

# wireless world

FEBRUARY 1981 60p

Australia AS 2.40  
Canada C\$ 4.25  
Denmark D.Kr. 20.25  
Germany Dm. 6.00  
Greece Dr. 125.00  
Holland Gfl. 3.75  
Italy L. 2500  
Norway Nkr. 21.00  
Singapore M\$ 3.50  
Spain Ptas. 150.00  
U.S.A. \$3.75



**Wind meter**

**'Just detectable'  
distortion**

**Morse decoding  
program**



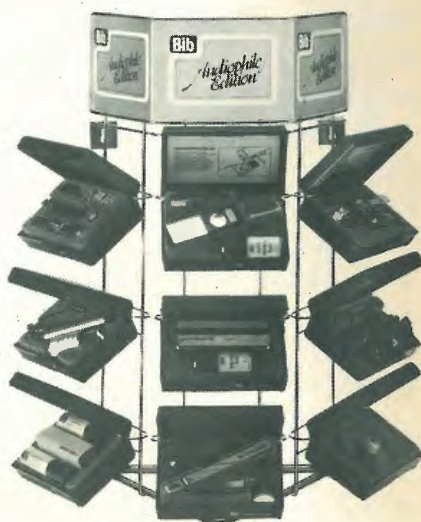
## Afterthought...or after thought?

When you think about the adverse effects of a magnetized tape head, it's inevitable – loss of high frequency response and undue background noise – the solution becomes obvious. Demagnetization.

The Bib Tape Head Demagnetizer is BSI approved, simple to use and suitable for both reel and cassette machines. A probe is easily brought to within a few millimetres of the tape head and held there for about 3 seconds – so there is no risk of damaging the head itself. And, if

used regularly, you can be sure of getting the best possible reproduction from your tape machine.

Don't wait until you can actually hear the problem. Think about preventing it now with a Bib Tape Head Demagnetizer – part of the Bib Audiophile range of quality audio maintenance products. Displayed in leading department stores and specialist audio dealers, the Bib Audiophile Centre contains all you need to keep your audio equipment in peak condition. Ref. 90-AE. RRP £8.74 inc. VAT.



**Bib**® *Audiophile Edition*

Bib Hi-Fi Accessories Ltd.,

Kelsey House, Wood Lane End, Hemel Hempstead, Hertfordshire. HP2 4RQ. Telephone: (0442) 61291 Telex: 826437

Bib Hi-Fi Accessories Inc. 1751 Jay Ell Drive, Richardson, Texas 75081 USA. Telephone (214) 238 1224 Telex 792451.

Bib Hi-Fi Accessories, 43 Birmingham Street, Alexandria, New South Wales, Australia 2015. Telephone 67 2750 Telex 20779.

WW-004 FOR FURTHER DETAILS

# wireless world

FEBRUARY 1981 60p

Australia AS 2.40  
Canada C\$ 4.25  
Denmark Dkr. 20.25  
Germany DM. 6.00  
Greece Dr. 125.00  
Holland Gld. 5.75  
Italy L. 22000  
Norway Nkr. 21.00  
Singapore M\$ 5.50  
Spain Ptas. 150.00  
U.S.A. \$3.75

WIRELESS WORLD FEBRUARY 1981 VOL 87 NO 1541



**Wind meter**

**'Just detectable' distortion**

**Morse decoding program**

# FREE PROJECT BOOK WITH APS NEW EBBO BREADBOARDS

WITH EACH EBBO IC-1 OR DC-1 STARTER PACK A FREE STEP BY STEP 10 PROJECT BOOKLET ANYBODY CAN BUILD ELECTRONIC PROJECTS WITH EBBO MONEY BACK GUARANTEE IF YOU CAN'T

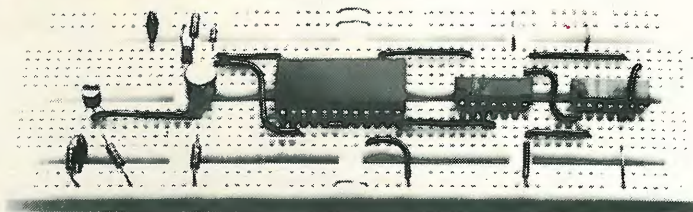
## POWERACE THE MOST EXPENSIVE BREADBOARD IN THE WORLD



Three poweraces that give you the ultimate in breadboarding. Built in power supplies and a FREE logic probe is built into MODEL 102

POWERACE 101	923221	£61.30
POWERACE 102	923222	£95.80
POWERACE 103	923223	£95.80

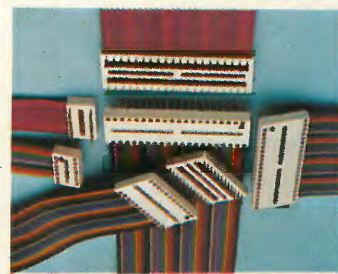
## SUPERSTRIP SS2 THE BIGGEST SELLING BREADBOARD IN THE WORLD



When you buy a SUPERSTRIP BREADBOARD you buy a breadboard to last you for ever, we give you a LIFETIME guarantee. SUPERSTRIP is the most used breadboard by hobbyists, professionals and educationalists because it gives you more for your money ... With 840 contact points SUPERSTRIP accepts all DIP's and discrete components and with eight bus bars of 25 contact points each SUPERSTRIP will take up to nine 14-pin DIP's at any one time. You should only buy a breadboard once so buy the biggest seller with a lifetime guarantee.

SUPERSTRIP SS2 923252 PRICE INCL VAT £9.78

## DIP-DIP-DIP-DIP-DIP JUMPERS AP DIP JUMPERS ARE THE LOWEST PRICE IN THE UK

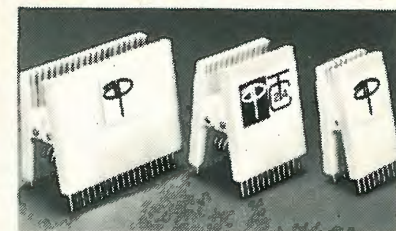


- EX-STOCK DELIVERY
- 5 STANDARD LENGTHS  
6, 12, 18, 24, 36"
- WITH 14, 16, 24, 40 CONTACTS
- FULLY ASSEMBLED AND TESTED
- INTEGRAL MOULDED ON STRAIN RELIEF
- LINE BY LINE PROBEABILITY

SINGLE-ENDED		DOUBLE-ENDED all prices 1-9 off. Huge discounts for quantity					
CONTACTS	24"	CONTACTS	6"	12"	18"	24"	36"
14	£1.67	14	£2.11	£2.21	£2.31	£2.43	£2.63
16	£1.89	16	£2.33	£2.45	£2.58	£2.66	£2.97
24	£2.74	24	£3.45	£3.62	£3.78	£3.94	£4.30
40	£4.38	40	£5.31	£5.61	£5.91	£6.22	£6.81

We can supply DIP, SOCKET, PCB, CARD-EDGE RS232, assemblies made-up, tested, ready for use, cheaper than you can buy the parts, ask for quote.

## TEST-CLIP TEST-CLIP



Clip an AP TEST-CLIP over an IC and you immediately bring up all the leads from the crowded board into an easy working level.

### 22 NEW AP TEST-CLIPS TO PICK FROM

examples:	TC 14	923695	£2.76
	TC 16	923700	£2.91
	TC 24	923714	£8.50
	TC 40	923722	£12.88



Cutaway model of a capacitor measuring microphone from Brüel & Kjaer (UK) Ltd symbolically introduces the article on 'just detectable' distortion in this issue.

### IN OUR NEXT ISSUE

A range of counters for construction based on the versatile Intersil ICM7216 i.c. From a set of modules a variety of instruments can be assembled.

Magnetic recording progress. Tape recording has developed rapidly, urged on by the popularity of hi-fi reproduction. James Moir reviews advances in equipment and tape coatings.

Guide to s.a.w. devices for the professional applications engineer, covers electrical characteristics and applications of three s.a.w. types: bandpass filters, delay lines and oscillators.

Current issue price 60p, back issues (if available) £1.00, at Retail and Trade Counter, Units 1 & 2, Bankside Industrial Centre, Hopton Street, London SE1. Available on microfilm; please contact editor.

By post, current issue 96p, back issues (if available) £1.50, order and payments to EEP General Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS.

Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton Surrey SM2 5AS. Telephones: Editorial 01-661 3500. Advertising 01-661 3129. Telegrams/Telex: 892084 BISPRS G.

Subscription rates: 1 year £10.00 UK and \$33.80 outside UK. Student rates: 1 year £5.00 UK and \$16.00 outside UK.

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 World Ltd, 527 Madison Avenue, Suits 1217, New York, NY 10022. 2nd-class postage paid at New York.

# wireless world

ELECTRONICS / TELEVISION / RADIO / AUDIO

FEBRUARY 1981 Vol 87 No 1541

31 The new bureaucracy

32 'Just detectable' distortion  
by James Moir

35 Wind speed and direction indicator  
by N. Pollock

39 World of amateur radio

40 News of the month  
Business communications satellite Video cassettes levy  
Response to c.b. Green Paper

44 Morse decoding  
by N. Kyriazis

47 Letters to the editor  
Open channel frequencies Commercial broadcasting The speed of light

51 T.t.l. logic probe  
by A. J. Jameson

54 F.m. detectors - 2  
by S. W. Amos

57 Battery-powered instruments  
by Ian Hickman

62 Circuit ideas  
Gate tester Wide-range p.p.m. Programmable bandpass filter

67 Interfacing microprocessor systems  
by P. Jackson and S. O. Newstead

71 Multiplex keying for organs - 2  
by A. W. Critchley

77 Tellegen's theorem - some applications  
by Harry E. Stockman

80 New products

82 Sidebands  
by Mixer

## NEW EBBO

The NEW Modular Circuit Building System

Until now hobbyists had to buy professional solderless breadboards for their projects and pay professional prices. But now there's EBBO a brand new total breadboarding system that's not only economically priced but offers far more advantages to hobbyists and schools. At the core of the system are two starter packs, one for discrete component projects, the other for integrated circuit (IC) projects. Each starter pack comes with a number of EBBO system modules fitted into a tray and an illustrated booklet which guides you step by step in building ten projects. Building a project is simple because the modules are colour-keyed and letter/number indexed and because EBBO is expandable, you can add to your system as many of the available compatible modules. For schools and beginners we have a complete step by step approach to teach yourself electronics consisting of five basic electronics books and the discrete starter pack. So buy your EBBO Starter Pack, get your free step by step 10 project booklet and start building projects yourself. Free advice or money back guarantee.

### BASIC INTEGRATED CIRCUIT STARTER PACK

The IC Starter Pack includes two terminal strips, two distribution strips and a spacer/support strip already in an EBBO tray, ready for use. A free project booklet containing ten IC projects with step-by-step instructions completes the pack.

IC-1 Starter Pack £4.24

### BASIC DISCRETE COMPONENT STARTER PACK

This Starter Pack contains a tray, discrete component strip, battery holder and connector and project booklet with ten projects.

DC-1 Discrete Starter Pack £4.67



All prices shown are recommended retail incl. VAT  
In difficulty send direct, plus 50p P & P.  
Send S.A.E. for a free copy of colour catalogues detailing our complete range.

AP PRODUCTS, PO BOX 19, SAFFRON WALDEN, ESSEX, (0799) 22036



# Electronic Brokers - Europe's Premier Used Computer Company offer SUPERLATIVE USED COMPUTER EQUIPMENT - AS NEW CONDITION

.....February 1981..... Latest Computer Equipment.....



**PDP11 C.P.U.s**  
This bestselling mid-range mini is now coming available on the second-user market at worthwhile price savings and, often just as important, we can offer fast delivery.  
Available with parity MOS core or cache memory, expandable to 124KW, the processor includes as standard many features which are often expensive add-ons on other systems.  
★ Integral memory management.  
★ Integral extended instruction set (EIS)  
★ Self-test diagnostic routines.  
★ Automatic bootstrap loader.  
★ Direct memory access.  
★ Automatic Power Fail/Restart.

**PDP11 OPTIONS**

AA11D VT01 Controller with 4-slot System Unit	£125.00
DD11A 4-slot System Unit	£125.00
DD11B 4-slot System Unit	£150.00
DD11-DK 9-slot backplane	£465.00
DL11 Serial Interface	£250.00
DL11WA/B Serial Interface/Line Clock	£395.00
DR11C General Purpose Interface	£250.00
DRV11V 16-bit Parallel Interface	£225.00
DZ11A 8-line EIA MUX	£1395.00
FP11A Floating Point	£1750.00
KL11 TTY Interface	£150.00
KW11L Real Time Clock	£150.00
KW11P Programmable Clock	£345.00
M105 Device Selector	£30.00
M792 ROM Diode Matrix	£195.00
M920 Unibus Connector	£12.00
M9310-YB Bootstrap	£325.00

**POWER SUPPLIES**  
DEC.  
H720 Power supply for BA11 Expander Box, BRAND NEW SURPLUS ..... £175.00

**PDP8A C.P.U.**  
DEC.  
PDP8A Processors, systems and add-on memory usually available.

**PDP8A MEMORY**

MMBAA 8KW Core	£750.00
MMBAB 16KW Core	£995.00

**PDP8E CPU, MEMORY, OPTIONS**

DEC.	
DP8EB Communications Adaptor	£395.00
KABE Positive 1/0 Bus	£95.00
KDBE Databreak	£145.00
KL8E Synchronous Interface	£250.00
KP8E Power fail/auto restart	£95.00
MM8E 4KW Core memory stack	£350.00
TABE Dual Cassette Drive and Controller	£525.00
VT8E Set graphics Control Modules	£250.00

**TERMINALS**  
DEC.  
LA34 DECwriter 1V 30cps desk-top terminal, 132 columns, upper/lower case ASCII ..... £495.00

LA36 DECwriter 11 Keyboard Printer Terminal. The Terminal that has become an industry standard, with 132 column upper/lower case printing and switch-selectable speeds of 10, 15 & 30cps. Available with either 20mA or RS232 interface ..... £750.00  
VT52 24 lines by 80 columns, 7 x 7 dot matrix, upper and lower case ASCII, includes numeric keypad, 20mA or RS232 interface. £450.00  
VT100. Also available from time to time, DEC's latest 132 column display terminal. Please enquire for latest price and delivery ..... £750.00

**VDUs**  
Hazeltine.

H1000 The low, low priced teletypewriter-compatible video display terminal, offering your choice of transmission speeds up to 9600 baud as well as parity generation and checking. 12 x 80 display upper case ASCII, RS232 interface, choice of baud rates SUPER VALUE	£199.00
--	---------

**MAGNETIC TAPE**  
DEC.  
Available from time to time — TU10, TU45, TE16 TS03 etc.

**DISKS**

DEC.	
RK05 J add-on disk drive 2 1/2 meg. Exchangeable cartridge type. From	£1850.00
RK06 Add-on disk drive 14 meg. Free standing. From	£3250.00
RK07-ED Add-on Disk drive 28 meg. P.O.A.	
RL01-AK Add-on Disk drive 5 meg.	£1975.00
RP02 20 meg add-on disk drive	£1250.00
RP04 add-on 88 meg disk drive	£8000.00
RP06 add-on 176 meg disk drive	£15,950.00
RX11-BD Dual floppy disk drive and control. Controllers usually available for above drives.	£1800.00

**VDUs**  
Hazeltine.

H2000 Superb spec. including full XY cursor addressing and edit facility, 27 x 74 display, upper case ASCII, RS232 interface, switch-selectable baud rates ..... £299.00  
H2000C NOW ALSO AVAILABLE with 25 x 80 line format and C-MOS logic ..... £375.00

Modular One. Now with upper/lower case, XY cursor addressing, 24 x 80 line display, dual intensity detachable keyboard, choice of 8 transmission rates up to 9600 baud ..... £399.00

**PRINTERS**  
Centronics 101.  
Heavy Duty Matrix printer with 64 ASCII upper case character set. 165 cps operation, 132 print positions with adjustable tractor feed, Parallel input. ONLY ..... £495.00

**GP80 GRAPHICS.**  
BRAND NEW — LOST COST MATRIX PRINTER IDEAL FOR MICROPROCESSOR USERS SUCH AS HOBBYISTS & EDUCATIONALISTS OR ANY LOW-BUDGET APPLICATION

★ Full upper/lower case ASCII PLUS GRAPHICS Mode  
★ 80-column printing with adjustable tractor feed  
★ Standard and double-width characters (12 cpi and 6 cpi)  
★ 30 cps print speed with 1-line buffer  
★ Standard parallel (Centronics-type) interface  
★ Optional interfaces available for RS232, IEEE488, Tandy, PET, Apple II  
★ ONLY ..... £199.00 (Mail order total ..... £240.35)

**GE Terminus 1200.**  
RO printer, 80 columns, tractor feed, upper/lower case, ASCII, 20mA interface ..... £325.00

**Hazeltine.**  
Thermal printer, 80 columns, 30 cps silent RO with parallel TTL input ..... £395.00

**Tally 1602.**  
Matrix printer, parallel input, upper/lower case, tractor feed, as new NOW ONLY ..... £995.00

**Teletype.**  
ASR 33 input/output terminal incorporating paper tape punch and reader, 64 ASCII upper case character set, 110 baud operation, even parity keyboard choice of RS232 or 20mA interface. ..... £595.00

**Options.**

ICL-type keyboard	£50.00
8th level marking	£25.00
Remote reader control	£50.00
Reader step	£20.00
Auto reader	£25.00
Pedestal	£30.00

February 1981..... Latest Computer Equipment

**PRINTERS**

**Low Cost Printer Offer.**  
Teletype 33 printer mechanism including case but no keyboard or electronics, 64 upper case ASCII, 10 cps, pinfeed platen, ideal for the electronic hobbyist ONLY ..... £85.00

**Termiprinter 7075.**  
Impact printer, upper/lower case, pin feed, RS232 ..... £325.00

**Texas.**  
725 portable terminal with acoustic coupler ..... £625.00  
733 ASR terminal utilising high performance twin cassette drive for fast time-saving transmission and off-line storage.  
★ Silent operation  
★ Switch-selectable transmission speeds 10, 15 & 30 cps  
★ Full tape editing capability  
★ High-speed duplication and rewind  
★ Standard RS232 interface ..... £1375.00  
745 LIGHTWEIGHT (13lbs) terminal with integral acoustic coupler, 10/30 cps, carrying case ..... £750.00

**MONITORS**

**EMI.**  
15in. diagonal tube, integral power supplies, accepts composite or separate video input. BRAND NEW SURPLUS ..... £100.00

**Ball Miratel TTL15.**  
15in. diagonal green phosphor tube, integral power supply. Requires separate horizontal and vertical video input. BRAND NEW SURPLUS ..... £75.00

**FLOPPY DISK DRIVES**

**Shugart SA400.**  
5 1/4" MINI-FLOPPY (NEW)  
★ Capacity (unformatted):  
110Kb (single density)  
220Kb (double density)  
★ Transfer rate: 125/250 kilobits/sec.  
★ Average access time: 463ms.  
★ Read/Write and Write Protect electronics  
★ Power requirements +5VDC + 12VDC  
★ Dimensions 5 1/4" x 3 1/4" x 8", weight 3lbs  
Supplied complete with technical manual.  
Application notes are available on interfacing the SA400 to Intel 8080A, Motorola etc ..... £195.00

**Shugart SA450.**  
Double-sided, double density minifloppy providing 440KB unformatted storage capacity, yet the same compact size and weight as the SA400. .... £299.00

**Shugart SA801.**  
8" FLOPPY (NEW)  
★ Capacity (unformatted):  
400Kb (single density)  
800Kb (double density)  
★ Transfer rate: 250/500 kilobits/sec.  
★ Average access time: 211ms  
★ Read/Write and Write Protect electronics  
★ Power requirements +24VDC + 5VDC — 5VDC  
★ Dimensions 4 3/8" x 9 1/2" x 14 1/4"  
Supplied complete with technical manual ..... £395.00

**PAPER TAPE PUNCHES**

**Digitronics.**  
P120 paper tape punch. Solenoid-actuated unit capable of punching 5 to 8 channel tapes at speeds up to 35 cps. Pulse amplitude 27 VDC. Compact table-top unit. .... £95.00

**Fact 4070.**  
The top quality punch that has become an industry standard. Asynchronous 75cps operation. Adjustable for punching 5, 6, 7 or 8 level tape. Self-contained desk-top unit incorporating supply and take-up spools, chad box, and TTL-compatible control logic ..... £650.00

**KEYBOARDS**

**George Risk.**  
New ASCII Keyboards New Low Prices  
KB771 Superb 71-station ASCII keyboard incorporating separate numeric/Cursor control pad and installed in custom-built steel enclosure with textured blue enamel finish. Ideal for the VDU builder. Case dimensions: 17 1/4" x 7 1/2" x 3 1/8". Total weight 4kg. PRICE ..... £85.00  
Mail Order Total ..... £103.50

KB756 56-station ASCII keyboard mounted on P.C.B.	£39.50
Mail Order Total	£47.15
KB756MF as above, fitted with metal mounting frame for extra rigidity	£45.00
Mail Order Total	£53.48
KB710 10-key numeric pad, supplied with connecting cable	£8.00
Mail Order Total	£9.78
KB701 Plastic enclosure for KB756 or KB756MF	£12.50
Mail Order Total	£15.24
KB702 Steel enclosure for KB756 or KB756MF	£18.00
Mail Order Total	£23.00
KB2376 Spare ROM encoder	£12.50
Mail Order Total	£15.24
KB15P Edge connector for KB756 or KB756MF	£3.25
Mail Order Total	£4.31
DC-512 DC converter to allow operation at 5V only (plugs in to P.C.B.)	£7.50
Mail Order Total	£9.20
DB25S Mating connector for KB771	£4.25
Mail Order Total	£5.46
PERK 56-station ASCII keyboard for PET complete with PET interface, built-in power supply and steel enclosure	£95.00
Mail Order Total	£115.00

Discounts available for quantities.

**Hours of Business: 9 a.m.-5 p.m. Mon-Fri.**  
Closed lunch 1-2 p.m.  
ADD 15% VAT TO ALL PRICES  
Carriage and Packing charge extra on all items unless otherwise stated.

W/W-041 for further details

Electronic Brokers is the largest specialist buyer and seller of used computers in Europe.

Our specialists deal daily in DEC, Data General and many of the numerous and well-known manufacturers of related systems and peripherals such as Teletype, Hazeltine, Texas, Hewlett Packard, Textronix. All computer equipment offered by Electronic Brokers is maintenance eligible by the original manufacturer.

Our customers come from the fields of industry, education, research, government and general commerce. We have met their needs time and time again.

Whether your requirements are quick replacement, low cost development systems, additional capacity for existing equipment, or a cost-effective used configuration — we are only a phone call or telex away.

Call us on 01-278 3461 and speak to one of our skilled sales specialists familiar with your equipment needs.



Electronic Brokers

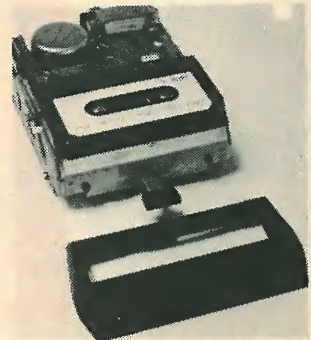
Electronic Brokers Limited  
61/65 Kings Cross Road  
London WC1X 9LN England  
Telephone: 01-278 3461  
Telex: 298694 Elebro G



# WORLD

## SUPER BARGAIN OFFERS LENCO FFR CASSETTE DECK

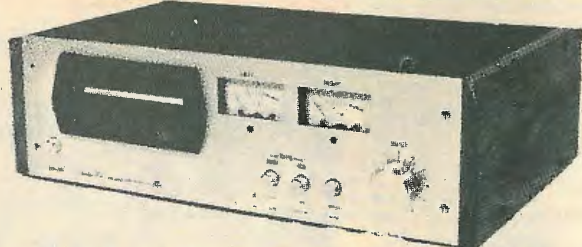
For those who missed our recent bargain CT4s we now are delighted to be able to offer Brand New Lenco FFR Decks complete with motor speed and auto-stop control board fitted and tested. These will operate with any supply between 9 and 16 volts. This deck can be used for both record and playback applications and is fitted with an erase head. A mono record/play head is fitted and we can supply an extra stereo head, if ordered with the deck at the very special price of £2 plus VAT. We also supply, with each deck and completely FREE, one of our specially moulded escutcheons. This deck would normally cost about £25 but we are able to offer them, while they last, at only £9.99 plus VAT.



**TOP LOADING HI FI CASSETTE DECK.** Very limited quantity of British made Thorn 4499 top loading decks fitted with stereo R/P head, 3 digit re-settable counter, 12 volt electronic speed controlled motor and auto stop read.  
**Very special price £12.99** Complete with top cover and cassette door. Post etc. £1.50. VAT £2.34.

**LINSLEY-HOOD PEAK DRIVE INDICATOR**  
A very useful device, connected to loudspeakers giving a 4 light readouts of peak power delivered for the protection of both the loudspeaker and the perceived quality of sound. Gives instant indication even for peaks of only 5 microseconds duration. Unit uses CMOS technology, is self-contained and battery powered. Complete Kit except batteries, only £17.40 plus VAT.  
Reprint of Article 250. No VAT. Post Free.

## LINSLEY HOOD CASSETTE RECORDER 1



We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells 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 £75 plus VAT.  
REPRINTS of the 3 articles describing this design 45p. No VAT.  
REPRINT of Postscript article 30p. No VAT.

Part Cost of Post, Packing and Insurance.

Order up to £10 — 50p P&P Export Orders — Postage or shipping at cost plus  
Orders £10 to £49 — £1 £2 Documentation and Handling  
Over £50 — £1.50

Please send 9x4 SAE for lists giving fuller details and price breakdowns.

Instant easy ordering, telephone your requirements and credit card number to us on

Oswestry (0691) 2894

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

## NEW NEW NEW

### Linsley-Hood 35 and 45 Watt MOSFET Power Amplifiers

New. Latest hot-off-the-press design by John Linsley-Hood described in this month's issue of Hi Fi News. External appearance is identical to the 30 watt design but minor circuit changes and MOSFET output devices give lower distortion, audibly better sound and higher power output. The delicacy and transparency of tone quality enable this amplifier to outperform on a side-by-side comparison the bulk of amplifiers available today, even surpassing the Authors own 75 watt design.  
Complete Kit for fully integrated 35 watt MOSFET amplifier £87.40. Plus VAT  
Same but 45 watt output £94.80. Plus VAT.  
Conversion Kit with full instructions for use with existing 30-watt amplifiers £16.90. Plus VAT.  
Reprints of MOSFET article. 25p. No VAT. Post Free.

### LINSLEY-HOOD 30 WATT AMPLIFIER

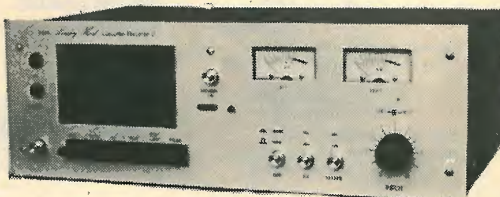


The very latest amplifier design to be published and in our opinion the best yet. The concept was to produce an amplifier that sounded as good as the authors 75 watt design but which was cheaper and simple to build for applications where the higher power is not needed. This new kit is designed to match the Linsley-Hood Cassette Recorder 2 and a tuner will be available later to make a complete stackable system. A very advanced assembly system has been devised by us to make construction ultra simple and anyone who can solder components in a printed circuit board will find it great fun. Conventional wiring is at an irreducible minimum, only being needed to connect the mains transformer and pilot light. For an amplifier of this quality this kit represents incredible value for money.

All parts can be bought separately at a total cost of £79.12 but complete kits are available at a special introductory discount price of only £72 + VAT.

Reprints of original Articles from 'Hi Fi' News' 50p. Post Free. No VAT.

### LINSLEY HOOD CASSETTE RECORDER 2



Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother and daughter arrangement used on our Linsley Hood Cassette Recorder 1.

This latest version has the following extra features. Ultra low wow-and-flutter of .09% — easily meets DIN Hi-fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents re-recording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest £94.80 + VAT we ask for the complete kit.

### CASSETTE HEADS

- HS15 SENDUST ALLOY SUPER HEAD. Stereo R/P. Longer life than Permalloy. Higher output than Ferrite. Fantastic frequency response. Complete with data ..... 7.60
- HS16 Very latest Sendust Alloy Super Head with even better HF Response ..... 8.20
- HC20 Stereo Permalloy R/P head for replacement uses in car players, etc. .... 4.25
- HM90 Stereo R/P head for METAL tape. Complete with data ..... 7.20
- H561 Special Erase Head for METAL tape ..... 4.90
- H524 Standard Ferrite Erase Head ..... 1.50
- 4-Track R/P Head. Standard Mounting ..... 7.40
- R484 2/2 (Double Mono) R/P Head. Std. Mtg. .... 4.90
- ME151 2/2 Ferrite Erase. Large Mtg. .... 4.25
- CCE/8M 2/2 Erase. Std. Mtg. .... 7.90

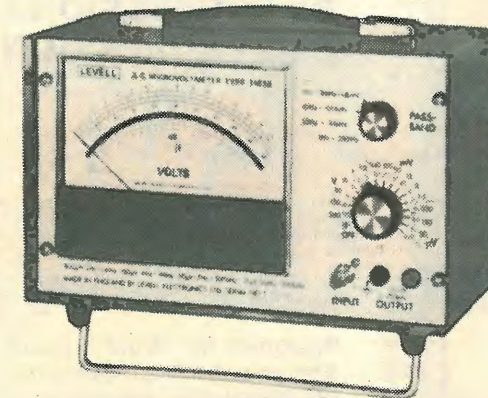
All prices plus VAT

# WORLD

**HART ELECTRONIC KITS LTD**  
PENYLAN MILL OSWESTRY  
SHROPSHIRE  
phone (0691) 2894  
Telex 35661  
Hartel G



# DON'T GAMBLE WITH PERFORMANCE BUY LEVELL VOLTMETERS



### A.C. MICROVOLTMETERS

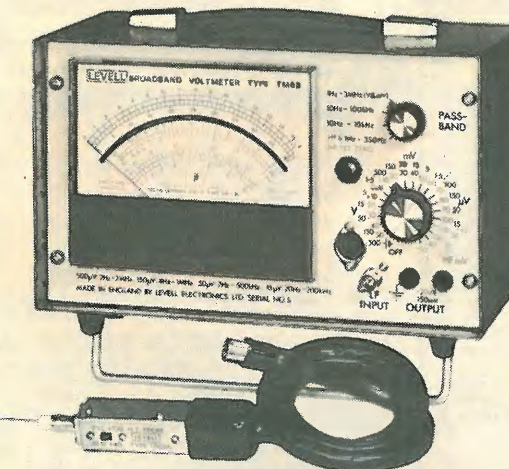
**VOLTAGE & dB RANGES** 15µV, 50µV, 150µV . . . 500V fsd.  
Acc. ± 1% ± 1% fsd ± 1µV at 1kHz.  
— 100, —90 . . . + 50dB.  
Scale —20dB/ + 6dB ref. 1mW/600Ω.

**RESPONSE** ± 3dB from 1 Hz to 3MHz,  
± 0.3dB from 4 Hz 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** £130 type **TM3B** £145



### BROADBAND VOLTMETERS

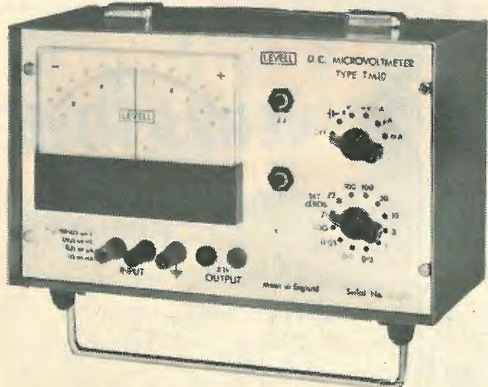
**H.F. VOLTAGE & dB RANGES** 1mV, 3mV, 10mV . . . 3V fsd.  
Acc. ± 4% ± 1% fsd at 30MHz.  
— 50, —40 . . . + 20dB.  
Scale —10dB/ + 3dB ref. 1mW/50Ω.

**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** £199 type **TM6B** £215



### 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** £106

These instruments incorporate many useful features, including long battery life. All A type models have 83mm scale meters and case sizes of 185 x 110 x 130mm. B types have 127mm mirror scale meters and case sizes of 260 x 125 x 180mm. Fully detailed 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.**

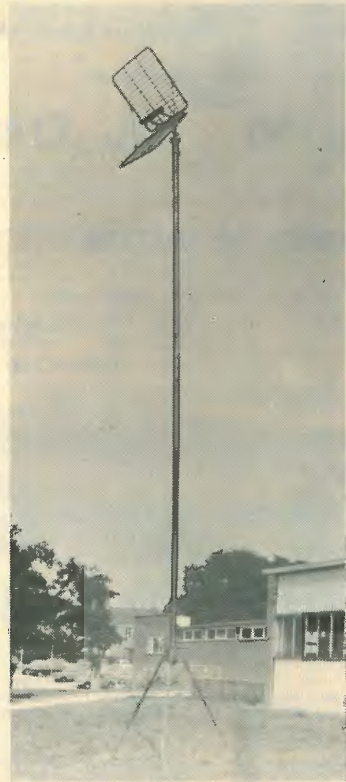
MOXON STREET, BARNET, HERTS., EN5 5SD.  
TEL: 01-449 5028/440 8686

# FAST ERECTING CLARK MASTS

For World-wide Telecommunications in the 1980s

Clark Masts Ltd. are specialists in the design and manufacture of telescopic and sectional mast systems. With over 25 years' experience in supplying masts to meet exacting military and civil specifications we have the expertise you can depend on. Extended heights 4m-30 metres capable of lifting headload 1 kg-200 Kgs., sectional or telescopic air operated for field or vehicle mounting. Write or phone us for details today.

Field mounted Clark 10 metre Type 73 sectional mast shown with radio relay antenna fitted. Available in heights up to 30 metres, mechanically extended.



12 metre Clark P.U. Mast Kit shown field mounted. A light-weight mast available in 8, 10 and 12-metre models, manually extended.

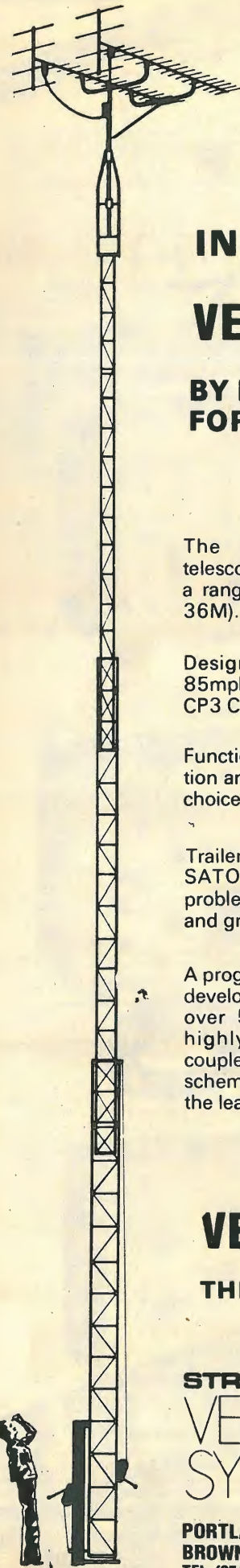
CLARK MASTS LTD.  
Binstead  
Isle of Wight  
PO33 3PA, England



Telephone: Ryde (0983) 63691

Telex: 86686

WW - 018 FOR FURTHER DETAILS



## INSIST ON VERSATOWER

BY PROFESSIONALS—  
FOR PROFESSIONALS

The VERSATOWER range of telescopic and tilt-over towers cover a range of 25ft to 120ft (7.5M to 36M).

Designed for Wind Speeds from 85mph to 117mph conforming with CP3 Chapter V, part 11.

Functional design, rugged construction and total versatility make it first choice for telecommunications.

Trailer mounted or static, the VERSATOWER solves those difficult problems of antenna support, access and ground level maintenance.

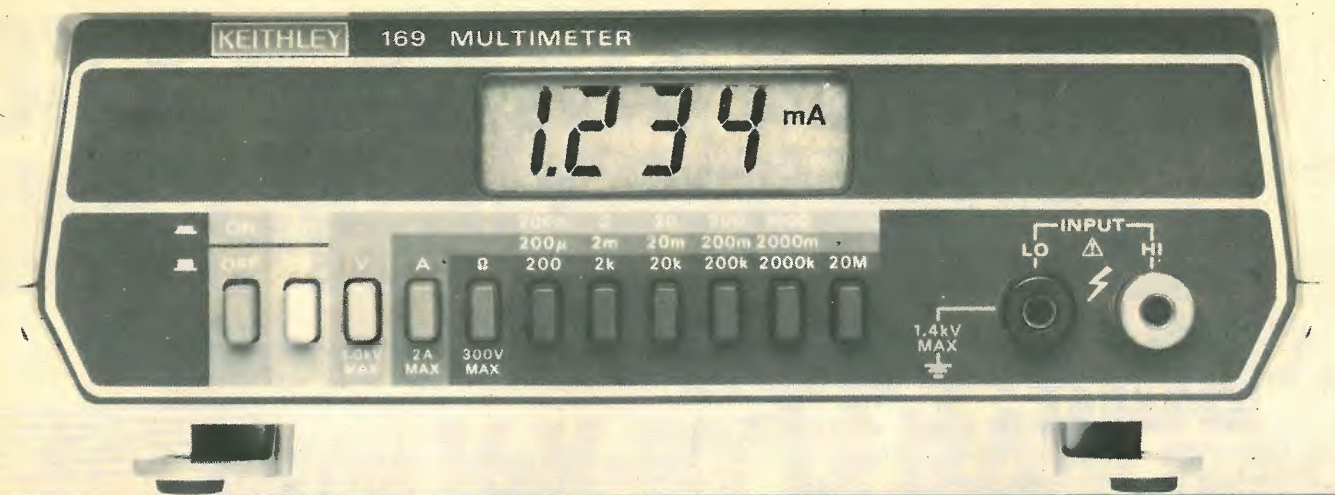
A programme of continuous product development has led to a range of over 50 models, all available at highly competitive prices. This coupled with our quality assurance scheme ensures that we maintain the leader position we enjoy today.

## VERSATOWER THE PROFESSIONALS' CHOICE

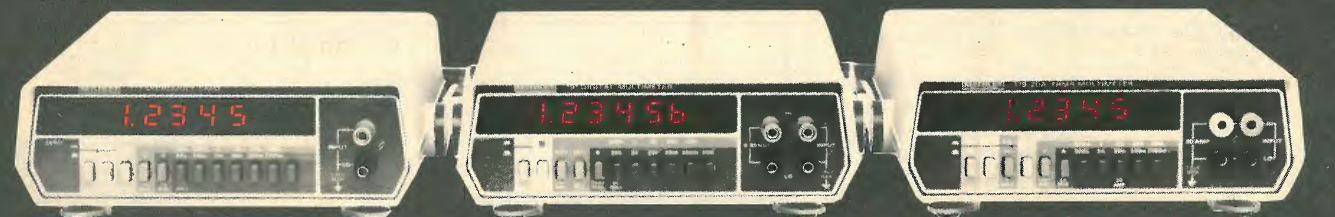
STRUMECH  
VERSATOWER  
SYSTEM

PORTLAND HOUSE, COPPICE SIDE  
BROWNHILLS, WEST MIDLANDS  
TEL: (05433) 4321 · TELEX: 335243 SEL

WW-044 FOR FURTHER DETAILS



# HIGH QUALITY



# WIDE CHOICE

Keithley D.M.M. Test Equipment: Quality. With machines like the 169 shown above. 3 1/2 digits; .25% accuracy. A no-nonsense five function D.M.M. at a no-nonsense price.

Choice. The Keithley range spans Pocket, 3 1/2, 4 1/2, 5 1/2 digit D.M.M.'s; many with I.E.E.E. options. So we can be sure of having exactly the right product for your own requirements. Built to a standard that very few people can equal.

# LOW COST

Cost. And at a price even fewer can match. From £79 + V.A.T., Keithley D.M.M. test equipment is backed by the resources of a specialist company with a formidable reputation. To find out more, just fill in the coupon, and get your free literature today.

**KEITHLEY**

Keithley Instruments Ltd  
1 Boulton Road Reading Berkshire RG2 0NL  
Telephone (0734) 861287  
Telex 847047

WW - 006 FOR FURTHER DETAILS



I would like to know more about  
Keithley D.M.M.'s. I am particularly  
interested in:  3 1/2 Digit Models  4 1/2 Digit Models  5 1/2 Digit Models  
 I.E.E.E. Position

Name \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
Tel \_\_\_\_\_

# Why the Sinclair ZX80 is Britain's best-selling

## Built: £99.95

Including VAT, post and packing, free course in computing, free mains adaptor.

## Kit: £79.95

Including VAT, post and packing, free course in computing.

This is the ZX80. A really powerful, full-facility computer, matching or surpassing other personal computers at several times the price. 'Personal Computer World' gave it 5 stars for 'excellent value'. Benchmark tests say it's faster than all previous personal computers.

Programmed in BASIC—the world's most popular language—the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous—over 20,000 ZX80s have been sold so far!

### Powerful ROM and BASIC interpreter

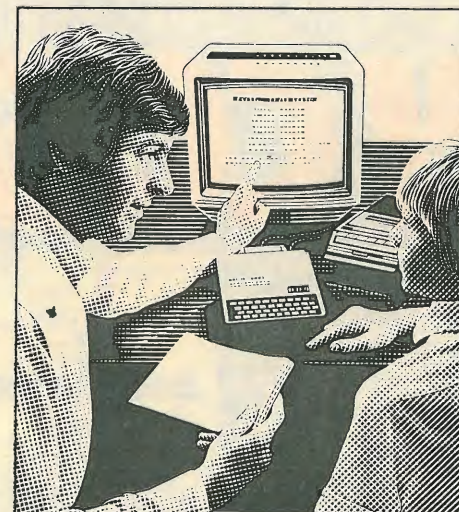
The 4K BASIC ROM offers remarkable programming advantages:

- \* Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
- \* Unique syntax check. A cursor identifies errors immediately.
- \* Excellent string-handling capability—takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison).
- \* Up to 26 single dimension arrays.
- \* FOR/NEXT loops nested up to 26.
- \* Variable names of any length.
- \* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
- \* Randomise function, useful for games and secret codes, as well as more serious applications.
- \* Timer under program control.
- \* PEEK and POKE enable entry of machine code instructions.
- \* High-resolution graphics.
- \* Lines of unlimited length.

### Unique RAM

The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer—typically storing 100 lines of BASIC.

No other personal computer offers this unique combination of high capability and low price.



The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing—and enjoy their personal computer.

### The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you—don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming—from first principles to complex programs.

### Kit or built—it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor—600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

# personal computer.

## Now available for the ZX80... New 16K-BYTE RAM pack



### Massive add-on memory. Only £49.95.

The new 16K-BYTE RAM pack is a complete module designed to provide you—and your Sinclair ZX80—with massive add-on memory. You can use it for those really long and complex programs—or as a personal database. (Yet it can cost as little as half the price of competitive add-on memory for other computers.)

For example, you could write an interactive or 'conversational' program to show people what your ZX80 can do. With 16K-BYTES of RAM, they could be talking to your computer for hours!

Or you can store a mass of data—perhaps in a fairly simple program—such as a name and address list, or a telephone directory.

And by linking a number of separate programs together into one giant, but modular, program, you can achieve the same effect as loading several programs at once.

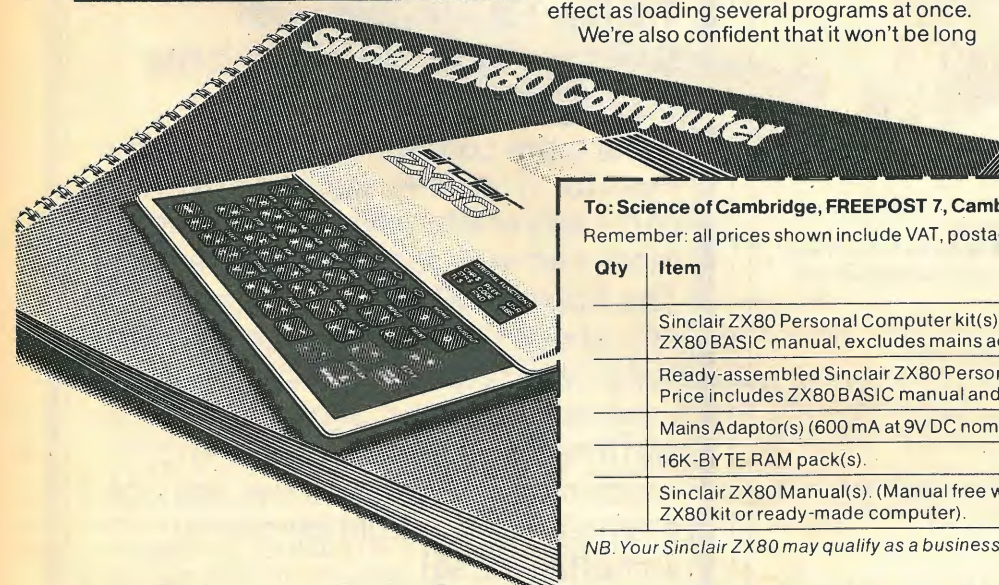
We're also confident that it won't be long

before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines—and brush up your chess perhaps!

The RAM pack simply plugs into the existing expansion port on the rear of the ZX80. No wires, no soldering. It's a matter of seconds and you don't need another power supply. You can only add one RAM pack to your ZX80—but with 16K-BYTES who could want more!

### How to order

Demand for the ZX80 exceeds all other personal computers put together! So use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt—and we have no doubt that you will be.



To: Science of Cambridge, FREEPOST 7, Cambridge CB2 1YY.

Remember: all prices shown include VAT, postage and packing. No hidden extras. Please send me:

Qty	Item	Code	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	02	79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	01	99.95	
	Mains Adaptor(s) (600 mA at 9V DC nominal unregulated).	03	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	Sinclair ZX80 Manual(s). (Manual free with every ZX80 kit or ready-made computer).	06	5.00	

NB. Your Sinclair ZX80 may qualify as a business expense.

