcoming draft of the IEC standard, they illustrate the lines along which it must develop in order to document existing i.c.s.

References

1. IEC, 1975, Graphical symbols for binary logic elements, IEC Publication 117-15.
2. BSI, 1977, Graphical symbols for binary logic elements, BS3939, Section 21, Issue 2.
3. Whittaker, G.M., 1978, Functional Logic Symbols, Ferranti Ltd., Edinburgh, Report No. EIS 840.
4. TI, 1975, TTL Data Book for design engineers, first edition, Texas Instruments.
5. Panavia, 1977, SP-P-0004/A Section 6, Graphics Symbols and reference designators, Part 4, Electronic Symbols, Nato unclassified.

The author

Giles Whittaker was educated at Cranbrook School in Kent and shortly after leaving school took a commission in the Royal Signals, in which he served for three years. After his army service, he went to Aberdeen University, where he took an honours degree in electrical engineering and went immediately to Ferranti, in Edinburgh to join a team of technical writers. Mr Whittaker is now project leader of the team, and is currently concerned with avionics equipment using microprocessors.



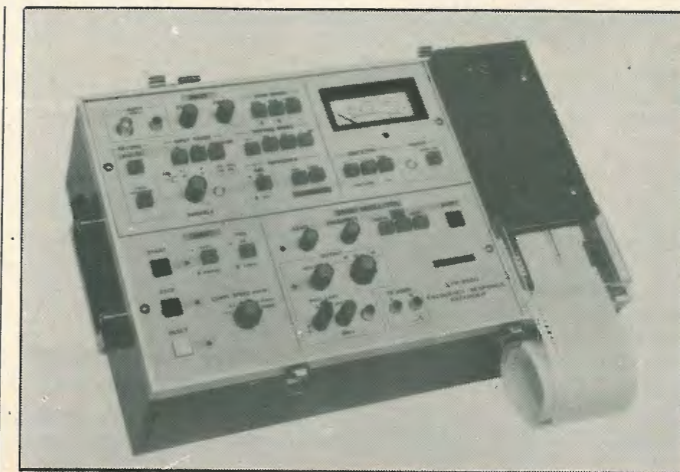
NEW PRODUCTS

Professional readers are invited to enter codes on the reply-paid card bound in at pages 112/3

Frequency-response recorder

A measurement "tool" designed to analyse the performance of audio equipment, which can provide plots of frequency response on either log or linear scales, has recently been produced by Martron Ltd. This frequency-response recorder consists of an audio sweep oscillator and pen recorder, which is linked to a three-way meter, indicating frequency, sweep oscillator output and a.c. input. The LFR-5600 also has display oscilloscope outputs, and automatic start circuitry is included for use with tape recorders. A built-in recorder plots d.c. levels, enabling wow and flutter, drift, and other characteristics to be recorded. Martron Ltd, 20 Park Street, Princes Risborough, Bucks.

WW301

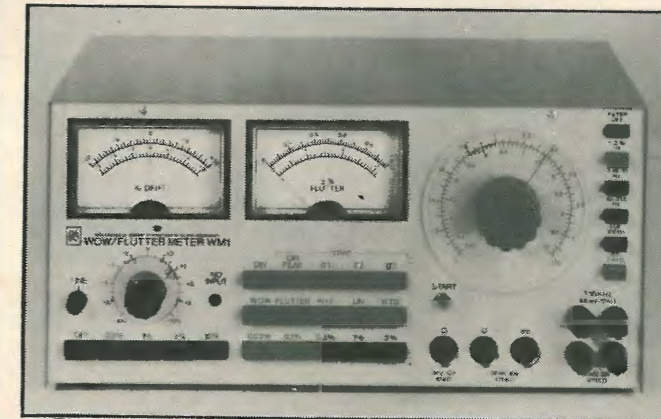


WW301

Wow and flutter meter

A feature of the Bang & Olufsen wow and flutter meter WM1 is a built-in frequency analyser for wow and flutter spectra, covering 1Hz to 316Hz in five ranges. The instrument has two pointer indicators, one for drift measurement from $\pm 0.316\%$ to $\pm 10\%$; and one for wow/flutter from $\pm 0.03\%$ to $\pm 3.16\%$. It has separate filters for wow and flutter measurements, and the f.s.d. of 0.03% in the most sensitive position makes it suitable for work on professional audio equipment. It offers sigma and quasi peak measurements based on 5s or 30s periods in addition to normal peak periods. Input voltage is 3mV to 10mV and there is automatic indication of too low input. Analogue output (to c.r.o. etc) is 1V. Optional extras are t.t.l.-compatible remote control and a crystal controlled reference oscillator. Bang & Olufsen Nederland, Koninginneweg 54, 1241 Kortenhoeft, Netherlands.

WW302



WW302



WW303

Pocket radiotelephone

Cleartone Electronics have just announced their latest hand-portable unit, the Ranger CH800, which operates in the 148-174 MHz band with either 2 or 4 watts output. Cleartone say the equip-

ment is "pocket-sized" (which presumably depends on the size of your pocket), the precise measurements being 151mm x 45mm x 62mm. In addition to its availability in 4 or 6 channel versions, it is housed in a rugged Lexan outer case for protection in harsh environments, and will operate for up to eight hours from its re-chargeable ni-cad batteries. Servicing is apparently easy, with all circuits on one side of a p.c. board, and access to several test points permits unprecedented ease in circuit trouble-shooting. Tone options and accessories are also available, and Cleartone point out that sales and service is available, nationwide. List price is £325. Marketing Dept, Cleartone Electronics Ltd, Abercarn, Gwent, South Wales.

Automatic component bridge

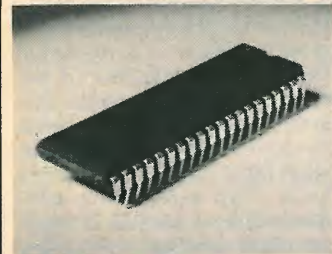
Using a microprocessor as the central calculator, Wayne Kerr's B605 Automatic Component Bridge, which permits the user to "plug in and read," is a further development of some of the company's earlier measuring packages, such as the B424 Component Meter. The intention,

according to the manufacturer, has been to extend typical facilities to achieve a high level of accuracy while maintaining simplicity of operation. The traditional transformer/ratio-arm solution to the bridge problem has given way here to a technique involving an extension of the analogue bridge method. The phase-comparison of two signals results in numerical material which feeds a bridge circuit and a d.v.m. The signals are synthesized by a 32MHz crystal-controlled clock and a divide-by-16 counter, the microprocessor carrying out the final arithmetic. A common measuring chain is used to check the voltage across the "unknown" component and an internal "standard" component, with a guard amplifier ensuring that the parallel voltages are proportional to the magnitude of the unknown impedance. The clock generates 100Hz, 1kHz or 10kHz signals as selected by the operator's front panel settings, and the signal level is adjusted by attenuator to suit the integrator's dynamic range, before being passed to the phase-sensitive detector. The 20 bit resolution of the d.v.m. helps to avoid truncation error problems during the microprocessor's solution of the transformation equations, and the numbers are stored in r.a.m. until all measurements are made and the calculations effected. Briefly, the process can be summarized as a situation where Fourier analysis of each signal using a separately derived phase reference permits measurement of in-phase and quadrature components of the signals, the fifth offset correction then being made and the terms being enumerated in the dual-slope integrating d.v.m. Display is thereafter automatic, given that the correct numerical range has been selected. Resolution is claimed to be an "impressive" 0.0001pF on the C range, and accuracy 0.1% guaranteed across the whole (1 ohm to 1 Megohm) impedance range. Power supplies can be either mains or battery, and the display is liquid crystal rather than l.e.d. in view of the battery option. Price is in the range £1,000 to £1,200. Wayne Kerr, Wilmot Brendon Electronics Ltd, Durban Road, Bognor Regis, West Sussex PO22 9RL.

WW304

Temperature controller chip

Featuring an on-chip power-failure detector, the new General Instruments AY-3-1270 provides control facilities for home heating, cooling, and air conditioning systems. The controller is designed for digital thermometer applications and, in addition to accepting inputs direct from a thermistor temperature sensor, it will drive the display devices without the need for interface circuitry, according to the manufacturer. In the event of power being removed for longer than a specified time, or when



temperatures vary outside normal levels, warning is provided by flashing the display on and off until manually re-set. Temperature sensing error is $\pm 1^\circ\text{C}$ and hysteresis can be set to 0, 0.2, 0.4, 0.8, 2, 4 or 8°C . Power requirements are claimed to be non-critical, 9V at 40mA being all that is required, and typical applications are air conditioning systems, automobile engine temperature measurement, and heater control in addition to boiler and freezer control. The package is a 40 pin dual-in-line type, suitable for use in ambient temperatures from -25°C to $+70^\circ\text{C}$. General Instrument Microelectronics Ltd, Regency House, 1-4 Warwick Street, London W1R 5WB. WW305

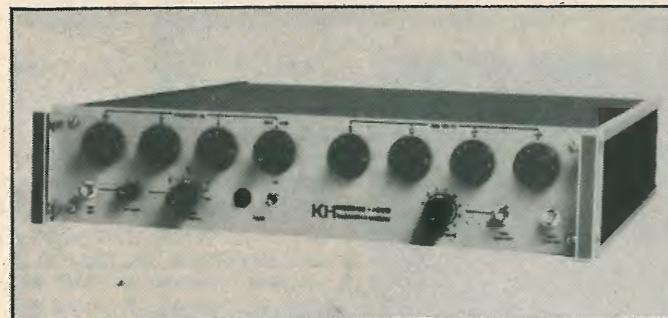
Intelligent primary multiplex analyser

A compact, easy to use microprocessor-based instrument intended for automated voice channel measurements has been developed by Hewlett Packard in their South Queensferry, Scotland plant. Increased speed in circuit checking of multiplexed telephone equipment is one of the claimed advantages of the new unit, and the integrated system, which represents a new concept in automated measurement of voice-channel apparatus, has taken more than five years to develop. Comparable in size with a laboratory oscilloscope, the analyser can sequence through an exhaustive series of tests before calculating and displaying the results automatically. As well as characterising the analogue-to-analogue performance of pulse-code-modulated channel banks, separate tests of analogue to digital and digital to analogue

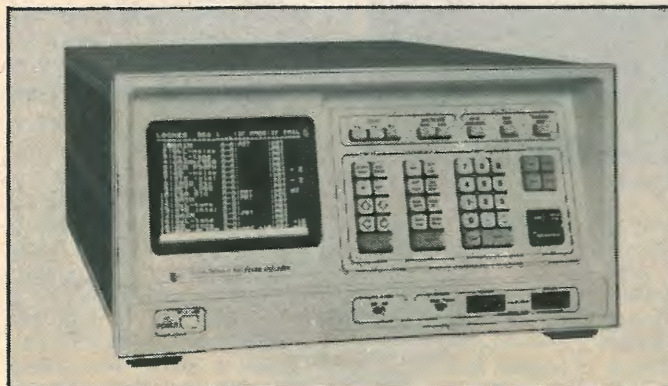
performance can be made, and the unit can be used to check out frequency-division multiplexed terminals and time-division multiplexed switching equipment, including single channel p.c.m. codecs. Standard CCITT measurement masks are stored in r.o.m. and facilities are provided to allow an operator to store alternative masks in non-volatile memory. In order to cover world requirements, two models are being produced. Model HP3779A provides voice channel measurements to CEPT (Conference of European Postal and Telecommunications administrations) recommendations and with a digital option will test p.c.m. equipment conforming to CCITT recommendations G.711 and G.732. This represents 30 voice channels in 32 time slots encoded using the A-law and time division multiplexed into a 2048 k.bit digital stream. The B version is intended for Bell system users, and similarly it may be used to test p.c.m. equipment to CCITT recommendations G.711 and G.733, in other words, 24 voice channels in 24 time slots encoded using the μ -law and time division multiplexed into a 1544 k.bit digital stream. Measurement capability of both versions is available on request. Hewlett Packard Ltd, King St Lane, Winnersh, Wokingham, Berkshire. WW306

Ultra-low distortion oscillator

An ultra-low distortion oscillator intended for critical audio laboratory applications, the 4024A presents typical distortion



WW307

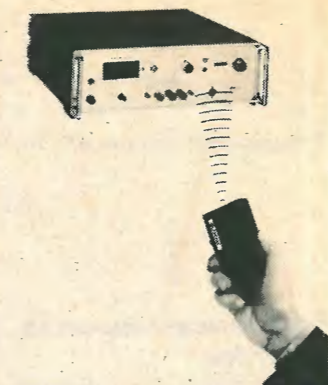


WW306

of less than 0.005% through the entire audio range. Tuning error is 0.5% with re-settability of 0.1%, and the tuning range, selected by three "digit" rotary switches, is 0.001Hz to 100kHz. The main sine wave output is controlled by a four-digit attenuator, providing 1mV resolution and a maximum output of 10V r.m.s. Amplitude stability is better than $\pm 0.1\%$ for a period not exceeding one hour, and in addition to these features, the unit provides a quadrature sine wave output and square pulse output. Amplitude is variable to 10V r.m.s. on "quadrature sine wave," while square wave and pulse output is variable to 5V peak to peak with pulse width variable from $.1\mu\text{s}$ to $100\mu\text{s}$. Keithley Instruments Ltd., 1 Boulton Road, Reading, Berks RG2 0NL. WW307

Remotely controlled power supply

Control of equipment by remote means, mainly using ultrasonics, has become an accepted "stunt" in the domestic tv field. The technique fulfils an industrial function in the remotely controlled power supply from Oltronix of Switzerland, who have recently announced the introduction of their RACPAC DPM. The system differs from the conventional form in that signals are at infra-red level and consist of bi-phase coded, 6-bit pulse sequences, in charge of a digital output panel indicating output ranges of 0 to 32V and 0 to 60V at claimed power outputs of 300, 600 and 900W. Functions controlled are on/off, pre-set output voltage

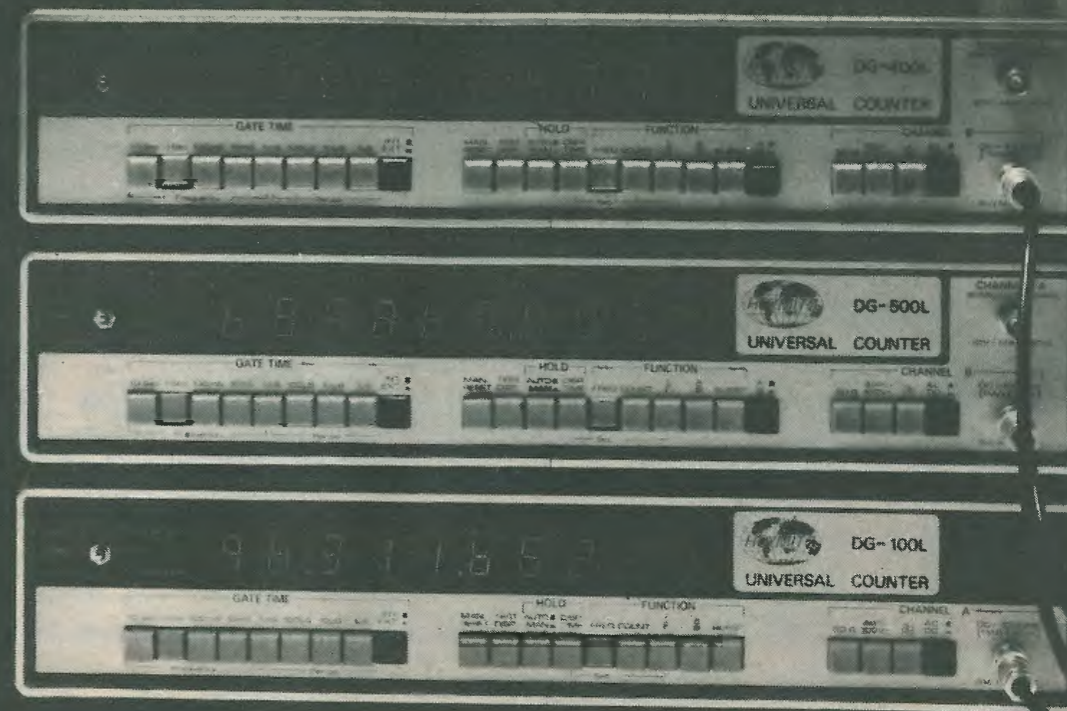


and current (limit) plus several alternative features which can be built in to order by the manufacturer, although we have no information on just what these options might be. The controller is hand-held, battery-operated, and has an operational range of 25 metres; furthermore it seems to be the first unit of its kind to appear, and may well be of interest to laboratory and industrial users. Final price depends upon the range of options selected. UK agents: Wessex Electronics Ltd, 114-116 North Street, Downend, Bristol BS16 5SE. WW308

Production optical fibre

An operationally-proven optical fibre for the domestic and industrial market is available on a four-to-six week delivery basis. Specified as a six-fibre multi-channel cable for high bandwidth applications, the cable is said to save valuable installation time, since it can be laid and spliced in a fraction of the time required for twisted-wire paired cables. The makers, the US Valtec Corporation, say it can be installed with conventional coaxial cable pulling equipment, and each colour-coded sub-channel includes a dielectric strength member which imparts its strength to commercially-available, single-channel connectors. The entire cable is protected in corrugated aluminium sheathing to prevent crushing and the access of moisture. This cable is coded TC-MG-06 and the manufacturer claims a signal-carrying capacity equivalent to 2,100-pair copper wire cable, even though the fibre-optic cable's diameter is only 16.5mm, thereby achieving great savings in duct and storage space as well as transportation costs. Further options include steel sheathing as protection against rodents and copper conductors for electrical transmission. Communications Fibreoptics Division, Valtec Corporation, West Boylston, Ma. 01583, USA. WW309

If you like made to measure . . .



. . . you'll like MTG

— UNIVERSAL TIMER COUNTERS — UNIVERSAL COUNTERS — FREQUENCY METERS —
Professional testing equipment made to measure by
MTG Instruments.

MTG

MTG (Instruments) Ltd.
Bournemouth, England.

Telephone or write today for details,
brochures by return of post.

Beacon House, Christchurch Road, Lansdowne, Bournemouth,
Dorset. BH1 3LB.
Telephone: (0202) 22648.

Overseas Agents and Distributors.

The Netherlands. Reinaert Electronics. Blasiusstraat 14-16. 1091 CR Amsterdam, The Netherlands.
PO Box 4299.

Denmark. Transcan Electric APS. Mollevaenget 15. 2970 Horsholm, Denmark.

Kenya. United Import Agencies. PO Box 43951. Nairobi, Kenya.

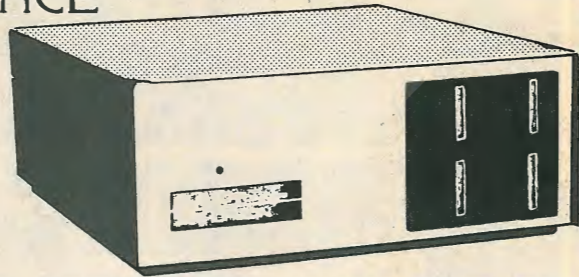
Middle East. EPIC. Electronic Precision Instrument Company, PO Box 1262.
Cairo, Arab Republic of Egypt.

Applications are open for Overseas Agents and Distributors.

NORTH STAR * HORIZON

DOUBLE DENSITY PERFORMANCE at SINGLE DENSITY PRICES.

- * One Double Density Mini Floppy (180K Bytes)
- * 16K Fast RAM
- * Serial I/O Interface
- * DOS/BASIC
- HRZ-16W £1330
- * Z80A Based S100 Bus Expandable System



Send for our
new catalogue
& price list

EXIDY SORCERER

- * Plug in ROM Cartridges
- * S100 Expansion Unit
- * Cassette Interface
- * Z80 C.P.U.
- * User definable graphics



NEWBEAR COMPUTING STORE

Head Office: Bone Lane, Newbury, Berkshire.

Telephone Newbury (0635) 49223

Northern Office: 2A Gatley Road, Cheadle. Tel 061-491-2290

STEVENSON Electronic Components

RESISTORS

Carbon film resistors. High stability. Low noise 5%.

E12 series. 4.7ohms to 10M. Any mix:

each	100+	1000+
0.25W	1p	0.9p
0.5W	1.5p	1.2p

Special development packs consisting of 10 of each value from 4.7ohms to 1 Meg-ohm (650 res.) 0.5W £7.50. 0.25W £5.70.

OPTO

LEDs 0.125in. 0.2in.

Red	TIL209	TIL220	9p
Green	TIL211	TIL221	13p
Yellow	TIL213	TIL223	13p

Clips 3p

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p

METAL FILM RESISTORS

A range of high precision, very high stability, low noise resistors. Rated at 1/4W, 1% tolerance. Available from 51ohms to 330K in E24 series. Any mix:

each	100+	1000+
1/4W	1% 4p	3.5p
		3.2p

Special development pack consisting of 10 of every value from 51ohms to 330K in E24 series. Any mix: (a total of 930 resistors) £23.75

OUR NEW ILLUSTRATED 40 PAGE CATALOGUE CONTAINS A WIDE RANGE OF COMPONENTS INCLUDING:

BOOKS, HARDWARE AND AN EXTENSIVE SELECTION OF PASSIVE COMPONENTS

Send large S.A.E.

TRANSISTORS

AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	LS03	16p
BC147	7p	BFY50	15p	LS04	16p
BC148	7p	BFY51	15p	LS08	16p
BC149	8p	BFY52	15p	LS10	16p
BC158	9p	MJ2955	98p	LS13	30p
BC177	14p	MPSA06	20p	LS14	70p
BC178	14p	MPSA56	20p	LS20	16p
BC179	14p	TIP29C	60p	LS30	16p
BC182	10p	TIP30C	70p	LS32	24p
BC182L	10p	TIP31C	65p	LS37	26p
BC184	10p	TIP31C	65p	LS40	22p
BC184L	10p	TIP32C	80p	LS42	53p
BC212	10p	ZTX107	14p	LS47	70p
BC212L	10p	ZTX108	14p	LS48	48p
BC214	10p			LS54	16p
BC214L	10p			LS73	29p
BC214L	10p			LS74	29p
BC477	19p			LS75	44p
BC478	19p			LS76	35p
BC479	19p			LS78	35p
BC548	10p			LS83	60p
BCY70	14p			LS85	70p

74LS

LS00	16p	LS73	29p	LS156	80p
LS01	16p	LS74	29p	LS157	45p
LS02	16p	LS75	44p	LS164	90p
LS03	16p	LS76	35p	LS174	60p
LS04	16p	LS78	35p	LS175	60p
LS08	16p	LS83	60p	LS190	80p
LS10	16p	LS85	70p	LS192	70p
LS13	30p	LS86	30p	LS193	70p
LS14	70p	LS90	45p	LS196	80p
LS20	16p	LS93	45p	LS251	60p
LS30	16p	LS95	65p	LS257	55p
LS32	24p	LS123	56p	LS258	55p
LS37	26p	LS126	40p	LS266	40p
LS40	22p	LS132	60p	LS283	60p
LS42	53p	LS136	36p	LS290	55p
LS47	70p	LS138	54p	LS365	45p
LS48	48p	LS139	50p	LS366	45p
LS54	16p	LS151	50p	LS367	45p
		LS155	80p	LS368	45p
				LS386	35p
				LS670	180p

TTL

7400	12p	7454	14p	74132	50p
7401	12p	7473	25p	74141	56p
7402	12p	7474	25p	74148	90p
7404	12p	7475	32p	74150	70p
7408	14p	7476	28p	74151	50p
7410	12p	7485	70p	74156	52p
7413	25p	7489	145p	74157	52p
7414	48p	7490	32p	74164	70p
7420	12p	7492	35p	74165	70p
7427	24p	7493	34p	74170	125p
7430	12p	7494	52p	74174	68p
7442	43p	7495	52p	74177	58p
7447	55p	7496	50p	74190	72p
7448	58p	74121	25p	74191	72p
		74122	33p	74192	64p
		74123	40p	74193	64p
		74125	35p	74196	55p
		74126	35p	74197	55p

DIODES

1N914	4p	1N4148	3p
1N4001	4p	1N5401	13p
1N4002	4p	1N5402	15p
1N4004	5p	1N5404	16p
1N4006	6p	1N5406	18p
BZY88series	2V7 to 33V	8p ea.	

LINEAR

LM301AN	28p	NE555	25p
LM318N	125p	NE556	60p
LM324	50p	NE555	120p
LM339	50p	NE567	170p
LM380	120p	SN76003	200p
LM1830	150p	SN76013	140p
LM3900	50p	SN76023	140p
LM3909	60p	SN76033	200p
MC1496	60p	TBA800	70p
MC1458	35p	TDA1022	650p
		ZN414	75p

SKTS

Low profile by Texas.

8 pin	10p	24 pin	24p
14 pin	12p	28 pin	28p
16 pin	13p	40 pin	40p

Soldercon pins: 100:50p. 1000:370p

CMOS

4001	15p	4018	65p	4050	28p
4002	15p	4024	45p	4066	40p
4007	15p	4027	35p	4068	20p
4011	15p	4028	52p	4069	16p
4013	35p	4029	60p	4071	16p
4015	60p	4040	68p	4073	16p
4016	35p	4042	54p	4093	48p
4017	55p	4046	100p	4095	48p
		4049	28p	4510	70p
				4511	70p
				4517	70p
				4518	70p
				4520	65p

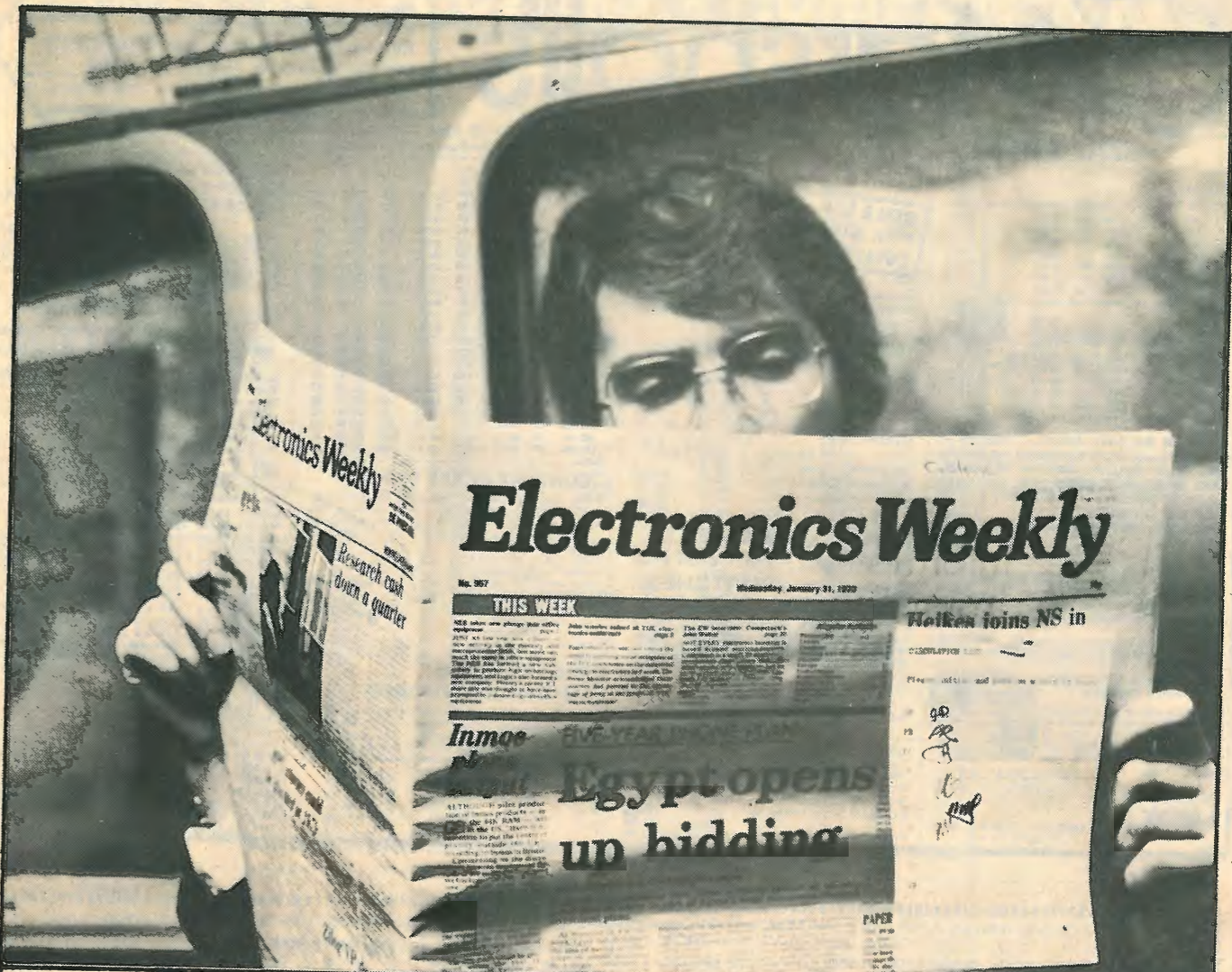
FULL DETAILS IN CATALOGUE!

ORDERS
DESPATCHED
BY RETURN
POST

Quantity discounts on any mix TTL, CMOS, 74LS & Linear circuits: 25+ 10%, 100+ 15%. Prices VAT inc. Please add 30p for carriage. All prices valid to 30th April. Official orders welcome.

BARCLAYCARD & ACCESS WELCOME.

Mail orders to: STEVENSON (Dept WW)
236 High St, Bromley, Kent, BR1 1PQ, England



READ THE NEW NEWS BEFORE IT BECOMES OLD NEWS.

Company news changes fast in the electronics industry - but it can't outpace Electronics Weekly. Mergers, new projects, major policy changes, the battles for markets... the whole electronics business scene is covered week by week; and interviews with leading industrialists provide insights into the way the top companies are developing their business.

You couldn't have a more valuable briefing on the company situation - but its value obviously depreciates if you receive Electronics Weekly late, and are the last to know about developments that may vitally affect your business and your customers.

For only 10p a week you could see Electronics Weekly ahead of everyone. Fill in and post this coupon... and news about your industry will always be new!

To: Subscription Department, IPC Business Press Ltd., Oakfield House, Perrymount Road, Haywards Heath, Sussex.

Please send me Electronics Weekly for a year. I enclose cheque/p.o. for UK £6 (inclusive of p. & p.) Overseas \$15.60, payable to IPC Business Press Ltd.

Name _____

Address _____

Electronics Weekly

Largest range of quality components in the U.K. — over 8,000 types stocked

Marshall's

Retail Sales: London: 40-42 Cricklewood Broadway, NW2 3ET Tel: 01-452 0161/2. Also 325 Edgware Road, W2. Tel: 01-723 4242
Glasgow: 85 West Regent Street, G2 2QD Tel: 041-332 4133 And Bristol: 1 Straits Parade, Fishponds Road, B516 2LX. Tel: 0272 654201

Head Office and Mail Order to Dept. ELK
A. Marshall (London) Ltd.
Kingsgate House, Kingsgate Place
London NW6 4TK. Tel: 01-624 0805
Telex 21442

TRIACS
POWER TRIACS AT UNBEATABLE PRICES
TIC206D 400v 4A £0.60
TIC225D 400v 6A £0.70
TIC226D 400v 8A £0.70
TIC236D 400v 12A £1.00
TIC246D 400v 16A £1.21
TIC253D 400v 20A £1.87
TIC263D 400v 25A £2.27

THYRISTORS
TIC44† 0.6A 30v £0.30
TIC46† 0.6A 100v £0.50
TIC47† 0.6A 200v £0.60
*2N5060 0.5A 25v £0.32
*2N5061 0.5A 50v £0.33
*2N5062 0.5A 100v £0.40
*2N5063 0.5A 150v £0.43
*2N5064 0.5A 200v £0.45
See catalogue for full range.

SOLE U.K. DISTRIBUTORS FOR SIEMENS D.I.L. SWITCHES

The new dual-in-line switch of printed circuits.

The transparent cover protects the contacts against dust.

Voltage rating 24V
Current rating 0.5A

All contact parts are nickel plated and gold plated.

NEW SIEMENS TURN-SLIDE SWITCHES

This new version of the rotary switch is especially suitable for setting programs. The rotary switch is of 1 element no stops.

Voltage rating 60V
Current rating 0.5V
Fixed contacts gold-plated £2.65

DUAL IN LINE PLUGS
These connectors are compatible with conventional AWG26 and AWG28 tape cable on a 1.27mm (0.05") centre spacing. An additional metal latch is provided for strain relief.

Available in 16 and 24 pins.
Price 16 pin DIL £1.60
24 pin DIL £2.00

TRANSISTORS

See catalogue for full range

2N1554	80	2N2195	49	3N154	99	AD143	1.45
2N1553	1.50	2N2194	49	3N159	1.35	AD144	2.85
2N1613	30	2N2217	35	3N187	1.80	AD150	3.10
2N1637	72	2N2218	35	3N200	2.85	AD161	1.00
2N1638	70	2N2218A	30	3N201	1.35	AD162	1.00
2N1711	30	2N2219	38	4N001	1.20	AF106	0.60
2N1889	30	2N2219A	39	4N001A	1.20	AF108	0.62
2N1890	30	2N2220	39	4D232	60	AF114	70
2N1893	30	2N2221	25	4D233	70	AF115	70
2N1907	5.95	2N2221A	25	4D235	65	AF116	70
2N1974	98	2N2222	25	4C181	45	AF117	70
2N1980	45	2N2222A	25	4C182	54	AF118	70
2N1991	1.10	3N01	3.50	4C183	59	BC113	22
2N2060	7.00	3N83	2.25	4C184	59	BC114	22
2N2102	5.00	3N128	1.35	4C176K	70	BC115	22
2N2147	1.35	3N139	1.60	4C176	54	BC116	21
2N2160	1.35	3N140	1.10	ACK187	39	BC118A	22
2N2192	5.8	3N141	95	4C187K	65	BC117	22
2N2193	5.8	3N142	70	4C188	34	BC118	22
2N2194	5.2	3N143	88	4C188K	65	BC119	33
2N2194A	5.2	3N153	1.80	AD124	1.45	BC123	65

NEW LOW PRICE PET 2001-8 Computer

£59.00 VAT inclusive
This super personal computer is based on the MOS Technology 6502 Microprocessor (also used in KIM) and includes internal Memory 8K BYTES (8 K) standard with possibility to expand memory to 32K BYTES in 8K increments. It also provides interface facilities for floppy disc and printer.

NEW LOW PRICE "KIM" The Ready to Use Microprocessor System

Not a kit but supplied fully tested, wired and guaranteed. Expandable Memory that grows with your system just as evaluation kit. Starting with KIM 1 at £107.95 VAT includes you get immediate capability which can be expanded to a complete system capable of addressing up to 8K BYTES of Memory.
KIM 15 EXPANDABLE: Expand as you learn up to 8K. KIM 1 - Basic board with above features assembled. £107.95
KIM 3 - 8K static RAM card plugs into motherboard. £140.35
KIM 4 - Motherboard (takes 8 x KIM 3) + power supply £75.55

CONVERT TV SET TO VDU

The new CRT control chip from Thomson CSF SF96364. Convert your TV set into an electronic VDU - 16 lines x 64 characters - requires RAM character generator and little else for a basic VDU. Available as chip or full display card.
Full cursor control. 5 volts TTL compatible. Line erase, full card includes UART, Modem, Char. gen etc. Comp video out from encoded keyboard in.

TTL See catalogue for full range

74LS00N	£0.26	74LS47N	£1.08	SN74155N	£0.70
74LS01N	£0.26	74LS48N	£1.08	SN74157N	£0.70
74LS02N	£0.26	74LS49N	£1.09	SN74160N	£0.90
74LS03N	£0.26	SN7490AN	£0.36	SN74161AN	£0.90
74LS04N	£0.29	SN7491AN	£0.60	SN74162AN	£0.90
74LS05N	£0.29	SN7492N	£0.36	SN74163AN	£0.90
74LS06N	£0.26	SN7493N	£0.36	SN74164N	£0.90
74LS09N	£0.26	SN7494N	£0.90	SN74500N	£0.77
74LS10N	£0.26	SN7495N	£0.76	SN74501N	£0.77
74LS11N	£0.26	SN7496N	£0.54	SN74504N	£0.94
74LS12N	£0.26	SN7497N	£1.95	SN74510N	£0.77
74LS13N	£0.58	SN74100N	£1.46	SN74511N	£0.77
74LS14N	£0.75	SN74107N	£0.24	SN74540N	£0.77
74LS15N	£0.26	SN74108N	£0.95	SN74546N	£0.77
74LS20N	£0.26	SN74109N	£1.40	SN74555N	£0.77
74LS21N	£0.26	SN74121N	£0.26	SN74557N	£1.70
74LS22N	£0.32	SN74122N	£0.55	SN74511AN	£1.70
74LS23N	£0.32	SN74123N	£0.55	SN745140N	£0.77
74LS24N	£0.26	SN74124N	£1.20	SN745157N	£2.95
74LS28N	£0.29	SN74125N	£0.45	SN745188N	£2.70
74LS29N	£0.26	SN74141N	£0.56	SN745189N	£3.81
74LS32N	£0.27	SN74145N	£0.85	SN745200N	£3.50
74LS33N	£0.29	SN74146N	£1.35	SN745201N	£3.71
74LS37N	£0.32	SN74150N	£0.90	SN745262N	£12.50
74LS38N	£0.32	SN74151N	£0.76	SN745271N	£2.95
74LS39N	£0.48	SN74152N	£0.65	SN745288N	£2.70
74LS42N	£0.26	SN74153N	£0.65	SN745289N	£1.81
74LS42N	£0.26	SN74154N	£1.20	SN745289N	£1.81

PCB MOUNTING KEYBOARD SWITCHES

Digitair is a remarkable new modular electronic switch input component for use with dual in line packages (DIP). The inner construction, in connection with standard TTL-ICs, eliminates more costly and troublesome conductor plate sandwiched switches. Suitable for mounting on "1" matrix boards.

Standard SPST SR	£0.95
or with LED TYPE SR	£1.65

Over 8,000 line items stocked. 4 branches - nationwide. As official distributors for: NATIONAL TEXAS, MULLARD, SIEMENS, SESCOSEM, VERO, ANTEK, SIFAM, ARROW HART, and ELECTROLUBE WE HOLD THE BIGGEST STOCK SELECTION IN THE U.K. Send for our new 1979 catalogue now - 50p inc. P&P.

* MAIL ORDER - Quick service on all orders - Please add 40p per P&P to all orders. Telephone orders on credit cards. £10.00 minimum.

PORTABLE DIGITAL MULTITESTERS COMPLETE WITH CHARGER
Main/battery operated c.w. rechargeable NiCd batteries plus charger. Measures DC AC Volts, ohms and current. Large LCD display, guaranteed one year. Range: Volts DC: AC 0.1, 1, 10, 100, 1,000 Volts. Case optional £ extra.

LOW PRICES
LM3A £88.56 £76.00 (3 digit 1% Acc.)
LM3.5A £102.80 £90.00 (3 1/2 digit 0.5% Acc.)

TRANSISTORISED 3cm RADAR AMPLIFIER SWITCH: with 24v waveguide switch, 9 x 4cm ins. with crystal CV.2355 and spark gap VX.1046. £16.20 + £1.00
TRANSISTORISED VIDEO INDICATOR (used with above amplifier): 1 1/2" C.R.T. £10.80 + £1.00 post.
INSULATION TEST SET 0 to 10 KV, negative earth, with Ionisation Amplifier, 100/230 Volts. AC £45.90, carr. £3.00.
RACAL RA-17 RECEIVER 500KHz-30MHz, s/hand, good condition, £365.00 (including VAT 12 1/2%).
AVO TRANSISTOR ANALYSER CT.446: £37.80, carr. £2.20.
MARCONI FREQUENCY METER 1026/4: 2000-4000MHz 'as new' condition. £32.40 or secondhand condition £24.30.
1026/2: 100-160MHz £32.40 'as new' or s/hand £24.30. Carriage for all type £2.00.
TELEPRINTER TYPE 7B: Pageprinter 24v. d.c. power supply, speed 50 bauds per min. S/hand cond. (excellent), no parts broken £21.60, carriage £3.50.
AUTO TRANSFORMER: 230v. 50c/s, 1000 watts. Mounted in strong steel case 5" x 6 1/2" x 7". Bitumen impregnated. £12.96, carr. £2.00.
CRYSTAL TEST SET TYPE 193: Used for checking crystals in freq. range 3,000-10,000KHz. Mains 230v 50Hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. £27.00, carr. £2.00.
BC-221 FREQUENCY METER: 125-20,000kc/s complete with original calibration charts. £22.50 carr. £3.00.
ANTENNA MAST 36ft: Aluminium base dia. 3" tapering to 2" at top. Complete red hazard lights, stays, guys, etc. Approx. wt. 3 tons. £105. Carr. £10.00.
ADVANCE PLUG-IN UNIT. Sweep delay time base. TG 10287 £75.00 + £2.00 Post.
TELONIC PLUG-IN UNIT. Type L7. £45.00 + £2.00 Post.
FIELD FLUID SAMPLING SET TYPE TP/SKP/10,000 with thermal control millipore oil sampling kit. £125.00. Carriage £4.00.
RING TOROIDAL DUST CORES: Size 2 1/4" outside, 1 1/4" inside, 5/16" thick. Box of two £1.10 + 30p post.
ROTARY INVERTERS TYPE PE-218E: Input 24-28v. d.c. 80 amps, 4,800rpm. Output 115v. a.c. 13 amp 400c/s. 1Ph. P.F.9 £21.60 + £3.00 carr.
R.F. POWER RADIATION METER CT.477. Covering X, S and L bands. £125.00. Carriage £4.00.
RECTIFIER UNIT: 200-250v. a.c. input, 24v. d.c. at 26 amps output continuous rating. £37.80, carr. £5.00.
MARCONI SIGNAL GENERATOR 801/DS: 10-480mHz. £318.60.
ROTARY CONVERTER: 24 volts d.c. input, 230 volts, 100 watts output. £27.50, carriage £4.00.

RADIO TELETYPE TERMINAL SET SG1A 115 volts a.c. £17.50, carriage £3.00.
TELEGRAPH DISTORTION TEST SET (TYPES 5CBV and 5BV) 230v. a.c. £25.00, carriage £3.00.
RESONATOR PERFORMANCE CT.424 8.5 to 9.0 kmc/s 3 cm. £75.00, post £2.00.
INVERTER 24 volts d.c. input 400 cycles 1pH 6600 r.p.m. 200 volts peak. £7.50. £1.50 post.
OXYGEN BOTTLE 1800lb. w.p. £10.00, carriage £3.00.
NOISE SOURCE UNIT with CV.1881 noise source mount. Produces thermal noise 15.5dB 200/250 a.c. £75.00.
LOW SPEED TAPE COMPARATOR (Datronic) 3/4" tape, £45.00, £5 carr.
ADDO 1" TAPE REPRODUCER: £65.00, carriage £5.00.
MUIRHEAD D514 T.M.S.: 12v. d.c. or 100-250v. a.c. volts input. Range 100-40,000Hz. £15.00, carriage £4.00.
AUTOTUTOR MARK II: (Viewer Training Aid) 230v. a.c. Designed for use in intrinsic programming method, info stored on microfilm and projected through optical system onto viewing screen. £120.00.
AVO VALVE TESTER & CHARACTERISTIC METER: £75.00, carr. £5.00.
RANK FLUTTER METER TYPE 1740: £65.00, carr. £4.00.
MICROMETER CONDENSER TYPE C.689: 0-8.5uF precision variable condenser. £35.00, post £2.00.
HS33 HEADSET. Low Imp. £5.00 pair + 75p Post.
MARCONI UNIVERSAL BRIDGE. Type TF868 £85.00. Carr. £4.00.
MUIRHEAD DECADE OSCILLATOR TYPE 890D: £85.00, carr. £5.00.

BARGAIN MAPS
Large stocks of unused U.S.A.F. surplus maps, weather charts, etc. including:-
ONC-E1 - U.K. in full and part N.W. Europe. Scale 1:1,000,000.
JNC-9N - N. Europe, U.K., Scandinavia. Scale 1:2,000,000.
JN-21N - Europe (Mediterranean). Scale 1:2,000,000.
SIZE: 58" x 42", colour. Many others. Please send S.A.E. for list.
Price each 70p (inc. p+p)
25 x Maps (either same type OR assorted) £10.00 + £1.00 p+p.
10 x Maps (either same type OR assorted) £6.00 (inc. p+p).
Above prices include VAT at 8% (except where stated)
Carriage quotes given are for 50-mile radius of Herts.