TOTAL: £

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £ \_\_\_\_\_

Please print

Name: Mr/Mrs/Miss \_\_\_\_\_

Address \_\_\_\_\_

FREEPOST—no stamp needed.

WRW02

# sinclair ZX80

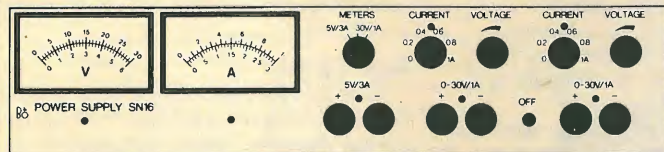
### Science of Cambridge Ltd.

6 Kings Parade, Cambridge, Cambs., CB2 1SN.  
Tel: 0223 311488.



# POWER SUPPLY?

Take your pick from the SN series



Bang & Olufsen's SN 14, 15, and 16 are versatile current and voltage supply units for use in the lab, production, workshop and training centers.

Which one you choose will depend on what you need.  
 SN 14: 0-20V/0-2A remotecontrolable  
 SN 15: 0-50V/0-1A remotecontrolable  
 SN 16: 2x0-30V/0-1A and 5V/3A

Bang & Olufsen electronic instruments are also, wow/flutter-meters, oscillators, milliohmmeters, voltmeters and distortion-meters.

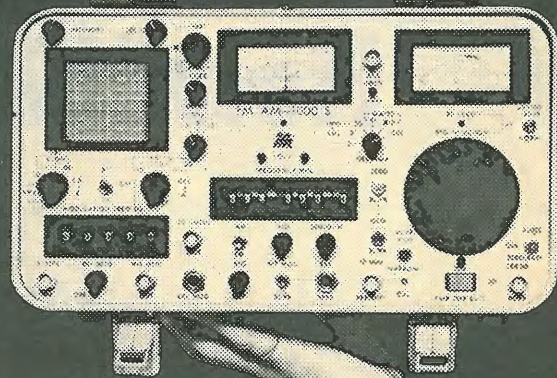
UK agent: Danbridge (UK) Limited, Sherwood House, High Street, Crowthorne, Berkshire RG11 7AT  
 Tel.: (034 46) 2369 TLX: 847782

# Bang & Olufsen

DK - 7600 Struer

WW - 017 FOR FURTHER DETAILS

# Testing... Testing... Testing...



The New SUPER-S has RF power output, to 0 dBm, 2-tone generator, a phase locked BFO and is now reduced in price.

# anywhere!

## The New FM/AM 1000s with Spectrum Analyser—we call it the SUPER-S

A portable communications service monitor from IFR, light enough to carry anywhere and good enough for most two-way radio system tests. The FM/AM 1000s can do the work of a spectrum analyser, oscilloscope, tone generator, deviation meter, modulation meter, signal generator, wattmeter, voltmeter, frequency error meter—and up to five service engineers who could be doing something else!

For further information contact Mike Taylor



## FieldTech

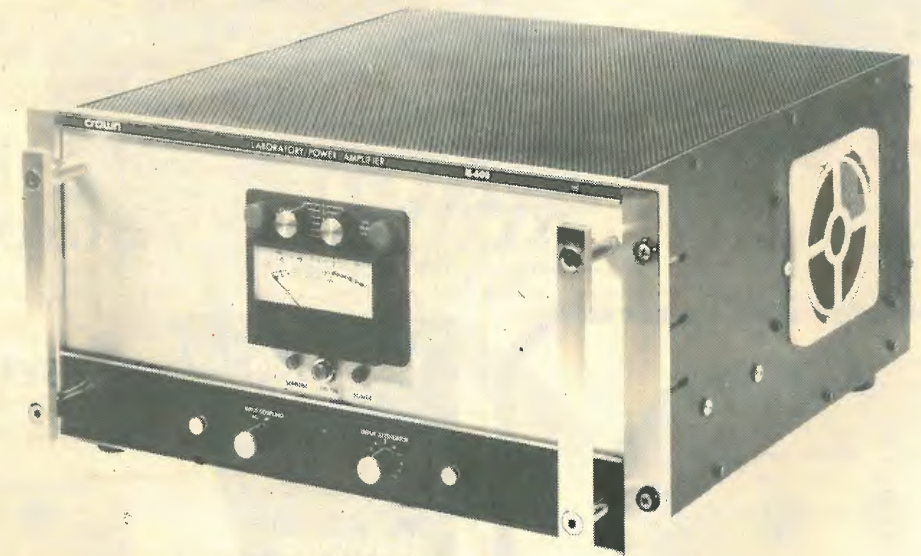
FieldTech Ltd  
 Heathrow Airport—  
 London Hounslow  
 TW6 3AF  
 Tel: 01-759 2811  
 Telex: 23734  
 FLDTEC G

IFR precision simulators

WW-042 FOR FURTHER DETAILS



# AMCRON INDUSTRIAL MUSCLE



## Model — M600

- ★ POWER RESPONSE DC — 20KHz ± 1dB.
- ★ OUTPUT POWER IN EXCESS OF 1.5kW INTO 2.75 Ohm LOAD (CONTINUOUS R.M.S.).
- ★ D.C. OUTPUT 20 AMPS AT 100 VOLTS OR 2KVa.
- ★ HARMONIC DISTORTION LESS THAN 0.05% DC-20KHz AT 1kW INTO 6 OHMS
- ★ PLUG-IN MODULES: CONSTANT VOLTAGE/CURRENT, PRECISION OSCILLATORS ★ UNIPOLAR AND BIPOLAR DIGITAL INTERFACES, FUNCTION GENERATORS, AND MANY OTHERS.
- ★ OUTPUT MATCHING TRANSFORMERS AVAILABLE TO MATCH VIRTUALLY ANY LOAD.
- ★ FULL OPEN AND SHORT CIRCUIT PROTECTION GUARANTEED STABLE INTO ANY LOAD.
- ★ TWO UNITS MAY BE CONNECTED TO PROVIDE UP TO 4 kW.
- ★ INTERLOCK CAPABILITY FOR UP TO EIGHT UNITS.
- ★ 3-YEAR PARTS AND LABOUR WARRANTY.

For full details on all Amcron Products write or phone Chris Flack

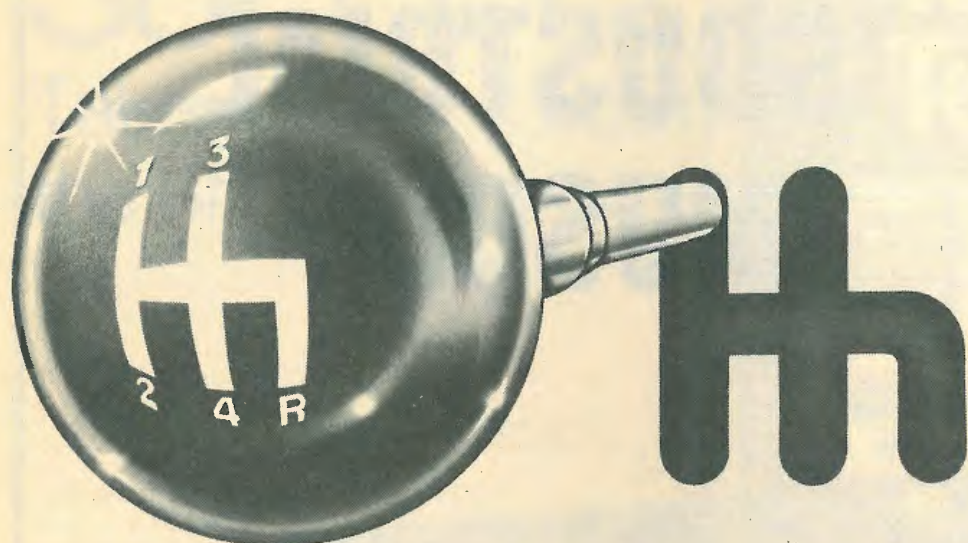


## Kirkham Electronics

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

WW - 005 FOR FURTHER DETAILS

# For top performance at low power change down to ZN426 D to A.



You want a monolithic 8-bit digital to analogue converter for low power applications? Go for ZN426. It has on-chip 2.5V precision reference and takes only 5mA from a single 5V supply.

Ferranti DAC's give reliable performance and reduce costs.

Send for data or contact:  
I C Marketing,  
Ferranti Electronics Limited,  
Fields New Road,  
Chadderton,  
Oldham, OL9 8NP.  
Telephone: 061-624 0515  
Telex: 668038

## FERRANTI Semiconductors

WW — 019 FOR FURTHER DETAILS

EL02/50/100

## SERIES III + COMPATIBILITY



Series III and IIIS precision pick-up arms are suitable for all cartridges having  $\frac{1}{2}$ " fixing centres, weighing not more than 12 grams and requiring a tracking force not higher than 2.5 grams. They are adaptable to suit the mass and compliance of the cartridge, which may employ a moving coil, moving iron, moving magnet or any other generating principle.

Series III arms are true low mass designs with headroom to increase effective mass as desired whereas with high mass arms reduction is generally impracticable.

We shall be pleased to send you information sheet No. 24 which tells you how to adjust effective mass to suit your cartridge. It could make all the difference to your listening.

# SME

*The best pick-up arm  
in the world*

Write to Dept 0660,  
SME Limited,  
Steyning, Sussex, BN4 3GY,  
England

WW — 008 FOR FURTHER DETAILS

### MORE SPEC. FOR YOUR MONEY



**TYPE 631 FILTER OSCILLATOR**

£112 & 2.50 carriage, ins. etc.

COVERS THE RANGE 0.1Hz to 100KHz

MODES —

ACCEPT	Q from less than 1 to over 300
REJECT	90 dB notch
HI and LO PASS	12 dB per octave
OSCILLATE	Sinewave and squarewave

**TYPE 631LF — £118.13** & 2.50 carriage, ins. etc.

Low frequency version 0.01Hz to 10KHz

OMB ELECTRONICS, RIVERSIDE, EYNSFORD, KENT DA4 0AE  
Tel. Farningham (0322) 863567

Prices, which are CWO and ex-VAT, are correct at the time of going to press and are subject to change without notice.

**FROM OMB ELECTRONICS**  
WW — 053 FOR FURTHER DETAILS

**PRODUCTION  
TESTING**

**DEVELOPMENT**

**SERVICING**

**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

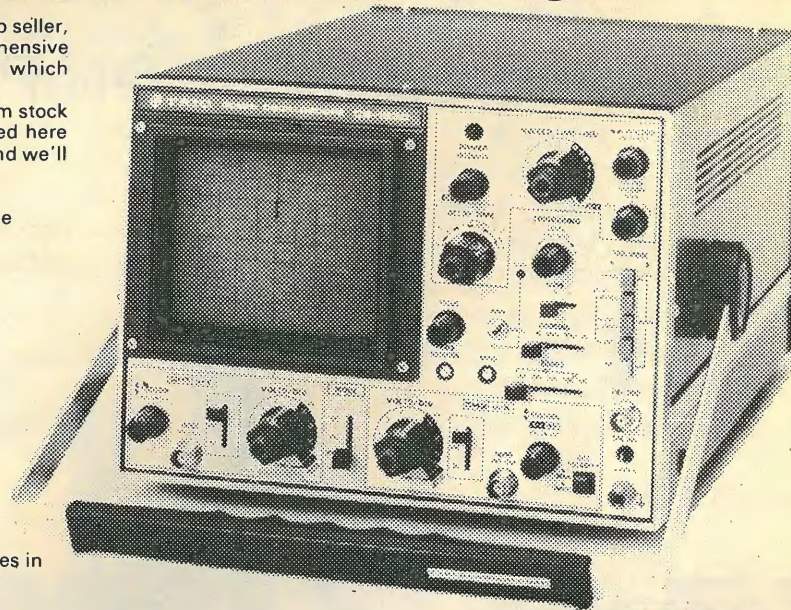
VALRADIO LIMITED, BROWELLS LANE, FELTHAM  
MIDDLESEX TW13 7EN  
Telephone: 01-890 4242/4837

WW—032 FOR FURTHER DETAILS

# CS1830 FROM TRIO

Since its introduction, the CS1830 has been our top seller, and no wonder, when you glance at the comprehensive specification and the extremely attractive price which includes two matching X1/X10 probes. Add to that the fact that we can normally supply from stock and you have a winner. Some of the details are listed here but if you need further information, just contact us and we'll be happy to assist.

- C.R.T.:**  
120 x 96 mm rectangular PDA with internal graticule
- Y Bandwidth:**  
DC - 30MHz
- Sensitivity:**  
5mV/div (30MHz)  
2mV/div (20MHz)
- Input RC:**  
1M/23pF
- Risetime:** 11.7nS
- Beam Switch:**  
Chop/alternate
- Modes:**  
CH1, CH2, Dual, Add, Subtract
- Time Base:**  
Triggered, auto, or single shot
- Sweep Time:**  
0.5S/div-200nS/div (40nS using X5 mag) 20 ranges in 1-2-5 sequence
- Sweep Delay:**  
100mS-1uS adjustable with trace bright up for delay location
- Z Modulation:**  
TTL compatible 10K impedance 5MHz bandwidth
- Trace Rotation:**  
Electrical
- And the Price?**  
**£455 + VAT** (includes 2 probes)



Also  
**CS1577A**  
Dual 30MHz/2mV Signal  
Delay etc  
**£410 + VAT**



# NRD-515 receiving for the discerning few.



- NRD 515 SYNTHESISED HF MONITORING RECEIVER ..... **£948.75 inc. VAT**
- NHD 515 MULTICHANNEL MEMORY UNIT ..... **£161.00 inc. VAT**
- NVA 515 LOUDSPEAKER UNIT ..... **£27.60 inc. VAT**
- CFL 260 600Hz CW FILTER ..... **£34.50 inc. VAT**

The NRD 515 is a PLL-synthesised communications receiver of the highest class featuring advanced radio technology combined with the latest digital techniques. The new NRD 515 is full of performance advantages including general coverage, all modes of operation, PLL digital VFO for digital tuning, 24-channel frequency memory (option), direct mixing pass-band tuning, etc. JRC's 65 years of radio communications experience will give you "the world at your fingertips". The NRD 515 is but a single item from the JRC product range which extends all the way to full marine radio installations for supertankers.

**LOWE ELECTRONICS Ltd.**  
CHESTERFIELD ROAD, MATLOCK, DERBYSHIRE DE4 5LE

TEL. 0629 2430/2817

WW-037 FOR FURTHER DETAILS

# THREE FOR FREE FROM CSC



Available from selected stockists  
**ELECTRONICS BY NUMBERS**

Electronics by Numbers  
Projects No 7, No 8, No 9

### No. 7 DIGITAL DICE

Roll the dice - the electronic way! The digital dice gives you an instant score randomly chosen from 1 to 6, every time you press the button. No losing this under the table!

### No. 8 QUIZ MASTER

Play your own 'Sale of the Century'! Up to four contestants pit their wits; the first one to get the answer lights up his 'win' light, and stops anybody else from having a go.

### No. 9 MOVING TARGET GAME

Test your reactions! A moving 'line of light' travels along from left to right, over and over again. You've got to 'fire' at just the right moment to score a hit. Fun for all the family!

Want to get started on building exciting projects, but don't know how? Now using EXPERIMENTOR BREADBOARDS and following the instructions in our FREE 'Electronics By Numbers' leaflets, ANYBODY can build electronic projects. For example, take one of our earlier projects, a L.E.D. Bar Graph;

### EXPERIMENTOR BREADBOARDS

No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of any size.

All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP 4B.

**EXP 325 £1.60** The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.



**EXP 350 £3.15** Specially designed for working with up to 40 pin ICs perfect for 3 & 14 pin ICs. Has 270 contact points including two 20 point bus-bars.



**EXP 300 £5.75** The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS. Use this breadboard with Adventures in Microelectronics.



**EXP 600 £6.30** Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



**EXP 650 £3.60** Has 6" centre spacing so is perfect for MICROPROCESSOR applications.



**EXP 4B £2.30** Four more bus-bars in "snap-on" unit.

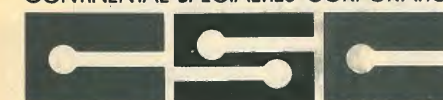


The above prices are exclusive of P&P and 15% VAT.

### THE CSC 24 HOUR SERVICE TELEPHONE (0799) 21682

With your Access, American Express, Barclaycard number and your order will be in the post immediately

CONTINENTAL SPECIALTIES CORPORATION



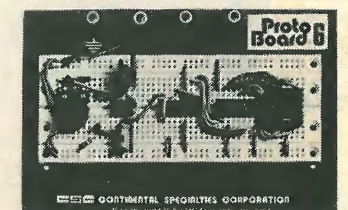
C.S.C. (UK) LTD Dept. 7PP  
Unit 1, Shire Hill Industrial Estate,  
Saffron Walden, Essex CB11 3AQ.  
Tel: Saffron Walden (0799) 21682 Telex: 817477

For full detailed instructions and layouts of Projects, 7, 8 and 9, simply take the coupon to your nearest CSC stockist, or send direct to us, and you will receive the latest 'ELECTRONICS BY NUMBERS' leaflet.

If you missed projects, 1, 2 and 3, or 4, 5 and 6, please tick the appropriate box in the coupon.

### PROTO-BOARDS

The ultimate in breadboards for the minimum of cost. Two easily assembled kits.



PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

**PROTO-BOARD 6 KIT £9.20**



PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

**PROTO-BOARD 100 KIT £11.80**

**IT'S EASY WITH C.S.C.**

**TO RECEIVE YOUR FREE COPY OF PROJECTS 7, 8 and 9**

**Just clip the coupon**

Give us your name and full postal address (in block capitals). Enclose cheque, postal order or credit card number and expiry date, indicating in the appropriate box(es) the breadboard(s) you require.

**For immediate action**  
The C.S.C. 24 hour, 5 day a week service.  
**Telephone 0799 21682** and give us your Access, American Express or Barclaycard number and your order will be in the post immediately

EXPERIMENTOR BREADBOARDS	CONTACT	IC CAPACITY 14 PIN DIP.	UNIT PRICE INC. P&P & 15% VAT	Qty req.
EXP 325	130	1	£ 2.70	
EXP 350	270	3	£ 4.48	
EXP 300	550	6	£ 7.76	
EXP 600			£ 8.39	
EXP 650	270	use with 0.6 pitch Dip's Strip Bus-Bar	£ 5.00	
EXP 4B	Four 40 Point Bus-Bars		£ 3.50	

PROTO-BOARDS	CONTACTS	UNIT PRICE INC. P&P & 15% VAT
PB6	630	£11.73
PB100	760	£14.72

C.S.C. (UK) Limited, Dept. 7PP, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.  
Tel: Saffron Walden (0799) 21682 Telex: 817477

NAME.....  
ADDRESS.....  
I enclose cheque/P.O. for £.....  
Debit my Barclaycard, Access, American Express card No. ....  
Expiry date.....  
If you missed project No's 1, 2, 3, 4, 5, and 6, tick box.   
For Free catalogue tick box

ALL INSTRUMENTS FEATURED HERE ARE AVAILABLE EX-STOCK OR ON SHORT DELIVERY



# PHILIPS METERS MAKE A FINE FAMILY

**PM 2517 digital multimeter**

- \* Full four digits
- \* Choice of LED or LCD display
- \* True RMS AC readings (AC coupled)
- \* Autoranging with manual override
- \* Current up to 10 A
- \* Options include temperature and data hold probes

**Reader inquiry number 220**

**PM 2505 electronic analogue multimeter**

- \* 62 measuring ranges
- \* High V and A sensitivity
- \* 10 MΩ input impedance
- \* Continuity check by sound signal

- \* Linear resistance ranges to 30 MΩ
- \* Automatic polarity indication
- \* Unique movement for high accuracy and repeatability

**Reader inquiry number 221**

# OSCILLOSCOPE VALUE STARTS HERE



**PM 3207 dual trace oscilloscope**

- \* Ideal for service and general purpose applications
- \* 15 MHz/5mV
- \* Triggering from either channel or external input
- \* Auto TV triggering
- \* Same sensitivity on X and Y channels
- \* B-invert facility
- \* Full 8 x 10cm screen

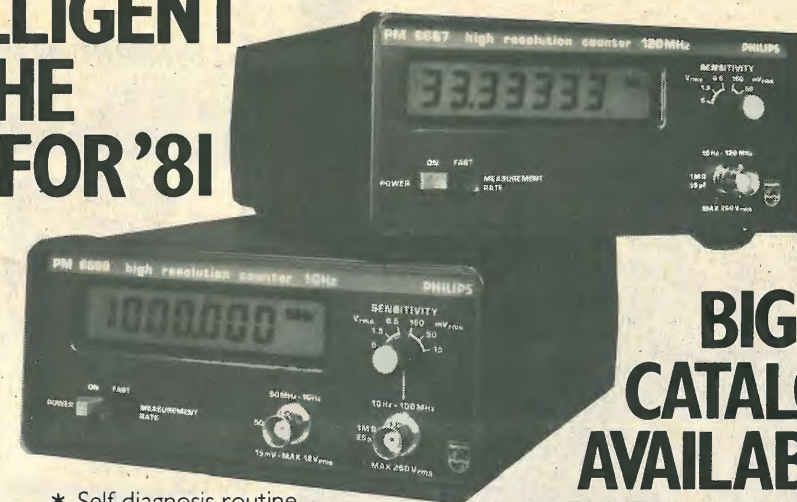
**Reader inquiry number 222**

**PHILIPS Test & Measuring Instruments**

# PHILIPS INTELLIGENT COUNTERS-THE RESOLUTION FOR '81

**PM 6667 and PM 6668 high resolution counters**

- \* 1 GHz (PM 6668) or 120 MHz (PM 6667)
- \* Reciprocal technique giving fast high resolution measurements down to 10 Hz
- \* Auto triggering on all waveforms and duty cycles
- \* 15 mV RMS sensitivity
- \* High stability X-tal oscillators: 10<sup>-7</sup>/month
- \* Microprocessor control



- \* Self-diagnosis routine
- \* Battery option

**Reader inquiry number 223**

## BIG NEW CATALOGUE AVAILABLE

**FREE** The 1981 Philips Test and Measuring Instruments catalogue is available now — and it's free.

Within its 300 pages are details and specifications of the full Philips range, including all the latest products.

Send for your copy by circling **reader inquiry number 228**.

**Distributors for Philips Test and Measuring Instruments**

All the products in this advertisement, with the exception of the pulse and LF equipment, are available from Philips Service Centres. Telephone 01-686 0505 for the address of your nearest branch.

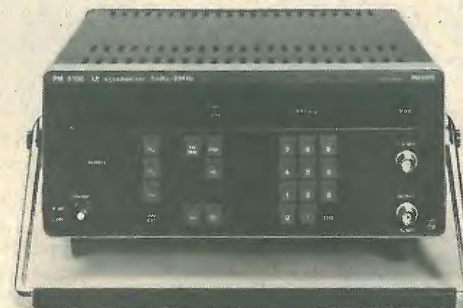
The PM 2517 digital multimeter and PM 3207 oscilloscope are also distributed by Wessex Electronics Ltd, 114-116 North Street, Downend, Bristol BS16 5SE. Tel (0272) 571404.

These facilities are in addition to the comprehensive sales and support service provided by the Philips Electronic Instruments Department (see address below).

# LF PRODUCT WITH A SPECIAL TOUCH

**PM 5190 LF synthesizer**

- \* 0.001 Hz — 2 MHz frequency range
- \* IEC — bus interface standard for total remote control
- \* Microprocessor control with LED indication
- \* Extremely accurate frequency setting



- within  $\pm 1 \times 10^{-6}$
- \* High short and long-term stability
- \* Fast "feather touch" parameter selection
- \* Sine, triangle, square

waveforms plus TTL output

**Reader inquiry number 224**

# TWO EXAMPLES FROM THE WIDE PULSE RANGE

**PM 5716 pulse generator**

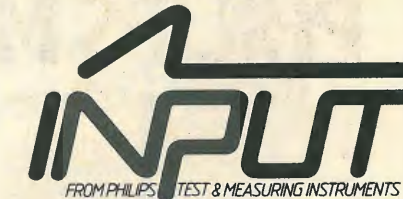
- \* 1 Hz-50 MHz repetition rate
- \* 6nS-100 mS rise and fall times
- \* 2V-20V amplitude within the range of -20V-+20V
- \* Independent control for upper and lower pulse levels
- \* Pulse amplitude limiter to protect device under test
- \* Built-in 50Ω backmatch
- \* Versatile facilities for external triggering, gating and pulse amplifying

**Reader inquiry number 226**

**PM 5705 pulse generator**

- \* 0.1 Hz to 10 MHz frequency range
- \* TTL - compatible outputs, normal and complementary
- \* 1.0V to 15V into 50Ω for TTL, HNIL and MOS applications
- \* Baseline offset from 0 up to +2V
- \* External triggering on positive or negative slope: gating and single shot facilities
- \* Education package 5705 E also available

**Reader inquiry number 227**



Use the inquiry service to obtain information about the products which interest you. Alternatively phone Cambridge 358866 and speak to our Commercial office on extension 145 or 148.

	Inquiry No
<b>PM 2517 digital multimeter</b>	<b>220</b>
<b>PM 2505 analogue multimeter</b>	<b>221</b>
<b>PM 3207 15 MHz oscilloscope</b>	<b>222</b>
<b>PM 6667/6668 counters</b>	<b>223</b>
<b>PM 5190 LF synthesizer</b>	<b>224</b>
<b>PM 5132 function generator</b>	<b>225</b>
<b>PM 5716 pulse generator</b>	<b>226</b>
<b>PM 5705 pulse generator</b>	<b>227</b>
<b>1981 Test &amp; Measuring catalogue</b>	<b>228</b>

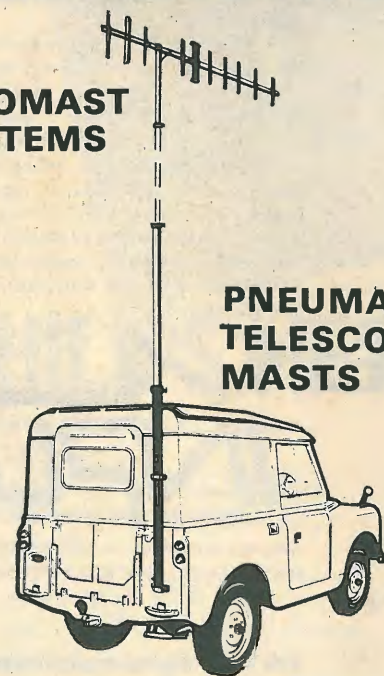
**Pye Unicam Ltd**  
Philips Electronic Instruments Department,  
York Street, Cambridge CB1 2PX, England.  
Tel Cambridge (0223) 358866 Telex 817331

# PHILIPS

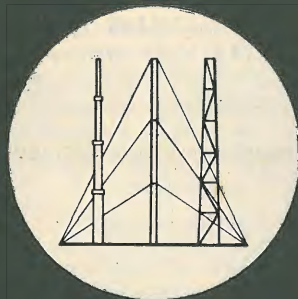


# Hilomast Ltd

**HILOMAST SYSTEMS**



**PNEUMATIC TELESCOPIC MASTS**



## HILOMAST LIMITED

THE STREET HEYBRIDGE — MALDON  
ESSEX CM9 7NB ENGLAND  
Tel. MALDON (0621) 56480  
TELEX NO. 995855

WW-043 FOR FURTHER DETAILS

### COMMUNICATION TUBES — EX STOCK

4-65A	5763	QQV06-40A
4-125A	6080	QQV07-50
4-250A	6146/A/B	QV08-100
4-400A	6155	QY4-125
4-1000A	6156	QY4-250
4CX250B	7527	QY4-400
4CX350A	8042	QY5-3000A
4CX1500A	QQV03-10	& MORE
4CX1500B	QQV03-20A	

### R/F POWER TRANSISTORS — EX STOCK

2N3375	2N5102	BLY33	BLY88
2N3553	2N5590	BLY34	BLY89
2N3632	2N5591	BLY36	BLY91
2N3733	2N5641	BLY53A	BLY92
2N4040	2N5642	BLY55	BLY93
2N4127	2N5643	BLY83	BLX13
2N4128	2N6080	BLY84	BLX14
2N5070	2N6081	BLY85	BLX67
2N5071	2N6082	BLY87	BLX68
2N5090	2N6083		& MORE



SEND FOR DETAILS TO:  
AERO ELECTRONICS (AEL) LTD  
GATWICK HOUSE  
HORLEY, SURREY, ENGLAND  
TEL: (02934) 5353  
TELEX 87116 (AERO G)  
CABLES AERO G TELEX HORLEY

WW-048 FOR FURTHER DETAILS



**L.E.D.s .125 and .2**

	1+	100+	1000+
RED	.08	.069	.058
YELLOW			
or GREEN	.11	.10	.09

**1N4148 Diodes**

	1+	.02
	100+	.016
	1000+	.013

Prices per 100. Larger and Mixed. Quantity prices available.

### CARBON FILM RESISTORS E12 SERIES

	.25W	
100 off one type		.70p
500 off one type		.64p
1000 off one type		.58p
	.5W	
100 off one type		.90p
500 off one type		.80p
1000 off one type		.72p

### T.I. LOW PROFILE I.C. SOCKETS



	1+	100+	500+
8pin	.075p	.068p	.06p
14pin	.09	.082	.073
16pin	.10	.096	.085
18pin	.125	.113	.10
20pin	.14	.126	.113
22pin	.15	.135	.12
24pin	.15	.135	.12
28pin	.16	.145	.125
40pin	.24	.215	.19

Please add £1.50 handling charge and 15% V.A.T.

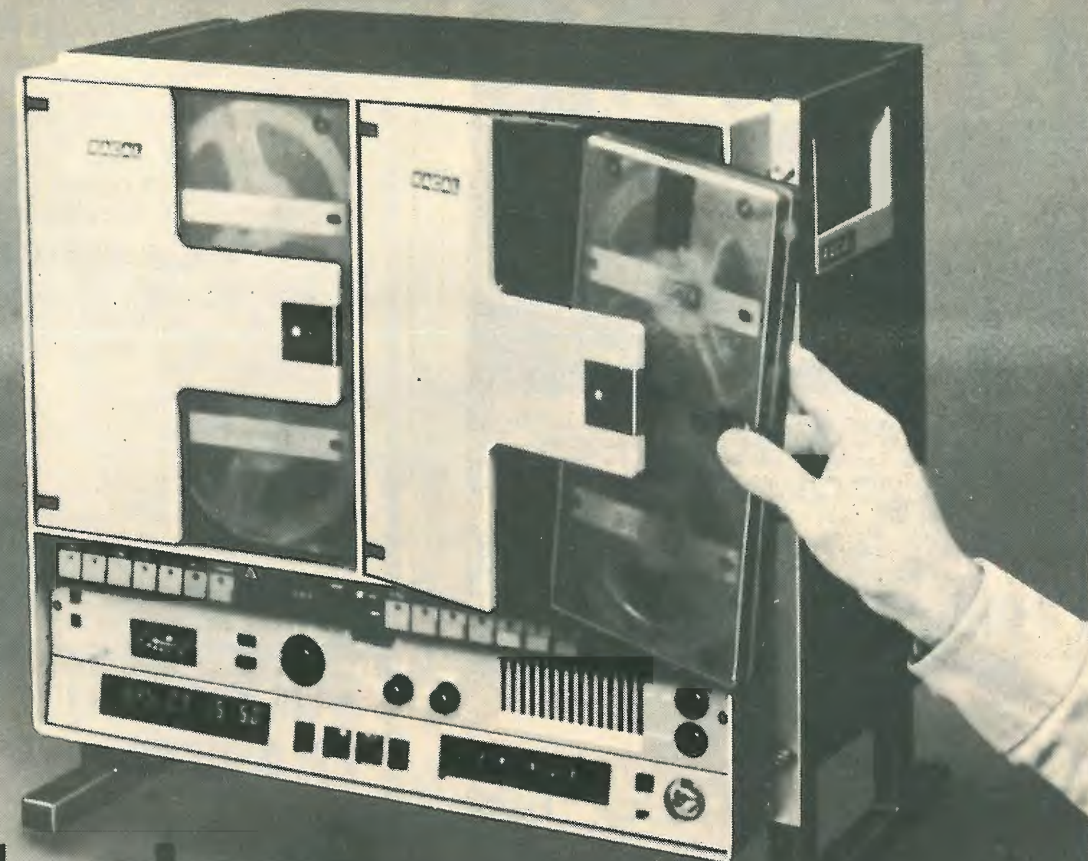
We also stock transistors, diodes, TTL, CMOS, capacitors, switches, connectors etc. Free catalogue available to trade customers only. Enquiries welcome.

## Harrison Bros.

Electronic Distributors

22 Milton Road, Westcliff-on-Sea  
Essex SS0 7JX England  
Tel. Southend-on-Sea (0702) 32338

WW-011 FOR FURTHER DETAILS



# Autostore.

## Low-cost voice-logging for people with more important things to do.

The problem: logging telephone and radio messages without spending a fortune on equipment or hiring an expensive technician to operate it.

The solution: the new Racal Recorders Autostore.

**SIMPLICITY**  
With its automatic cassette-loading and fully automatic changeover from one deck to another, Autostore can—quite literally—be operated by whoever happens to be around.

And it provides over 24 hours of unattended continuous recording on eight channels.

**VERSATILITY**  
Able to log radio and telephone messages simultaneously, Autostore can form part of a new system—or fit just as easily into an existing one.

And its uses vary from ambulance, fire, police and security applications to the recording of financial transactions, conferences, oil installation communications and taxi services.

**RELIABILITY**  
Available in 4 or 8 channel versions, and with integral micro-processor controlled automatic Timesearch capability to enable rapid message retrieval, Autostore is engineered to the very highest standards by the company which pioneered air traffic control recording techniques.

**FULL DETAILS**  
For full details of Autostore send off the coupon today.

I am interested in recording my communications accurately and reliably. Please:

- send me full details of Autostore
- arrange for a demonstration at my own premises

Name \_\_\_\_\_  
Position \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
Tel: \_\_\_\_\_

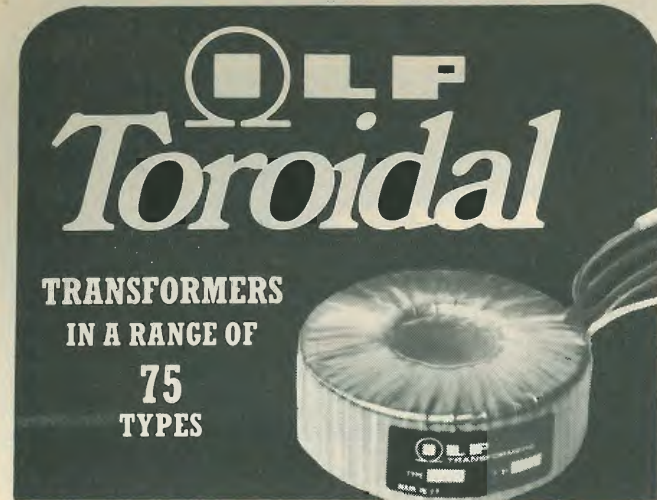
Racal Recorders Limited, Hardley Industrial Estate, Hythe, Southampton, Hampshire SO4 6ZH, England.

## Racal Recorders

Racal Recorders Limited, Hardley Industrial Estate, Hythe, Southampton, Hampshire SO4 6ZH, England.  
Tel: (0703) 843265 Telex: 47600



WW-067 FOR FURTHER DETAILS



# Toroidal

**TRANSFORMERS**  
IN A RANGE OF  
**75**  
TYPES

We use advanced winding technology to make our toroidal transformers. They have only half the weight and height of their laminated equivalents and are appreciably more efficient. Our toroidals cost virtually the same as the older types which they are rapidly replacing. Induced hum is reduced by a factor of ten. Supplied with rigid mounting kit with centre bolt, steel and neoprene washers.

**30VA** 70mm dia. x 30mm Weight 0.45 Kg **£4.71**  
(+£1.00 p.p. + 0.86 VAT)

**160VA** 110mm dia. x 40mm Weight 1.8 Kg **£8.88**  
(+£1.40 p.p. + £1.54 VAT)

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT	TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
1X010	6+6	2.50	5X012	12+12	6.66
1X011	9+9	1.66	5X013	15+15	5.33
1X012	12+12	1.25	5X014	18+18	4.44
1X013	15+15	1.00	5X015	22+22	3.63
1X014	18+18	0.83	5X016	25+25	3.20
1X015	22+22	0.68	5X017	30+30	2.66
1X016	25+25	0.60	5X018	35+35	2.28
1X017	30+30	0.50	5X019	110	1.45
			5X029	220	0.72
			5X030	240	0.66

**50VA** 80mm dia. x 35mm Weight 0.9 Kg **£5.19**  
(+£1.10 p.p. + 0.94 VAT)

**225VA** 110mm dia. x 45mm Weight 2.2 Kg **£10.59**  
(+£1.50 p.p. + £1.81 VAT)

2X010	6+6	4.16	6X014	18+18	6.25
2X011	9+9	2.77	6X015	22+22	5.11
2X012	12+12	2.08	6X016	25+25	4.50
2X013	15+15	1.66	6X017	30+30	3.75
2X014	18+18	1.38	6X018	35+35	3.21
2X015	22+22	1.13	6X026	40+40	2.81
2X016	25+25	1.00	6X028	110	2.04
2X017	30+30	0.83	6X029	220	1.02
2X028	110	0.45	6X030	240	0.93
2X029	220	0.22			
2X030	240	0.20			

**80VA** 90mm dia. x 30mm Weight 1 Kg **£5.76**  
(+£1.20 p.p. + £1.04 VAT)

**300VA** 110mm dia. x 50mm Weight 2.6 Kg **£12.27**  
(+£1.60 p.p. + £2.08 VAT)

3X010	6+6	6.64	7X016	25+25	6.00
3X011	9+9	4.44	7X017	30+30	5.00
3X012	12+12	3.33	7X018	35+35	4.28
3X013	15+15	2.66	7X026	40+40	3.75
3X014	18+18	2.22	7X025	45+45	3.33
3X015	22+22	1.81	7X028	110	2.72
3X016	25+25	1.60	7X029	220	1.36
3X017	30+30	1.33	7X030	240	1.25
3X028	110	0.72			
3X029	220	0.36			
3X030	240	0.33			

**120VA** 90mm dia. x 40mm Weight 1.2 Kg **£6.72**  
(+£1.30 p.p. + £1.20 VAT)

**500VA** 140mm dia. x 60mm Weight 4 Kg **£16.35**  
(+£1.70 p.p. + £2.71 VAT)

4X011	9+9	6.66	8X017	30+30	8.33
4X012	12+12	5.00	8X018	35+35	7.14
4X013	15+15	4.00	8X026	40+40	6.25
4X014	18+18	3.33	8X025	45+45	5.55
4X015	22+22	2.72	8X033	50+50	5.00
4X016	25+25	2.40	8X028	110	4.54
4X017	30+30	2.00	8X029	220	2.27
4X028	110	1.09	8X030	240	2.08
4X029	220	0.54			
4X030	240	0.50			

• I.L.P. TOROIDAL TRANSFORMERS ARE GUARANTEED FOR 5 YEARS

**CHOICE OF 3 PRIMARY INPUTS**

I.L.P. Toroidal Transformers are available in choice of 110V, 220V, 240V, coded as follows: (Secondaries can be connected in series or parallel)  
For 110V Primary insert 0 in place of "X" in type number.  
For 220V Primary (Europe) insert 1 in place of "X" in type number.  
For 240V Primary (U.K.) insert 2 in place of "X" in type number.  
Example - 120VA 240V 15+15V. 4A = 42013.

\* CUSTOMER DESIGN ENQUIRIES INVITED. QUANTITY PRICE LIST AVAILABLE.

**FREEPOST** facility. (U.K. only).

Simply address envelope to **FREEPOST** to address below. NO STAMP REQUIRED.

**TO ORDER** Enclose cheque/Postal Order/Money Order payable to I.L.P. Electronics Ltd or quote your ACCESS or BARCLAYCARD account No. To pay C.O.D. add £1 extra to TOTAL value of order. Also available from ELECTROVALUE and MARSHALLS.

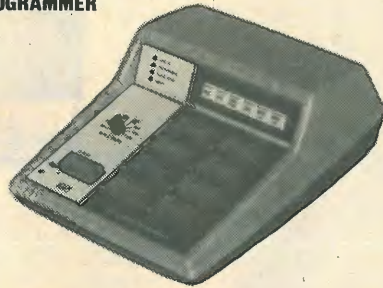


**I.L.P. TRANSFORMERS**  
A division of I.L.P. ELECTRONICS LTD.  
**FREEPOST T5 GRAHAM BELL HOUSE ROPER CLOSE**  
**CANTERBURY CT2 7EP**  
Phone (0227) 54778 Technical (0227) 64723 Telex 965 780

## BULK EPROM PROGRAMMING

**2-YEAR WARRANTY**

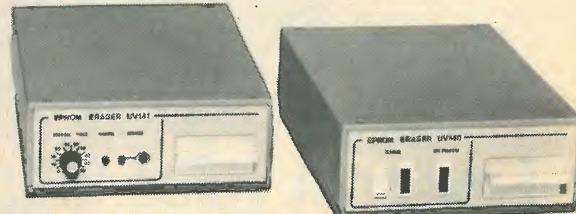
**P4000 PRODUCTION EPROM PROGRAMMER**



This unit provides simple, reliable programming of up to 8 EPROMS simultaneously. It has been designed for ease of operator use — a single 'program' key starts the self check — blank check — program — verify sequence. Independent blank check & verify controls are provided along with mode, pass/fail indicators for each copy socket and a sounder to signal a correct key command & the end of a programming run. Any of the 2704/2708/2716 (3 rail) & 2508/2758/2516/2716/2532/2732 (single rail) EPROMS may be selected without hardware or personality card changes.  
**PRICE £545 + VAT.** Postage paid

## BULK EPROM ERASING

**EX-STOCK**



**MODEL UV141 EPROM ERASER**  
● 14 EPROM capacity  
● Fast erase time  
● Built-in 5-50 minute timer  
● Convenient slide-tray loading of devices  
● Safety interlocked to prevent eye and skin damage  
● Rugged construction  
● MINS & ERASE indicators  
● Price £78 + VAT postage paid.

**MODEL UV140 EPROM ERASER**  
Similar to Model UV141 but without timer. **Price £61.50 + VAT** post paid

## BULK EPROMS

**EX-STOCK**

2716 (450ns) (single rail)	£9.00	£8.00	£7.35	£7.00	£6.60
2708 (450ns)	£4.80	£4.30	£3.90	£3.60	£3.40

**DEDUCT A FURTHER 5% FOR CASH WITH ORDER ON THESE EPROM PRICES.**  
Postage and Packing is included in all prices. ADD VAT at 15%. All our EPROMS are manufactured by leading companies and are fully guaranteed, branded and to full specification.

**WRITE OR TELEPHONE FOR FURTHER DETAILS OR SEND OFFICIAL COMPANY ORDERS/CHEQUES TO:**

**PLEASE NOTE NEW ADDRESS & TELEPHONE NUMBER**

**GP INDUSTRIAL ELECTRONICS LTD.**  
Unit 6, Burke Road, Totnes Industrial Estate, Totnes, Devon  
Telephone: Totnes (0803) 863360 sales, 863380 technical  
DISTRIBUTORS REQUIRED - EXPORT ENQUIRIES WELCOME

WW-010 FOR FURTHER DETAILS



# Is it on your desk yet?

In a hurry for electronic components?  
Open up  
**THE ONE-OFF SHOP**  
- your Verospeed catalogue

**VEROSPEED**  
JANUARY '81


**VEROSPEED - The fast**  
Phone: 0703 618525 be  
**VEROSPEED, Stansted Road.**

**NEW IN THE NEW VEROSPEED CATALOGUE**

**3M SCOTCHFLEX® IT'S CLICKED**  
Verospeed now offers a choice of four Scotchflex P.C.B. mounted Headers from 10 to 60 ways. A new pin length (3,94 mm.) covers all P.C.B. requirements and both the right angle and straight pin versions are available with long or short ejector ears. A full complement of Ribbon Cable mounted Sockets, Polarising Key and Strain Relief Clips completes the range.  
The DIN 41612 compatible range of Connectors has also been expanded to include the 64/64 Cable and Frame mounting Plugs and Sockets. The components and tooling are all available "by return" from Verospeed.  
**Equipment Wire**, Mains Cables, Ribbon Cables, Uniradio, Coax, Miniature and Standard Multicores. The widest selection at the most competitive prices. 154 product lines devoted to Equipment Wires and Cables manufactured to BS and DEF Standards. Equipment Wire section includes a 7/0.12 mm. PVC covered wire for small P.C.B. applications and E.T.F.E. Wire — a 120°C Tefzel insulated wire which offers a low cost alternative to P.T.F.E. All are manufactured by the world's biggest manufacturer of Cables — B.I.C.C. — and are available via Verospeed's famous "by return" service.

It's the new Verospeed catalogue — with the big company look that marks the new Verospeed — Fast becoming Britain's biggest distributor of branded electronic components. With a catalogue 3 times a year — a big company list of over 2000 products, many of them not found in other catalogues, and big company back-up, Verospeed still delivers that small-company response. All orders phoned in by 3.00 p.m. go out in the 5.30 post.

Send for your copy of the one-off shop. Test our service by phoning 0703 618525 before 3.00 p.m. — and your catalogue will be in the post tonight.  
Look for it in **THE ONE-OFF SHOP**



**VEROSPEED** Britain's fastest growing distributor of **branded** electronic components.  
Verospeed, Stansted Road, Boyatt Wood, Eastleigh, Hants. SO5 4ZY Telex 477144

WW — 069 FOR FURTHER DETAILS

# CB RADIO ACCESSORIES

**THE LARGEST DISTRIBUTORS OF CB ACCESSORIES IN THE U.K.** Come and see the biggest and best selection of CB Radio Accessories from all the leading manufacturers, including:

**HiHarada** **K40** **WT** **Teled CB PRODUCTS** **Mura CORPORATION SA**

**COMMUNICATION ANTENNAS** **SIRTEL** **TURNER** **CB** by ARISTA

**TELEX** Sole UK agents for: **NV-RAMA** the antenna specialists co. **SWR METERS** including RAMA, HANSEN etc.

**Mura Electronics (UK) Ltd.**, 79 Church Rd, Hendon, London NW4 Tel: 01 203 5277/8

Please send an SAE with all enquiries. Phone orders by ACCESS - but minimum £5 Callers welcome

CATALOGUES 60p ea... all three for £1.60 POST/PACKAGE CHARGE NOW 35p

**ambit INTERNATIONAL**

**200 North Service Road, Brentwood, Essex**

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

CATALOGUES 2 & 3...60p ea 4...75p (4 inc. rev. of part 1) ALL PARTS: £1.75.....

**The AMBIT catalogue - now with the new Part 4 for 1981**  
The most complete range of specialist radio components in Europe.

SSB transceiver module - based on G4CLF designs

- \* High level mixer
- \* 8 pole filter
- \* 1 W AF on the PCB
- \* Direct freq. display with DFM7
- \* USB/LSB
- \* 1:2 shape factor

Add an LO and the RF selectivity, and you have a very simple yet high performance signal processing 'heart' of an SSB transceiver in the range 100kHz to 1000MHz (with the correct LO/RF stages). The Ambit 91600 costs just £44 +vat, and includes an 8 pole SSB crystal filter, SL1600 signal processing circuitry, double balanced schottky diode mixer and full USB/LSB electronic switching.

The use of 10.7MHz, instead of 9MHz (as in the original unit) now enable direct connection to an AMBIT DF7 for 1kHz frequency readout with far greater ease and accuracy than can be achieved with mechanical dial systems. Buy them both and save. 15%..DFM7+91600= £69.46 inc.

The state of the art in radio and audio

- \* VHF tunerheads
- \* Stereo decoders
- \* Frequency synthesis
- \* Block LPFs
- \* keyswitches
- \* DC audio control ICs
- \* Ultimate HiFi
- \* Crystal filters (& theory)
- \* Ceramic filters for AM/FM
- \* Mechanical filters
- \* Fixed chokes
- \* MC meters
- \* CMOS/TTL
- \* NBFM IFs
- \* WBFM IFs
- \* flat top LEDs
- \* Variable chokes
- \* Piezo sounders
- \* potentiometers
- \* 24 bit NC plotters
- \* low noise RIAA ICs
- \* UHF Helical filters
- \* miniature electrolytics
- \* 30Mb hard disks

You need all three sections for a complete picture. Each section is revised on a triennial cycle - so this year the part 4 contains the revised remnants of the original part 1 - plus all the many new items for 1981. £1.75 for the lot, or 60p each for parts 2 & 3, and £0.75p for the bumper part four section. (prices include postage).

Special Offers... each catalogue is supplied with a 'special offer' order form that will enable you to save the cost of the catalogues with your first few purchases.

**Professional Quality**

## LEDs

Our range of discrete light-emitting diodes currently provides about 400 variations in size, shape, light output and colour. There are — RECTANGULAR, SQUARE, TRIANGULAR, CIRCULAR and BAR DISPLAYS with various lenses. A few of the most popular types are listed below.

**Zaerix Electronics Limited**

**46 Westbourne Grove London, W2 5SF**  
Telex 261306  
Tel: 01-221 3642

Type	Description	Lens colour	mcd. typ.	Price each	
				100+	1000+
L-32RD	Miniature types	Red	2.0	0.048	0.036
L-32ID	3mm diameter	Red	5.0	0.085	0.064
L-32YD	Diffused lens	Yellow	4.0	0.081	0.061
L-32GD		Green	3.5	0.077	0.058
L-51RD	5mm (0.2in) diameter	Red	2.0	0.049	0.037
L-51ID		Red	5.0	0.087	0.065
L-51YD	Diffused lens	Yellow	4.0	0.084	0.063
L-51GD		Green	3.5	0.078	0.059

Minimum order value £20 (£100 export). Plus postage and packing.

WW — 062 FOR FURTHER DETAILS

**Radio Control Systems**

As well as the parts for constructing sophisticated digital proportional radio control systems, we offer kits of parts for complete receivers and transmitters (now including hardware). Only state-of-the-art FM systems, readily adapted to 35MHz if required.

- \* Dual IF ceramic filters
- \* gold plated servo connector
- \* single IC transmitter/encoder
- \* prewound coils for easy alignment
- \* FM crystals extra

The RCRX4 8 channel FM receiver with triple ceramic filtering, complete with case..£16.10  
94445 4 channel FM transmitter based on ET1 October 1980 system £8.57  
94446 5 channel FM receiver, based on ET1 October 1980 system (inc case) £14.26  
TX Case Complete transmitter case hardware, with two joystick controllers £26.62  
SD1 NE544 based servo driver electronics kit (no mechanics) £3.28

\* Matching 'Signal', 'Tune' and 'VU' scales.

\* Custom scales OA

Moving coil indicator meters: over 10,000 in stock for immediate delivery  
The new part 4 catalogue lists many of the stock designs, but a much wider range is available to order (subject to minimum requirements). Meters for nearly all occasions, including precision voltmeter and ammeters.

- \* Signal level
- \* 'tuning'
- \* VU

NEW: Miniature electrolytics 0.01CV leakage  
\* smaller than tants  
\* vastly lower priced

Miniature PC mounting 12v relays 2A/24v contacts, single or dual changeover types available

SPDT: £1.65  
DPDT: £1.85

\* sealed against flux

\* ideal antenna changeover etc

\* Clock timer switching

\* many standard types

**The Mark III Series of DIY HiFi.**

The Mark III series of HiFi is the ultimate DIY audio system. There are probably more features and facilities to the square inch of front panel than any other commercial HiFi around - let alone DIY systems. From the twin 500VA PSUs of the HMOSEFET 100W power amp, to the 1dB tracking of the DC controlled preamp and the versatility of the CMOS MPU controlled tuner, there is no match for performance, style or sound quality - come and hear for yourself in our foyer.

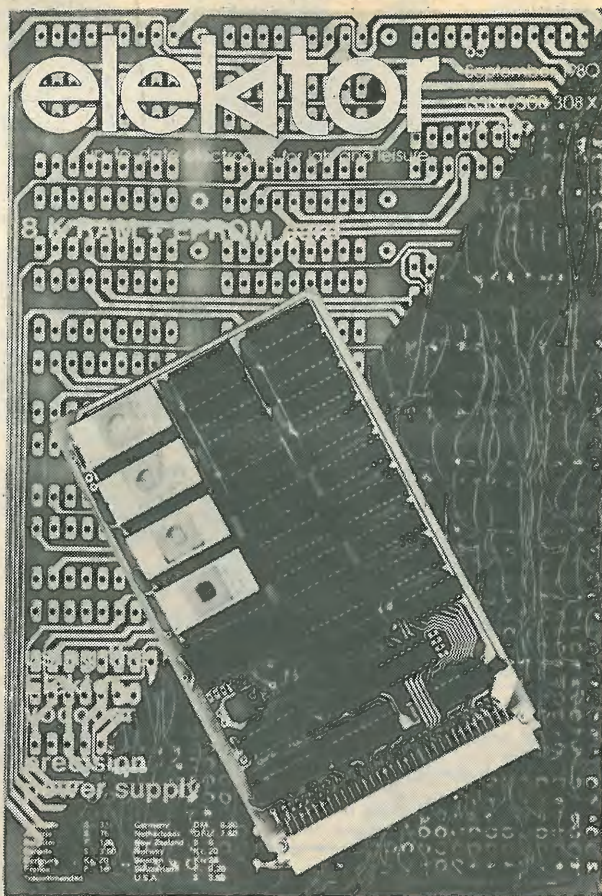
- Mark III synthesised tuner £175.00 + vat
- Mark III B FM-only tuner £185.00 + vat
- Mark III DC controlled signal preamp £175.00 + vat
- Mark III 100W rms/channel MOS PA £160.00 + vat

LCD modules: including various clock/timer/alarm systems, DVM, serial data decoder/displays. The clock shown is the CM161 - 12/24 hrs, day/date, alarm, backlight. All for just £11.44 including VAT.

# elektor PRINTED CIRCUIT BOARDS

Did you know that Elektor is the only monthly electronics magazine to supply printed circuit boards for featured projects? At present over 300 different boards are available with designs covering many aspects of the hobby, ranging from microcomputers to electronics in the car. Included among the variety of constructional articles described in the February issue of Elektor you will find circuits for noise reduction and a 150w AC-DC converter for use in your car.

Place an order with your newsagent or order direct from Elektor Publishers Ltd., 10 Longport, Canterbury, Kent. Price .60p (+20p postage and packing)



# sales



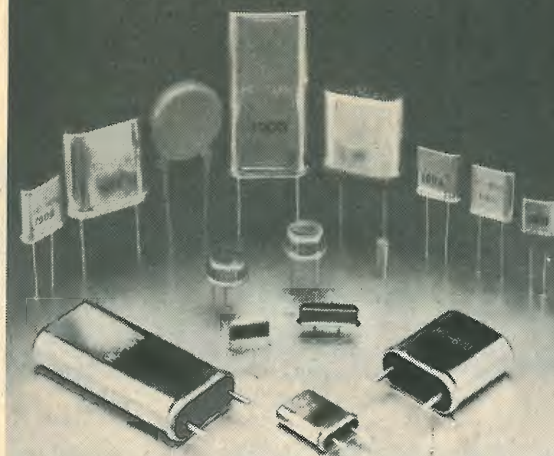
- ANALYSERS**  
 AIRMEC 248A Wave Analyser 5-300MHz ..... £100.00  
 KROHN HITE 330B Band Pass Filter 0.02Hz-2KHz ..... £75.00  
 PARAMETRON 477 Spectrum Analyser 50MHz, 18 months old ..... £800.00
- BRIDGES**  
 MARCONI TF.1313 Universal Bridge 0.25% ..... £250.00  
 MARCONI TF.868B Universal Bridge 1.0% ..... £175.00  
 MARCONI TF.2701 In Situ Bridge 1.0%. Battery Operated ..... £95.00  
 WAYNE KERR B.601 R.F. Bridge 15KHz-5MHz ..... £95.00  
 WAYNE KERR B.641 Autobalance Bridge 0.1% Digital Readout ..... £250.00
- COUNTERS**  
 HEWLETT-PACKARD 5245L/5253B Counter Timer DC-500MHz 8 Digit ..... £375.00  
 MARCONI TF.2411 Counter Timer DC-50MHz 7 Digit ..... £85.00  
 PHILIPS PM.6630 Counter Timer DC-160MHz 8 Digit ..... £150.00  
 PHILIPS PM.6620 Counter Timer DC-45MHz 6 Digit ..... £95.00
- METERS**  
 AIRMEC 314A Electronic Voltmeter 50mV-300V 900MHz ..... £65.00  
 AIRMEC 210 Modulation Meter 3-300MHz ..... £65.00  
 BOONTON 91DA R.F. Voltmeter 1.2GHz. No Probe ..... £40.00  
 DYMAR 711 VHF Millivoltmeter ..... £65.00  
 FLUKE 8100A D.M.M. AC/DC & Resistance 5 digit 0.01% ..... £100.00

- HEWLETT-PACKARD 3400A RMS V/Meter 50mV-300V ..... £35.00  
 MARCONI TF.2600 Sensitive Millivoltmeter ..... £130.00  
 SIEMENS 3U84-1b Thermal Wattmeter 0-12.4GHz 500mW ..... £120.00  
 SOLARTRON 203A D.M.M. ..... £300.00
- OSCILLOSCOPES**  
 COSSOR CDU.150 Dual Beam 50MHz Sens. 5mV/cm ..... £385.00  
 TELEQUIPMENT S.32A Single Beam ..... £85.00  
 TEKTRONIX 654 D/Beam DC-10MHz Storage + 3A6 & 3B3 Plug Ins ..... £550.00  
 TEKTRONIX 603 Storage Monitor ..... £650.00  
 TEKTRONIX 545A D/Beam 33MHz + 4 Trace "M" Type Plug In ..... £325.00  
 HEWLETT-PACKARD 141A D/Beam 200MHz Plug In 1402A & 1423A Storage Variable Persistence ..... £495.00  
 TEKTRONIX 1L5 Spectrum Analyser Plug In 50Hz-1MHz ..... £600.00  
 TEKTRONIX 1L10 Spectrum Analyser Plug In 1MHz-36MHz ..... £600.00
- SIGNAL SOURCES**  
 AIRMEC 304 Power Oscillator 50KHz-100MHz 10V into 50 Ohms ..... £200.00  
 AIRMEC 365A Signal Generator 1-320MHz AM/FM ..... £225.00  
 ADVANCE PG.52B Pulse Generator P.6, P1A, P2A, P3A Plug Ins ..... £550.00  
 MARCONI TF.801D/8S Signal Generator ..... £285.00  
 MARCONI TF.995A/3S Signal Generator ..... £220.00  
 MARCONI TF.1066B/6 Signal Generator ..... £350.00  
 MARCONI TF.1101 R-C Oscillator 20Hz-200KHz ..... £95.00  
 MARCONI TF.1245/46/47 "Q" Meter + 2 Oscillators 40KHz-300MHz ..... £550.00  
 MARCONI TF.1370A R-C Oscillator. 10Hz-10MHz ..... £175.00  
 R & S SMLR Power Signal Generator 100KHz-30MHz ..... £250.00  
 HEWLETT-PACKARD 606B Signal Generator 50KHz-65MHz O/P Up to 3V ..... £350.00
- MISCELLANEOUS**  
 Variacs 20A ..... £60.00  
 MONTFORD UK.82K Climatic Oven -50 to +100°C ..... £1,000.00  
 Avo 160 Portable Valve Tester ..... £100.00  
 Avo Transistor and Diode Tester ..... £75.00  
 General Radio 1232A Tuned Amp + Null Detector 20Hz-20KHz ..... £100.00

**MARTIN ASSOCIATES**  
 71 Basingstoke Road  
 Reading, Berks.  
 Tel. Reading (0734) 868109

WW - 071 FOR FURTHER DETAILS

## Quartz Crystals



Stocks of standard items exceed a quarter of a million. Individual units to the tightest specification made to order.

This technology is available now from



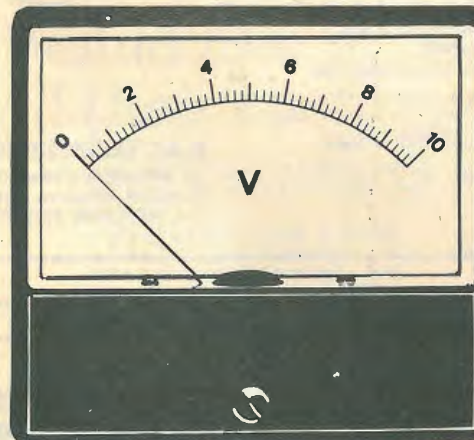
**Interface  
Quartz  
Devices  
Limited**

29 Market Street  
Crewkerne  
Somerset TA18 7JU

Crewkerne (0460) 74433  
Telex 46283 inface g

WW - 075 FOR FURTHER DETAILS

## METER PROBLEMS?

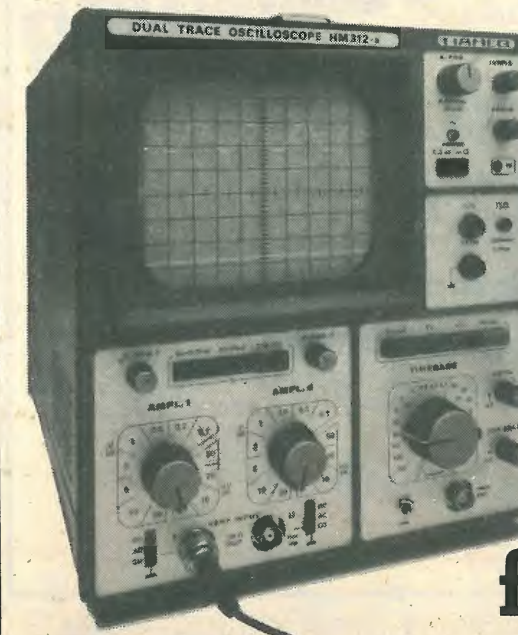


137 Standard Ranges in a variety of sizes and stylings available for 10-14 days delivery. Other Ranges and special scales can be made to order.

Full information from:  
**HARRIS ELECTRONICS (London)**  
 138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW - 050 FOR FURTHER DETAILS

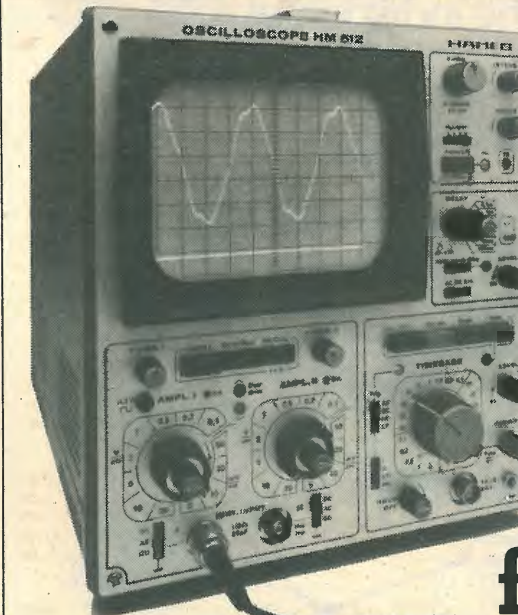
**Incredible Quality  
Incredible Performance  
Incredible Price!!!**



**HM312 Dual Trace Oscilloscope.**  
 DC-20MHz. Sensitivity 5mV-20V/cm. Time base range 0.5uS-0.2S/cm with x5 horiz mag to 100nS/cm, with variable control uncalibrated to 40nS/cm. CRT screen 8 x 10cm. Full XY using chII as X input. Bandwidth 2.3MHz. TV trigger.

**NOW BETTER VALUE THAN EVER AT**

**£220**



**HM512 Dual Trace Oscilloscope with delayed sweep.**  
 DC-50MHz. Sensitivity 5mV-20V/cm Time base range 0.1uS-2.0S/cm with x5 horiz mag to 20nS/cm. Delay ranges 7 decade steps 100ns-1S with fine control CRT screen 8 x 10cm. Full XY using ch II as x input, bandwidth 4 MHz. Z input. Delay line allows viewing of leading edge. Vertical overscan indicated by 2 LED's.

**£580**

Other models available.  
 HM307 10MHz plus component tester. £138.00  
 HM412 20 MHz with sweep delay. £350.00  
 HM812 50 MHz storage. £1458.00

All scopes can be fitted with a long persistence CRT at extra cost.

**World-beating Oscilloscope Offers**  
 FROM  
**Electronic Brokers**

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

Prices do not include carriage or VAT.

WW - 055 FOR FURTHER DETAILS



# Memories

2114-300ns	1k x 4 SRAM	£2.25
4116-200ns	16k x 1 DRAM	£2.61
2708-450ns	1k x 8 EPROM	£3.60
2516-450ns	2k x 8 EPROM	£7.20
2716-450ns	2k x 8 EPROM	£7.20
2532-450ns	4k x 8 EPROM	£18.00

Please add 50p for postage—Prices exclude V.A.T.  
Send s.a.e. for price list.

## STRUTT LTD.

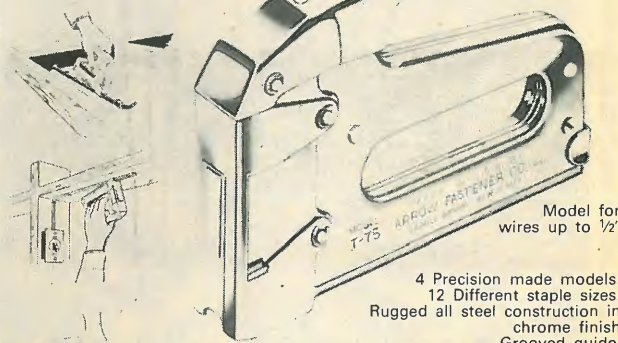
**ELECTRONIC COMPONENT DISTRIBUTORS  
MANUFACTURERS & SUB-CONTRACTORS  
to the ELECTRONIC INDUSTRY**

3c Barley Market Street  
Tavistock  
Devon, England PL19 0JF  
Tel. Tavistock (0822) 5439/5548  
Telex: 45263

## TRUE AS AN 'ARROW'

Professional Wire and Cable Fasteners  
for all installation requirements.

TELEPHONE - ELECTRONICS  
COMMUNICATIONS - ALARM  
SYSTEMS, ETC.,



Model for wires up to 1/2"

- 4 Precision made models.
- 12 Different staple sizes.
- Rugged all steel construction in chrome finish.
- Grooved guide.
- Grooved driving blade.
- Tapered striking edge.
- Jam-proof mechanism (patented).
- Short span easy compression handle.

Some of the features that make an Arrow cable fastener the outstanding tool for all installation engineers.

Illustrated literature and details of Staple sizes available from:

**SPECIAL PRODUCTS  
DISTRIBUTORS LTD.**

81 PICCADILLY, LONDON W1V 0HL. Tel: 01 629 9554. Telex 265200 (A B RACEN)  
— Cables Speciproduct London W1.

WW-021 FOR FURTHER DETAILS

## PA:CE AP360 POWER AMPLIFIER

AP360 Stereo Power Amplifiers have been well-tried and proven in the music industry. They prove that sonic quality, ruggedness and reliability can be combined in one amp.



Independent power supplies eliminate crosstalk and ensure an accurate sound reproduction.

Power Output. 180 Watts RMS per stereo channel, into 4 Ohms.

AP360 (jacks) . . . . . £170.00  
AP360 (XLR) . . . . . £180.00

(Incl. Carriage U.K. Mainland. Excl. V.A.T.)

Manufactured in England by:

**PACE INDUSTRIAL  
EQUIPMENT LTD.**  
Queen's Road, Royston SG8 5AQ  
Tel. (0763) 45321. Telex 817929

WW-065 FOR FURTHER DETAILS

## DISPLAY ELECTRONICS

Would like to wish  
all their customers  
and business  
associates  
a Very  
Happy and  
Prosperous  
1981



Dept. W.W., 64-66 Melfort Rd., Thornton Heath,  
Surrey. Telephone: 01-689 7702

## the indispensable BIRD43



### THRULINE® WATTMETER

0.45-2300 MHz / 0.1-10,000 watts

The Standard of the Industry  
What more need we say...

Exclusive UK representative

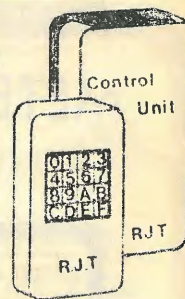
**aspen electronics limited**

2 KILDARE CLOSE, EASTCOTE, MIDDX. HA4 9UR  
TELEPHONE: 01-868 1188 — TELEX 8812727

WW-049 FOR FURTHER DETAILS

## ELECTRONIC COMBINATION LOCK:

Improves security of home or office.  
Over 65,000 combinations available,  
user can select any desired 4-digit code.  
Illuminated keyboard for night-time use.  
Operates from 12v. a.c./d.c. supply.  
For use with easily obtainable 8-12 volts  
electric door releases (these can be  
supplied at extra cost).  
Easy to install.  
Full instructions supplied.



Price £54.95 + VAT  
(Post paid)

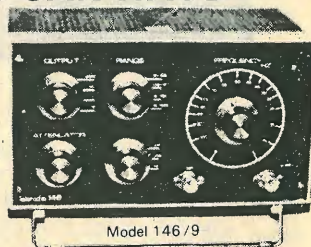
**R.J.T. ENGINEERING LTD.**  
48 Mowbray Crescent  
Stotfold, Hitchin, Herts.  
Tel. HITCHIN 730069

WW-068 FOR FURTHER DETAILS

## ONE OF THE MOST USEFUL TOOLS YOU CAN HAVE

### AUDIO SIGNAL GENERATOR

Low distortion (.002% at 1 KHz)  
Range 10Hz-100kHz  
Output 1v rms into 600 ohms.  
Sine/Square signals.  
Fixed and variable attenuation.  
Battery or mains.  
Based on a John Linsley Hood design.  
Also available with frequency meter (from £50)



Model 146/9

£36 (Batty.) + U.K. Tax £5.40.  
Mains version £46 (+ U.K. Tax £6.90).  
(Kit of parts £31 + tax £4.65); p.p. £2.

### TELERADIO ELECTRONICS

325 Fore Street, Edmonton, London N9 OPE. 01-807 3719  
Closed Thursdays. Lists sent on request. Also R.F. & Function-Generators. T.H.D.  
Analyser & Millivoltmeter. SWR and Frequency Meters

WW-070 FOR FURTHER DETAILS

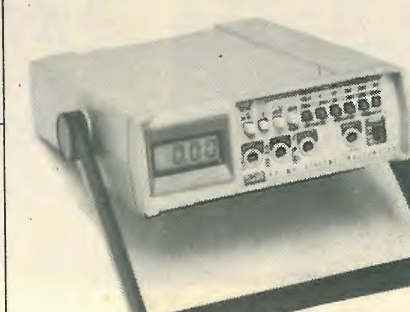
# EXTENSIVE RANGE OF NEW FLUKE DMM'S FROM ELECTRONIC BROKERS

IMMEDIATE  
DELIVERY



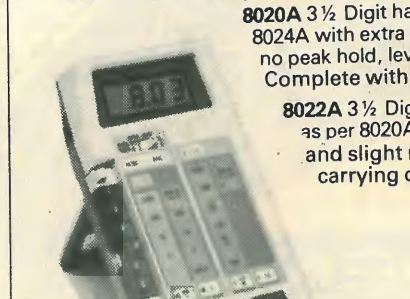
**8050A** 4 1/2 Digit LCD DMM with true RMS on AC volts and current DC volts 200mV-1KV, 10µV resolution AC volts. 200mV-750V, 10µV resolution. DC/AC current 200µA-2A, 0.01µA resolution resistance 200Ω-20MΩ, 0.01Ω resolution. Also reads dB direct referenced to 16 stored impedances. Conductance ranges 2mS and 200nS. £245 mains model £285 mains battery

**8012A** 3 1/2 Digit LCD DMM with true RMS on AC volts and current. DC volts 200mV-1KV, 100µV resolution. AC volts 200 mV-750V, 100µV resolution. DC/AC current 200µA-2A, 0.1µA resolution. Resistance 200Ω-20MΩ, 0.1Ω resolution Low resistance 2Ω and 20Ω, 1mΩ resolution Conductance ranges 2mS-20µS-200nS



£199.00 mains model £219.00 mains battery.  
**8010A** 3 1/2 Digit LCD DMM Same spec as 8012A plus a 10Amp AC/DC current range, but no low resistance range. £159.00 mains model £179.00 mains battery.

**8024A** 3 1/2 Digit hand held LCD DMM with peak hold Level Detector and continuity tester. DC volts 200mV-1KV, 100µV resolution. AC volts 200mV-750V, 100µV resolution. DC/AC current 2mA-2A, 1µA resolution. Resistance 200Ω-20MΩ, 0.1Ω resolution. Conductance 200nS. Peakhold of AC or DC volts and current. Level detector operates around +0.8V reference. Audio tone on level and continuity, £149.00, carrying case £7.00 extra.



**8020A** 3 1/2 Digit hand held LCD DMM. spec as per 8024A with extra conductance range of 2mS but no peak hold, level or continuity ranges. Complete with carrying case. £125.00.

**8022A** 3 1/2 Digit hand held LCD DMM. Spec as per 8020A but no conductance ranges and slight reduction in accuracy. £75.00 carrying case £7.00 extra.

Also available a range of accessories including current shunts, EHT probe, rf probe, Temperature probe and touch and hold probe. Full details on request.

The warranty period on all items shown is 1 year other than the 8020A which is 2 years.

## Electronic Brokers

61-65 King's Cross Road  
London, WC1X 9LN  
Tel: 01-278 3461 - Telex 298694  
Prices do not include carriage or VAT.

WW-056 FOR FURTHER DETAILS

SHURE®  
**StarMaker™**  
 SERIES  
**SM77•SM78**  
**cardioid dynamic microphones**



**a new look for the 80's**

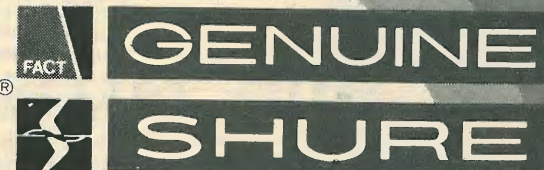
There's so much that's new about these professional microphones we can only touch the highlights. Exclusive "picture perfect" SUEDECOAT™ Tan or Ebony matt finish looks great—*permanently*. Significantly smaller, exceptionally light in weight; yet so extraordinarily rugged and reliable we call them the "Light Heavyweights." They feature the crisp sound that makes Shure the world's most widely used professional performer microphones.

Shure Electronics Limited  
 Eccleston Road, Maidstone ME15 6AU  
 Telephone: Maidstone (0622) 59881

Please send me your free  
 SM77/SM78 Brochure.

Name \_\_\_\_\_  
 Company \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_

WW-061 FOR FURTHER DETAILS



# wireless world

## The new bureaucracy

In the 1940s the construction of computer memory was difficult and expensive. So was the construction of a processor (then called a mill, or arithmetic unit). It was out of the question to cope with the technical problems of building a combined unit. The Von Neumann architecture was a creature of these historical engineering constraints. The result was a list processor, and all problems to be solved by digital electronics had to be converted into a list of sequential steps. The people who did the conversion were called 'programmers'.

It is historically unfortunate that this Von Neumann architecture proved to be so versatile that it remained fixed long enough (1944-1980) for a glamorous mythology, and also a client society, the programmers, to develop around it, innocent of technology and also rather lacking in knowledge of the nature of the problems to be solved. This architecture has now been carefully copied, without improvement, into today's microprocessor. The resulting situation, which we are encumbered with, is similar to the man at the information desk in a railway station. He knows nothing about the technology of trains or railway line networks, or that train times can be altered, neither does he know the reasons why you want to make your journey. All he can do is advise you on how to use the existing schedule, which is very awkward indeed.

The programmer class became powerful enough to insist that the computer remain unchanged, and there has been no change in computer architecture for 36 years. Similarly, the railway information man would prefer the time-table and network of lines to remain unchanged, but, unlike the programmer, he does not always have his way.

Programmers developed a glamorous view of themselves, and made heavy inroads into the media. From the beginning they were very well paid, to say the least. Borrowing from Marshal McLuhan's philosophy, they caused society to think that the essence of modern society was 'information processing', and even that the human brain was an 'information processor' following their own baroque, bureaucratic procedures. This left them free to remain ignorant on the one hand of the technological nature of their machines, and on the other hand to take little interest in the customer's real problem, for which he wanted a mechanised solution. In classic style, the programmer introduced an informational bureaucracy between machinery and problem to be solved, and insisted that any link between the two must be via the mandarin language which was devised in the 1950s to try to make the best use of the slow, awkward Von Neumann machine architecture of that time.

This incursion of an informational bureaucracy between social needs and technological solutions is now likely to be institutionalised by the setting up of a 'Minister of Information Technology' (December 1980 issue, News, p.46). In fact, there is nothing technical about the information explosion that technically uninformed programmers are busily creating around themselves and us.

Digital electronics is a very powerful branch of engineering with massive potential for social benefit, but it will be hampered in contributing to society's needs until the technically uneducated, parasitic bureaucracy variously called 'information technology', 'computer science', 'information science' gets off its back and lets it get on with the job.

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

**Deputy Editor:**  
PHILIP DARRINGTON  
01-661 3500 X3586

**Technical Editor:**  
GEOFF SHORTER, B.Sc.  
01-661 3500 X3590

**Projects Editor:**  
MIKE SAGIN  
01-661 3500 X3588

**News Editor:**  
MARTIN ECCLES  
01-661 3500 X3589

**Drawing Office Manager:**  
ROGER GOODMAN

**Technical Illustrator:**  
BETTY PALMER

**Production & Design:**  
ALAN KERR

**Advertisement Controller:**  
G. BENTON ROWELL

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

DAVID DISLEY  
01-661 3500 X3593

BARBARA MILLER  
01-661 3500 X3592

**Classified Manager:**  
BRIAN DURRANT  
01-661 3106

JOHN GIBBON (*Make-up and copy*)  
01-661 3500 X3561

**Publishing Director:**  
GORDON HENDERSON

# 'Just detectable' distortion levels

Attempts to arrive at a practical criterion for assessing audio equipment

by James Moir, F.I.E.E. James Moir & Associates

**Are distortion levels of 0.1% really detectable when programme material is being reproduced? asks the author. Manufacturers' t.h.d. figures would be of much greater value if information were available on the levels of distortion that were just detectable or just acceptable, he says. This article first examines the various signal characteristics which control the detectability of distortion to the ear, then reviews attempts that have been made to determine 'just-detectable' distortion, including a new technique devised by the author. Finally the author gives some actual examples of what he considers to be 'just-detectable' distortion levels in various kinds of audio equipment.**

Equipment suppliers generally provide a reasonable amount of information on the extent of the harmonic distortion introduced by their amplifiers and tuners, though less frequently on loudspeakers and most other items of equipment. This distortion data is usually in the form of a quotation of the total harmonic distortion (t.h.d), the r.m.s. sum of the individual harmonics. Typical values are generally in the range of 0.01 to 0.1% for amplifiers, 0.1 to 0.3% for tuners and around 0.5% for loudspeakers. Analogue record/reproducer systems have much higher distortions, 3% to 8% being average values, even for professional equipment. On the reasonable assumption that low values of harmonic distortion are desirable if 'clean' sound is to be obtained, information about the t.h.d. is desirable.

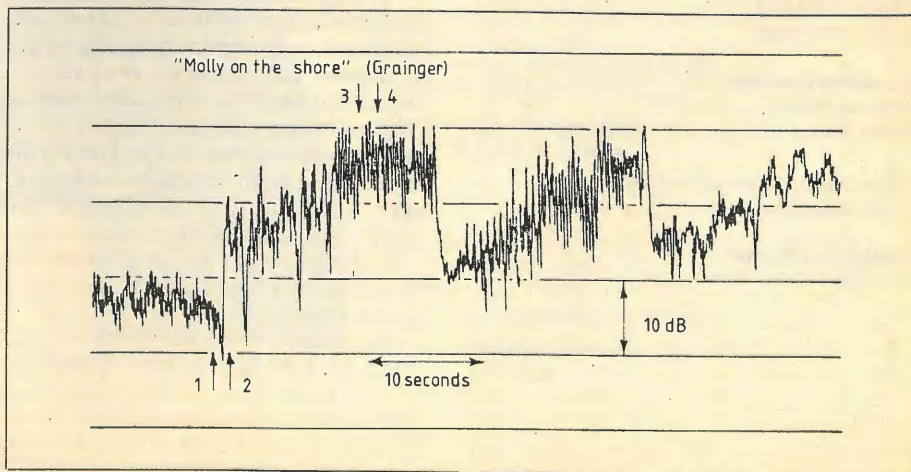
The adoption of t.h.d. as an objective measure of subjectively judged distortion follows the international standardisation, though it is appreciated that it is almost certainly the accompanying intermodulation components that are responsible for the 'objectionableness' of the distortion signal. In the majority of situations the total intermodulation distortion is directly proportional to the total harmonic distortion, the relative values depending only upon the ratio of the amplitudes of the two test signals.

However the value of the manufacturers' t.h.d. data would be greatly increased if information on the levels of distortion that are just detectable or just acceptable were available. Are distortion levels of 0.1% really detectable when programme material is being reproduced? Is an amplifier having 0.01% or 0.001% distortion

audibly 'cleaner' than one having a t.h.d. of 1%? This is the problem to which the present discussion is directed. It would be idealistic to suggest that zero distortion should be the target. A more realistic approach would be to try and define the level of distortion that is 'just detectable' using modern equipment and critical listeners.

The 'just detectable' level is a function of so many variables that a precise specification, a single figure such as 0.1% or 1%, is unlikely to emerge from the discussion. Even in the simple situation where the test signals are single-frequency tones it is impossible to specify a single figure without setting wide limits. An experienced observer will detect the addition of a second or third harmonic when this is less than 0.1% but, given the opportunity to make repeated comparisons of the distorted and un-distorted tone, he will lower the detection level by a factor of at least ten, so 0.01% distortion becomes detectable. But the 'just detectable' level of distortion in sinusoidal tones is rarely of more than academic importance and will not be given further consideration. However, the same problem exists when attempting to detect the presence of distortion in a musical programme, if the test facilities allow a smooth variation of the distortion content the 'just detectable' distortion (JDD) level continues to decrease with increasing experience and it is doubtful if any figure is meaningful with-

Fig 1. Illustrating large variations of audio signal level that can occur in musical performances - for example between points 1 and 2. (Chart recording of instantaneous levels during one minute of "Molly on the Shore" by Percy Grainger).



out providing full information on the test routine.

The specification of the 'just detectable distortion' in programme material is inherently more difficult, for the signal is continuously varying in amplitude and in consequence the instantaneous value of the distortion is also varying continuously.

Fig. 1 is a chart recording of the instantaneous levels during a one minute period of 'Molly on the Shore' (Grainger) taken from an Enigma recording No. K. 53574. Between points 1 and 2 the level will be seen to vary by at least 30dB but this is not an extreme example, for records are capable of handling a volume range of at least 50 to 60dB and this range is commonly employed.

If we now look at some data on the variation of the distortion with signal output of a typical amplifier and a domestic type of loudspeaker, we get the results illustrated by Fig 2. If it is assumed that a maximum level of 95dB at 1 metre is the highest level that will be reproduced it is seen that the distortion content is in the region of 3%. At a level about 30dB lower the distortion has fallen to less than 0.1%.

The amplifier introduces much less distortion into the signal. If the sound level of 95dB is achieved by a power output of 10 watts (a rather inefficient speaker) the distortion introduced is about 0.1% or less and it falls even lower at lower power outputs. Thus the distortion that is audible in the acoustic signal is practically all due to the loudspeaker and it varies over a range of about 30 to 1 when the acoustic signal output varies over a range of about 30dB. (The numerical agreement is a coincidence.) Thus one has the problem of trying to decide what is the effective value of the distribution when it varies over a range

of 30dB during a short section of the programme. The degree of distortion that is detectable is obviously a function of the distribution in time of the instantaneous amplitudes of the music. If the loud signals persist for a small fraction of the total time then the high levels of distortion that appear on loud signals will be less objectionable than if these loud signals occupied a large fraction of the few seconds over which the brain is able to analyse the signal while still exposed to the music.

Now the detectability of distortion depends not only upon the instantaneous value of the distortion, but also upon the length of time during which each burst of distortion persists. It appears from experiments on the fusing of tone pulses that the hearing system requires a time interval of 10-20 milliseconds to form an opinion about the spectral content of a mid-frequency tone. At the low frequency end of the spectrum the processing time rises to 40-60 milliseconds. This may be the mechanism that makes the hearing system oblivious to bursts of distortion of short duration, the just detectable value increasing very rapidly as the duration of the distortion decreases.

We investigated this aspect using a simple double zener clipper to clip sine wave pulses of variable length while listening on headphones for the just detectable distortion point. Fig 3 illustrates the results. It will be seen that the distortion due to clipping of a 4 millisecond burst reached about 10% before it was detectable, but increasing the pulse length to 20 milliseconds reduced the 'just detectable' distortion point to around 0.3%. As a consequence it will be appreciated that programme amplitude indicating meters in which the deflection is a function of the peak signal amplitude (p.p.ms) rather than the average or r.m.s amplitude (VU meter) may have the disadvantage of indicating the amplitude of signal peaks that do not result in audible distortion. In many applications the use of a p.p.m. type meter may only result in a reduction in the signal noise-to-noise ratio.

For this reason, a passage that contains perhaps one peak having a duration of several seconds will sound 'dirtier' than a similar passage in which there are many peaks of the same amplitude, but each of short duration, even though the total duration of the peaks is the same for both passages.

However, there are other factors that are of significance. It is well established that distortions of the simple amplitude dependent type (harmonic and intermodulation distortion) are less obvious when the distortion occurs at the low frequency end of the spectrum. The data quoted later suggests that the just detectable value of distortion at a frequency of 100Hz is at least ten times the just detectable value at frequencies in the 1000Hz region. Thus the just detectable distortion is likely to depend not only on the distribution in time of the peak amplitudes in the music, but also on the frequency band in which they

occur. Characteristically the sustained peaks occur in the low frequencies where the distortion introduced is less easily detected. Indeed it has even been claimed that distortion introduced in the low frequency region makes the music sound 'rich' 'round' or 'fat', a view that is unlikely to appeal to the hi-fi purist.

There is also good evidence that the intermodulation distortions that result from second-order curvature of the transfer characteristics are less disturbing subjectively than the distortions introduced by odd order curvature. All these considerations suggest that any simple single figure value that is quoted as an objective indication of the effective total distortion in a system is unlikely to agree with a subjective estimate of the consequent quality deterioration, for the annoyance aroused by the presence of the distortion will depend on the order of the harmonic responsible for the major proportion of the objectively measured distortion.

In summary the just detectable distortion depends on:

1. The ratio of the peak-to-mean amplitudes of the signal during the effective listening interval.
2. The duration of each amplitude peak; ten peaks each lasting two milliseconds are less objectionable than one peak lasting twenty milliseconds in the same listening period.
3. The frequency band in which the maximum distortion occurs. Peaks of distortion at the low frequency end of the audio band are more difficult to detect than peaks of the same amplitude in the middle frequency band.
4. The order of the harmonics introduced by the overload. Even harmonics and the resultant quadratic intermodulation distortion components are less objectionable than the odd harmonics and the resultant cubic intermodulation components.

In spite of all these complications there have been many attempts to determine a figure for the JDD and these will be briefly considered, but the wide spread of the dates at which the tests were carried out, the intrinsic quality of the sound systems employed and the variation in the methods of expressing the distortion necessitate great care in making any closely detailed comparison of the quoted distortion values.

Using a system claimed to be flat between limits of 40Hz and 14kHz, Olson suggested that the introduction of 0.7% distortion was just detectable, the JDD being the same for both even order and odd order distortion, a conclusion that is at variance with almost all the data obtained by subsequent investigators. Olson also noted that the JDD was doubled if the frequency range was restricted to 4kHz, the possible basis for P. P. Eckersley's comment that "the wider the window, the more dirt gets in".

In his book 'Elements of Acoustic Engineering' published in 1940, Olson notes that: "Tests of music reproduction on a system with a uniform response from 45 to 8500Hz at a peak level of 80dB have indi-

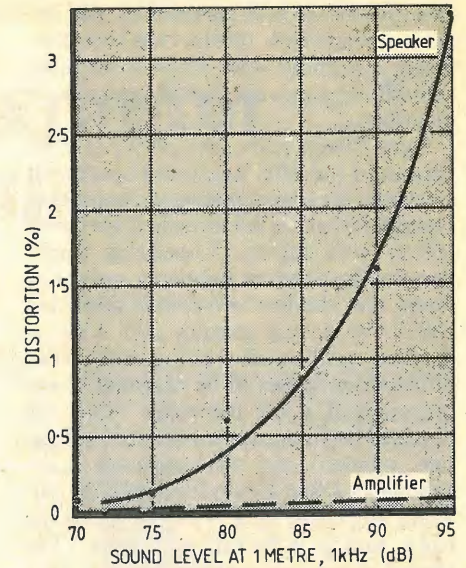


Fig 2. Percentage distortion against sound level for a typical 8-in loudspeaker and amplifier.

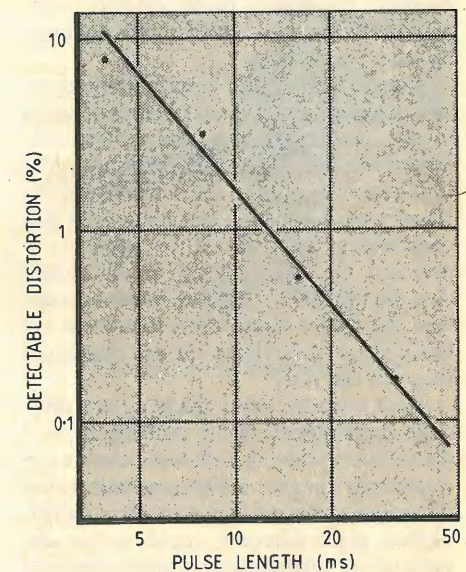


Fig 3. Detectable distortion vs. pulse length for burst of 1kHz sine wave of variable length. Detectability depends on length of time for which each burst of distortion persists.

cated that 5% second harmonic and 3% third harmonic are noticeable on a direct comparison with a system having less than 1% total distortion."

In the late thirties the problem of determining the JDD was exercising the world's telephone administrations, while they were trying to fix some performance limits for the telephone lines used for the international distribution of speech and music. Braunmuhl and Weber in Germany and the BBC and Post Office Research Department in this country made very extensive investigations of the subject, the tests being extended to produce data on the sensitivity of the hearing system to distortion when this distortion was confined to selected frequency bands. There is reasonable agreement between the results obtained from both the investigations in finding that around 1%-2% distortion is detectable when it occurs in the range above about 500Hz, but that the distortion may be allowed to rise to something in the range of

15% to 25% if it is confined to the frequency band below 100Hz. Odd order harmonic distortions were found to be more subjectively annoying than the even order distortions.

Some fifteen years later (1950) D.E.L. Shorter of the BBC Research Department compared the sound quality of a number of systems for which the measured harmonic spectra were known. Comparing amplifiers having different harmonic spectra he found that the just perceptible distortion was 0.4% in one instance and 2.6% in another, an illustration of the wide spread of distortion values to be expected in any quotation of a just detectable value. He obtained better agreement between subjective opinion and the objective measurements when he multiplied each harmonic amplitude by  $n^2/4$  before taking the r.m.s. sum. ( $n$  is the harmonic order.) The spread of just perceptible values was then reduced to 0.8% to 1.3% but it should be remembered that weighting in this way prevents his values being directly compared with the unweighted values obtained by other researchers.

Wigan (1961) made a very comprehensive investigation of the problem and came to the conclusion that the subjectively judged unpleasantness is a function of the time-rate-of-change of the departure of the signal from normality, but his results and conclusions are difficult to apply to a practical case where only the harmonic data are available. They do, however, confirm the earlier suggestions that there are likely to be wide limits on any suggested value for the JDD.