W. MILLS

The Maltings, Station Road
SAWBRIDGEWORTH, Herts.
Tel: Bishop's Stortford (0279) 725872

To avoid disappointment please telephone to arrange appointment if wishing to view equipment

SEMICONDUCTORS - COMPONENTS

CERAMIC PAK

Containing a range of first quality miniature ceramic capacitors.
1616 - 24 3 of each value - 22pf 27pf 33pf 39pf 47pf 56pf 68pf 82pf 100pf 120pf 150pf 180pf 220pf 270pf 330pf 390pf 470pf 560pf 680pf 820pf 1000pf 1500pf 2200pf 3300pf 4700pf 5600pf 6800pf 8200pf 10000pf 15000pf 22000pf 33000pf 47000pf 56000pf 68000pf 82000pf 100000pf 150000pf 220000pf 330000pf 470000pf 560000pf 680000pf 820000pf 1000000pf 1500000pf 2200000pf 3300000pf 4700000pf 5600000pf 6800000pf 8200000pf 10000000pf 15000000pf 22000000pf 33000000pf 47000000pf 56000000pf 68000000pf 82000000pf 100000000pf 150000000pf 220000000pf 330000000pf 470000000pf 560000000pf 680000000pf 820000000pf 1000000000pf 1500000000pf 2200000000pf 3300000000pf 4700000000pf 5600000000pf 6800000000pf 8200000000pf 10000000000pf 15000000000pf 22000000000pf 33000000000pf 47000000000pf 56000000000pf 68000000000pf 82000000000pf 100000000000pf 150000000000pf 220000000000pf 330000000000pf 470000000000pf 560000000000pf 680000000000pf 820000000000pf 1000000000000pf 1500000000000pf 2200000000000pf 3300000000000pf 4700000000000pf 5600000000000pf 6800000000000pf 8200000000000pf 10000000000000pf 15000000000000pf 22000000000000pf 33000000000000pf 47000000000000pf 56000000000000pf 68000000000000pf 82000000000000pf 100000000000000pf 150000000000000pf 220000000000000pf 330000000000000pf 470000000000000pf 560000000000000pf 680000000000000pf 820000000000000pf 1000000000000000pf 1500000000000000pf 2200000000000000pf 3300000000000000pf 4700000000000000pf 5600000000000000pf 6800000000000000pf 8200000000000000pf 10000000000000000pf 15000000000000000pf 22000000000000000pf 33000000000000000pf 47000000000000000pf 56000000000000000pf 68000000000000000pf 82000000000000000pf 100000000000000000pf 150000000000000000pf 220000000000000000pf 330000000000000000pf 470000000000000000pf 560000000000000000pf 680000000000000000pf 820000000000000000pf 1000000000000000000pf 1500000000000000000pf 2200000000000000000pf 3300000000000000000pf 4700000000000000000pf 5600000000000000000pf 6800000000000000000pf 8200000000000000000pf 10000000000000000000pf 15000000000000000000pf 22000000000000000000pf 33000000000000000000pf 47000000000000000000pf 56000000000000000000pf 68000000000000000000pf 82000000000000000000pf 100000000000000000000pf 150000000000000000000pf 220000000000000000000pf 330000000000000000000pf 470000000000000000000pf 560000000000000000000pf 680000000000000000000pf 820000000000000000000pf 1000000000000000000000pf 1500000000000000000000pf 2200000000000000000000pf 3300000000000000000000pf 4700000000000000000000pf 5600000000000000000000pf 6800000000000000000000pf 8200000000000000000000pf 10000000000000000000000pf 15000000000000000000000pf 22000000000000000000000pf 33000000000000000000000pf 47000000000000000000000pf 56000000000000000000000pf 68000000000000000000000pf 82000000000000000000000pf 100000000000000000000000pf 150000000000000000000000pf 220000000000000000000000pf 330000000000000000000000pf 470000000000000000000000pf 560000000000000000000000pf 680000000000000000000000pf 820000000000000000000000pf 1000000000000000000000000pf 1500000000000000000000000pf 2200000000000000000000000pf 3300000000000000000000000pf 4700000000000000000000000pf 5600000000000000000000000pf 6800000000000000000000000pf 8200000000000000000000000pf 10000000000000000000000000pf 15000000000000000000000000pf 22000000000000000000000000pf 33000000000000000000000000pf 47000000000000000000000000pf 56000000000000000000000000pf 68000000000000000000000000pf 82000000000000000000000000pf 100000000000000000000000000pf 150000000000000000000000000pf 220000000000000000000000000pf 330000000000000000000000000pf 470000000000000000000000000pf 560000000000000000000000000pf 680000000000000000000000000pf 820000000000000000000000000pf 1000000000000000000000000000pf 1500000000000000000000000000pf 22000

9072

We thought that might make you stop and look at our ad. Now that you have stopped why don't you take advantage of our keen competitive prices and place an order with us. You could save yourself ££££s.

Table listing various electronic components such as Transistors, Bridge Rec, Mirrors, Diodes, Thyristors, and Linear ICs with their respective part numbers and prices.

STRUTT ELECTRICAL & MECHANICAL ENGINEERING LTD. Telex 45263

3C Barley Market St., TAVISTOCK, DEVON, PL19 0SF. Tel: Tavistock 0822 5439

WW - 072 FOR FURTHER DETAILS

Table listing various electronic components such as Linear, LM380, SN76013ND, TBA700, LM381N, SN76023ND, TBA7200, LM382, SN76033ND, TBA7500, LM391, SN76227N, TBA800, LM555, SN76281B, TBA810, LM70705, SN76228N, TBA820, LM710DIL, SN76287N, TBA9200, LM723T05, SN76660N, TCA2700, LM723DIL, TAA300, TCA2750, LM733, TAA350, TCA4500A, LM741, TAA550, TDA1008, LM748, TAA570, TDA1034, LM748A, TAA661B, TDA2002, LM1303N, TAA700, TDA2020, LM1458, TAA790, TDA2100, LM1308, TAD100, XR2206, LM3900, TAD110, XR2207, LM3909N, TBA120T, XR2208, MC1310P, TBA4800Q, XR2216, MC1312P, TBA5200Q, XR2567, MC1314P, TBA5300Q, XR4136, LM301AN, MK50398, TBA540, XR4202, LM304, MM5314, TBA550Q, XR4212, LM307N, MM5316, NE529K, XR4739, LM308T05, NE529K, NE555, ZN414, LM308DIL, NE555, 95H90, LM309K, NE555, 25p, TBA641A12, LH310T05, NE555, 80p, LM317K, NE562B, 400p, LM324, SAD1024, 1500p, LM339, SL1978, 650p, LM339, SN76003N, 110p, LM348N, SN76013N, 110p

T. POWELL 306 St Paul's Road London N1 Telephone 01-226 1489

RADIO SHACK LTD for DRAKE. Advertisement for Radio Shack Ltd featuring a TR-7 Transceiver and a list of products. Includes contact information for Radio Shack Ltd at 188 Broadhurst Gardens, London NW6 3AY.

WEST HYDE BOCON BOPLAST advertisement. Features images of BOCON and BOPLAST components, a large 'WH' logo, and detailed text describing the products. Includes a table of dimensions and prices for various BOCON and BOPLAST models.

WEST HYDE DEVELOPMENTS LIMITED, Unit 9, Park Street Industrial Estate, AYLESBURY, BUCKS. HP20 1ET. Phone: Aylesbury (0296) 20441. Telex: 83570

LYNWOOD ELECTRONICS advertisement. Features an image of a Leisure Series electronic timer and text describing its features and price. Includes contact information for Lynwood Electronics at 20 Stourcliffe Avenue, Bournemouth BH6 3PT.

SINCLAIR PRODUCTS advertisement. Lists various electronic components and kits such as Battery Eliminator Kits, T-DEC and CSC Breadboards, and TV Games. Includes contact information for Sinclair Products.

J.P.S. ASSOCIATES advertisement. Features the slogan 'we wondered why....' and lists various electronic modules and components. Includes contact information for J.P.S. Associates at Belmont House, Steele Road, Park Royal, London NW10 7AR.



NRDC-AMBISONIC UHJ



SURROUND SOUND DECODER

The **first ever** kit specially produced by Integrex for this British NRDC backed surround sound system which is the result of 7 years' research by the Ambisonic team. W.W. July, Aug., '77.

The unit is designed to decode not only UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections.

The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

Complete kit, including licence fee **£49.50 + VAT**
or ready built and tested **£67.50 + VAT**

NEW S5050A STEREO AMP

50 watts rms-channel. 0.015% THD. S/N 90 dB, Mags/n 80 dB.

Tone cancel switch. 2 tape monitor switches.

Complete kit only **£63.90 + VAT.**

Wireless World DolbyTM noise reducer

Trademark of Dolby Laboratories Inc.



Featuring:

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

Typical performance

Noise reduction better than 9dB weighted. Clipping level 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output

Dynamic Range >90dB

30mV sensitivity.

Complete Kit **PRICE: £43.90 + VAT**

Also available ready built and tested **Price £59.40 + VAT**

Calibration tapes are available for open-reel use and for cassette (specify which) **Price £2.40 VAT ***

Single channel plug-in DolbyTM PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components **Price £9.00 + VAT**

Single channel board with selected fet **Price £2.75 + VAT***

Gold Plated edge connector **Price £1.75 + VAT***

Selected FETs **65p** each + VAT, **110p** + VAT for two, **£2.10** + VAT for four.

Please add VAT @ 12½% unless marked thus*, when 8% applies (or current rates)

We guarantee full after-sales technical and servicing facilities on all our kits, have you checked that these services are available from other suppliers?



Please send SAE for complete lists and specifications

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

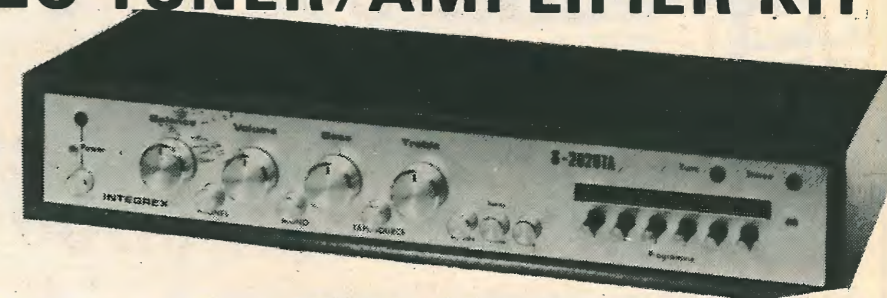
INTEGREX LTD.

INTEGREX

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET

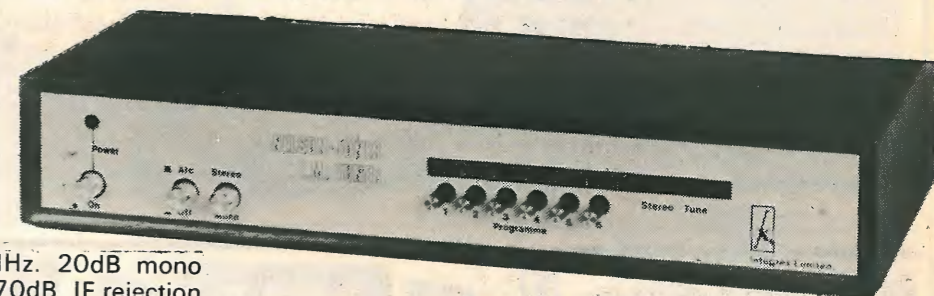
A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.



Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88-104MHz. 30dB mono S/N @ 1.2µV. THD 0.3%. Pre-decoder 'birdy' filter. **PRICE: £59.95 + VAT**
Nelson-Jones Mk. 2 Stereo FM Tuner Kit. Price: **£69.95 + VAT.**

NELSON-JONES MK. I STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.



Brief Spec. Tuning range 88-104MHz. 20dB mono quieting @ 0.75µV. Image rejection - 70dB. IF rejection - 85dB. THD typically 0.4%. IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price.



Sens. 30dB S/N mono @ 1.2µV
THD typically 0.3%

Tuning range 88-104MHz
LED sig. strength and stereo indicator

Mono **£36.40 + VAT**
With ICPL Decoder **£40.67 + VAT**
With Portus-Haywood Decoder **£44.20 + VAT**

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET HF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter. Push-button tuning

PRICE: Stereo £33.95 + VAT

S-2020A AMPLIFIER KIT

Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring. Power 'on/off' FET transient protection.



Typ Spec. 24+24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £35.95 + VAT

BASIC NELSON-JONES TUNER KIT	£15.70 + VAT	PHASE-LOCKED IC DECODER KIT	£4.47 + VAT
BASIC MODULE TUNER KIT (stereo)	£18.50 + VAT	PUSH-BUTTON UNIT	£6.00 + VAT
PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT			£8.80 + VAT

WW - 055 FOR FURTHER DETAILS

Z & I AERO SERVICES LTD.
 Head Office: 44a WESTBOURNE GROVE, LONDON W2 5SF
 Tel. 727 5641 Telex 261306

RETAIL SHOP
 85 TOTTENHAM COURT ROAD, W.1
 Tel. 580-8403

SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS



TYPE U4313
 Sensitivity D.C. 20,000 o.p.v.
 Sensitivity A.C. 2,000 o.p.v.
 D.C. Current 60µA-1.5A
 A.C. Current 0.6mA-1.5A
 D.C. Volts 75mV-600V
 A.C. Volts 15V-600V
 Resistance 1K-1M
 Capacity 0.5µF
 Accuracy 1.5% D.C. 2.5% A.C.

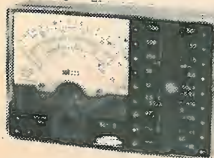
Price complete with pressed steel carrying case and test leads
 Packing and postage

£10.50
 £1.50



TYPE U4324
 D.C. Current: 0.06-0.6-60-600mA-3A
 A.C. Current: 0.3-3-30-300mA-3A
 D.C. Voltage: 0.6-1.2-3-12-30-60-120-600-1200V
 A.C. Voltage: 3-6-15-60-150-300-600-900V
 Resistance: 500Ω-5-50-500KΩ
 Accuracy: D.C. 2.5% A.C. 4% (of F.S.D.)

PRICE complete with test leads and fibreboard storage case **£9.50**
 Packing and postage **£1.20**



TYPE U4323 COMBINED WITH SPOT FREQUENCY OSCILLATOR

Sensitivity: 20,000Ω/V
 Voltage ranges: 2.5-1000V A.C./D.C.
 Current ranges: 0.05-500mA D.C. only
 Resistance: 5Ω-1MΩ
 Accuracy: 5% F.S.D.
 Oscillator output: 1kHz 50/50 squarewave
 465KHz sinewave modulated by 1KHz squarewave

PRICE, in carrying case, complete with leads and manual **£8.00**
 Packing and postage **£1.00**



TYPE U4341 COMBINED MULTIMETER AND TRANSISTOR TESTER

Sensitivity: 16,700Ω/V D.C., 3,300Ω/V A.C.
 Current: 0.06-0.6-6-60-600mA D.C., 0.3-3-0-30-300mA A.C.
 Voltage: 0.3-1.5-6-30-60-150-300-900V D.C.
 1.5-7.5-30-150-300-750V A.C.
 Resistance: 2-20-200KΩ-2MΩ
 Transistors: Collector cut-off current 60µA max
 D.C. current gain 10.350 in two ranges

PRICE, complete with steel carrying case, test lead, battery and instruction manual **£9.50**
 Packing and Postage **£1.50**

THIS OFFER IS VALID ONLY FOR ORDERS ACCOMPANIED BY REMITTANCE WHICH SHOULD INCLUDE DELIVERY CHARGES AS INDICATED AND 8% V.A.T. ON THE TOTAL.

OUR 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE SEND P.O. for £0.30 FOR YOUR COPY

WW-054 FOR FURTHER DETAILS



ORBAN from USA
 Dual channel multispring reverb unit. Each channel features four springs — far smoother than single spring systems. "Twang" and "boing" are virtually eliminated by incorporating a floating threshold limiter. Bass, mid-range EQ and bandwidth controls. The best compact reverb unit available.

ITAM 882
 New Stereo Mixer, built to a specification not a price! Ultra low noise, -128dB. 8 inputs+8 direct outputs, 2 outputs with VU meters. 2 limiters. XLR mic inputs (balanced). 3 band EQ + mid sweep. **£395+VAT**

ITAM Graphic Equalizer
 A fully professional graphic equalizer at a reasonable price. Stereo, with 10 bands per channel, 19 inch rack mounting. **£280 + VAT.**

AMPEX ATR-700
 Now every studio can afford legendary Ampex performance and reliability. Fully professional specification including balanced inputs/outputs, Cannon connectors, variable tape speed, sel sync. The price will fit this year's budget, not next year's! Sole distribution by ITA.

OTARI DP4050 OCF IN CASSETTE DUPLICATOR
 Now with 3 1/2 + 7 1/2 master capability and Ferrite heads. Duplicates 6 cassettes each run at 8 times speed. Over 80 stereo C60 per hour. Unquestionably the finest in cassette copier available from the world's largest duplicator manufacturer.

QUAD
 The new 405 power amplifier is now in stock. 100 watts per channel — simply the best, for £££'s less! Immediate Delivery!

OPTOELECTRONICS

RED £0.10	HP5082-7730 £1.15
GREEN £0.19	DL704 £1.15
YELLOW £0.18	FND507 £1.05
RED £0.14	DL704 Economy £0.75
GREEN £0.19	DL707 Economy £0.75
YELLOW £0.18	

DISPLAYS

74 Series TTL

7400 0.12	7473 0.27	74153 0.85
7401 0.12	7474 0.27	74154 1.05
7402 0.15	7475 0.33	74155 0.70
7403 0.12	7476 0.25	74156 0.70
7404 0.15	7480 0.50	74157 0.65
7406 0.25	7482 0.73	74160 0.70
7407 0.25	7483 0.60	74161 0.95
7408 0.14	7485 1.05	74162 0.75
7409 0.18	7486 0.30	74163 0.75
7410 0.12	7489 2.45	74164 0.85
7411 0.18	7490 0.34	74165 0.85
7412 0.20	7491 0.75	74166 1.25
7413 0.36	7492 0.45	74167 2.95
7420 0.12	7493 0.45	74173 1.45
7425 0.25	7494 0.90	74174 1.05
7427 0.25	7495 0.55	74175 0.90
7430 0.12	7496 0.55	74176 1.05
7432 0.27	74100 1.35	74177 0.95
7437 0.27	74104 0.45	74180 1.10
7438 0.27	74105 0.45	74181 2.10
7440 0.12	74107 0.35	74182 1.20
7441 0.49	74121 0.30	74185 2.10
7442 0.50	74122 0.40	74190 1.05
7445 0.60	74123 0.52	74191 1.05
7446 0.60	74125 0.45	74192 0.95
7447 0.55	74126 0.55	74193 0.95
7448 0.50	74132 0.85	74194 0.95
7450 0.12	74136 0.75	74195 0.95
7451 0.15	74141 0.60	74196 0.95
7453 0.15	74145 0.70	74197 0.95
7460 0.15	74150 0.90	74198 1.95
7472 0.27	74151 0.55	74199 1.95

C-MOS

4000 0.18	4046 1.35
4001 0.16	4047 0.95
4002 0.16	4048 0.90
4007 0.16	4049 0.90
4010 0.45	4050 0.90
4011 0.15	4059 0.25
4012 0.15	4070 0.25
4013 0.38	4076 0.20
4014 0.90	4078 0.20
4015 0.90	4082 0.95
	4083 1.25
	4084 1.00
	4085 1.00
	4086 0.70
	4089 0.25
	4099 0.25
	4101 0.25
	4102 0.25
	4103 0.25
	4104 0.25
	4105 0.25
	4106 0.25
	4107 0.25
	4108 0.25
	4109 0.25
	4110 0.25
	4111 0.25
	4112 0.25
	4113 0.25
	4114 0.25
	4115 0.25
	4116 0.25
	4117 0.25
	4118 0.25
	4119 0.25
	4120 0.25
	4121 0.25
	4122 0.25
	4123 0.25
	4124 0.25
	4125 0.25
	4126 0.25
	4127 0.25
	4128 0.25
	4129 0.25
	4130 0.25
	4131 0.25
	4132 0.25
	4133 0.25
	4134 0.25
	4135 0.25
	4136 0.25
	4137 0.25
	4138 0.25
	4139 0.25
	4140 0.25
	4141 0.25
	4142 0.25
	4143 0.25
	4144 0.25
	4145 0.25
	4146 0.25
	4147 0.25
	4148 0.25
	4149 0.25
	4150 0.25
	4151 0.25
	4152 0.25
	4153 0.25
	4154 0.25
	4155 0.25
	4156 0.25
	4157 0.25
	4158 0.25
	4159 0.25
	4160 0.25
	4161 0.25
	4162 0.25
	4163 0.25
	4164 0.25
	4165 0.25
	4166 0.25
	4167 0.25
	4168 0.25
	4169 0.25
	4170 0.25
	4171 0.25
	4172 0.25
	4173 0.25
	4174 0.25
	4175 0.25
	4176 0.25
	4177 0.25
	4178 0.25
	4179 0.25
	4180 0.25
	4181 0.25
	4182 0.25
	4183 0.25
	4184 0.25
	4185 0.25
	4186 0.25
	4187 0.25
	4188 0.25
	4189 0.25
	4190 0.25
	4191 0.25
	4192 0.25
	4193 0.25
	4194 0.25
	4195 0.25
	4196 0.25
	4197 0.25
	4198 0.25
	4199 0.25

RAM

2102 450 nSec. £1.40

Linear

380 14 Pin DIL £1.05
381 14 Pin DIL £0.00
387 8 Pin DIL £0.75
555 8 Pin DIL £0.30
565 14 Pin DIL £1.10
567 8 Pin DIL £1.40
741 8 Pin DIL £0.20
741 TO5 £0.25
748 8 Pin DIL £0.35
3048 14 Pin DIL £0.75
3130 8 Pin DIL £0.95
3140 8 Pin DIL £0.85
3140 TO5 £0.80
3900 14 Pin DIL £0.60
301 8 Pin DIL £0.30
308 8 Pin DIL £0.90
377 14 Pin DIL £1.40
378 14 Pin DIL £1.90
379 14 Pin DIL £2.20

C7205EN MULTITESTER 20,000 OPV £9.75 P&P 75p

LB1 TRANSISTOR/DIODE TESTER £19.95 P&P 75p

IT 1/2 20,000 OPV £11.95 P&P 75p

TE200 R.F. SIGNAL GENERATOR £57.00 P&P £1.25

TMK500 MULTITESTER 30,000 OPV £20.95 P&P 75p

LT101, 1,000 OPV £6.95 P&P 75p

ELECTRO-TECH COMPONENTS LTD.
 364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667
 CALLERS WELCOME

1-7 Harewood Avenue, Marylebone Road, London NW1.
 Tel: 01-724 2497 Telex: 21879

FRANCE: Son Professionnel, 2 Rue des Tennerolles,
 92210 Saint Cloud (Paris). Tel. 602 6815.

MARCONI TEST EQUIPMENT

TF791D Deviation meter
 TF455E Wave analyser. New. **£135**
 TF1101 RC oscillators. **£65**
 TF1099 20MHz Sweep generators
 TF1041 B & C. VT Voltmeters
 TF1102 Amplitude modulator. 500MHz
 TF1020A Power meter. 100W. 250MHz. **£85**
 TF1152A/1 Power meter. 25W. 500MHz. **£75**
 TF890A/1 RF test set. **£425**
 TF801B/3S Signal generator. **£175**
 TF1064B/5 VHF. FM Signal generator
 TF1400 Pulse generator
 TF675F Pulse generator
 TF1370 Wide-range RC oscillator. **£125**
 TF2162. MF Attenuator
 TF1058 UHF/SHF signal generator
 TF995A/4. AM/FM signal generator
 TF1066 AM/FM signal generator
 MARCONI TF144H/4 Signal Generator

ADVANCE CONSTANT VOLTAGE TRANSFORMERS

Input 190-260V AC. Output constant
 220 Volts. 250W. **£25** (£2 carriage)

PYE RESISTANCE BOXES

5 decade resistance boxes measuring from 11.111
 ohm to 0.001 ohm. **£20**

NICKEL CADMIUM BATTERIES

Size 'D' (HP2) 4 A.H. **£2** (pp. 20p)
 Size 'F' 6.00 A.H. **£2.75** (pp. 25p)

POWER SUPPLIES

FARNELL Switching power supplies 5VDC. 1KW
 ADVANCE RMA20. 0-7V @ 20 Amps. **£39**
 Both brand new, boxed, with book.
 APT 1045918. 12.5V-14.5V DC @ 5A **£25**
 APT10459/13. 24V (var) 5A **£25**
 (All items + £1 carr.)

BECKMAN TURNS COUNTER DIALS

Miniature type (2.2mm diam.). Counting up to
 15 turn "Helipot". Brand new with mounting
 instructions. Only **£2.50 each**.

Wandel & Gottman Equipment

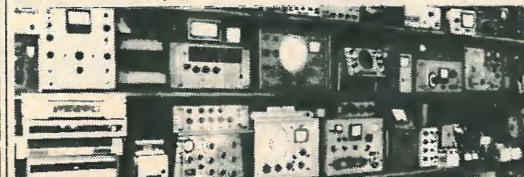
Level Meter 0.2-1600KHz
 Level Oscillator 0.2-1600KHz
 Level Transmitter 0.3-1350KHz
 Carrier Frequency Level Meter

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1
 TEL: 01-723 8753

TEST EQUIPMENT

ADVANCE Q-Meter type T1 **£85**
 GAUMONT-KALEE Flutter Meter
 HEWLETT-PACKARD 302A Wave-Analyser
 RACAL type 801R. 100MHz digital frequency meter
 TEXSCAN X-Y oscilloscope. 9-inch CRT
 TELETYPE ASR33 now in stock
 SOLARTRON 1420. 2 digital voltmeter. 6 ranges to 1KV
 BOONTON 80 Signal generator. 2-400MHz **£105**
 BOONTON 230A RF Power Amplifier **£325**
 BPL Capacitance decade (5) CD133. 100pF-1uF **£45**
 GERTSCH Frequency meter and deviation meter 20-1000MHz
 HEWLETT-PACKARD 695A Sweep oscillator
 HEWLETT-PACKARD Sweep oscillator **£350**
 DERRITRON. Digital Wheatstone Bridge **£110**
 MUIRHEAD K-134-A Battery op. wave analyser
 WEINSHEL Power Supply Modulator M03



BRUEL & KJOER Vibration equipment 1018
 BRUEL & KJOER Frequency analyser 2105
 BRUEL & KJOER Microphone amplifier 2603 **£195**.
 BRUEL & KJOER Type 3301 Automatic frequency response
 recorder 200Hz. **£750**.
 MUIRHEAD-PAMETRADA D489EM Wave Analyser
 TEKTRONIX 555 scope with plug-ins types CA (2 off), 21, 22
 TEKTRONIX 515A Oscilloscope
 TEKTRONIX 545 main frames. **£210**. Choice of plug-in units
 extra
 TEKTRONIX 585A oscilloscope with '82' P.I. DC-80MHz
 TEKTRONIX type 561A DC-10MHz **£350**
 TELEQUIPMENT DM53A Storage oscilloscope
 TEKTRONIX 556. 50MHz oscilloscope

NOTICE. 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 our three months' guarantee. Calibration and
 certificates can be arranged at cost. Overseas enquiries:
 welcome. Prices quoted are subject to an additional 8% VAT.

ROHDE & SCHWARZ EQUIPMENT

HUZ Field Strength Meter. 47-225MHz.
 AMF TV. Demodulator 55-90MHz.
 Selective UHF v./meter, bands 4&5 USVF.
 Selectomat. RF Voltmeter. USWV. BN 15221

Standard attenuator. 0-100dB, 0-300MHz. DPR. **£450**
 UHF Sig. gen. type SDR 0.3-1 GHz **£750**
 UHF Signal generator type SCH. **£175**
 UHF Test receiver type USVD **£325**
 POLYSKOP SWOB 1.

KROHN-HITE 10-Watt Amplifier DC-1MHz

GR Impedance Bridge type 1650A **£175**

SPECTRAL DYNAMICS SD104/5 SWEEP GENERATOR

Sine/Square/Triangle outputs. Linear & Log
 Sweeps. Sweep rate 0.001Hz/sec to 1KHz/sec.
 Metered frequency indication **£250**

'CENTAUR' INSTRUMENT COOLING FANS

Made by Rotron Holland. These are very high
 quality, quiet running fans, specially designed for
 the cooling of all types of electronic equipment.
 Measures 4.5 x 4.5 x 1.5in. 115V AC. 11 Watts.
 The list price of these is over £10 each.
 Also 230V. AC available. 115V. **£4.50**
 (postage 25p). 230V **£5**

TEKTRONIX TYPE 556 OSCILLOSCOPE WITH TYPES 1A1 and 1A2 PLUG-IN UNITS. First-class condition throughout.

BRYANS 21000 Auto Plotter. X-Y-T Recorder

PACE ELECTRONICS VARI PLOTTER
 Type 1100E **£175**

MUIRHEAD DECADE OSCILLATORS Type 890A.
 1Hz-110KHz in four decade ranges. Scope
 monitored output for high accuracy of
 frequency. Excellent generator.

15 - 240 Watts!

HY5
 Pre-amplifier

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

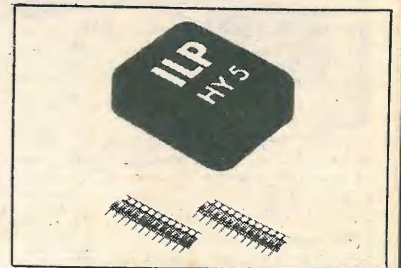
FEATURES: Complete pre-amplifier in single pack -- Multi-function equalization -- Low noise -- Low distortion -- High overload -- two simply combined for stereo.

APPLICATIONS: Hi-Fi -- Mixers -- Disco -- Guitar and Organ -- Public address.

SPECIFICATIONS:

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

ACTIVE TONE CONTROLS: Treble - 12dB at 10kHz. Bass - at 100Hz.
DISTORTION: 0.1% at 1kHz. Signal/Noise Ratio 68dB
OVERLOAD: 38dB on Magnetic Pick-up. **SUPPLY VOLTAGE:** 16.50V
Price £6.27 + 78p VAT. P&P free.
 HY5 mounting board B1 48p + 6p VAT P&P free.



HY30
 15 Watts into 8Ω

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

FEATURES: Complete kit -- Low Distortion -- Short, Open and Thermal Protection -- Easy to Build.
APPLICATIONS: Updating audio equipment -- Guitar practice amplifier -- Test amplifier -- Audio oscillator.

SPECIFICATIONS:

OUTPUT POWER: 15W R.M.S. into 8Ω. **DISTORTION:** 0.1% at 15W.
INPUT SENSITIVITY: 500mV. **FREQUENCY RESPONSE:** 10Hz-16kHz -- 3dB.
SUPPLY VOLTAGE: ±18V.
Price £6.27 + 78p VAT. P&P free.



HY50
 25 Watts into 8Ω

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

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

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

SPECIFICATIONS:

INPUT SENSITIVITY: 500mV.
OUTPUT POWER: 25W RMS into 8Ω. **LOAD IMPEDANCE:** 4-16Ω. **DISTORTION:** 0.04% at 25W at 1kHz.
SIGNAL/NOISE RATIO: 75dB. **FREQUENCY RESPONSE:** 10Hz-45kHz -- 3dB.
SUPPLY VOLTAGE: ±25V. **SIZE:** 105 x 50 x 25mm.
Price £8.18 + £1.02 VAT. P&P free.



HY120
 60 Watts into 8Ω

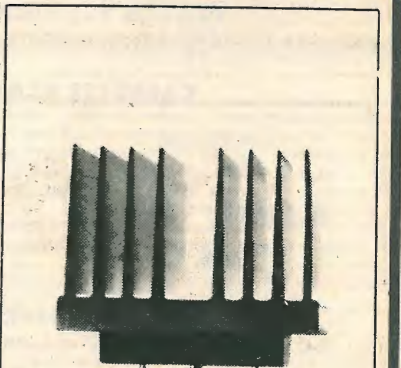
The HY120 is the baby of I.L.P.'s new high power range designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.

FEATURES: Very low distortion -- Integral Heatsink -- Load line protection -- Thermal protection -- Five connections -- No external components.

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

SPECIFICATIONS:

INPUT SENSITIVITY: 500mV.
OUTPUT POWER: 60W RMS into 8Ω. **LOAD IMPEDANCE:** 4-16Ω. **DISTORTION:** 0.04% at 60W at 1kHz.
SIGNAL/NOISE RATIO: 90dB. **FREQUENCY RESPONSE:** 10Hz-45kHz -- 3dB. **SUPPLY VOLTAGE:** ±35V.
Size: 114 x 50 x 85mm.
Price £19.01 + £1.52 VAT. P&P free.



HY200
 120 Watts into 8Ω

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

FEATURES: Thermal shutdown -- Very low distortion -- Load line protection -- Integral Heatsink -- No external components.

APPLICATIONS: Hi-Fi -- Disco -- Monitor -- Power Slave -- Industrial -- Public address.

SPECIFICATIONS:

INPUT SENSITIVITY: 500mV.
OUTPUT POWER: 120W RMS into 8Ω. **LOAD IMPEDANCE:** 4-16Ω. **DISTORTION:** 0.05% at 100W at 1kHz.
SIGNAL/NOISE RATIO: 96dB. **FREQUENCY RESPONSE:** 10Hz-45kHz -- 3dB. **SUPPLY VOLTAGE:** ±45V.
SIZE: 114 x 100 x 85mm.
Price £27.99 + £2.24 VAT. P&P free.

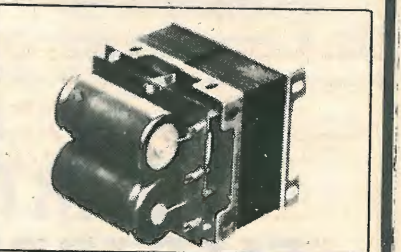
The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power, levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family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

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

APPLICATIONS: Public address -- Disco -- Power slave -- Industrial

SPECIFICATIONS:

OUTPUT POWER: 240W RMS into 4Ω. **LOAD IMPEDANCE:** 4-16Ω. **DISTORTION:** 0.1% at 240W at 1kHz.
SIGNAL/NOISE RATIO: 94dB. **FREQUENCY RESPONSE:** 10Hz-45kHz -- 3dB. **SUPPLY VOLTAGE:** ±45V.
INPUT SENSITIVITY: 500mV. **SIZE:** 114 x 100 x 85mm.
Price £38.61 + £3.09 VAT. P&P free.



HY400
 240 Watts into 4Ω

POWER SUPPLIES

PSU36 suitable for two HY30's **£6.44 + 81p VAT**
 PSU50 suitable for two HY50's **£8.18 + £1.02 VAT**
 PSU70 suitable for two HY120's **£14.58 + £1.17 VAT**
 PSU90 suitable for one HY200 **£15.19 + £1.21 VAT**
 PSU180 suitable for two HY200's or one HY400 **£25.42 + £2.03 VAT**

TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS

I.L.P. Electronics Ltd.

Graham Bell House
 Roper Close
 Canterbury
 Kent CT2 7EP
 Tel (0227) 54778

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



SOFTY the all in one Development And Training Aid with Software-Firmware Copier and Programmer

- ★ Execute programmes on TV screen by resident micro-processor programme will halt and display contents of all internal registers at set break points.
- ★ Develop your firmware on TV screen with true memory mapped hex display with block shifts, displacement calculations, insertion and deletion, byte matching and other assembler functions.
- ★ Produce your firmware with high speed on board EPROM programmer, approx. 2 mins. for 2708. Also handles 2704 and 2716.
- ★ Replaces monitor or debug programme.
- ★ Plus many other standard features including high speed cassette interface and user programmable function keys.
- ★ Universal Monitor which can be directly connected to ANY external microprocessor in system situ for firmware development (written by resident micro and executed by external micro).

SOFTY is equivalent to Development Systems costing thousands of pounds. Yet **SOFTY** only costs you for kit and full instructions **£99.95 plus VAT**, built and tested -- **£145 plus VAT**. Full details available on request or send cheque or P.O. to:

VIDEOTIME PRODUCTS
 56 Queen's Road, Basingstoke, Hants RG21 1REA
 Tel: (0256) 56417. Telex: 858747.

We welcome Barclay & Access Orders by telephone. (Trade and Export enquiries welcome).

WW-105 FOR FURTHER DETAILS

ASTONISHING STEREO DISC AMPLIFIER 2

FOR BROADCASTING, DISC MONITORING AND TRANSFER WITH THE HIGHEST QUALITY. Stereo Disc Amplifier 2 is a self-contained mains-powered unit which accepts cartridge inputs and produces balanced line level outputs. Permanent rumble filtering and switched scratch filtering is included.

FURTHER SPECIFICATIONS: (For THD, Static and Dynamic IMD, Cartridge impedance interaction, etc. see December, page 122).

1kHz at 6mV set for 0dBV. 7 output, loaded 600 Ohms	
Frequency Response Accuracy relative to inverse of IEC98-4 record characteristic	
30Hz-20kHz	Within 0.5dB
Low Frequency Response	
18dB/octave	3dB at 24Hz
High Frequency Filter	
Front panel switch	10kHz, 18dB/octave
Change in response at 8kHz or below	Less than 0.5dB
Noise	20Hz-20kHz
Short circuit input	mean rtd. CCIR468 2 wtg and peak meter
High inductance cartridge, 1H + 1kOhm	-74dBV.7
R.F. immunity in a carrier field strength of +100dBμV/m, 84MHz, 100% amplitude modulated by 1kHz sine wave	-66dBV.7
	-60dBV.7
Output level	Less than 70dBV.7
Outputs Electronically balanced	Source impedance 50 Ohms, protected against mains or static voltages applied to lines

1) Outlet Distribution Amplifier 2 * Peak Programme Meter, moderate, single and twin, and PPM, IEC/65-10A Drive Circuits * Peak Deviation Meter * Programme and Deviation Chart recorders.

SURREY ELECTRONICS

The Forge, Lucke Green, Cranleigh, Surrey GU6 7BG. Tel. 04866 5997

CONNECTORS
CANNON
PAINTON
BELLING LEE
PLESSEY
GREENPAR
AMPHENOL

1,000s in stock from:

Servo and Electronic Sales
SERVO AND ELECTRONIC SALES LTD.
 24 HIGH STREET, LYDD, KENT TN29 9AJ
 TELEPHONE: LYDD (0679) 20252. TELEX: 965265 AB SERVOE G

sanwa from: **Quality Electronics Limited**
 At above address

J. L. Linsley-Hood High Quality Cassette Recorder



We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily built and tested layout. All these features added to the high quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust Alloy record/play head, available separately at £7.60 plus VAT, but included FREE as part of the complete kit at £81.50 plus VAT.

TEST CASSETTE TC1

Special Hart Copyright test tape makes it easy to set up VU level, head azimuth and tape speed, without test instruments. Suitable for any cassette recorder. Complete with instructions £2.50 inc VAT.

VFL 910. Vertical Front Loading Cassette Mechanism. Features include: Tape counter, record, interlock, FG servo drive motor, full auto-stop pause control, muting switch, oil damped cassette door, 0.9% W&F, fitted with HS15 head. Limited supplies. £31.99.

OPTIONAL EXTRAS. Set of six knobs. £1.49. Auto-stop reed and mounting kit. £0.90.

PLASTIC ESCUTCHEON

Suitable for CRV and CT4 mechanisms. As used on our cassette recorder, complete with mounting screws £1.99 plus VAT.

CASSETTE HEADS

A large range of cassette heads for domestic, industrial and audio visual purposes is available from us. The very best stereo head that we can find is our HS15 Sendust Alloy Super Head. This has an even better high frequency response than our HS14 which it replaces. Unlike cheaper and ferrite types this excellent high frequency performance is combined with a high output, thus maintaining the best possible signal to noise ratio. Price £7.60 plus VAT. 4-TRACK Record/play head. Scans all 4 tracks on cassette tape. Suitable for auto-reverse mechanisms, film sync, quadrophonics and many other purposes. Standard impedance £7.40 plus VAT. Full details of these and other heads are in our lists.

LENCO CASSETTE MECHANISMS

We hold stocks of Lenco tape transports for all uses, we can also supply spare parts. For example: CRV Motors complete £4.00 plus VAT. CRV Drive Belts 90p plus VAT.

CASSETTES

Our laboratory tests on recorders made us realise how important the choice of cassette is. Wow and flutter is obviously affected by the quality of the housing but the performance differences caused by the tape are enormous. It is possible to record a signal at the same level on two different cassettes one of which will replay at a VU level 10db higher than the other. Poor tape can also lose all signals above 8KHz! These tests enable us to offer what we think is the best value available. The tape is a Super Ferric High Energy Low Noise formulation.

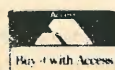
- C90 80p } Complete with library case and index card
- C60 60p }
- C10 35p } Complete in library case. Suitable for Micro Programming.

ALL UK ORDERS ARE POST FREE
Please send 9x4 SAE for lists giving fuller details and price breakdowns.

HART ELECTRONICS

Penylan Mill, Oswestry, Salop

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



WHARFEDALE SPEAKER KITS

At what must be the LOWEST PRICE EVER!

Three fantastic, unrepeatable offers on high quality, famous Wharfedale speaker kits. Each kit comes complete with speaker chassis, crossover units, hardware and comprehensive easy-to-assemble cabinet instructions, template, etc (no cabinets supplied).

WHARFEDALE DENTON 2XP SPEAKER KIT

Impedance 4-8 ohms. Maximum input 25 watts DIN per channel. Typical enclosure size 355 x 246 x 222 mm. Frequency response in typical enclosure: 65-20,000 Hz DIN.

Kit comprises: Two 8" base drive units, two 2-way crossover units, two tweeters. Assorted hardware. Instruction manual and template. Price £24.95 per pair. Plus post and pack £2.50

WHARFEDALE LINTON 3XP SPEAKER KIT

Impedance 4-8 ohms. Maximum input 30 watts DIN per channel. Typical enclosure size 476 x 264 x 240 mm. Frequency response in typical enclosure: 50-20,000 Hz DIN.

Kit comprises: Two 8" base drive units, two 4" mid-range units, two tweeters, two 3-way crossover units, assorted hardware. Instruction manual and template. Price £37.95 per pair plus post and pack £2.50

WHARFEDALE GLENDALE 3XP SPEAKER UNIT

Impedance 4-8 ohms. Maximum input 40 watts DIN per channel. Typical enclosure size 560 x 305 x 265 mm. Frequency response in typical enclosure: 50-1,900 Hz + 3 dB.

Kit comprises: Two 10" base drive units, two 4" mid-range drive units, two tweeters, two 3-way crossover units, assorted hardware. Instruction manual and template. Price £54.95 per pair. Plus post and pack £2.50

ALL UNITS SUPPLIED FULLY GUARANTEED Also available from all our branches. HI-FI CARE (RETAIL) LTD. 249, 7, 242, 227 and 231 Tottenham Court Road, London, W1, England

MAIL ORDER DEPT. WW4 Phone 01-580 4534 and 01-580 7592. Access and Barclaycard orders can be made by telephone on 01-580 4534.

Cheques made payable to HI-FI Care (Retail) Ltd. Postal address: Hi-Fi Care (Retail) Ltd. Dept. WW, 245 Tottenham Court Road, London W1P 9AD

LEADING SPECIALISTS IN CARTRIDGES, STYLIS AND AUDIO ACCESSORIES

Audio Moduler

Build your system of make add-ons with SESCOM audio modules.

Pre-amplifiers	Equalizers	Other Modules	Accessories
LA-3 Line Amplifier Transformer Balanced 600 ohm output	PCF80 Active (bass, mid-range, treble) high pass filter, low pass filter.	EF37A Line amp, power amp, compressor, sine wave oscillator, plug-in power supply.	ES1 Sheet metal, sockets, slide pots.
PS-1 Power Supply 24 volts DC regulated 120/240 VAC input	EF37A Line amp, power amp, compressor, sine wave oscillator, plug-in power supply.	EF37A Line amp, power amp, compressor, sine wave oscillator, plug-in power supply.	EF37A Line amp, power amp, compressor, sine wave oscillator, plug-in power supply.

SEND FOR YOUR FREE COPY OF OUR NEW CATALOG

Quality Engineered Sound Products

SESCOM INC. P.O. Box 590, 12931 Building Ave., Gardena, CA 90247 U.S.A. (213) 770-3510, (800) 421-1828, TWX (910) 346-7023

SW-008 FOR FURTHER DETAILS

Samson's (ELECTRONICS) LTD.