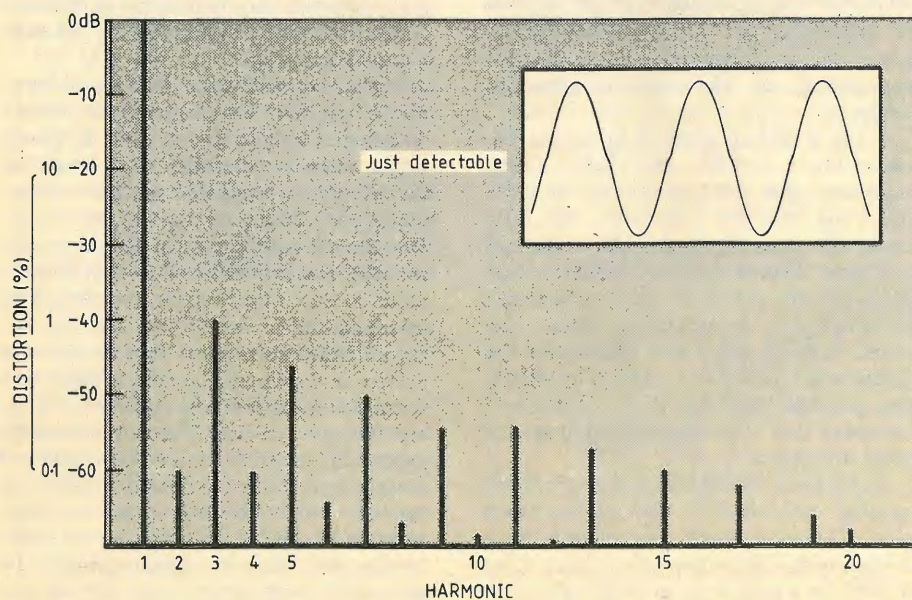
More recently Fryer made a very thorough investigation of the problem using a distortion producing technique that introduced only the first order intermodulation distortion components into a clean signal. Skilled male listeners could detect the presence of total distortion components of about 2% to 4% in piano music and 4% to 5% in other types of programme. However his circuitry did not introduce the harmonic distortion that would inevitably accompany the intermodulation products if they were produced by curvature of the

transfer characteristics of an amplifier or other circuit component. If the harmonic components had been included the r.m.s. sum would probably have been near the top end of the quoted JDD range of 4%, but, as with Shorter's weighted data, his JDD percentage cannot be directly compared with the data obtained by others.

Recently we took the opportunity of making a re-assessment using modern equipment. A 15in/s master tape recording of a concert orchestral programme was used as a signal source, the amplifier output being fed to a pair of headphones chosen for their good frequency response and particularly low distortion. We were specially interested in the audibility of cross-over distortion, a particularly annoying form of distortion. A simple addition to the bias circuitry in a good amplifier allowed the bias on the output stages to be smoothly varied by a single knob control from the under-biased to the over-biased condition, thus varying the amount of cross-over distortion over a wide range.

The amplifier output signal was monitored by an oscilloscope to show up any amplitude limiting and to reproduce the calibration waveforms. Bias on the output stages was adjusted until distortion on the programme material when subjectively judged was just detectable, each listener spending as much time as he wished in finding the point at which the distortion was 'just detectable'. The bias control knob carried calibration markings and these were recorded for each observation and averaged over about twenty determinations to obtain the quoted JDD value. Additional readings were taken at a distortion level well below the 'just detectable' to confirm that the residual distortion 0.13%

Fig 4. Cross-over distortion analysis, showing amplitude of harmonics measured on a narrow-band analyser. Inset is waveform, as seen on an oscilloscope, of a sinewave signal having the same peak-to-peak amplitude as the programme signal and showing the slight cross-over distortion.



in the equipment was unlikely to affect the results obtained.

This is a very sensitive technique for determining the 'just detectable distortion' for after a few comparisons the subject begins to recognise the particular form of distortion introduced into the music by the bias change. During subsequent comparisons the subject becomes increasingly sensitive to that particular distortion. After 10-15 minutes' experience his sensitivity to the distortion has probably increased by a factor of at least ten times.

As pointed out earlier in the discussion the actual distortion content in the reproduced music cannot be directly measured but it can be approximately indirectly. The peak-to-peak amplitude of the programme material at the level at which the distortion was just detectable was marked on the oscilloscope face and a sine wave signal of the same peak-to-peak value substituted. This sine wave signal across the headphones was then analysed in the conventional manner using a Marconi Type TF2330 narrow band analyser, all components up to about the 20th being separately measured. Fig. 4 indicates the amplitude of all the harmonics that were present and also reproduces the waveform of the sine wave signal having the same peak-to-peak amplitude as the programme signal. If the r.m.s. sum of the harmonics is taken in the conventional manner it is 1.2%, or if weighted using the Shorter technique, multiplying each harmonic by  $n^2/4$  then it is 15%. It is an interesting observation that when distortion on the sine wave signal was 'just detectable' visually it was also 'just detectable' audibly.

On examining the data from all the investigations and rather naturally giving rather greater weight to our own results in view of the relatively recent date of the investigation, it would appear that the 'just detectable' level can be no lower than 1%. Indeed in view of the critical nature of our test technique, smoothly adjustable distortion and repeated comparisons using the same test passage, it would seem unlikely that even experienced observers listening to a normal programme presentation could detect the effect of adding 1% distortion to the signal. It would seem reasonable to suggest that Fryer's value of around 3% distortion represents the 'just detectable' level in practice with limits in the range between 1% and 5%. If it is intended to be ultra-critical our 'well below the detectable distortion' value of 0.13% could be accepted as the desirable target.

With these values in mind it is interesting to see how all the individual items of equipment in a system measure up to this standard. Amplifiers appear to be the only system component that have a performance that comfortably exceeds the 'just detectable' standard. Reasonably priced units can introduce distortions that are below 1% (40dB down) at half their rated output power. Amplifiers in the very top class, but still in domestic usage, have distortions in the 0.01% to 0.001% class (60-80dB down).

continued on page 38

# Wind speed and direction meter — 1

Digital and analogue indication for racing yachts or met. stations

by N. Pollock

**A windspeed and direction measuring instrument suitable for amateur construction is described. Although specifically designed for yacht masthead use it is also suitable for land-based meteorological applications. The novel masthead transducer unit avoids the use of expensive commercial components and can be constructed relatively easily by anyone with access to a small lathe.**

A cockpit display of masthead windspeed and direction has become an essential for offshore racing yachts and is very useful for the cruising yachtsman. A number of commercial instruments are available, but they tend to be very expensive. The main requirements for such an instrument are as follows.

- the masthead unit must be small, light and weatherproof.
- the number of wires coming down the mast must be reasonably small.
- both speed and direction systems should work over a speed range of about 1 knot to 60 knot. At lower speeds, boat motion makes the indications unreliable, while at higher speeds it is only too evident what the wind is doing.
- the direction display should have a resolution of 1°, at least over the range of 45° port and starboard of head-to-wind. This is needed for fine tuning when beating to windward.
- There should be a continuous 360° analogue-type display of direction which can be read at a glance in moments of stress, such as when gybing in a strong breeze.
- the system should operate from a 12V accumulator with a low current consumption.

To the best of the author's knowledge, no instrument suitable for amateur construction which meets all the above requirements has been described previously. A number of wind direction indicators using simple 3 or 4-bit optical encoders has appeared over the years, but they have inadequate resolution. A high-resolution direction indicator with a limited angular operating range, suitable for close hauled use, is described in Reference 1.

## Operating principle

The most difficult problem in designing this type of instrument is the selection of the method of encoding the wind direction

information. Commercial 360° rotation, low-friction potentiometers, selsyns, resolvers and non-contacting digitizers can all be eliminated due to cost and availability problems.

The encoding technique adopted is one originally described by Tyson<sup>2</sup>. The principle of operation will be described with reference to Fig. 2. A cup anemometer and a wind vane, shown in Fig. 1, are mounted on a pair of coaxial shafts, which carry a pair of opaque discs with a small clearance between them. A fixed annular direction disc surrounds the small-diameter direction disc. These three discs are shown separated in Fig. 2, for clarity. A light source is located below the anemometer disc. The clock photodetector, fitted above a hole in the fixed annulus, produces a pulse train as the circle of holes in the anemometer disc

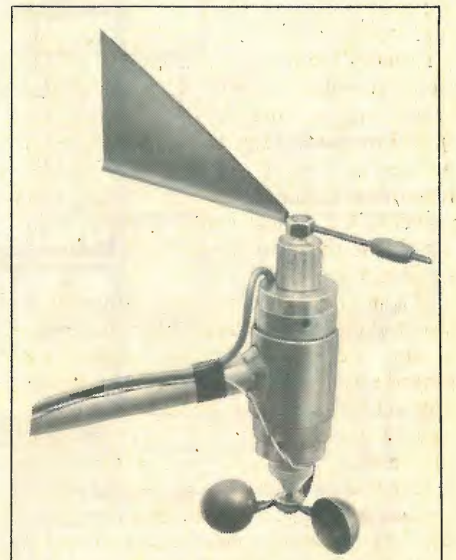


Fig. 1. Complete masthead assembly.

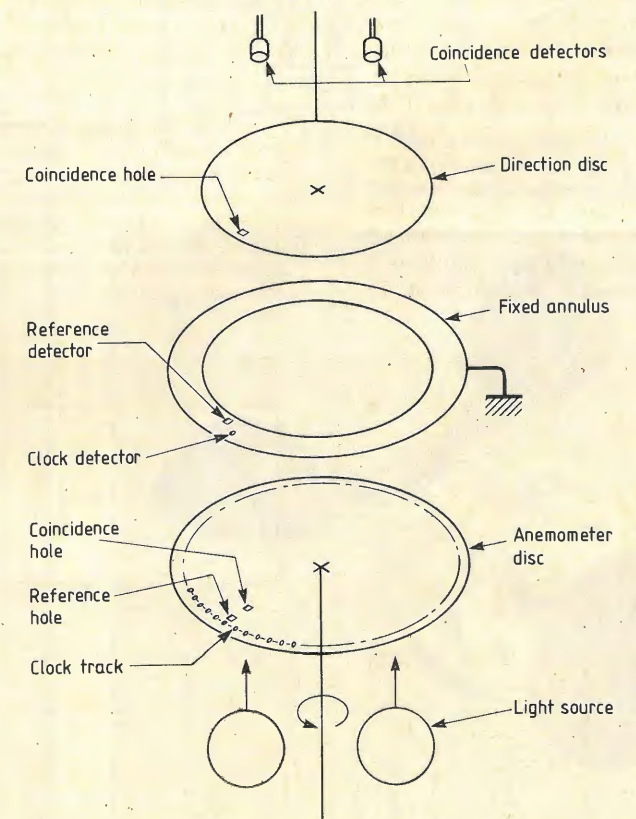


Fig. 2. Operation of transducers. Annulus and upper disc are normally in same plane.

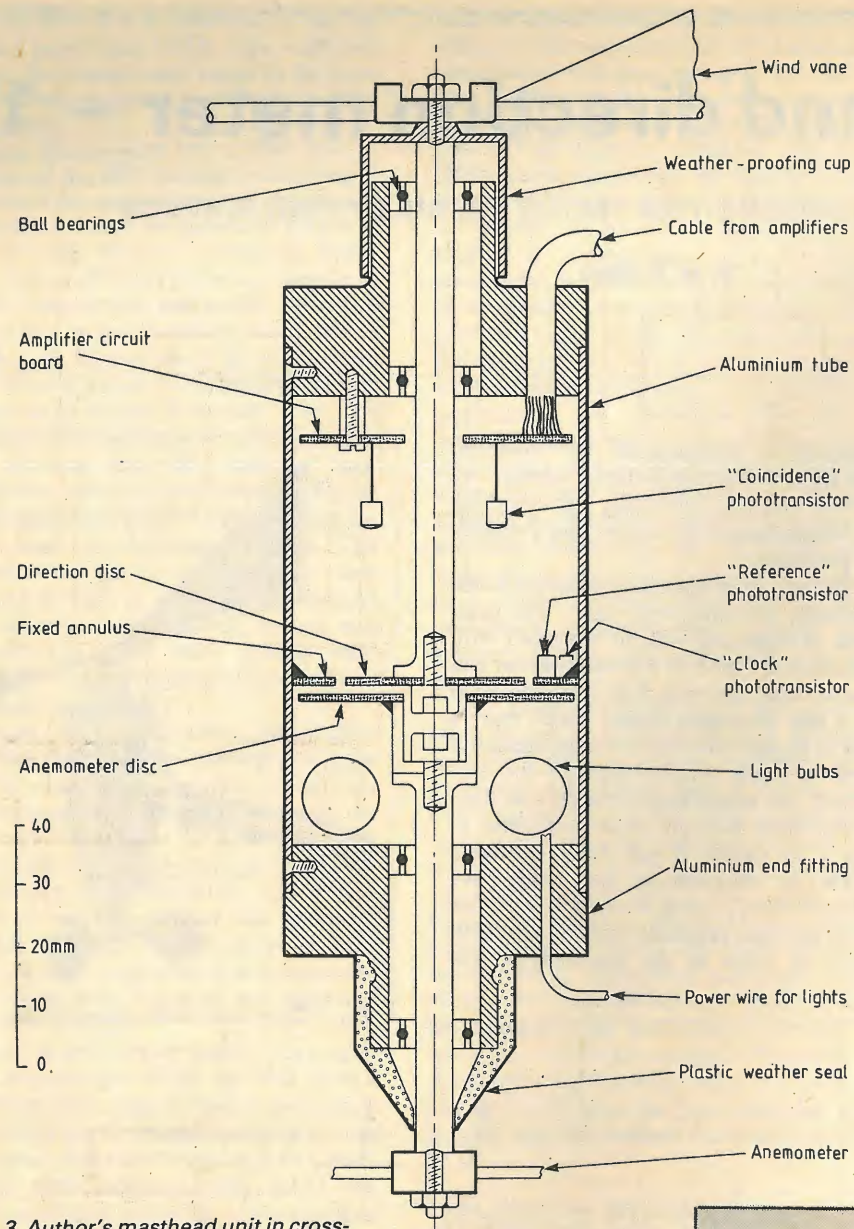


Fig. 3. Author's masthead unit in cross-section. Dimensions may be arranged to suit materials and components to hand.

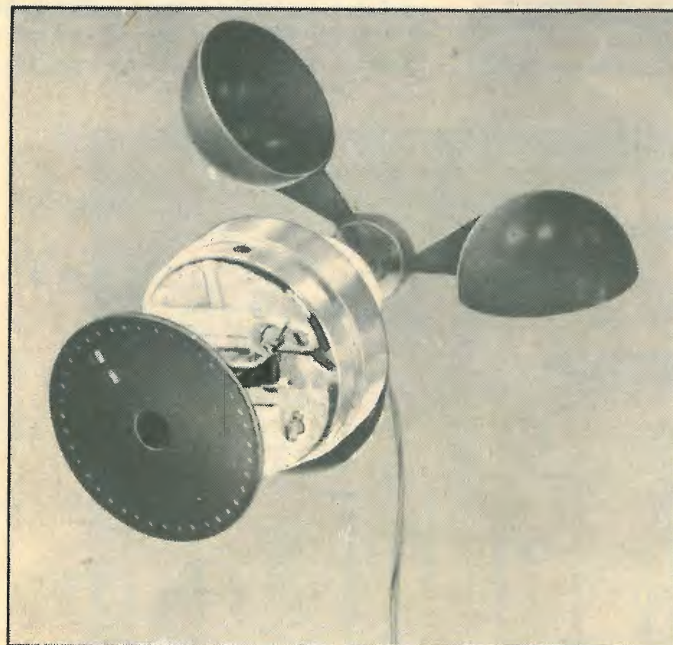


Fig. 4. Anemometer mounting and perforated disc. 'Festoon' bulbs without end caps are used.

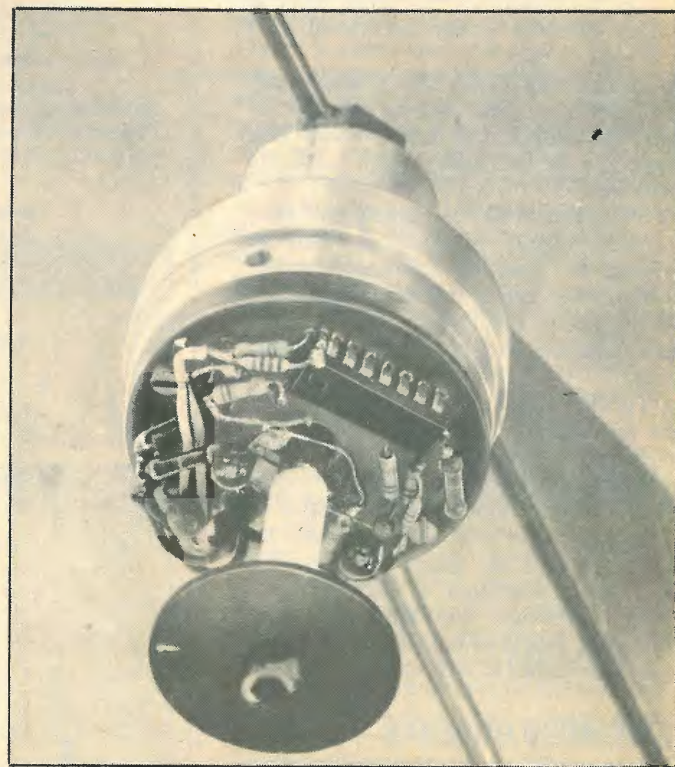


Fig. 5. Amplifier board and direction disc driven by vane. LM339 contains all four amplifiers.

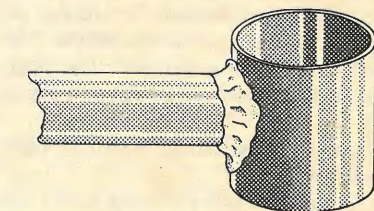


Fig. 6. Method of mounting assembly on masthead. Unit is clamped in sleeve.

(which are referred to as the clock track) sweep past, the frequency of this clock-pulse train giving the windspeed. Once per revolution of the anemometer disc, the reference hole passes the reference photodetector and an output pulse results. Also once per revolution, at a point dependent on the angular position of the direction disc, the two coincidence holes pass each other and the coincidence photodetectors produce an output pulse. The number of clock pulses occurring between the reference and coincidence pulses gives the wind vane angle. In this simple form, the angular resolution is equal to the angle between successive clock-track holes. This resolution limit can be overcome by using a phase-lock-loop frequency multiplier to increase the clock frequency.

### Mechanical design of masthead unit

This article is primarily concerned with the electronics of the system, but to assist potential constructors, some hints of the mechanical design will be included. A cross-section view of the prototype masthead unit is shown in Fig. 3 and photographs of the various components are re-

produced in Figs. 4 and 5. The unit was constructed inside a piece of 50 x 1.6mm aluminium tube, the various discs being cut from glass-fibre printed-circuit board. The clock track has 36 holes 1.7mm diameter, equally spaced on a 40mm diameter circle, the clock photodetector window in the fixed annulus is 1.0mm diameter and all the other holes in the discs were about 1.7mm square. The light source consists of two tubular, linear-filament, automotive tail-light bulbs with the end contacts removed to fit them in the available space. Ball bearings are secured in the end fittings and the shafts fixed in the bearings with an adhesive such as "Loctite Bearing Mount". The spacing between the discs (about 0.4mm) was set using temporary spacers between them while the adhesive on the shafts cured. This procedure avoids the need to accurately machine bearing-locating shoulders. Adjacent faces of the discs were painted matt black, while the rear faces of the discs and the rest of the interior was painted white.

The wind vane can be constructed from a variety of materials, the major requirements being that it should be of light weight and accurately balanced about its axis of rotation. A strong, well-balanced cup anemometer is difficult to make, so a commercial unit, manufactured by VDO and obtainable from chandlers was adapted. This anemometer, which had a mean cup radius of about 44mm, was found to give a clock calibration factor of 22.5 hertz/knot. Since the system speed calibration is adjustable, any convenient commercial or home-made anemometer could be substituted.

### Power supply

A 9V supply was selected for the instrument, since it can conveniently be derived from a 12 volt battery system. The circuit of a suitable regulator is shown in Figure 7.

### Masthead circuit

To provide high-level, low-impedance signals to drive the long wires down the mast, the three photodetector outputs are amplified in the masthead transducer unit. The necessary circuitry conveniently fits on a circular printed-circuit board which mounts on the direction end fitting, as shown in Fig. 5. The circuit of the masthead system is shown in Fig. 8. The two 12V bulbs in series are operated so far below their rating that they should have a very long life. It is desirable that the clock and coincidence amplifiers just swing to full output when the anemometer disc is rotated slowly and the direction disc is in

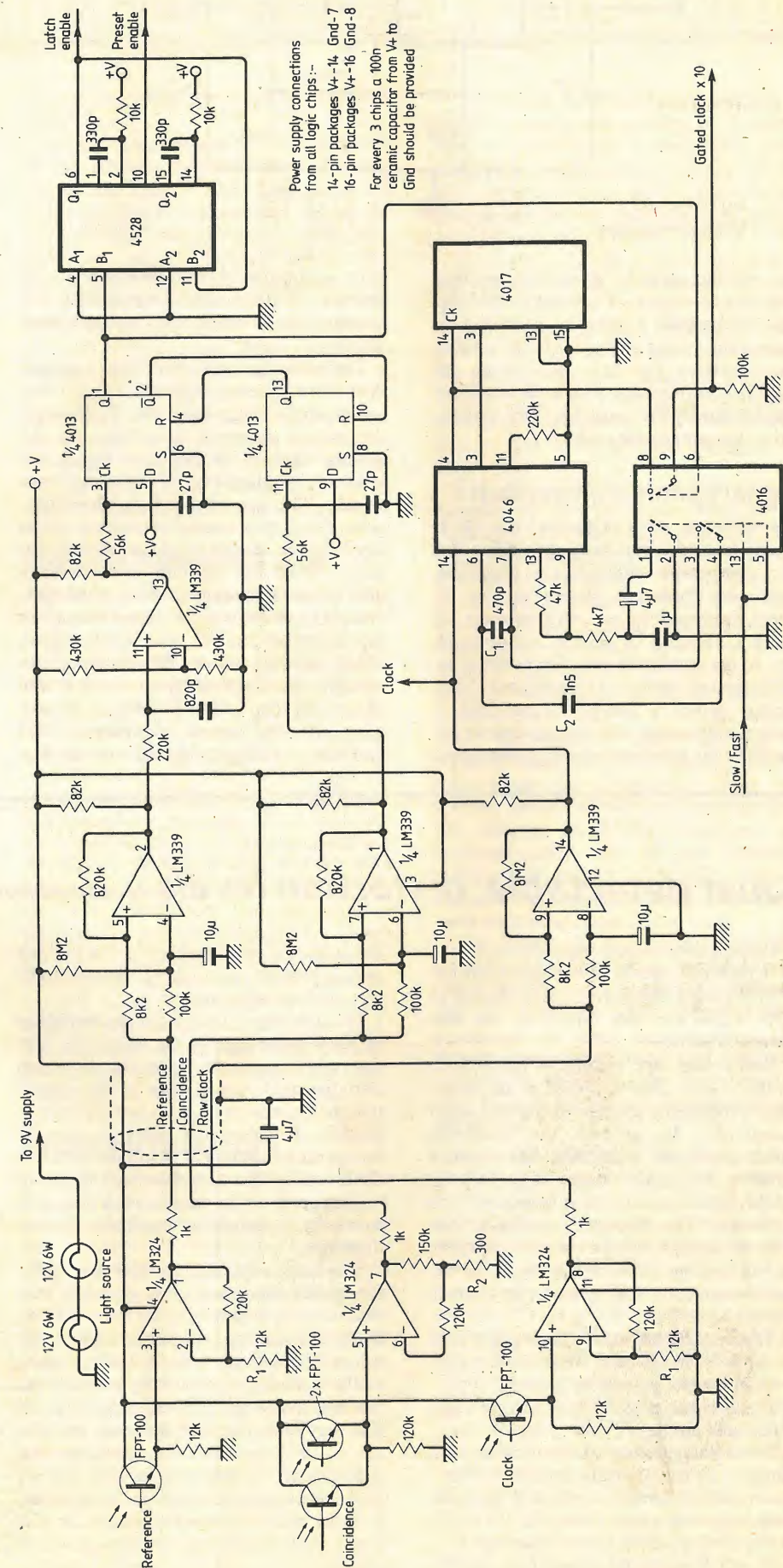


Fig. 8. Circuit diagram of masthead amplifiers and signal conditioner. On 14 pin packages, 9V goes to pin 14, 0V to pin 7; on 16 pin types, 9V is on pin 16 and 0V on pin 8. A 100n ceramic capacitor should be connected between 9V and 0V for every three i.cs. ▶

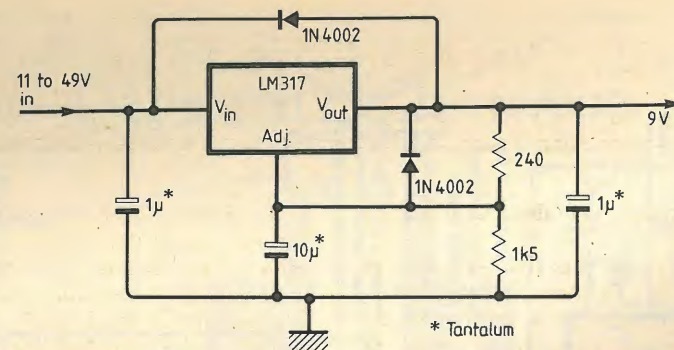


Fig. 7. Voltage regulator.

the position which gives the smallest coincidence output. If the mechanical design is changed it may be necessary to change the values of  $R_1$  and  $R_2$  to achieve this situation. The  $1k\Omega$  resistors on the amplifier outputs are to ensure amplifier stability under the capacitive load presented by the connecting cable.

### Signal conditioning circuit

The reference, coincidence and raw clock signals from the masthead unit drive the three comparators with adaptive triggering levels and hysteresis shown in Fig. 8. These comparators are very tolerant of changes, induced by ageing, temperature etc., in the amplitude and offset voltage of the incoming signals. The reference comparator drives a low-pass filter and a further comparator which compensates for the different response speeds of the refer-

ence and coincidence photodetector systems. Without this compensation the measured angle would vary with the wind speed.

The reference and coincidence signals then drive an edge-triggered RS flip-flop constructed from a 4013 dual D flip-flop, the output of which goes high on the leading edge of the reference signal and low on the leading edge of the coincidence signal. (The use of a simpler level-triggered flip-flop produced erroneous results when the two signals nearly coincided). An output from the flip-flop drives a 4528 dual monostable multivibrator, which generates the two  $4\mu s$  logic pulses needed by the direction circuit. The clock signal, which has one pulse per  $10^\circ$  of anemometer rotation, is multiplied by 10, using a 4046 phase-lock loop and 4017 counter, to give one pulse per degree of rotation. This  $CLOCK \times 10$  signal is gated with the flip-

flop output, using a 4016 analogue switch.

In practice, the maximum lock-in frequency ratio obtainable from a 4046 is about 50:1, which barely covers the design wind-speed range. To ensure reliable operation, the 4046 timing and loop-filter capacitors are switched for high-speed and low-speed operation, the switching being controlled by the SLOW/FAST logic signal derived from the speed-measuring circuit described later. The SLOW/FAST signal goes high when the speed drops through 10 knots and low when the speed rises through 20 knots: this hysteresis ensures that the capacitor switching, which causes the 4046 to momentarily lose lock, occurs only infrequently. Capacitors of  $C_1$  and  $C_2$  are appropriate for a clock calibration factor of 22.5 hertz/knot. If the anemometer used has a different calibration factor,  $C_1$  and  $C_2$  must be altered in inverse proportion to the ratio of calibration factors.

### References

1. Pope, M. I. Apparent wind-direction indicator. *Wireless World*, April 1969, pp. 176-177.
2. Tyson, G. R. A high-performance wind sensor using novel optoelectronic encoding. *Proceedings of the Institute of Radio and Electronics Engineers, Australia*, Vol. 36, No 11, Nov. 1975, pp. 365-368.

To be continued

## 'Just detectable' distortion levels continued from page 34

Gramophone records reproduced by the best pick-ups can have distortions in the 3%-6% range, but distortions in the 8% to 10% region are very typical of the best current records.

Reel-to-reel tape recordings have t.h.ds in the 2%-3% class but most of the distortion components are due to the odd order harmonics. In general the distortion content of tape recordings has a much simpler harmonic structure than the distortion spectra of a gramophone recording. The distortion content of cassette recordings is about twice as high as in reel-to-reel machines but the variation between nominally similar cassettes is much greater.

Typical current tuners have distortions in the 0.2% to 1% class. Indeed a live f.m. transmission generally provides programme material of the best quality available to the public.

Good loudspeakers of the monitor class can provide sound levels around 80dB at 1 metre with distortions of about 0.3% in the mid-frequency range, rising to 1% or 2% at the low frequency end of the range.

It will be seen that amplifiers are the only units in a system that have distortions that are well below the JDD value. Gramophone recordings appear at the bottom of

the distortion league table but this ranking should be greatly improved when digitally recorded pressings appear.

The distortions introduced by amplifiers of good design are so far below the 'just detectable' and so far below the distortion introduced by other units in the system that they appear to be of no consequence in practice. However it is relatively easy for the amplifier designers to obtain such low distortion levels and as this eases the job of the designers of the other system units it is worth while designing amplifiers for low distortion.

The levels suggested as 'just detectable' are much higher than those generally considered to be acceptable, but there is little, if any, engineering evidence to suggest that values of distortion in the 0.1% region are really necessary. It should be remembered that it is the system distortion that is heard and that when the overall system includes any of the current record/reproduce links, the system distortion is in the 2%-3% range, even using professional equipment. It is the record/reproduce equipment that is the weak link in our sound reproducer system.

Returning to the opening question, it seems unlikely that items of equipment that have distortion levels around 0.01%

will sound any 'cleaner' than those having distortions about 0.1% but they sound better in the advertising department.

Finally it will be observed that the discussion is based on the assumption that the non-linear distortions, the harmonic and intermodulation components, are the primary distortions. T.i.m., d.i.d., s.i.d. and most, perhaps all, of the currently popular esoteric distortions are not thought to be significant in equipment of professional or semi-professional standard used as the designer intended.

### References

1. Braunmuhl & Weber. The Disturbing Effect of Non-linear Distortion, *Akustische Zeit*, Vol. 2, 35-147, 1937.
2. *Post Office Engineers Journal*, April 1939.
3. Shorter. The Influence of High Order Distortion Products, *Electronic Engineering*, April 1950.
4. Wigan. New Distortion Criterion, *Electronic Technology*, April 1961.
5. Fryer. Inter-modulation Distortion Listening Tests. AES London Convention 1979.
6. Moir. The Sound of Transistors, *Hi-Fi News*, July 1976.
7. Moir. Crossover Distortion in Class AB Amplifiers. AES London Convention 1975. □

# WORLD OF AMATEUR RADIO

## Atlantic barrier

For British amateurs (as for Marconi) the Atlantic has always been considered the single most important hurdle for radio signals. The ability to bridge the Atlantic on each of the various frequency bands available to amateurs often seems to be what "DX" (long distance) is all about. Two recent events have highlighted this special cachet: one the happy event of the first successful spanning of the Atlantic by ionospheric reflection on 70MHz (in a cross-band 70 to 50MHz contact since American amateurs are not permitted to use 70MHz and British amateurs cannot use 50MHz) by Gordon Pheasant, G4BPY, of Walsall; the other, a sad event, the death of J. W. ("Jimmy") Mathews, G6LL, an active amateur for more than 50 years and the first European amateur to make contact with America on 28MHz ("Ten Metres") in October 1928.

**First on 50 and 70MHz.** The 70/50MHz contact was made between G4BPY and Canadian VE1ASG (St John, New Brunswick) on November 17 at 1627GMT. Morse signals from the British stations on 70MHz were heard weakly in Canada at a time when the Canadian 50MHz signals were coming into the UK at great strength. Two-way contact was made and has since been confirmed.

Ten days later, Gordon Pheasant chalked up another "first" for a British amateur station. On November 27, he made contact with VK60X in Caernavon, West Australia, hearing the Australian signals on 50MHz and replying on 28MHz. This completed for G4BPY his 50/28MHz "worked all continents". His contacts with Asia (Cyprus), South America (Equador) and (Europe) were made in late 1979 at the time of the sunspot maximum, while Africa (South Africa) followed in March 1980. But in completing "WAC" he was only a whisker ahead of Ken Ellis, G5KW whose contact ten minutes later with VK60X also completed a 28/50MHz cross-band WAC.

**On 28 in '28.** In 1928, Jimmy Mathews, G6LL was one of the very few British amateurs with a home-constructed crystal-controlled transmitter capable of running with an input of about 50 watts to a DET1 valve. He was also one of the few amateurs who believed that 28MHz (double the frequency of the then popular 20-metre band) was capable of providing long-distance contacts. What was not appreciated at that time was the significance of the fact that 1928 was in the declining phase of a sunspot cycle. In the event, following his initial contact on October 21 with American station NU2JN (this was before the adoption of the international prefixes) a few other stations "got across" but then

the band virtually went dead for five or six years.

Jimmy Mathews was the first recipient of the RSGB's Wortley-Talbot Trophy, one of the Empire Link Stations of the 1930s and played a prominent role in the early technical publications of the Society, including a period when he was Honorary Editor of the old "T & R Bulletin". Although not a professional engineer (his career was in banking) his technical expertise and constructional ability were outstanding. In 1941 he was one of the first of the many British amateurs at "The Farmyard" (the special Intelligence interception station at Hanslope Park) where he spent a number of years as an engineering officer. He remained an active amateur virtually until his death.

## GB2RS news service

The weekly GB2RS amateur radio news bulletins that go out from amateur stations in many parts of the UK are being listened to by about 2000 of the RSGB's 25,000 members, according to Basil O'Brien, G2AMV, 1981 president of the society. These self-help broadcasts, specially authorized by the Home Office, have been transmitted since September 1955 and the service was expanded during 1979. Some 1569 members responded to a questionnaire from which it is evident that of these 701 receive the bulletins on 3.5MHz, 652 on 144MHz f.m., 207 on 144MHz s.s.b. and 27 on 7MHz a.m. (the 7MHz transmissions are intended primarily for listeners not having communications receivers). The survey showed that 1275 members enjoyed satisfactory reception compared with 157 who found reception inadequate. The survey shows that this form of broadcasting to a specialist section of the community can be remarkably successful.

## From all quarters

Some of the candidates who sat the Radio Amateur's Examination on December 1 claim that the "multi-choice" questions and answers still included a number in which more than one answer could be correct and that there were other ambiguities in what was clearly intended to be a testing set of questions. As a result of specific complaints, the City & Guilds Institute have agreed that question 37 in Part 2 of the paper *could not* be answered correctly, and the paper is being marked out of 59 questions only.

The VHF Committee of the RSGB is recommending that the frequency band 144.15 to 144.40MHz should be reserved for s.s.b. stations seeking "long-distance" contacts while 144.40 to 144.50MHz should be used for local and mobile operation with a local calling frequency at 144.40MHz.

The British Amateur Television Club in CQ-TV reports that a group of "narrow-band tv" enthusiasts in Melbourne, Australia recently successfully transmitted 32-line pictures in the 1.8MHz band to receiving stations in Adelaide (430 miles) and Sydney (470 miles).

In the UK, a 32-line Nipkow-disc system was demonstrated by Douglas Pitt at BATC's Leicester convention last September. Currently there are over 50 amateur tv stations in the UK transmitting fast-scan television on u.h.f. A group of French and Swiss amateurs in the Geneva area are experimenting with 10GHz amateur tv and have achieved distances of 25km.

John Tye, G4BYV of Swanton Morley, Norfolk can be well pleased with the remarkable results he achieved during 1980 using home-constructed equipment on the 2.3GHz (13cm) band. His contacts on s.s.b. included SM6ESG, Sweden (869km) and OK1KIR/P, Czechoslovakia (866km). Many of the transistors he uses are "out-of-spec" disposals. He produces an s.s.b. signal at 144MHz and this is then mixed in a 2C39A cavity with the 2160MHz output from an oscillator chain starting at 90MHz, then amplified in a further 2C39A cavity stage with 42 watts d.c. input. His receiver has an NE64535 low-noise amplifier, followed by HP35823 stage and interdigital mixer with HP2565 Schottky diode and i.f. output at 144MHz. His 4-ft diameter dish aerial is made from wire-mesh with aluminium T ribs.

The RSGB has commented upon the Government consultation document in which the proposal is made to levy a fee of £30 on planning applications seeking permission to erect aerial masts. The Society urges that either no fee or a purely nominal fee should be payable where the mast is intended for non-professional applications.

*Radio-ZS*, journal of the South Africa Radio League, reports that local amateurs are co-operating with the South African Broadcasting Corporation in investigating the reception of tv pictures from the Russian Stations and Ekran series of geostationary satellites. These are located at around 55° East and 99° East and are using down frequencies between 702 to 726MHz except for Ekran 3 on about 4GHz. The 700MHz transponders use powers of up to about 200 watts. Despite the use of frequency-modulated vision signals, black-and-white pictures are being resolved in South Africa on normal u.h.f. tv receivers intended for amplitude-modulated vision provided that aerials of more than about 16dB gain are used. Colour, however, is on the SECAM system and cannot be realized on PAL-type receivers as used in South Africa.

Pat Hawker, G3VA.

# NEWS OF THE MONTH

## Satellite for business communications

Now in orbit is the first of a group of three communications satellites designed to provide voice, video, high-speed data and facsimile services for American business firms and industries. Launched in November 1980, the satellite is called SBS, which stands for the name of its owner, Satellite Business Systems, a private company jointly owned by IBM Corporation, Comsat General Corporation and Aetna Life and Casualty. It is expected to begin commercial operations early this year.

The spin-stabilized satellite was built by Hughes Aircraft Company's space and communications group at El Segundo, California, and was launched by NASA on a Delta rocket into a geosynchronous orbit at 106° West longitude, roughly south of El Paso, Texas. It is 7ft in diameter and over 9ft high in its "stowed" position, but when, in space, its solar panels are fully extended and its communications aerial is raised it has an overall height of 21ft 8in. The solar panels take the form of two concentric

cylinders, the outer of which extends nearly six feet downward in space. This capability of expanding in space doubles the spacecraft's solar-power generating capacity over many previous satellites. Improved solar cells also enhance this capacity.

The electronics payload includes a high-speed, digital 10-transponder system capable of relaying data at rates up to 480 Mb/s. Reception and transmission make use of the 12/14 GHz satellite band and in fact the SBS is the first US domestic commercial satellite to operate at these frequencies. The aerial beams, which are despun, cover the continental United States, delivering higher power to metropolitan regions in the East, Mid-West and West Coast where the communications traffic for SBS's customers is greatest.

The second satellite in the series is scheduled for launch on a Delta vehicle in April this year, and the third one will be launched from the Space Shuttle in late 1982. By 1983 Satellite Business Systems also plans to establish an inter-city satellite telephone service connecting up to 150 metropolitan calling areas.

For use with the satellite 100 earth terminals are being built, also by Hughes. They will be installed on the roofs of customers' buildings or on adjacent ground. Delivery has already started and is expected to be completed in 1982.

## Levy on blank video cassettes?

At the first meeting of the British Videogram Association's Council of Management, Donald MacLean of Thorn-EMI was elected Chairman and Maurice Oberstein of CBS, Vice-chairman. Peter Scaping will act as Secretary while the Association is becoming established.

Videogram producers are evidently experiencing roughly the same problems as those in the audio recording industry; the Association's priorities include consideration of the 'commercial piracy problem' and 'an approach to Government for a levy on the sales of blank video cassettes . . .' with a view to controlling the recording of tv programmes on domestic video recorders. When asked whether such a tax was, perhaps, a little unfair on people who intended to use the tapes for other purposes, Michael Kuhn of Polygram, who chairs the working party on industrial relations and copyright, expressed the view that "there's a case for saying

'too bad.'" Alternatively, he suggested, such purchases could be exempted from tax if they signed a form at the time of purchase to the effect that they had no intention of using the tape for nefarious purposes. Such a provision, he pointed out, was common in libraries where one-off photocopying was permitted for the purposes of study.

Mr Kuhn went on to explain that the Association was determined that in a "short time", the UK would be the centre of video production and experimentation, the "hub of the video industry", in fact. To attract video manufacturers here, there would need to be rights agreements and unfair competition must be prevented. He saw home taping as unfair competition on the same level as piracy and 'parallel importing', which is the production of tapes in less strictly controlled countries and imported here.

*With the increasing expansion of Ceefax comes the added demand for a stable, bright image for those who prepare the pages for transmission. These EV 6000 Series colour picture monitors, at a price of about £1200 each, have been chosen by the BBC for use by the Ceefax journalists and are supplied by Electronic Visuals Ltd, of Woking.*



## Data convention

In the past few months a European convention on data exchange and protection has been drawn up and has been approved by the committee of ministers of the Council of Europe. At the time of writing it is due to be formally signed by the Member States at the end of January. The convention aims to move obstacles to the free passage of data between participating countries by encouraging them to trust each other's data protection. It specifically requires that each country must have data protection legislation in force before it can ratify the convention. What form this legislation must take is not stated, but a set of principles to be followed has been provided. These include a right of subject access to files, rectification of mistakes and publishing the existence of files.

Compared with the rest of Europe, Britain has been slow in producing legislation on data protection. There were the 1975 proposals made in the White Paper "Computers and Privacy" (February 1976 issue, p.29) and later the Lindop report (February 1979 issue, p.38) but so far no definite laws have emerged. However, the UK government's representative at the Council of Europe, Donald Cape, did vote in favour of approving the new European convention and, in view of the requirement on data protection mentioned above, this does imply that the government has finally made up its mind to go ahead with such legislation.

Meanwhile the European Parliament has been studying a radical ECC proposal for a directive

## Prestel goes international

Prestel, the public viewdata service of British Telecom, is to add international data retrieval to its facilities in July this year. The decision to implement Prestel International, as it is called, was made following the successful outcome of an international market trial which ran throughout 1980. The trial involved more than 300 business users in seven countries and had the co-operation of the telecommunications authorities and carriers concerned.

The international service is expected to follow the pattern found most successful in the trial - information for specific business sectors. These included shipping movements, investment statistics and commodity prices, plus a considerable use of private "closed user groups" in which organisations have exclusive use of certain parts of the information bank to meet their own needs. It will have a single database, which will be quite separate from the one used for Prestel in the UK. This will be updated by selected international information providers, and British Telecom say it is designed to enhance and complement rather than compete with any national service there may be. The full international service, like the trial, will run on a GEC 4080 computer, sited in London. A second GEC computer will be commissioned towards the end of 1981 and will be located in the United States. Further computers will be brought into service in other countries, according to demand.

Access to public information on the international database will be available to users normally for the cost of a call on their own country's domestic telephone network. Access to the private closed user groups will be available via the public telephone network or data links, at

the national or international call rate to the nearest computer.

Although access will be possible from anywhere in the world, direct support and marketing is to be restricted initially to the seven trial countries - Australia, the Netherlands, Sweden, Switzerland, West Germany, the United States and the United Kingdom - plus Hong Kong. Tariff levels for the full service, which will be run on commercial lines, are being decided and will be announced nearer the launch date.

The trial database used more than 20,000 pages of information, provided by more than 50

national and international organisations. These included BP, ICL, ICI, Newsweek (USA), News Limited of Australia, and the Chase Manhattan Bank. Public service and government organisations included the Australian Department of Productivity, the European Economic Community Commission, and the House of Lords library.

At present there are 11 countries operating national trial viewdata services, six of which have Prestel computers and software and all of which use the terminal standards applicable to Prestel.

It is expected that considerable use will be made of the developing packet switched data services, including Euronet (see News, February 1980 issue, p.58) and the International Packet Switched Service.

## Voice recognition for mariners

Because senior officers on ships don't readily take to the idea of pressing buttons on keyboards but are used to barking orders at subordinates, a seagoing version of Prestel viewdata has been equipped with a voice recognition system instead of the usual keypad for interactive communication. The seagoing Prestel is called Seaview and its purpose is to give ships' officers immediate access to information available in shore-based data banks. Developed by a partnership between Siemens and Computer Analysts and Programmers (CAP), in collaboration with British Telecom, the Home Office, the Departments of Trade and Industry and Liverpool Polytechnic, the Seaview system underwent trials at sea off Dover last year, using 150 of the pages available in Prestel. In a more recent test using voice recognition, uttering the command word "Dover" caused the display screen of a terminal to show all the information held within Prestel on the Dover coastline.

The voice recognition was developed by Threshold International Electronics Ltd (formerly EMI Threshold Ltd and now a company in which Siemens has a major shareholding). The analogue voice signals are first digitized and then fed into a computer system which uses a voice recognition algorithm developed as software by CAP. The system depends on the user's first recording 240 speech sounds on magnetic tape, each sound being recorded ten times to allow for variations in the production of the speech. In operation the spoken command words are matched against these stored reference patterns. More recently Threshold have field-tested a new voice recognition algorithm called Quicktalk which recognizes semi-connected speech and allows the speech input speed to be doubled. (See also the section on speech recognition and understanding in "Artificial Intelligence" by Malcolm Peltu in the January 1981 issue.)

## in Europe

that would give employees a right to know what is going on in national and multinational corporations. If adopted, the directive would require central managements of corporations with national subsidiaries, as well as multinational companies operating within the European Community, to provide regular information to their employees on matters that directly affect them, including production plans, management changes, and employment trends.

The ECC proposal argues that while large companies have become more complex, with subsidiaries or establishments in a given country or even in several foreign countries, consultation with employees still tends to be conducted at local shop, plant or office level. Even local governments, let alone workers whose very livelihoods may be affected, are often ignorant of the motives for action taken at higher levels. In general, also, disclosure of information to employees is confined to local business matters so that workers can only obtain a partial or incorrect picture of the affairs of the company as a whole.

The proposal is in line with OECD and International Labour Office voluntary guidelines, and with existing industrial practices in the community, as for example in West Germany, Belgium and the Netherlands. But the idea that disclosure procedures should be mandatory, though welcomed by trade unions, has so far aroused considerable misgivings among employers.