9 & 10 CHAPEL ST., LONDON, N.W.1
01-723 7851 01-262 5125
ADJACENT TO EDGWARE ROAD MET. LINE STATION

PLEASE ADD 8% TO ALL ORDERS INC. CARR.

CURRENT RANGE OF NEW L.T. TRANSFORMERS OPEN TYPE TAG CONNECTIONS ALL PRIMARIES 220-240V

Type	Sec Taps	Amps	Price	Carr.
1	24-30-40-48-60	12	£29.74	£2.00
2	24-30-40-48-60	10	£26.25	£2.00
3	24-30-40-48-60	8	£23.85	£1.75
4	24-30-40-48-60	5	£13.95	£1.75
5	24-30-40-48-60	3	£10.54	£1.00
6	24-30-40-48-60	2	£7.60	£1.00

6-8-10-12-16-18-20-24-36-40-48-60V CAN BE OBTAINED FROM THE ABOVE RANGE

7	19-25-33-40-50v	10	£23.25	£2.00
8	19-25-33-40-50v	6	£15.66	£1.50
9	19-25-33-40-50v	3	£8.45	£1.25
10	19-25-33-40-50v	2	£7.60	£1.00

5-7-8-10-13-15-17-20-25-30-40-50V OR 25-0-25V OR 20-0-20V CAN BE OBTAINED FROM THE ABOVE RANGE

11	12-15-20-25-30v	10	£16.75	£1.75
12	12-15-20-25-30v	5	£8.25	£1.25
13	12-15-20-25-30v	2	£5.27	£1.00

14	12-24v	12v 60A, 24v 30A	£34.20	£3.00
15	12-24v	12v 30A, 24v 15A	£17.25	£2.00
16	12-24v	12v 20A, 24v 10A	£13.95	£2.00
17	12-24v	12v 10A, 24v 5A	£7.95	£1.00
18	12-24v	12v 4A, 24v 2A	£4.03	£1.00

19	15-20-24-30v	2	£4.95	£1.25
20	50V CT	1	£3.75	£1.00
21	60V CT	1	£3.75	£1.00
22	50V CT	3	£8.95	£1.25
23	60V CT	2 1/2	£9.95	£1.25
24	6v twice each	4	£2.00	50p
25	12v twice each	2	£2.50	75p
26	28-32v	4	£6.50	£1.25

AUTO STEPDOWN TRANSFORMERS FOR AMERICAN EQUIPMENT

240-110V 80-2250 WATTS Fully shrouded, fitted with American two or three pin socket outlet and three core 240V mains lead. Send for latest price list. American plugs, sockets, adaptors also available.

AUTO STEPDOWN TRANSFORMERS
Open frame type by famous makers. Tapped 240-220-100-110-120V 750 watts, £10 carr. £2.50 watts £7.50 carr. £2. Top panel connections.

ISOLATION TRANSFORMERS FRACTION OF MAKERS PRICE.
Pri. 240v. Sec. 240v. 3,000 watts enclosed in steel case £60 carr. £5. Pri. 200-220-240v. Sec. 240v. 700 watts. Open type. Cable end connections £12.50 carr. £2. Pri. 240v. Sec. 220-240v. 500 watts. Open type top panel connections £8.50 carr. £1.50.

PARMEKO ISOLATION TRANSFORMERS 240-110V

Ex-equipment, perfect condition. Metal shrouded case. Table top connections. Pri. tapped 190-200-210-220-230-240-250-260v. Sec. 125v 13A £35 carr. £4. Pri. tapped 200-210-220-230-240-250v. Sec. tapped 90-100-110-120v 7.5A £19.50 carr. £2.

HEAVY DUTY CT. LT. TRANSFORMERS

Pri 220-240V Sec 70-0-70V 10 amps. Open frame C Core type. Size 7x7x6ins. Top panel connections £27.50 carr. £3. Pri. 120-240V Sec 60-0-60V 10 amps. Open frame type. Size 6x6x6ins. Cable lead connections £22.50 carr. £3. Pri. 220-240V Sec 100-0-100V 8 amps. C Core type. Size 9x8x7ins. Top panel connections £27.50 carr. £3.

SPECIAL PURCHASE BY FAMOUS MAKERS

L.T. TRANSFORMERS IDEAL FOR UP-TAKE POWER SUPPLY CIRCUITS
No 1 GRESHAM Pri. 240V Sec. 43v 3amp. Fully tropicalised. Open type wire connections £3.95 pp 75p. No 2 HINCHLEY Pri. 240V Sec. 33v 5amps and 18-0-18v 1A. Tropicalised open frame. Wire connections. Two in series will give 33-0-33v 5A and 18-0-18v 2A £3.95 pp 75p. No 3 PARMEKO Pri. 240V Sec. 30v 5A and 12v 2amps. Table top connections £4.95 pp £1.

LOW POWER L.T. TRANSFORMERS BY FAMOUS MAKERS. ALL PRIMARIES 240V. TAG OR LEAD CONNECTIONS
No 1 20v 3A £3.75 pp 75p. No 2 27v 1A £1.50 pp 50p. No 3 12v 1 1/2A and 24v 1/2A. 2 separate windings £1.50 pp 50p. No 4 12v 1A. £1 pp 50p. No 5 20v 1A £1.50 pp 50p. No 6 55v 1/2A and 6.3v 1/2A £1.50 pp 50p. No 7 24v 1A shrouded type £1.50 pp 50p. No 8 13v 3A and 15v 1A 2 separate windings C core type. £3.80 pp £1. No 9 15v 1A 2.5A 3.5A 250v 80M/A 3 separate windings £3.50 pp £1. No 10 27v 1.8A 9v 1.8A 3.1A 3 separate windings £3.80 pp £1. No 11 13-0-13v 1A £2.50 pp 50p.

LT. SMOOTHING CHOKES
4.8M/H 10 amps £4, pp £1. 150M/H 3amps £3.50, pp £1. 100M/H 2amps potted type £2.50, pp £1. 13M/H 1.5amps potted type £1.50, pp 50p. 2+2M/H 1.2amps £2, carr. £1. C core types 10M/H 25amps £8.50, carr. £2. 18M/H 10amps £4.50, carr. £1.50. Gardner 50M/H 10amps open type top panel connections £8.50, carr. £2.

NEW "C" CORE TRANSFORMERS BY FAMOUS MAKERS. FRACTION OF LIST PRICE. UNNEEPALE OFFER ALL PRIMARIES 220-240V

No 1 Sec. 15v. 40A £18.75 carr. £3. No 2 sec. 12v 40A £17.50 carr. £3. No 3 sec. 15-0-15v 9v 4 times. 19v 6A. 27-0-27v 1.3A. 27 x 1.8A separate windings £8.95, carr. £2. No 4 Sec. 12.6v 5.75A £4.75 pp £1. No 5 11.6v 3.5A £3.50 pp £1. No 6 17.5v 1A three times £4.50 pp £1. No 7 12.3v 10A. and 30-0-30v 15A £4.95 pp £1. No 8 12.3v 5A and 30-0-30v 250m/a £3.75 pp £1. No 9 Sec. 18-22-27v 250m/a twice £2.50 pp 75p. No 10 Sec. 24v 480m/a twice. 6.3v 5A and 128v 6m/a £4.50 pp £1. All above transformers are conservatively rated.

HEAVY DUTY LT TRANSFORMERS OPEN FRAME TYPE TERMINAL TAG CONNECTIONS

ALL PRIMARIES 220-240V No 1 Sec. 17v+2v+1 1/2v+1 1/2v separate windings all at 20A £9 pp £2. No 2 Sec. 17v+2v+1 1/2v+1 1/2v separate windings all at 10A £6 pp £1.50. No 3 Sec. 30v 6A £8.50 pp £1.75. No 4 Sec. 65v 2.2A and 30-0-30v 100m/a £3.95 pp 75p.

AEI 20 AMP CONTACTORS

Coil voltage 110v AC. No 1, 2 make, 2 break; No 2, 4 makes; No 3, 3 makes, 1 break. Brand new box. Fraction of makers price £1.25 pp fixing, 7 amp contacts by famous makers. No 1 240v AC 300 95p. No 2, 240v AC 200 85p. No 3, 240v AC 100 75p. No 4, 110v AC 200 65p. No 5 24v DC 200 75p. No 6, 12v DC 200 75p. 150 per relay. Single top panel relays 6v DC 100. Size 1 1/4in. 3/4in dia. 60pp PP 15p.

AC WKG BLOCK CAPACITORS BY FAMOUS MANUFACTURERS

MFD	Volts	Price
75	440VAC	50p
1	470VAC	60p
1.25	400VAC	65p
2.4	360VAC	75p
2.5	360VAC	75p
2.7+0.1	700VAC	£1.25
3	440VAC	£1.00
3.5	250VAC	£1.00
4	250VAC	£1.00
5	360VAC	£1.25
6	440VAC	£1.50
7.2	440VAC	£1.50
8.4	440VAC	£1.00
15	250VAC	£1.75

PP up to 2.5 MFD 25p, 2.7 to 15MFD 50p+8% on total.

BLOCK PAPER CAPACITORS
6 MFD 300v wkg. AC. £1 pp 25p. 6 MFD 350v DC wkg. 75p pp 25p. 1 MFD 1,500v DC wkg. 60p pp 25p. 0.1 MFD 3,000v DC wkg. 50p pp 25p.

"C" CORE LT. TRANSFORMERS NEW SURPLUS BY FAMOUS MAKERS.

ALL PRIMARIES 220-240V. No 3 18-0-18v 12.5A £12.50 carr. £2. No 4 Sec. 1 tapped 22-23-24-25-26-27v. 6A Sec. 2 20-21-22-23-24-25v 3 1/2A. Sec. 3 18-19-20-21-22-23-24. Sec. 4 11-12-13-14-15-16v 1/2A. Sec. 5 11-12-13-14-15-16v 1/2A. Sec. 6 100-0-100v 150m/a £12.00 carr. £3. No 6 Sec. 25-28v 5A. Sec. 2 26v 2 1/2A. Sec. 3 26v 2 1/2A. Sec. 4 24v 1A. Sec. 5 16v 1A. Sec. 6 12v 1A. Sec. 7 6.3v 3A. Sec. 8 6.3v 3A. Sec. 9 5.7A 128-0-120v 14M/A. £4.75 pp £1.25. No 10 11.6v 3.5A £3.50 pp £1. No 11 10.7v 5.1A three times £4.50 pp £1.25. No 11 23-0-23.5v. 0-11A £1.50 pp 75p. No 12 12v 1A 22v 1.4A. 21v 0.7A. £2 pp 75p. No 13 15v 0.5A. 6.4v 0.3A. £2 pp 75p. No 14 10-0-10v 0.47A. 28-21-0-21-28v 0.37A. £2 pp 75p.

LT. TRANSFORMERS NEW SURPLUS FAMOUS MAKERS. FRACTION OF MAKER'S PRICE

No 1 Pri 115-220-240v. sec. 10v 7v 20A open type tag board connections £8.95 carr. £1.50. No 2 Pri. 115-220-240v. sec. 9.3v 7A and 25v 0.8A open type tag board connections £4.75 carr. £1.50. No 3 Pri. 115-220-240v. sec. 9v 2A and 9v 1A open type terminal block connections £2.50 pp £1. No 4 Pri 230v sec. 90v 1.1A open type tag board connections £3.00 pp £1. No 5 Pri. 120-240v sec 13v 3A and 15v 1A open type terminal block connections £3.00 pp £1. No 6 Pri 240v sec. 30v 5.5A and 12v 2.2A open type table top connections £5.75 carr. £1.50. No 7 Pri 230v sec. 24v 3.5A and 12v 2.2A potted type £3.00 pp £1. No 8 Pri 220-240v. sec. 6v 1A twice shrouded GPO type £2.00 pp 75p. No 9 Pri. 110-220-240v. sec. 1.3v 1.8A, sec. 2 9v 1.8A, sec. 3 27v 1.8A. 9-12-27-30-36-39v 1.8A can be obtained, open type table top connections. £3.75 pp 75p. No 10 Pri. 220-240v sec. 10v 1.5A and 50v 0.6A £3.50 pp 75p.

H.T. TRANSFORMERS BY FAMOUS MAKERS. ALL PRIMARIES 240V

Type MT33 300-0-300V 150MVA. 6.3v ct 4A 5-5.3v 3A. £4.50 pp £1. MT12. Sec 300-0-300V 20MVA. 6.3v ct 4A. 5-5.3v 2A. £4.00 pp £1. MT11. Sec. 300-0-300V 100MVA. 6.3v 3.5A 5v 2A or 6.3v 1A £3.75 pp £1. MT7. Sec. 350-0-350V 100MVA. 6.3v 3.5A 5v 2A or 6.3v 1A. £4.00 pp £1.

VALVES

Minimum Order £1.00

VALVES VAT PLEASE ADD 12 1/2 %

A1065	1.25	EL41	0.80	PL509	3.25	3A4	0.60	6J6	0.50	20L1	1.00	
ARP3	0.60	EL81	1.05	PL802	2.80	3D6	0.40	6J7	0.75	20P1	0.40	
ATP4	0.50	EL84	0.60	PL160	1.80	3D21	20.00	6J7G	0.50	20P3	0.80	
812H	3.00	EL86	0.95	PY80	0.60	354	0.50	6K7	0.70	20P5	1.10	
DAF96	0.50	EL90	1.30	PY81/8000.55	3V4	0.85	6K8GT	0.55	25L6GT	0.80	20P6	0.80
DET22	19.50	EL91	1.80	PY82	0.45	5B/254M	6.50	6L6M	1.90	25Z4G	0.70	
DF96	0.60	EL95	0.75	PY83	0.50	5B/255M	6.50	6L6GT	0.90	30C15	1.00	
DK96	0.80	EL802	1.50	PY500	1.35	5V4G	1.10	6L7	0.85	30C17	1.1	



4 1/2 digits £139 KEITHLEY

Now... the next generation of bench DMMs!

Two New Keithley Models offer uncompromising performance and outstanding value!

- Accuracy 3 1/2's can't match 0.04% + 1 digit on dc volts and ohms
Large, bright, 20,000-count LED display that's quick and easy to read.
Convenient bench size that won't get "lost" yet doesn't crowd.
Exceptional reliability.

Model 178 offers functions and ranges for most measurement needs 100µV to 1200V dc, 100µV to 1000V ac, 0.1Ω to 20MΩ. Model 179 is a full-function, multi-feature model offering the same advantages as the 178. Plus TRMS AC; 10µV Sensitivity; Hi and Lo Ohms; AC and DC Current Yet it's still half the price you'd expect. Only £199.

Both models feature designed-in reliability Rugged circuits use a minimum of parts — high quality, off-the-shelf parts — carefully assembled and tested by Keithley. Outstanding overload protection and rugged mechanical design keep both units going even after severe abuse. One-year accuracy specifications minimise recalibration costs. A battery option, user installable, gets you off "line" for critical measurements or for field use.

For complete specifications on the 178 and 179, call Keithley Instruments, 1 Boulton Road, Reading, Phone 0734 861287

KEITHLEY The measurement engineers. WW-030 FOR FURTHER DETAILS

To obtain further details of any of the coded items mentioned in the Editorial or Advertisement pages of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp. These Service Cards are valid for six months from the date of publication.

Please Use Capital Letters

If you are way down on the circulation list, you may not be getting the information you require from the journal as soon as you should. Why not have your own copy?

To start a one year's subscription you may apply direct to us by using the card at the bottom of this page. You may also apply to the agent nearest to you, their address is shown below.

OVERSEAS SUBSCRIPTION AGENTS

- Australia: Gordon & Gotch (Australasia) Ltd, 380 Lonsdale Street, Melbourne 3000, Victoria
Japan: Western Publications Distribution Agency, 170 Nishi-Okubo 4-chome, Shinjuku-Ku, Tokyo 160
Belgium: Agence et Messageries de la Presse, 1 Rue de la Petite-ILE Brussels 7
Lebanon: Levant Distributors Co., P.O. Box 1181, Makdesi Street, Halim Hanna Bldg, Beirut
Canada: Davis Circulation Agency, 153 St. Clair Avenue West, Toronto 195, Ontario
Malaysia: Times Distributors Sdn. Bhd., Times House, 390 Kim Seng Road, Singapore 9, Malaysia.
Cyprus: General Press Agency Ltd, 131 Prodomou Street, P.O. Box 4528, Nicosia
Malta: W. H. Smith Continental Ltd, 18a Scots Street, Valletta
Denmark: Dansk Bladdistribution, Hovedvagtsgade 8, Dk. 1103 Kobenhavn.
New Zealand: Gordon & Gotch (New Zealand) Ltd, 102 Adelaide Road, Wellington 2
Finland: Rautakirja OY, Koivuvaaranukuja 2, 01640 Vantaa 64, Finland.
Nigeria: Daily Times of Nigeria Ltd, 3 Kakawa Street, P.O. Box 139, Lagos
France: Dawson-France S.A., B.P. 40, F-91121, Palaiseau
Norway: A/S Narvesens Kiøskompani, Bertrand Narvesens vei 2, Oslo 6
Germany: W. E. Saarbach GmbH, 5 Koln 1, Follerstrasse 2
Portugal: Livaria Bertrand s.a.r.l. Apartado 37, Amadora
Greece: Hellenic Distribution Agency, P.O. Box 315, 245 Syngrou Avenue, Nea Smyrni, Greece.
South Africa: Central News Agency Ltd, P.O. Box 1033, Johannesburg
Holland: Van Dittmar N.V., Oostelijke Handelskade 11, Amsterdam 1004
India: International Book House, Indian Mercantile Mansion East, Madame Cama Road, Bombay 1
Sweden: Wennegren Williams A. B. Fack S-104, 25 Stockholm 30
Iran: A.D.A., 151 Khabian Soraya, Tehran
Switzerland: Naville & Cie SA, Rue Levrier 5-7, CH-1211 Geneve 1
Schmidt Agence AG, Savogelstrasse 34, 4002 Basle
Israel: Stelmatzky's Agency Ltd, Citrus House, P.O. Box 628, Tel Aviv
Italy: Intercontinental s.a.s. Via Veracini 9, 20124 Milano
U.S.A.: John Barrios, IPC Business Press, 205 East 42nd Street, New York, N.Y. 10017

Postage will be paid by Licensee

Do not affix Postage Stamps if posted in Gt. Britain, Channel Islands or N. Ireland

BUSINESS REPLY SERVICE Licence No. 12045

WIRELESS WORLD, PRODUCT REPLY SERVICE, 429 BRIGHTON ROAD, SOUTH CROYDON, SURREY CR2 9PS

Enquiry Service for Professional Readers

WIRELESS WORLD Wireless World, April 1979 WW 964

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the space provided.

Form with columns for product reference numbers (e.g., WW 1000, WW 1001) and checkboxes for selection.

Form for personal details: Name, Name of Company, Address, Telephone Number.

Form for PUBLISHERS USE ONLY with A/E field.

Form for company details: Position in Company, Nature of Company/Business, No. of employees at this establishment, I wish to subscribe to Wireless World.

VALID FOR SIX MONTHS ONLY

Wireless World: Subscription Order Form

To become a subscriber to Wireless World please complete the reverse side of this form and return it with your remittance to:

Subscription Manager, IPC Business Press, Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH, England

Table titled 'ASTRA-PAK GRAND SALE' listing various electronic components like resistors, capacitors, and diodes with their specifications and prices.

WW-036 FOR FURTHER DETAILS

Hall Electric Limited International Tube Distributor

Haltron

Receiving Radio/TV

Transmitting

Power Rectifiers

Thyratrons

Hall Electric
Your One Source
Supply of Tubes
and Semiconductors

Electron House, Cray Avenue, Orpington, Kent BR5 3QJ Telephone: Orpington 27099. Telex: 896141 Cralec G

WW - 084 FOR FURTHER DETAILS

U.K. RETURN OF POST MAIL ORDER SERVICE, ALSO WORLDWIDE EXPORT SERVICE

BSR DE LUXE AUTOCHANGER

Plays 12", 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge: AC 200/250V. Size 13 1/2 x 11 1/4 in. 3 speeds. Above motor board 3 3/4 in. Below motor board 2 1/2 in. with Ceramic Stereo/Mono cartridge. **£17.50** Post £1



HEAVY METAL PLINTHS ONLY

Cut out for most BSR or Garrard decks. Silver grey finish. Model "A" Size 14 1/2 x 12 1/2 x 3 in. **£3.50** Post £1.00

Model "B" Size 16 x 13 1/4 x 3 in. **£4.50** Post £1.00
TINTED PLASTIC COVERS ONLY
Sizes: 14 1/2 x 12 1/2 x 4 in. **£3.**
15 1/4 x 13 1/2 x 4 in. **£3.75.**
15 x 13 1/2 x 3 in. **£3.50.** 17 1/4 x 9 1/2 x 3 1/2 in. **£3.** Post £1.
14 1/2 x 14 3/4 x 2 1/2 in. Rosewood sides **£4.**
Ideal for record decks, tape decks, etc.

BSR SINGLE PLAYER

Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern design. **£19.50** Post £1
BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£22.50.**
BSR MP60/P128 Stereo Ceramic, balanced arm, cueing device. Bias compensator **£24.50.** Magnetic **£5** extra.



GARRARD HI-FI AUTO CHANGER

Model 5-300 **£14.95** Post £1
3-speed stereo cartridge. Cueing devices



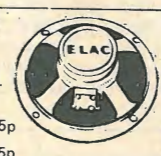
SMITH'S CLOCKWORK 15A TIME SWITCH

0-6 HOURS **£3.30** Post 35p
Single pole two-way surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new.



ELAC HI-FI SPEAKER

8in. TWIN CONE
Large ceramic magnet. 50-16,000 c/s. Bass resonance 40 c/s. 8 ohm impedance. 10 watts. RMS. **£5.95** Post 35p
20 watt model **£8.95** Post 45p



LOW VOLTAGE POWER PACK for MODELS

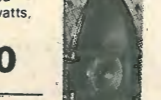
Ready made. Famous make. Will supply 10 volts D.C. at 400mA. With terminals and mains lead. **£2.50** Post 50p

VOLUME CONTROLS
5kΩ to 2MΩ LOG or LIN L/S 35p. D.P. 60p. Stereo L/S 85p. D.P. £1. Edge 5K. S.P. Transistor 45p.

80 Ohm Coax
FRINGE LOW LOSS 15p yd. PLUGS 10p. SOCKETS 10p. LINE SOCKETS 25p. OUTLET BOXES 80p. 300 ohm FEEDER 5p yd.

EMI 13 1/2 x 8in. LOUSPEAKERS

With tweeter and crossover. 10 watt. 3 or 8 ohm. **£8.95** Post 45p
With tweeter and crossover. 15 watts. 8 ohm. **£10.50** Post 65p



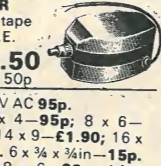
With tweeter and crossover. 20 watt. **£11.50** Post 75p
8 or 15 ohm. 20 to 20,000 c.p.s. Post 75p

Suitable Bookshelf Cabinet
Teak finish. For EMI 13 x 8 speakers. Size 16 x 11 x 8 inches approximately. **£8.50** Post £1.00



THE "INSTANT" BULK TAPE ERASER

Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. Will also demagnetise small tools. **£5.50** Post 50p
Head Demagnetiser only **£4.75.**



RELAYS. 12V DC 85p. 6V DC 85p. 240V AC 95p.

BLANK ALUMINIUM CHASSIS. 6 x 4 - **95p.** 8 x 6 - **£1.40.** 10 x 7 - **£1.55.** 12 x 8 - **£1.70.** 14 x 9 - **£1.90.** 16 x 6 - **£1.85.** 16 x 10 - **£2.20.** **ANGLE ALI.** 6 x 1/2 x 1/4 in - **15p.** **ALUMINIUM PANELS.** 6 x 4 - **24p.** 8 x 6 - **38p.** 14 x 3 - **40p.** 10 x 7 - **54p.** 12 x 8 - **70p.** 12 x 6 - **44p.** 16 x 6 - **70p.** 14 x 9 - **94p.** 12 x 12 - **£1.** 16 x 10 - **£1.16.** **PLASTIC AND ALI BOXES IN STOCK. MANY SIZES** **VARICAP FM TUNER HEAD** with circuit & connections. Some technical knowledge required **£4.95.** **TAG STRIP** 28-way **12p.** **TAPE OSCILLATOR COIL.** Valve type. **35p.** **BRIDGE RECTIFIER** 200V PIV 1/2 amp **50p.** 8 amp **£2.50.** **TOGGLE SWITCHES** SP 30p. DPST 40p. DPDT 50p. **MANY OTHER TOGGLES IN STOCK. Please enquire.** **PICK-UP CARTRIDGES** ACOS. GP91 **£2.00.** GP94 **£2.50.** **SONOTONE** stereo **£2.00.** **WIRE-WOUND RESISTORS** 5 watt, 10 watt, 15 watt **15p.** **CASSETTE MOTOR.** 6 volt **£1.00.**

RCS SOUND TO LIGHT KIT Mk. 2

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home use. Easy to build. Full instructions supplied. Cabinet **£4** extra. Will operate from 200MV to 100 watt signal. **£17** Post 35p

R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS

All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer. Input 200/240V a.c. Output voltages available, 6 or 7.5 or 9 or 12V d.c. up to 100mA or less. Size 3 x 2 1/2 x 1 1/2 in. Please state voltage required. **£2.95** Post 45p

R.C.S. POWER PACK KIT

12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£3.35** Post 30p

R.C.S. "MINOR" 10 watt AMPLIFIER KIT

This kit is suitable for record players, guitars, tape playback, electronic instruments or small P.A. systems. Two versions available Mono, **£12.50.** Stereo, **£20.** Post 45p. Specification 10W per channel; input 100mV; size 9 1/2 x 3 x 2 in. approx. S.A.E. details. Full instructions supplied. A.C. mains powered.

R.C.S. DRILL SPEED CONTROLLER / LIGHT DIMMER KIT.

Easy to build kit. Printed circuit Will control up to 480 watts AC mains **£3.25** Post 35p

R.C.S. STEREO PRE-AMP KIT.

Inputs for high, medium or low imp per channel, with volume control and P.C. Board **£2.95** Post 35p

MAINS TRANSFORMERS

250-0-250V 70mA, 6.5V, 2A	ALL POST 75p
250-0-250V 80mA, 6.3V, 3.5A, 6.3V, 1A	£3.45
350-0-350V 80mA, 6.3V, 3.5A, 6.3V, 1A	£4.80
300-0-300V 120mA, 2x6.3V, 2A CT., 5V, 2A	£5.80
220V 45mA, 6.3V, 2A	£1.75
HEATER TRANSFORMER, 6.3V 1/2 amp	£1.50
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs	
2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£5.30
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£5.30
2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£8.50
3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£11.00
5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£14.50
12V, 100mA	£1.00
12V, 750mA	£1.30
10-0-10V 2amp	£2.45
30V, 5 amp and 17V-0-17V, 2 amp	£3.45
0, 5, 8, 10, 16V, 1/2 amp	£1.95
9V, 3 amp	£2.75
25-0-25V 2 amp	£3.50
30V, 2 amp	£3.00
30V, 1 1/2 amp	£2.75
20V, 40V, 60V, 1 amp	£3.50
12V, 3 amp	£2.95
10V, 30V, 40V, 2 amp	£2.75
40V, 2 amp	£2.95
20V, 1 amp	£2.20
20V-0-20V, 1 amp	£2.20
30V-0-30V, 2 amp	£7.00
2 of 18V, 6 amp, each	£9.00
12-0-12V, 2 amp	£2.95
9V, 1/2 amp	£1.30
AUTO TRANSFORMERS, 115V to 230V or 230V to 115V 150W	£5.00
250W, 400W, 500W	£7.00
500W	£8.00
FULL WAVE BRIDGE CHARGER RECTIFIERS:	
6 or 12V outputs, 2 amp	75p. 4 amp £1.25
CHARGER TRANSFORMERS, 1 1/2 amp	£3.50. 4 amp £6.50.
12V, 1 1/2 amp Half Wave Selenium Rectifier	25p

COMPACT SPEAKERS

Teak 4 or 8 ohm White 4 ohm only 13 x 10 x 6 in. approx. 50 to 14,000 cps. 10 watts. **£16 pair** Post £1.30

EXTENSION SPEAKERS £3.95 ea.

Globe shaped cases in high gloss mouldings of red or green, are finished with chrome frontal trim and provided with screw-on rubber inset protective bases. In addition, 2 1/2 metres of strong lead already fitted with phono plug is supplied. Full Range Quality Frequency Response Impedance: 8 ohms Power Peak: 5 watts

LOW VOLTAGE ELECTROLYTICS

1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.** 500mF 12V **17p.** 25V **35p.** 50V **47p.** 100V **70p.** 200mF 6V **25p.** 25V **42p.** 420mF / 500V **£1.30.** 2500mF 50V **62p.** 3000mF 25V **47p.** 50V **65p.** 3900mF 100V **£1.60.** 4700mF 63V **£1.20.** 2700mF / 76V **£1.** 5000mF 6V **25p.** 12V **42p.** 35V **85p.** 5600mF / 76V **£1.75.**

HIGH VOLTAGE ELECTROLYTICS

8+8/450V 50p 50+50/300V 50p 16/350V 30p 8+16/450V 50p 32+32/450V 75p 32/500V 75p 16+16/450V 50p 100+100/275V 65p 50/350V 50p 32+32/350V 50p 150+200/275V 70p

MANY OTHER ELECTROLYTICS IN STOCK

SHORT WAVE 1000pF air spaced gangable tuner, **95p.** **TRIMMERS** 10pF, 30pF, 50pF, 5p, 100pF, 150pF, 15p. **CERAMIC**, 1pF to 0.01mF, 5p. Silver Mica 2 to 5000mF, 5p. **PAPER** 350V-0.1 7p; 0.5 13p; 1mF 150V 20p; 2mF 150V 20p; 500V-0.001 to 0.05 12p; 0.1 15p; 0.25 25p; 0.47 35p. **MICRO SWITCH SINGLE POLE CHANGE OVER** 20p. **SUB-MIN MICRO SWITCH**, 25p. Single pole change over. **TWIN GANG**, 385 + 385pF **50p.** 500pF standard **75p.** 365 + 365 + 25 + 25pF. Slow motion drive **65p.** **120pF TWIN GANG**, 50p; 365pF **TWIN GANG**, 50p. **NEON PANEL INDICATORS** 250V. Amber or red **30p.** **RESISTORS**, 1Ω to 10M, 1/4W, 1/2W, 1W, 20% 2p; 2W, 10p. **HIGH STABILITY**, 1/4W 2% 10 ohms to 1 meg., 12p. Ditto 5%. Preferred values 10 ohms to 10 meg., 5p.

ELECTRO MAGNETIC PENDULUM MECHANISM 95p

Post 30p. 1.5V DC operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or metronome, strobe, etc.

BAKER SUPERB

12in 25 watt **£22** Post £1.60

High Fidelity
Quality loudspeaker, low cone resonance ensures clear reproduction of the deepest bass. Special copper drive and concentric tweeter cone. Full range reproduction with remarkable efficiency in the upper register.

Bass resonance 25 cps Useful response 20-17,000 cps 16,500 gauss Flux Density 16,500 gauss 8 or 16 ohms models

"SALE" BAKER "BIG-SOUND" SPEAKERS. Post £1
"Group 25" 12 inch **£12** 30 watt 4 or 8 ohm
"Group 35" 12 inch **£14** 40 watt 4 or 8 ohm
"Group 50/15" 15 inch **£33** 75 watt 8 or 16 ohm

BAKER LOUSPEAKER, 12 INCH, 60 WATT

GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. RESPONSE 30-16,000 CPS **£21** Post £1.60
MASSIVE CERAMIC MAGNET WITH ALUMINIUM PRESENCE CENTRE DOME.

TEAK VENEERED HI-FI SPEAKER CABINETS

For 13x8in. or 8in. speaker **£8.50** Post £1
For 6 1/2in. speaker and tweeter **£5.95** Post 75p
Many other cabinets in stock. Phone your requirements. **SPEAKER COVERING MATERIALS.** Samples Large S.A.E. **LOUDSPEAKER CABINET WADDING** 18in wide **20p** ft.

R.C.S. 100 watt VALVE AMPLIFIER CHASSIS

Four inputs. Four way mixing, master volume, treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, PA, where high quality power is required. 5 speaker outputs. AC mains operated. Slave output socket. Produced by demand for a quality valve amplifier. 100V line output to order £10 extra. Send for leaflet. Suitable carrying cab **£21** Price **£99** carr. **£6.00**

Horn tweeters 2-16kc/s. 10W 8 ohm or 16 ohm £3.60.

Audax Tweeters 3-18kc/s. 50W 8 ohm **£7.50.** **CROSSOVERS. TWO-WAY** 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps / 3000 cps **£2.20.**

LOUDSPEAKERS PM 3 OHM 7x4in. £1.50; 6 1/2in. £1.95;

8x5in. **£1.90;** 8in. **£2.50.** **SPECIAL OFFER:** 80 ohm, 2 1/4in., 2 3/4in., 3in. ohm, 3in., 25 ohm, 2 1/2in., 3in., 5x3in., 7x4in., 8 ohm, 2 1/2in., 3in., 3 1/2in., 5in., 15 ohm, 3 1/2in. dia, 6x4in., 7x4in., 5x3in., 3 ohm, 2 1/2in., 2 3/4in., 3 1/2in., 5in. dia. **£1.50 each.**

PHILIPS LOUSPEAKER, 8in., 4 ohms, 4 watts, £1.95

RICHARD ALLAN TWIN CONE LOUSPEAKERS 8in. diameter **4W £2.50.** 10in. diameter **5W £2.95;** 12in. diameter **6W £3.50.** 3/8" / 15 ohms, please state. **MOTOROLA PIEZO ELECTRIC HORN TWEETER.** **£7.95**

Handles up to 100 watts. No crossover required. **BLACK PLASTIC CONSTRUCTION BOX** with brushed aluminium facia. Sturdy job. Size 6 1/4 x 4 1/4 x 2in. **£1.50**

BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 4 8/16 ohms. A.C. Mains. Separate treble and bass controls. Master volume control. 100 volt line model **£99** **£79** **£1.50** carr.

BAKER 50 WATT AMPLIFIER

£59 Post £1
Superior quality ideal for Halls / PA systems, Disco's and Groups. Two inputs with Mixer Volume Controls, Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). Blue wording on black cabinet.

GOODMANS COMPACT 12-INCH BASS WOOFER

Standard 12in. diameter fixing with cut sides 12 x 10. 14,000 Gauss magnet. 20 watts R.M.S. 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 30-8000 c.p.s. **£9.95** each Post £1

ALUMINIUM HEAT SINKS. FINNED TYPE.

Sizes 5 x 4 x 1 1/2 95p. 6 1/2 x 2 x 2 1/4 85p. **JACK PLUGS.** Plastic 25p; Metal 30p. **JACK PLUGS Stereo Plastic 30p; Metal 35p.** **JACK SOCKETS.** Open 20p; Closed 25p. **JACK SOCKETS Stereo Open 25p; Closed 30p.** **FREE SOCKETS - Cable end 30p.** **2.5mm and 3.5mm JACK SOCKETS 15p.** **2.5mm and 3.5mm JACK PLUGS 15p.** **DIN TYPE CONNECTORS** Sockets 3-pin, 5-pin 10p. Free Sockets 3-pin, 5-pin 25p. Plugs 3-pin 20p; 5-pin 25p. **PHONO PLUGS and SOCKETS** ea. 15p. Free Socket for cable end ea. 15p. **Screened Phono Plugs** ea. 15p. **TV CONVERGENCE POTS** Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms. **15p** each

MONO PRE-AMPLIFIER.

Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates a circuit for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. **£4.50** Post 50p

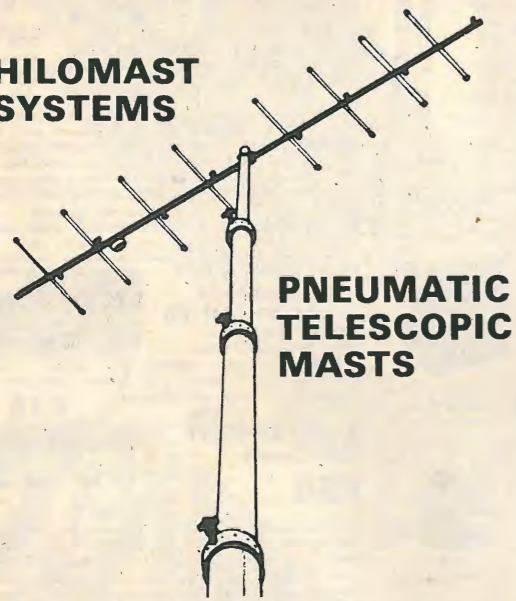
RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, CROYDON

Radio Books and Components Lists 20p. (Minimum posting charge 30p.) Cash prices include VAT. (We accept Access or Barclaycard. Phone your Order) Tel. 01-684 1665



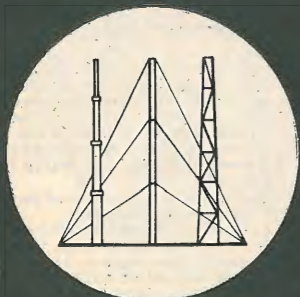
Hilomast Ltd

HILOMAST SYSTEMS



PNEUMATIC TELESCOPIC MASTS

Pneumatic and winch operated telescopic masts and towers. Vehicle, field and wall mountings available. Many standard models ex-stock.



HILOMAST LIMITED
THE STREET HEYBRIDGE — MALDON
ESSEX CM9 7NB ENGLAND
Tel. MALDON (0621) 56480
TELEX NO. 995855

WW-078 FOR FURTHER DETAILS



Model 146
VERY LOW DISTORTION
(.0015%)
AUDIO SIG. GENERATOR
Based on
J. Linsley Hood Design (W.W.)
£36
(Kit. £31) + tax 8%

Low cost version, A0113 (02% dist), **£27.50 (Kit £23)**. Other instruments include: Millivoltmeter, Tachometer, Noise level meter, Distortion Analyser, F.M. Sig. Gen. Crystal Frequency Standard, KEF Speaker Units. Send S.A.E. for lists. VAT extra 8%. Post/Pkg. £1.50.

TELERADIO ELECTRONICS
325 Fore Street, Edmonton, N.9. 01-807 3719
Closed all day Thursday

FOTOLAK

POSITIVE LIGHT SENSITIVE AEROSOL LACQUER

Enables YOU to produce perfect printed circuits in minutes! Method: Spray cleaned board with lacquer. When dry, place positive master of required circuit on now sensitized surface. Expose to daylight, develop and etch. Any number of exact copies can of course be made from one master. Widely used in industry for prototype work.

FOTOLAK	£1.50	Pre-coated 1/16 Fibre-glass board	£1.50
Developer	30p	204mm x 114mm	£3.00
Ferric Chloride	40p	204mm x 228mm	£6.00
		408mm x 228mm	£9.00
		467mm x 305mm	£9.00

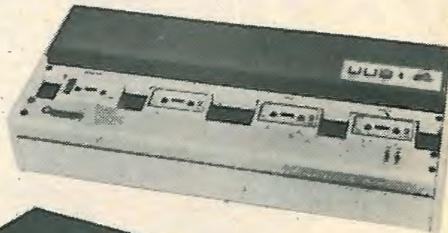
Plain Copper-clad Fibre-glass.	Single-sided	Double-sided
Approx. 3.18mm thick sq. ft.	£1.25	£1.50
Approx. 2.00mm thick sq. ft.	£2.00	£2.25
Approx. 1.00mm thick sq. ft.	£1.50	£1.75
Single sided Copper-clad Paxolin, 10 sheets 245mm x 150mm		£2.50
Clear Acetate Sheet for making master, 260mm x 260mm		12p

Postage and packing 60p per order. VAT 8% on total
G. F. MILWARD ELECTRONIC COMPONENTS LIMITED
369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339

NEW! Cassette copiers from PENTAGON

Simple operation—fully automatic 16 times speed. Choice of one or three copies. C32/34—outproduces all other makes—75 C60 per hour. Budget Price from £587 + VAT

Model C32S—Mono
Model C34S—Stereo



Model C-1—Mono
Model C-4—Stereo

PENTAGON from ITA

1-7 Harewood Avenue, Marylebone Road
London NW1. Tel. 01-724 2497. Telex: 21879

WW-091 FOR FURTHER DETAILS

Catronics NEW WW TELETEXT DECODER

components and PCB for new Character Rounding "Board 4" available now. PCB £14.60. Kit (inc. PCB) £25.75

"Board 3" is also available as an additional unit to update the "Wireless World" Teletext Decoder to give double height characters, colour background, conceal/reveal, etc., as described in December 1977 and January 1978 issues of Wireless World

The Kit includes plated-through hole P.C.B., all components and installation instructions. Price £33.68 + VAT (£3.47) + P&P (30p) = £37.45 total. P.C.B. available separately at £19.30.

Our main kits contain all the printed circuit boards and components necessary to build the complete decoder.

A reprint of the series of articles is available at £1.95 + large 18 1/2 p SAE (included free in complete kit).

Prices on the right are for the Version with TEXAS X887, including VAT.



Set of 5 PCBs £26.80 + 30p p&p
Components Kit (inc. PCBs) £139.25 + £1.50 p&p
Cabinet £21.00 + £1.00 p&p

Also PLATED THROUGH hole PCB at additional cost of £27.00

FULL FAULT-FINDING AND REPAIR SERVICE AVAILABLE
COMPONENTS ALSO AVAILABLE SEPARATELY — SAE for price list
READY BUILT AND TESTED DECODERS — £241.87 + £5 Carr.
DE LUXE VERSION WITH NEW FACILITIES — £292.50 + £5 Carr.

FULL SPEC. PROFESSIONAL TELETEXT DECODER

We are now agents for V.G. Electronics Ltd., and can offer their model VGE1022 (as supplied to broadcasting authorities, etc.) at the SPECIALLY REDUCED PRICE OF £248 + VAT = £279

FREQUENCY COUNTER CHIPS

The following counter i.c.s. are now available
74C926 £5.30; ICM 7208 £15.70; ICM 7216D £19.65; ICM 7226 £27.20.
Application information available.

Try us for 7 segment displays, display drivers and prescaler I.C.s

Catronics Communications House, 20 WALLINGTON SQUARE, WALLINGTON, SURREY. Tel. 01-669 6700

WW-924 FOR FURTHER DETAILS

S I N T E L

SENDER FOR S I N T E L FREE CATALOGUE

CD4015	0.83	CD4032	0.89	CD4049	0.50	CD4072	0.20	CD4099	1.65
CD4016	0.48	CD4033	1.25	CD4050	0.43	CD4073	0.20	CD4502	0.81
CD4017	0.79	CD4034	1.71	CD4051	0.82	CD4075	0.20	CD4510	1.01
CD4018	0.83	CD4035	1.06	CD4052	0.82	CD4076	1.17	CD4511	1.25
CD4019	0.50	CD4036	2.86	CD4053	0.82	CD4077	0.38	CD4514	2.47
CD4000	0.15	CD4020	1.11	CD4037	0.85	CD4054	1.04	CD4078	0.20
CD4001	0.17	CD4021	0.90	CD4038	0.96	CD4055	1.18	CD4081	0.20
CD4002	0.17	CD4022	0.82	CD4039	2.78	CD4056	1.18	CD4082	0.20
CD4006	1.04	CD4023	0.18	CD4040	0.97	CD4059	4.29	CD4085	0.84
CD4007	0.18	CD4024	0.70	CD4041	0.75	CD4060	1.00	CD4086	0.64
CD4008	0.87	CD4025	0.20	CD4042	0.69	CD4063	0.98	CD4089	1.39
CD4009	0.50	CD4026	1.55	CD4043	0.88	CD4066	0.55	CD4093	0.80
CD4010	0.50	CD4027	0.44	CD4044	0.84	CD4067	3.35	CD4094	1.69
CD4011	0.18	CD4028	0.77	CD4045	1.26	CD4068	0.20	CD4095	0.94
CD4012	0.20	CD4029	1.03	CD4046	1.20	CD4069	0.20	CD4096	0.94
CD4013	0.43	CD4030	0.50	CD4047	0.89	CD4070	0.46	CD4097	3.35
CD4014	0.83	CD4031	2.00	CD4048	0.50	CD4071	0.20	CD4098	0.98

SOLDERCON	CLOCK CHIPS	DISPLAYS	CRYSTALS	MEM80002	190.00
100	0.50	3.10	2.95	2.95	13.88
1000	4.00	3.45	3.50	3.50	6.94
3000	10.50	5.40	4.90	4.90	16.80
			2.0246	1.85	22.40
			211244	2.90	10.15
			780-PD		10.15

Free data is available on some of these items. SEND FOR FREE CATALOGUE

SOME 74LSTTL NOW AVAILABLE PLEASE SEND FOR LIST

Our offices are at Chapel Street, Oxford, but please do not use this as a postal address
FAST SERVICE. We guarantee that Telephone Orders for goods in stock, received by 4.15 p.m. (Mon-Fri.) will be dispatched on the same day by 1st Class Post (some heavy items by parcel post) and our stocking is good. Private customers should telephone and pay by giving their Access or Barclaycard number with a minimum value of £5. Official orders no minimum. Official orders, Companies, Govt., Nats. Ind., and Univs.
ORDERS: C.W.O. add VAT at 8% + 35p p&p. TELEPHONE and CREDIT invoiced ORDERS add VAT at 8% + 60p p&p minimum charge (the balance will be charged at cost). Please send FAST SERVICE. EXPORT ORDERS welcome, no VAT but add 10% (Europe), 15% (Overseas) for Mail p&p. For export postage rates on heavy items—contact us first.