*The Doro 721 QA answering machine, recently launched by Ansamatic can act as a message taker, information giver, dictation/transcription and recording machine. It also has the ability to ask a series of questions of the caller, such as account number, address, goods required, delivery date, etc.*



## C.b. Green Paper — CBA's response

In response to the invitation extended by the Home Office in the Green Paper-discussion document Open Channel, the Citizens' Band Association has submitted a detailed reply with a letter to all MPs, offering them a copy and the loan of a 27MHz receiver so that they can gauge the level of illegal use.

The C.B.A.'s submission is extremely critical of the Home Office proposals which, the C.B.A. say, are didactic in tone, stating as fact a number of things which are no more than opinions. Out of 27 numbered paragraphs and sections, the C.B.A. finds itself in wholehearted agreement with only six and in qualified agreement with a further four. In common with what the Home Office say is the "vast majority" of over 12,000 submissions, the C.B.A. is not in favour of a frequency in the 92.8MHz region on the grounds of its probable high cost and short range. It also mentions the possible danger to health of such frequencies, particularly in hand-portable use.

The Home Office is accused of "grossly overstating" the problems of interference to television and other users of the 27MHz band. The C.B.A. claim that, in the ten countries where 27MHz is used legally, there is some interference with other services, but say that

"this is generally quite tolerable". It does not explain to whom it is quite tolerable.

The submission concluded with a call on the Home Office to announce a v.h.f. f.m. system during December 1980 or, if this is not possible, to legalise the 27MHz immediately, using the American 40-channel a.m. system unchanged.

One feels that the C.B.A. have submitted a somewhat intemperate document, which may, for that reason, not carry with it the influence its case deserves.

★ ★ ★

In a written answer on December 18, Mr William Whitelaw, the Home Secretary, said that he was "disposed to allocate frequencies to Open Channel Radio in the neighbourhood of 930 MHz." This is in line with recommendations contained in the discussion document 'Open Channel', published in August.

Since, on December 17, the Home Office was still engaged in correlating the 12,000-plus responses to the discussion document, it appears that Mr Whitelaw has not felt compelled to pay excessive attention to the views expressed, which were, according to the Home Office department doing the correlation, greatly in favour of frequencies other than 930 MHz.

## Computer network aids astronomers

A network of computers has been set up at six centres in the UK to provide and co-ordinate image processing and data reduction for British astronomers. Called the Starlink network, it is controlled from the Science Research Council's site at the Rutherford and Appleton Laboratories, Chilton, Didcot, Oxfordshire.

Astronomers in Britain now have access to a wide range of telescopes operating at all wavelengths, on the ground and in space. These are equipped with instruments that produce data in the form of large digital arrays so there is now a pressing need for powerful data processing facilities. Previously astronomers either had to reduce the data manually or devise their own data processing systems. The modest facilities that did exist could be used by only a few astronomers and were heavily over-subscribed, particularly where interactive reduction of the image data was demanded. In the 1980s most astronomy will be done using data in digital form and adequate image processing machinery is essential.

The Starlink system is based on six Digital Equipment Corporation's VAX 11/780 computers linked in a communications network using Post Office lines. Each computer supports two image displays. The display system used, the Advanced Raster Graphics System (ARGS) made by Sigma Electronics, will show colour images consisting of a matrix of up to 512 x 512 picture elements. It can switch between such pictures, transform the colour mappings to highlight features, zoom in on parts of the picture, generate lines and other graphics and perform other such functions. Each of these displays form part of an 'image processing workstation' consisting of the ARGS, a graphics terminal (for spectra, intensity plots, etc) and a v.d.u. from which the user controls the system. In addition there are other terminals from program development.

Through the network the astronomer will also have access to devices such as larger plotters and camera systems to produce colour prints and slides of astronomical objects.

## Intelsat V launched

Intelsat V, the first in a new generation of nine geostationary communications satellites, was launched by NASA on December 6. When it is placed in its permanent orbit, it will take up a position 21.5° west over the equator.

During 1979, around twenty million telephone calls were made between the UK and USA, and the number rises by over 30% per year. Each new set of communication satellites must have increased traffic capacity to cope with this locacity, and an Intelsat V has double the capacity of an Intelsat IV. It can handle 12,000 telephone calls and two television channels simultaneously.

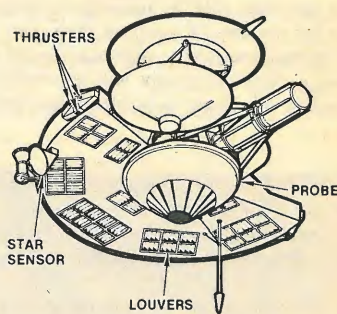
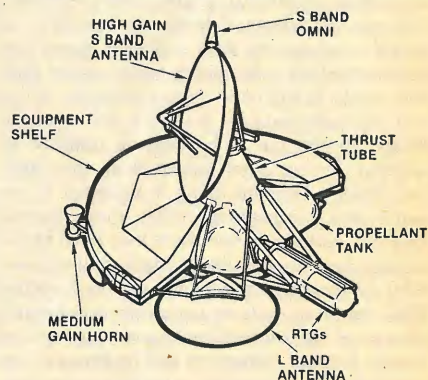
Five of the nine Intelsat V satellites, which

will be launched at intervals up to 1983, are to carry facilities for ship communication, forming part of the global system operated by the International Maritime Satellite Organization (Inmarsat).

The new satellites are not spun for stability, but employ flywheels and earth/sun sensors to maintain the structure in the required attitude. Further novel features include its use of the 14-11 GHz band, which is less congested than the 4-6 GHz band — also used in Intelsat V. Similar frequencies can be used for different purposes by aiming the beams in widely divergent directions at heavy-traffic regions on the earth, and by cross-polarizing the transmissions.

## Jupiter probe

The Galileo probe will transport an atmospheric entry probe to the planet Jupiter later in the decade as part of NASA's planetary exploration programme. The carrier will receive scientific data transmitted from the probe during its descent through the Jovian atmosphere and then relay the data over a distance of 560 million miles back to Earth. The probe carrier spacecraft will be launched from the Shuttle in March 1984 and will transport the Galileo probe to Jupiter on a journey lasting approximately 3½ years. Both probe and carrier are to be developed for NASA by the Hughes Aircraft Company.



GALILEO PROBE CARRIER

## VDUs get clean bill of health — almost

According to a research paper published by the Health and Safety Executive, visual display units used commercial process and business machines are not a risk to the health of most operatives.

The level of radiation of all wavelengths emitted from the screen and elsewhere in the equipment are said to be insignificant compared with national and international limits for continuous exposure, in both short and long term, although no figures are quoted.

One area in which the paper does admit cause for concern is the possibility of epileptic attacks being precipitated in certain circumstances. Since the majority of people who suffer from epilepsy have their first seizure before the age of 20, it is assumed that a first attack is unlikely to be triggered by a v.d.u., but for those who are known to be prone to photosensitive epilepsy, there is a risk, as there is with a large-screen domestic television set. It is increased by prolonged close-range viewing and, in particular, by 25Hz interlacing, which is used in both television and character-enhanced (rounded) v.d.us. Photosensitive epileptics are urged to seek medical advice before working with v.d.us.

## News in brief

**Viking** — the Swedish scientific satellite is to be launched in 1984 to observe the magnetosphere above the north hemisphere. It incorporates a band-S (2GHz) transponder supplied by Thomson-CSF. The coherent transponder will receive remote-control instruction and telemetry data and send back localisation signals.

The BBC was able to open their 22nd local radio station, **Radio Lincolnshire**, three days ahead of the scheduled date in order to broadcast a service from Lincoln Cathedral attended by The Queen and the Duke of Edinburgh. V.h.f. signals are transmitted from Belmont and are of mixed horizontal and vertical polarisation. Medium wave transmissions are radiated from Lincoln, providing a daytime service up to a radius of about 20 miles. A more powerful medium wave transmitter is to be operated in about a year's time.

**Radar simulators** are needed to help train operators in control procedures. Marconi Radar simulators, as supplied to the RAF recently, are designed to produce a very realistic situation for trainee operators, and in the course of complex tactical situations which are set for executive team training. The computer-generated models of airspace activity can depict any type of aircraft or armament as well as geographical or meteorological factors. The equipment interfaces readily with all types of display and communications equipment. It can be set up either on its own or can be added to an operational radar system, when it may be used without interfering with the operational readiness of the system.

**Electronic Brokers Ltd**, who market second-hand test equipment, minicomputers and peripherals, with a refurbishing and calibration service have recently moved to new premises at 61-65 Kings Cross Road, London WC1X 9LN. Their telephone number is 01-278 3461.

Underlining the conclusions of the Photovoltaic Solar Energy Conference, held in Cannes, that solar electrical systems is one of the fastest growing 'alternative energies', Lucas Energy Systems Ltd have recently landed a £2 million contract to supply batteries with solar and mains chargers for about 600 sites in Algeria.

**Audio 81** hi-fi show is to be held at the Holiday Inn, Swiss Cottage, London, from 3 p.m. on Friday 6th February to 6 p.m., Sunday 8th February. It will remain open until 8 p.m. on Friday and Saturday. The sponsors, Audio T and A T Labs, promise a complete cross section of the hi-fi industry from the large Japanese companies to the smaller enthusiast British manufacturers.

**Harmonized electronics standards.** As part of the continuing policy of harmonizing the series of standards produced in conjunction with the European Committee for Electrotechnical Standardisation, the BSI have published BS CECC 11000 *Harmonized system of quality assessment for electronic components: generic specification: cathode-ray tubes* and BS CECC 12000 *Harmonized system of quality assessment for electronic components: generic specification: image converter and image intensifier tubes*. Both standards give the terminology, quality assessment procedures, test and measurement conditions for the entire families of the products. They are available from BSI Sales Department, 101 Pentonville Road, London N1 9ND.

## More satellite communications for shipping

A new global satellite communications system is being set up to meet the growing international telecommunications needs of the world's shipping and offshore industries during the 1980s. Initiated by the International Maritime Satellite Organisation in November, it involves the leasing of two dedicated ESA satellites, Marecs A and Marecs B, as well as three Intelsat V satellites with Maritime Communication Subsystem packages and one Marisat satellite of the Comsat General Corporation. The system will provide coverage of the Atlantic, Pacific and Indian oceans and will also act as a follow-on to Comsat's existing Marisat system. Transition from Marisat to the new system is expected to be made in early 1982.

The decision by Inmarsat involves contracts to three major suppliers — ESA, Intelsat and Comsat — worth 180 million US dollars over the period 1982-89.

A second major decision made by Inmarsat is on the space segment portion of charges for the telephony and telex services. The final rates to end-users of Inmarsat services will now be determined by telecommunications administrations who are signatories to Inmarsat. These rates will reflect additional charges for the use of the coast earth stations of the telecommunication administrations, as well as any landline extension charges.

The coast earth stations of the present Marisat system will continue to provide service in the new system in 1982. They are the Comsat stations in Southbury, Connecticut and in Santa Paula, California, USA, and the Kokusai Denshin Denwa Co. Ltd (KDD) station in Yamaguchi, Japan.

Other stations expected to operate in 1982 include: a second KDD station in Ibaraki; the Norwegian Telecommunication Administration's station in Eik; the Ministry of Communications of Kuwait station in Umm-Al-Aish; the Singapore Telecommunications Administration station; the Italian PTT's station in Fucino and the British Telecommunications station in Goonhilly.

Nine additional coast earth stations are planned, or under study for operation in 1983, while another dozen are similarly under consideration for the post-1984 period.

Inmarsat has also selected KDD of Japan and the Communication Satellite Corporation of USA to be suppliers of network co-ordination services. These services, based on coast earth stations in Ibaraki and Yamaguchi in Japan and in Southbury, USA, will control and co-ordinate the traffic through the satellites in the Pacific, Indian and Atlantic Ocean regions, respectively.

## Racal-Decca in Transit

The cost of marine navigation by satellite is drastically reduced by the introduction of Racal-Decca's new DS4 sat-nav receiver. At £3,000, the technique can now be used by small ships and pleasure craft, while its performance is such that it is well suited to use by vessels such as supertankers.

The satellite system used in the US Navy Navigation Satellite System (NNSS), now known as Transit — a system of five satellites in polar orbits which transmit on 400 MHz. Position is obtained by Doppler measurements on the satellites carried out in the receiver each time a satellite is over the horizon and in a usable position relative to the ship. Intervals

between passes are around 2.4 hours average (4 hours maximum) so that the position between passes must be obtained by dead reckoning. This is also performed by the receiver using inputs from the ship's gyrocompass and log.

Displayed information includes latitude, longitude, time, date, heading and speed, and the user can obtain the course and distance to ten waypoints and information on the next 100 satellite passes to enable him to plan the voyage. Under normal ionospheric conditions and with an error of 0.2 knot in speed, the receiver will determine position to within 0.05 nautical miles.





# Morse decoding

## A machine-code program for decoding Morse transmissions on a home computer

by N. Kyriazis

Decoding Morse by means of a computer is a fairly simple matter and many programs have already been produced for home computers such as the TRS 80. This article describes a certain amount of immunity to the effects of noise and interference associated with short-wave reception, which would normally cause unacceptable decoding errors.

To minimize the effects of poor sending and to ensure reliable decoding from typical short-wave reception, the following features have been included in the program.

- The ability to recognize and reject the effects of short-lived interference, such as that generated by ignition systems.
- The ability to recognize and reject short gaps in the transmission which may occur as a result of the type of interference described above. (These gaps may not occur in more advanced receivers which have effective noise limiters.)
- Generous tolerance for the definition of *dits*, *dahs*, characters, spaces, etc., to cater for the different "fists" of c.w. operators.
- The provision of simple "filtering" of the input from the receiver to reduce the effects of noise on weak signal during fades.

### Program description

The program compares the time lengths of *mark* periods, i.e. periods of tone output from the receiver, and *space* periods, i.e. periods of no tone output, with a predetermined time unit. The tone mentioned here is, of course, the audio frequency generated by the receiver in the c.w. mode, usually around 750-1000Hz. This audio output from the receiver must be converted to a logic-compatible signal, so that it can be fed into the computer via one of the five serial inputs. Bit 1 was used in this application, but any other bit may be used if required by modifying the masking instruction following the IN instruction, details of which will be given later. The various elements of Morse characters are defined as follows.

- A *dit* has a duration of one unit of time.
- A *dah* has a duration of three units.
- Elements of the same character are spaced one unit apart.
- Characters are spaced three units apart.
- Words are spaced at least five units apart.

To make the program tolerant to sending errors (bad "fists") and to minimize the effects of interference, as mentioned earlier, the time unit values for the elements of the Morse characters are modified as follows:

- A *dit* becomes a *mark* period which is between one half and two units long.
- A *dah* becomes a *mark* period which is two or more units long.
- An inter-element *space* is from one half to one and a half units long.
- The *space* between characters is from one and a half to four units long.
- Words have a *space* between them of four units or more.

A maximum limit of eight units length is placed upon the *dah* by the program as will be described later. *Mark* or *space* periods less than one half unit long are regarded as the result of interference and are dealt with accordingly by the program.

It may seem initially that there is too much tolerance in the definition of these basic Morse elements as, for example, a *dit* has a range of 4:1 in time duration. It has been found, however, that this method works well in practice and most hand-sent Morse is decoded accurately. The regard-

ing by the program of *mark* units of less than one half unit as interference reduces to a large extent the tendency to display the letter E as a series of Es under interference conditions. Similarly, the minimum limit of one half unit for a *space* results in fewer errors during periods when the output signal from the receiver is weak and reaches the minimum limit required to operate the interface circuitry.

Before giving the detailed description of the terms used in the accompanying flow-chart: MARK - a counter used for measuring the duration of "tone" output from the receiver which corresponds to the key-down time and is represented by the H register of the Z80. SPACE - a counter used for measuring the "no-tone" or key-up time which is represented by the L register of the Z80. UNIT - used to hold the current basic time unit of the Morse code being received, i.e. the duration of an inter-element space, which is represented by the B register of the Z80. CHAR - is the variable that holds the HEX equivalent of a Morse character after it is converted by the program. A *dit* is represented by a logic "1" and a *dah* by logic "0". The initial value of CHAR before any elements are inserted is HEX01 and elements are inserted by shifting CHAR one bit to the left first so that no ambiguity results. For example, the Morse character *dit dah* (A) will be HEX 06, and the character *dah dah dit dit* (Z) will be HEX 13. CHAR is represented by the C register of the Z80.

### The program in machine code

0C00	11 00 81 01	01 0C 21 00	00 CD 95 0C	30 34 24 7C
0C10	CB 3F CB 3F	CB 3F B8 38	07 CD 95 0C	30 E5 18 F9
0C20	CD 95 0C 38	E9 2C 78 CB	3F BD 38 0C	CD 95 0C 30
0C30	F4 7C 85 67	2E 00 18 D6	7C CB 3F B8	CB 11 26 00
0C40	18 09 2C 7D	CB 3F CB 3F	B8 30 18 CD	95 0C 30 F2
0C50	24 78 CB 3F	BC 38 29 CD	95 0C 38 F4	7D 8C 6F 26
0C60	00 18 DF 79	FE 01 28 06	CD AB 0C CD	AB 0C 2E 00
0C70	26 00 CD 95	0C 30 F9 24	78 CB 3F BC	30 F4 18 A0
0C80	78 CB 3F 80	BD 38 07 78	85 CB 3F 47	18 03 CD AB
0C90	0C 2E 00 18	8B C5 06 05	0E 00 DB 00	E6 02 81 4F
0CA0	CD 36 03 0F	10 F4 79 FE	06 C1 C9 79	FE 01 20 20
0CB0	7B E6 38 FE	38 20 19 13	7B E6 07 20	FA 7A FE 87
0CC0	38 02 16 81	C5 D5 06 80	3E 20 12 13	10 FC D1 C1
0CD0	C5 E5 79 01	32 00 21 E8	0C ED B1 01	31 00 09 7E
0CE0	12 13 E1 C1	0E 01 C9 00	01 06 17 15	0B 03 1D 09
0CF0	1F 07 18 0A	1B 04 05 08	19 12 0D 0F	02 0E 1E 0C
0D00	16 14 13 30	38 3C 3E 3F	2F 27 23 21	20 2E 6A 2D
0D10	4C 35 BA 7A	73 47 55 52	37 00 20 01	02 03 04 05
0D20	06 07 08 09	0A 0B 0C 0D	0E 0F 10 11	12 13 14 15
0D30	16 17 18 19	1A 31 32 33	34 35 36 37	38 39 30 3D
0D40	2E 2F 2C 23	2D 3C 3F 3A	3B 29 22 2A	

The main program depicted in the flow-chart uses two subroutines, one to test the input to the computer from the receiver interface and to determine whether a *mark* or a *space* is being presented (in this case the interface gives a logic "0" when a tone is seen and a logic "1" where there is no tone) and another to display the decoded Morse character. More details of these subroutines will be given later in this description.

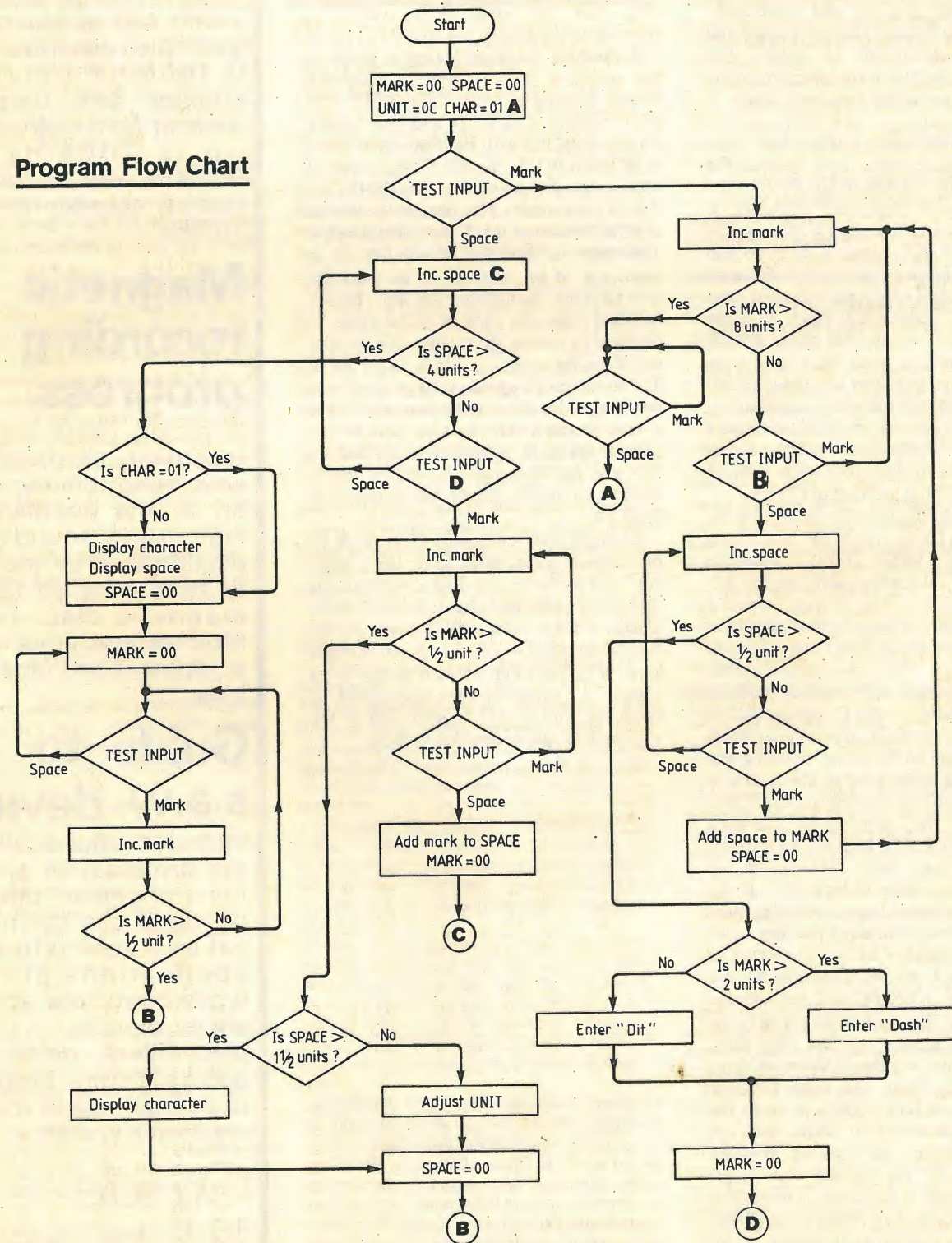
Referring again to the flow-chart, the program starts by clearing the MARK and SPACE to HEX 00, setting the UNIT to HEX 0C (corresponding to about 17

w.p.m.) and the CHAR to 01 (one *space*). Next, the TEST INPUT subroutine is called and if the input is a *mark*, the MARK is incremented. If the *mark* value reaches eight units the program will wait until a *space* is detected and then return to the start and reset. Hence, *mark* periods are limited to eight units and if one tunes to the calibrator of the receiver the program resets automatically as it sees a *mark* greater in length than eight units. If the *mark* does not reach eight units the MARK counter is incremented until a *space* is encountered. The SPACE counter is then incremented but if the *space* does

not reach one half unit in length, it is regarded as a break due to interference and its length is added to the *mark* period. If the *space* count does reach a length of half a unit then it is regarded as a valid *space*, so the program checks whether the *mark* is greater than two units and if so inserts a *dah* (logic "0") in the CHAR register. If the MARK is not greater than two units a *dit* (logic "1") is inserted. The MARK counter is now reset 00 and the program enters the SPACE count sequence at block D.

The SPACE counting sequence that starts at block C is almost identical to the

### Program Flow Chart



MARK sequence as far as the handling of short *mark* periods is concerned but when a valid *mark* is encountered, i.e. a mark of more than a half unit long, it checks whether the SPACE count is less than one and a half units. If less than one and a half units long, the *space* is regarded as an inter-element space. The value in SPACE is added to the UNIT, the sum divided by two and the result entered in UNIT again. This results in an exponential adjustment of the UNIT towards the value representing the incoming speed. This allows the program to adapt automatically to the speed of the sender, provided it is not less than two thirds or greater than two times the preset speed (about 17 w.p.m.). If the *space* is greater than one and a half units then it is regarded as a character space and the display subroutine is called. The SPACE is set to 00 and the program enters the MARK counting sequence again at block B.

If the SPACE count reaches four units then it is regarded as a word space and if the content of CHAR is not 01 (no elements inserted) then the character is displayed and is followed by a space on the v.d.u. The SPACE count is set to 00 and then the program waits for a valid *mark* (more than a half unit long) before it exits to the MARK sequence at block B. If the CHAR register contains 01 when SPACE reaches a count of more than four units then nothing is displayed and the program waits for a valid *mark* before continuing. This is to avoid the printing of spaces under some interference conditions that cause the *space* to reach four units without any elements being inserted in CHAR.

And now, here are some details of the two subroutines used by the main program. All TEST INPUT question blocks use a subroutine that has the following function:— The output from the receiver interface is input to the accumulator and masked by an AND instruction to retain only bit 1. Next, the contents of the accumulator (which will be either HEX 02 or 00) are added to the C register which was originally pushed onto the external stack and then set to 00 on entering the subroutine. A time delay of about 1ms is now called and the process repeated five times. Hence, the C register will contain a number which will be 00 if all the samples of the input were logic "0", or 0A (10 decimal) if they were all logic "1". If the input changes state during sampling then the C register will contain a number equal to twice the number of "1s" input. The content of the C register is compared to a fixed number (HEX 06) and the subroutine returns to the main program with the carry flag set if there are less than three logic "1" inputs or reset if there are three or more "1s". Thus, the main program uses a Jump on Carry (JRC) to go to the MARK sequence or a JNRC for the SPACE sequence (the receiver interface gives a logic "1" for no tone and a logic "0" when a tone is detected). Taking five samples of the input provides some immunity to noise during weak signal or interference conditions.

The display of characters is handled by

another subroutine which checks to see if the v.d.u. address points to the last eight positions of a line, in which case if the character is a space the next two lines are cleared and a new line called to avoid splitting words and to keep the display tidy. Next a search is made through the Morse table to find the ASCII equivalent of the HEX code for the converted character which is then sent to the v.d.u. for display. If a HEX code outside the table is presented an asterisk will be printed. The Morse table contains the characters from A-Z, numbers from 0-9 and the following auxiliary characters; full stop, comma, question mark, semicolon, oblique (/), break (-), double-break (=), end of transmission (#), end of work (<), wait ("), colon and parenthesis.

A machine language listing is given in the standard W.W. scientific computer format starting at 0C00. The TEST INPUT routine is at 0C95 and the display routine at 0CAB with the conversion table at 0CE8 to 0D18, the HEX equivalent of Morse characters, and 0D1A to 0D4B, the ASCII equivalent. The instruction E6 02 at 0C9C is used to mask bit 1 of the input. This may be modified if another bit is used, e.g. if bit three is to be used the instruction becomes E6 08. Note, however, that the byte at 0CA8 must be changed to a value three times the weighting of the bit used, e.g. HEX 18 for bit 3. The initial preset speed of the program can be changed by altering the byte at 0C05 to a value equal to the unit of time of the desired speed in milliseconds divided by five, e.g. for 12 w.p.m. the unit of time is 100ms, so 0C05 should be changed to HEX 14.

A simple receiver interface was made by the author using parts from the "junk-box" but for better results he recommends that a more effective circuit be built using ideally a p.l.l. tone switch such as the NE567 arranged to give a t.t.l. output with logic "0" given when a tone is received and a logic "1" when the tone is removed. A hand-key with a 1kΩ resistor tied to the +5V supply can be used for testing. □

European Electronic Component Distributor Directory 1980/81, is one of the Mackintosh compilations, which details distributors, in their several guises, in France, Italy, UK, West Germany. Names and addresses of the distributors are given first and are followed by a keyed list of products handled by each company. The Directory contains 304 pages and is available at £30/75 dollars from Mackintosh Publications Ltd, PO Box 28, Luton, England LU1 5DB.

## IN OUR NEXT ISSUE

### A range of counters

Constructing a range of counters based on the versatile Intersil ICM7216 i.c.. From a set of modules a variety of instruments can be assembled. Examples described are a 0-100MHz universal counter, two frequency measuring instruments, up to 200MHz and 500MHz, and a low frequency counter for 10Hz-10MHz.

### Magnetic recording progress

In recent years the tape recording progress has developed rapidly, urged on by the popularity of high-quality sound reproduction and by the need to store data on tape or magnetic disc. James Moir reviews advances in equipment and tape coatings.

### Guide to s.a.w. devices

Intended specifically for the professional applications engineer, this article describes the electrical characteristics and applications of three types of surface acoustic wave devices — band-pass filters, delay lines and oscillators. Emphasis is on their use in modern electronic systems.

On sale  
18 February

# LETTERS TO THE EDITOR

## "OPEN CHANNEL" FREQUENCIES

The recent Green Paper called "Open Channel" (October 1980 issue, p.68) has aroused great interest from all those concerned with radio communications, not least Philips Research Laboratories, Redhill. We have carried out field trials to ascertain the performance of a radio service at 900MHz, and made comparisons of 900MHz with other frequencies.

Three-watt transmitters for 27, 85, 172, 456 and 958 MHz were installed in a van. The 27MHz equipment was a.m., the others were f.m. with a peak deviation of ±5kHz. The antennas were simple monopoles, mounted on the vehicle roof 7 feet above ground.

An estate car was fitted with receivers for each band, from which signal level and speech were recorded. Transmissions to the estate car were also made from a base station, where the antennas were approximately 33 feet above ground level.

At 958MHz, the useful range in an urban environment was about 1.5 miles when operating base to mobile, and ¾-1 mile mobile to mobile. Listening tests showed that the coverage was patchy, but it was found that reception was relatively unaffected by tunnels and bridges. A test in open country, with a near line-of-sight path, revealed that the mobile range was about 3-3½ miles. Under more usual mobile conditions it was found that the range was about 1½ miles due to the presence of trees and hedges.

A summary of the results is shown in the following table.

Useful range in miles for a 3W transmission		
Frequency MHz	Base-mobile	Mobile-mobile
958	1.5	0.75-1
456	4-5	3
172	9	7
85	13	8
27	7	5

Fading was noticeable at 456MHz, very noticeable at 172MHz, but virtually absent from the 85 and 27MHz transmissions. The surprisingly low results for 27MHz were due to heavy interference from overseas stations.

By use of the inverse fourth power law, the range predictions cited in the "Open Channel" document can be scaled from 25W down to 3W, and are shown below.

Base to mobile range in miles		
Frequency MHz	Our results 3W	"Open Channel" Predictions 3W
900	1.5 (958MHz)	3
450	4-5	6
225	9 (172MHz)	9

These results show that the usable range falls as the frequency is raised. The range at 900MHz could be increased by raising the transmitter power, and by use of a gain antenna. A 30W, 900MHz vehicle mounted transmitter should achieve an urban range of 2-3 miles. The power output of hand-portable equipment is limited to a few watts by safety and battery size, so a range of only a few hundred yards would be achieved at 900MHz.

The results show that the range of a personal radio service at 900MHz would not prove to be equal or better than that at 27MHz. It therefore

seems unlikely that present illegal users of 27MHz would invest in equipment that would give them a performance inferior to that to which they are accustomed.

C. S. Barnes and D. W. H. Calder  
Philips Research Laboratories  
Redhill  
Surrey

## IS LIGHT VELOCITY A CONSTANT?

This letter is an open invitation to interested physicists to begin working towards an experiment that could test directly the constancy of the velocity of light and hence the validity of the theory of relativity. The experiment would endeavour to measure time intervals four orders of magnitude greater than those in the Michelson-Morley experiment and thus would be entirely free of time dilation and length contraction effects.

Two clocks will be required, able to measure time down to 100 picosecond and, most important, able to be synchronised within the same uncertainty. By "synchronised" I mean compared by some appropriate technique while both positioned at one point in space.

Now keeping one of the clocks at the point A, the other clock will be transported to the point B, a distance *d* in the direction of Earth's orbital velocity *v*. (The speed of transport can, of course, be adjusted so that time dilation imparted to the clock will be as small as we please.)

Let a ray of light depart from A at the *t<sub>A</sub>* time, let it at the *t<sub>B</sub>* time be reflected at B and arrive at A again at the *t<sub>A'</sub>* time. Then  $t_B - t_A = d/(c-v)$  and  $t_{A'} - t_B = d/(c+v)$ .

Thus  $\Delta t$ , the time difference between the two journeys, is equal to  $d/(c-v)$  minus  $d/(c+v)$  or  $2dv/(c^2 - v^2)$ . If we take *d* = 3km and assuming *v* = 30 km/s, then  $\Delta t$  will very nearly equal to 2 nanoseconds.

In the Michelson-Morley experiment  $\Delta t = dv^2/c^3$ ; using the same numerical values for *d* and *v* as above,  $\Delta t \approx 3 \times 10^{-13}$  second. As time dilatation and length contraction are quantities of the same order, they will have no bearing on our results.

Increasing the distance between the two clocks to 30km or 300km would result in the correspondingly greater value for  $\Delta t$  (20 and 200 nanoseconds, respectively), thus broadening the required time uncertainties tenfold or hundredfold respectively.

Our reasoning has, so far, been quite consistent with the theory of relativity. The two clocks should according to the theory be declared to be out of step by that ( $\Delta t$ ) amount of time.

Why? Because of the manner in which the theory defines synchronism. To quote Einstein ("On Electrodynamics of Moving Bodies", Dover):

(we cannot define the common time for the clocks at A and B) ... "unless we establish by definition that the time required by light to travel from A to B equals the time it requires to travel from B to A"

that is, the two clocks are in step if  $t_B - t_A = t_{A'} - t_B$  and are out of step if  $t_B - t_A \neq t_{A'} - t_B$ .

The fault with this definition of synchronism is that it transposes the *a priori* and *a posteriori* modes of reasoning, thus freezing the postulate

of the velocity of light into a fait accompli law of nature.

Indeed, if we set out to throw any light on the nature of the velocity of light, then our clocks must be synchronised *prior* to performing any measurements. It is the clocks that will be used to decide whether the velocity of light is a constant and hence, contrary to Einstein, *light cannot be used to synchronise them*. (Light or an electric pulse can, of course, be used as a trivial means of setting, provided that during this process both clocks are positioned very close to each other.)

Thus if it is found in our experiment that  $t_B - t_A \neq t_{A'} - t_B$  we will be free to conclude that the velocity of light is not a constant; and should we find that the two time intervals were equal, well then ...

In either case we will need a theory to replace the one that has outlived its usefulness.

Michael M. Albahari  
Whangarei, New Zealand

## FLOATING BRIDGE AMPLIFIERS

I read with some interest the recent articles by R. M. Brady on the "Floating Bridge Amplifier" (September, October 1980). It is indeed a superior method of producing reliable, low-distortion, very high power amplifiers.

We have been producing such a design since 1972 in the form of the Amcron M600 (600 watts, 0-45kHz in 8Ω) and the corresponding bridge-bridge version, M2000 (2000 watts, 0-40kHz into 8Ω). They were advertised on p.6 of the September issue and p.89 of the October issue by Kirkham Electronics.

Gerald R. Stanley  
Crown International  
Elkhart  
Indiana, USA

## COMMERCIAL BROADCASTING

Lord Reith said in 1952 "Somebody introduced dog-racing into England. And somebody introduced Christianity and printing and the uses of electricity. And somebody introduced smallpox, bubonic plague and the Black Death. Somebody is minded now to introduce sponsored broadcasting into this country".

But another former BBC director-general, Sir Frederick Ogilvie wrote: "Freedom is choice. And monopoly of broadcasting is inevitably the negation of freedom, no matter how efficiently it is run, or how wise and kindly the boards or committees in charge of it. It denies freedom of choice to listeners. It denies freedom of employment to speakers, musicians, writers, actors and all who seek a chance on the air".

In 1977 Lord Annan's Committee on the Future of Broadcasting, although not without its criticisms of ITV-ILR, reported that any broadcasting service must be judged on the quality of its programmes and that it is one of the achievements of British broadcasting (in a passage clearly applying to both BBC and ITV) that "programmes are regarded as hand-made products produced by individual craftsmen and not as articles of mass production".

Clearly your editorial "Save our public service broadcasting" (December 1980) sided more with the late Lord Reith than either Sir Frederick Ogilvie or Lord Annan. But the picture it painted of commercial companies producing programmes designed to "insulate people from reality, to keep them quiet, uncritical and accepting" seems, to say the least, out of all touch with reality. What price "World in Action", "TV Eye", "The London Programme" . . . etc, etc? The Annan Report commented "There is one department in which the commercial sector has by common consent surpassed the BBC. That is in the presentation of news". Insulating its viewers from reality?

You assume, furthermore, that producers are dominated by the advertisers (do the better editors of our press take their cues from advertising managers?); it ignores the role of the IBA which "has the central responsibility for administering the ITV and ILR systems and is ultimately responsible for the content and quality of everything which is transmitted", it ignores the furious endeavours of the Corporation to hold 50 per cent of the audience rating to justify the payment of licences by *all viewers*, it ignores the fact that there is no clear dividing line between those who for part of their careers produce programmes for the whiter-than-white Corp or the blacker-than-black ITV. In short, sir, your editorial is written from cloud-cuckoo-land where smallpox, bubonic plague and the Black Death are the Reithian synonyms that never did and never will exist in public service broadcasting by either licence-funded or advertisement-funded British organizations.

J. Ring  
Member IBA  
Imperial College of Science and Technology  
London, SW7

Professor Ring is the IBA member with special interest in engineering. — Ed.

Your comments in the December 1980 issue on commercial broadcasting are particularly apt, especially in view of the fact that there was no demand or great enthusiasm, at the time, for its introduction. This is just one more area where succeeding Labour governments have failed to make a re-adjustment which is long overdue.

Robin H. Mann  
Barnet  
Herts

What has *Wireless World* come to? First you urge us to abandon our nuclear defences, and now (December issue) you tell us that the purpose of independent broadcasting is to "insulate people from reality, to keep them quiet, uncritical and accepting. It purveys a synthetic culture . . .", which sounds like another way of saying that viewers are stupid and don't know what they want.

In case there are other people with a similar view, here is a lesson in simple economics. Advertising is an information service, nobody is forced to buy anything. Advertising can increase turnover and competition, keeping prices down in the shops. ITV-ILR is paid for by advertising revenue which comes partly from savings made through mass production, enabled by increased turnover, which in turn means showing programmes most people want to see.

Independent broadcasting is therefore independent of government and dependent on the viewers. I would suggest any lack of choice in ITV-ILR programming is the result of having only one channel.

If people want to save public service broadcasting, as you put it, they should persuade the government to introduce a fairer funding system, where viewers who watch ITV-ILR

don't also have to subsidise BBC programmes, but where public broadcasting revenue is linked by some formula to the size of audience and range of programmes.

Perhaps, then, when public service broadcasting (or state broadcasting) operates under commercial pressures, rewards and competition will its programme output, technical support, and administration relate to what the viewer and listener actually want rather than what the staff think they should want.

Ian S. Thorburn  
Edinburgh

While I agree with your editorial in December's issue "Save our public service broadcasting", I would like to make the following points.

Competition between the BBC and ITV-ILR which leads to one out-bidding the other is the main cause of the BBC's financial problems. Entertainers and promoters are getting richer, as are the staff working for the broadcasting authorities.

It would be interesting to know the cost to the public when the IBA costs are added to the licence fee.

Will an increase in the licence fee solve anything? I think not: we will still get the BBC trying to out-bid the commercial broadcasters. Putting up the licence too much, with the large number of people unemployed, might result in a drop in revenue. What is the solution?

J. W. Jordan  
Stroud  
Glos

As a long term subscriber to *Wireless World* I have viewed with disquiet the recent trend towards political, rather than technical, editorials. Phrases in your most recent leader on the subject of commercial broadcasting bring to mind such descriptions as 'hysterical outburst' and 'political diatribe', yet even these do scant justice to the ill thought-out collection of clichés, non-sequiturs and downright untruths which appear on page 35 of the December issue.

It must be clear even to your jaundiced eye (cf. your own leader "the growing professionalism of commercial broadcasting") that neither quality nor lowest common denominator programming is the sole prerogative of any one organisation. The interdependence of advertisers and the media on which they advertise is all pervading, as I am sure you would find were you to fail to deliver to your advertisers the readership they expect. Far from rejoicing in the financial difficulties of the BBC, most thinking commercial broadcasters accept that a strong, high quality public service broadcasting service is essential to the maintenance of standards while, equally, an enlightened public service organisation will be able to make use of the many innovations and ideas which the economic pressures of commercial broadcasting of necessity produce.

As someone who makes his living from the despised (by your leader writer) commercial broadcasting, I found the last paragraph grossly offensive. My own organisation, with a full-time staff of 30, provides 18 hours a day, 7 days a week of entertaining, informative, and popular local commercial broadcasting. Lest the old saying about 'juke box radio' come to mind I would point out that a typical day includes 8-8½ hours of music, 2-2½ hours of news, 3 hours of talks, features and current affairs, 2 hours of commercials, 2 hours of 'short' features (interviews, traffic, what's on, where to go, etc.) and up to 1 hour of promotional material.

It really is 'make believe' to suggest that commercial broadcasting is only designed to "insulate people from reality" to purvey a "synthetic culture" or is a "substitute for the real thing".

Such biased and emotive phrases have no place in such an august and respected journal as *Wireless World*.

T. J. Mason  
Plymouth Sound Limited  
Plymouth

Congratulations on your editorial "Save our public service broadcasting" in the December 1980 issue. I couldn't agree more!

D. A. Barlow  
Bingley  
W. Yorkshire

## FAILURE OF DISTRESS SIGNALS AT SEA

The letter from Mr Boyd (December 1980 issue) adds considerable weight to the mounting evidence on the inadequacies of some ships' aerials at 500 kHz and the consequent risks to which both ships and crews are exposed. The circumstances described by Mr Boyd almost exactly parallel those experienced by Mr Harding, from whose letter I quoted in my article in *Nautical Review*, September 1979. I would like to comment on two points raised by Mr Boyd:

1. Whether insulator leakage, poor siting or low aerial capacitance is the dominant cause of poor performance will depend on the particular layout, and will vary from ship to ship. It is not therefore possible to dismiss the deck insulator as a factor, nor the analysis of the effects of leakage given in the "Admiralty Handbook of Wireless Telegraphy", which is as valid today as when it was written. Mr Boyd himself obtained improved performances on washing down the insulators.

2. The emergency generator may start automatically on some ships, but on others the diesel must be started manually and if the ship is listing or on fire, that may not be easy. The B.O.T. recognised the 500kHz battery equipment as being the ultimate means of salvation, and indeed required that an instruction card be displayed to enable any ship's officer to use it in an emergency.

It would not be necessary for Mr Boyd's marine superintendent to lay out \$10,000 for a mast aerial. Observation in many ports shows that the Continental powers (France, Belgium, USSR, Poland) are using multi-wire cage aerials to obtain maximum capacitance in the minimum space, with minimum number of supporting insulators. My article in *Safety at Sea*, May 1978, touches on that point.

My thanks to Mr Sawyer (December letters) for his comments.

John Wiseman  
London E3

## MICROCHIPS AND MEGADEATHS

I was somewhat surprised by the nature of your leading article "Microchips and megadeaths" in the November 1980 issue. The world has always existed of course with a "balance of power" in one form or another and I feel that I must put the following points to you.

1. You reprint an account of the Hiroshima atomic bomb but do not balance it with an account of the horrors suffered in Japanese prisoner-of-war camps by British and American soldiers. Why?

2. Can you ever see engineers in the communist countries being asked to voice their views on how their government should use their expertise? I think the answer is an emphatic "No."

3. Can you see the communist countries giving up their arms? I cannot.

4. If we gave up our weapons can you see the communist countries leaving us in peace or for that matter our own internal fifth column? I think not.

So it seems to me we keep our weapons or opt for world wide communism complete with its psychiatric hospitals for dissidents — I know what I would prefer.

L. G. Martin  
Abbots Leigh  
Bristol

We, the Central London Medical Branch of the Association of Scientific, Technical and Managerial Staffs, wholeheartedly support the leading article "Microchips and megadeaths" published in the November 1980 issue. We hope that this article is part of a more general policy of yours covering all articles, exhibition reports and advertisements. Scientists and engineers seem to have a tradition of being non-political, especially at rank and file level. Your article correctly points out that this must stop. Technically trained people must start to consider the results of their work in terms of morality rather than in the immediate attainment of purely technical achievement.

Many people interested in electronics, young and old, professional and amateur, read and respect *Wireless World*, considering it to be one of the more sophisticated in the field. From this position *Wireless World* has a positive contribution to make in the Campaign for Nuclear Disarmament. We wish that other electronics magazines would follow this lead so that future engineers and scientists can devote more of their time and the dwindling world resources to the pursuit of aims beneficial to the whole human race.

E. Cady (Branch Secretary)  
ASTMS (Central London Medical)  
London WC1

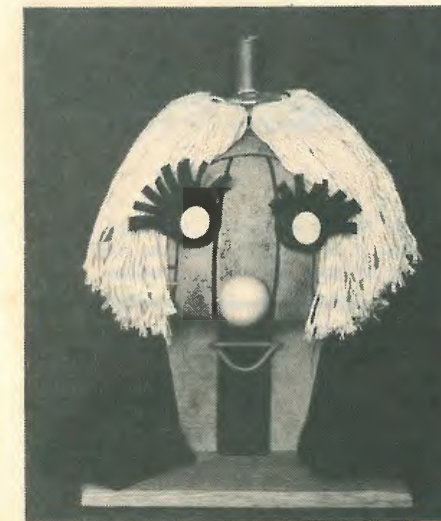
## "ANATOMICAL" LOUDSPEAKER

I fully agree with Mr R.I. Harcourt ("An acoustically small loudspeaker" October 1980) who draws attention to the inadequacies of the cuboid loudspeaker for the reproduction of certain sounds. It has, in fact, been my opinion for some years that to reproduce a given sound perfectly the loudspeaker should have the same size and 'anatomy' as the thing which emitted the original sound. If this is a correct view we can fairly easily design a speaker by giving a unit a housing which is near enough the same as that of the original source. But, obviously, one cannot take this principle very far. It would be impossible, for instance, to reproduce the sound from a whole orchestra by assembling an equivalent number of speakers all designed to reproduce perfectly the individual instruments, and to accommodate these in the living room. But we can go some way towards this. I am thinking of the human voice, the sound which is most important of all and to which we are specially attuned. For myself I cannot say that I have ever heard speech satisfactorily reproduced on any cuboid speaker: people just do not speak with boxes round their heads.