SEND YOUR ORDER TO
SINTEL
PO BOX 75C OXFORD
Tel: 0865 49791

TRANSFORMERS SAME-DAY DESPATCH

MAINS ISOLATOR				VAT 8% 12 or 24-VOLT			
Pri 120 or 240V Sec: 120 or 240V Centre Tapped and Screened				Separate 12V windings Pri 220-240V			
Ref.	VA (Watts)	£	P&P	Ref.	12v	24v	£ P&P
07*	20	4.40	.79	111	0.5	0.25	2.20 .45
149	60	6.70	.96	213	1.0	0.5	2.64 .78
150	100	7.61	1.14	71	2	1	3.51 .78
151	200	11.16	1.14	18	4	2	4.03 .96
152	250	13.28	1.50	85	5	2.5	5.00 .79
153	350	16.43	1.84	70	6	3	5.35 .96
154	500	20.47	2.15	108	8	4	7.42 1.14
155	750	29.06	OA	72	10	5	8.12 1.14
156	1000	37.20	OA	116	12	6	8.99 1.32
157	1500	51.38	OA	17	16	8	10.72 1.32
158	2000	61.81	OA	115	20	10	13.98 2.08
159	3000	86.66	OA	187	30	15	17.05 2.08
				226	60	30	36.14 OA

50 VOLT RANGE				30 VOLT RANGE			
Pri 220-240V. Sec. 0-20-25-33-40-50V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V and 25V-0-25V Screened				Pri 220-240V Sec. 0-12-15-20-24-30V Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V and 15V-0-15V			
Ref.	Amps	£	P&P	Ref.	Amps	£	P&P
102	0.5	3.41	.78	112	0.5	2.64	.78
103	1.0	4.57	.96	79	1.0	3.57	.96
104	2.0	7.16	1.14	3	2.0	5.77	.96
105	3.0	8.56	1.32	20	3.0	6.20	1.14
106	4.0	15.06	1.50	51	4.0	7.99	1.14
107	6.0	14.62	1.64	117	6.0	9.87	1.32
118	8.0	20.26	2.08	88	8.0	14.95	1.64
119	10.0	24.98	OA	89	10.0	17.25	1.84

60 VOLT RANGE				SCREENED MINIATURES Primary 240V			
Pri 220-240V Sec. 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V or 24V-0-24V and 30V-0-30V				Ref. mA Volts £ P&P			
Ref.	Amps	£	P&P	Ref.	mA	Volts	£ P&P
124	0.5	3.88	.96	238	200	3-0-3	2.57 .55
125	1.0	5.91	.96	212	1A, 1A	0-6-0-6	2.85 .78
127	2.0	7.60	1.14	13	100	9-0-9	2.14 .38
125	3.0	11.00	1.32	235	330, 330	0-9-0-9	1.99 .38
123	4.0	12.52	1.84	207	500, 500	0-8-9, 0-8-9	2.77 .71
40	5.0	15.84	1.84	208	1A, 1A	0-8-9, 0-8-9	3.53 .78
120	6.0	18.06	1.84	236	200, 200	0-15, 0-15	1.99 .38
121	8.0	25.56	OA	239	50MA	12-0-12	2.57 .38
122	10.0	29.55	OA	214	300, 300	0-20, 2-20	2.80 .78
189	12.0	34.06	OA	221	700 (DC)	20-12-0-12-20	3.41 .78

HIGH VOLTAGE MAINS ISOLATING				AUTO TRANSFORMERS			
Pri 200/220 or 400/440 Sec 100/120 or 200/240				Ref. VA (Watts) TAPS £ P&P			
Ref.	VA	£	P&P	Ref.	VA	TAPS	£ P&P
60	243	6.70	1.32	113	15	0-115-210-240V	2.48 .71
350	247	16.43	1.84	64	75	0-115-210-240V	4.01 .96
1000	250	37.10	OA	4	150	0-115-200-220-240V	5.35 .96
2000	252	61.81	OA	66	300		7.75 1.14

BRIDGE RECTIFIERS			
100v	25A	£2.10	
200v	2A	45p	
400v	2A	55p	
200v	4A	65p	
400v	4A	80p	
400v	6A	1.40	
500v	12A*	£2.35	

CASED AUTO TRANSFORMERS			
240V cable input. USA 115V. Flat pin outlets. £5.96 30p Ref.			
Ref.	VA	£	P&P
MINI-MULTIMETER	75VA	£7.73	1.14
DC1000V, AC-1000V	150VA	£10.91	1.14
AC/DC-1000V/V	250VA	£9.92	1.45
500VA	£19.17	1.64	67W
DC-100mA Res — 150K	750VA	£23.41	1.78
Bargain at £7.20	1000VA	£27.88	2.30
VAT 8% P&P 62p	1500VA	£26.02	0A
	2000VA	£49.87	0A

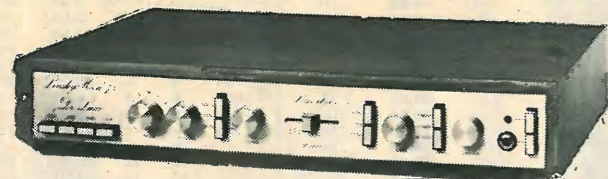
PANEL METERS			
43mm x 43mm 82mm x 78mm			
0-50µA	£6.20	0-50µA	£6.70
0-500µA	£5.95	0-500µA	£6.70
0-1mA	£5.95	0-1mA	£6.70
0-30V	£5.95	0-30V	£6.70
AV Cases and Accessories			
VU Indicator Edge 90mm 250µA			£3.36
VU Indicator Edge 54mm x 14mm µA FSD			£2.60
VU Panel Ind. 48 x 45mm, 250µA FSD			£2.60

MINIATURE TRANSFORMER				NEW RANGE TRANSFORMERS			
0-Centre Tapped-15V				Pri 0-120; 0-100-120; (120v or 220-240v) Sec. 0-36-48 twice to give 72v or 92v			
Ref.	VA	Price	P&P	Ref.	VA	Price	P&P
171	500MA	2.09	.45	2A	12, 14	PP £1.40	4A 18.17 PP £1.90
172	1A	2.96	.78	3A	14.70	PP £1.50	5A 26.64 PP £2.20
173	2A	3.59	.78				

ELECTRONIC KITS OF DISTINCTION FROM

POWERTRAN

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER



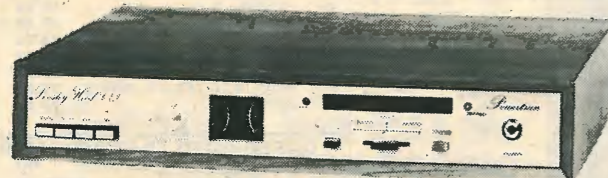
Pack	Price	Pack	Price
1. Fibreglass printed circuit board for power amp	£1.15	11. Fibreglass printed-circuit board for power supply	£0.85
2. Set of resistors, capacitors, pre-sets for power amp	£2.50	12. Set of resistors, capacitors, secondary fuses, semiconductors for power supply	£5.40
3. Set of semiconductors for power amp	£6.50	13. Set of miscellaneous parts including DIN s.k.t.s., mains input s.k.t., fuse holder, interconnecting cable, control knobs	£6.20
4. Pair of 2 drilled, finned heat sinks	£1.10	14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£8.20
5. Fibreglass printed-circuit board for pre-amp	£1.90	15. Handbook	£0.30
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£4.10	16. High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70
7. Set of low noise, high gain semiconductors for pre-amp	£2.40		
8. Set of potentiometers (including mains switch)	£3.50		
9. Set of 4 push-button switches, rotary mode switch	£5.40	2 each of packs 1-7, 1 each of packs 8-16 inclusive are required for complete stereo amplifier. Total cost of individually purchased packs	£92.80
10. Toroidal transformer complete with magnetic screen/ housing primary: 0 117-234 V; secondaries: 33-0-33 V, 25-0-25 V	£12.95		

PACK PRICES FOR STANDARD KIT

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier, this kit provides the perfect match. The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a.m. rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push-button pre-selection. Frequencies are indicated by a frequency meter and sliding LED indicators, attached to each channel selector pre-set. The PLL stereo decoder incorporates active filters for "birdy" suppression and power is supplied via a toroidal transformer and integrated regulator. For long term stability metal oxide resistors are used throughout.

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

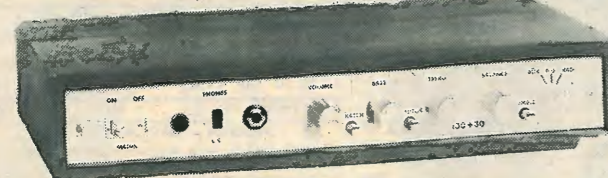
LINSLEY-HOOD CASSETTE DECK



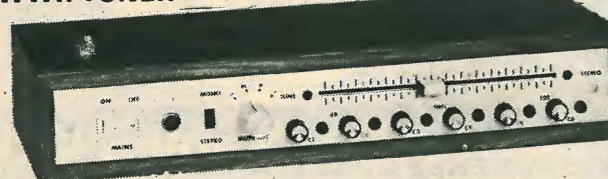
SPECIAL PRICE FOR COMPLETE KIT **£79.60 + VAT**

Published in Wireless World (May, June, August 1976) by Mr. Linsley-Hood, this design, although straightforward and relatively low cost, nevertheless provides a very high standard of performance. To permit circuit optimization separate record and replay amplifiers are used, the latter using a discrete component front-end designed such that the noise level is below that of the tape background. Pushbutton switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use. The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation. Speed control and automatic cassette ejection are both implemented by electronic circuitry. This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier. Circuit changes as published in February, 1978, follow-up article are included in the kit AT NO EXTRA COST! A higher performance head (Matsushita WY 436 AZ head as recommended in the follow-up article) is offered as an optional extra but this will be automatically supplied FREE OF CHARGE with all orders for complete kits!

T20+20 AND T30+30 20W, 30W AMPLIFIERS



WWII TUNER



SPECIAL PRICE FOR COMPLETE KIT **£47.70 + VAT**

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

Following the success of our Wireless World FM Tuner Kit this cost reduced model was designed to complement the T20+20 and T30+30 amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

AVAILABLE AS SEPARATE PACKS PRICES IN OUR FREE CATALOGUE

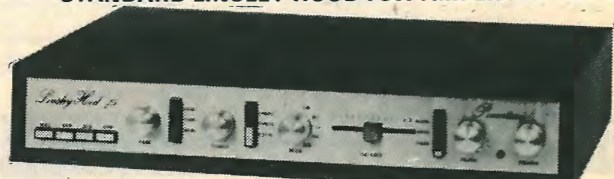
SPECIAL PRICE FOR COMPLETE KIT **£99.30 + VAT**

The standard model of our kit for Mr. Linsley-Hood's 75 watt design has for a long time offered exceptional performance at a very modest cost with high quality high power ready-built units of comparable quality generally being over three times the price.

Features of the amplifier include very low distortion (less than 0.01%), 75W rms per channel power output, rumble filter, variable slope scratch filter, variable transition frequency tone controls, tape monitoring facilities and individually adjustable inputs. This model is based on 5 circuit boards which not having the controls mounted on them can, if desired, be effectively used separately in high performance audio systems not based on our metalwork.

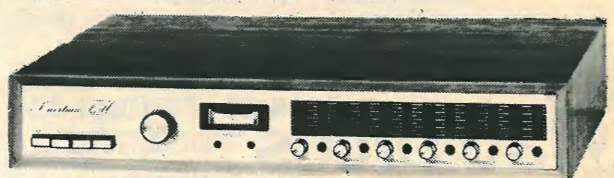
Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and are designed to have the potentiometers and switches mounted upon them. This system almost eliminates internal wiring, making installation, after their assembly, delightfully straightforward, and as each board can be easily removed in seconds from the chassis, checking and maintenance is so simple that even newcomers to electronics will be able to cope competently with the kit. Additional features of our new model are inclusion of the latest circuit improvements, generously sized heat sinks for heavy duty use, even in tropical climates, and metal oxide resistors throughout for long-term stability and reliability.

STANDARD LINSLEY-HOOD 75W AMPLIFIER



SPECIAL PRICE FOR COMPLETE KIT **£79.80 + VAT**

WIRELESS WORLD FM TUNER



SPECIAL PRICE FOR COMPLETE KIT **£70.20 + VAT**

Pack	Price	Pack	Price
1. Stereo PCB (accommodates 2 rep. amps, 2 meter, amps, bias/erase osc. relay)	£3.35	10. Set of capacitors, rectifiers, I.C. voltage regulator P.C.B. for power supply (Powertran design)	£2.80
2. Stereo set of capacitors, M.D. resistors, potentiometers for above	£7.95	11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc.	£3.40
3. Stereo set of semiconductors for above	£8.50	12. Set of metalwork including silk screened fascia panel, internal screen, fixing parts, etc.	£7.10
4. Miniature relay with socket	£2.90	13. Construction notes	£0.25
5. PCB, all components for solenoid, speed control circuits	£3.80	14. High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70
6. Goldring-Lenco mechanism as specified	£18.50		
7. Function switch, knobs	£1.90		
8. Dual VU meter with illuminating lamp	£5.95		
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V, Sec. 15V	£4.90		

One each of packs 1-14 inclusive are required for complete stereo cassette deck. Total cost of individually purchased packs **£83.00**

Matsushita WY 436 AZ head (optional extra) **£4.50** (free with complete kit)

Designed by Texas engineers and described in Practical Wireless, the Texan was an immediate success. Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the slimline T20+20 delivers 20W rms per channel of true Hi-Fi at exceptionally low cost. The easy to build design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers including scratch and rumble filters, adaptable input selector and headphones socket. In a follow-up article in Practical Wireless further modifications were suggested and these have been incorporated into the T30+30. These include RF interference filters and a tape monitor facility. Power output of this model is 30W rms per channel.

SPECIAL PRICES FOR COMPLETE KITS

T20+20 KIT PRICE **£33.10 + VAT**

T30+30 KIT PRICE **£38.40 + VAT**

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

POWERTRAN SFMT TUNER



PRICE FOR COMPLETE KIT **£35.90 + VAT**

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable a.f.c., switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the T20+20 and T30+30 amplifiers.

200+200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

- * Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- * Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- * Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- * Professional quality components, sturdy 19" rack mounting chassis complete with sleeve and feet for free standing work too.
- * Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experienced constructors and newcomers to electronics.
- * Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International



The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

COMPLETE KIT ONLY **£172.00 + VAT!**

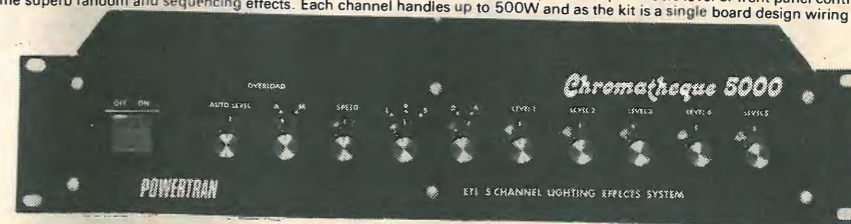
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of ears!

CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control minimal and construction very straightforward.

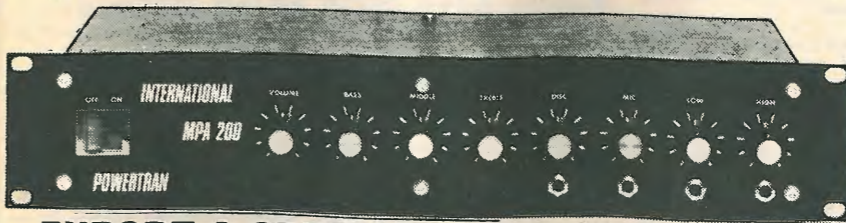
Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

COMPLETE KIT ONLY **£49.50 + VAT**



MPA200 100W MIXER/AMPLIFIER

Featured as a constructional article in Electronics Today International the MPA 200 is an exceptionally low-priced but professionally finished general purpose, rugged, high-power amplifier which has an adaptable range of inputs such as disc, microphone, guitar, etc. There are 3 wide range tone controls and a master volume control. Mechanically the design is simplicity in its extreme with minimal wiring making construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB's, controls, wire, etc. — Complete right down to the last nut and bolt!



COMPLETE KIT ONLY **£49.90 + VAT**

All kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world. Some of the countries to which we sent kits last year are shown in this advertisement. To assist in estimating postal costs our catalogue gives the same as for U.K. customers but no Value Added Tax charged. Postage charged at actual cost plus 50p per item. There is no minimum order charge. Prices: Order, International Money Order or cheque drawn on an account in the U.K. Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London.

Value Added Tax not included in prices UK Carriage FREE

PRICE STABILITY. Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until May 31, 1979, if the month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

U.K. ORDERS: Subject to 12 1/2% surcharge for VAT (i.e. add 1/4 to the price). No charge is made for carriage. *Or current rate if charged. SECURIOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m.-4.30 p.m. Monday-Thursday.

QUALITY: All components are brand new first grade full specification guaranteed devices. All resistors (except where stated as metal oxide) are low noise carbon film types. All printed circuit boards are fibreglass, drilled roller tinned and supplied with circuit diagrams and construction layouts.

FOR FURTHER INFORMATION PLEASE WRITE OR TELEPHONE FOR OUR FREE CATALOGUE

POWERTRAN ELECTRONICS
PORTWAY INDUSTRIAL ESTATE ANDOVER
ANDOVER HANTS SP10 3NN (0264) 64455

C.T. ELECTRONICS (ACTON) LTD.

Registered in England 1179820
267 & 270 ACTON LANE, LONDON W4 5DG. Telephone: 01-994 6275

9.30am-6.00pm
MON-SAT
CONTINUOUS

CMOS

4000UB	0.17	4027B	0.44	4075B	0.20
4001UB/B	0.17	4028B	0.77	4076B	1.17
4002UB/B	0.17	4029B	1.03	4077B	0.39
4006B	1.04	4032B	0.89	4078B	0.20
4007UB	0.18	4034B	1.71	4081B	0.20
4008B	0.67	4040B	0.97	4082B	0.20
4011UB/B	0.18	4043B	0.88	4093B	0.80
4012UB/B	0.20	4044B	0.84	40160B	1.19
4013B	0.43	40490B	0.50	40161B	1.19
4014B	0.83	4050B	0.43	40162B	1.19
4015B	0.83	4051B	0.82	40163B	1.19
4016B	0.48	4052B	0.82	40174B	0.95
4017B	0.79	4053B	0.82	40175B	0.95
4018B	0.83	4066B	0.55	40194B	1.19
4020B	1.11	4068B	0.20	4510B	1.01
4021B	0.90	40690B	0.20	4511B	1.25
4022B	0.82	4070B	0.46	4512B	0.91
4023UB/B	0.18	4071B	0.20	4516B	1.01
4024B	0.70	4072B	0.20	4518B	0.97
4025UB/B	0.20	4073B	0.20	4528B	0.80

TTL

7400	0.12	7451	0.20	74141	0.75
7401	0.12	7453	0.20	74150	1.00
7402	0.12	7454	0.20	74151	0.70
7403	0.12	7460	0.20	74153	0.70
7404	0.12	7470	0.35	74154	1.00
7405	0.18	7472	0.30	74155	0.70
7406	0.32	7473	0.30	74156	0.85
7407	0.32	7474	0.30	74157	0.70
7408	0.20	7475	0.45	74160	0.95
7409	0.20	7476	0.35	74161	0.50
7412	0.20	7480	0.60	74162	1.00
7413	0.30	7481	1.00	74163	1.00
7414	0.70	7482	0.90	74164	1.00
7415	0.30	7483	0.80	74165	1.00
7417	0.30	7484	1.10	74166	1.00
7419	0.50	7485	0.90	74167	2.50
7420	0.18	7486	0.30	74170	2.00
7421	0.20	7489	1.60	74174	0.95
7422	0.35	7490	0.35	74175	0.80
7423	0.32	7491	0.50	74176	0.80
7425	0.30	7492	0.45	74177	0.80
7426	0.30	7493	0.40	74180	0.80
7427	0.30	7494	0.90	74181	1.85
7428	0.40	7495	0.65	74182	0.95
7430	0.18	7496	0.65	74184	1.50
7432	0.25	7497	1.90	74185	1.50
7433	0.50	74100	1.40	74186	2.50
7437	0.30	74104	0.70	74190	1.00
7438	0.30	74105	1.70	74191	1.00
7440	0.18	74107	0.30	74192	1.00
7441	0.70	74109	0.55	74193	1.00
7442	0.50	74110	0.55	74194	1.00
7443	1.30	74118	0.95	74195	0.95
7445	1.00	74119	1.30	74196	0.95
7446	1.00	74121	0.28	74197	0.80
7447	0.75	74122	0.55	74198	1.60
7448	0.75	74123	0.55	74100	1.60
7449	1.00	74125	0.50		
7450	0.20	74132	0.70		

6" IMHOFF 19" Racks. Brand new. **£25.00 each** +8% VAT.

ALUMINIUM BOXES		
ins L	W	H
AB7	5 1/4	2 1/2
AB8	4	4
AB9	4	2 1/2
AB10	4	5 1/2
AB11	4	2 1/2
AB12	3	2
AB13	4	2
AB14	5	2 1/2
AB15	6	3
AB16	10	3
AB17	10	4 1/2
AB18	12	5
AB19	12	8

SPECIAL OFFER
741 8 pin D.I.L. **15p** +8% VAT

VEROBOARDS		
ins L	W	H
0.1" Pitch Copper Clad		
2.5" x 5"		0.59
2.5" x 3.75"		0.50
2.5" x 5"		1.77
3.75" x 5"		0.66
3.75" x 7.5"		0.59
3.75" x 17"		2.28
4.7" x 17.9"		2.99
2.5" x 1" (Sold in 5s)		0.70

BLUE REXINE COVERED		
ins L	W	H
RB1	6	4 1/2
RB2	6	5
RB3	6	5 3/4
RB4	11	8
RB5	11	7 1/2

0.15" Pitch Plain Board		
ins L	W	H
2.5" x 5"		0.53
2.5" x 3.75"		0.44
3.75" x 17"		1.98
3.75" x 5"		0.74

11" Vero 19" sub rack units
1) Large DL27696, will accept card size 203(L)x(190-230)mm **£10** +8% VAT
2) Small 12401/C351 AIB will accept card size 203x(95-115)mm. **£6.00** +8% VAT

TRANSFORMERS, all 240V primary
6-0-6 500mA (63x35x48) **£1.40**
0-11, 2A; 0-22, 1A (76x64x60) **£2.40**
12V 130mA (36x45x40) **£0.75**
17V 300mA (44x47x74) **£1.50**
18V 2A (80x55x70) **£2.80**
18V 2.5A (115x65x62) **£2.50**
28V 200mA (53x45x37) **£1.00**
32V 250mA (46x37x31) **£1.20**
0-2-4-6-8-10-12, 0-1-1, 5A **£6.00**

AUTO TRANSFORMERS
0-110-115-120-230-240-250V 150VA **£1.50**
0-110-115-230-250V 2KW **£20.00**

MAINS FILTERS
Potter 30A, 125V (184x51x70). Sealed **£3.00**
Erie 8A, 250V (61x120x47). Diecast box **£5.00**
Brimar CRT M17/15GV, with scan coils and Wallis power supply. Rectangular screen (96x130) **£20.00**

CINCH BARRIER STRIPS
5A 8-way (57x6) **£0.16**
10A 6-way (66x8) **£0.24**
10A 10-way (105x8) **£0.40**
10A 12-way (124x8) **£0.48**

CAM TIMERS by General Time
0-4.5min. with 22A 150VAC ms (70x70x60) **£4.00**
0-60sec. with 10A 250VAC ms (84x84 fascia) **£4.00**
1-1.7sec. with 10A 250VAC ms (80x80x50) **£4.00**

LARGE PANEL METERS (Clear view)
SI fam 140-0-140microAmp (107x145). Calibrated 0-14 and 7-0-7. Boxed **£5.00**
Anders 1mA f.s.d. (145x115). Calibrated 0-15KV. boxed **£5.00**

We have at time of press over 2 million Electrofil & Welwyn Metal Oxide Resistors well below manufacturer's price. Phone for details.

This advertisement is a fraction of stock held by us. Phone for details:

No mail order accepted unless over £5.00.
Hours of business 9.30am-6pm, Mon-Sat continuous. Carriage & packing charge extra. Government, colleges and export welcome.

We have considerable stock of PT10 & PT15 Presets. Special price for PT15 of the following value: 100Ω, 1k5, 2k2, 4k7, 10k, 22k, 47k, 100k. All the above values @£25/1,000. @12 1/2% VAT. Retail prices all values 10p either PT10 size or PT15. Open or enclosed.

2200μF 100V computer grade electrolytic Mullard **£1.00** +VAT. 12 1/2.

PL259 Plugs with Reducers **50p each** retail. SO239 to suit Plug (259) Bulkhead Socket **45p each** +8% VAT.

BNC Plugs. Brand new. **30p** +8% VAT. Either 50Ω or 75Ω.
N Connectors available at a fraction of list price. Phone for details.

Sealectro Plugs (miniature) Conhex for VHF & UHF applications

75p straight entry type 51-130-3187-91. **90p** right-angled gold plated type 055-014-3196. All the above RF connectors are held in depth and are brand new.

Cassette Monotape Heads 1/4" **£1.00 each**. Brand new.
Cassette Erase Tape Heads 1/4" **£1.00 each**. Brand new. + 12 1/2% VAT.
Potentiometers W. Wound 1Ω-100Ω by A. B. or Colvern Ltd, 1 1/2 watt **40p**, 3 watt **60p**, 5 watt **80p**.

ROTARY SWITCHES available in 30 different types, prices range from **45p-£1.20** +8%.
PREH Television Push-button Tuner Units. 4 and 6 button, brand new in original boxes. **75p each** + 12 1/2% VAT. Large quantity available.

SPECIAL OFFER 100k LIN Mono Slider Potentiometer by Noble (metal body). 63mm length, **price 20p each** + 12 1/2% VAT. All boxed as original. **Discount on quantity.**

The above advertisement is a fraction of our stock holding. Trade & Export welcome. No Mail Order other than trade. VAT extra 8% or 12%. P&P dependent on article, etc.

EDGE CONNECTORS
Single sided 0.1 pitch:
24-way (fixing holes 73mm)—UCL **£0.70**
40-way (fixing holes 118mm)—RS **£1.20**
78-way (length 204mm)—UECL **£1.50**

Single sided 0.15 pitch:
15-way (fixing holes 73mm). Gold plated. EB **£0.60**
18-way (fixing holes 85mm) inc. locating pin **£0.75**
32-way (fixing holes 136mm). Gold plated. EB **£1.50**
27-way (fixing holes 122mm) **£1.30**
Double sided 0.1 pitch:
2x40-way (fixing holes 117mm). Gold plated **£2.00**
Double sided 0.15 pitch:
2x40-way (fixing holes 165mm). Gold plated **£2.00**

PUSHBUTTON SWITCHES by A.B. Electronics
4-way 2PCO, **£0.50**, 7-way, 5x2PCO, 2x4PCO **£0.80**

ILLUMINATED SWITCHES by Licon
Rectangular snap in (01-800 series). 10A contacts. Min. flange bulb holders
2PCO Latching **£1.50** SPCO Momentary **£1.00**
2PCO Momentary **£1.50** Indicator only **£0.50**
Price includes lenses but not bulbs.
Red, yellow, blue, green and white lenses available.

KEYSWITCHES — HEAVY DUTY by Kraus & Naimer
2P (1PM-1PB) 12A 600VAC **£1.50** 49mm square
10P (4PM-6PB) 12A 600VAC **£3.00** fascia
By Baco:
8P (4PM-4PB) 10A 380VAC **£3.00**

LEVER SWITCHES GPO BP1000 Type
4PCO, 8PCO with knobs **£0.60**
All the above at 8% VAT

SPECIAL OFFER 2k 2 LIN single gang Potentiometer by Egen. 1/4" shaft, 3/8" bush plastic spindle. **Price 10p each** + 12 1/2% VAT. **Discount on quantity.**

Miniature Moulded Track Presets by Plessey. Screwdriver operation. 0.25W dissipation. PCB fixing. **15p each** +8%.
Open Cermet Presets. Most values in stock. **15p each** +8% VAT.
Trim pots 10Ω-500kΩ 10 turn and 20 turn **50p each** +8% VAT. By MEC, Paignton, Bournes Mini Square, 3/4" rectangular or 1 1/2" rectangular Cermet or W. Wound.

Convergence Pots. Most television values. **20p each** + 12 1/2% VAT.

MOTORS (+8% VAT)

PAPST Motor HSZ 20-25-2-425 EEM. 42V 50C/S 10μf cap across size: < 6cm Diam 3.4cm. Shaft: < 1.7cm Diam 4mm. **£1.00 each.**

Smiths Motor 240V 50 C/S 3-hole fixing. Spaced 4.75cm 3rpm. Shaft 1.5cm 3mm diam. **£1.50 each.**
Cassette-deck Motor by Fujiya. 6V DC. < 3.25cm. Diam. 3.5cm. Shaft diam 2mm < 9mm. 3-hole fixing 4cm to centres. **£1.25 each.**

General Time Motors with clutch. 240V 1/5rpm. 2-hole fixing. 4.75cm, 3cm depth. Body diam. 4.85cm. Shaft length 1cm, diam. 3mm. **£1.50 each.**
Crouzet Motors. Speeds 6rpm and 10rpm. 2-hole fixing. 4.75cm, 3.9cm depth. Body diam. 4.5cm. Shaft < 0.9cm. Diam. 4mm. **£1.50 each.**
Miniature DC Motor 4-15V operation. High torque. < 3.5cm. Body diam. 2cm, 2-hole front fixing, shaft diam. 1.75mm. **£1.00 each.**
Plus large stocks General Time Motors in the following speeds: 1/180, 1/2 rpm 12V DC; 1/5rpm 240V; 1rpm 240V.

Miniature Motor Clutches by General Time (USA) 24V operation. Body diam. 2.2cm, 6mm shaft centre. **£1.30 each.**

NEW SURPLUS NEW SURPLUS

TTL TEXAS INSTRUMENTS

AT DISPOSAL PRICES, in packs of 25 except 74198(15) and 74151(5).

STOCK UPDATE:					
Device	Stock	Unit Price	Device	Stock	Unit Price
7400	8475	0.75	74109	515	15
7401	75	0.75	74123	2000	25
7402	1459	0.75	74125	2264	20
7404	8650	0.75	74153	1425	30
7408	2000	0.8	74161	39025	40
7412	280	1.8	74163	700	40
7413	738	1.5	74164	275	40
7428	454	2.2	74175	1000	30
7430	7050	0.9	74198	889	80
7437	4054	1.2	74278	340	80
7438	1975	1.2	74393	1272	80
7485	40	40	75110	1115	60
7493	775	1.6	75451	4000	18
7496	581	30			

For quantities up to 1,000 prices as shown, Over 1,000 on any single item — where stocks allow — deduct 10%. Add 8% VAT (p&p free).

MINIMUM ORDER £20 + VAT.

LINEAR

CA3014	£2.00	LM723	.40
CA3018	.70	LM725	2.20
CA3020	2.00	LM733	.63
CA3028	.90	LM741	.15
CA3036	1.10	LM747	.86
CA3046	.70	LM748	.45
CA3048	2.30	KM3900	.70
CA3075	1.60	TAA700	4.25
CA3089	2.75	TBA510	2.25
CA3090	4.20	TBA520	2.40
CA3140	0.95	TBA530	2.20
NE555	.25	TBA550	3.40
NE556	.80	TBA800	1.00
NE560	4.20	TBA810	1.10
LM304	1.30	TBA820	1.10
LM308	.40	76013	1.40
LM324	.53	76023	1.40
LM340	.70	78XX series	
LM380	1.00		
LM709	.45	79XX series	
LM710	.60		

STABILISED POWER SUPPLIES:

FARNELL A15 Ip.210/240V @ 50-400Hz. Dual Op., adjustable 12-17V @ 100mA per rail. Remote sensing, current limit overload protection with automatic voltage reset. Card (130x164mm.) mounted, clearance 38mm. With manual — **£5.00** plus 8% VAT.

FARNELL 7/3SC Ip.120/240V. Op. has adjustable current limit 0-2A. Remote sensing. 96x93x188mm. Available in 5V, 15V, or 30V versions. Brand new. **£15.00** plus 8% VAT.

COUTANT OA2 op. amp power supply. Ip. 120/240V. Dual op. 12-15V @ 100mA (138x80x45mm.) Brand new. **£15.00**

COMPUTER APPRECIATION

86 High Street, Bletchingley, Redhill, Surrey RH1 4PA. Tel. Godstone (0883) 843221

DATA PRODUCTS Model 2310 LINE PRINTER. 300 lines per minute drum printer with E sign. In immaculate condition with very low hours. **£850.00**

CENTRONICS Model 101A matrix printer. 165 c.p.s. **£650.00.**

LOGIBAX Moxel LX180 matrix printer. 180 c.p.s. **£650.00.**

REPCO Model 120 matrix printer. 120 c.p.s. Parallel TTL interface, electro-sensitive Teledeltos paper. Compact desk-top unit. **£85.00.**

TELETYPE Model ASR33 with 20mA interface and reader control. Fully reconditioned. **£425.00.**

TELETYPE Model KSR33 ex ICL 1900 console. Needs 500mA drive current, but standard in all other respects. **£150.00.**

TELETYPE Model KSR33 with case and CCITT V24/EIA RS232 line unit by MOORE REED. **£225.00.**

I.B.M. 'Selectric' Model 72 I/O golfball typewriters. Refurbished, but WITHOUT head. **£150.00.**

I.C.L. Model 250 high speed (250 c.p.s.) optical paper tape reader. With photocell amps and facility to stop on a character. **£68.00.**

ELIOTTY 250 c.p.s. tape reader. As above, but previous model. **£45.00.**

ADDMASTER high speed miniature paper tape reader with TTL output. NEW. **£145.00.**

DATEK reader/punch units. Incorporating 40 c.p.s. Model 40 reader and 20 c.p.s. punch in compact desk-top unit. With power supply, but WITHOUT electronics. **£48.00.**

DIGITAL EQUIPMENT CORP. Model PC01 High Speed tape reader/punch. Incorporates 50 c.p.s. punch, and 300 c.p.s. reader, together with power supply and all electronics. Suitable for PDP 8/PDP 11. **£350.00.**

TELETYPE Model BRPE 110 high speed (110 c.p.s.) tape punch. **£95.00**

DATEK Model 40 tape reader. NEW and boxed. **£45.00.**

PERTEC Series 6000 magtape drives. Most models usually available from stock. **£250.00 - £475.00.**

PERTEC Model 6840-75-25 tape drive with cable and control for DATA GENERAL 'NOVA'. BRAND NEW. **£675.00.**

DIABLO Series 30 cartridge disc drives. Various models and options available. **£350.00 - £650.00.**

MOTOROLA CARD READER. Portable desk-top unit completely self-contained with RS232 serial interface. **£225.00.**

FLEXOWRITER Model 2301 machines now available fully refurbished in EIA and ISO codes. **£325.00.**

PDP 11 MEMORY type MS11-FP. 8K x 18 (parity) MOS on single card. **£275.00.**

PDP 8 SYSTEM comprising 4K processor and Model 580 magtape drive. **£260.00.**

GENERAL AUTOMATION Model SPC16 Minicomputer with 8K x 16 memory and expander box. Extensive software is available for this machine. **£425.00.**

INTERSL 'INTERCEPT' IM6100 prototyping system. PDP8E compatible microprocessor system with 4K CMOS and full programmers panel. **£850.00.**

WEIR Model DTM 1000 digital test set. Measure Volts A.C. and D.C., resistance and frequency. **£75.00.**

*VAT and carriage extra, all items.
*We are very keen to bid competitively for all good used or surplus equipment.

SOUTHEAST ENGLAND'S ELECTRONICS CENTRE

PHILIPS GM 6001 20 HZ - 1000 MHZ VVM

We are now able to offer this superb compact VVM at an even lower price.

Original specifications
1v-300v AC
300mv-1000v DC
10-1000MΩ resistance
Input Z
0.3v range 10MΩ
1v range 30MΩ
All others 100MΩ

Features include:
Large readable meter, switchable centre zero, lightweight, supplied complete with manual and mains plug, believed in good condition but untested.

NEW LOW PRICE
Less AC probe circuit shown in manual, only **£20.00** + p.p. £1.75

OPTO SMASH!

TIL 302/MAN 7 7 segment LED readout common anode direct drive (via resistors) from 7447 I.C. each **£1.00**

TIL 119/OC72 Darlington opto isolator 3 for **£1.00.**

SAVE THAT SPACE! THICK FILM RESISTOR NETWORK 7x100Ω resistor in DIL pack. Ideal for use with 7 seg. displays etc. 4 for **£1.00.**

TIL305 0.3" x 7" x 5 matrix LED alphanumeric readouts £4.75 each.

PHOTO TRANSISTOR Fairchild FPT-100 NPN silicon 30v, 25ma 4 for **£1.00**

LOGIC STATE TESTER

Yet another tremendous buy, this surplus P.C.B. consists of 12 in line LED's mounted on a board 10" x 3 1/2". 7 CMOS IC's transistor and resistor arrays are wired as a superb "Logic State Tester". It will accept, store and display a serial data word of up to 12 bits wide. We have obtained the circuit and can offer this complete with applications guide for only **£4.25**

HOW TO GET HERE
Victoria or London Bridge to East or West Croydon. 1 minute from West Croydon Bus and Rail Stations. 25 minutes Gatwick Airport.

TEST EQUIPMENT

OSCILLOSCOPES
Tektronix 545A double beam DC - 25MHz fast risetime complete with C.A. plug in **£195.00**

Marconi TF1330 dual input DC - 15MHz IV/CM **£125.00**

Marconi TF2200 double beam DC - 33MHz complete with 2 plug ins **£215.00**

Hewlett-Packard 105B double beam 100MHz sampling, complete with probes **£240.00**

Solartron CD568 single beam **£55.00**

Many other scopes ex-stock from **£25.00**

SIGNAL GENERATORS
Marconi TF867 15KHZ-30MHZ **£80.00**

Marconi TF801B/3/5 12-485MHZ **£140.00**

Airmec 204 0-320MHZ AM-FM **£125.00**

RBS SLSV BN 41002 25-480MHZ **£160.00**

RBS Sweep Generator 50KHZ-12MHZ **£225.00**

RBS SMLM BN4105 power sig. gen. 30-310MHZ **£140.00**

MISCELLANEOUS
RBS BN1523 UHF test receiver **£200.00**

RBS BN1523 Selective Microvoltmeter 10KHZ-30MHZ **£175.00**

Marconi TF1020A/IX 500 wattmeter, dual range, 0-50, 80-100 watts **£55.00**

DISPLAY I.C. AND TRANSISTOR BARGAINS NEVER CHEAPER

All I.C.'s and Transistors by well known manufacturers and fully guaranteed. No fall outs. Comprehensive data on I.C.'s 12p per type.

2N4351 N channel MOS FET, **2N4352** P channel MOS FET, 95p each **£1.50** per pair.

HIGH VOLTAGE NPN POWER SWITCHING transistors BVcbo 600v BVceo 500v 8vbe 5v 1c5 amps Pc 125 watts HFE 60 typ fr 2.5 mhz ideal invertors, etc. TO3 E 1.50 each 4 for **£5.00.**

BF258 NPN 250v @ 200 ma 40p each 3 for **£1.00.**

A.E.I. power TRIACS 10 amp 400v ready mounted on 2 1/2" x 2 1/2" heatsink 95p each 4 for **£3.50.**

I.R. BS801 2.5 amp 100v bridge rec. P.C. mount long leads. 30p each 4 for **£1.00.**

IN4998 4 amp 100v P.C. mount diodes Long leads 12p each 10 for **£1.00.**

LM309K +5v 1.2amp regulator **£1.00** each 6 for **£5.00.**

E.C.C. 1.6 amp 400v triacs 35p each 4 for **£1.00.**

2N1671B unijunction 450mw 30v 45p each 3 for **£1.00.**

2N1671B unijunction 450mw 30v 45p each 3 for **£1.00.**

IN4004 SD4 1 amp 400v diodes 6p each 20 for **£1.00.**

I.R. 10 AMP BRIDGE RECS. 200 volt working. **£1.00** each.

M.P.U. CORNER

SAVE £120 TANDY TRS 80 MEMORY UPDATE

Update your new or existing TRS 80 from 4K to 16K of RAM. Install your own chips and save £120.00. Kit includes full instructions and 8 x 16K full spec. devices. Simple plug-in and jumper **£108** change no soldering.

TRS 80 software now in stock. Programs include:
Micro Chess, Space Fighter, Startrek 3, etc.

RACAL SUPERGRADE CIO CASSETTES

screw fixing, complete with library cases, 2 for **£1.00**, 10 for **£4.50**, p+p 70p.

Self-adhesive die cut Cassette labels 20 for **£1.00**.

FPO3725 4 NPN 50v 500ma silicon transistors in 14 D.L.L. pack 65p each 2 for **£1.00.**

TEXAS LOW PROFILE I.C. SOCKETS
14 DIL 14p each 9 for **£1.00**
22 DIL 25p each 5 for **£1.00**
24 DIL 30p each 4 for **£1.00**

2N5109 R.F. power output 400ma 2.5 watts up to 1200 mhz TO5 70p each 2 for **£1.00.**

AF279 low noise P.N.P. germanium up to 780 mhz 30p each 4 for **£1.00.**

2N4304 WN720 F.E.T. transistor. 35p each 4 for **£1.00.**

POWER SUPPLY UNITS

5 VOLT 2.5 AMP T.T.L. P.S.U.

Made for T.T.L. this compact ex computer systems unit features a 10 amp transformer with D.C. outputs of 5 volts @ 2.5 amps and 7.5 volts @ 5 amps. The 5 volt output is fully regulated and smoothed and has electronic current limiting. May be easily modified for 5 volts @ 7.8 amps, believed working but untested.

Complete with circuit **£7.25** p.p. **£1-50**

MULLARD & PLESSEY HY-GRADE SMOOTHING CAPS

1500 mF 100v Screw Term **50p***
3300 mF 63v Screw Term **60p***
4500 mF 25v Screw Term **60p***

*Ex equipment but tested

SEMICONDUCTOR 'GRAB BAGS'

Amazing value mixed semiconductors, includes transistors, diodes, linear I.C.'s, triacs, diodes, bridge recs. etc. All devices guaranteed brand new, full spec. with manufacturers markings, fully guaranteed. **50 + BAGS £2.75 100 + BAGS £4.95**

ULTRA 0.1" EDGE CONNECTORS. Open ended, easily cut, 39 way double sided 75p each. 78 way single sided **£1.50** each.

PLESSEY EDGE STACKABLE DECADE SWITCHES Gold plated contacts, dimensions 2 x 2 x 3/8 80p each 8 for **£5.00.**

AMPHENOL 501 BNC chassis socket hole fixing 45p each

C90 Audio Cassettes screw type construction 40p each 3 for **£1.00.**

Scotch 215 Long Play Tape Brand new "low noise on 1200' 5 1/4" spools **£1.50** each 4 for **£5.00** + P.P. 45p

1000 Watt fully shrouded auto transformer block connections **£13.75** + P.P. **£2.25**

Bulbs 24v 14 watt white frosted S.B.C. 8 for **£1.00.**

S.B.C. Bulb Holders All steel cap, standard panel mount easily fixed via nut and round hole. Ideal disco displays, scoreboards etc. 4 for **£1.00.**

Xtal filters S.E.1. QC1121/7B miniature low insertion loss P.C. mount C.F. 10.7 mhz with B.W. of 7.5 khz. 2000Ω imp in-out Brand new at **£7.50**

Heavy Duty Flat Insulated Earth Braid 80-100 amp braided tinned copper in heavy clear P.V.C. sheath 40p per metre **£5.00** for 15 metres P.P. 8p per metre.