I did something about this a few years ago: I made it the theme of an 'entertainment' lecture to our students. My argument went as follows: the sound of a voice comes primarily from the larynx and from there, through a lined bony tube, makes an exit via the mouth cavity. And of course, some important sounds emanate from the chest as well. I first produced a Wellington

boot and filled it with rags; this was the chest and lungs. On the top of the boot I placed a little loudspeaker on a board; this was the larynx. I then produced a skull (loaned by a kindly Anatomy Department), cupped it in a shallow foam polystyrene plinth with a hole in it, and sat this on the speaker board. The jaw was propped open with a match-stick and the brain cavity filled with cotton wool. I then reproduced the recorded voices of lecturers with whom the students were familiar. The effect was remarkably good, the clarity was especially impressive and there was none of the booming which makes listening to speech reproduced on a box speaker so tiring. A student later admitted to having quailed on hearing the craggy accents of his class head.

I took the theme one step further. Prior to the lecture I had recorded a soulful Scottish tune played by a musician friend on a violin. During the lecture I replayed this using as a loudspeaker the same violin with a small unit strapped underneath, there being contact made between the unit and the underside of the violin by means of a cork. The reproduction could hardly be distinguished from the original and I demonstrated



Lena the loud-talker

this by inviting my friend out of the audience, whereupon he played the second of a duet on the same violin while it was reproducing his original recording. The effect was stunning. I have never seen an audience so affected by a demonstration. Strong men wept, almost.

Recently I returned to the problem of my skull and wellie boot loud-talker — how to 'normalise' it. The skull is, of course the main difficulty — they are not easily procured, even in this Burke and Hare country. The result of my labour is Lena (named after the lady who provided the mop head). But Lena is not as good — let me say at this point — as my original S and WB loud-talker. She is, however, obviously on the right lines.

Firstly, it will be noticed that she has no chest. Actually she has, it is in her cranium. The whole thing is inverted and the chest, in fact, consists of a partly cut-away p.v.c. football stuffed with rags. At the base of the chest, behind the nose, is the larynx, and under that is the throat, leading down to the mouth. The other embellishments are added for aesthetic reasons.

It occurs to me that it would be pleasing to fashion the instrument in the likeness of one's nearest and dearest — what a fine tribute, or memorial, it might make.

John T. Lloyd  
Department of Natural Philosophy  
University of Glasgow.

## ELECTRONIC ORGAN TONE FILTERS

Many thanks to your magazine and to Dr Pykett for a much-needed basic guide to tone filters suitable for the average home-built organ. I would certainly agree with Dr Pykett's reply to Mr Robins of Rugby, and add that the art of a classical organist (electronic or pipe) is to breathe life into a mechanical system and add interest to the music using the means he has available. By this I do not mean gimmicks but phrasing judiciously and accenting notes, making them sound louder by giving a slightly longer pause before the note is played. The cinema organist, of course, keeps one foot glued to the swell pedal to add interest. The more discriminating classical organist can use it to add a swell box full of strings to the great flues at the appropriate time with good effect. However, having heard Bach's *Passacaglia* performed more convincingly on a tiny one-manual pipe organ than on a four-manual monster, I am convinced that, as with a Stradivarius, it is the performer and not the instrument which produces a good or a bad performance.

Bernard Jones says that pipe organs can only get more expensive. I prefer to say that their value can only appreciate whereas electronic organs depreciate, especially at such a time of rapid development as the industry is going through now. However, ranks of "free-phase" oscillators will always sound superior — like valve amplifiers.

May I suggest one oscillator per note, each driving its own amplifier and speaker mounted in a wooden rectangular cabinet tuned to the length of the standing wave for that note?

M. R. Berzins  
Hanwell  
Middlesex

## WW's FIELD OF INTEREST

I have been following with interest the recent deviations from topics of a strictly technological nature in *W.W.* from questioning the grounds of relativity theory to commenting on the role of the electronics and telecoms industry in providing the means of implementation for certain political philosophies.

It is only to be expected that some readers will be disturbed by suggestions that their leaders may be mistaken in various matters; the shock may be greater if they have previously concentrated their attention on books and journals limited by their particular interests in technology. May I refer briefly to a few of the correspondents in December's issue:

Desmond Thackery finds controversies in basic physics to be above his head, but nevertheless entertaining.

Reg Williamson is not amused by cranky views and wants to confine *W.W.* to good (clean?) engineering.

Peter C. Gregory is a technical person and knows a few highly skilled persons, and can thus state that suggestions of gaps in their knowledge are rubbish.

M. G. Scroggie, whilst conceding that it is difficult to know what to do, declares *W.W.*'s comments on nuclear strategy to be insulting and, indeed, treasonable!

The editor has much to answer for, and there is yet more — "Worried" thinks there are too many advertisements!

Perhaps some of us are worried, even deeply concerned, at the present state of the world and the frame of mind of some of the scientists, technologists and engineers who occupy them-

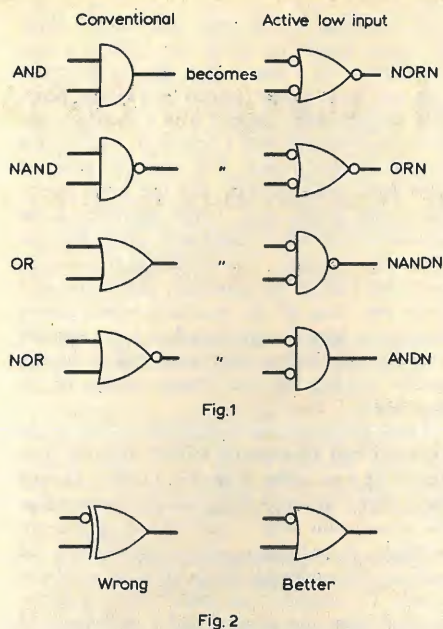
selves with the techniques of communication and control.

What proportion of the *W.W.* readership, one wonders, wants only information on bare technicalities, well-remunerated jobs that are open, and perhaps a few words on how wonderful everything is going everywhere?

Yes, we pay 60p a month to be informed, to relate ourselves to the activities of our fellows, and to have our view of life broadened; at least that's what I would have thought. If fair comment is to be stifled, free enquiry suppressed, what may we have to pay one day to obtain information we desperately desire but which is withheld in the interests of state security?

I, for one, welcome the broadening of *W.W.*'s field of interest, even if I may sometimes be unamused or confused, or find it weighty with "commercials" — after all, I don't have to read every word if I don't want to; I can even manage without an "off" switch.

C. B. V. Francksen  
Farnborough  
Hants



### THE DEATH OF ELECTRIC CURRENT

I refer to the interesting article by Mr Ivor Catt in your December 1980 issue. It is indeed refreshing to find Mr Catt having a sideways look at the apparently trivial matter of electric current.

If one rewrites the Maxwell equations using tensor notation in a four dimensional Riemannian Space, the effects predicted by Mr Catt become more obvious. E and H cease to have separate meanings, removing that most embarrassing of dualisms and the electromagnetic field (complicated in three dimensions) becomes a simple tensor field in four dimensions.

N. D. Levin  
Telecommunications Accessories Ltd  
Thame  
Oxon

#### The author replies:

It's a pity that the obfuscation has to continue like this. I did not realize that my December 1980 article predicted any effects. What were they?

Ivor Catt

### LOGIC DIAGRAMS

While I applaud the aims of Tony Cassera's article "Intentional logic diagrams" in the November issue, I disagree with his use of a suffix L as the mnemonic for the 'active low' signal in place of the bar over its name.

In microprocessor, and I presume mainframe computer, jargon and even in 'ordinary' logic the prefix N is used to indicate an 'active low' signal (e.g. the N in NAND which is used to show that the output is 'active low'). The origin of this I suppose the term Negative Logic used to describe circuitry where the more negative voltage is regarded as the true, i.e. logic 1, state.

So I suggest the use of N rather than L as either prefix or suffix to indicate the 'active low' signal.

We could even coin some new names to go with Mr Cassera's modified symbols as shown here in Fig. 1. Incidentally the EXOR symbol for the 'active low' input version as shown in the article is inconsistent — the symbol does not need the extra bar at the input but should be as in Fig. 2. In fact this really should be the

symbol in conventional logic as well as it is the one type of gate (along with EXNOR) whose function is the same for both normal and 'active low' inputs.

Rex I. G. Palmer  
Ascot  
Berks.

The term NAND is generally understood to be a contraction of NOT AND, where the NOT corresponds to the denial 'not' used in formal logic. — Ed.

### TV SETS FOR THE HARD OF HEARING

I was interested in the plight of your correspondent Mr Holloway (October letters), who had a problem finding a television set with a headphone facility.

Mr Holloway was not specific as to whether he was looking for a monochrome or colour receiver but, in any case, many sets make use of power supplies which connect the chassis either directly, or via a diode bridge, to the mains. Obviously direct connection of the chassis to a headphone socket would be a hazard to a customer and some form of isolation is necessary. Since little power is involved a small transformer would be suitable but this must have adequate isolation to safeguard the customer. BS 415: 1979 requires this isolation to be able to withstand over 2kV.

Such a transformer could prove to be a comparatively expensive component and a set designer must consider whether the extra cost on the receiver would still be acceptable to potential customers.

The above line of reasoning partly led to our decision to use a switch mode power supply to fully isolate most of the chassis on our current range of receivers (see part 4 of my recent series of articles on these chassis). This enabled us to provide a headphone socket as standard throughout the range; however, I do not think we are the only UK or European manufacturer to provide this facility.

It seems rather a sad reflection on the dealers in Mr Holloway's area that they showed little or no interest in promoting British made sets with these features.

Ray Wilkinson  
Decca Radio & Television Ltd  
Bradford  
W. Yorkshire

### LEVY ON BLANK TAPES

As one of the relatively few holders of the Amateur Recording licence, I found myself totally unable to support the proposed levy on blank tapes and those who have studied the case for a levy will indeed be amazed. So much money is alleged to be at stake that a levy of several pounds per cassette would be called for.

As technically informed people we should readily see that if it were imposed there would be a great sale for a new generation of tape recorders running at 1 1/2 in/s or even 3/4 in/s speeds and even with four mono tracks. The fact is that most "pop" music, in which the money lies, is listened to on cheap transistor radios or record players and hi-fi is unwanted. Obviously, for this and many more reasons, a levy on tape is doomed to failure.

But is your correspondent Mr Simmons (December letters) not a little naive in accepting without qualification the proposition that musicians and their agents are entitled to a just reward for their labours? The money which is alleged to be lost by the use of tape recorders is that which once had to be spent if one received a permanent record of a performance. Is it necessarily just that any price could be placed upon the permanent record whether it was a gramophone record or tape? The very existence of the Monopolies Commission indicates that the answer must be no. Therefore one needs to examine a little more carefully the matter of copyright, because that is the mechanism used for keeping the prices of records and pre-recorded tapes at a level far higher than the costs, royalties apart, justify.

In simple terms the musical world divides into classical, where the composers are dead and their works are out of copyright, and the world of "pop" where composers now aim for the "jackpot." The performers of both ought in theory to be content with a flat rate fee for their performances on the basis that it is just a job of work, but if that notion suits classical musicians it manifestly does not suit "pop" musicians who are going for the "jackpot" as well. In practice of course it may be difficult to distinguish between performers and composers in the "pop" field but even so it strikes me that the proposed levy is a Luddite-type action.

Two media, namely radio and records, were exploited vigorously and with the objective of making money. Radio, whatever the BBC may say, was the advertising medium and the objective was to make the money. Tape has now come and it is easy to record from radio, with the obvious result. Perhaps we should reflect that had the BBC not allowed itself to become the tool of the record producers we would never have been exploited as the source of vast sums of money which went to the record producers. Now we have the means of not being exploited by using a tape recorder, it is that freedom which is being attacked.

Looking back to the old days, e.g. those of the 78 r.p.m. record, it is noteworthy that we paid a modest fee to the BBC which provided music on a considerable scale almost entirely by employing musicians and paying royalties to the composers. What went wrong? It seems to me that by hook or by crook a lot of people in the "pop" world are determined to get far more out of us than the BBC ever did.

It will fail if for no other reason than that "pop" music is ephemeral and the same tape will be used ad nauseam and the new generation of good tapes will be those with literally infinite life.

L. Streatfield  
Poole  
Dorset

# T.t.I. logic probe

Performs static and dynamic tests on logic circuits, including 'glitch' detection

by A. J. Jameson, B.Sc.

**The probe described is unusual in that it will detect and indicate the presence of 'glitches', the transients caused by propagation delays in logic circuits. In addition to the usual static testing, it also shows positive or negative coincidence in two pulse trains of different frequencies.**

A logic probe is a useful aid to testing and fault-finding digital systems. The many commercial and amateur designs currently available provide information about the static and dynamic behaviour of circuits, but have the limitations of not providing 'coincidence-detection' and cannot indicate the presence of 'glitches' in the waveform under investigation.

For example, in the simple case of Fig. 1, a 'standard' probe would indicate pulses at A and B, but the output C would remain high, leading to the conclusion that either the gate is faulty or the pulses are not coincident. The next step in the exercise would probably require the use of a dual-beam oscilloscope to prove whether or not A and B are coincident. Even so, if the pulses are of different frequencies, the task of 'coincidence proving' may be impossible using an oscilloscope. In addition, the use of an oscilloscope has made the purpose of the highly portable, pocket-sized logic probe somewhat futile.

Another example encountered all too often, despite careful design, is that of 'glitches' produced by static and dynamic race-hazards. In the example of Fig. 2, a negative-going 'glitch' is produced due to the propagation delay ( $t_d$  through the JK flip-flop. This example is also shown in Fig. 3, where a 20ns pulse has been produced using the circuit above.

The use of a logic probe on such a circuit would reveal no faults whatsoever. Even an oscilloscope with delayed-sweep facilities would probably show nothing unless the frequency of A was greater than 1MHz. However, the presence of such a circuit within a system, gives rise to erratic operation and is quite often diagnosed as an 'elusive dry-joint'.

The logic analyser probe now described, solves these problems whilst still providing the features of the standard probe. It should be mentioned that the t.t.I. i.c.s used in the probe are operating with pulse durations shorter than is recommended by manufacturers. Although two probes have been made without trouble in this respect, it may be necessary to experiment with several i.c.s. The total cost of the unit is about £10.

### Circuit operation

**Protection circuitry.** The protection circuitry shown in Fig. 4 has been incorporated to prevent damage to the probe due to incorrect supply voltages. In addition, D<sub>5</sub> is illuminated when the supply voltage is correct, i.e., when the applied voltage is 4.5-5.8V. This feature is very useful, as all too often the most obvious fault of incorrect supply voltage is overlooked and much time can be wasted investigating 'suspect' digital circuitry.

Under normal operation, T<sub>r1</sub> is off, T<sub>r2</sub> is on and hence 5V is applied to the probe

circuitry via RLA. However, above 5.8V, D<sub>2</sub> conducts and T<sub>r1</sub> is biased on. This switches T<sub>r2</sub> off and opens RLA, thus isolating the logic probe circuitry.

Also, voltages above 4.5V cause D<sub>4</sub> to conduct, switching T<sub>r3</sub> and T<sub>r4</sub> on and thus D<sub>5</sub> is lit.

**Probe circuit.** IC<sub>1</sub> and IC<sub>2</sub> in Fig. 5 form 'window discriminators' with threshold voltages of 2V and 0.8V. These i.c.s are 9637 dual differential line receivers and, because of the input characteristics of the device, R<sub>10</sub> and R<sub>12</sub> are needed to 'pull-down' the input to 1.5V when the probe is floating.

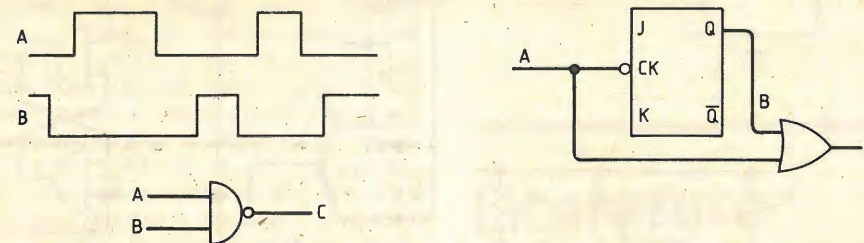


Fig. 1. An ordinary probe would not show whether a lack of output from the gate was due to the pulse trains not being in coincidence, or the gate being faulty.

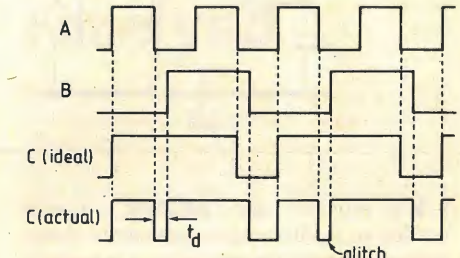
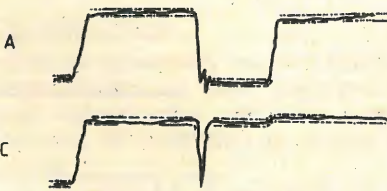


Fig. 2. Propagation delay between the input and output of the flip-flop produces a narrow pulse or glitch at C.

Fig. 3. Evidence of the glitch in Fig. 2, based on a screen photograph.

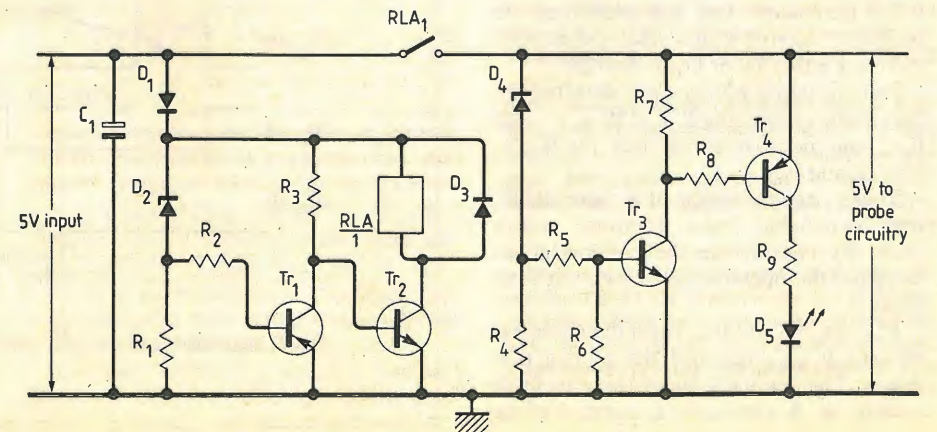


Fig. 4. Protection circuit avoids damage to the probe in the presence of incorrect supplies, and shows that the supply voltage is in the usable range.

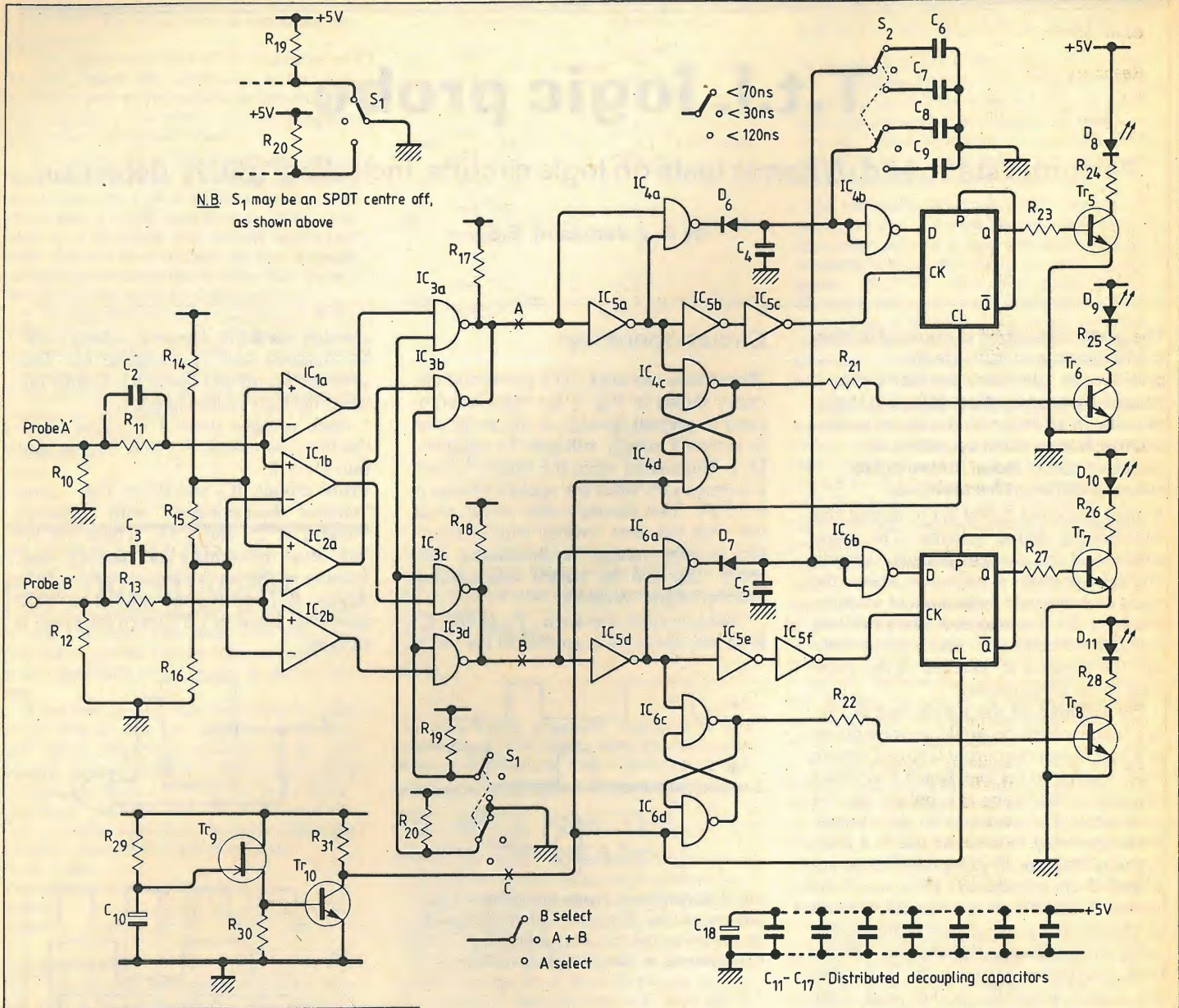


Fig. 5. Circuit diagram of the probe.

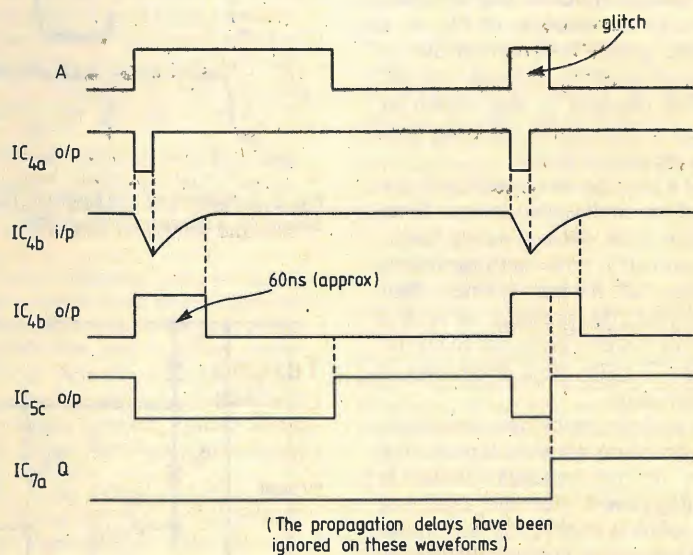


Fig. 6. Waveforms show glitch detection.

IC<sub>3</sub> provides the ANDing circuitry needed to facilitate the coincidence detection mode of operation.

The latches comprising IC<sub>4c,d</sub> and IC<sub>6c,d</sub> indicate the logic level at the probe. If a 1 is present at the input to IC<sub>1</sub>, point A will also be high. This in turn is inverted by IC<sub>5a</sub> and a low is therefore present on IC<sub>4c</sub>. Thus Tr<sub>6</sub> is conducting and the red l.e.d. D<sub>9</sub> is lit. These latches are reset by narrow pulses produced by the unijunction oscillator Tr<sub>9</sub>.

If a permanent 1 or 0 is present at the probe, it overrides this reset pulses and therefore either D<sub>9</sub> or D<sub>11</sub> remain lit.

Positive going glitches are detected by the circuit comprising IC<sub>4a,b</sub>, IC<sub>5a,b,c</sub> and IC<sub>7a</sub>, and negative-going ones by IC<sub>6a,b</sub>, IC<sub>5d,e,f</sub> and IC<sub>7b</sub>.

These circuits consist of a monostable, with switchable pulse duration, and a latch. By considering the positive glitch detector, the operation of the circuit is as follows.

IC<sub>4a</sub>, D<sub>6</sub>, C<sub>4</sub> and IC<sub>4b</sub> form the monostable and IC<sub>5a,b,c</sub> equalize the propagation delays. The leading edge of the waveform present at A produces a negative-going

**Components**

**Resistors (1/6W)**

1, 3, 4	1k0
2, 7, 10, 12	10k0
21, 22, 23, 27	
5	4k7
6	22k0
8	2k7
9	100R
11, 13	560R
14	910R
15, 16	270R
17, 18, 19, 20	2k2
24, 25	220R
26, 28, 30	120R
29	33k0
31	1k5

**Capacitors**

1	100µF 10V tantalum
2, 3	22pF mica
4, 5	strays
6, 8	3.3pF mica
7, 9	10pF mica
10	2.2µF 35V tantalum
11, 12, 13, 14	
15, 16, 17	10nF ceramic
18	10µF 35V tantalum

**Semiconductors**

D <sub>1</sub>	1N4002
D <sub>2</sub>	BZY88 4V7
D <sub>3</sub>	contained in relay
D <sub>4</sub>	BZY88 4V3
D <sub>5</sub>	TIL212 (yellow)
D <sub>6,7</sub>	OA47
D <sub>8,9</sub>	TIL209 (red)
D <sub>10,11</sub>	TIL211 (green)
T <sub>1,2,3,6</sub>	2N3704
T <sub>7,8,10</sub>	
T <sub>9</sub>	TIS43
T <sub>4</sub>	2N3702

**Integrated circuits**

1, 2	9637 (Fairchild)
3	SN74LS03
4, 6	SN74LS132
5	SN74LS14
7	SN74LS74

**Miscellaneous**

RLA	d.i.l. relay s.p.s.t. (N/O)
S <sub>1</sub>	d.p.d.t. or s.p.d.t. centre-off
S <sub>2</sub>	d.p.d.t. centre off
	1mm sockets 3 red; 2 black
	Case to suit (100 x 50 x 25mm)

**Printed circuit boards**

A set of 2 double-sided p.c.bs for the logic probe will be available for £6.00 inclusive of v.a.t. and UK postage from M. R. Sagin, 23 Keyes Road, London N.W.2. Alternatively, copies of the author's suggested layout can be supplied from this office on receipt of a stamped, addressed envelope. Please mark your envelope 'Logic'.

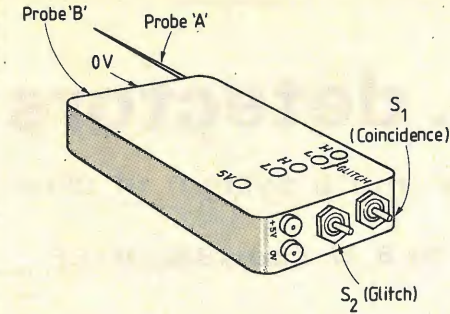


Fig. 7. Suggested form of case.

pulse at the output of IC<sub>4a</sub>, whose duration is equal to the propagation delay through IC<sub>5a</sub> (approximately 15ns). This pulse duration is extended by D<sub>6</sub>, C<sub>4</sub>, and IC<sub>4b</sub>: C<sub>4</sub> is discharged rapidly via D<sub>6</sub> and the output of IC<sub>4b</sub> becomes high. D<sub>6</sub> is now reverse biased and C<sub>4</sub> is charged by the input circuitry of IC<sub>4b</sub>, until the high input-threshold level of IC<sub>4b</sub> is reached, when the output of IC<sub>4b</sub> returns to a low.

The duration of the monostable period has two additional lengths, determined by C<sub>6</sub> and C<sub>8</sub>, which enable the glitch period to be determined approximately.

The propagation delay of IC<sub>4a,b</sub> is compensated by a similar delay through IC<sub>5a,b,c</sub>. Thus, the trailing edge of the pulse at the CK input to IC<sub>7a</sub> is time coincident with the positive edge of the pulse at the D input. These pulses are illustrated in Fig. 6, which shows that if the pulse produced by the monostable (IC<sub>4b</sub> output) is of shorter duration than the input pulse at A, then the Q output of IC<sub>7a</sub> remains unchanged and therefore is not detected as a glitch. However, if the pulse from IC<sub>4b</sub> is longer than that at A, then the D-type flip-flop (IC<sub>7</sub>) toggles and the Q output goes high, registering a glitch. This latch is periodically reset by the unijunction oscillator.

**Construction**

As will be appreciated, pulses of less than 100ns duration are easily attenuated by stray capacitance and inductance. Therefore, all leads must be as short as possible.

By careful choice of components, it will be found that the two boards may be 'sandwiched' with component sides together and therefore can be fitted into a case of 100x50x25mm, as illustrated in Fig. 7.

**Testing**

If a high-frequency oscilloscope (of around 50MHz bandwidth) is available, the test circuit consists of a simple oscillator running at about 1MHz, driving a 74121 monostable with a variable pulse duration from 20-200ns. Using such an arrangement, it is a comparatively simple matter of checking the pulse lengths at which the glitch circuitry operates.

However, without a suitable oscilloscope, the only way of checking the mo-

**Specification**

Power consumption	100mA (l.e.ds off)
	180mA (all l.e.ds on)
P.s.u. indication	4.5V-5.8V ± 0.2V
Input impedance	5k
'Low' threshold	0.8V ± 0.1V
'High' threshold	2.0V ± 0.1V
Max. input freq.	25MHz
Min. det. glitch	15ns
Glitch det. ranges	(1) 30ns
	(2) 70ns approx.
	(3) 120ns

nostable periods is to generate glitches of approximately known length, relying on the propagation delays of cascaded gates. It should be stressed that the timing periods need only be approximate and consequently, no great difficulty will be encountered.

The probes consist of a 1mm plug with a sewing needle soldered in place and another needle, soldered to a short length of wire. The earth point should be connected by a short lead to the area under investigation to minimize pulse attenuation. □

**Literature received**

Celestion have sent us a leaflet on the interferometric testing of loudspeaker cones, using the Doppler effect in a laser system. The leaflet also provides a complete history. It was accompanied by a spectacularly illustrated brochure and an incomprehensible poster. WW401

Greenwell's catalogue of electronic components, hardware, tools, etc, complete with prices, is now available from Greenwell Electronics Ltd, 443 Millbrook Road, Southampton SO1 0HX, price 50p.

A series of leaflets from Ferranti describe the F100-L, which is said to be the only 16 bit microprocessor to be designed, developed and made in Europe for commercial and military applications. The leaflets can be obtained from Ferranti Computer Systems Ltd, Computer Sales Dept., The Courtyard, 20 Denmark St., Wokingham, Berks. RG11 2BB. WW402

A full catalogue of the enormous range of TAB books, which includes publications on radio, antiques, aviation, d.i.y., car mechanics and many more subjects, is available from TAB Books, Inc., Blue Ridge Summit, PA 17214, U.S.A. WW403

Babani's range of low-cost publications on radio and electronic topics are described in their new catalogue, which can be had from Bernard Babani (Publishing) Ltd, The Grampians, Shepherds Bush Road, London W6 7NF. WW404

# F.m. detectors - 2

A survey and a system of classification

by S. W. Amos, B.Sc. M.I.E.E.

## Phase-comparator detectors

This type of detector also makes use of the varying phase relationship between two input signals, nominally in quadrature, such as the voltages across the primary and tuned secondary windings of a transformer but it does so in a manner quite different from that of the detectors described earlier. In Seeley-Foster and ratio detectors the two input signals are added to produce resultant voltages (the amplitude of which varies with the phase difference) which are applied to amplitude detectors, the combined output giving the required modulation-frequency signal.

In phase-comparator detectors the two input signals are limited so as to form rectangular pulses. Limiting may be carried out in separate stages preceding the phase comparator or in the phase comparator itself. The degree of overlap of these pulses varies with the phase difference between the two inputs and determines the output current of the comparator which is therefore a copy of the modulation waveform. The output of the comparator thus depends on the relative timing of the two sets of pulses and is independent of the amplitude of the input signals provided this is sufficient to give satisfactory limiting. To summarise: in the detectors described in the first article the amplitude of the primary and secondary voltages is the significant quantity whereas in the phase comparator it is the timing of these voltages which matters.

The general form of a phase-comparator detector is illustrated in the block diagram of Fig. 13(a).

### Self-limiting phase-comparator detectors

In an early form of phase-comparator detector the two input signals are applied to the two input grids of a special valve. The grids are required to give limiting action: in other words positive-going signals are required to increase anode current up to a particular value after which further positive excursions should produce no change in anode current. This is the type of control achieved by the suppressor grid of a pentode. Signals applied to such a grid deflect cathode current from anode to screen grid or vice versa but cannot increase or decrease cathode current which is determined by the screen-grid and control-grid potentials. Thus the ideal valve for this particular application is one with two suppressor grids.

In addition it is important to minimise

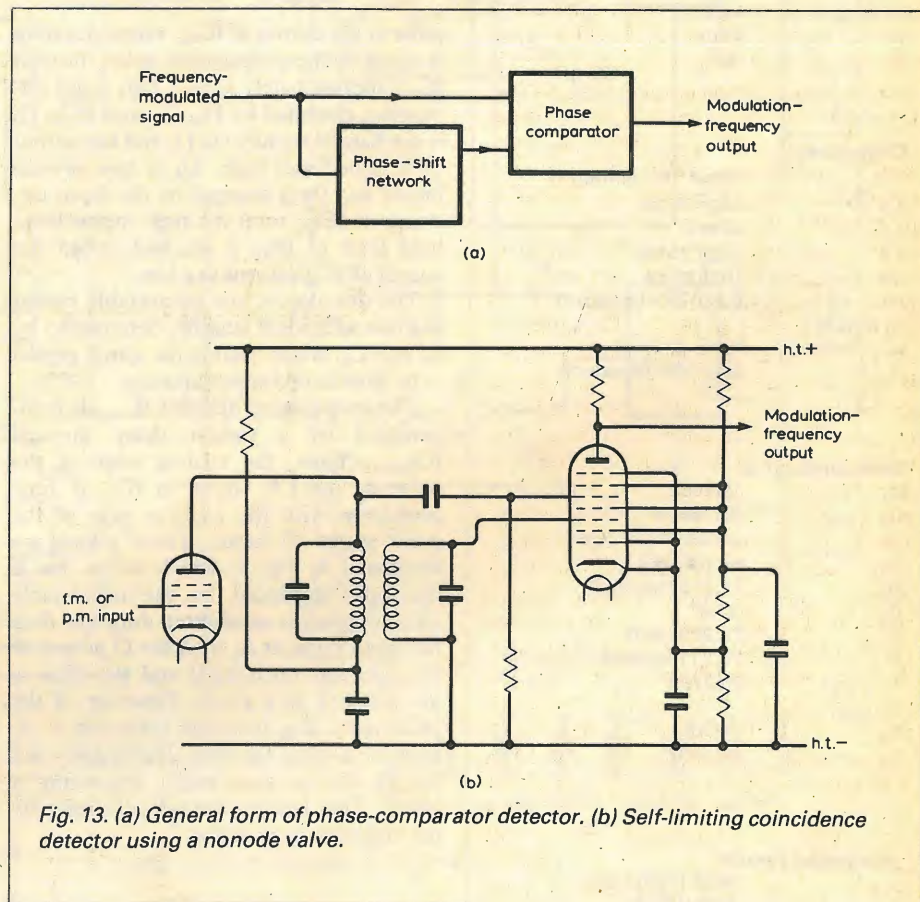


Fig. 13. (a) General form of phase-comparator detector. (b) Self-limiting coincidence detector using a nonode valve.

damping of the input-signal source (normally the primary and tuned secondary windings of a transformer) by the input grids when they are driven positive with respect to cathode and, to this end, input-grid current must be kept to a low value. This is achieved by so constructing the valve that each input grid is situated between two positively-charged screen grids where there is no space charge to support grid current. Finally therefore the valve required consists of three screen grids, two input grids, a control grid and a suppressor grid next to the anode to suppress tetrode kink.

Thus was the nonode derived and Fig. 13(b) shows the circuit diagram of an f.m. detector using a nonode. Its operation is illustrated in the waveform diagrams of Fig. 14 which show that anode current can flow only when  $V_{g3}$  and  $V_{g5}$  are both positive i.e. when the pulses derived from primary and tuned secondary windings overlap. As the degree of overlap varies with frequency modulation the anode current varies

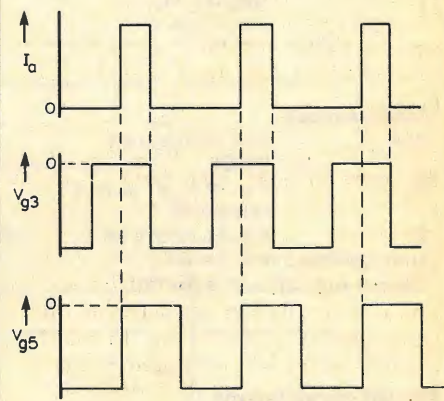


Fig. 14. Action of the nonode valve. Diagram shows  $V_{g3}$  and  $V_{g5}$  in quadrature, the conditions when the input signal is at the centre frequency. Anode current can flow only when  $V_{g3}$  and  $V_{g5}$  are simultaneously at zero.

accordingly and so contains a strong modulation-frequency component.

There was a simpler valve which was used in a similar way to the nonode. It was a pentode in which the two input signals were applied to the control grid and the suppressor grid but the geometry of the electrode structure was quite different from that of a conventional pentode in order to achieve the type of limiting action required at the two grids. It was known as a gated-beam valve.

### Transistor phase-comparator detectors.

In its simplest form a transistor equivalent of the nonode or gated-beam tube could take the form shown in Fig. 15. One of the disadvantages of such a simple circuit is that the output would contain a large component at the input frequency in addition to the wanted modulation-frequency component and in practical forms of phase-comparator detector precautions are taken to minimise this unwanted component.

In integrated circuits, for example, extensive use is made of the push-pull principle and a simplified version of a typical circuit is given in Fig 16. The output of the i.f. amplifier (also included in the i.c.) is applied in the form of push-pull pulses to the bases of  $Tr_5$  and  $Tr_6$  so that when one of these transistors is driven into conduction the other is cut off. The quadrature signal is derived from the i.f. output by use of an external LC circuit and associated reactance (one possible arrangement is shown in dashed lines) and is applied also in pulse form to two push-pull pairs  $Tr_1Tr_2$  and  $Tr_3Tr_4$  in a balanced circuit which ensures that none of the quadrature component appears between the output terminals. Suppose  $Tr_1$  base is driven positive by the quadrature signal at an instant when  $Tr_5$  is conductive. The effect is to promote conduction in  $Tr_1$  and thus to cut  $Tr_2$  off, producing a net output between the output terminals. Half a cycle later, when  $Tr_6$  is conductive,  $Tr_3$  and  $Tr_4$  behave similarly and again there is a net output. The duration of these outputs depends, of course, on the extent of the overlap between the i.f. and quadrature inputs and varies with the phase difference between the two inputs. The output can be used as a.f. in f.m. receiver or for a.f.c. purposes.

$Tr_7$  is included to stabilise the mean current through the detector and is one of the many auxiliary components included in i.c.s to ensure that the performance is substantially unaffected by variations in ambient temperature or in supply voltage.

A number of i.c.s designed for use in f.m. receivers incorporate detectors with a circuit similar to that of Fig. 16 and they are often described as balanced, symmetrical, quadrature or product detectors.

### Counter discriminator

This uses a principle quite different from those employed in the detectors so far described. If an f.m. signal is rectified the result is a succession of half-sinewave pulses the frequency of which varies according to the modulation. At periods where the pulses are crowded the mean

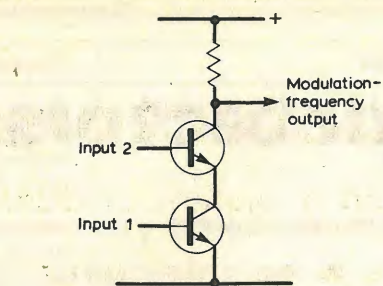


Fig. 15. Basic form of transistor coincidence detector.

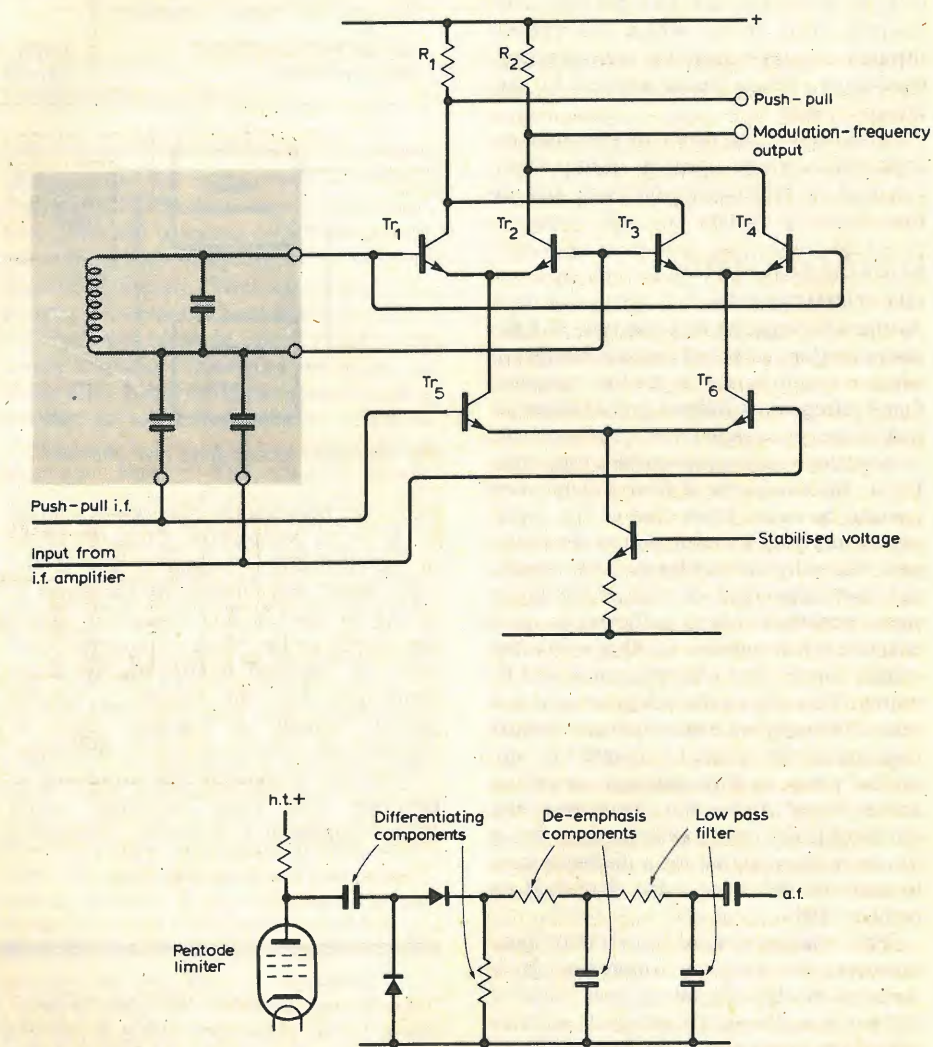


Fig. 16. Simplified version of coincidence detector used in i.c.s.

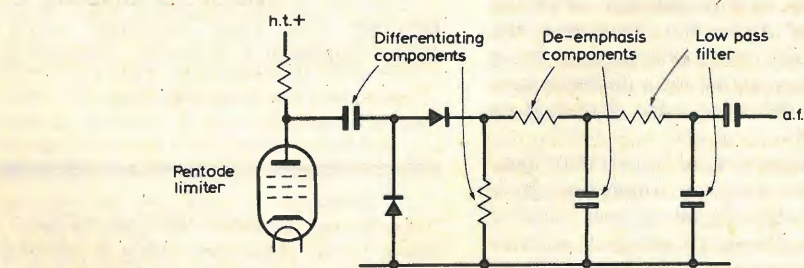


Fig. 17. Early form of pulse-counter discriminator.

value per unit time is greater than at instants when they are less crowded. This variation in mean value represents the modulation waveform and if the rectified signal is passed through a low-pass filter to suppress all but a.f. the output consists of the wanted modulation-frequency component superposed on a direct component. The change in frequency in the signal radiated from an f.m. broadcast transmitter is, however, very small compared with the centre frequency, typically  $\pm 75\text{kHz}$  maximum at a carrier frequency of, say,  $90\text{MHz}$  - a variation of less than  $\pm 0.1\%$  representing a very small change in mean value of the rectified signal and thus a very small a.f. output from the low-pass filter. The relative change in frequency is greater in the i.f. circuits,  $\pm 75\text{kHz}$  in

10.7MHz being approximately  $\pm 0.7\%$ . It is usual, however, in receivers using pulse-counter discriminators to employ an i.f. of  $455\text{kHz}$  or even lower. At  $455\text{kHz}$  the maximum change in frequency is nearly  $\pm 17\%$  which gives a worthwhile modulation-frequency component in the rectified signal.

The signal presented to the low-pass filter must be free of amplitude variations because these would give a spurious output. Moreover all the input pulses must be of identical shape because variations in shape could also give unwanted components in the output. The problem is, therefore, to generate from the i.f. signal a series of pulses all of identical form and amplitude, the number per unit time varying according to the modulation.

Early pulse-counter discriminators were fed with square waves from the final limiting stage in the i.f. amplifier. The square wave was differentiated in an RC circuit which, as shown in Fig. 17, incorporated diodes to eliminate negative-going blips. The resulting train of positive-going blips was passed through a low-pass filter with a cut-off frequency of, say 30kHz. A simple RC filter is shown in Fig. 17 which is taken from an article published by M.G. Scrggie in 1956.\*

In more recent pulse-counter discriminators the positive-going blips are used to trigger a multivibrator giving, for example, 1- $\mu$ s pulses which are passed through a squarer stage (to eliminate any overshoots) before being applied to the low-pass filter.

Pulse-counter discriminators are used in applications where linearity is important e.g. in f.m. rebroadcast receivers and in f.m. deviation meters.

### Locked-oscillator discriminators

As the title suggests this last type of f.m. discriminator is based on an oscillator which is synchronised by the f.m. signal so that its frequency follows any changes in that of the input signal. Such a system can be expected to have two useful properties. Firstly the amplitude of the oscillator output can be many times that of the input signal, implying a useful degree of voltage gain. Secondly the oscillator output amplitude is independent of that of the input signal provided this is sufficient to give effective synchronising: in other words the system should give effective amplitude limiting. Thus the oscillator can be used as a source of amplified and amplitude-limited f.m. signals which can be followed by any of the types of discriminator described above. Used in this way, of course, the oscillator is not itself a discriminator but a source of input signal for a discriminator. Circuits of this type were described as early as 1944.

The synchronised oscillator can, however, act as a discriminator. If it operates in class C, taking one burst of current from the supply per cycle of oscillation, the frequency of the bursts follows that of the input signal and so contains a modulation-frequency component which can be used as detector output. For the reasons given under the previous section, however, a low value of intermediate frequency (and hence oscillator frequency) is necessary to give a worthwhile performance from such a circuit.

**Phase-locked-loop circuits.** In this more recent application of the principle the frequency of the oscillator is controlled not by direct application of the f.m. signal but by a control voltage dependent on the difference between the phase of the oscillator and that of the f.m. signal. The circuit, illustrated in principle in Fig. 18, is so designed that the effect of the oscillator control voltage is to minimise the phase

### Classification of f.m. detectors

Type	Example	Self-limiting?
(a) f.m.-to-a.m. converter plus a.m. detector	slope detector	no
	Round-Travis detector	
	Seeley-Foster discriminator	yes
	ratio detector	
(b) phase-comparator	nonode	yes
	gated-beam tube	
	balanced detector	
	symmetrical detector	no
	quadrature detector	
product detector		
(c) counter discriminator		no
		no
(d) locked-oscillator discriminator	early types	yes
	phase-locked-loop	no

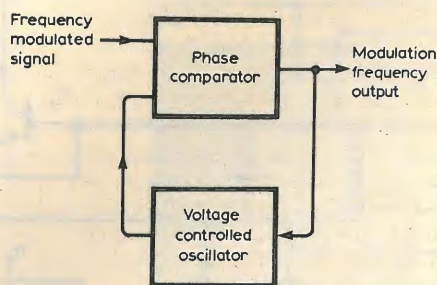


Fig. 18. Phase-locked-loop f.m. detector.

difference between the two signals applied to the phase comparator. Thus the phase of the oscillator is locked to that of the input signal and follows any variations in it. As in the circuits described earlier the output of the phase comparator contains the required modulation-frequency component but the output is usually passed through a low-pass filter to suppress any radio-frequency components.

This type of detector has something in common with those described under "phase comparator detectors". Compari-

son of Fig. 13(a) and 18 shows that in phase-comparator circuits the quadrature input is derived from the other input by use of a phase-shifting network whereas in the phase-locked-loop the second input is derived from the output of the comparator so introducing negative feedback.

The oscillator must be such that its frequency can be readily controlled by a voltage applied to it. It can be a Hartley or Colpitts type in which part of the capacitance of the frequency-determining network is provided by a varactor, the d.c. input to which therefore controls the operating frequency. Alternatively, and this arrangement avoids any need for an LC circuit, the oscillator can be an astable multivibrator, the control voltage being applied to the resistors of the RC circuits which determine the free-running frequency of the oscillator. The phase comparator may have a circuit similar to that shown in Fig. 16.

To conclude this article the classification of f.m. detectors surveyed is summarised in the table above.

## BOOKS

Proceedings have been published in book form of the European Hybrid Microelectronics Conference of 1979, which was held at Ghent in Belgium, to discuss various topical aspects concerning applications and manufacturing techniques. Each of the papers is categorized and slotted into one of eleven sections, the last ten of which are devoted to technical matters related to the production and uses of thin and thick-film components and hybrid circuits.

As one of the intentions of the papers is to advance hybrid microelectronic technology already in existence, the level of background knowledge required to enable full comprehension of the subjects is, of course, high. Illustrations and an occasional photograph supplement the written matter, which seems to consist of direct copies of originals as the type face varies from one paper to another. The print is, however, in all cases clear, the quality of paper used is quite high and random samples indicate that those works written by authors whose na-

tive language was not English were not prone to the gross syntax errors which often make works of a scientific or highly technological nature even more difficult to understand.

Not yet mentioned is the first section of the book which is entitled Opening Session and consists of a paper called Economics and Market by E. Effenburger. Included in this paper is an attempt to evaluate the world market for hybrids and resistor networks which, although it constitutes only seven pages of a book of around 560 pages in total, is a rather good assessment of trends in this field. Mr Effenburger concludes "his paper by stating "In our opinion the time for film technics is now favourable and the significant growth is yet to come".

With a full title of **Proceedings - European Hybrid Microelectronics Conference 1979**, this book is denominated ISBN 90 6231 068 0 and published in paperback form by the Dutch Efficiency Bureau, P.O. Box 90, Pijnacker, The Netherlands.

# Battery-powered instruments

Choosing and using dry batteries, with some suggestions for improving service life

by Ian Hickman

The use of batteries as the power source for small electronic instruments and equipment is often convenient and sometimes essential. The absence of a trailing mains lead (especially when there is no convenient socket into which to plug it) and the freedom from earth loops and other hum problems offset various obvious disadvantages of battery power. When these and other considerations indicate batteries as the appropriate choice, the next choice to be made is between primary and secondary batteries, i.e., between throw-away and rechargeable types.

### Rechargeable versus primary batteries

Rechargeable batteries offer considerable economies in running costs, though the initial cost is high. For example, direct comparisons can be made between certain layer-type batteries, e.g. PP3, PP9, and also certain single cells, e.g. AA, C and D size primary cells, where mechanically interchangeable, rechargeable nickel/cadmium batteries and cells are available. These cost about ten to twenty times as much as the corresponding zinc/carbon (Leclanché) dry battery or cell, and as much or more again for a suitable charger. This doubtless accounts for the continued popularity of the common or garden dry battery. Another point to bear in mind is that, contrary to popular belief, the ampere-hour capacity of many nickel/cadmium rechargeable batteries is no greater than (and in the case of multicell types often considerably less than) the corresponding zinc/carbon battery. Nevertheless, where equipment is regularly used for long periods out of reach of the mains, rechargeable batteries are often the only sensible power source - a typical example would be a police walkie-talkie. In other cases the choice is less clear: for instance, an instrument drawing 30 to 35mA at 9V, and which is used on average for four hours per day five days a week, would obtain a life of 100 or more hours from a PP9 type dry battery (to an end point of 6.5V, at 20°C).

Assuming the cost of a PP9-sized, rechargeable nickel/cadmium battery plus charger is 25 times the cost of a PP9 dry battery, it would be two and a quarter years before the continuing cost of dry batteries would exceed the capital costs for the rechargeable battery plus charger. (The effects on the calculation of interest charges on the capital, inflation and the

very small cost of mains electricity for recharging have been ignored.)

### Using primary batteries

Often, then, the lower initial costs will dictate that a product uses primary batteries, and any measures which can reduce the running costs of equipment so powered must be of interest. When a decision to use primary batteries has been taken, there are still choices to be made, one of which is the choice between layer-type batteries or single cells. Some designers prefer to use a number of individual cells in series to power a piece of equipment, rather than a layer-type battery. The main advantage here is in a wider choice of "battery" voltage by using the appropriate number of cells, although if the usual moulded-plastic battery holders are used, one generally arrives at a voltage obtainable in the layer type.

The other advantage of using individual cells is that the user then has the choice of primary cells other than zinc/carbon, such as alkaline batteries. On low to medium drains with an intermittent duty cycle, e.g. radio, torch, calculator, these will give up to twice the life of zinc/carbon batteries. However, they are approximately three times the price and therefore the running cost is greater. With very high current requirements and continuous discharge regimes the ratio of capacity realized (alkaline: zinc/carbon) would be increased.

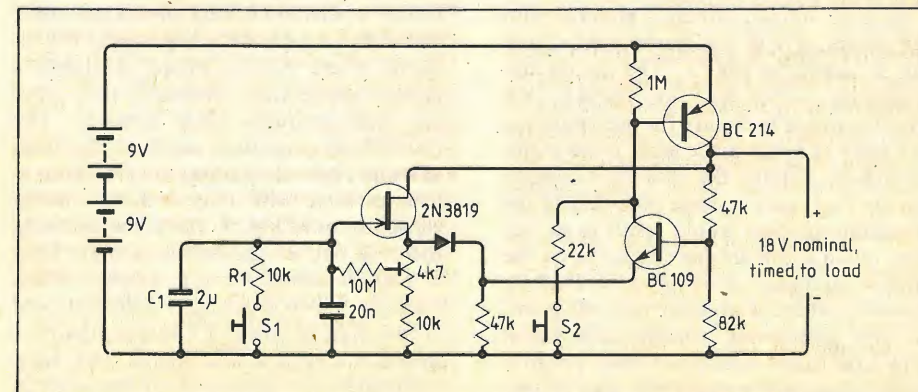
One of the main disadvantages of batteries is that they frequently prove to be flat just when one needs them. As often as not, this is because the instrument has inadvertently been left switched on. If the batteries are of the zinc/carbon type, they can then deteriorate and the resultant

leakage of chemicals can make a very nasty mess. (If the batteries are rechargeable nickel/cadmium types this problem does not arise: modern nickel/cadmium batteries are not damaged by complete exhaustion. However, note that if a nickel/cadmium "battery" is being assembled from individual cells they should all be in the same condition - ideally new - and in the same state of charge. Otherwise, one cell may become exhausted before the rest and thus be subject to damaging "reverse charging".)

A really effective indicator on a battery-powered instrument might prevent this lamentable waste of batteries. However, of the many types of 'on' indicator used, nearly all have proved of very limited effectiveness. One well-known manufacturer uses a rotary on/off switch, the part transparent skirt of the knob exposing fluorescent orange sectors when in the 'on' position, and this is reasonably effective when the front panel is in bright light. Indicator lamps have also been used but usually with intermittent operation to save current. Examples are a blocking oscillator causing a neon lamp to flash, and a flasher circuit driving an l.e.d. Unfortunately, the power that can be saved by flashing a lamp is very limited. The flashing rate cannot be much less than one per second or it may fail to catch one's attention. On the other hand, the eye integrates over about 100ms, so flashes much shorter than this must also be much brighter to give the same visibility. Thus a saving of about ten to one in power (ignoring any "housekeeping" current drawn by the flasher circuit) is about the limit in practice.

The author must have ruined as many batteries as most people by inadvertently leaving equipment switched on when not in use, and decided many years ago that the only effective remedy was to replace

Fig. 1. Ten-minute timer designed by the author in 1969.



\* 'Low-distortion f.m. discriminator', *Wireless World*, April 1956.

the on/off switch by an 'on' push-button. This switches the equipment on and initiates an interval at the end of which the instrument turns itself off again. Clearly, it would be most annoying if just at the wrong moment - say when about to take a reading - the instrument or whatever switched itself off, so the push-button should also, whenever pushed, extend the operation of the instrument to the full period from that instant. One can thus play safe, if in doubt, by pressing the button again, 'just in case'.

The period for which the instrument should stay on is, of course, dependent on its use and the inclination of the designer. However, a very short period - a minute or less - would generally be rather pointless; provided one had one hand free one would be better off with a straightforward "on whilst pressed" button, which is also cheaper and simpler. For many purposes, ten or fifteen minutes is a suitable period, but clearly it is not critical unless the equipment is exceedingly current-hungry. After all, it is being left on overnight (or a week-end) that ruins batteries controlled by an ordinary switch, not the odd half hour or so.

In the late 1960s, when the author first used a ten-minute timer to save batteries, producing such a long delay economically and with little cost in "housekeeping" current was an interesting exercise, especially as monstrously high resistances were ruled out as impractical or at best expensive. So the circuit of Fig. 1 was developed and proved very effective. The preset potentiometer was set to pick off a voltage just slightly positive with respect to the gate of the n-channel depletion f.e.t., so that only a small aiming potential was applied across the 10MΩ resistor to the timing capacitor, C<sub>1</sub>. Thus pressing the 'on' button set the complementary latch, turning on the instrument and initiating a bootstrapped ramp at the source of the f.e.t. This eventually turned off the latch and hence the instrument, unless the button were pressed again first, when the capacitor was discharged again via R<sub>1</sub> and the interval updated. This circuit was very effective in saving batteries, although the exact period was rather vague due to variation of the gate bias voltage of the f.e.t. with temperature. Incidentally, the purpose of the 0.02μ capacitor was to enable the preset potentiometer to be set for a 6 second period before the 2μF capacitor was connected in circuit. This made setting up the 600 second period much less tedious.

An even simpler circuit is possible with the advent of v.m.o.s. power f.e.t.s, and this is shown in Fig. 2. The circuit undoubtedly works well in practice, but whilst it might be handy for incorporation in a piece of home-made gear, it has major drawbacks. Firstly, the data sheet maxima for the f.e.t. gate leakage plus that of the tantalum capacitor would result in an 'on' time much less than that predicted by the time-constant of 47μF and 10MΩ. Secondly, there is no clear turn-off point. As the gate/source voltage falls below +2V, the drain resistance rises progressively, gradually starving the load of cur-

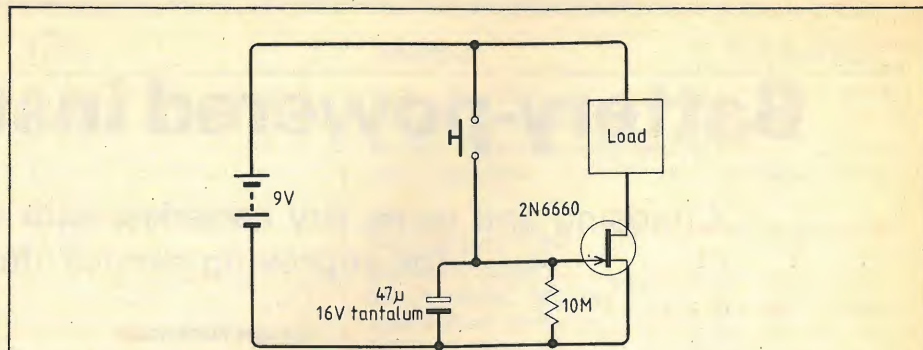


Fig. 2-V.m.o.s. circuit, which is simple but which does not turn off cleanly.

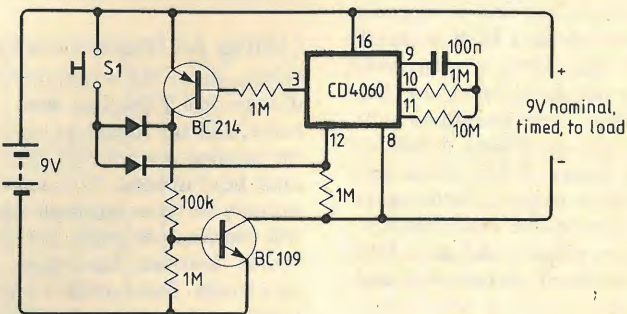


Fig. 3. Delay circuit using an oscillator, followed by a counter. Very long delays can be obtained by this method.

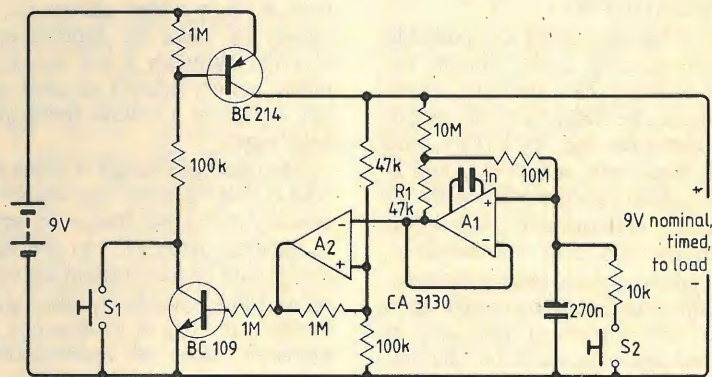


Fig. 4. Analogue delay circuit avoids possibility of interference from oscillator. A<sub>1</sub> and A<sub>2</sub> are CA 3130.

rent rather than switching it off cleanly. This might be handy if you like your transistor radio to fade out gradually while you go to sleep, but it is not generally a useful feature.

With such a wide choice of integrated circuits it is possible nowadays to obtain long delays much more easily, and one way is simply to count down from an RC oscillator using readily obtainable values of resistance and capacitance. Various timer i.c.s are available working on this principle, although for a dry battery powered instrument, where current saving is always a prime consideration, obviously t.t.l. types are less desirable than c.m.o.s. The CD4060, in particular, can form the basis of a timer providing an on interval of up to half an hour with only a 0.1μF timing capacitor, as in Fig. 3. Here, on operating the push button, the complementary latch is set, switching on the output, which starts the CD4060 oscillator with the count at zero. The divide by 2<sup>14</sup> output at pin 3 is therefore at logic 0, holding the p-n-p transistor and hence also the n-p-n transistor in

saturation. On reaching a count of 2<sup>13</sup>, the output at pin 3 rises to the positive rail, turning off the p-n-p transistor and hence the n-p-n transistor and the output. Clearly, by increasing the timing resistor and capacitor at pins 10 and 9 respectively, delays of many hours could be obtained if required.

Such a timing circuit is reasonably cheap to incorporate in an instrument and requires no setting up. As shown in Fig. 3, it is capable of supplying up to 10mA or more load current; larger load currents simply require the 100kΩ resistor in the base circuit of the BC109C transistor to be reduced in value as appropriate. The circuit will switch off quite reliably, even though an electrolytic capacitor be fitted in parallel with the load to give a low source impedance at a.c. If a d.p.s.t. push button is used, the circuit can be further simplified by the omission of the two diodes.

The small, but nonetheless finite, "housekeeping" current drawn by the circuit of Fig. 3 means of course that whilst 'on', the battery is actually being run down

slightly faster than if an on/off switch were used. However, in practice this is more than offset by the reduced running time of the equipment. Quite apart from inadvertent overnight running, an equipment fitted with an automatic switch-off circuit is usually found to clock up considerably less running hours during the normal working day than one with a manual on/off switch.

With modern i.c.s, counting down from an oscillator running at a few Hertz is not the only way of obtaining a long delay with modest values of R and C. Fig. 4 shows an updated version of the bootstrapped timer of Fig. 1, which could be preferable for use in sensitive instruments where interference might be caused by the fast edges of the oscillator in Fig. 3. The analogue delayed switch-off circuit of Fig. 4 achieves the long delay by applying a very much smaller forcing voltage to the 10MΩ timing resistance than the reference voltage at the non-inverting input of A<sub>2</sub>. With the values and devices shown, no setting up is required as this forcing voltage is still large compared with the maximum offset voltage of the CA3130, A<sub>1</sub>. For longer delays, the 47kΩ resistor R<sub>1</sub> may be reduced, but it would then be necessary to zero the input offset voltage of A<sub>1</sub> for consistent results from unit to unit. This circuit also will switch off reliably with an electrolytic bypass capacitor connected across its output.

Figure 5 shows a useful and inexpensive battery-voltage monitor which may be connected across the output of either of the circuits of Figures 3 and 4. The preset potentiometer can be set so that the front-panel-mounting light-emitting diode illuminates when the supply voltage to the circuit falls below the design minimum, e.g. 6V. The temperature co-efficient of the supply voltage at which the l.e.d. illuminates is approximately -20mV/°C, which is generally acceptable, but this can be considerably reduced, if required, by connecting a germanium diode in series with the lower end of the 22kΩ preset potentiometer. The 47μF capacitor delays the build-up of voltage at the base of Tr<sub>1</sub> on switch-on, causing the l.e.d. to illuminate for a second or so, assuring the user that batteries are fitted to the instrument and are in good condition. If the voltage falls to an unserviceable level whilst the instrument is on, the l.e.d. will illuminate again.

By connecting the monitor circuit across the output of the delayed switch-off circuit, the monitor draws housekeeping current only whilst the instrument is on.

### Choosing the battery size

Using one of the above circuits can reduce the average daily running time of an equipment by a useful amount (as well as eliminating overnight run-down), but the question still remains - "which dry battery to use?" Circuit design considerations usually dictate the minimum appropriate supply voltage. If a 6V nominal supply is chosen, a wider choice of capacities is available using four single cells rather than a layer type battery, but for many purposes, an

end of life voltage of around 4V is too inconvenient. A 9V battery can provide a more useful end of life voltage, whilst if a higher voltage is required, two layer type batteries in series can be used, 6V or 9V types as required.

To decide what size battery of a given voltage to use, refer to the battery manufacturer's data. Tables 1 to 3 give the total service life in hours to various end voltages (at 20°C) for three different types of layer batteries. The top value PP9 and the ubiquitous PP3 represent the upper and lower capacity ends of the range, whilst the PP6 is one of the three intermediate sizes - PP4, PP6 and PP7 in order of increasing capacity - which, whilst readily available, are not quite so commonly used. It is important to note that the tables give the service life in hours for the stated current at 9V, i.e., for a constant resistance load. Thus the current provided at for example a 6V end point is only two thirds of that in the left-hand column of the table.

The first fact which strikes one is the much greater milliampere-hour capacity of the PP9 than the PP6 and of the PP6 than the PP3, in each case the ratio approaching 6:1. Yet the price differential (by comparison) is tiny. It would therefore appear at first sight that it must always pay to use the PP9, or at least the largest battery capable of being accommodated within the case of equipment. In general this is true, except for an equipment drawing only a very small current and/or receiving only very occasional use. Under these circumstances a large battery would only be partially used before dying of "shelf life", and a smaller cheaper battery would be a more sensible choice. In fact if the current drawn is very small - microamps or up to a milliamp or so - it is worth considering saving the cost of a switch entirely and letting the equipment run continuously. It is in any case good practice to replace a layer type battery every year, regardless of how much or little use it has had, although in a temperate climate they will often remain serviceable much longer than this. In tropical climates routine replacement after 6 to 9 months is recommended.

The circuits of Figs. 3 and 4, when 'on' apply the full battery voltage to the load circuit, except for a 300mV or so drop due to the collector saturation voltage of the series pass transistor. This being so, the load current is likely to be very nearly proportional to the battery terminal voltage, and hence Tables 1 to 3 are directly applicable. (Strangely, this is the exception rather than the rule; more of which later). Thus if a 9V battery is to be used, Tables 1 to 3, plus those for the PP4 and PP7 will indicate the optimum style of battery, bearing in mind the load current, daily running time and acceptable end voltage. Having chosen the battery type, a graph can readily be drawn for the appropriate daily usage to permit interpolation between the current values in the table, giving an accurate estimate of the total serviceable life. Fig. 6 is an example of such a graph, for the PP9 battery at 20°C, with four hours daily usage, to an end point of 6.5V. In the author's experience,

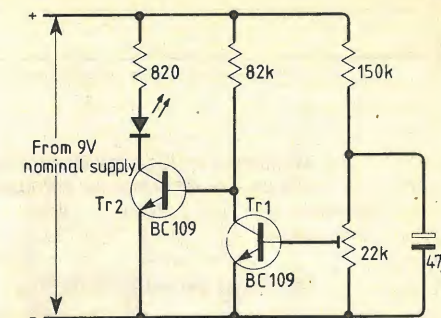


Fig. 5. Low battery-voltage indicator. L.e.d. illuminates when supply falls below designed minimum.

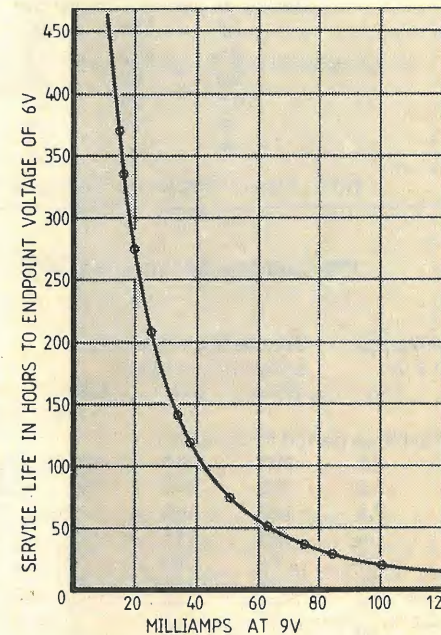


Fig. 6. Service life of PP9 battery, used four hours per day.

the figures quoted in Table 1 are conservative, and although there must be some variation from battery to battery, they can safely be taken as minima rather than typical. This view is confirmed by informal tests which were carried out some years ago by the laboratories of the Finnish PTT in Helsinki.

There is a growing (and welcome) tendency for Japanese and US battery manufacturers to adopt IEC designations for their products rather than using their national or in house codes, and we can expect U.K. manufacturers to follow suit in the next year or two.

A final point about using dry cells is a warning that attempts to recharge them are futile and can be dangerous. Recharging leads to the evolution of gases which the sealed cell cannot vent and the cell constituents cannot recombine. In the case of a layer-type battery, the gas evolved forces the layers apart, resulting in an open circuit battery.

### Stabilized supplies

A piece of electronic test or measuring equipment powered by dry batteries is often required to possess a degree of accuracy and stability which can only be obtained by operation from a stabilized



PP3 Estimated Service Life at 20°C

Milliamps at 9.0v	Service life in hours to endpoint voltages of				Milliamps at 9.0v	Service life in hours to endpoint voltages of				
	6.6v	6.0v	5.4v	4.8v		6.6v	6.0v	5.4v	4.8v	
Discharge period 30 mins/day										
10	26	29	32	34	1	322	355	395	412	
15	17	19	21	23	1.5	215	240	260	277	
25	9.2	11	12	13	2.5	132	147	162	167	
50	2.3	4.1	5.1	5.8	5	63	71	77	82	
Discharge period 2 hours/day										
1.5	180	190	200	205	10	17	23	30	33	
2.5	112	122	132	136	15	-	12	17	19	
5.0	56	62	68	72	Discharge period 12 hours/day					
10.0	24	28	31	34	0.5	695	750	785	815	
15	14	16	20	22	1.0	365	390	417	427	
25	-	7.4	9.5	11	1.5	240	262	277	292	
					2.5	125	152	162	170	
					5.0	44	54	62	72	
					7.5	18	22	29	36	

Note: Also available are the higher capacity PP3P for miniature dictation machines etc. and the PP3C for calculator service.

PP6 Estimated Service Life at 20°C

Milliamps at 9.0v	Service life in hours to endpoint voltage of			
	6.6v	6.0v	5.4v	4.8v
Discharge period 4 hours/day				
2.5	492	517	535	545
5.0	240	270	287	302
7.5	142	166	173	194
10	93	111	124	137
15	51	63	73	81
20	33	42	49	55
25	23	30	35	40
50	-	7.8	10	12
Discharge period 12 hours/day				
0.75	2075	2200	2325	2400
1.0	1510	1650	1760	1815
1.5	965	1080	1155	1200
2.5	532	620	635	690
5.0	214	263	202	312
7.5	117	147	109	187
10	75	97	111	127
15	38	50	59	69
25	16	21	25	31
Discharge period 30 mins/day				
50	15	19	22	24
75	0.6	10	12	14
100	25	6.2	7.8	9.1
150	-	2.3	3.5	4.4
Discharge period 2 hours/day				
7.5	169	194	205	215
10	117	140	151	161
15	67	83	93	99
25	31	38	45	48
50	8.9	12	14	16

PP9 Estimated Service Life at 20°C

Milliamps at 9.0v	Service life in hours to endpoint voltages of			
	6.6v	6.0v	5.4v	4.8v
Discharge period 30 mins/day				
125	24	35	40	44
150	16	28	33	37
166.67	12	23	29	33
187.5	7.8	19	24	28
250	1.9	9.3	16	19
Discharge period 2 hours/day				
25	193	233	269	286
33.3	150	180	209	223
37.5	122	147	168	180
50	81	99	113	124
62.5	57	71	82	92
75	41	53	62	69
83.33	33	45	53	60
100	20	32	39	44
125	9.8	19	25	29
150	6.1	13	17	20
Discharge period 4 hours/day				
15	332	370	409	437
16.67	291	336	367	394
18.75	266	294	324	349
20	235	273	304	328
25	180	208	234	251
33.33	115	141	158	176
37.5	96	118	134	148
50	59	75	90	101
62.5	37	51	63	72
75	25	35	46	54
83.33	19	30	38	44
100	12	20	27	31
Discharge period 12 hours/day				
15	292	340	379	407
16.67	254	294	321	352
25	127	151	178	206
33.33	73	89	105	134
37.5	58	71	86	110
50	30	40	47	65
62.5	17	24	30	42

supply voltage. The current drawn by the instrument at the stabilized voltage is then usually constant, and the data in the tables is thus no longer appropriate. The bulb of a flash lamp likewise tends to be a constant current load, due to its high temperature coefficient of resistance — remember the barretter? On the other hand, the motor of a battery-powered turntable or tape transport with a mechanical or electronic governor tends to draw a constant power, so that the current drawn actually rises as the battery terminal voltage falls. In theory, one could design a switching regulator for the stabilizer of our piece of electronic equipment, so that the current drawn from fresh batteries was actually less than that consumed at the stabilized voltage, rising to the same current as the battery terminal voltage fell to nearer the stabilized voltage.

In practice, for a stabilized voltage of two thirds of the nominal battery voltage, e.g. 12V for two PP9s in series, the efficiency of a conventional stabilizer is almost 66% if the housekeeping current is low, rising to well over 90% at end of life battery voltage. This can be held to less than 12.5V, i.e. an end point of barely over 1.0V per cell. The average efficiency of energy usage over the life of the battery is thus over 80%, a figure it would be difficult to better economically with a switching regulator, which would also need careful suppression if used in a sensitive measuring instrument. Thus a supply stabilizer for a dry battery operated instrument is likely to be of the conventional series type and the battery current drawn is virtually constant. To estimate the service life of the battery therefore, tables such as Tables 1 to 3 cannot be used directly, and the following method should be used.

For an initial battery voltage  $E_1$ , an end-of-life voltage  $E_2$  and a constant current  $I$ , the initial load resistance  $R_1 = E_1/I$ , and end-of-life load resistance  $R_2 = E_2/I$ . The effective load resistance  $R_c$  is defined as  $R_c = (R_1 + R_2)/2$  and Fig. 6 gives battery life, taking  $I_c = E_1/R_c$ .

Since  $I_c = 2E_1I/E_1 + E_2$ , the end-of-life voltage is 1V and initial battery voltage is 1.5V,  $I_c = 1.2I$ .

An automatic delayed switch-off is just as desirable in a battery-powered instrument incorporating a stabilizer as in one using the 'raw' battery voltage. The circuit of Fig. 3 incorporates a couple of transistors, and it would be elegant and economical to make these function also as the stabilizer circuit. This can be done with just a few extra components, as Fig. 7 shows. Whereas the positive-feedback loop of the complementary latch in Fig. 3 is completed only via the CD4060 pin 3 output, that in Fig. 7 is completed independently of the i.c. When the zener diode is not conducting, loop feedback is positive and one of the two stable states is with both transistors cut off. Once either transistor starts to conduct, the collector voltage of the BC 109 will fall rapidly until the zener diode conducts, at which point the loop feedback changes from positive to negative and a stable 'on' condition is established. This persists until a count of

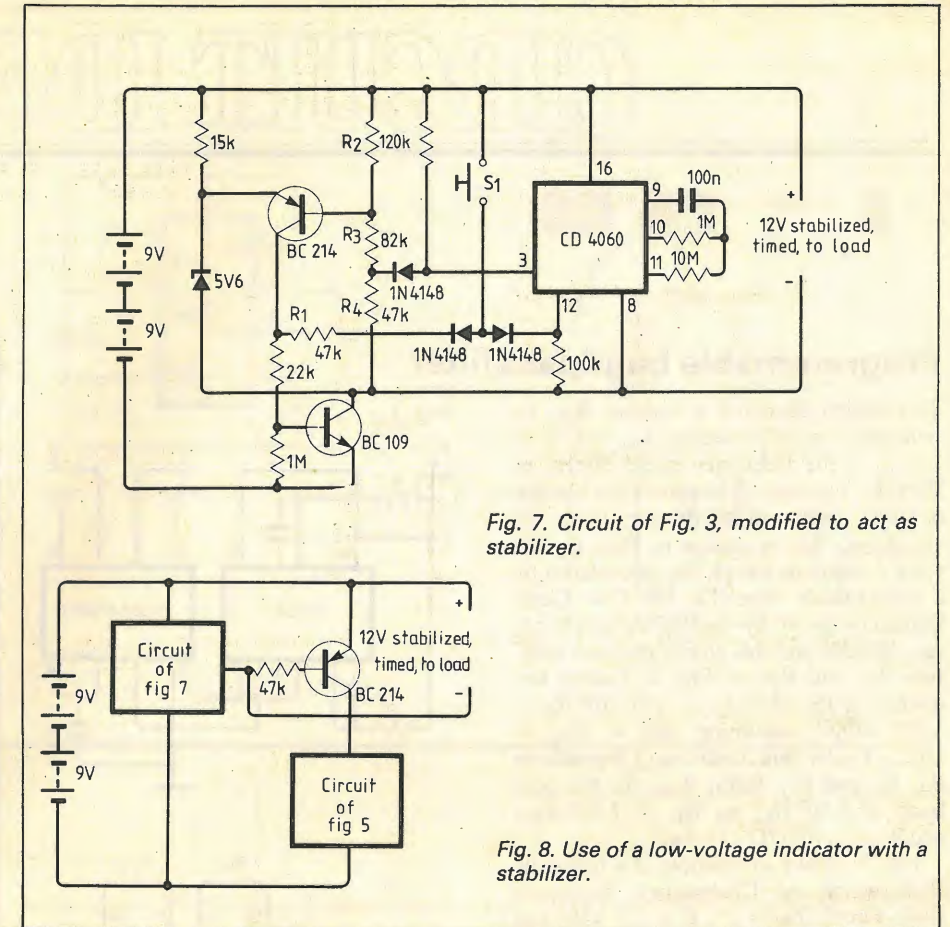


Fig. 7. Circuit of Fig. 3, modified to act as stabilizer.

Fig. 8. Use of a low-voltage indicator with a stabilizer.

$2^{13}$  is reached, when the output at pin 3 of the CD4060 rises to the positive rail, switching off the p-n-p transistor via the diode. The n-p-n device therefore also cuts off and the 'on' period terminates. The 10kΩ resistor at pin 3 of the i.c. is necessary to guarantee the switch-off of the BC214, since the p-channel output device in the CD4060 cannot achieve this unaided when the voltage between pins 8 and 16 falls to a low value.

With the circuit as shown in Fig. 7, i.e. no load connected, the output voltage will equal the battery voltage whilst the 'on' push button is closed. This applies equally at switch-on and when updating the 'on' period. However, for any completed instrument design, once the load current is known, it is a simple matter to calculate an appropriate value for  $R_1$  which will reliably initiate the circuit without exceeding the designed stabilized voltage. In practice also one would provide a preset potentiometer as part of the  $R_2, R_3, R_4$  chain to allow adjustment of the voltage at the base of the BC214. This will enable the stabilized output voltage to be set to, say, -12V exactly, despite the selection tolerance of the zener diode.

As the analogue delayed turn-off circuit of Fig. 4 also includes a p-n-p and an n-p-n transistor, it should be a fairly simple matter to turn these into a stabilizer along the lines of Fig. 7, though with inverted polarity of course. Such an analogue timed stabilizer could be useful where the instrument it powers might be troubled by the switching edges of the oscillator in Fig. 7. The battery voltage monitor of Fig. 5 obviously cannot usefully be connected

across the output of a stabilizer, nor, although its housekeeping current is only a fraction of a milliamp, would one want to leave it permanently connected across the battery. Fig. 8 shows how it can be adapted for use with the stabilized delayed switch-off circuit of Fig. 7. The 22kΩ potentiometer would, of course, be set to indicate a battery end voltage of 12.5V.

Tables 1-3 are reproduced by kind permission of the Ever Ready Company (Great Britain) Ltd. This company operates internationally under the trade name "BEREC" and has no connection with Union Carbide, which uses the trade mark "Eveready". □

### Amateur radio and illegal c.b.

Police investigation of illegal 27MHz "citizens' band" activities continues to include the stopping of vehicles carrying unusual-looking aerials, sometimes resulting in radio amateurs experiencing considerable difficulty in proving that their transmitters are legal. Since amateur licences are not computerised, immediate confirmation cannot be obtained through the police data networks, although it seems likely that this information will in time be stored on a Home Office computer and thus become part of the amateur's "electronic dossier".

# CIRCUIT IDEAS

## Programmable bandpass filter

This design simulates a resistor,  $R_{eq}$ , by switching a small capacitor,  $C_u$ , at a clock rate  $f_t$  in the frequency range 50kHz to 500kHz. The size of the equivalent resistor is  $1/f_t C_u$ , and a multivibrator circuit for simulating  $R_{eq}$  is shown in Fig. 1. The s.p.s.t. analogue switch can be replaced by a dual switch, type TL 191 CN. Clock frequency is set by the RC networks to, say, 100kHz and this circuit replaces resistors  $R_{F1}$  and  $R_{F2}$  in Fig. 2. Centre frequency of the filter,  $f_0$ , is  $1,592.10^8/R_F = 1,595.10^8 f_t C_u$  assuming  $R_{F1} = R_{F2} = 1/f_t C_u$ . Under this condition  $Q$  depends on  $R_4$ ,  $R_G$  and  $R_Q$ . Gain,  $A_{BP}$ , for the pass band is  $5.10^4/R_G$ , so  $R_G = 5.10^4/A_{BP}$ , and  $R_Q = 5.10^4/(2Q - 1 - A_{BP})$ .

Fig. 3 shows an example of a four-pole Butterworth or Chebyshev band-pass filter where  $Q_{BP}$  is 25,  $f_c$  is 1.5 kHz and  $A_{BP}$  is unity.

Computed values for Fig. 3.

	Butterworth	Chebyshev
$f_{n1}$	1.01424	1.02028
$f_{n2}$	0.98596	0.98012
$Q_1$	35.36850	35.08733
$Q_2$	35.36052	35.07999
$C_{u1} = C_{u2}$	95.6pF	96.1pF
$C_{u3} = C_{u4}$	93pF	92.3pF
$R_G$	50kΩ	50kΩ
$R_Q$	1040Ω	1040Ω

Operation of the band-pass is corrected by slight variation of the clock frequency  $f_t$ .

K. Kraus  
Ejpvic  
Czechoslovakia

Fig. 3

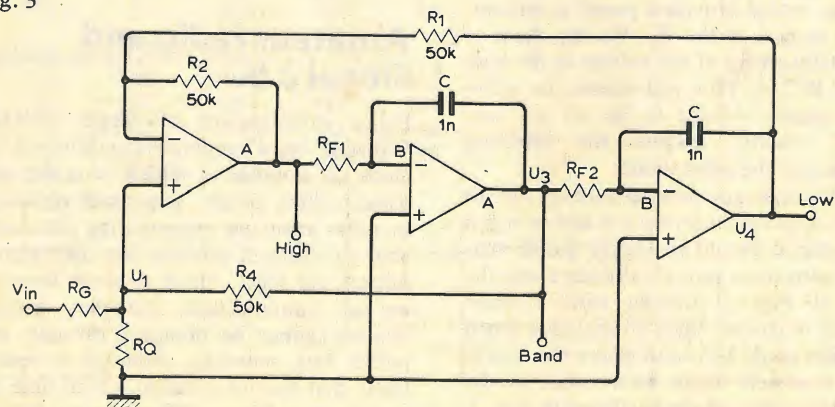


Fig. 1

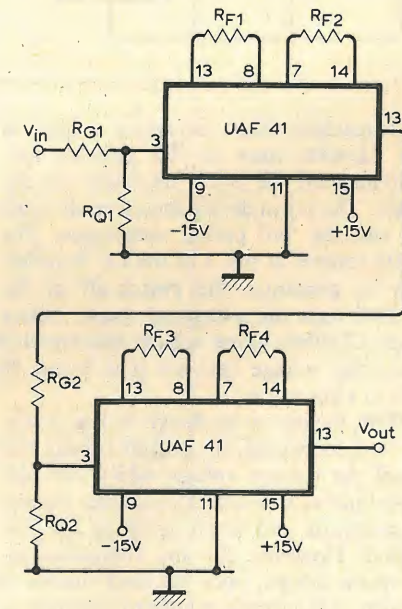
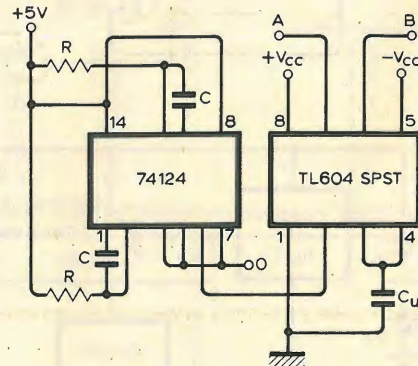


Fig. 2

## Improved audio-visual circuit

Where several locations or sub-systems are monitored, for example in an alarm system, it is common to have an audible alarm, which is activated if a monitor point is triggered, and an array of visual indicators to show the particular location(s) involved. Because the audible alarm has a large number of inputs, this system can be costly in terms of wiring and connectors.

A simpler solution is to use the i.e.d.s as an OR gate, with the output as a current to ground which can be detected by a current mirror. Because the current can become reasonably high,  $Tr_1$  must be a medium-power type. Although this unbalances the current mirror, linearity is not important in this switching application. The final design used a p-n-p switch as an active pull-up. With this arrangement only one input connection is required for the audible alarm.

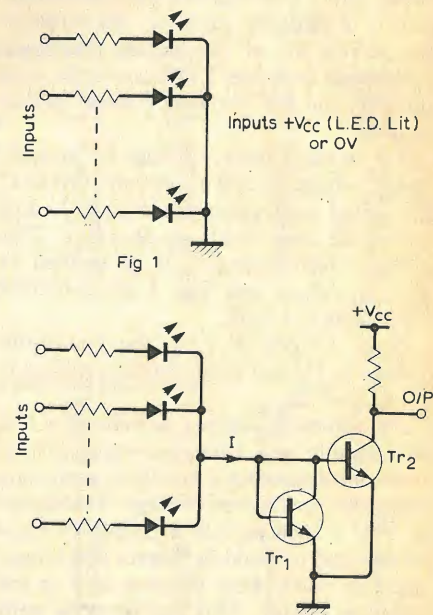


Fig 1

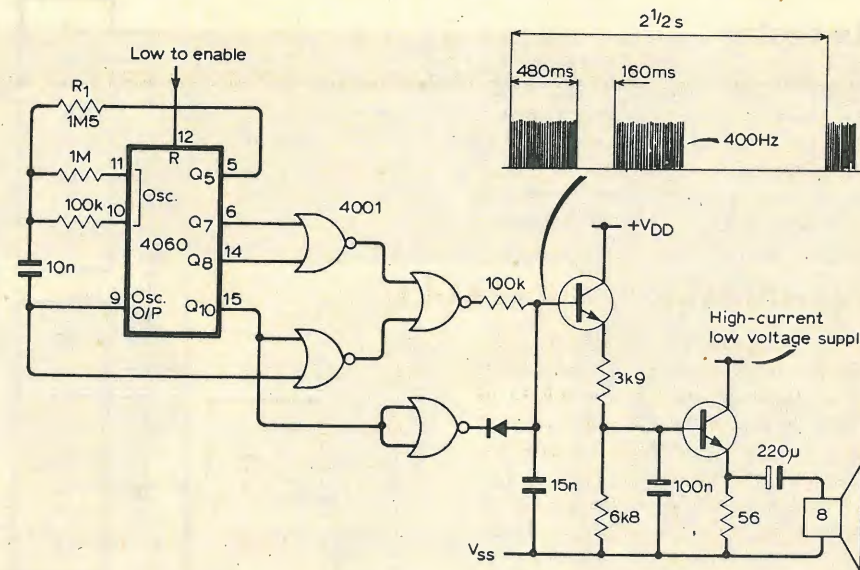
The mirror can also be used in an analogue mode for current to voltage conversion where the output represents the number of i.e.d.s turned on. The output can either cover all possible states, or  $Tr_2$  can saturate with, say, four or more i.e.d.s and operate an extra alarm when a pre-set number of faults require attention. Note that ac inputs and indicators can be used if a diode is connected across the base-emitter of  $Tr_1$ , and  $Tr_2$  output is taken through a retriggerable monostable.

T. M. Forcer  
Southampton

## Ringtone generator

A reasonable approximation to the standard telephone ringing tone can be achieved with two i.c.s and two transistors. A c.m.o.s. oscillator/binary divider generates both the tone and the gating signals so, in the quiescent state, only c.m.o.s. current and transistor leakage current is drawn. The output-stage values are appropriate for a  $V_{DD}$  of 10V and a low voltage supply of 4V. Resistor  $R_1$  gives a f.m. warble on the tone and can be omitted if this is not required.

T. Williams  
Tunbridge Wells  
Kent



## Wide-range p.p.m.

By using the exponential conduction characteristic of a silicon diode, a i.e.d. bar or moving-dot display of audio level over a range of 40dB can be achieved.

The collector load of  $Tr_1$  is bootstrapped by  $Tr_2$  and  $C_4$  to produce a near constant-current drive to  $D_1$  and  $D_2$ . The clipped signal is then amplified to drive a rectifier transformer, and  $Tr_5$  maintains a constant current through the rectifier bias diode  $D_3$ . Capacitor  $C_3$  and  $R_{14}$  determine the rectifier discharge time-constant, and  $IC_2$  buffers the output. The i.e.d. driver,  $IC_2$ , supplies 15mA through the display diodes, and  $R_{21}$ ,  $R_{22}$  limit the dissipation of  $IC_2$  during large input signals.