BULGIN miniature 6 way male chassis mount socket and matching shrouded free plug. 60p each 2 for **£1.00.**

Red L.E.D.'s full spec. 0.2" 12p each 10 for **£1.00.**

Dynamic Stick Mills 600Ω with built in on/off switch complete with lead and min. jack plug **£1.00** each

TO5 HEAT SINKS 'Thermalov' black anodised press on aluminium finned type. 15p each 10 for **£1.00.**

HARDWARE PACK Don't be stuck for the right nut and bolt for the job. Pack contains B.A. Metric, Unified, Self Tap, etc. nuts, bolts, screws, washers, etc. in brass bronze and steel. All steel items plated. Average contents 400-600 pieces. **£2.50** sold by weight, 2-lb bag

VERBATIM

Soft Sector Mini-Disks **£3.50** each.

FREE library case with pack of 10

50p p.p. on 10 pack

MUFFIN FANS

Ideal equipment cooling etc. tested, ex-equipment.

240v 50-60 HZ **£5.75** + p.p. 40p
110v 50-60 HZ **£4.75** + p.p. 40p

CRYSTALS

100KHZ **300p**
1MHz **370p**
3.2768MHz **350p**
10.7MHz **350p**
18MHz **300p**
27.135MHz **300p**

EDGEBOARD CONNECTORS

0.156" Solder Tail

2 x 10 way **85p**
2 x 15 way **100p**
2 x 18 way **120p**
2 x 22 way **135p**
2 x 25 way **160p**

KEYBOARD ENCODER

AY-5-378 **£10**
AY-5-3600 **£12**

INTEL 4004 MPU

Intel 4 bit MPU chip complete with data **£3.75** each

KEYBOARD

A special bulk purchase enables us to offer the above Keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt D.C. single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand "no time to test" price of only **£18.50** P.P. **£1-50**

ELECTRONIC COMPONENTS & EQUIPMENT

66% DISCOUNT

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 plus we always include something from our ads. for unbeatable value! Sold by weight

7lb £ 4-75 14lb £ 7-50 28lb £ 12-75 56lb £ 21-00

PLEASE ADD P + P £1.00

4CX250B

New and Boxed **£15.00** each

Where cost of post and packing not indicated please add 25p per order. Collection saves cost of postage but if collecting please telephone to check availability.

We are always interested in buying P.C.B.'s surplus components, test equipment, valves, etc. Phone for details

SMITHS EFFICIENCY RADIAL BLOWERS

Are your hot parts sweltering? Then keep them cool with our high efficiency radial snail type blowers. Made by Smiths, designed for continuous use in expensive electronic equipment very powerful and quiet, gives massive air flow to prolong component life and reliability. Easily mounted, air aperture 2 1/2" x 3". Ideal linear etc. Please state 240v or 110v operation. 50hz only.

BRAND NEW £4.25 P.P. **£1-10**

MINIATURE SNAIL BLOWER

This superb "little" blower, imagined as a cube measures only 3 1/2" x 3 1/2" x 3 1/2" with a 1 1/2" x 1 1/2" air output aperture. Almost silent running, ideal for miniature projectors, computers, P.S.U.'s, etc. Brand new at only **£3.99** + p.p. 55p.

ELECTRONICS

103 Tamworth Road Croydon CR9 1SG 01688 1833

MAIL ORDER INFORMATION:
All prices inclusive of VAT. Cash with order. Minimum order value **£1.00**. Postage quoted for UK only. Bona Fide account orders minimum **£10.00**. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard welcome.

TTLs by TEXAS	74174 93p	7415374 195p	9302 160p	RESISTORS	Carbon film 5% High
7400 13p	74175 85p	74LS377 170p	9302 175p	Stab Min To BS9110	5v 100Ω - 1MΩ E12
7401 14p	74177 90p	4000 SERIES	9308 316p	7p per pack of 5 (one value)	
7402 14p	74178 160p	4000 15p	9310 275p	£1.20 per 100 (one value)	
7403 14p	74180 90p	4001 17p	9311 160p	5p per pack of 3 (one value)	
7404 17p	74181 200p	4002 17p	9312 165p	£1.50 per oack of 100 (one value)	
7405A 90p	74182 90p	4006 85p	9314 225p		
7406 13p	74184A 150p	4007 18p	9316 225p		
7407 32p	74185 150p	4008 80p	9321 225p		
7408 17p	74186 500p	4009 40p	9322 150p		
7409 100p	74189 100p	4011 50p	9324 225p		
7410 15p	74192 100p	4012 18p	9328 200p		
7411 24p	74193 100p	4013 50p	9374 200p		
7412 20p	74194 100p	4014 84p			
7413 30p	74195 95p	4015 85p			
7414 50p	74196 25p	74LS378 200p			
7416 27p	74197 80p	4017 80p			
7417 27p	74198 150p	4018 88p			
7420 17p	74199 150p	4019 48p			
7421 40p	74200 110p	4020 100p			
7422 22p	74201 110p	4021 110p			
7423 34p	74251 140p	4022 100p			
7425 30p	74259 250p	4023 22p			
7426 30p	74265 90p	4024 50p			
7427 34p	74278 140p	4025 50p			
7428 36p	74280 150p	4026 130p			
7430 17p	74283 190p	4027 50p			
7432 30p	74284 400p	4028 84p			
7433 40p	74285 400p	4029 100p			
7437 35p	74290 150p	4030 55p			
7438 35p	74293 150p	4031 200p			
7440 17p	74294 200p	4033 180p			
7441 70p	74298 200p	4034 200p			
7442A 70p	74365 150p	4035 110p			
7443 112p	74367 120p	4041 80p			
7445 100p	74368 150p	4042 80p			
7446A 93p	74390 200p	4043 80p			
7447A 60p	74393 200p	4044 90p			
7448 60p	74394 125p	4045 100p			
7450 17p	74LS SERIES	4047 100p			
7451 17p	74LS00 16p	4048 55p			
7453 17p	74LS02 18p	4049 32p			
7454 17p	74LS04 18p	4050 48p			
7460 17p	74LS06 20p	4051 80p			
7470 36p	74LS08 20p	4052 80p			
7472 30p	74LS11 40p	4053 80p			
7473 34p	74LS13 45p	4055 125p			
7474 30p	74LS14 72p	4056 135p			
7475 36p	74LS20 22p	4059 100p			
7476 35p	74LS22 28p	4060 115p			
7480 50p	74LS27 38p	4063 120p			
7481 100p	74LS30 22p	4066 55p			
7482 84p	74LS32 40p	4067 450p			
7483A 90p	74LS34 40p	4068 120p			
7484 100p	74LS55 30p	4069 20p			
7485 90p	74LS73 50p	4070 30p			
7486 34p	74LS74 40p	4071 22p			
7489 210p	74LS75 50p	4072 22p			
7490A 33p	74LS83 90p	4073 22p			
7491 80p	74LS85 100p	4075 22p			
7492A 46p	74LS86 40p	4076 107p			
7493A 33p	74LS90 60p	4081 22p			
7494 95p	74LS93 60p	4082 22p			
7495A 70p	74LS107 45p	4093 40p			
7496 65p	74LS112 100p	4094 120p			
7497 180p	74LS123 75p	4098 120p			
74100 130p	74LS124 180p	4011 £11			
74104 65p	74LS128 120p	4502 120p			
74105 65p	74LS133 60p	4503 60p			
74107 34p	74LS138 60p	4507 55p			

Electronic Brokers

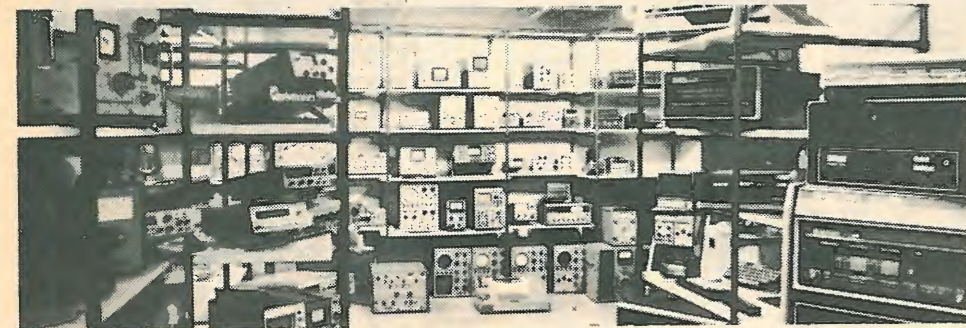
49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 298694

Our background

Electronic Brokers is Europe's largest specialist in quality, second user test equipment, mini-computers and associated peripherals. Established 11 years ago, we have pioneered the second user concept in Britain, and many overseas territories.

One reason for our success is the company's policy of continually

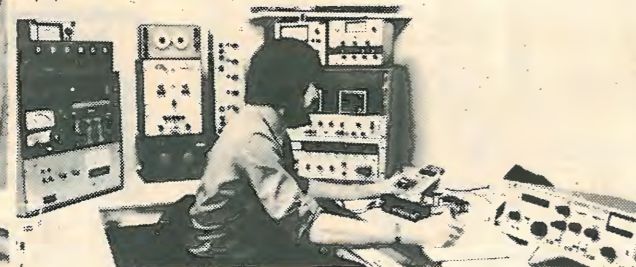
updating the type of equipment we sell. So from selling to private users, the business has rapidly developed, and today, our customer list includes leading international companies, research establishments, universities, colleges and government institutions throughout the world.



Back up

To support our growth we have a skilled team. This includes trained sales staff, whose role is not only to sell, but provide a helpful information service to our many customers. Backing this team is our own service laboratory where technicians monitor each item of equipment we sell. Our maxim is

service, and those who have dealt with us will know that we endeavour to always live up to our reputation. Equipment can be configured to customer's exact requirement, and a number of options can be made available — almost like custom-tailoring.

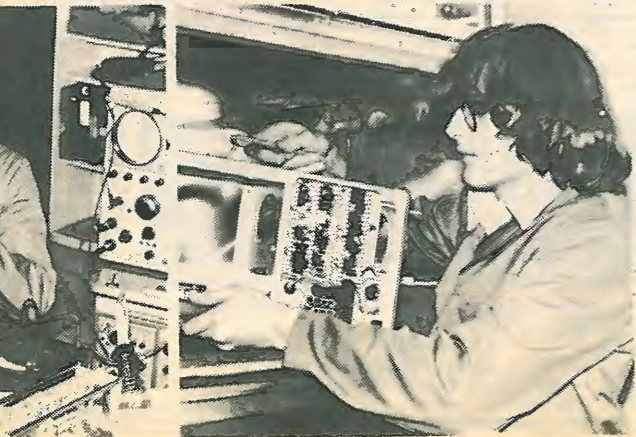


Refurbishing

Our own service laboratory checks each item that arrives at our Pancras Road headquarters. Electronic test equipment is then thoroughly cleaned and a schedule

prepared for any work which needs to be carried out to meet customer's requirements. Whether it is new test equipment or used, all items pass through the service

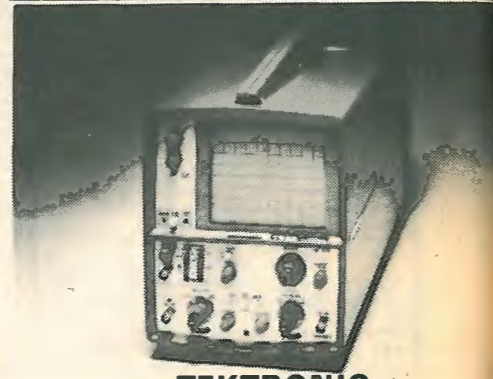
laboratory where they are given final tests to ensure they meet manufacturers' specifications, before delivery to the customer.



WW — 109 FOR FURTHER DETAILS

SEND FOR NEW 86 PAGE CATALOGUE

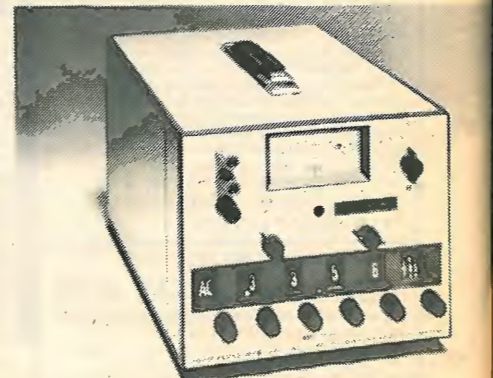
Containing latest information on our stocks of test equipment, mini-computers, computer peripherals, stroboscopes and tachometers. Airmail to overseas addresses £2.



TEKTRONIX
PORTABLE OSCILLOSCOPE TYPE T.932
DC-35 MHz at 2nV/cm.
Trigger holdoff. Bright CRT Display.
Lightweight.
SUPERB CONDITION — QUANTITIES AVAILABLE
£550.00



PHILIPS
A.M./F.M. SIGNAL GENERATOR
TYPE PM 5326
100kHz-125MHz.
Built-in 5 digit counter displays
RF carrier, marker and ext. freqs.
Stabilised o/p level.
Wobbulator facility for I.F. amplifiers AM/FM Radio & T Receivers.
AS NEW CONDITION. £695.00



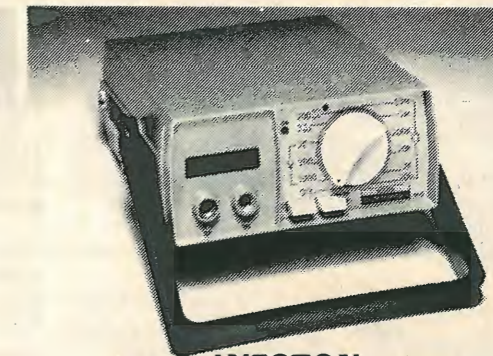
FLUKE
AC/DC DIFFERENTIAL VOLTMETER
TYPE 883AB
1mV - 1100V. 20Hz - 100kHz.
AS NEW CONDITION.
SHOWING A SUBSTANTIAL SAVING ON LIST PRICE.
£975.00

No.1 in Europe for Test Equipment

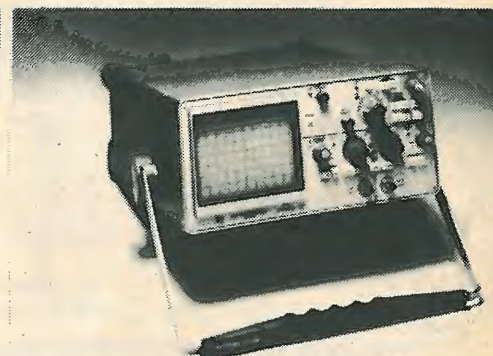
Add 8% VAT to all prices



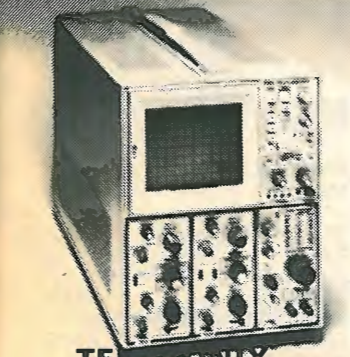
GENERAL RADIO
SOUND LEVEL METER 1933
WITH CASSETTE DATA RECORDER 1935
& C weighting. 10dB-130dB.
Equipped with 1/2 microphone.
Wide band analyser with 10
octave freqs. 31.5Hz-16KHz.
Uses high quality C60 cassettes.
Fully operated.
£2,600.00



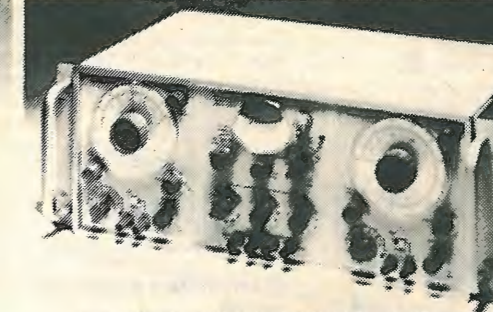
WESTON
DIGITAL MULTIMETER TYPE 4449
3 1/2 digit. Scale length 1999.
AC-DC Volts 100mV-1kV.
100µV resolution.
AC-DC current 100µA-1mA.
UNUSED CONDITION — QUANTITIES AVAILABLE.
£79.50



TEKTRONIX
PORTABLE OSCILLOSCOPE TYPE 432
Dual Trace. DC-25MHz.
1mV-10V/Div. 20nS-5S/Div.
A superb solid state scope.
Ideal for the service engineer.
QUANTITIES AVAILABLE.
£495.00



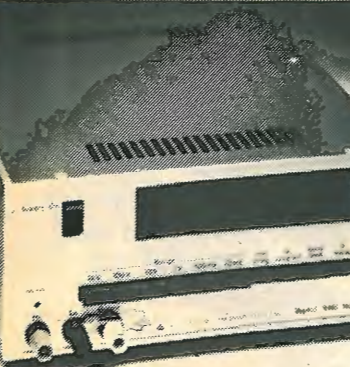
TEKTRONIX
STORAGE SCOPE TYPE 7313
Double split screen.
7A18 and 7B53A Plug-in units.
25MHz. 5mV-5V/Div.
5S-5S/Div. with X10 Mag.
Delayed and intensified sweep.
Div./µS max writing speed.
£2,500.00



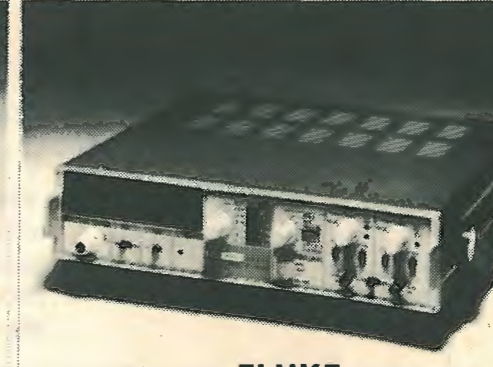
MARCONI INSTRUMENTS
TWO TONE A.F. SIGNAL SOURCE
TYPE TF 2005R
2 Identical Oscillators.
20Hz-20kHz.
0-11dB attenuator with metred O/P.
Z 600Ω - 150Ω - 75Ω.
QUANTITIES AVAILABLE.
SUPERB VALUE.
£35.000



HEWLETT PACKARD
WAVE ANALYSER TYPE 310A
1kHz - 1.5MHz. 10µV - 100V.
Dynamic range 75dB.
B.F.O. and recorder O/P.
Built in AM, LSB & USB Detector.
£1,200.00



GOULD ADVANCE
TRUE R.M.S. VOLTMETER
TYPE DRM6
DC coupled.
3 digit
rate display + 100% overrange.
Accuracy 0.1% ± 1 digit
from 10mV FS. to 1000V F.S.
UNUSED CONDITION.
QUANTITIES AVAILABLE.
£295.00



FLUKE
UNIVERSAL TIMER COUNTER
TYPE 1953A
Options 15 & 16
9 digit. LED display.
DC - 125MHz. 30mV sensitivity.
Variable trigger level.
IEEE interface, rear inputs.
£850.00



SOLARTRON
DIGITAL MULTIMETER
TYPE A.243
5 1/2 digit. Scale length 119999
AC volts 1.850V. 10µV resolution
DC Volts 100mV-1kV. 1µV resolution.
Resistance 1kΩ - 10MΩ.
£675.00

Electronic Brokers

49/53 Pancras Road London NW1 2QB Tel: 01-837 7781. Telex 29869

No 1 for Mini Computers and Peripherals Electronic Brokers

BRIDGES

GENERAL RADIO
Impedance Bridge 1608A £1450

MARCONI INSTS.
In Situ Univ Bridge TF2701 £395

WAYNE KERR
Univ. Bridge B221 (0.1%) £275
Univ. Bridge B521 (1%) £120
Low Impedance Adaptor Q221 £75

CALIBRATION EQUIPMENT

HEWLETT PACKARD
DC Voltage Source & Differential Voltmeter 740B £850
DC Voltage Source & AC/DC Diff. Voltmeter 741B £975

FLUKE
DC Voltage Calibrator 332A £1350
True R.M.S. Differential Voltmeter 931B £1050
High Voltage Divider 80E £225

TEKTRONIX
Time Mark Generator 184 £275
Time Mark Generator 2901 £450
5nS Pulse Generator 2101 £525
Pulse Generator 109 £320

SOUND LEVEL METERS

GENERAL RADIO
Portable Sound Level Meter 1565B £225
Portable Sound Level Meter 1981 £575
Portable Sound Level Meter 1983 £190

DIGITAL COUNTERS

GOULD ADVANCE
500MHz Counter TC15 + 15P1 £495

80MHz Counter TC17 or TC17A £195
10MHz Counter TC21 £195

FLUKE
80MHz Multi-Function Counter 1900A £175
125MHz Multi-Function Counter 1910A-01 £285
125MHz Multi-Function Counter 1910A £199
520MHz Communications Counter 1920A-06 £490
125MHz Multi-Function Counter 1925A £405
520MHz Univ. Timer Counter 1953A-07 £675
125MHz Univ. Timer Counter 1953A-15-16 £850

PHILIPS
80MHz Timer Counter PM6612 £405
1GHz Timer Counter PM6615 £795
80MHz Freq. Counter PM661 £185
512MHz Freq. Counter PM6645 £710

DIGITAL VOLTMETERS & MULTIMETERS

ADVANCE
True R.M.S. Voltmeter DRM6 £295

FLUKE
3 1/2 digit D.M.M. 8020A £99
4 1/2 digit D.M.M. 8040A-01 £220
4 1/2 digit D.M.M. 8600A £290

HEWLETT PACKARD
5 1/2 digit D.M.M. 34702A + 34740A £295

PHILIPS
4 digit D.M.M. PM.2424 £300
4 1/2 digit DC. D.V.M. PM2443 £430
3 1/2 digit D.M.M. PM2513 £90
3 1/2 digit D.M.M. PM2513A £95

SCHLUMBERGER-SOLARTRON
5 1/2 digit Digital Multimeter A243 £675

OSCILLOSCOPES

COSSOR
35MHz Dual Trace. CDU.150 £450
50MHz Dual Trace. 4000 £495

DYNAMCO
30MHz. Dual Trace. 7100 £350
40MHz. Dual Trace. 7500 £495

PHILIPS
50MHz Portable Dual Trace. PM3240 £950
5MHz Miniscope Battery/Mains PM3010 £325

TEKTRONIX
15MHz Battery/Mains D.T. 422 £750
24MHz Dual Trace Bench. 543B + CA £350
50 MHz Dual Trace Bench. 647 + 10A2 + 11B2 £600
Sampling 661 + 5T3 + 4S1 £585

24MHz D.T. Bench. 545B + CA £425
50MHz D.T. Bench. 547 + 1A1 £775
80MHz D.T. Bench 585A + 82 £775
Digital Delay Plug In. 7D11 £850

Four Trace Plug In M £275
Four Trace Plug In 1A4 £600
Dual Trace Plug In CA £60
Differential Comparator Plug In Z £150

OSCILLOSCOPE PROBES

ELECTRONIC BROKERS (NEW)
X1 Probe Kit EB90 £9
X10 Probe Kit EB91 £11
X1 X10 Probe Kit EB95 £15

GREENPAR
X1 x 10 Probe Kit GE 81600/2 £27

SIGNAL SOURCES

ADVANCE
Sine/Square Oscillator H1E £80

Low Dist. Oscillator SG68A £120

HEWLETT PACKARD
AM/FM. Generator 202H £495
VHF Sig. Generator 608D £495
VHF Sig. Generator 608E £675
UHF. Sig Generator 612A £950

MARCONI INSTS.
A.M. Sig. Generator TF801D/1 from £400
A.M. Sig. Generator TF801D/8S £600
AM/FM Sig. Gen. TF995A/2M £475
AM/FM Sig. Gen. TF995A/5 £380
AM/FM Sig. Gen TF995B/2 £675
AM/FM Sig. Gen. TF2006 £875
Two Tone Source TF2005R £350

A.F. Oscillator TF2000 £325
R.C. Oscillator TF1101 £120
A.F. Oscillator TF2100 £150

PHILIPS
Function Generator PM5167 £875
AM/FM Signal Generator PM5326X £735

SIGN/ROGERS
Low Distortion Oscillator S324 £90

MISCELLANEOUS

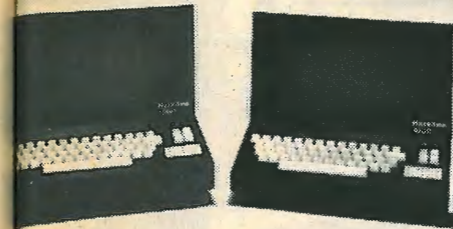
BRUEL & KJAER
Measuring Amplifier 2607 £1200
Deviation Bridge 1504 £190

E.N.I.
R.F. Power Amplifier 500L £315

HEWLETT PACKARD
Distortion Analyser 333A £515

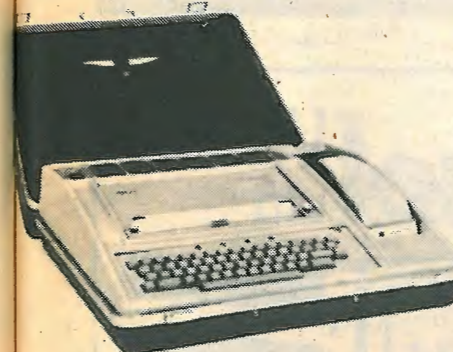
MARCONI INSTRUMENTS
A.F. Transmission Test Set TF2332 £425
M.F. Transmission Test Set TF2333 £600
Quantization Distortion Tester TF2343 £400
Distortion Factor Meter TF2331 £435
Deviation Meter TF791D £195

PHILIPS
Pulse Generator PM5712 £525
Pulse Generator PM5715 £575
Pulse Generator PM5775 £600
Pulse Generator PM5776 £700



HAZELTINE VDUs

BULK PURCHASE BRINGS YOU THESE TOP-QUALITY VDUs AT LOW LOW PRICES.
Teletype compatible. 12" Diagonal Screen. TTY format keyboard. 64 ASCII character set. 5 x 7 dot matrix. Switch-selectable transmission speeds up to 9600 baud. Switch-selectable parity. Standard RS232 interface. Glass Teletype Models—
H-1000 (960 characters) £350.00
H-1200 (1980 characters) £425.00
Buffered/Editing Model with direct cursor addressing and detachable keyboard-H2000A (1998 characters) £495.00.



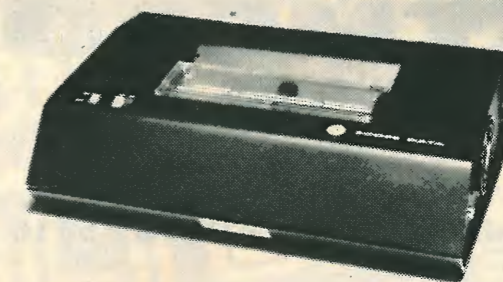
TEXAS SILENT 700

Model 725KSR Terminal mounted in integral carrying case complete with built-in acoustic coupler. 64 ASCII character set with 5 x 7 dot matrix. 30 cps. Weight 35lbs. Dimensions 21 1/2" x 19" x 6 1/2". £695.00.



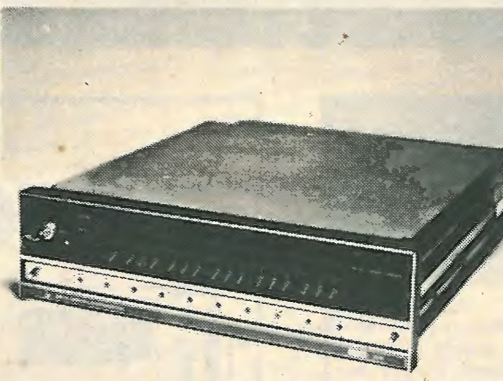
NEW ASCII KEYBOARDS

756 ROM-encoded 56-station keyboards with full 128 ASCII character set. Standard TTL logic. Power requirements +5 -12V. Supplied with full technical data and circuitry (see next column for prices).



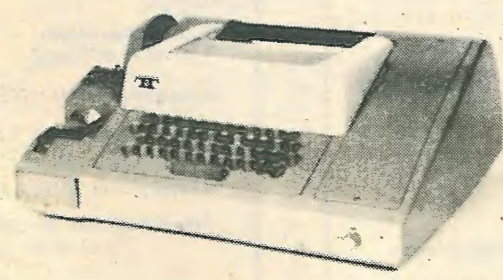
SCOPE DATA PRINTERS

240 cps. 80 column receive-only matrix printer. Full upper and lower case ASCII character set. Standard RS232 interface. Electro-sensitive printing ensuring quiet operation. BRAND NEW SURPLUS. ONLY £695.00.



DATA GENERAL NOVA

Special Purchase of these popular 16-bit minis. Prices from: £995.00 (4K 1200 series CPU) to £3,500.00 (32K 800 series CPU with 2.5 Meg disc).



ASR33 and KSR33 TELETYPE

Input/Output terminals with 64 ASCII character set. 110 baud operation. Paper tape punch and reader (ASR33 only). Choice of interface (20mA or RS232) KSR33 — £425.00, ASR33 — £650.00, Pedestal £30.00.

DEC EQUIPMENT

BIG SAVINGS ON OUR LARGE STOCKS OF PROCESSORS, PERIPHERALS AND ADD-ON MEMORY:
PDP8A Add-on RAM Read/Write Memory: £225
MSBAA 2K £375
MSBAA 4K £550
PDP11-04/11-34 Add-on MOS Memory: £550
MS11FP 8K £550
MS11JP 16K £1,200
PDP11-05/11-40/11-45 Add-on Parity Core Memory: £1,000
MM11UP 16K £1,250
MF11UP 16K complete with backplane £1,500
PC81 High Speed Reader/Punch & Control for PDP81 £895
DD11A 4 SPC-slot backplane £195
DR11B DMA interface complete with backplane £750
KW11P Programmable Clock £345
PR11 High-speed paper tape reader and control £1,450
RT01AB Single-line data entry terminal with hex keyboard and 20mA interface £150
TC11 TU56 DECtape drive and control £1,395

COMPUTER PERIPHERALS

PRINTERS
CENTRONICS MODEL 101 MATRIX PRINTER
64 ASCII (uppercase) character set. 132 Column. 165 characters per second. 5 x 7 dot matrix. Parallel Input. PRICE £750
WANG THERMAL PRINTERS
64 ASCII (uppercase) character set. 80 Columns. Silent Operation. 30 characters per second. RS232 Input. PRICE £495

SEALLECTRO PATCH BOARDS
Program boards for switching and interconnecting input/output circuits. 11 x 20 XY matrix. Interconnection is by means of shorting. Skip and component holding pins (not included). Dimensions: 7 1/2" x 5 3/4" x 1 1/2".

PRICE £12.50 (mail order total £14.58)
BURROUGHS SELF-SCAN ALPHANUMERIC DISPLAYS
Single line panel display with 16 or 18 5 x 7 dot matrix positions and a repertoire of 64 characters. Input requirements: a six-bit (binary) code must be present at the data input terminal during the first five clock pulses of each character position. Power requirements: Positive logic supply 4.75-5.25V, 160mA. Negative logic supply -11.4 - -12.6V -50mA. Display power supply 237.5-262.5V 30mA. Supplied with full technical data.
£55 (mail order total £60.21)
CALCOMP 565 DIGITAL DRUM PLOTTER Y-Axis 11", X-Axis 12". Maximum speed 900 increments (6.3") per second. Input: Positive or negative polarity pulses, amplitude greater than 10V, rise time less than 10 microsec., minimum pulse width 4 microsec. Source impedance less than 500 ohms.
£55 (mail order total £60.21)

BADGE READER MATRIX TYPE MODEL 161
AMP Model 161 split matrix type (6x14) + 6x14. Gold plated contact spring and interposer buss. Dimensions: 3 1/2" x 4" x 2 1/4". PRICE £25 (mail order total £28.08)

NEW KEYBOARDS

(mail order total)
KB756 key-stations mounted on PCB £49.50 £55.08
KB756MF, as above, fitted with metal mounting frame for extra rigidity £55.00 £61.02
Optional Extras:
KB15P Edge Connector £3.25 £4.05
KB701 Plastic Enclosure £12.50 £14.31
KB702 Steel Enclosure £25.00 £28.82
KB710 Numeric Pad £8.00 £9.18
KB2376 Spare ROM Encoder £12.50 £14.04

LATEST ADDITION TO THE RANGE
KB771 71 Station keyboard incorporating separate numeric/cursor control pad and installed in custom-built steel enclosure with textured enamel finish. Case dimensions: 17 1/4" x 7 1/2" x 3 3/4". Total weight: 4Kg.
PRICE £95 (mail order total £108)
Quantity Discounts available.

NEW KEYTOP/KEYSWITCH KITS—ASCII CHARACTER SET BRAND NEW SURPLUS
Pack of 58 keytops and keyswitches comprising 49 "Qwerty" set. TTY format + 9 Edit/Function keys.
PRICE £15 (mail order total £17.28)

SURPLUS KEYBOARDS

KB3 ROM-encoded ASCII keyboard with 63 push-button key stations. Selectable mode—either full ASCII or TTY. Selectable parity. TTL-compatible. Power requirements: +5V-12V. Constructed on rugged PCB with metal mounting plate. Supplied with full technical data. Manufacturers surplus.
ONLY £35 (mail order total £39.42)

18-KEY PUSH-BUTTON CALCULATOR KEYBOARDS

18 keys including numerals 0-9, decimal point, C K + - x / = Push button "make-or-break" keys. Overall dimensions 5 1/2" x 4 1/4" x 1 1/2". Mounted on PCB with output from each key + common.
PRICE £4 (mail order total £4.58)

Carriage and Packing charge extra on all items unless otherwise stated.

Add 8% VAT to ALL PRICES

Please note: All instruments offered are secondhand and tested and guaranteed 12 months unless otherwise stated.

Hours of Business: 9 a.m.-5 p.m. Mon.-Fri.: closed lunch 1-2 p.m.

A copy of our trading conditions is available on request.

ALL INVOICES, ENQUIRIES, ETC. TO
OUR TEMPORARY ADDRESS OF

CHILTMEAD LTD

**NORWOOD ROAD
READING**

Telephone No.: READING 65916

AUTOMATIC/STANDBY INVERTERS

These units are designed to permanently provide power to essential electrical equipment. Incorporating a 12V DC trickle battery 500mA charger operating while the public power supply is maintained and internal inverter with control relays that automatically restore mains power in the event of a domestic power failure. All assembled in ventilated cases.

Features: Neon panel indicators to show mains or inverter operating mode, DC inline fused, AC output fused, separate DC and a.c. relays.

Inverter power output provides 240V AC at 50Hz with square wave form smoothed and filtered.

Installation is simple, just connect the mains lead to an earthed socket, clip the battery leads onto a 12V DC car battery, insert the lead of the electrical item you want to permanently operate. Guaranteed 2 years. Delivery 16/20 days.

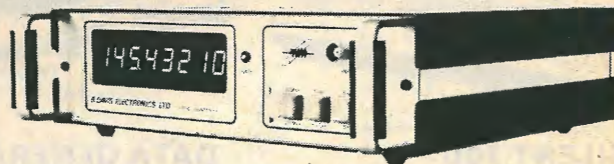
ACE/1—Cased 6½" x 4½" x 5" at 150 watts	£38.50
ACE/2—Cased 8" x 6" x 6" at 200 watts	£46.73
AC/4—Cased 12" x 10" x 10" at 300 watts	£70.87
AC/2—Cased 12" x 10" x 10" at 400 watts	£91.00
CE/7—Cased 12" x 12" x 12" at 700 watts	£158.90

Please add £5.00 per unit carriage — Overseas at cost

Callers by appointment — Telephone: 01-736 0635

**ELECTROVANCE, P.O. BOX 191
LONDON SW6 2LS**

crae UK
LTD.



Model HFC600-D 1HZ=600MHZ Frequency Counter fitted with XTAL Oven 8 digit .5" LEDs driven to high brightness.

Ranges= 1HZ - 50MHZ= 60 - 600MHZ.

Gate = XTAL 5.24288MHZ 1.0 or .1 sec. by pushbutton selection.

Input Imp=50Ω at 60 - 600MHZ 1Ωin par with 15PF at 60MHZ.

Typical Sensitivity = 10mV = 50MHZ. 20mV = 200MHZ. 150mV = 500MHZ.

Resolution= 1HZ=0-60MHZ. 10HZ=60-600MHZ.

Typical Stability = 3 parts 10⁻⁶ per °C after 1 min. warm-up time.

Power= 100-240V A.C. 40-60HZ=9-16V D.C.

Size=H.68mm W=263mm D=216mm. (Provision for int. batt pack). Anodized aluminium cabinet.

Price **£145.00 + VAT**

7 HUGHENDEN ROAD, HASTINGS, SUSSEX,
TN34 3TG ENGLAND. Telephone: (0424) 428131

WW — 101 FOR FURTHER DETAILS

You should be working with Microprocessors

MICRO'S AT WORK

A 2 day intensive course for managers, engineers and programmers who need a better understanding of how to design systems based on microprocessors.

A Planned and Co-Ordinated Training Course
Micro's at Work is a 'total immersion' course which takes you progressively from basics right through to practical applications. You'll learn the unifying principles, the most important techniques, how to establish good design habits from the start, how to structure your designs so they're easy to implement, easier to test and lead to better products. It's two highly intensive days that will make micros work for you.

Learn from the Professionals

The course leaders are professional lecturers, with the rare ability to communicate the basic principles effectively. They are also widely published authors engaged in front line research in micro-electronics, and are actively working with industrialists on the design of successful microprocessor based products.

Silicon—A New Approach to Seminars

From the start you're in a total learning environment which sets new standards in technical training. The courses are manufacturer and publisher independent. Where necessary slides, film and closed circuit TV are combined to put over clearly even the most complex points. And at the end of each course you are given comprehensive easily understood lecture notes that enable you to use the course materials in your subsequent work. Delegates will be invited to extension courses and 'in house' and 'hands on' sessions can also be arranged.

Your seminar leaders are:
Dr. K. D. Baker, B.Sc., D. Phil.,
M.I.E.E.E., M.B.C.S., M.A.C.M.
P. Cooke, B.Sc., F.I.E.E., C. Eng.,
M.I.E.E.E.
Dr. D. J. Woollons, B.Sc., Ph.D.,
M.I.E.E., C. Eng.

The following have also agreed to contribute

Prof. Colin
Prof. of Computer Science, University of
Strathclyde

Tony Davies
Founder of Membrain Ltd.
M.D. of Schlumberger UK and Solartron Ltd

Prof. Gilles
Prof. of Computer Science, University of
Glasgow

Dr. Martin Healey
Chairman NCC Microcomputer Committee.
Reader in Control, University College Wales

Howard Komstein
Application Manager Intel Corporation UK

Chris Nabavi
Head of Microcomputers E.R.A.

Gill Ringland
Software Manager Inmos Ltd

Derek Roberts
M.D. of Plessey Microelectronics
Chairman S.R.C. Working Party on Computers

Dr. Jan Stuart
Founder Chairman of the Microprocessor
Application Group (I.E.E.)
Head of Microprocessor Application Section D.O.I.
Warren Spring Laboratory and Chief Technical
Advisor MAPCON

SILICON

For more information

I would like more information on this and other Silicon Courses

I am interested in "in house" training

For Tickets to MICRO'S AT WORK

Please register the delegates named on the right for the following courses:

Dates

April 18 & 19 — Manchester May 8 & 9 — London

April 24 & 25 — Cambridge May 15 & 16 — Glasgow

May 1 & 2 — Bristol May 22 & 23 — Bournemouth

Enclose a cheque for £120 plus VAT total £129.60 for each

delegate, payable to 'Silicon Seminars'. Fee includes all

conference materials, coffee, luncheons and teas but not

accommodation. Your tickets, a VAT receipted invoice and full

pre-conference materials will be sent to you by return.

SILICON

WW — 108 FOR FURTHER DETAILS

Name _____

Name _____

Name _____

Company _____

Address _____

Post to: Miss Jennie Wisher, Silicon Seminars, PO Box 67
Cobham, Surrey. KT11 3AG Telephone 09326-2388

SERVICE TRADING CO

WHY PAY MORE?!

MULTI RANGE METERS Type MF15A, A.C./D.C. volts 10, 50, 250, 500, 1000, Ma. 0.5, 0.10, 0-100. Sensitivity 2000V, 24 ranges. Dimensions 133 x 93 x 46mm. Price £7.00 plus 50p P&P (£8.10 inc. VAT & P).



TRIAIC. Raytheon type symmetrical Triac. Type Tag 250/500V. 10 amp 500 p.w. Glass passivated plastic triac. Swiss precision product for long term reliability £1.25 P&P 10p (£1.46 inc. VAT & P) (inclusive of date and application sheet). Suitable Diac 22p.

0 to 60 MINUTES CLOCKWORK TIMER. Double pole 15 amp 230AC. Contacts (no dial). £1.50, P&P 30p (£1.94 inc. VAT & P). N.M.S.

MERCURY SWITCH Size 27m x 5mm. 10 for £5.00, P&P 30p, total including VAT £5.72. Min. quantity 10. N.M.S.

230 VOLT AC FAN ASSEMBLY Powerful continuously rated AC motor complete with 5 blade 6 1/2" aluminium fan. New reduced price £3.00 P&P 65p (£3.94 inc. VAT & P). N.M.S.

21-WAY SELECTOR SWITCH with reset coil The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil. 230/240V. A.C. operation. Unit is mounted on strong chassis. Complete with cover. Price £5.50 P&P 75p (£6.75 inc. VAT & P). N.M.S.

VORTEX BLOWER AND VACUUM UNIT Dynamically balanced totally enclosed 9" rotor with max. air delivery of 1.5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular apertures fitted to base of unit. Powerful continuously rated 115v a.c. motor mounted on alloy base with fixing facilities. Dimensions: Length 22cm x width 25cm x height 25cm. These units are ex-equipment but have had minimum use. Fully tested prior to despatch. Price £12 + £1.50 P&P (£14.58 inc. VAT & P). Suitable transformer for 230/240v a.c. £6 + £1 P&P (£7.56 inc. VAT & P).

CENTRIFUGAL BLOWER Aperture type FF8 1608 022 220/240V A.C. Suction or blow from 16x14cm. Price £3.75 P&P 75p (incl. VAT £4.88). Other types available. S.A.E. for details. N.M.S.

24V DC BLOWER UNIT! USA made. 24V D.C. 8 amp blower that operates well on 12v. 4 amp D.C. producing 30 cu. ft. min. at normal air pressure. Maximum housing dia. 110mm. Depth inc. motor 75mm. Nozzle length 19mm. dia. 22mm. Ideal for cooling mobile equipment, car, caravan, etc. £4.50 P&P 75p (£5.67 inc. VAT & P). N.M.S.

MINIATURE UNISELECTOR 12V. 11 way 4 bank (3 non-bridging). 110mm. £2.50 P&P 35p (£3.08 inc. VAT & P).

MICRO SWITCHES Sub mini lever switch type MML46. 10 for £2.50. Type 3 115M 906T 10 for £2.50 post paid (£2.70 inc. VAT & P). BF lever operated 20a. c/o. mf. Unimac USA. 10 for £4.00 plus 50p P&P (min. order 10). (£4.88 inc. VAT & P). D.P. C/O lever m. switch, mfg. by Cherry Co., USA. Precious metal, low resistance contacts. 10 for £2.50, P&P 30p. Total inc. VAT £3.02 (min 10). N.M.S.

NEW HEAVY DUTY SOLENOID Mfg. by Magnetics Devices. 240V A.C. Operation approx. 10lbs. pull at 1/4 in. Rating intermittent. Price £4.00 P&P 60p (£4.96 inc. VAT) N.M.S. **PYE EYETHER** 240V A.C. Solenoid. Approx. 1 lb. pull, 1/4 in. travel, intermittent rating. Price £1.00 P&P 20p (£1.30 inc. VAT & P). N.M.S. **WESTOOL TYPE HMB MODEL 2** 240V A.C. Approx. 1 1/2 lb. pull at 1/4 in. Rating 1. Price £1.50 P&P 20p (£1.84 inc. VAT & P). N.M.S.

240 A.C. SOLENOID OPERATED FLUID VALVE Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring 1/2 in. b.s.p. inlet outlet. Precision made. British mfg. Price £3.50 Post 50p (£4.32 inc. VAT & P). N.M.S.

INSULATION TESTERS (NEW) Test to I.E.E. spec. rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in. W. 4 in. H. 6 in., weight 6 lb. **500 VOLTS 500 megohms** £49.00 Post 80p (£53.78 inc. VAT & P) **1000 VOLTS 1000 megohms** £55.00 Post 80p (£60.26 inc. VAT & P) SAE for leaflet.

YET ANOTHER OUTSTANDING OFFER New IMFD 600V Duffler wire ended capacitors. 10 for £1.50 P&P 50p (£2.16 inc. VAT & P). (Min 10). N.M.S.

VARIABLE VOLTAGE TRANSFORMERS INPUT 230 v. A.C. 50/60 OUTPUT VARIABLE 0/260V A.C. BRAND NEW. All types. 200W (1 Amp) fitted A/C volt motor **£14.50** **0.5 KVA (Max. 2 1/2 Amp) £17.00** **1 KVA (Max. 5 Amp) £22.50** **2 KVA (Max. 10 Amp) £37.00** **3 KVA (Max. 15 Amp) £45.50** **5 KVA (Max. 25 Amp) £74.00** **10 KVA (Max. 50 Amp) £168.00** **17 KVA (Max. 75 Amp) £260.00** Carriage extra

LT TRANSFORMERS 0-10V 15V at 3 amp (ex new equip) £2.50 P&P 50p (£3.24 inc. VAT) 13.0-13V at 1 amp £2.50 P&P 50p (£3.24 inc. VAT) 25.0-25V at 2 1/2 amp £4.50 P&P 75p (£5.87 inc. VAT & P) 0-4V 6V 24V 32V at 12 amp £18.50 P&P 11.90 (£22.03 inc. VAT & P) 0-6V 12V at 20 amp £14.70 P&P 11.50 (£17.50 inc. VAT & P) 0-12V at 20 amp or 0-24V at 10 amp £12.00 P&P 11.50 (£14.58 inc. VAT & P) 0-6V 12V at 10 amp £8.25 P&P 11.25 inc. VAT £10.26 (0-6V 12V 17V 18V 20V at 20 amp £19.00 P&P 11.50 £22.15 inc. VAT & P) 0-10V 17V 18V at 10 amp £10.50 P&P 11.50 inc. VAT £12.96 Other types in stock phone for enquiries or send sac for leaflet

ROTARY VACUUM AIR COMPRESSOR & PUMP Carbon vane oil-less. 100/115v a.c. 1/12 h.p. motor 50/60 cycle 2875/3450 rpm. 20" vacuum 1.25 c.f.m. 10 p.s.i. (approx. figures). Mfr. by Gast Co. Fraction of maker's price £14.00 P&P £3.00 (Total £18.20 inc. VAT). Suitable transformer £3.50 P&P 50p. (Total £3.78 inc. VAT). N.M.S.

BLOWER/VACUUM PUMP 3 phase A.C. motor 230/250v or 380/440v. 1.425 rpm 1/4 hp cont. Direct coupled to William Allday Alcosa carbon vane blower/vacuum pump. 0.9 cfm 8 hg. Price £22.00 P&P £2.00 (£25.92 inc. vat + p). N.M.S.

STROBE! STROBE! STROBE! **HY-LIGHT STROBE KIT Mk. IV** Latest type Xenon white light tube. Solid state timing and triggering circuit. 230/240 volt A.C. operation. Speed adjustable 1-20 f.p.s. Designed for large rooms, halls, etc. Light output greater than many (so called 4 Joule) strobes. Price and reflector post £1 (£21.80 inc. VAT & P). Specially designed case and reflector for Hy-Light £8.80 Post £1.00 (£10.58 inc. VAT & P).

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES 4ft. 40 watt £8.70 (callers only). 2ft. 20 watt £8.20. Post 75p (£9.51 inc. VAT & P). (For use in stan bi-pin fittings). Mini 12in. 8 watt £2.80. Post 35p (£3.40 inc. VAT & P). 9in. 6 watt £2.25 Post 35p (£2.81 inc. VAT & P). 6in. 4 watt £2.25 Post 35p (£2.81 inc. VAT & P). Complete ballast unit. Either 6", 9" or 12" tube 230V. A.C. op. £3.50 plus P&P 45p (£4.27 inc. VAT & P). Also available for 12V. D.C. op. £3.50 plus P&P 45p (£4.27 inc. VAT & P). 400w UV lamp and ballast complete £31.50. Post £3. (£37.26 inc. VAT & P). 400w UV lamp only £11.25 Post £1. (£13.45 inc. VAT & P).

SQUAD LIGHT A new conception in light control. Four channels each capable of handling 750 watts of spotlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only £60.00 (£85.61 inc. vat + p) S.A.E. (Footscap) for further details. Post 75p

WIDE RANGE OF DISCO LIGHTING EQUIPMENT S.A.E. (Footscap) for details

XENON FLASH GUN TUBES Range of Xenon tubes available from stock. S.A.E. for full details.

RELAYS Wide range of AC and DC relays available from stock. Phone or write in your enquiries. **230/240V A.C. Relays:** Arrow, 2 c/o. 15 amp £1.50 (£1.84 inc. VAT & P). T.E.C. open type 3 c/o. 10 amp £1.10 (£1.40 inc. VAT & P). Omoron or Keyswitch 1 c/o. 7 amp £1.00 (£1.30 inc. VAT & P). **D.C. Relays:** Open type 9/12V 3 c/o 7 amp £1.00 (£1.30 inc. VAT & P). Sealed 12V 1 c/o 7 amp octal base. £1.00 (£1.30 inc. VAT & P). Sealed 12V 2 c/o 7 amp octal base. £1.25 (£1.56 inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin. £1.35 (£1.67 inc. VAT & P). 24V. Sealed 3 c/o 7 amp 11-pin £1.35 (£1.67 inc. VAT & P) (amps - contact rating). P&P on any Relay 20p. Other types available - phone for details. N.M.S.

VAT AT CURRENT RATE MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

GEARED MOTORS 100 R.P.M. 115 lbs. ins.!! 115 lb. ins., 110 volt, 50Hz, 2.8 amp, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 115mm. ex-equipment tested £12.00 Post £1.50 (£14.58 inc. VAT & P). Suitable transformer 230/240 volt £8.00 Post 75p (£9.45 inc. VAT & P). R & T

GEARED MOTORS 28 r.p.m., 20lb. inch 115v a.c. Reversible motor. 71 r.p.m., 10 lb. inch, 115v a.c. Reversible motor. Both types similar to above drawing. Price either type £4.75 + 75p P&P (£5.94 inc. VAT + P&P) Supplied with transformer for 240v a.c. operation £7.25 + P&P £1. (£8.91 inc. VAT + P&P). N.M.S.

FRACMO MOTOR 56rpm 50lbs inch 240VAC reversible. 0.7 amp. shaft length 35mm, dia. 16mm, weight 6 kilos 600 grams. Price £15.00 P&P £1.50 (£17.82). N.M.S.

PARVALUX MOTOR TYPE S.D.2 12V DC shaft 1/30th ph motor. Continuously rated 4000 rpm. Price £10.00 P&P 75p (£11.61 inc. VAT & P). N.M.S.

PARVALUX 230/250V a.c. MOTOR Type SD18 240V AC reversible 30 rpm 50lbs inch. Price £15.00 P&P £1.50 (£17.82 inc. VAT). N.M.S.

CITENCO FHP motor type C 7333/15 220/240V A.C. 19 rpm reversible motor, torque 14.5 kg. Gear ratio 144:1. Brand new incl. capacitor, our price £14.25 + £1.25 P&P (£16.74 inc. VAT & P). N.M.S.

CROUZET 230 240V AC 2 rpm synchronous geared motor £2.90 P&P 30p (Total £3.46 inc. VAT) N.M.S.

HAYDON 230V AC 1 rpm synchronous geared motor £2.90 P&P 30p (Total £3.46 inc. VAT) N.M.S.

REVERSIBLE MOTOR 230V A.C. General Electric 230V A.C., 1.600 r.p.m., 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm x 90mm. Spindle 5/16 dia. reversing. Ex-equipment tested £3.00. Post 50p (£3.78 inc. VAT & P).

12V DC GEARED MOTOR Precision built miniature motor. 6 1/2" DC operation. Incredibly powerful for size. Approx speed at 6V 60 rpm 40 ma. Approx speed at 9V 80 rpm 50 ma. Approx speed at 12V 120 rpm 60 ma. Size: 22mm dia. 38mm length. weight 55 gram. Drive spindle 5 mm x 2 mm dia. Price: £2.50 post paid (£2.70 inc. VAT)

METERS (New) - 90mm DIAMETER AC Amp., Type 6272 0-1A, 0-5A, 0-20A. AC Volt. 0-5V, 0-50V. DC Amp., Type 65C5, 0-2A, 0-10A, 0-20A, 0-50A. DC Volt. 0-15V, 0-30V. All types £3.50 ea + P&P 50p (£4.32 inc. VAT). 0-50A D.C. 0-100A D.C. Price £5.00 + 50p P&P £5.94 incl. VAT

'VENNER TYPE' ERD TIME SWITCH 200/250V AC 30 amp. 2 on / 2 off every 24 hrs. at any manually pre-set time. 36-hour spring reserve and day omitting device. Built to highest Electricity Board specification. Price £7.75 P&P 75p (£9.18). R & T.

SANGAMO WESTON TIME SWITCH Type S251 200/250V AC 2 on 2 off every 24 hours. 20 amps contacts with override switch, diameter 4" x 3", price £8.00 P&P 50p (£7.02 inc. VAT & P). Also available with Solar dial. R & T.

AEG TIMESWITCH 200/250V AC 1 on / 1 off every 24 hours. 80 amp contact (ideal storage heaters). Spring reserve £10.00 P&P 50p (Total: £11.34 inc. VAT). N.M.S.

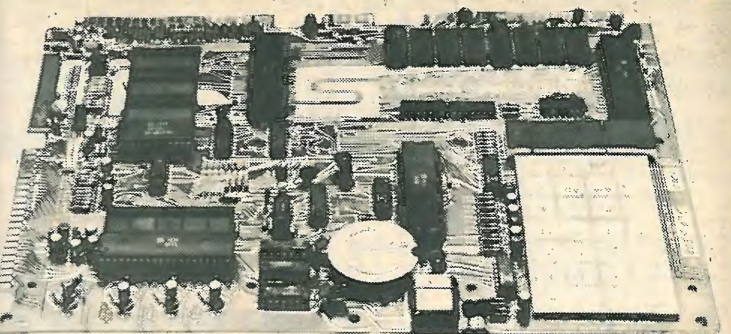
AC MAINS TIMER UNIT Based on an electric clock, with 25 amp, single-pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm. Price £2.25. Post 40p (Total inc. VAT & Post £2.87). N.M.S.

POWER RHEOSTATS New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated. **25 WATT** 10 25 100 150 250 500 1k 1.5k ohm £2.40 Post 20p (£2.81 inc. VAT & P). **50 WATT** 250 ohm £2.90 Post 25p (£3.40 inc. VAT & P). **100 WATT** 1 5 10 25 50 100 250 500 1k 1.5k 2.5k 5k ohm £5.90 Post 35p (£6.75 inc. VAT & P). **Black Silver Skirted Knob** calibrated in Nos. 1.9 1", in dia. heavy-duty. Ideal for above Rheostats 24p ea. **SPECIAL OFFER** **BERCO type L RHEOSTAT** 85 ohm 300 watt 1.86 amp £7.50 P&P 50p (Total: £8.64 inc. VAT). N.M.S.

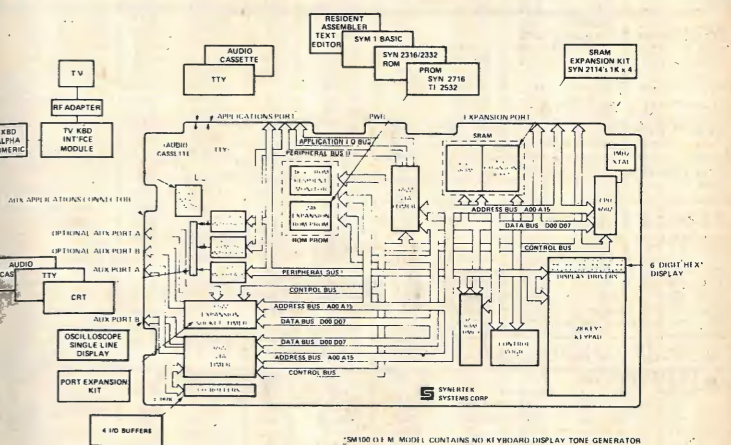
FRACMO MOTOR 1400 rpm HP 1/30 continuously rated 115V AC fitted with anti-vibration cradle mounting. Supplied complete with transformer for 230/240V AC op. £10.00 P&P £1.00 (Total: £11.88 inc. VAT). N.M.S. N.M.S. - New Manufacturers' Surplus. R & T - Reconditioned and Tested

ACCOUNT CUSTOMERS MIN. ORDER £10.00

SYNERTEK* SYM-1 MICROCOMPUTER



- Features Include:**
- Ready to use because it's fully assembled, tested and completely integrated as soon as you open the shipping container.
 - 51 total I/O lines, expandable to 71.
 - The powerful SY6502 8-bit microprocessor with advanced architectural features which make it one of the largest selling "micros" on the market today.
 - Five on-board programmable interval timers available to the user for timing loops, watchdog functions, and real-time communications protocols.
 - 4K-byte ROM SUPER-MON resident monitor and user expandable.
 - Single 5-volt power capability is all that is required.
 - 1K-bytes of static RAM on-board with sockets provided for immediate expansion to 4K bytes on-board, with total memory addressability to 65,536 bytes.
 - User PROM/ROM - the system is equipped with 4 PROM/ROM expansion sockets for SY2316/SY2332 ROMs or 2716/2732 EPROMs, up to 28K bytes.
 - Standard interfaces: digital audio cassette recorder interface with remote control; full duplex 20mA teletype interface; system expansion bus interface; TV/KB controller board interface; RS 232 compatible interface; four strappable relay drivers or input buffers; and a 32-character single line oscilloscope display interface.
 - Application port - 15 bidirectional TTL lines for user applications with expansion capability for added lines.
 - Expansion port for add-on modules (51 I/O lines in basic system).
 - Separate power supply connector for easy disconnect of the DC power.
 - Uses same hardware interface buses as KIM-1 (MOS Technology).



Sym-1 Microcomputer Board £192 (+8% VAT)
Sym-1 Reference Manual £7 (no VAT)

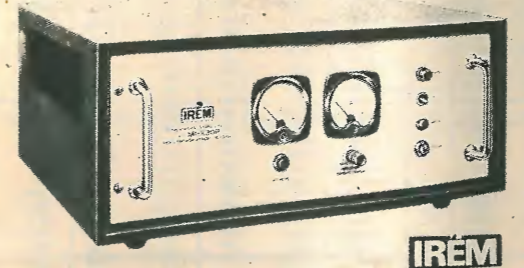
*Synertek Inc. is a Honeywell Company

Ex-stock from: - **CITADEL PRODUCTS LTD.** 50 High Street, Edgware, Middx. HA8 7EP. Tel: 01-951 1848

WW-096 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, W.4. Telephone 994 7155

WW-095 FOR FURTHER DETAILS

MAIL ORDER PROTECTION SCHEME (Limited Liability)

If you order from mail order advertisers in this magazine, except for classified advertisements, and pay by post in advance of delivery, Wireless World will consider you for compensation if the advertiser should become insolvent or bankrupt, provided:

1. You have not received the goods or had your money returned; and
2. You write to the publisher of Wireless World explaining the position not earlier than 28 days from the day you sent your order and not later than 2 months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.

We guarantee to meet claims from readers made in accordance with the above procedure as soon as possible after the advertiser has been declared bankrupt or insolvent up to a limit of £3,550 per annum for any one advertiser so affected and up to £10,000 per annum in respect of all insolvent advertisers. Claims may be paid for higher amounts, or when the above procedure has not been complied with, at the discretion of Wireless World; but we do not guarantee to do so in view of the need to set some limit to this commitment and to learn quickly of readers' difficulties.

This guarantee covers only advance payments sent in direct response to an advertisement in this magazine (not, for example, payments made in response to catalogues, etc., received as a result of answering such advertisements. Personal advertisements are excluded.

THE PROFESSIONALS NEW! 600 MHz Mini Counter

NEW MODEL CTR-2A • 500 MHz & 1 GHz COUNTERS NEW! 600 MHz Mini Counter £145 + 8% VAT

General Purpose Low Cost Counter Without the Sacrifice of Basic Performance "Check the features we have that some other low-cost counters don't have"

- All Metal Cabinet
- 8 Digit .4 LED Display
- Input Cable Included
- 12V Input Jack
- Sensitivity 10 MV at 60 MHz
- 240V or 12V Operation
- Push Button Controls
- Gate Light
- Completely Auto Decimal Point
- Selectable Gate Times (1 sec & 1 sec)
- Built-in Preamp
- Crystal Time Base 1 ppm

Prices: CTR-2A-500 £280 & VAT 8% CTR-2A-1000 £420 & VAT 8%

We are exclusive UK Distributors for **DAVIS ELECTRONICS**, NY, U.S.A. and European Distributors for **LUNAR ELECTRONICS**, San Diego, California, U.S.A. (Linear Amplifiers & Receive Preamplifiers)

SOTA COMMUNICATION SYSTEMS LTD. 26 CHILDWALL LANE, BOWRING PARK, LIVERPOOL L14 6TX. Tel: 051-480 5770

WW-076 FOR FURTHER DETAILS

ALL MAIL ORDERS, ALSO CALLERS AT 57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560 Closed Saturdays

SERVICE TRADING CO. SHOWROOMS NOW OPEN AMPLER PARKING 9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ Tel: 01-437 0576

LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, London SW16 6ED

RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS				VALVES				INTEGRATED CIRCUITS				BASES				CRTs			
AA119	0.27	ASZ15	1.25	BD131	0.35	BF257	0.24	CRS3/60	0.90	OAZ201	1.00	OC203	1.75	ZTX502	0.16*	2N1309	0.55	2N3771	1.75
AA190	0.27	ASZ16	1.25	BD132	0.38	BF258	0.26	CRS3/90	1.50	OAZ206	1.00	OC204	2.50	ZTX503	0.17*	2N1613	0.25	2N3772	1.00
AA192	0.42	ASZ17	1.25	BD133	0.41	BF259	0.32	CRS3/120	2.00	OAZ207	1.00	OC205	2.50	ZTX504	0.20*	2N1671	1.50	2N3773	3.00
AA213	0.18	ASZ20	1.50	BD134	0.44	BF260	0.34	CRS3/150	2.50	OAZ208	1.00	OC206	2.50	ZTX505	0.20*	2N1893	0.25	2N3819	0.58*
AA215	0.34	ASZ21	2.00	BD135	0.45*	BF261	0.35	CRS3/180	3.00	OAZ209	1.75	OC207	1.75	ZTX506	0.18*	2N2147	0.75	2N3820	0.45*
AA217	0.27	ASZ22	2.00	BD136	0.46*	BF262	0.36	CRS3/210	3.50	OAZ210	1.00	OC208	1.25	ZTX507	0.18*	2N2148	1.65	2N3823	0.55*
AA218	0.20	ASZ23	2.00	BD137	0.47*	BF263	0.37	CRS3/240	4.00	OAZ211	1.00	OC209	1.25	ZTX508	0.18*	2N2218	0.25	2N3826	0.72
AA219	0.20	ASZ24	2.00	BD138	0.48*	BF264	0.38	CRS3/270	4.50	OAZ212	1.00	OC210	1.25	ZTX509	0.18*	2N2219	0.24	2N3830	0.13*
AA220	0.20	ASZ25	2.00	BD139	0.49*	BF265	0.39	CRS3/300	5.00	OAZ213	1.00	OC211	1.25	ZTX510	0.18*	2N2220	0.18	2N3831	0.13*
AA221	0.20	ASZ26	2.00	BD140	0.49*	BF266	0.40	CRS3/330	5.50	OAZ214	1.00	OC212	1.25	ZTX511	0.18*	2N2221	0.18	2N3832	0.13*
AA222	0.20	ASZ27	2.00	BD141	0.49*	BF267	0.40	CRS3/360	6.00	OAZ215	1.00	OC213	1.25	ZTX512	0.18*	2N2222	0.18	2N3833	0.13*
AA223	0.20	ASZ28	2.00	BD142	0.49*	BF268	0.40	CRS3/390	6.50	OAZ216	1.00	OC214	1.25	ZTX513	0.18*	2N2223	0.18	2N3834	0.13*
AA224	0.20	ASZ29	2.00	BD143	0.49*	BF269	0.40	CRS3/420	7.00	OAZ217	1.00	OC215	1.25	ZTX514	0.18*	2N2224	0.18	2N3835	0.13*
AA225	0.20	ASZ30	2.00	BD144	0.49*	BF270	0.40	CRS3/450	7.50	OAZ218	1.00	OC216	1.25	ZTX515	0.18*	2N2225	0.18	2N3836	0.13*
AA226	0.20	ASZ31	2.00	BD145	0.49*	BF271	0.40	CRS3/480	8.00	OAZ219	1.00	OC217	1.25	ZTX516	0.18*	2N2226	0.18	2N3837	0.13*
AA227	0.20	ASZ32	2.00	BD146	0.49*	BF272	0.40	CRS3/510	8.50	OAZ220	1.00	OC218	1.25	ZTX517	0.18*	2N2227	0.18	2N3838	0.13*
AA228	0.20	ASZ33	2.00	BD147	0.49*	BF273	0.40	CRS3/540	9.00	OAZ221	1.00	OC219	1.25	ZTX518	0.18*	2N2228	0.18	2N3839	0.13*
AA229	0.20	ASZ34	2.00	BD148	0.49*	BF274	0.40	CRS3/570	9.50	OAZ222	1.00	OC220	1.25	ZTX519	0.18*	2N2229	0.18	2N3840	0.13*
AA230	0.20	ASZ35	2.00	BD149	0.49*	BF275	0.40	CRS3/600	10.00	OAZ223	1.00	OC221	1.25	ZTX520	0.18*	2N2230	0.18	2N3841	0.13*
AA231	0.20	ASZ36	2.00	BD150	0.49*	BF276	0.40	CRS3/630	10.50	OAZ224	1.00	OC222	1.25	ZTX521	0.18*	2N2231	0.18	2N3842	0.13*
AA232	0.20	ASZ37	2.00	BD151	0.49*	BF277	0.40	CRS3/660	11.00	OAZ225	1.00	OC223	1.25	ZTX522	0.18*	2N2232	0.18	2N3843	0.13*
AA233	0.20	ASZ38	2.00	BD152	0.49*	BF278	0.40	CRS3/690	11.50	OAZ226	1.00	OC224	1.25	ZTX523	0.18*	2N2233	0.18	2N3844	0.13*
AA234	0.20	ASZ39	2.00	BD153	0.49*	BF279	0.40	CRS3/720	12.00	OAZ227	1.00	OC225	1.25	ZTX524	0.18*	2N2234	0.18	2N3845	0.13*
AA235	0.20	ASZ40	2.00	BD154	0.49*	BF280	0.40	CRS3/750	12.50	OAZ228	1.00	OC226	1.25	ZTX525	0.18*	2N2235	0.18	2N3846	0.13*
AA236	0.20	ASZ41	2.00	BD155	0.49*	BF281	0.40	CRS3/780	13.00	OAZ229	1.00	OC227	1.25	ZTX526	0.18*	2N2236	0.18	2N3847	0.13*
AA237	0.20	ASZ42	2.00	BD156	0.49*	BF282	0.40	CRS3/810	13.50	OAZ230	1.00	OC228	1.25	ZTX527	0.18*	2N2237	0.18	2N3848	0.13*
AA238	0.20	ASZ43	2.00	BD157	0.49*	BF283	0.40	CRS3/840	14.00	OAZ231	1.00	OC229	1.25	ZTX528	0.18*	2N2238	0.18	2N3849	0.13*
AA239	0.20	ASZ44	2.00	BD158	0.49*	BF284	0.40	CRS3/870	14.50	OAZ232	1.00	OC230	1.25	ZTX529	0.18*	2N2239	0.18	2N3850	0.13*
AA240	0.20	ASZ45	2.00	BD159	0.49*	BF285	0.40	CRS3/900	15.00	OAZ233	1.00	OC231	1.25	ZTX530	0.18*	2N2240	0.18	2N3851	0.13*
AA241	0.20	ASZ46	2.00	BD160	0.49*	BF286	0.40	CRS3/930	15.50	OAZ234	1.00	OC232	1.25	ZTX531	0.18*	2N2241	0.18	2N3852	0.13*
AA242	0.20	ASZ47	2.00	BD161	0.49*	BF287	0.40	CRS3/960	16.00	OAZ235	1.00	OC233	1.25	ZTX532	0.18*	2N2242	0.18	2N3853	0.13*
AA243	0.20	ASZ48	2.00	BD162	0.49*	BF288	0.40	CRS3/990	16.50	OAZ236	1.00	OC234	1.25	ZTX533	0.18*	2N2243	0.18	2N3854	0.13*
AA244	0.20	ASZ49	2.00	BD163	0.49*	BF289	0.40	CRS3/1020	17.00	OAZ237	1.00	OC235	1.25	ZTX534	0.18*	2N2244	0.18	2N3855	0.13*
AA245	0.20	ASZ50	2.00	BD164	0.49*	BF290	0.40	CRS3/1050	17.50	OAZ238	1.00	OC236	1.25	ZTX535	0.18*	2N2245	0.18	2N3856	0.13*
AA246	0.20	ASZ51	2.00	BD165	0.49*	BF291	0.40	CRS3/1080	18.00	OAZ239	1.00	OC237	1.25	ZTX536	0.18*	2N2246	0.18	2N3857	0.13*
AA247	0.20	ASZ52	2.00	BD166	0.49*	BF292	0.40	CRS3/1110	18.50	OAZ240	1.00	OC238	1.25	ZTX537	0.18*	2N2247	0.18	2N3858	0.13*
AA248	0.20	ASZ53	2.00	BD167	0.49*	BF293	0.40	CRS3/1140	19.00	OAZ241	1.00	OC239	1.25	ZTX538	0.18*	2N2248	0.18	2N3859	0.13*
AA249	0.20	ASZ54	2.00	BD168	0.49*	BF294	0.40	CRS3/1170	19.50	OAZ242	1.00	OC240	1.25	ZTX539	0.18*	2N2249	0.18	2N3860	0.13*
AA250	0.20	ASZ55	2.00	BD169	0.49*	BF295	0.40	CRS3/1200	20.00	OAZ243	1.00	OC241	1.25	ZTX540	0.18*	2N2250	0.18	2N3861	0.13*
AA251	0.20	ASZ56	2.00	BD170	0.49*	BF296	0.40	CRS3/1230	20.50	OAZ244	1.00	OC242	1.25	ZTX541	0.18*	2N2251	0.18	2N3862	0.13*
AA252	0.20	ASZ57	2.00	BD171	0.49*	BF297	0.40	CRS3/1260	21.00	OAZ245	1.00	OC243	1.25	ZTX542	0.18*	2N2252	0.18	2N3863	0.13*
AA253	0.20	ASZ58	2.00	BD172	0.49*	BF298	0.40	CRS3/1290	21.50	OAZ246	1.00	OC244	1.25	ZTX543	0.18*	2N2253	0.18	2N3864	0.13*
AA254	0.20	ASZ59	2.00	BD173	0.49*	BF299	0.40	CRS3/1320	22.00	OAZ247	1.00	OC245	1.25	ZTX544	0.18*	2N2254	0.18	2N3865	0.13*
AA255	0.20	ASZ60	2.00	BD174	0.49*	BF300	0.40	CRS3/1350	22.50	OAZ248	1.00	OC246	1.25	ZTX545	0.18*	2N2255	0.18	2N3866	0.13*
AA256	0.20	ASZ61	2.00	BD175	0.49*	BF301	0.40	CRS3/1380	23.00	OAZ249	1.00	OC247	1.25	ZTX546	0.18*	2N2256	0.18	2N3867	0.13*
AA257	0.20	ASZ62	2.00	BD176	0.49*	BF302	0.40	CRS3/1410	23.50	OAZ250	1.00	OC248	1.25	ZTX547	0.18*	2N2257	0.18	2N3868	0.13*
AA258	0.20	ASZ63	2.00	BD177	0.49*	BF303	0.40	CRS3/1440	24.00	OAZ251	1.00	OC249	1.25	ZTX548	0.18*	2N2258	0.18	2N3869	0.13*
AA259	0.20	ASZ64	2.00	BD178	0.49*	BF304	0.40	CRS3/1470	24.50	OAZ252	1.00	OC250	1.25	ZTX549	0.18*	2N2259	0.18	2N3870	0.13*
AA260	0.20	ASZ65	2.00	BD179	0.49*	BF305	0.40	CRS3/1500	25.00	OAZ253	1.00	OC251	1.25	ZTX550	0.18*	2N2260	0.18	2N3871	0.13*
AA261	0.20	ASZ66	2.00	BD180	0.49*	BF306	0.40	CRS3/1530	25.50	OAZ254	1.00	OC252	1.25	ZTX551	0.18*	2N2261	0.18	2N3872	0.13*
AA262	0.20	ASZ67	2.00	BD181	0.49*	BF307	0.40	CRS3/1560	26.00	OAZ255	1.00	OC253	1.25	ZTX552	0.18*	2N2262	0.18	2N3873	0.13*
AA263	0.20	ASZ68	2.00	BD182	0.49*	BF308	0.40	CRS3/1590	26.50	OAZ256	1.00	OC254	1.25	ZTX553	0.18*	2N2263	0.18	2N3874	0.13*
AA264	0.20	ASZ69	2.00	BD183	0.49*	BF309	0.40	CRS3/1620	27.00	OAZ257	1.00	OC255	1.25	ZTX554	0.18*	2N2264	0.18	2N3875	0.13*
AA265	0.20	ASZ70	2.00	BD184	0.49*	BF310	0.40	CRS3/1650	27.50	OAZ258	1.00	OC256	1.25	ZTX555	0.18*	2N2265	0.18	2N3876	0.13*
AA266	0.20	ASZ71	2.00	BD185	0.49*	BF311	0.40	CRS3/1680	28.00	OAZ259	1.00	OC257	1.25	ZTX556	0.18*	2N2266	0.18	2N3877	0.13*
AA267	0.20	ASZ72	2.00	BD186	0.49*	BF312	0.40	CRS3/1710	28.50	OAZ260	1.00	OC258	1.25	ZTX557	0.18*	2N2267	0.18	2N3878	0.13*
AA268	0.20	ASZ73	2.00	BD187	0.49*	BF313	0.40	CRS3/1740	29.00	OAZ261	1.00	OC259	1.25	ZTX558	0.18*	2N2268	0.18	2N3879	0.13*
AA269	0.20	ASZ74	2.00	BD188	0.49*	BF314	0.40	CRS3/1770	29.50	OAZ262	1.00	OC260	1.25	ZTX559	0.18*	2N2269	0.18	2N3880	0.13*
AA270	0.20	ASZ75	2.00	BD189	0.49*	BF315	0.40	CRS3/1800	30.00	OAZ263	1.00	OC261	1.25	ZTX560	0.18*	2N2270	0.18	2N3881	0.13*
AA271	0.20	ASZ76	2.00	BD190	0.49*	BF316	0.40	CRS3/1830	30.50	OAZ264	1.00	OC262	1.25	ZTX561	0				

ELECTRONIC ENGINEERS

SMITHS INDUSTRIES LIMITED AVIATION DIVISION have openings in their Research & Engineering Department which will appeal to Engineers who seek a challenging and rewarding vocation. If you are interested in any of the following fields:-

- *DIGITAL HARDWARE/ SOFTWARE (REAL-TIME COMPUTING)
- *ANALOGUE HARDWARE
- *COMPONENT APPROVAL
- *CONTROL SYSTEMS (ANALYSTS & DESIGNERS-FIXED AND ROTARY WING AIRCRAFT)

we have vacancies at various levels in these Design Branches:-

- FLIGHT DECK INSTRUMENTS
- FLIGHT CONTROL SYSTEMS
- TEST EQUIPMENT
- FLIGHT CONTROL RESEARCH
- ELECTRONIC DISPLAYS
- ENGINEERING STANDARDS
- MICRO ELECTRONICS
- COMPONENTS ENGINEERING (GYROS & ACCELEROMETERS)
- WEAPON SYSTEMS (AVIONIC & NAVAL)

Applicants should have preferably a Degree with a minimum of two years experience although, relevant experience or other qualifications in lieu would be considered.

Write to
H. Upson,



SMITHS INDUSTRIES LIMITED

AVIATION DIVISION
Bishops Cleeve, Cheltenham, Glos. GL52 4SF.
or use our ANSAFONE facility:- (0242-67-5359)

(9020)

Broadcasting Engineer enjoy the benefits of working at the fore of broadcasting technology

We require an Engineer, male or female, qualified to HNC or equivalent level, with at least three years' experience in a broadcasting discipline to maintain the advanced electronic equipment at our main transmitting stations and relay stations bringing Independent Television and Independent Local Radio into millions of homes.

The successful applicant will become a member of a team based at our Black Mountain Transmitting Station, Hannahstown, Dunmurry, Northern Ireland and will be required to travel throughout Northern Ireland. A current driving licence is required. The post will involve some week-end working. Equipment familiarisation training will be provided.

The salary will be on a scale up to £5,688 per annum, with provision for movement on to a higher scale rising to £6,399 per annum. These rates are inclusive of a productivity supplement.

Relocation expenses will be paid where applicable.



INDEPENDENT
BROADCASTING
AUTHORITY

Act now! Write or telephone for an application form quoting Ref. No. WW/35ER to:- Mr. M. Wright, Personnel Officer - Engineering Regions, Independent Broadcasting Authority, Crawley Court, WINCHESTER, Hants. SO21 2QA. Telephone No: Winchester 822574.

Electronics Technician

£4017-£4917 pa inc.

to provide technical assistance to staff and students in the Polytechnic's projects laboratory, based at Enfield.

Major responsibilities will include the development of the Microprocessor Unit, the design and construction of matching circuits for transducers and data logging equipment, and construction of working systems incorporating microprocessors.

Knowledge of workshop practice is essential, together with a good electronics qualification or sound industrial and manufacturing experience in allied fields.

Write quoting ref 4.16D for further details and an application form, posting first-class to: **Appointments Officer, Middlesex Polytechnic, Bounds Green Road, London N11 2NQ. Closing date 2 April.**

(9057)

Middlesex Polytechnic

UNIVERSITY OF LEICESTER

Electronics Technician

There is a vacancy in the Electronics Workshop of the Joint Biological Sciences Medical Sciences Workshops for a Technician to work on the design, development, construction and repair of scientific electronic equipment used in teaching and research. Fault-finding and repair work will form a significant part of the job and experience in this type of work would be useful. Applicants must be qualified to ONC standard or equivalent. The post carries good conditions of service, including four weeks' annual holiday. Salary on an incremental scale for Technicians Grade 5 £3186 to £3720 p.a. (under review).

Applications in writing should be forwarded to the Administrative Officer, School of Biological Sciences, University of Leicester, University Road, Leicester LE1 7RH.

(9025)

MAINTENANCE ENGINEER

A Maintenance Engineer is required for the repair and testing of a range of professional audio and lighting control equipment.

Applicants should have sound knowledge of modern analogue and digital techniques and, ideally, possess a current driving licence. Salary will be negotiable around £4,000 p.a.

Apply with full details of qualifications to **Box No. 8956 (London area).**

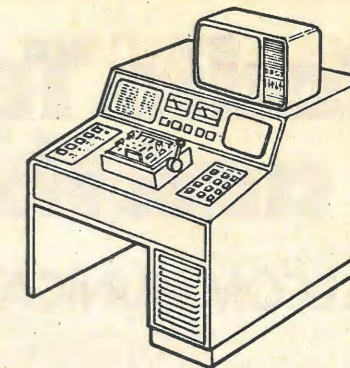
(8956)

UNIVERSITY OF LONDON KING'S COLLEGE ELECTRONICS TECHNICIAN GRADE 5

Required for the Department of Chemistry. In addition to the construction of specialised equipment the applicant would be expected to assist in the maintenance of laboratory instruments, a knowledge of which is desirable. Salary on scale £3651 per annum, rising to £4,185 per annum inclusive (under review). Good conditions, four weeks' annual holiday. Contributory pension scheme. Apply in writing with full details to: **The Head Clerk (Ref. 210235 / WW), King's College, London, Strand WC2R 2LS.**

(9026)

TEST EQUIPMENT ENGINEERS



Come and join Rediffusion and help us design a brand new range of test equipment for production testing our future colour receivers. Our present equipment is a combination of sophisticated manual and automatic test consoles employing both analogue and digital circuitry. We are currently looking at the application of microprocessors to the testing of television modules and are confident that our future equipment will take advantage of these latest techniques.

Applications are invited from well qualified and experienced test equipment engineers to join our energetic young team at Chessington, Surrey, working in a congenial and stimulating environment. We have vacancies at both senior and intermediate levels, offering excellent salaries and opportunities for career advancement in this exciting field.

Since engineers are expected to see their projects through to completion, some travelling to our factories in the North East is expected to assist on installation and commissioning and to give back-up service where necessary.

Additionally, an intermediate engineer is required to be based at Bishop Auckland in our Engineering Department on the main factory site. This position involves some design and development work interspaced with the planned maintenance of complex production test equipment.

If you are interested in these challenging positions and would like more details or wish to discuss the matter in depth, please write to or telephone:

REDIFFUSION

Mr H. Brearley,
Rediffusion Consumer Electronics Limited,
Fullers Way Sth., Chessington, Surrey KT9 1HJ
Telephone: 01-397 5411

WE HAVE AN OPEN DOOR FOR AN OPEN MIND Test Engineers

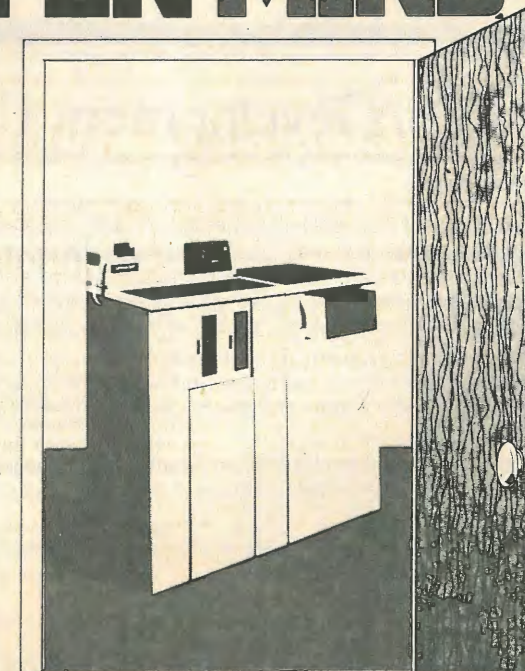
Open minds and creative thinking have made Linotype-Paul the market leader in the field of sophisticated phototypesetting equipment for the world's graphics industries.

We are leaders not by accident but by design and in order to maintain our position and our record growth pattern we now have excellent openings for electronics engineers at all levels.

If you have an electronic engineering background coupled with at least 2 years practical experience and/or a formal qualification we'd like to meet you.

Anyone with experience in the following, would also be welcome. Prototype Wipers, A.T.E. Engineers, Electronic and Mechanical Inspectors, Skilled Fitters, P.C.B. Draughtsmen/women, Programmers, Electronic and Mechanical Development Engineers.

Ring Cheltenham 41441, reversing charges, or write to Patrick Cooper, Personnel Officer, Linotype-Paul Ltd., Chelham House, Bath Road, Cheltenham.



Linotype-Paul 1974

Radio Technology and the Future

TELECOMMUNICATIONS OPPORTUNITIES

In the Home Office Directorate of Radio Technology you will be responsible for the study of radio propagation matters over the whole of the radio frequency spectrum above 10 kHz and for the forward planning, management and regulation of frequency bands allocated to the broadcasting, fixed, maritime and land mobile, and space services.

The work will also involve preparing specifications and giving type-approval of equipment for fixed and mobile services, applying computer techniques to frequency assignment problems, developing equipment for the location and suppression of radio interference, and giving technical advice on all aspects of licensing radio services and in connection with the international radio monitoring service.

The vacancies are in Central London and Stanmore, Middlesex.

Candidates (aged at least 25) must have ONC in Engineering (with a pass in Electrical Engineering 'A') or in Applied Physics, or hold an equivalent qualification. In addition, they must have had at least 7 years' experience of skilled work on radio, radar or other electronic work.

Salary in London starts at £5230 and rises to £5710; £250 less at Stanmore. Good promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 5 April, 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote ref: T/5096/4.

HOME OFFICE

(9075)

THE OPEN UNIVERSITY



Faculties of Science and Technology

Electronics Designer

Science and Technology, Electronics Common Facilities have a vacancy for an Electronics Designer. The successful applicant will fill the post as the main electronics designer in a small team backing up both science and technology based research and home experiment kit development.

The work is varied and covers virtually the whole range of electronics. Design experience is essential as is an innovative nature.

The salary range (which is under review) is £4 245-£4 782. Terms and conditions are good. Housing is readily available within the city of Milton Keynes set in the north Buckinghamshire countryside.

Application forms and further particulars are available from the Recruitment Office (MH494 2), The Open University, P.O. Box 75, Walton Hall, Milton Keynes, MK7 6AL or telephone Milton Keynes 63405; there is a 24 hour answering service on 63868.

Closing date for applications 26th March

(9021)

UNIVERSITY OF LONDON GOLDSMITH' COLLEGE

New Cross, London SE14 6NW

TECHNICIAN

Required in the Psychology Laboratory to start as soon as possible. Applicants should have qualifications and/or experience in one of the following:—

- (a) Maintenance of electronic equipment (e.g. CC TV and general audio-visual equipment).
- (b) Construction and maintenance of general laboratory equipment involving general workshop procedures.

The appointment will be on either Grade 3, 4 or 5 depending upon qualifications and experience, with salary on one of the following scales:—

- Grade 3 — £2,697 x 5 increments to £3,084 per annum
 - Grade 4 — £2,976 x 5 increments to £3,426 per annum
 - Grade 5 — £3,210 x 5 increments to £3,747 per annum
- plus £465 London Allowance

Write for further particulars, to the Personnel Officer, to whom applications should be sent by 30th April, 1979.

(9059)

MARINE ELECTRONICS

We need an engineer familiar with Radar, MF/HF synthesised SSB/VHF Autopilots, etc. to service and install anywhere, but must be based in London.

If you are able to be your own boss apply giving details of experience, salary required.

We are also prepared to offer an engineering partnership arrangement, if you are the right man.

TELESONIC MARINE LTD.
243 Euston Road
London N.W.1.

(8959)

Engineers

- DESIGN / DEV
- TEST
- FIELD SERVICE

High Salaries - Most Areas

Phone 01-731 4353

Apex Personnel (8995)

Senior Engineer

Service Continuity Section

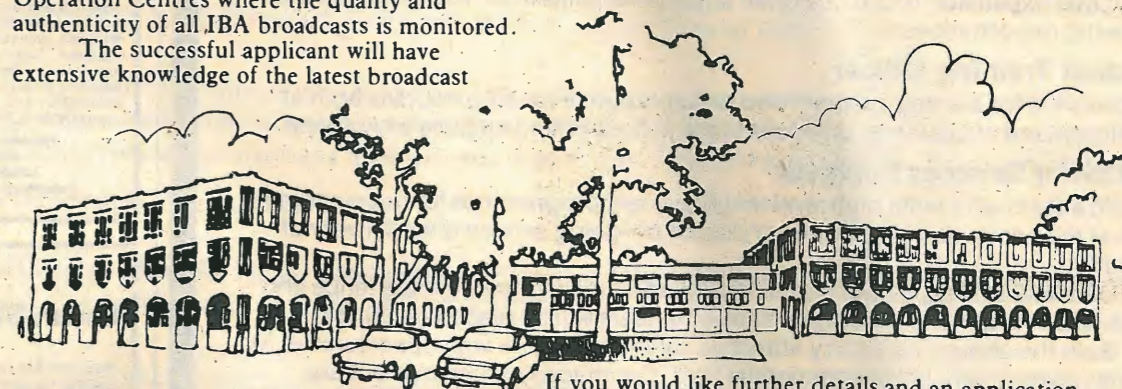
An unusual vacancy exists for an engineer to lead a small multi-disciplinary team researching into operational procedures which will enhance continuity and security of the radio and television services transmitted by the Authority.

The increasing incidence over recent years of electronic hijacking of broadcast transmitters has led to the decision to form a special group to analyse past events and postulate theories explaining the modus operandi of the miscreants. The team will also be expected to formulate appropriate alterations in the design of transmitting stations and the 42 new Regional Operation Centres where the quality and authenticity of all IBA broadcasts is monitored.

The successful applicant will have extensive knowledge of the latest broadcast

technology and the ability to appreciate the bizarre nature of the problem. He or she may have been involved in the planning or execution of a past event and will be familiar with satellite and digital systems, though experience of teletext techniques would be considered.

Working conditions are second to none in our well equipped laboratories and the group will be given the opportunity to take over as much working space as required. The fresh approach which the post entails necessarily confines applications to those not already in the employ of the Authority in any technical capacity.



IBA INDEPENDENT BROADCASTING AUTHORITY

If you would like further details and an application form, please write or telephone, quoting reference KS/AT to:

Senior Personnel Officer,
Independent Broadcasting Authority, Crawley Court, Winchester, Hampshire, SO21 2QA. Telephone: Winchester 822270.

(9080)

Design/Development Engineers

c£6,000 p.a.

Croydon

Aeronautical and General Instruments Ltd. is an expanding public company well respected internationally for the design, development and manufacture of aerial reconnaissance equipment, marine instrumentation and telecommunications.

Two Electronics Engineers are needed to spearhead design and development work on an exciting new product area in the telecommunications field. They would be involved in both software and hardware aspects of microprocessor design and in data transmission technology. Some foreign travel would be involved.

Applicants should have at least two years design experience, preferably in logic design. They could therefore be in their 20's, and should be qualified to HNC or degree level.

These are key appointments providing both an interesting challenge and excellent career opportunities.

Please send brief career details to:



Roger Hindle Limited

34 Queens Gate Place Mews London SW7 5BQ.

(9038)

WYE COLLEGE (University of London)

WORKSHOP TECHNICIAN (ELECTRONICS)

Applications are invited for the above post in the Department of Agriculture Engineering Workshop in which electronic instrumentation is widely used. Applicants should probably have an ONC/OND in Technology or Engineering with some practical experience of analogue to digital converters. Applicants with City and Guilds Certificate 231 will also be considered. Salary scales: Grade 1 £2,193-£2,499 p.a.; Grade 2 £2,364-£2,880 p.a.; Grade 3 £2,688-£3,060 p.a. (all under review) according to age and qualifications. Application forms and further particulars available from Personnel Officer, Wye College, Ashford, Kent. Tel. No. 812401, Ext. 228. Applications should be received as soon as possible.

(9027)

Senior Electronics Service Engineer

A SENIOR MAINTENANCE ENGINEER IS REQUIRED FOR THE REPAIR AND CALIBRATION OF PROFESSIONAL EQUIPMENT USED IN THE EXECUTION OF RESEARCH PROGRAMMES AT THE LABORATORY.

This involves the maintenance of oscilloscopes, pulse generators, counters, digital voltmeter, precision high power magnet controller and

analysers of various kinds. Experience in fault finding on some of the equipment is necessary.

It is hoped to gradually extend the maintenance capability to include microprocessors, computers and associated peripherals.

Please send for an application form to M. L. Malpass, Personnel Manager, Philips Research Laboratories, Cross Oak Lane, Redhill, Surrey, quoting reference 113.



Research Laboratories

PHILIPS

(9090)



ATE A closely guarded secret?

It's no secret that automatic test and inspection is revolutionizing the electronics industry.

Our Autotest systems, with an international reputation for both versatility and reliability, are used for varied applications, from testing television PCB's to fault location on avionic systems. At the sharp end of our Autotest business the continued expansion of our customer support facilities in St. Albans offers the following opportunities:-

Product Training Officer

Responsible for the arrangement and presentation of training courses both at St. Albans and at customer premises in the programming and use of Autotest.

Customer Services Engineer

To join a team who write high level language user programmes for our customers both at the commissioning stages and as an on-going service after delivery of systems.

Candidates should have digital, analogue or measurement experience and whilst qualifications may be significant, emphasis will be placed on ability.

Both the above posts carry attractive salaries together with opportunities for greater involvement in the commercial field. Conditions of employment are excellent including productivity bonus, pension and sick pay schemes and we can offer generous relocation expenses where appropriate.

For further information of these opportunities, perhaps others that may interest you, please telephone John Prodger. or write to the

Recruitment Manager,
Marconi Instruments Ltd.,
Freepost,
St Albans, Herts.
Telephone St Albans 59292

A G.E.C. MARCONI ELECTRONICS COMPANY (9041)

Marconi Instruments

UNIVERSITY OF LIVERPOOL DEPARTMENT OF PHYSICS

ELECTRONICS TECHNICIAN

to assist with developing and constructing digital and analogue electronic equipment. Applicants must possess ONC, C & G or equivalent qualification and have some experience. Good opportunity to learn about micro-processors. Salary within a range up to £3720 p.a. (under review).

Application forms may be obtained from The Registrar, The University, P.O. BOX 147, Liverpool, L69 3BX. Quote Ref: RV/508/WW. (9069)

READY, STEADY, GROW!

Join a firm that's doubled its profits for each of the last three years and grow with Rofin. High interest jobs for:

**ELECTRONICS SERVICE ENGINEER
ELECTRONICS TEST ENGINEER
ELECTRONICS TEST TECHNICIAN
INSTRUMENT TECHNICIAN
WITH PRECISION, MECHANICAL
AND OPTICAL EXPERIENCE**

Telephone or write to Bill Hamsworth, Rofin Ltd., Winslade House, Egham Hill, Egham, Surrey. Tel. Egham 7541. (9079)

APPOINTMENTS IN ELECTRONICS £5 - £10,000

Take your pick of the permanent posts in:

MISSILES — MEDICAL COMPUTERS
RADAR — COMMS MICROPROCESSOR
HARDWARE — SOFTWARE

For free expert advice and immediate action on salary and career improvement, phone or write to, Mike Gernat BSc.

Technomark
Engineering and Technical Recruitment

11 Westbourne Grove
London W2. 01 229 9239 (8423)

Cyclotron Unit Medical Research Council requires a Junior Technician B

Preferably under 23 years for the servicing and maintenance of electronic equipment and to act as standby cyclotron operator, involving occasional shift duties. An ONC or equivalent qualifications in a relevant subject required. Some servicing experience preferable. Salary according to age and experience in the range of £2523 to £3369 (inclusive of London Weighting). Day release facilities available. Also a

Junior Technician A

Aged 16 and over, to assist in electronics team. Experience not essential. Day release facilities available. Four GCE 'O' levels required. Salary according to age and experience in the range £2259 to £3258 (inclusive of London Weighting). For further information and application form, please contact Miss A. Pires at the Cyclotron Unit.

Hammersmith Hospital
Ducane Road
London W12 0HS
Telephone No. 01-743 4594
Ext. 103 (9101)

Radar/Radio Engineer

required for maintenance of Airport ground radars 10 cm. and 3 cm., navigational aids and communications equipment. Technical qualifications desirable and it is essential that applicants have considerable experience and are capable of working without close supervision. Salary, including shift pay, weekend enhancement and pay supplement, approx. £4050 to £5142, plus some overtime. Written applications, giving age, experience and qualifications, to the Airport Director, Southend Airport, Southend-on-Sea, Essex.

(9067)

CHELSEA COLLEGE University of London

ELECTRONICS TECHNICIAN ENGINEERS/TECHNICIANS

required for interesting work in Electronics Workshop serving Electronics and Physics research and teaching. Work includes prototype instrument design, development and construction, and the servicing of electronic equipment. We have two vacancies, one at grade 5, salary £3651 to £4185 per annum, and the other at grade 3, salary £3153 to £3525 per annum. Both salaries are inclusive but are under review. Generous holidays.

Day release for further study may be arranged at grade 3. Details and application form from Mr. M. E. Cane (3/5EW), Department of Electronics, Chelsea College, Pulton Place, London, SW6 5PR.

(9070)

PIONEER®

An extensive expansion programme to diversify our after sales service activity has created additional vacancies at our service centre in Iver.

BENCH SERVICE TECHNICIANS

We require service personnel to join a friendly team of Technicians in our modern well equipped service department and laboratory to assist in repair and maintenance of sophisticated Audio and In-Car stereo equipment of our world renowned brand.

Applicants should hold C & G Radio and TV, Electronics Technician or equivalent certificate with a minimum of two years' experience in the Audio field. Alternatively five years' of relevant experience with sound knowledge of Electronics is acceptable.

Salary in the area of £3,500 to £4,500 per annum, according to experience.

If you think that you can help us in our expansion programme then contact us now and find out more about our generous staff benefits. We offer excellent working conditions, training programmes and day release to advance your career and knowledge in the field of high fidelity.

Luncheon Vouchers. Pension Scheme.

Apply in writing to: **Mr. A. H. K. Littlemore, Pioneer High Fidelity (G.B.) Ltd., The Ridgeway, Iver, Bucks., or telephone Iver (0753) 652222/7.**

(9030)

SYSTEMS ENGINEERS

Simulators are today's most advanced training systems and by incorporating tomorrow's technology into an already highly sophisticated product we have created an exciting and challenging environment.

To meet this challenge we would like to hear from men and women who are qualified to HND/degree level and have relevant experience in Systems Simulation or Systems engineering, utilising Assembler language — a knowledge of high level languages would be useful.

Should you believe your experience or qualifications are in line with our requirements and would like additional information please contact: John Perry on Crawley 28811 up to 5.30 p.m. or Crawley 35279 after 5.30 and listen to our Ansafone message.

PROJECTION ENGINEER

Required to service our projection and sound equipment. Applicants should either be qualified projectionists or have a basic knowledge of this type of equipment. Male and female applicants please contact the Personnel Manager.

Rank Film Laboratories
North Orbital Road
Denham
Uxbridge
Tel. Denham 2323

(9043)

Celestion

Loudspeakers for the Perfectionist

Situated in a pleasant part of East Anglia, are in the forefront of loudspeaker design and manufacture. Expansion policies have created the following opportunities for self-motivated people prepared to join an established team:

SENIOR JIG & TOOL DESIGN DRAUGHTSMAN/ WOMAN

to design press tools, jigs, fixtures and special purpose machines. We require several years' experience in jig and tool design, plus an ONC or equivalent qualification. A knowledge of pneumatics would be an advantage.

PLANNING ENGINEER

to contribute to planning in new products from development through to final manufacture, detailing processes, specifying equipment and tooling requirements, and assisting with factory layout. Applicants would be expected to have experience in engineering and assembly methods in medium batch production, and be qualified to at least ONC standard. Experience of CPA techniques would be helpful.

DRAUGHTSMAN/WOMAN

to join Design and Development team, initially to carry out routine drawings and modifications, but with capability to progress to design work. Applicants should be in their early 20's, and have a minimum of two years' experience in light or electro mechanical engineering, and hold a City and Guilds Technician's Certificate or equivalent qualification.

The Company offers competitive salaries, a contributory pension scheme with free life assurance, and appropriate re-location expenses.

For an application form please apply to: **The Personnel Officer, Rola Celestion Ltd., Ditton Works, Foxhall Road, Ipswich, Suffolk IP3 8JP. Telephone No. Ipswich 73131.** (9066)

Brompton Hospital Junior Medical Electronics Technician

Required to undertake work involving maintaining, installing and developing Medical Electronics equipment. Applicants should have a good general knowledge of electronics and be qualified to ONC (Electrical and electronic engineering standard or equivalent). Previous hospital experience not essential.

Salary will be on scale £3423-£4498. Further information available from the Physicist in Charge Mr. R. B. Logan-Sinclair, Tel: 01-352 8121 Ext. 4252.

Application form and job description from Miss J. A. Jenks, Personnel Manager, Brompton Hospital, Fulham Road, London SW3 6HP. Telephone as above Ext. 4357. (9042)

SERVICE ENGINEER

required for the repair and maintenance of electro-mechanical coin machines. Basic knowledge of wiring diagrams and small mechanical parts helpful but training will be given. Must have a clean driving licence. Salary around £70 per week.

J.C.W. (AUTOMATICS) LTD.
83 Lavender Hill
Battersea, S.W.11
Tel: 228 4359 (9079)

TEST ENGINEER

Up to £6000 p.a.

We are one of the world's leading producers of sophisticated environmental test equipment, with over twenty years' experience in high performance electro-hydraulic test machines and vibration systems.

Excellent career opportunities exist for engineers with HNC or equivalent in Electronics or Radio and TV and an interest in mechanics, to undertake bench testing of printed circuit assemblies, with subsequent involvement in the testing of complete systems. Applicants should have experience in fault-finding to component level.

Apply in writing, or telephone
Servotest Ltd.
 Sarsfield Road
 Greenford
 Middx UB6 7AA
 Tel: 01-998 1552 (Mrs. T. Malin)



(9056)

GRANADA TELEVISION LIMITED

YOUNG ELECTRONIC ENGINEERS

(Male or female)

We are looking for Electronic Engineers to fill a number of interesting jobs in the technical operations department at our Manchester studios.

The duties cover the operation and maintenance of all our electronic equipment including TV cameras, video recorders, film scanners and distribution and display equipment. The kind of people we need will probably hold a formal qualification in electronics engineering, but more important, will have a good understanding of basic electronics including digital techniques and the engineering principle of colour television. They must be fit with normal colour vision and prepared to work irregular hours including weekends. People with no previous broadcasting experience will be appointed at £3,775 per annum on a scale rising to £5,939 by annual increments.

Experienced staff will be appointed at the appropriate point of this scale. Four weeks' annual leave plus pension and free life assurance.

Write with full details of education, qualifications and experience, stating age to:



Robert Connell
 Granada Television Limited
 Quay Street
 MANCHESTER M60 9EA

(9035)

Sony Broadcast Limited

are engaged in marketing SONY professional broadcast equipment throughout Europe, Africa and the Middle East.

We have now an opening for a

Senior Lecturer

to assist the Technical Training Manager in providing expertise and support for our products, with a special emphasis on conducting training courses for customers and participating in the planning of further expansion of this important function.

Candidates should have a wide experience in video tape recording, in the theoretical analysis of digital circuitry and analogue/digital signal processing, and a sound knowledge of the broadcasting industry in its most modern applications. They must have the ability to present ideas clearly to a wide range of students and answer the most difficult questions.

The above senior position is permanent at the Company's modern offices in Basingstoke's new business area. A certain amount of travel through the whole marketing area and to the Headquarters of Sony Corporation could be involved.

We will provide whatever additional training is necessary to familiarise the successful candidate with our modern and sophisticated equipment.

A highly competitive and attractive salary is offered to the right person, together with the usual benefits of a large multi-national Company.

Please write in confidence, giving career history and essential details to:

Personnel Manager



Sony Broadcast Ltd.
 City Wall House
 Basing View, Basingstoke
 Hampshire UK RG21 2LA

(9034)

LABORATORY TECHNICIANS

Vacancies exist within the BBC's Equipment Department based at Chiswick for both Senior Laboratory Technicians and Laboratory Technicians.

Duties include the testing of newly manufactured broadcasting equipment and the work is interesting and varied, covering techniques in sound, television and radio frequency engineering.

For the Senior Laboratory Technician posts applicants should possess 3 years' relevant experience together with HNC and City and Guilds F.T.C. in either Telecommunications or Electronics. The current salary range is £4195 to £5715 but this is under review.

For the Laboratory Technician posts applicants should have 1 year's relevant experience together with ONC and Final City and Guilds in either Telecommunications or Electronics. The current salary range is £3805 to £4605 but this is under review.

Accessibility is reasonable due to the proximity of the M4 and Gunnersbury station. Staff restaurant facilities are available and conditions of service are competitive.

Requests for application forms to Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA, quoting reference no. 79.E.4017/WW.



(9017)

★£8,000★ FOR YOUR SONY U-MATIC EXPERIENCE.....

And that's not all - this could be the offer you just can't refuse!

Joining this leading international company, you would be responsible for the service and repair of Sony U-matic VTR and television equipment - incorporating NTSC and PAL colour systems - plus Convergence Editing Units and professional audio systems. In addition, the opportunity may arise to work on advanced cameras and there is the possibility of some overseas travel.

Based in West London close to road and rail links, working conditions are excellent with sophisticated modern workshop facilities and pleasant surroundings.

In addition to the attractive salary, there is an excellent BUPA membership scheme.

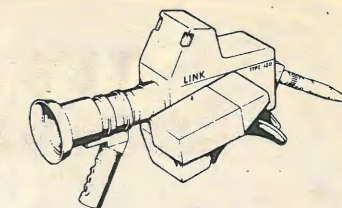
For further details please contact Mike Gernat quoting ref: MB2.



5-11 Westbourne Grove, London W2
 Telephone 01-229 9239

(9023)

LINK



TELEVISION

WE ARE Link Electronics Ltd., a successful expanding company with room for individual ability to make itself felt.

WE MAKE A full range of TV studio broadcast equipment, including colour cameras.

WE NEED DEVELOPMENT ENGINEERS at senior and junior levels, to put good theoretical knowledge into practice in circuit design of all types of broadcast equipment, employing the latest techniques. You must have 2-3 years' relevant experience in industry, preferably obtained in a TV or similar environment.

SENIOR TEST ENGINEER to undertake test and commission of advanced and complex TV cameras and associated equipment. This appointment is at a senior level and so direct experience of similar equipment is a must.

WE OFFER:
SALARY Above average, according to ability and not a rigid grade structure.

BENEFITS Generous holidays, free life and health insurance, pension scheme, staff restaurant, relocation expenses.

LOCATION A modern factory in a very pleasant part of Hampshire with no traffic problems and easy access to London, the South Coast and many major towns.

HOUSING A wide choice. Prices from about £15K upwards if you want to buy.

TO APPLY: Either phone Jean Smith at Andover (0264) 61345 and ask for an application form or write with enough information to make form unnecessary.



North Way, Andover
 Hampshire, England
 Telephone: Andover (0264) 61345

(9022)

Section Chiefs c.£6,000

Test Equipment Repair and Calibration

Our client is a prominent electronics company, enjoying a period of sustained growth and success in their field.

To meet increasing commitments they currently need to recruit experienced engineers, qualified to HNC or C. & G. Full Tech. Cert. to assume the responsibility of leading teams involved in the repair and calibration of proprietary test equipment.

The work is carried out in a spacious, custom-built, clean air, temperature controlled laboratory, using a wide range of digital and analogue test equipment covering audio to microwave frequencies.

Career progression prospects are excellent, and in addition to the salary, these positions also command a comprehensive range of fringe benefits.

Applicants, male/female, should write with full personal and career details to: Position Number STA 7192, Austin Knight Limited, London, W1A 1DS.

Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Position Number Supervisor.



**UNIVERSITY OF KEELE
DEPARTMENT OF PHYSICS**

TECHNICIANS

with experience in either Electronics or Physics required for teaching and research laboratories. Posts at Grade 5 and Grade 2B are available for which the salary scales are £3186-£3720 and £2529-£2880 (under review) per annum respectively.

Application forms and further particulars available from the Professor of Physics, The University, Keele, Staffs. ST5 5BG, to whom applications should be returned by 6th April, 1979.

(9065)

**TOP JOBS IN
ELECTRONICS**

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone or write: **BUREAUTECH AGY, 46 SELVAGE LANE, LONDON, NW7. 01-959 3517.**

(8994)

RADIO TELEPHONE SERVICE ENGINEER required in Croydon. Proven ability to repair equipment more important than formal qualifications. Salary commensurate with ability. Contact **LONDON CAR TELEPHONES** on 01-680 1010. (8822)

LABORATORY TECHNICIANS

BBC Engineering Designs Department requires technicians in Central London laboratories to assist engineers with the development, construction and testing of sound and television broadcasting equipment.

Vacancies exist both for people with experience of this type of work and for trainees. Excellent opportunities for promotion.

LABORATORY TECHNICIANS

Successful candidates will probably be in their 20's and have a keen interest in, and a minimum of two years' practical experience of electronics. They will have at least ONC or City & Guilds Part 2 or equivalent. Salary according to qualifications and experience in the range £3805-£4195 rising to £5095.

JUNIOR LABORATORY TECHNICIANS

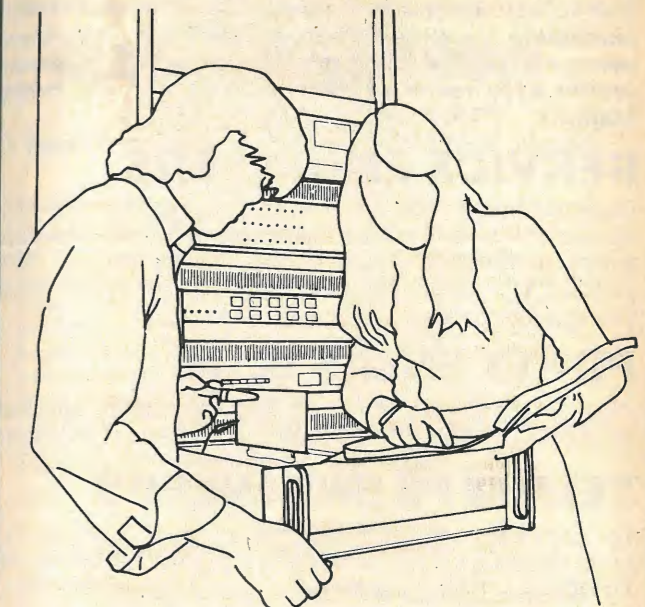
Successful candidates will probably be aged 18-20 and have a keen interest in electronics. They will either be recently qualified to ONC or City & Guilds Part 2 (T4) standard or have started the final year of such a course. Salary according to qualifications in the range £3465-£3735. On the job training given.

Requests for application forms to **The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA.** Quoting Reference Number 79.E.2065/WW and enclosing a self addressed envelope at least 9" x 4", or telephone 01-580 4468. Ext.2675. Closing date for completed application forms is 14 days after publication.



9039

Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation. If you are interested to hear more, please fill in the following details:-

Name _____ Age _____

Address _____

Telephone Work/Home (if convenient) _____

Years of experience 0-1 1-3 3-6 Over 6

Present salary £2,500- £3,500- £4,500- over
 3,500 4,500 5,500 £5,500

Qualifications None C & G HNC Degree

Present job _____

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292



A GEC MARCONI ELECTRONICS COMPANY

(9002)

We need another
Technician/Engineer

To join the VTR team at our Elstree studio centre, NW of London.

As a major television company we make extensive use of video-tape recording for programmes shown throughout the UK and across the world. The VTR section is very active, and works to a high standard: it is large enough to provide technical interest and scope (a major re-equipment programme is pending), but is still informal enough for satisfying involvement.

Ideally, we need someone (male or female) with experience of VTR equipment, but we'd be willing to consider people with video experience in other areas of broadcast or CCTV engineering.

The money is good—up to £5719 to start (depending on experience and qualifications) with automatic progression to £6839p.a. and further service increments to £7378p.a. (ACTT Agreement).

Application forms from:

**Recruitment Officer,
ATV Network Limited
Eldon Avenue, Boreham Wood, Herts.
Tel: 01-953-6100
Please quote Vacancy 101(E)**

(9064)



Nene College Northampton

School of Technology

(1) Applications are invited for the post of

Lecturer, Grade 1 in Electrical Engineering

Candidates should have recent industrial experience and be of graduate or Chartered Engineer status. In addition to lecturing in electrical and electronic principles, it is expected that the successful candidate will be able to assist in the teaching of microelectronics.

Salary scale: £3192-£5334 (under review) with additions for qualifications and experience.

(2) Applications are invited for the temporary post of

Lecturer, Grade 11 in Electrical Engineering

Candidates should be graduates or Chartered Engineers with recent industrial experience. The successful applicant will be able to lecture in one of the fields of Industrial Control, Power or Electronics.

The Post is tenable for one academic year from September 1979.

Salary Scale: £4101-£6558 (under review) point of entry depending on previous experience.

Application forms and further particulars are available from the Senior Administration Officer, Nene College, Moulton Park, Northampton NN2 7AL.

(9092)



require a young

Graduate Engineer

to join an established Electronics Laboratory situated at the Company's Headquarters at Stourton, Leeds 10.

The Laboratory is involved in the design, development and maintenance of industrial control and non-destructive testing systems, including eddy current, ultrasonic and strain measurement techniques.

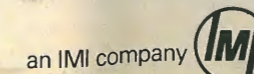
There is a need to strengthen the Laboratory team to meet present and future needs.

The successful candidate will be a graduate engineer with some experience of industrial electrical/electronic control work.

The Company offers fully competitive conditions of employment; an attractive progressive salary range; 23 days' annual holiday plus 8 public holidays, Pension and Profit-sharing Schemes.

Applications, giving full details of age, qualifications and experience and present salary should be addressed to:

The Senior Appointments Officer, Central Personnel Services, Yorkshire Imperial Metals Limited, P.O. Box 166, Leeds LS1 1RD.



SERVICE ENGINEERS

EARN UP TO £7,000 p.a.
PLUS EXCITING VARIETY OF WORK

Electronic Brokers Limited are Europe's leading suppliers of refurbished test and computer equipment. Due to our continued expansion programme we have immediate vacancies for the following experienced personnel within our organisation which is situated within easy reach of King's Cross and St. Pancras stations.

SERVICE ENGINEERS

Capable of repairing and recalibrating a wide variety of test equipment by well-known manufacturers, with the opportunity to progress on to digital equipment i.e. VDUs, printers, etc. Salary up to £5,500 p.a. basic plus bonus, LVs and overtime.

PDP11 ENGINEERS

Able to reconfigure computer systems. Salary negotiable depending on experience. Plus bonus, LVs and overtime.

TELETYPE ENGINEERS

For complete refurbishing of teletypes. Opportunity to progress on to other computer peripherals. Salary circa £5,000 p.a. basic plus bonus, LVs and overtime.

ELECTRONIC BROKERS LIMITED

Phone Mike Jones on 01-837 7781 or write to him at Electronic Brokers Limited, 49-53 Pancras Road, London, NW1.

(9029)

TEST ENGINEERS

REQUIRED IN NEW ZEALAND

Are you planning to emigrate to New Zealand and need work in the electronics industry on arrival?

AWA New Zealand Limited have a number of vacancies for test engineers working on a wide range of communications equipment in their modern plant near Wellington, New Zealand.

The job entails production testing of HF SSB and VHF AM and FM products.

Successful applicants will be joining a staff of 120 people in a pleasant environment dedicated to excellence in building professional electronic equipment.

Salary is negotiable and will depend on qualifications and experience. If you have experience in communications electronics and need a change of scene write now detailing qualifications and work history to:

Mr. R. V. Johansen, Production Manager
AWA New Zealand Limited
P.O. Box 50-248
Porirua, New Zealand

(9100)

CHIEF ENGINEER

Electro-mechanical
Components

Belling and Lee Limited require a Chief Engineer for their Components Division at Enfield, Middlesex. The Division, which employs over 500 people, designs, manufactures and markets a wide range of professional connectors, circuit protection and signal distribution components.

The Chief Engineer reports to the Divisional Director and is responsible for directing and motivating component design, development and production engineering teams towards providing new designs of electro-mechanical components produced by up-to-date cost effective manufacturing processes and machines.

Applicants (male or female) should be Chartered Engineers who can demonstrate a developing record of success in engineering management and have experience of design, production engineering and tooling for metalwork, plastic moulding and assembly associated with small components produced by batch production methods.

A very attractive salary and employee benefits are offered for this senior appointment.

Applications which are confidential, should be addressed to: Mr. J. D. Bostock, Personnel Manager, Belling and Lee Ltd., Great Cambridge Road, Enfield, Middx. Phone: 01-363 5393



Belling-Lee
Better by design

(9018)

LVW/TT

London Weekend Television

have vacancies for experienced

ELECTRONIC ENGINEERS

to work in Electronic Maintenance and Telecine Areas at the South bank Studios. Salary range £4,008 to £5,777 per annum.

Please telephone 01-261 3237 for an application form.

(9032)

ELECTRONICS TECHNICIAN (Grade 5) required in Department of Psychology, University of Reading, to take charge of the electronics workshop. The work involves both design and construction, and advice to staff and students on electronic problems, with considerable freedom of choice in methods used. The departmental programme already depends heavily on advanced analogue and digital techniques. Minimum qualifications would be a recognised apprenticeship; at least 7 years varied experience desirable. Salary in scale £3,186 - 3,720 p.a. (under review). Apply with full details and names of 2 referees, quoting Ref. T.W.W. 06A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks, RG6 2AH. (9044)

Zambia

Your skills will be welcomed and well rewarded in our young but fast-developing nation. We need your help in realising the potential provided by our vast national resources.

Ministry of Power, Transport and Communications

Radio Engineers

K2388 - K4416 (c. £1528 - £2826)

Supplement up to £7026 (married), £3978 (single).

Requirements:

Either 5-year apprenticeship, service trade certificate, ICAO certificate or equivalent: knowledge of medium-powered HF transmitters, frequency key shifting, SSB and equipment, medium-frequency non-directional radio beacons plus low and high powered VHF, AM equipment: and knowledge of either (a) VHF, omni-range, automatic VHF, direction finders, distance measuring equipment, (b) instrument landing systems, (c) radar X-band terminal and PP1 talkdown equipment, (d) audio and remote control equipment, public address equipment, airport magnetic type equipment, inter-office communications, underground control cables, impulse and DC switching systems or (e) teleprinter telegraphy (torn tape) and associate page printers, tape recorders (auto heads), printing reperforators, semi-automatic message switching systems.

Responsibilities:

Installation/maintenance/overhaul of ground terminal radio communication equipment and navigational aids.

Strong Financial Attractions

As well as the salary quoted, you will enjoy TAX-FREE supplements, a TAX-FREE terminal gratuity, low-cost accommodation, low taxation and free passages. Together, these add up to exceptional real earnings. Starting salaries relate to qualifications/experience, while gratuities total 25% of basic salary. Salary-related supplements are reviewed annually and paid by the British Government to designated British nationals (annual maximum is shown), while appointment grants, education allowances, car loans, medical aid assistance and free holiday visits for children educated

in Britain are also provided for those receiving supplements. N.S. Sterling equivalents given are approximations only due to constant exchange rate fluctuations.



For further information please send full personal/professional details (without obligation and in total confidence), indicating which position interests you, to: Recruiting Officer, Zambia High Commission, 7-11 Cavendish Place, London W.1.

Help us to help ourselves

THE POLYTECHNIC, HUDDERSFIELD

Department of Music

SENIOR TECHNICIAN T5 £4,773-£5,073 Ref. NT.381

Required as soon as possible a highly qualified technician (graduate or equivalent) with appropriate experience, to take technical charge of the Electronic Music Studio now being set up in the Department of Music.

Application forms available from the Establishment Office, Polytechnic, Queensgate, Huddersfield HD1 3DH. Telephone 22288, Ext. 2225.

Application forms should be returned by 28th March, 1979.

(9028)

CA CAPITAL
APPOINTMENTS LTD.

FREE JOBS LIST
for
FIELD SERVICE ENGINEERS
BASIC SALARIES TO
£7,000 + CAR

(8781)

30 Windmill Street, London, W1
01-637 5551

BASINGSTOKE AND NORTH HAMPSHIRE HEALTH DISTRICT SENIOR ELECTRONICS TECHNICIAN to install and maintain electronic medical equipment in Basingstoke and Alton. Qualifications: O.N.C., H.N.C. or equivalent. Salary: £3,744-£4,788 p.a. Application forms and job descriptions available from the District Personnel Department, Basingstoke District Hospital, Aldermaston Road, Basingstoke, Hants. Tel: Basingstoke 29908/9. Quote reference no. WW12/09398. Closing date: 9th April, 1979. (9085)

Foreign and Commonwealth Office

Telecommunications Officers

... in London and at Hanslope Park, Milton Keynes, for work on the installation, modification, maintenance and operation of HF, VHF, UHF and microwave receivers, associated test equipment, recorders, telephone and teleprinter equipment, electronic ancillary apparatus (some using analogue and digital techniques), voice frequency telegraph and other specialised equipment.

Candidates must have served an apprenticeship or have had equivalent training. They should normally have 3 years' relevant experience; and hold ONC in Engineering (with pass in Electrical Engineering 'A') or Applied Physics or TEC/SCOTEC in a relevant subject or equivalent qualification. *Ex-Service people*, who have had suitable training and at least 3 years' appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary, starting between £3285 and £4355 (according to age), rises to £4705; London £524 more. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by April 5, 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/5069.**

(9073)

Electronics Engineer



Polydor Limited, a member of the international Polygram Group of Companies, marketing records and tapes, has the above vacancy situated at their Head Office in the West End.

We require a person with an excellent knowledge of advanced transistor and some digital techniques to work for our Recording Studio.

Applicants, aged 24-30 should possess high qualifications (for example a BSc degree). Some experience in the audio field is essential.

We offer a good salary, LV's, 4 weeks annual holiday, contributory pension scheme and generous discount on Company products.

(9072)

Please telephone Brian McFall or Hazel Phillips,
Personnel Department, Polydor Limited

Tel: 01-499 8686.

Electronic Design Engineers

with experience in digital design, engineering or product support.
Reading, Berks.

Digital Equipment, the inventors of the mini-computer and world leaders in this field, have built a highly successful division called Computer Special Systems. This is a group of experts who are dedicated to meeting the specific and one-off needs of our clients.

The expansion of CSS has created a need for professional Engineers at all levels to take responsibility for either the engineering or technical support of the division's equipment.

The need is for Engineers, qualified to Degree or HNC level, with at least 2 years experience (4 years+ for senior positions) in either digital design, engineering or product support, including responsibility for meeting schedules and technical targets. You should also be able to perform circuit and logic design and liaise with customers on technical matters. As a self-starter, you

must be able to demonstrate your ability to achieve agreed objectives set to strict schedules.

We are offering salaries in the range of £5,500-£8,000 p.a. Fringe benefits are those to be expected from a major international company including relocation assistance to the Reading area where appropriate. Future career prospects are outstanding for successful men or women.

For more information, telephone or write to: John Atkins or Ray Renowden on Reading (0734) 85211 or write to Digital Equipment Company Ltd., Arkwright Road, Reading, Berks. Please quote ref 509.

digital

We've always looked for Test Engineers who weren't afraid of New Ideas

Pye Telecommunications have made many original contributions to the technology of mobile radio; for instance, we were the first manufacturer to use printed circuit boards. But whatever we have achieved, we have always backed it with the specialist skills and abilities of our test engineers - the men and women who put the final seal of approval onto all our equipment.

If you welcome the challenges offered by a wide variety of products, many incorporating up-to-the-minute technology, then you'll fit in at Pye. To join us you should have had sound experience of fault diagnosis, alignment, and testing at PCB level, preferably on communication equipment. Forces experience would be particularly suitable. As the leading manufacturer of two-way UHF/VHF radio

systems in Europe, we can offer you excellent working conditions, well-equipped workshops with a broad range of modern test gear, good career prospects and a stable company structure where you will find security and job satisfaction. Starting salaries are between £3800 and £4300 depending on technical ability.

The positions are based at Haverhill in Suffolk, where key-worker housing may be available for those moving from other parts of the country.

For further details please write or phone, reversing the charges where necessary, to Mrs. Catherine Dawe, Senior Personnel Officer, Colne Valley Road, Haverhill, Suffolk. Tel: Haverhill 4422.

 **Pye Telecommunications Ltd**
Colne Valley Road, Haverhill, Suffolk.
Tel: Haverhill 4422.

21225
16 TO 26
19b DC
10M
901
(8932)

MICRO-PROCESSOR AND DIGITAL FAULT-FINDING

Are you experienced in this field? Then we need you to service our audio visual systems at our European service centre in Wembley. We are growing fast so there are excellent promotion prospects with an attractive salary in flexible working conditions.

For more details ring **Mediatech, 903 7279.** (9076)

UNIVERSITY OF SHEFFIELD

ELECTRONICS TECHNICIAN

(Grade 8)

Required to control a workshop serving the Departments of Biochemistry, Genetics and Microbiology. Duties will involve varied electronic and electrical work, including development, construction, testing and servicing and repair of scientific equipment.

Applicants should have nine to ten years' relevant experience, and possess knowledge of modern sophisticated circuitry. H.N.C. or equivalent qualification is essential.

Salary on scale £3654-£4365 p.a. (under review) according to age and experience.

Please write to the Administrative Officer (Personnel), (Ref. S1197/WW), The University, Sheffield S10 2TN. (9096)

UNIVERSITY OF SOUTHAMPTON

INSTRUMENT TECHNICIAN

The Department of Chemistry has a vacancy for an Instrument Technician to help maintain a varied range of scientific equipment and to develop specialised one-off devices in connection with research.

Applicants should have an appropriate engineering qualification (at least ONC or equivalent) together with relevant experience of electronics and the maintenance of electromechanical equipment. A knowledge of optical equipment would be an advantage.

The appointment will be made on the grade 5 salary scale £3186-£3720 per annum (under review).

Applications giving date of birth, details of qualifications and experience and the names and addresses of two referees should be sent to Mr. C. N. Saul, The University, Southampton SO9 5NH, quoting reference number 521/T/WW. (9098)

AGRICULTURAL RESEARCH COUNCIL INSTITUTE OF ANIMAL PHYSIOLOGY BABRAHAM, CAMBRIDGE CB2 4AT

ELECTRONICS CRAFTWORKER

(up to £67.75 a week for a suitably experienced person over 21 years of age) to work in the Electronics Department on the construction and maintenance of electronic instrumentation for agricultural research. House to rent available. Pay £59.25 for a 40-hour week plus Flexibility Allowance of 21.25p for each hour worked. Day release for Technical College in approved cases. Non-contributory superannuation scheme. 3 weeks' paid holiday and 10½ days public holidays a year. Canteen. Apply with full details of experience to the Secretary of the Institute by the 14th April, 1979, quoting ref. B.C.3. (9099)

CAPITAL APPTS.

FREE LISTS

101 Design/Development, and Test Jobs

Permanent and Contract

To £6,000

(8782)

637 5551 day, 636 9659 eve.

Telecommunications & Recording Specialists

There are opportunities to put your specialist knowledge and training to the fullest possible use in the following sections:

Equipment Control - New Scotland Yard and Thornton Heath

... to lead teams of technicians engaged on installation, operation, modification and maintenance of a wide range of equipment from mobile radio to intruder systems and control centres. Sound theoretical knowledge and sufficient practical aptitude to maintain systems at peak efficiency essential. Ref. T/5057/1.

Tape Recording - S.E. London

... work includes preparing for specialised tape recorders; copying and processing tapes; giving evidence in Court about work carried out on tapes; occasionally analysing various phenomena on tape recordings. Candidates should have a thorough understanding of tape recorders and recording techniques, have experience of work in professional broadcast studios on audio, and video recorders, and be fully conversant with checking tapes for quality and defects. Ref. T/5057/1.

VHF/UHF Communications - S.E. London

... to be concerned with the use and modification of VHF and UHF communications equipment for specialised Police use, together with the prototype design and development of electronic equipment. Candidates should have a good general knowledge of VHF and UHF communications techniques and digital logic systems, some laboratory experience in the design and development field, and ability to innovate and develop ideas. Ref. T/5057/1.

Intruder Alarm Systems - East Dulwich

... work includes surveying and planning alarm systems for use by Met. Police, managing tests on alarm systems, and suggesting modifications to systems to reduce false calls. Candidates should have a clear understanding of the requirements for power supplies used in the alarm systems industry (active and standby). Ref. T/5057/1.

Network Planning and Implementation - Central London

... to join group responsible for the planning and implementation of Met. Police speech, telegraph and data networks, and day-to-day organisation of Post Office telecommunications services. Candidates should have had recent experience of P.O. procedures for the provision of PBXs and associated line plant, and a working knowledge of telegraph and/or data transmission. Ref. T/5053/1.

All candidates (men and women aged at least 21) must have ONC in Engineering (with a pass in Electrical Engineering 'A') or appropriate C. + G. Certificate or an equivalent or higher qualification. Salary, starting between £3,750 and £4,820 (according to age), rises to £5,170. Inner London salaries quoted; £190 less at Thornton Heath. Promotion prospects. Non-contributory pension scheme. For further details and an application form (to be returned by 17 April, 1979), write to Civic Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote appropriate reference.

A challenge to your skill - with the Metropolitan Police

(9019)

SERVICES

DESIGN SERVICE. Electronic Design Development and Production Service available in Digital and Analogue Instruments, RF Transmitters and Receivers for control of any function at any range. Telemetry, Video Transmitters and Monitors, Motorised Pan and Tilt Heads etc. Suppliers to the Industry for 16 years. Phone or write Mr. Falkner, R.C.S. Electronics, 6 Wolsey Road, Ashford, Middlesex. Phone Ashford 53661. (8341)

DESIGN AND DEVELOPMENT, competent engineering effort available for all aspects of electronic design. Single circuits or complete systems, prototype to production run. E.I.A., 80 Wheatland Lane, Wallasey, Merseyside. 051-639 9122. (8615)

PRECISION SHEET METAL work. chassis, panels, etc., steel, stainless or aluminium, long/short runs, good deliveries. EES Ltd., Clifford Rd, Monks Road, Exeter 56280 36489. (8060)

SITUATIONS VACANT

ENGINEERS

For Systems Design of Advanced Products

M.E.L., a division of Philips Electronic and Associated Industries Ltd., is an established leader in the defence electronics field. The Company has a very wide product range and is rapidly expanding in a number of areas. We are looking for SYSTEMS ENGINEERS to join our growing Systems Department. The job will involve the evolution of new system concepts and system design of our new generation products. It will be necessary to keep abreast of technology and to be alive to the changing requirements of the market.

Much of the work will be done in collaboration with overseas companies or for overseas customers and international travel may be necessary. We should like to talk to engineers and scientists who wish to join this stimulating environment. Suitable candidates will have a degree or equivalent qualification and drive and initiative, as well as sound professional experience preferably, although not necessarily, in Electronic Warfare or Communications. H.M. Service personnel with operational experience in these areas are also invited to apply.

This is an opportunity to join a department of growing importance and influence in the Company and we are able to offer salaries and conditions commensurate with this position. We are also able to assist with our generous relocation package. For further information please contact: Roy Broadhurst, Personnel Department, M.E.L., Manor Royal, Crawley, Sussex RH10 2PZ or telephone Crawley 28787 Extension 219 for an Application Form.



(9037)



ARTICLES FOR SALE

MSF 60KHZ

TIME RECEIVER, built-in antenna. £13.70 or with sequential year, month, date, day, hours, minutes, seconds, display parts (no case or pcb) £24.40. **SIG. GEN.**, 10Hz-200KHz, logic and variable sine of square. £10.80. **V.L.F.** 2.10-150 KHz Receiver £10.70. **RADIO 4 GONE?** 200 KHz to Medium Wave Converter £9.70.

Each easy-assembly kit includes all parts, printed circuit, case, postage, etc., money back assurance to SEND off NOW.

CAMBRIDGE KITS, 45 (WR) Old School Lane, Milton, Cambridge. (9083)

HUGE BARGAIN PACK OF ELECTRONIC AND RADIO GOODIES. Too many items to list. All brand new and useful. No junk. Value at least £25. Only £9 including post and packing. C.W.O. (U.K. only). Refund if not delighted. A. Philpott, 171 Great Brays, Harlow, Essex CM18 6DT. (9068)

BRUEL & KJAER half inch capacitor microphone with power supply, £100 ono. Farnborough 0252 47009. (9048)

CLEARANCE SALE

Chassis Amps, Amplifiers, complete with power supply. 100 watts rms into 4 ohms £30 + VAT 120 watts rms into 4 ohms £35 + VAT 120 watt x 120 watt stereo £65 + VAT

V.W Leisure Electronics 36 Brindles, Canvey Island, Essex (9095)

T.V. TUBE REBUILDING. Complete plant, equipment, supplies and training. If you can afford the best contact Western-Whybrow Engineering. Tel. 073 676 2265. (8048)

60KHz MSF Rugby Receiver, BCD TIME OF DAY OUTPUT. High performance, phase locked loop radio receiver, 5V operation with second LED indication. Kit complete with tuned ferrite rod aerial £14.08 (including postage and VAT). Assembled circuit and cased-up version also available. Send for details, Toolex, Sherborne (4359), Dorset. (8252)

THE VINTAGE WIRELESS COMPANY

1920 to 1950
Receivers, valves, components, service data, historical research, books, magazines, repairs and restorations. A complete service for the collector and enthusiast of vintage radio.

S.A.E. with enquiry and for monthly newsheet
THE VINTAGE WIRELESS COMPANY
64 Broad Street, Staple Hill, Bristol BS16 5NL
Tel: Bristol 565472 (8966)

SOLAR CELLS: bits, books and bargains. Send stamp for list or 95p for Solar Cell booklet and Data sheets. Edcombe Ltd 34 Nathans Road, North Wembley, Middlesex HA0 3RX. (8061)

TEKTRONIX OSCILLOSCOPES type 545A. Complete with handbooks and type CA DC/24 MHz D/Trace vertical amplifiers. Exceptionally clean condition. Bargain price £220 inc. 14 Braidley Road, Bournemouth 0202 291481. (9077)

ARTICLES FOR SALE

RADIO AMATEUR'S HANDBOOK 1979

by A.R.R.L. PRICE: £7.90

New 56th Edition Completely Revised

WORLD RADIO TV H/B. 1979 Price: £9.20

THE TTL DATA BOOK FOR DESIGN ENGINEERS

by Texas Price: £5.90

UNDERSTANDING DIGITAL ELECTRONICS

by Texas Price: £4.00

SYSTEM DESIGN WITH MICROPROCESSORS

by D. Zissos Price: £7.50

THE COMPLETE MOTOROLA MICROCOMPUTER DATA LIBRARY

by Motorola Price: £9.40

TESTING METHODS & RELIABILITY ELECTRONICS

by A. Simpson Price: £4.35

DIGITAL PROCESSING OF SPEECH SIGNALS

by L. R. Rabiner Price: £18.00

PROGRAMMING FOR MINICOMPUTERS

by J. C. Cluley Price: £13.00

SOME COMMON BASIC PROGRAMS

by L. Poole Price: £6.30

* PRICES INCLUDE POSTAGE *

THE MODERN BOOK CO.

Specialists in Scientific & Technical Books

19-21 PRAED STREET LONDON W2 1NP

Phone 723 4185
Closed sat 1 p.m. (8974)

TRANSFORMER PROBLEMS?

1VA-1KVA Prototypes in 7-10 days. Phone Vince Sellar on 06076-66716.

TRENT TRANSFORMERS LTD
Chapel Street
Long Eaton, Nottm. (8363)

HI-FIDELITY DESIGNS No. 1 (a Wireless World publication). We had announced that this publication was out of print but we now discover that we have 350 copies in stock. Due to our announcement, many readers were disappointed, but we are now pleased to inform them that copies are available from The General Sales Manager, Room CP34, Dorset House, Stamford Street, London SE1 9LU. Please forward your order together with your remittance of £1.50 (including P&P) made payable to IPC Business Press Ltd. (8652)

G.W.M. RADIO LTD., 40/42 Portland Road, Worthing, Sussex. Tel. 34897. Pneumatic masts 40ft. By Scam Clark. 300 watt radar calorimeters, noise generators, type CT410, Eddy-stone communication receivers 730/4, v.g.c. £185.00 inc. Many bargains for callers, surplus always wanted. (8832)

TECHNOLOGICS CPG6RF colour bar and pattern generator. UHF Ae 1/P, new colour power battery design, 8 descending PAL colour bars crosshatch, dots, etc., full kit incl. case, etc., £36. Built £54. PG6RF kit £21.50, built £28. Add-on colour bar unit C6 in kit £15.50, built £22 plus £1 p&p, 8% V.A.T. Mail order from Technolitics, Dept WW, 8 Egerton St., Liverpool L8 7LY. (8951)

SITUATIONS VACANT

Marine Transmitter Development Engineer

In Marine Division we are responsible for the design and development of advanced HF Communication systems for the Merchant Navy at both low and high powers using solid state techniques as well as valves.

The two engineers we are seeking will have a professional qualification and some years experience of one of the following: Transmitter RF design, solid state drives and frequency generation equipment in general. You should also have the ability to progress your design through the production phase.

Write or phone for an application form to Mr. G. Short, Marconi Communication Systems Ltd., New Street, Chelmsford, Essex. Telephone Chelmsford 53221.

A GEC-Marconi Electronics Company



(9078)

ARTICLES FOR SALE

THE SCIENTIFIC WIRE COMPANY

PO Box 30, London, E.4

ENAMELLED COPPER WIRE

SWG	1lb	Box	4oz	2oz
10 to 19	2 65	1 45	75	60
20 to 29	2 85	1 65	90	70
30 to 34	3 05	1 75	1 00	75
30 to 40	3 40	1 95	1 15	84
41 to 43	4 55	2 55	1 95	1 30
44 to 46	5 05	3 05	2 15	1 70
47	8 00	5 00	3 00	1 80
48	15 00	9 00	6 00	3 30

SILVER PLATED COPPER WIRE

14 & 16	4 50	2 25	1 44	90
20 & 22	5 00	2 65	1 74	1 05
24 & 26	5 70	3 31	2 00	1 22
28 & 30	6 67	3 86	2 35	1 44

Prices include P&P and VAT
SAE brings list of copper & resistance Wires
Dealer Enquiries Invited (9063)

INVERTERS

High quality DC-AC. Also "no break" (2ms) static switch, 19" rack. Auto Charger.



COMPUTER POWER SYSTEMS
Interport Mains-Store Ltd.
POB 51, London W11 3BZ
Tel: 01-727 7042 or 0225 310916 (9101)

ARTICLES FOR SALE

SOWTER TRANSFORMERS

WITH 37 YEARS' EXPERIENCE we have the expertise to design and manufacture ANY TYPE OF AUDIO TRANSFORMER AT THE RIGHT PRICE.

Whilst we specialise in every kind of transformer for audio control desks and mixers demands are increasing for **LOUDSPEAKER TRANSFORMERS** and **100 VOLT LINE AUDIO OUTPUT TRANSFORMERS** FOR MOST KINDS OF AMPLIFIERS FROM 30 WATTS TO 500 WATTS OR MORE. We can also supply multi-output transformers for **COLUMN LOUDSPEAKERS**. A recent tendency is the demand for **OUTPUT TRANSFORMERS FOR ULTRA LINEAR AMPLIFIERS** using **KT 88** and **KT 66 BEAM TRODES** and for these we have standard designs with exceptional performance.

We call your attention to our very successful **MICROPHONE SPLITTER TRANSFORMER** type 4079 with a high impedance 200 ohm primary and two 200 ohm secondaries. It will handle up to 2.3 volts rms at 30 Hz and has a frequency response of plus/minus 1/2 dB from 20 Hz to 20 kHz. It is contained in a Mumetal Can 33 mm diam x 37 mm high and WORKING DETAILS OF THE CONSTRUCTION OF A SPLITTER ARE AVAILABLE ON REQUEST.

We will supply single transformers, or any quantity, with short delivery times and, without obligation on your part, will quote price and exact dispatch on receipt of your requirements. **E. A. SOWTER LTD., Manufacturers and Designers, P.O. Box 36 IPSWICH IP1 2EG, ENGLAND. Tel. IPSWICH (0473) 52784 and 219390.** (8289)

TO MANUFACTURERS, WHOLESALERS & BULK BUYERS ONLY

Large quantities of Radio, T.V. and Electronic Components.
RESISTORS CARBON & C/F 1/8, 1/4, 1/2, 1/3. 1 Watt from 1 ohm to 10 meg.
RESISTORS WIREWOUND. 1/2, 2, 3, 5, 10, 14, 25 Watt.
CAPACITORS. Silver mica, Polystyrene, Polyester, Disc Ceramics, Metalamite, C280, etc.
Convergence Pots, Slider Pots, Electrolytic condensers, Can Types, Axial, Radial, etc.
Transformers, chokes, hopts, tuners, speakers, cables, screened wires, connecting wires, screws, nuts, transistors, ICs, Diodes, etc., etc.
All at Knockout prices. Come and pay us a visit. Telephone 445 2713, 445 0749.

BROADFIELDS & MAYCO DISPOSALS
21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tally Ho Corner (9062)

A.B.S. BOXES 105mm, 72mm, 40mm, grey or black, 82p including VAT while stocks last. Boughton and Yarow, 2 York Road, Kennington, Ashford, Kent. TN2 49QQ. (9066)

MUIRHEAD WEATHER satellite facsimile equipment comprising D900-S machine 240 r.p.m. supporting 2.4KHz electronics units and cable, £150. — Bolton 52384. (9087)

ALL SERVICE SHEETS/MANUALS. S.A.E. please. Main suppliers T.V. Repair Manuals etc. — AUSWW, 76 Churches, Larkhall, Lanarks. (9081)

XTELS 1623, 1626 KHz £5 per pair, 1,000's more s.a.e. list. Hoop aerials £10. Throat mics £3. Relays 12v DPCO £3. Maginton Electronics, Coventry Airport. 0203 302668. (9088)

READY BUILT UHF modulator by A2TEC. As used in most video games. Special price £3 inc. Unalynn Limited, 52 Hillside Gardens, Edgware, Middx. 01-958 5600. Mail order only. (9051)

KEYBOARDS, 64 character in case, £15, circuit boards, 51b bundle for £3 many more ex-computer bits, s.a.e. for details. C. Clarke, 41 Grove Avenue, Bristol BS9 2RP. (9052)

AUDIO PRE-AMPLIFIERS, excellent specification, £8.95 plus p&p and VAT. Details SAE please. Audio Enterprises, 15 Long Lane, Holbury, Southampton, Hants. SO4 1LF. (9049)

Technicians: An Instrumentation Challenge with the Health & Safety Executive

These posts, at Cricklewood in London, are in the Instrument Maintenance Unit, which undertakes acceptance testing of new equipment, and provides a maintenance and repair service for an extensive range of portable measuring instruments and sampling equipment. This work is expanding to cover a variety of analytical equipment, and some instrument development is undertaken.

The technician appointed to the senior post will be personally involved in the more demanding maintenance, calibration and testing work carried out on sophisticated instruments, often without the use of circuit diagrams or working plans. In addition, the successful candidate will supervise and train other members of the team, and participate in the design of new calibration equipment, the modification of existing instruments, and in general development activities.

The successful candidate for the second post will work on the routine maintenance, calibration and testing of instruments. This will involve constructing, setting up and checking calibration test rigs, and the diagnosis of instrument faults.

Candidates for either post must hold ONC or equivalent in an appropriate subject, and have an aggregate of at least 4 years' training (eg apprenticeships and/or full-time study) and experience; at least eight years required for the senior post. They must have sound theoretical knowledge and practical experience relevant to the work.

Salary for the senior post will start at £4600 and rise to £5140. For the second post, salary starts between £3320 and £4045 according to age, and rises to £4600. Promotion prospects at both levels. Non-contributory pension scheme.

For further details and an application form (to be returned by 5 April, 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote ref: T(15)648 (9074)

ARTICLES FOR SALE

EXCLUSIVE OFFER

Ref	H"	Width"	Depth"	Price
PE	10	21	13	£10.00
LL10	54	21	18	£20.00
TT	64	25	26	£45.00
SL	71	25	26	£50.00
ST	85	22	24	£70.00

Rack cabinets for RA-17/117 £30.00
 Uniframe, single £30.00
 Uniframe, double £45.00
 Uniframe, triple £60.00

Over 60 types available from 12" to 90" high. Also twins, triples and consoles. Above are only a few types. Please send for full list.

AUDIO AND INSTRUMENTATION TAPE RECORDER-REPRODUCERS

- * Plessey 0333 Digital Unit, 7 track 1/2"
- * Plessey MS500 Digital Unit, 7 tracks 1/2"
- * Ampex FR-1100, 6 speeds, stereo 1/2"
- * Ampex FR500, 4 speeds, 7 track 1/2"
- * D.A.I. BM-4 speeds, 4 tracks 1/2"
- * Minicom CMP-100, 6 speeds, 7 tracks 1/2", 1/4", 1"
- * Ampex 351 2 speed 2 tracks 1/2"
- * 3M, 4 speeds 14 track 1"

Prices of above £70 to £500
 Also Transport Decks only available

We have a large quantity of "bits and pieces" we cannot list - please send us your requirements, we can probably help - all enquiries answered.

All our aerial equipment is professional MOQ quality

- * Hems Clarke Panadapher £95.00
- * Telefunken Surveillance Receiver £175.00
- * Sarvomech 2KVA Auto Regulators £80.00
- * Hallicrafters S24 Receivers £40.00
- * Velleux Aerials 1 1/2" and Helicopters £120.00
- * Textronix 5434 Oscilloscopes CA £290.00
- * Textronix 5454 Oscilloscopes D £275.00
- * Textronix 5814 Oscilloscopes 80 £360.00
- * Marconi TF 2200A Oscilloscopes £200.00
- * Solatron CO 1014 Oscilloscopes £110.00
- * Solatron 1016 Oscilloscopes £90.00
- * Rhode & Schwarz OVR 0 meters 50Kc/30 MCS £160.00
- * Rhode & Schwarz ZDO Diagram 300/2400 MCS £425.00
- * Rhode & Schwarz SMLM Signal Generators 20/200 MCS £180.00
- * Rhode & Schwarz SMF AM/FM Oscillators 10/200 £220.00
- * Rhode & Schwarz SDR VHF Signal Generators 300/1000M £300.00
- * Rhode & Schwarz SWH Sweep Generators 50K/12M £160.00
- * Rhode & Schwarz SW08-1 Polyscopes at 5/400M £400.00
- * Rhode & Schwarz S8R Signal Generators 1.5/2.48 £200.00
- * Rhode & Schwarz ESM-300 VHF Receivers 180/300M £275.00
- * Racal RA-17 P Receivers (New) £950.00
- * R.C.A. AR-88 Receivers £80.00
- * Edystone 7700 VHF Receivers (no turret coils) £90.00
- * Collins KWT 6 Transmitter Receivers 585 P.U.R. £150.00
- * Philips RC150 HF Transmitter Receivers £230.00
- * Rohand RD 504 Oscilloscopes £160.00
- * B & K 2407 Electronic Voltmeters £90.00
- * Advance Advac Electronic Voltmeters £170.00
- * Wayne Kerr B 801 R.F. Bridge P.U.R. £170.00
- * Winston "S" Band Spectrum Analyzers P.U.R. £260.00
- * M.E.S.L. Sweep Generators 4/8 GMCS £130.00
- * Airmec 352 Sweep Generators 200 cyc/200Kcs £45.00
- * Advance Transistor Tuners TT-15 £80.00
- * Advance Digital Voltmeters DM-1 £140.00
- * Marconi TF 323 Magnification Meters £425.00
- * Marconi TF 1066B FM Signal Generators £290.00
- * Marconi TF 801 D/T AM Signal Generators £150.00
- * Ferranti 75KVA Auto Voltage Regulators £240.00
- * Manson TR-101 Multipliers £90.00
- * Bradley CT 4718 Electronic Multimeters £130.00
- * Sarvomech 2kw Auto regulators P.U.R. £25.00
- * 125H Lattice Masts, 20' sides £55.00
- * 30H Lattice Masts, 14' sides £18.00
- * 10H Light Lattice Sections, 6' sides £4.50
- * EMI 1/2" Audio Tape 3600 FT Nab £18.00
- * SEA/28 C.R.T.s £19.00
- * 342P/2 (QMW) C.R.T.s £19.00
- * Plessey 3 & 6KCS S.S.B. Filters £14.00
- * AVO CT 471A Electronic Multimeters £75.00
- * EMI R 301 Tape Recorders £50.00
- * Snorrette L Tape Recorders £25.00
- * Uniselectors, 10 Bank 25-way £3.50
- * 40H Sectional Aluminium Masts, complete £45.00
- * Harde 504 Freq. meters 200-500 M/cs £16.00
- * Multi-purpose Trolleys with Jacks 19 x 17 £250.00
- * E.M.I. Documents CCTV Outfit £150.00
- * Advance 3KVA CV Transformers £150.00
- * Metal V.O.U. Tables 30" x 36" x 30" £24.00

MANUALS

- * Data Efficiency Responder 240V £28.00
- * Belling Lee 100 Amp Interference Filters £76.00
- * Oscilloscope Trolleys from £18.00
- * Racal MA1978 pre-selector £85.00
- * Rack Mounting Operator Tables £10.00
- * 75R Aluminium Lattice Masts, 20' sides £400.00
- * Addo 5 R Track Punches £48.00
- * Racal MA-175 I.S.B. Modulators (new) £45.00
- * Tally 5 R Track Tape Readers 60 cps £48.00
- * Tally 5 R Track Tape Readers Track Spooling £65.00

We have a quantity of Power Transformers 250 watts to 15KVA at voltage up to 40KV. Best quality at low prices. Lists available.

- * Racal RA-63 SSR Adaptors, new £70.00
- * Racal RA 298 I.S.B. Transistorised Converters (new) £120.00

We have a varied assortment of industrial and professional Cathode Ray Tubes available. List on request.

PLEASE ADD CARRIAGE AND V.A.T.
P. HARRIS
 ORGANFORD, DORSET, BH16 6BR
 BOURNEMOUTH (0202) 765011 (8981)

When you buy Hectaphone you buy more than Intercom

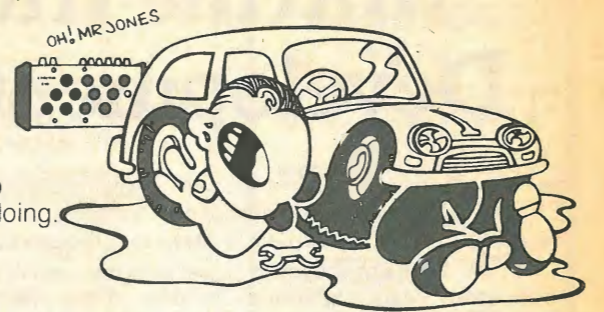
Instant talk back to your Hectaphone from up to 40ft. Never having to leave what you are doing.

Fully intercommunicating.

Any Station to any Station.

HIGHAMS ELECTRONIC COMMUNICATIONS LIMITED

Ferndown Industrial Estate, 96 Cobham Road, Wimborne, Dorset. BH21 7RE.
 Tel: (0202) 893514



- Mini up to 4 lines**
 EXAMPLE: 3 wall stations, amplifier, 30 metres cable
 Approx **£153.30**
- Maxi up to 8 lines**
 EXAMPLE: 6 wall stations, amplifier, 50 metres cable
 Approx **£313.50**
- Magnum up to 21 lines**
 EXAMPLE: 12 wall stations, amplifier, 100 metres cable
 Approx **£858.00**

(9091)

CHESSE CHALLENGER 10 level version ultra low prices including V.A.T. and postage and packing only £160. Gammonmaster 2 with doubling cube £115. Atari home video computer £127, extra cartridges only £12. Mail order only to Jagberry Limited, 95 Ardwell Avenue, Barkingside, Ilford, Essex. 01-588 7352. (8938)

REVOX B77 TAPE RECORDERS, limited number, used approx. 50 hours 3 1/2" two-track, guaranteed for twelve months. £515 inc. V.A.T. EMI AND RACAL ZONAL, professional tape on 7in and NAB spools. Keep prices. Send for list. NEVENCO C90 cassettes £6.50 for 10 inc. V.A.T. Audio equipment for professional users, e.g. Uher, AKG, Beyer, Sennheiser etc. New range of NEVENCO mixing consoles especially for churches, charities and missions. NEVENCO LIMITED, 2 Hills Road, Cambridge CB2 1JP. Tel: (0223) 62392. (8950)

CONSTRUCTOR PLANS - Hundreds sold! Pulse Induction Metal Locator, advanced economic switched CMOS design, Mk II £1.80. Mk III with stabiliser, 5 ICs £1.75. Radio Telescope 5-Metre £2. Solar Energy Furnace £1.80. Digital Multi-tested/frequency counter 22 ranges £1.50. R & E Publications, Highlands, Needham Market, Suffolk. (8976)

TEN YEAR GENERAL INDEX to "Wireless World", 1968, 1977, fully cross referenced, £5 inc. - Roscoe, 86 Kenilworth Crescent, Enfield, Middlesex EN1 3RG, England. (9047)

LAB CLEARANCE: Signal Generators; Bridges; Waveform, transistor analysers; calibrators; standards; millivoltmeters; dynamometers; KW meters; oscilloscopes; recorders; Thermal, sweep, low distortion true RMS, audio FR deviation. Tel. 040-376236. (8250)

EDUCATIONAL

C AND G EXAM
 Make sure you succeed with an ICS home study course for C and G Electrical Installation Work and Technicians. Radio/TV/Electronics Technicians. Telecomms Technicians and Radio Amateurs.

COLOUR TV SERVICING
 Make the most of the current boom! Learn the techniques of servicing Colour and Mono TV sets through new home study courses, approved by leading manufacturers.

TECHNICAL TRAINING
 Home study courses in Electronics and Electrical Engineering, Maintenance, Radio, TV, Audio, Computer Engineering and Programming. Also self-build radio kits. Get the qualifications you need to succeed. Free details from:

International Correspondence Schools, Dept. 280P, Intertech House, London SW8 4UJ. Or phone 01-622 9911. (8970)

ASSORTED pre-war and war time radios. Also selection of radio magazines dating from 1935-1955 including "Short Wave," Q.S.T., Wireless World, Stratton-on-Fosse 232542 evenings. (9063)

10 3 DIGIT DIGITAL Voltmeters. Will operate from -5v, 0, +5v supply. Cost £25 each. Also 3 power supplies for running D.V.M.'s, 12 2.1 MHz tuned concentric twin ultrasonic transducers, suitable for doppler imaging. Cost £13 each. Dimensions: 1.2 cm diameter, 5 mm thick. - J. F. Sutcliffe, Physics Department, Royal Devon & Exeter Hospital, Barrack Road, Exeter EX2 5DW. (9046)

204 COPIES Wireless Worlds, from 1951 to 1978, best offer secures, will sell separate copies. D. L. Jones, 177 Chevening Road, London NW6 6DT. (9046)

TEKTRONIX 453 Oscilloscope 50 MHz £600. Doram sine/sq. oscillator low D, n, mint, £50. Scopex 4D10A oscilloscope, brand new, 2 probes handbook boxed, £200. Marconi TF 995 sigen AM/FM £130. Avq 7/ Mk 2 £40. Add 8% VAT. "Q" Service Electronic Camberley Ltd., 29 Lawford Crescent, Ayleley, Camberley, Surrey. (0252) 871048. (9045)

EQUIPMENT

TO ALL MANUFACTURERS AND WHOLESALE IN THE ELECTRONIC RADIO AND TV FIELD

BROADFIELDS & MAYCO DISPOSALS
 will pay you top prices for any large stocks of surplus or redundant components which you may wish to clear. We will call anywhere in the United Kingdom.
 21 LODGE LANE
 NORTH FINCHLEY, LONDON N12 8JG
 Telephone Nos. 01-445 0749/445 2713
 After office hours 958 7624

LEGAL NOTICES

TRADE MARK NO. 510715 consisting of the word REVELATION and registered in respect of Gramophones and phonographs; and apparatus for use in wireless telegraphy included in class 8" was assigned on 14 June, 1976, by Revelation Supplies Limited of Blackhorse Lane, Walthamstow, London E17 to Antler Limited of Pilot Works, Alfred Street, Bury, Lancashire BL9 9LB WITHOUT THE GOODWILL OF THE BUSINESS IN WHICH IT WAS THEN IN USE. (9061)

BOOKS

THE STORY OF RADIO by W. M. Dalton, M.I.E.R.E. Authentic, nostalgic, readable. Volume I. How Radio Began. From electrics to radio 1914. Volume II. Every One An Amateur 1920/26, constructors & BBC. Volume III. The World Starts to Listen 1926/30. Receivers, transmitters, talkies, television. Each volume £4.50 p/p 50p. Adam Hilger Ltd., Techno House, Redcliffe Way, Bristol BS1 6NX. (9014)

* Ring Derek Pattinson now and discuss your requirements.
Crofton Electronics Ltd.
 35 Grosvenor Road, Twickenham, Middlesex.
 Tel. 01-891 1923 (8211)

ARTICLES FOR SALE

COLOUR, UHF AND TV SPARES. CEEFAX, ORACLE IN COLOUR. MANOR SUPPLIES "EASY TO ASSEMBLE" TELETEXT KIT. Including TEXAS Decoder. Aerial Input, completely external unit, no further connections to set. Full facilities, mixed TV programme and Teletext, Newsflash, Update, and many special features not found in other units. Demonstration model in operation at 172 West End Lane, NW6. Phone or write for further information.

TEXAS TIFAX XM11 Decoder module, new, £130, p/p £1.00. **NEW COMBINED COLOUR BAR GENERATOR PLUS CROSS HATCH KIT (Mk4)** UHF Aerial input type. Eight vertical colour bars plus R-Y, B-Y, Luminance combinations, Grey scale etc. Pushbutton controls. Battery operated £35*, De Luxe case £4.80*, aluminium case £2.40*, battery holders £1.50*, mains supply kit £5.78*, p/p £1.00. Built and tested (battery) £58*, p/p £1.20. **CROSS HATCH KIT**, UHF Aerial input type, also gives peak white and black levels. Battery operated, £11* p/p 45p. Add-on Grey Scale kit £2.90* p/p 35p. Aluminium case £2*, p/p 85p. Cross Hatch Unit, complete and tested in De Luxe case £20.80* p/p £1.

"WIRELESS WORLD" TV Tuner and FM Tuner Projects by D. C. Read. Kits of parts available, CRT test and reactivator kit for colour and mono £19.80 p/p £1.20. UHF Signal Strength Meter kit £18* p/p 90p. 625 TV IF Unit for Hi-fi amps or tape recording £6.80 p/p 70p. Decca Colour TV Thyristor Power Supply Unit, incl. H.T., L.T., etc. Incl. circuits £3.80 p/p £1.20 Bush A823 (A807) decoder panel £7.50, p/p £1. Bush 161 T-B panel A634 £3.80, IF panel A593 £3.80 p/p 90p. Bush Portable TV 11V stab power supply unit £4.80 p/p £1. Bush CTV 25 Convergence Panel plus yoke, blue lateral £3.60 p/p 90p. Philips Single Standard Convergence Units complete, incl. 16 controls £3.75 p/p 85p. Colour Scan Coils, Mullard or Plessey, £6 p/p 90p. Mullard AT 1023/05 Converg. Yoke £2.50 p/p 75p. Mullard or Plessey Blue Laterals 75p p/p 35p. BRC 3000 type Scan Coils £2 p/p 90p. Delay Lines: DL20 £3.50, DL50 £3.50, DLIE, DLI £5 p/p 45p. Lum delay lines 50p p/p 40p. G8 Tripler £6. BRC 3000 Tripler £6.60 p/p 75p. Others available. Philips G8 Decoder part-complete £2.50 p/p 75p. GEC 2040 Ex-Rental Panels. Decoder £5.00. Time Base £5.00, p/p 90p. VARICAP TUNERS UHF: Gen. instr. £3.50. ELC 1043 £4.50, ELC 1043/05 £5.50. VHF: ELC 1642 £4.80, Philips VHF £3.80. Salvaged UHF & VHF Vari-caps £1.50 p/p 35p. VARICAP CONTROL UNITS, 3 position, £1.20. 4 PSN £1.50, 5 PSN £1.80, 7 PSN £2.80. Special offer 6 position £1, p/p 35p. UHF Transd. Tuners incl. slow motion drive £2.80, 4 position push button £2.50, 6 psn. £4.20, p/p 90p. Helical Pots 100K, 4 for £1.20 p/p 30p. Thorn 850 Dual Std. Time Base panels 50p. Philips 625 IF panel incl. oct. 50p p/p 70p. Mullard Mono Scan Coils for Philips Stella, Pye, Ekco, Ferranti, Invicta £2.00 p/p 85p. Large selection LOPTS, FOPTS available for most popular makes. MANOR SUPPLIES 172 WEST END LANE, LONDON, N.W.6. Shop Premises. Callers welcome. Thousands of additional items available not normally advertised. (Nos. 28, 159 buses or West Hampstead-Bakerloo Line and British Rail). Mail Order: 64 Golders Manor Drive, London, N.W.11. Tel: 01-794 8751. V.A.T. Please ADD 12% TO ALL PRICES (EXCEPT WHERE MARKED*. V.A.T. 8%). (60)

PCB ARTWORK DESIGN SERVICE with component notation masters and assembly drawings. PADS Electrical Ltd, 01-850 6516, 45 Southwood Road, New Eltham SE9.

AGENTS WANTED
 PCB AGENT WANTED. Very generous commission offered on all PCB work obtained. Please reply Box No WW 9093. (9093)

CAPACITY AVAILABLE

I.H.S. SYSTEMS
 Due to expansion of our manufacturing facilities we are able to undertake assembly and testing of circuit boards or complete units in addition to contract development. We can produce, test and calibrate to a high standard digital analogue and RF equipment in batches of tens to thousands. Telephone to arrange for one of our engineers to call and discuss your requirements, or send full details for a prompt quotation.
TEL. 01-253 4562
 or reply to Box No. WW 8237 (8237)

CAPACITY AVAILABLE

ELECTRONIC CIRCUIT Design and prototype construction production assembly. Test and PCB artwork design. Write: Powerline Electronics, High Street, Bognor Regis, Sussex PO21 1EZ or telephone STD 024-32 (Pagham) 66587 evenings.

SMALL BATCH productions wiring assembly to sample or drawings. Specialist in printed circuits assembly. Rock Electronics, 42 Bishopscote, Harlow, Essex 0279 33018.

COURSES

PLYMOUTH POLYTECHNIC

HONOURS DEGREE IN COMMUNICATION ENGINEERING

Enhance your career opportunities by studying for a degree in this interesting and rewarding field of engineering. Plymouth Polytechnic offers a

4-year sandwich course to students with satisfactory 'A' levels, ONC/OND, C & G or equivalent qualifications. Sponsorship and grants are available.

For further information contact:

Head of Communication Engineering, Plymouth Polytechnic.

Drake Circus, Plymouth, Devon. PL4 8AA 9058

CAPACITY AVAILABLE

PCB ASSEMBLY CAPACITY AVAILABLE

Low or high volume, single or double sided, we specialise in flow line assembly. Using the Zevatron soldering system and on line lead cutting, we are able to deliver high quality assemblies on time, and competitively priced. Find out how we can help you with your production. Phone or write. We will be pleased to call on you and discuss your requirements.
TW ELECTRONICS LTD.
 120 NEWMARKET ROAD
 BURY ST. EDMUNDS, SUFFOLK
 TEL: 0284-3931
 Sub contracting assemblies to the Electronics Industry (9068)

WIND YOUR OWN COLLS

Short runs, Long runs, One type, Many types, Simple, Complex.

You name it

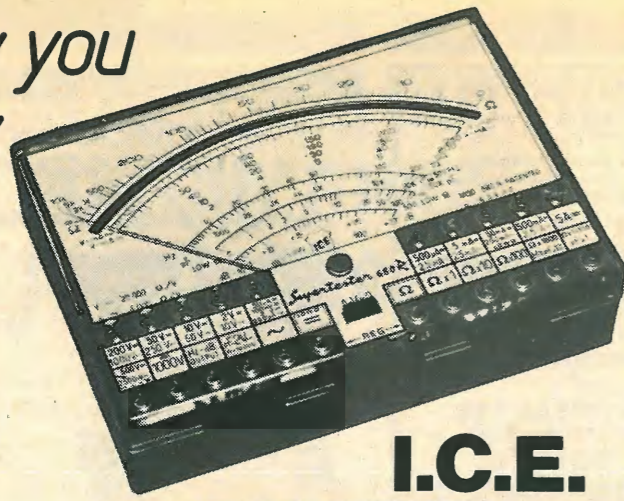
AIRTRONICS LTD
 Large or small PRODUCTION RUNS
 GARDNER INDUSTRIAL ESTATE
 KENT HOUSE LANE
 BECKENHAM KENT BR3 1UG
 01-659 1147 8936

Specialised PCB Service

Layouts - Photography - Drilling
 Roller Tinning - Gold Plating
 Legend Printing - Profiling
 Special quick prototype service
Crofton Electronics Limited
 35 Grosvenor Road, Twickenham Middlesex - Tel. 01-891 1923

HIGHWAY ELECTRONICS. Logic design, PCB artwork, assembly, testing, custom built electronics, Unit 112, Springvale Ind. Estate, Cwmbran, Gwent NP44 5BG. Telephone Cwmbran (06333) 68042. (8347)
SKILLED HAND assembly, one-offs and small batch runs. - I. G. Bowman, 59 Fowey Avenue, Torquay, S. Devon. (9000)

Here's why you should buy an I.C.E. instead of just any multimeter



I.C.E.

WW-104 FOR FURTHER DETAILS

- * Best Value for money.
- * Used by professional engineers, D.I.Y. enthusiasts, hobbyists, service engineers.
- * World-wide proven reliability.
- * Low servicing costs.
- * 20K/volt sensitivity and high accuracy.
- * Large mirror scale meter.
- * Fully protected against overload.
- * Large range of inexpensive accessories.
- * 12 month warranty, backed by a full after sales service at E.B. Sole U.K. Distributors

Prices from £16.60 — £32.00 + VAT
Send for full colour leaflet and prices on whole range including accessories.

ELECTRONIC BROKERS LIMITED

49-53 Pancras Road, London NW1 2QB.
Tel: 01-837 7781. Telex: 298694.

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 133-151

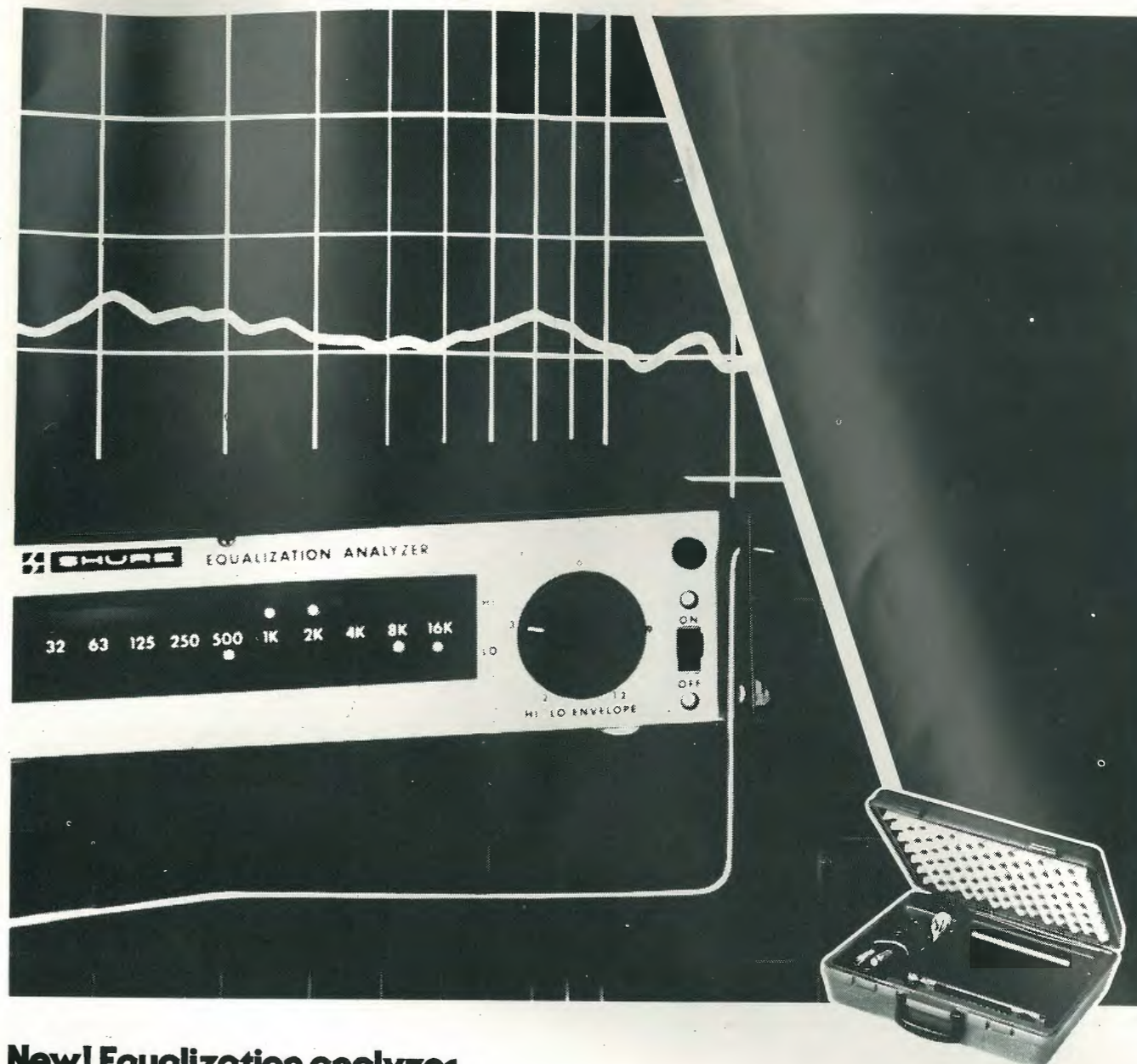
PAGE	PAGE	PAGE
Acoustical Mfg. Co. Ltd. 19	Gould Advance Ltd. 8	Olson Electronics Ltd. 37
Adcola Products 40	Greenwood Electronics 21	Omnitest Ltd. 20
AEL Crystals 39		
Ambit International 30, 31		
Amtron Ltd. 37, 108	Hall Electric Ltd. 114	Phillips Electrical 42
Antex 87	Harnsworth Townley & Co. Ltd. 16	Powell, T. 102
Aspen Electronics Ltd. 22	Harris Electronics (London) Ltd. 14, 18	Powertran Electronics 75, 118, 119
Astra-Pak 112	Hart Electronics 110	Pye Unicam 10, 15, 35
Audix Ltd. 38	H/H Electronics 34	
Aura Sounds 36	Hi-Fi Care 110	
	Hilmomast Ltd. 116	
Barrie Electronics Ltd 117	I.L.P. Electronics Ltd. 109	Radford Lab. Insts. Ltd. 37
Bayliss, A. D. & Son Ltd. 12	Industrial Tape Applications 107, 116	Radio Components Specialists 115
Bell & Howell 25	Integrex Ltd. 104, 105	Radio Shack 102
Bib Hi-Fi Accessories Cover IV	Intel Group of Companies 88	Ralfe, P. F. 108
Bi-Pak Semiconductors Ltd. 101		R.C.S. Electronics 39
Boss Industrial Mouldings Ltd. 28		R.S.T. Valves 132
	JPS Associates 103	
Cambridge Learning 17	Keithley Instruments Ltd. 112	Sabtronic (UK) Ltd. 14
Carston Electronics Ltd. 6	KGM Electronics 16	Samsons (Electronics) Ltd. 111
Carter Associates 39	Kirkham Electronics 4	Science of Cambridge 5
Catronics 117		Scopex Instruments Ltd. 113
CEC Corporation 21	Labgear Ltd. 26	Service Trading Co. 130
Chiltmead Ltd 128	Langrex 132	Servo & Electronics Sales Ltd. 108
Circuit Designs No. 3 29	Lascar Elec. 40	Sescom 110
Citadel Products Ltd. 131	Leavers-Rich Equipment Ltd. 26	Shackman Inst. Ltd. 31
Clarke-Smith 18	Lektrokit 38	Shure Electronics Ltd. Cover iii
C. N. Stevenson 98	Levell Electronics Ltd. 3	Silicon Seminars 129
Colomor (Electronics) Ltd. 111	Light Soldering Developments Ltd. 20	Sintel 117
Computer Appreciation 122	Lowe Electronics Ltd. 22	Sota Communication System 131
Crajel UK Ltd. 128	Lynwood Elec. 103	Special Products Ltd. 20
Crellon (Hewlett Packard) 9		Strutt Elec. & Mech'l Engrs Ltd. 102
Crimson Elektrik 24	Manners, K. T. 131	Sugden, J. E. & Co. Ltd. 38
C.T. Electronics 120, 121	Maplin Electronic Supplies 7	Surrey Electronics Ltd. 108
	Martin Associates 30	Swanley Electronics Ltd. 103
	Marconi Instruments Ltd. Cover ii	
Datong 40	Marshall, A. & Sons (London) Ltd. 100	
Display Electronics 123	MCP 11, 36	3M United Kingdom 26
Drake Transformers 12	Medelec 10	Technomatic Ltd. 122
	Microsystems 23	Teleradio Hi-Fi 116
Eagle International 41	Mills, W. 100	Transam Components 32, 33
Eddystone Radio Ltd. 8	Milward, G. F. 116	
Elektro-Tek 106	MTG Instruments 97	Valradio Ltd. 16
Electronic Brokers Ltd. 124, 125, 126, 127, 152	Multicore Solders Ltd. Cover iv	Vero Electronics Ltd. 14
Electronics Weekly 99	MHZ Electronics 24	Vero Speed 22
Electrovoice 128	Natural Panasonic 76	Videotime 108
Eraser Int'l Ltd. 36	Newbear Computer Stores 98	
Farnell Instruments Ltd. 27		
Ferranti 88		
Fluke International 13		
Future Film Developments 40		

OVERSEAS ADVERTISEMENT AGENTS:

France: M. D. Soubeyran, Compagnie Francaise D' Editions, Division Internationale, 40 Rue du Colisee, Paris 8e Telephone: 225-77-50 — Telex 280274.
Hungary: Mrs. 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: Ray Barnes, IPC Business Press, 205 East 42nd Street, New York, NY 10017 — Telephone: (212) 689 5961 — Telex: 421710.
Mr. Jack Farley Jnr., The Farley Co., Suite 1584, 35 East Wacker Drive, Chicago, Illinois 60601 — Telephone: (312) 6 3074.
Mr. Victor A. Jauch, Elmatex International, P.O. Box 34607, Los Angeles, Calif. 90034, USA — Telephone (213) 821-8581 — Telex 18-1059.

Mr. Jack Mentel, The Farley Co., Suite 650, Ranna Building, Cleveland, Ohio 44115 — Telephone: (216) 621 1919.
Mr. Ray Rickles, Ray Rickles & Co., P.O. Box 2008, Miami Beach, Florida 33140 — Telephone: (305) 532 7301.
Mr. Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E. Atlanta, Georgia 30305. Telephone: (404) 237 7432.
Mike Loughlin, IPC Business Press, 15055 Memorial, Ste 119, Houston, Texas 77079 — Telephone (713) 783 8673.
Canada: Mr. Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 — Telephone: (416) 364 2269.
*Also subscription agents.



New! Equalization analyzer... Balance a system... Balance a budget.

Quick and accurate adjustment of sound system frequency response is finally within the reach of most budgets. The Shure M615AS Equalization Analyzer System is a revolutionary breakthrough that lets you "see" room response trouble spots in sound reinforcement and hi-fi systems—without bulky equipment, and at a fraction of the cost of conventional analyzers.

The portable, 11-pound system (which includes the analyzer, special microphone, accessories, and carrying case) puts an equal-energy-per-octave "pink noise" test signal

into your sound system. You place the microphone in the listening area and simply adjust the filters of an octave equalizer (such as the Shure SR107 or M610) until the M615 display indicates that each of 10 octaves are properly balanced. You can achieve accuracy within ± 1 dB, without having to "play it by ear." Send for complete descriptive brochure.

Shure Electronics Limited
Eccleston Road
Maidstone ME15 6AU
Telephone: Maidstone (0622) 59881

TECHNICORNER
The M615 Analyzer's display contains 20 LEDs that indicate frequency response level in each of 10 octave bands from 32 Hz to 16,000 Hz. A rotary hi/lo envelope control adjusts the HI LED threshold relative to the LO LED threshold. At minimum setting, the resulting frequency response is correct within ± 1 dB. Includes input and microphone preamplifier overload LEDs. A front panel switch selects either flat or "house curve" equalization. The ES615 Omnidirectional Analyzer Microphone (also available separately) is designed specifically for equalization analyzer systems.



high quality

Multicore solder helps Europe's OTS-2 satellite orbit at 23,000 miles

OTS-2, a forerunner of a European communications satellite, was launched from Cape Canaveral on May 11th 1978.

Now orbiting the equator at a height of 23,000 miles, OTS-2 was built for the European Space Agency by the MESH consortium, led by British Aerospace Dynamics Group, Stevenage.

In building OTS-2, complete precision was called for. Which is why Ersin Multicore solders were used for many of the soldering operations.

Quite simply, Multicore solders have *that* kind of reputation. For quality, toughness and reliability. That's why so many electronics manufacturers won't use anything else.

Next time you need solder of any kind, aim as high as OTS-2... and use Multicore.

Full details of Ersin Multicore solders, solder chemicals and high purity bar solders for automatic soldering from



Multicore Solders Ltd

Maylands Avenue
Hemel Hempstead Herts HP2 7EP
Tel: Hemel Hempstead 3636
Telex: 82363