To adjust the circuit, set  $R_{24}$  for maximum input,  $R_{25}$  to the mid-position and  $R_{26}$  to maximum resistance. Apply 12V and feed a 1kHz signal of at least +12dBm

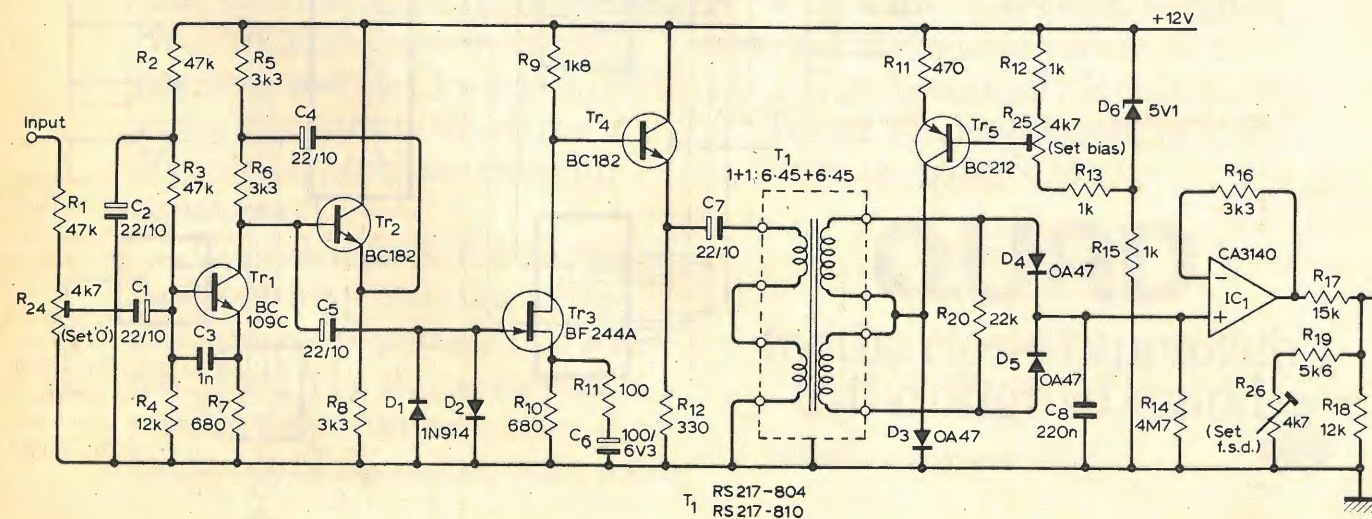
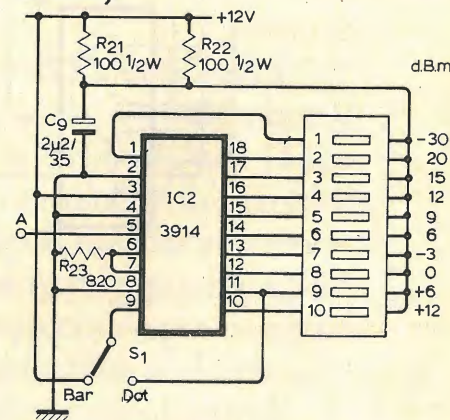
to the input. All of the i.e.d.s should turn on. Reduce the input to 0dBm and adjust  $R_{24}$  until i.e.d. 8 is just extinguished. Increase the input to +12dBm and adjust  $R_{26}$  until i.e.d. 10 is just on. Repeat the last two adjustments as necessary. Reduce the input to -30dBm and adjust  $R_{25}$  until i.e.d. 1 is just on. Re-adjust  $R_{24}$  and  $R_{26}$  if necessary.

The calibration should now be within 1dB over the range 80Hz to 15kHz. The lower sensitivity limit can be extended by connecting a 33Ω resistor in series with  $D_3$ .  $R_{25}$  can then be adjusted so that i.e.d. 1 turns on with an input of -55dBm, but the scale below i.e.d. 8 will need to be recalibrated.

The circuit is fairly sensitive to temperature variations, due to the characteristics of  $D_1$  and  $D_2$ , but it is nevertheless useful

in studios and other controlled environments.

N. McLeod  
Hove  
E. Sussex



T1 RS 217-804  
RS 217-810

### Gate tester

Fig. 1 tests quad dual-input type gates by comparing the logic operations of a reference i.c. with the device under test. Input signals are provided by a square-wave generator and divider.

Two alternative circuits are shown for testing 3-input and 4-input gates, using the same output arrangement.

K. Wright  
Colchester  
Essex

Fig. 1

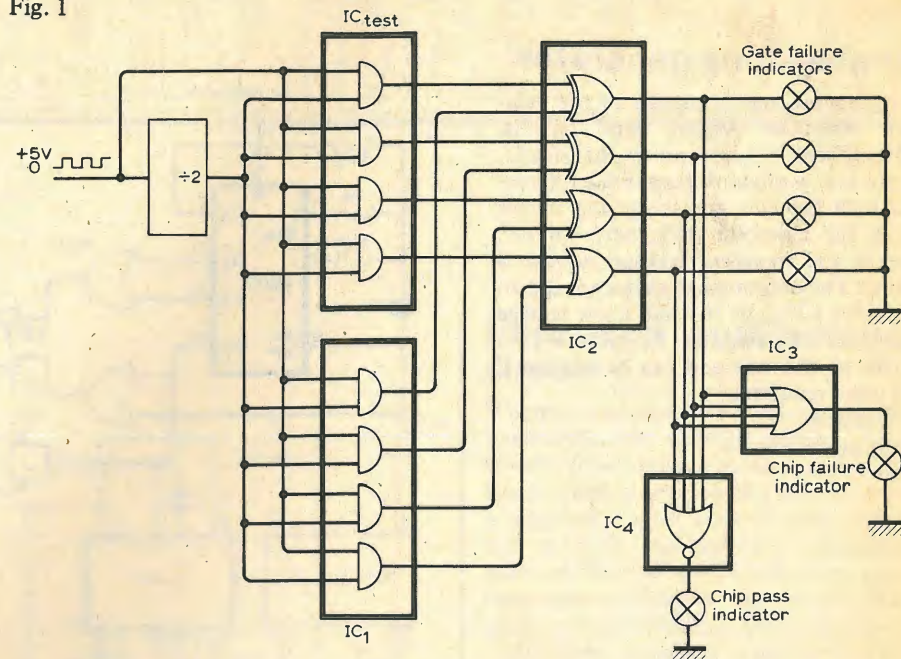


Fig. 2

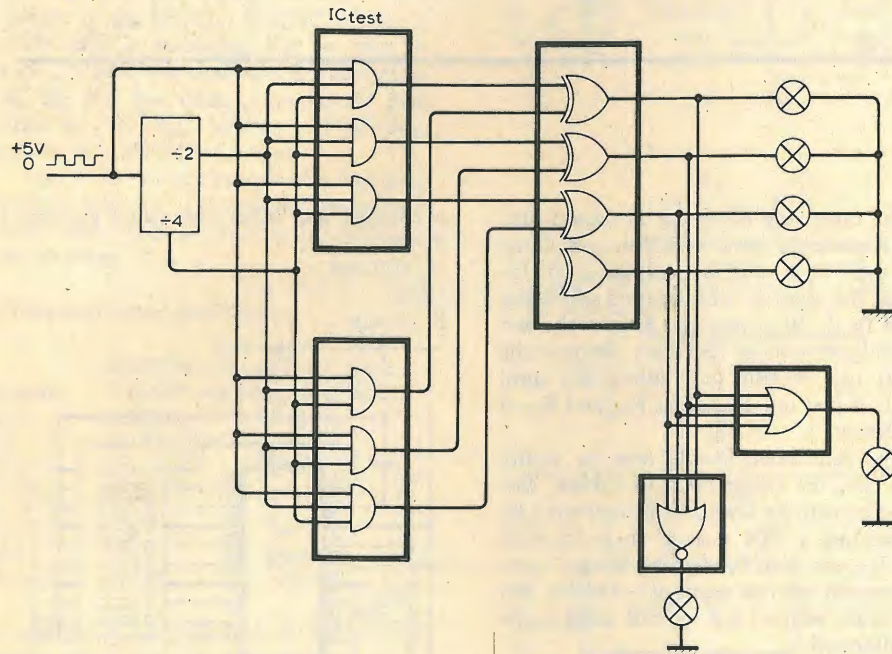
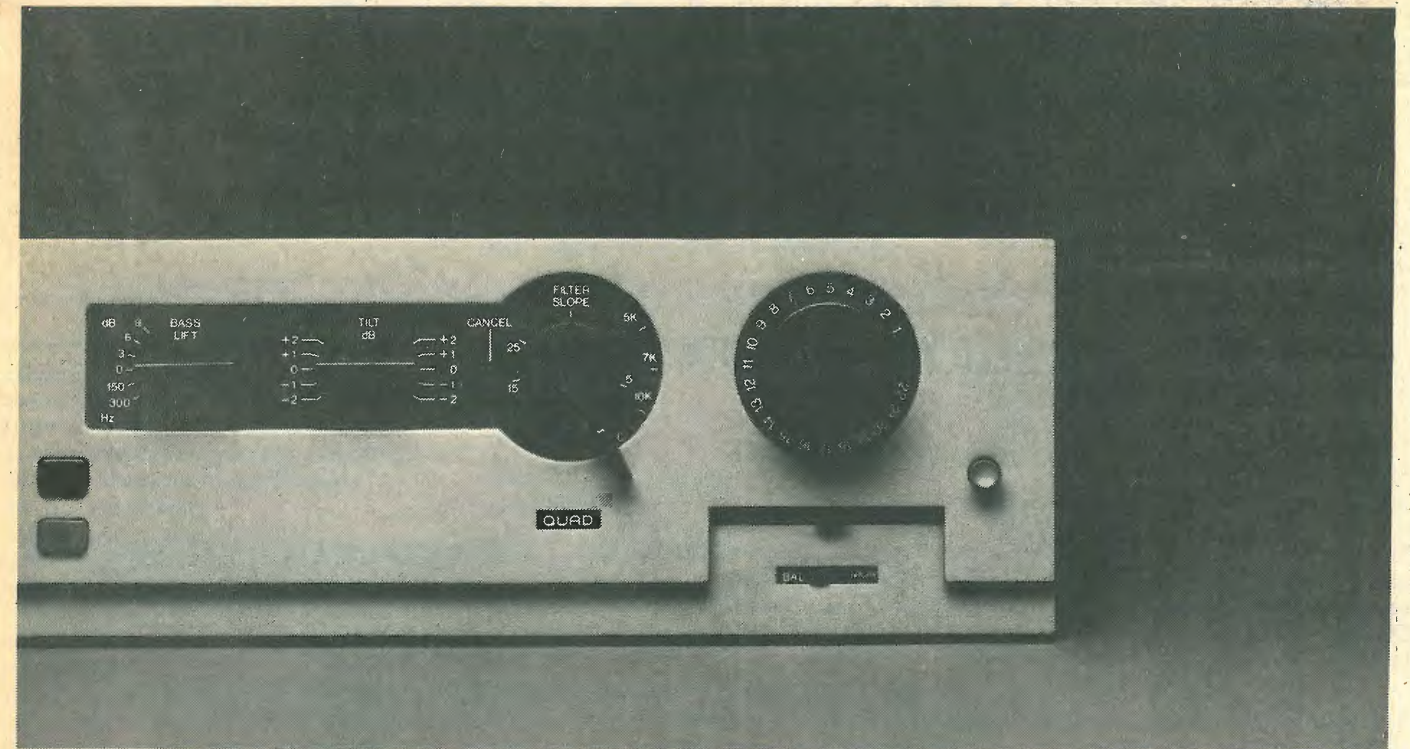
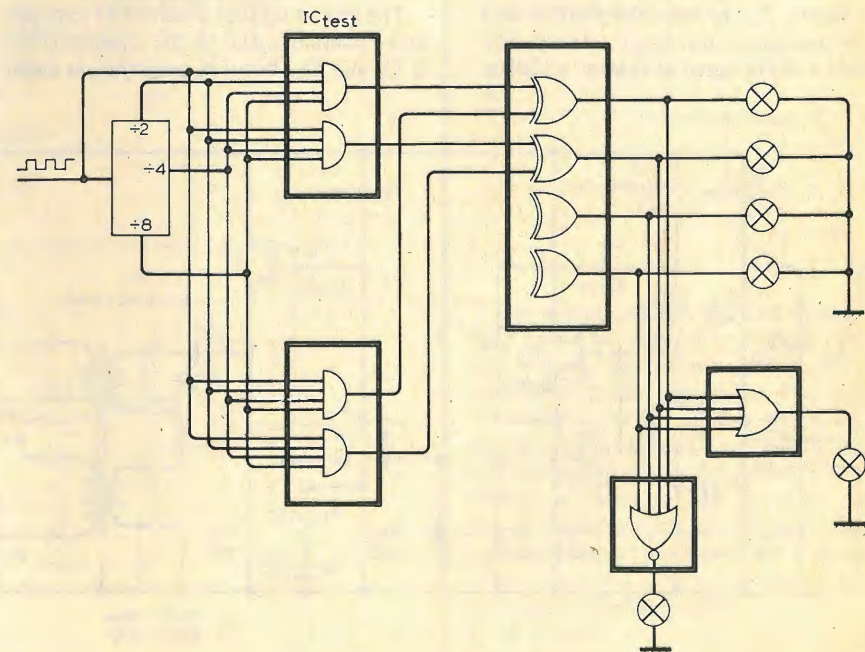


Fig. 3



# If everything were perfect...

It is rarely necessary to have to boost the bass response of a top quality high fidelity system, (although the Quad 44 tilt control does enable subtle changes to be made to the overall balance of the programme), but there are a number of high quality loudspeakers on the market, which because of their Lilliputian dimensions, necessarily have attenuated low frequency response and the Quad 44 is fitted with a bass control which in the lift position provides optimum equalisation.

Considerations of domestic harmony frequently dictate loudspeaker placement that is less than ideal. The almost inevitable result is the excitation of the fundamental eigentones of the room

and music reproduction with a characteristic and unpleasant honk.

The step side of the Quad 44 bass control switch eliminates this problem without rolling off the low frequency information, simply by putting a 5dB step in the frequency response, reproducing domestic bliss and a closer approach to the original sound!

To learn all about the Quad 44 write or telephone for a leaflet.

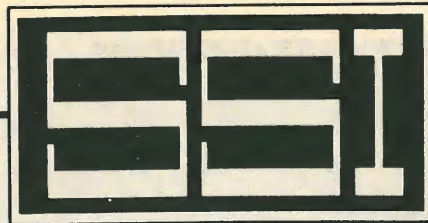
The Acoustical Manufacturing Co. Ltd., Huntingdon, PE18 7DB. Telephone: (0480) 52561.

# QUAD

for the closest approach to the original sound

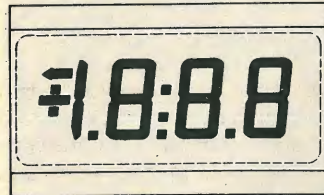
QUAD is a registered trade mark.





## Semiconductor Supplies International Ltd.

Dawson House, 128/130 Carshalton Road  
Sutton, Surrey, England, SM1 4RS  
Tel: 01-843 1128 (Sales) 01-843 0829 (A/C Dept.)  
Telex: 946650



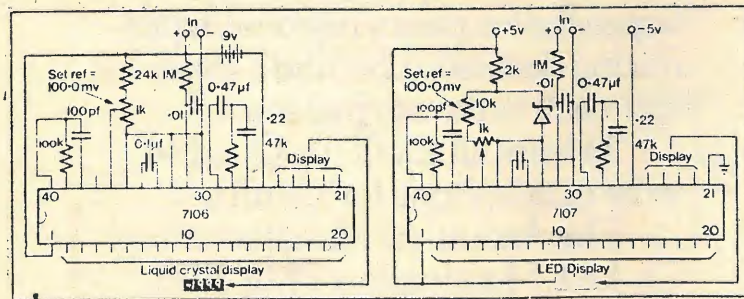
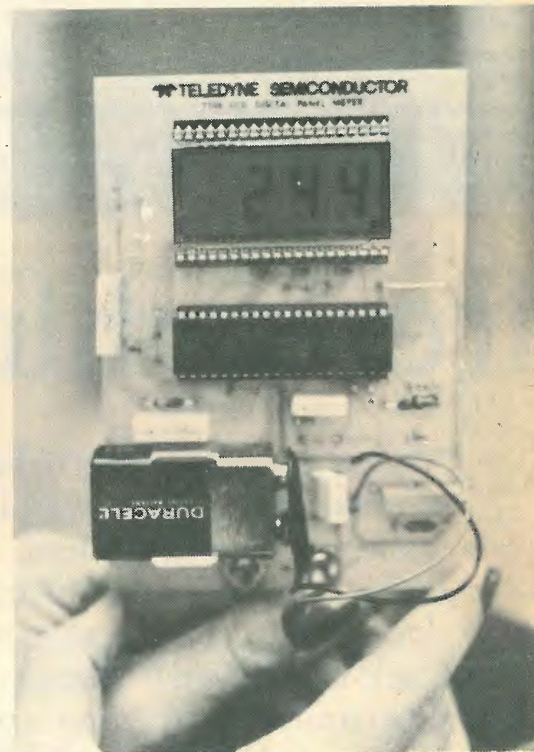
### BUILD YOUR OWN HIGH ACCURACY 3 1/2 DIGIT PANEL METER

Teledyne Semiconductor has introduced two evaluation kits for the new 7106/7107 3 1/2 Digit Monolithic CMOS A/D Converters. The kits are simple to use and will measure AC and DC voltages, multi-range DVMs, resistance currents, temperatures and other physical dimensions.

The 7106 kit uses a liquid crystal display and is normally powered by a single 9V battery. It is portable, can be used inside or outside and will not fade in sunlight. The 7107 kit uses light emitting diode displays and requires an external power supply. It operates under normal indoor ambient light conditions. Both kits include parts for 200MV full scale. The kits use the I.C. internal reference, which at 100ppm is adequate for most applications. However, they can be modified to operate from an external reference where higher stability is required.

Each evaluation kit contains one I.C. (either 7106 or 7107), one display (either LCD or LED), a PCB, passive components, miscellaneous hardware and a detailed 6-page application note.

The comprehensive application note contains all assembly instructions.



**THE 7106 EVALUATION KIT COSTS  
£17.44 + VAT**  
**THE 7107 EVALUATION KIT COSTS  
£14.31 + VAT**

**TELEDYNE SEMICONDUCTOR**

PLEASE CONTACT OUR SALES OFFICE FOR FURTHER DETAILS ON DATA CONVERSION PRODUCTS (A/D; D/A; V/F; F/V; IC. Voltage References)  
WE ALSO STOCK THE 3 1/2 DIGIT L.C.D. DISPLAY (12.7 mm CHARACTER HEIGHT) FROM BROWN BOVERI  
WW-074 FOR FURTHER DETAILS

# Interfacing microprocessor systems

The control of industrial plant and simulator circuits

by P. Jackson and S. O. Newstead

Several microprocessor systems are available, either in kit form or assembled, which can be adapted to control plant. These systems are usually modified desk-top computers with connections to additional memory devices.

Although many training establishments purchase such systems to teach programming, interfacing the microprocessor is not always tackled. This article outlines the design principles required for interface circuits and describes a simple boiler simulator suitable for microprocessor control.

Interfacing circuits for plant control should enable a microprocessor to read an 8-bit digital number, operate an a-to-d converter and read the output, switch external devices on and off independently, and output an 8-bit digital number. The first function is useful when several pieces of equipment are monitored. For example, when raising steam an oil-fired industrial heating boiler must have a flame, an induced draught fan and a forced draught fan in continuous operation. A sensor on each fan and a sensor on the flame, whose outputs are converted to logic levels, can be read as the three l.s.bs of an 8-bit number with the remaining bits connected to ground.

A subroutine which deals with this monitoring process can be written as follows, SUBROUTINE NO. 1010

```

1000 RETURN
1010 READ 27,A
1020 IF A=7 GOTO 1000
1030 IF A=0 PRINT "ALL SYSTEMS FAIL"
1040 IF A=1 PRINT "F.D. & FLAME FAIL"
    
```

1100 WRITE 30.1  
1110 GOTO 600  
The digital number is read into the microprocessor and stored in memory location A. The circuit which responds to instruction 1010 is discussed later. If the plant is operating correctly, the program leaves the subroutine. However, if there is a fault it is displayed on the v.d.u., instruction 1100 switches on an audible warning and the plant closes down. Instruction 600 is assumed to be the start of the closing down routine. A pro-

gram stop can be included in this routine as follows,

```

650 IF A=7 GOTO 670
660 STOP
670
    
```

Therefore, a healthy system can be tempo-

rarily closed down, and a faulty system closed down permanently. The second function is useful whenever an analogue transducer is used. For example, pressure, temperature, acidity, rate of flow or position measuring devices. The program must be held until the a-to-d converter has completed its task. If the converter uses a counter and a comparator, the time for the converter to operate is proportional to the magnitude of the analogue signal. The status strobe from the converter is therefore

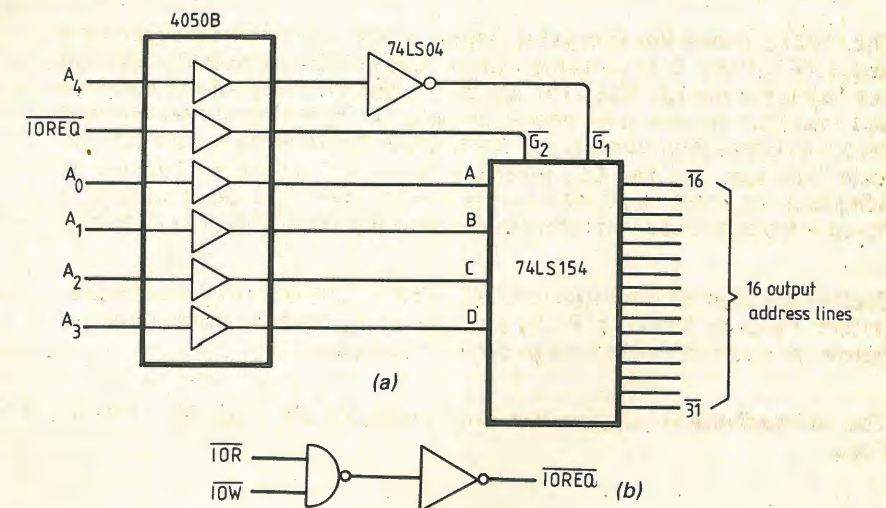


Fig. 1 (a). 16-address demultiplexer. If ports 8 to 15 are required, use 74LS138 in place of 74LS154. Control signals from a microprocessor system may be RD and WD to distinguish between read and write, with IOREQ and MREQ to distinguish between input/output ports and memory. Alternatively, they can be IOR and IOW with MR and MW. In this case IOREQ can be achieved as shown in (b).

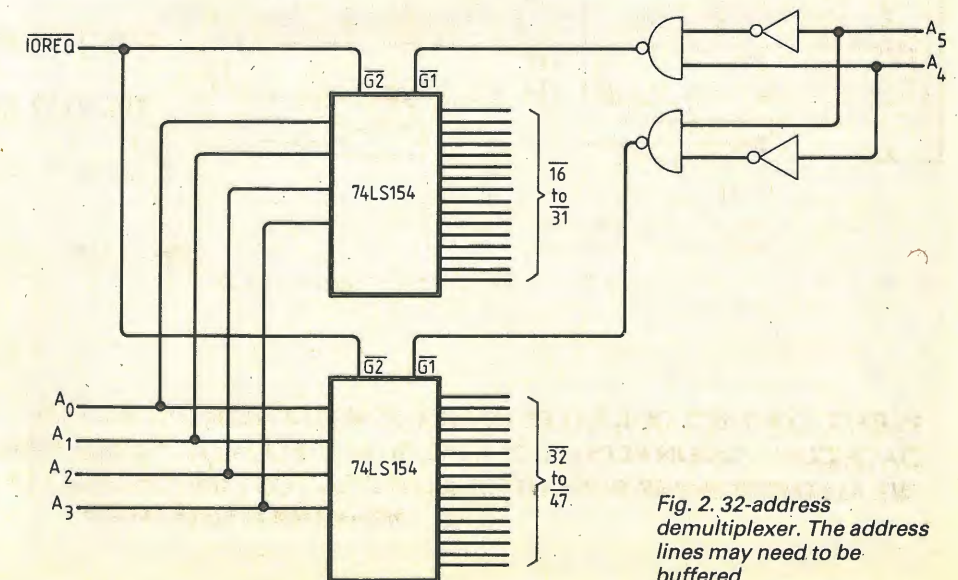


Fig. 2. 32-address demultiplexer. The address lines may need to be buffered.

used to hold the program.

The third function, switching external devices on and off, is the control of the plant by the processor. The final function, which gives an 8-bit digital number as an output on eight lines, can be used when variable control signals are needed. A programmable power supply in automatic test equipment could be controlled in this way.

When designing interface circuits, the signals available from the c.p.u. must be considered together with the system it is connected to and the plant to be controlled. Some of the pins on the c.p.u. are fully buffered and will drive 74LS logic, others are unbuffered and will drive c.m.o.s. As the interface circuits will probably contain a mixture of 74LS and 74 gates, control signals from the microprocessor must be buffered, and a c.m.o.s. 4050B provides six buffers at a reasonable cost. If the microprocessor contains a large memory, c.m.o.s. buffers may be needed between address, data and control signals from the microprocessor must be buffered, and a c.m.o.s. 4050B provides six buffers at a reasonable cost. If the microprocessor contains a large memory, c.m.o.s. buffers may be needed between address, data and control signals from the microprocessor must be buffered, and a c.m.o.s. 4050B provides six buffers at a reasonable cost.

Some microprocessor systems already contain ports, and the process to be described assumes that these exist but additional ports are needed. The ports which are added to the microprocessor, and through which the four functions listed previously are carried out, need to be addressed. Microprocessors have 8, 12 or, more usually, 16 address lines which form the address bus. These are normally fully buffered to cope with the complete memory, 64K for 16 address lines. For port use, the eight least significant lines A0 to A7 are available together with the input/output read (IOR) and input/output write (IOW) control signals. The control signals are used when read and write instructions are reached in a programme.

Although machine code can be used to fetch data from a port or to output data to another port, because it is generally easier to work in a high-level language, the examples given here are in BASIC.

A system as purchased may contain some ports which use addresses 0 to, say, 7. Additional ports for plant control can therefore be numbered 8 to 255, using A0 to A7. To obtain 16 extra ports use Fig. 1, or Fig. 2 for 32. C.m.o.s. buffers have been included but it may be possible to use 74LS154 devices and omit the buffers. To read an 8-digit number, connect the eight lines which carry the number to the inputs of the tristate buffer in Fig. 3. An instruction such as 30 READ 26, B will cause address lines A1, A3 and A4 to go high, and when the IOREQ pulse reaches the demultiplexer in Fig 1, line 26 will go low. The other demultiplexer outputs remain high.

While the IOREQ pulse is present, the RD pulse is received by the tristate buffer in Fig. 3. This pulse, together with address 26, opens the buffer and connects the input signal to the data bus. During the RD pulse the buffer in the c.p.u. opens and closes to load the number on the data bus into a register. Several tristate buffers can be connected to the data bus and selected

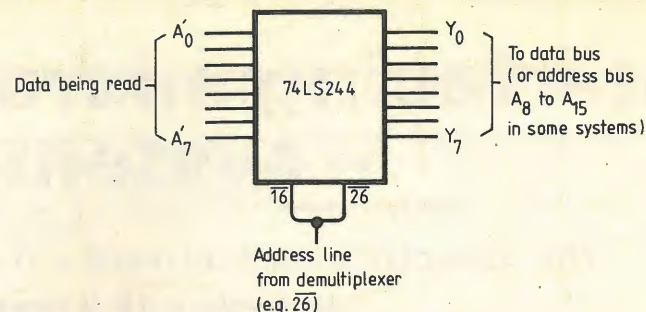


Fig. 3. 8-bit number input using a tristate buffer. In some systems ports are addressed on address lines A0 to A7 and data is transmitted on data lines D0 to D7. Other systems reserve data lines for memory data and use address lines A8 to A15 as data lines when ports are addressed by A0 to A7. This should be checked in the c.p.u. manual.

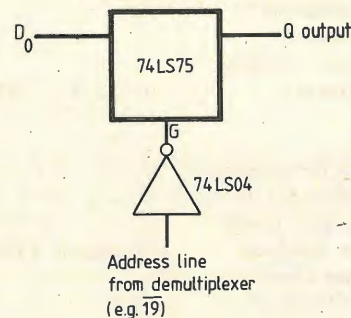


Fig. 4. Output latch. Q is set to D0 when the IOREQ pulse strobes the address demultiplexer. An 8-bit number can be latched into an output port by using eight latches fed from D0 to D7, and connecting the G pins in parallel.

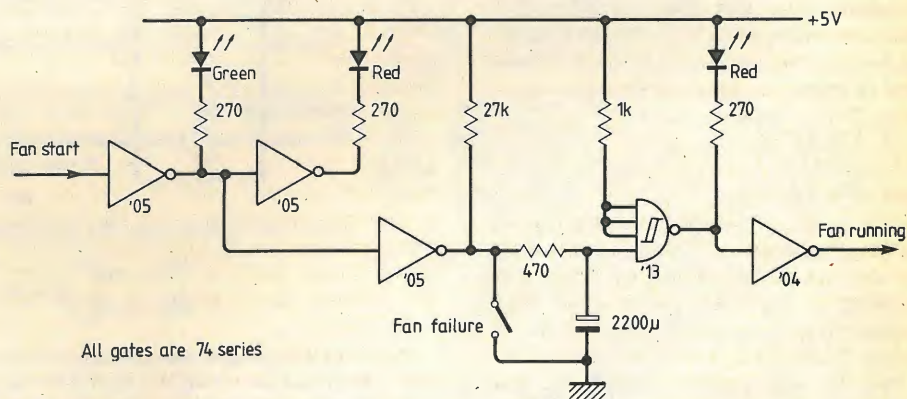


Fig. 5. Fan simulator.

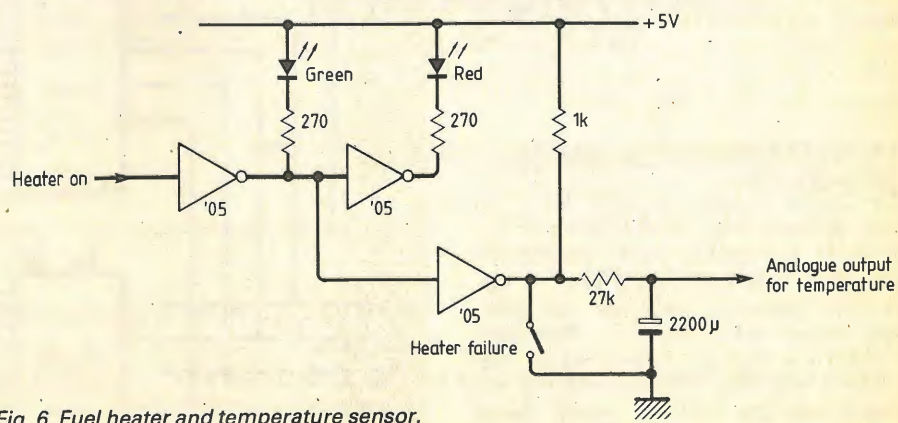


Fig. 6. Fuel heater and temperature sensor.

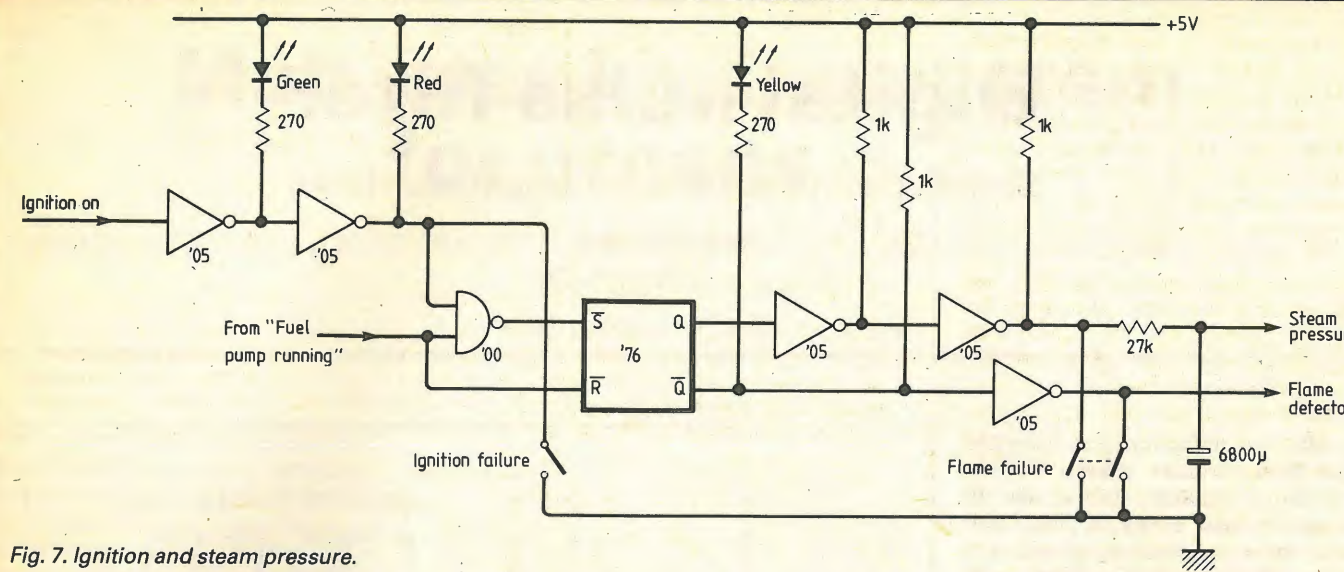


Fig. 7. Ignition and steam pressure.

ted in turn by each address. If the input to one of these buffers is obtained from an a-to-d converter, three instructions may be used. The first instruction produces a pulse which sets the converter counter to zero and starts the count. At the same time, the c.p.u. is set to a Hold mode, which prevents it from advancing in the program until the wait signal is removed. The wait signal is held by the status signal from the a-to-d converter. The second instruction reads data into the c.p.u., and the third instruction resets the latch set by the first instruction. Typical instructions to read an analogue signal from address 20 and to store it in the memory at location Q are,

```
80 WRITE 19,1
90 READ 20,Q
100 WRITE 19,0
```

where 19 is the address of the latch which starts the converter. In this example, which uses the circuit in Fig. 4, the least significant data line is coupled with address line 19 to operate the latch in two ways. If this is not done, two address lines must be used, which makes the data quoted in the write instruction irrelevant. This method is advantageous when surplus address lines are available.

External devices may be switched by latches with different addresses as shown in Fig. 4, or eight latches with the same address, connected to D0-D7, can output an 8-bit number. These can also be viewed as eight separate switchable lines. If reed relays are driven by the 74 logic which makes up the interface system, it is possible to control many types of plant.

### An oil-fired boiler simulator for microprocessor control

This simple model illustrates sequential switching of equipment, monitoring of the plant by reading a digital number and taking appropriate action, reading of an analogue number via an a-to-d converter and taking action based upon its value, use of a software time delay after switching a device on and then verifying that the device is operating, printing pressure and temperature at predetermined intervals and, in

the event of major failure within the plant, closing down and locking out the plant followed by a print out of the failures and an audible alarm.

The boiler simulator comprises an induced draught fan and forced draught fan. When the starters are switched on, these fans gradually run up to speed so the fan-running signal is subject to a delay. When the boiler is started, the fans must run for a while to purge the furnace before fuel is sprayed in.

A fuel pump, which must not be switched on unless the furnace has been purged, the fuel has been heated above the minimum temperature and the ignition has been switched on.

A flame detector. The flame must appear a short time after the fuel pump has been switched on and, if it does not appear, the boiler must be shut down. The microprocessor can be programmed so that a flame failure stops the fuel pump, purges the furnace and attempts to ignite the boiler again.

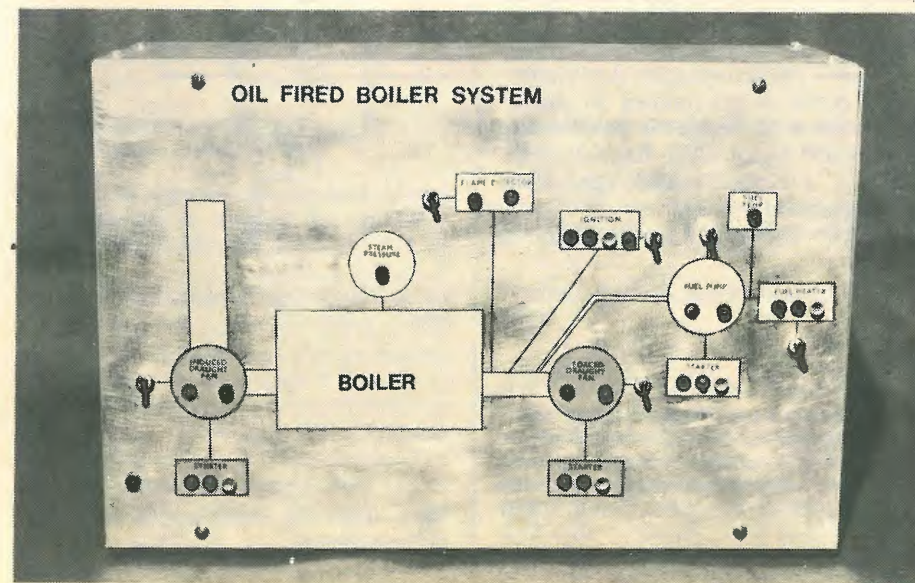
A fuel heater. This is easily switched on, but a check can be made by measuring the fuel temperature, switching on the heater, introducing a software delay, measuring

the fuel temperature again and checking that the temperature has risen.

The logic, is 74 series throughout, does not provide latches in the simulator because they are part of the output ports of the microprocessor system. A logic 1 applied to the fan start input of Fig. 5 switches the starter i.e.d.s from red to green. After a short delay the red i.e.d., which indicates that the fan has run up to speed, turns on and a logic 1 appears at the fan-running terminal. The delay must be allowed for by the software. This circuit can be used for both fans and for the fuel pump with a smaller capacitor to simulate the faster response. If the fan-failure switch is closed, the starter will operate but the fan will not run up to speed.

The a-to-d converter in Fig. 6 gives an output proportional to the fuel temperature. This output is between 00 and FF (0 and 255) and can be displayed as °C without scaling. Once the oil is alight, the ignition can be switched off. If the fuel pump stops, however, the flame will go out. Flame failure and ignition failure can be manually introduced at any time as shown in Fig. 7 and the program should cater for these eventualities.

Prototype boiler simulator



# Digital noise filter

Simple design suitable for electronic clocks

by P. A. F. Lam

Although l.s.i. techniques and mass production have produced reliable low cost digital clocks, the logic circuits are still susceptible to false triggering pulses from electrical noise and switching transients. A common solution to this problem is the addition of a carefully designed low-pass filter, but, in some applications, this does not always remove the problem. A more effective solution is the addition of a simple digital noise filter which can eliminate over 90% of all false trigger pulses.

A typical digital clock arrangement is shown in Fig. 1(a) and a modified circuit is illustrated in Fig. 1(b). The filter is based on a non-retriggerable monostable, shown in Fig. 2, whose time constant must be smaller than the period of the incoming pulses in Fig. 3. In most clocks i.c.s, the time reference is derived from the mains frequency, therefore,  $T = 1/50s$  and  $t < 1/50s$ . Because the monostable is non-retriggerable, the clock is immune to noise which occurs during the  $t$  period in Fig. 4. If a false pulse appears in the  $T-t$  region, the monostable is triggered but the next correct trigger pulse occurs within the new  $t$  range and is rejected. Therefore, the reference frequency is not changed and the phase error only lasts for one pulse. Clock accuracy can only be affected if a continuous stream of noise pulses occur during the  $T-t$  region in a time  $T^1 \geq nT$  where  $n$  is  $(T/t) - 1$ .

A longer period for  $t$  gives a higher noise immunity coefficient  $n$  but, usually,  $t$  cannot be longer than 95% of  $T$  due to the stability of the circuit. If this filter is to be used in a very noisy environment, the addition of an ordinary power-line filter will improve the performance. Application of this circuit is not limited to digital clocks because the design can be extended to any digital signal which has a periodic nature e.g., the synchronizing signal from a communication modem.

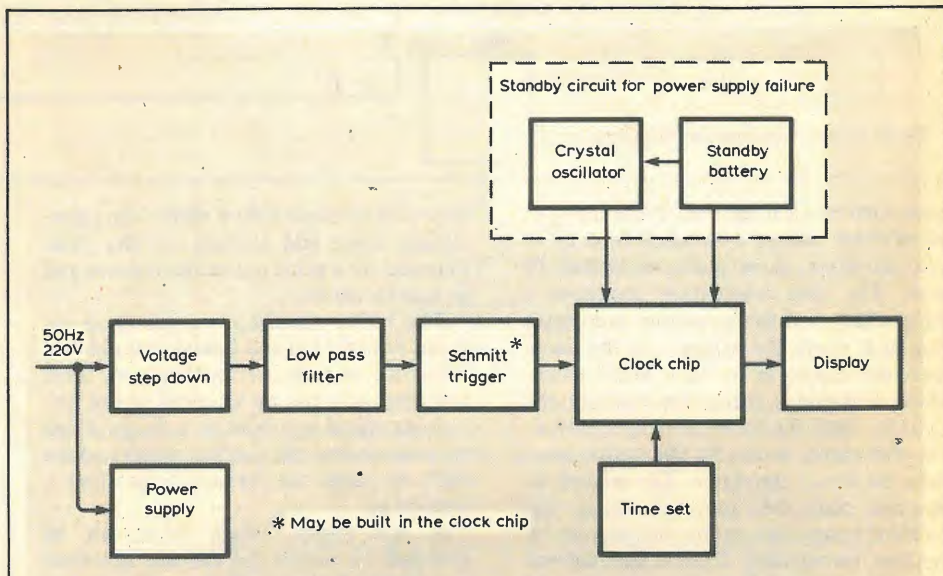


Fig. 1. (a) Typical digital clock arrangement, (b) modified system incorporating a noise filter.

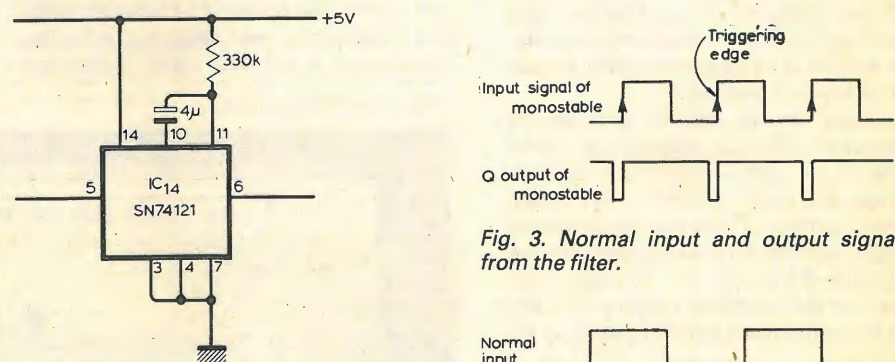


Fig. 2. Non-retriggerable monostable noise filter.

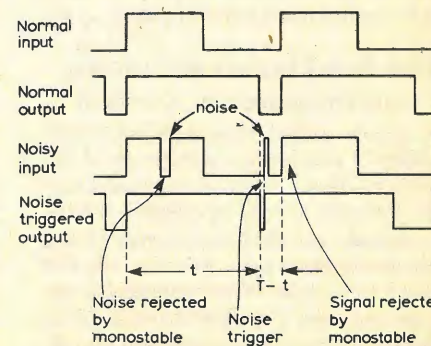


Fig. 4. Input and output signals with noise pulses present.

We have received from Plessey an application note on the use of the TDA 1085A phase-control i.c. in closed-loop systems with tachometer frequency or voltage feedback. It is available from Plessey Semiconductors, Crowley's Hill Estate, Kembrey Street, Swindon, Wilts SN2 6BA. WW405

# Multiplex keying system for organs - 2

A practical solution to the wiring problem of multiple key contacts in pipe or electronic organs

by A. W. Critchley, Dipl.El., M.I.E.R.E.

**TDM system reduces drudgery and cost of building an organ, whether pipe, electronic or hybrid. It permits a wide range of organ features, many hitherto unobtainable on electronic organs, allowing closer simulation of pipe organs at a fraction of the cost. The principles can easily be adapted for microprocessor control at a much lower hardware cost and complexity.**

As demultiplexers comprise not only a significant part of the electronics but also a source of complexity it obviously pays to use the extension principle, see part 1.

The various manual outputs come out of the pitch shift register at different times so they must be delayed to arrive at a common demultiplexer at the same time. So manual scan period delays are necessary when collecting the voice outputs for an extension organ, but not for the traditional one.

## Mixture stops

These are normally found only on the large pipe organs and almost never on cinema organs. The principal reason is that they require two or more ranks of pipes for each stop. They have a peculiarity in that the notes sounded are always toward the top of the range, no matter which keys are played, to add brilliance. To achieve this the individual ranks break to lower notes as they come in turn to the top of the keyboard. These breaks occur at different places in the scale of the manual.

To be strictly musical these stops should key generators which are independent from the rest of the organ (and have no tremulant on them either) as the pitches are supposed to be true harmonics of the keyed pitches. This is really a question for argument amongst purists but the reasoning is that the multiple notes sounded generate beat frequencies which should be the same as the fundamental or other low harmonics of the keyed notes. With common generators this does not happen due to the deliberate mis-tuning of the even-tempered scale and the resulting beats are off tune.

For most purposes this does not matter too much as a pipe organ is full of mistuned beats at the best of times (the chorus effect) due to the many independent pipes - especially so when mixtures are likely to be used. In an electronic organ of one generator rank it is a different story. Still,

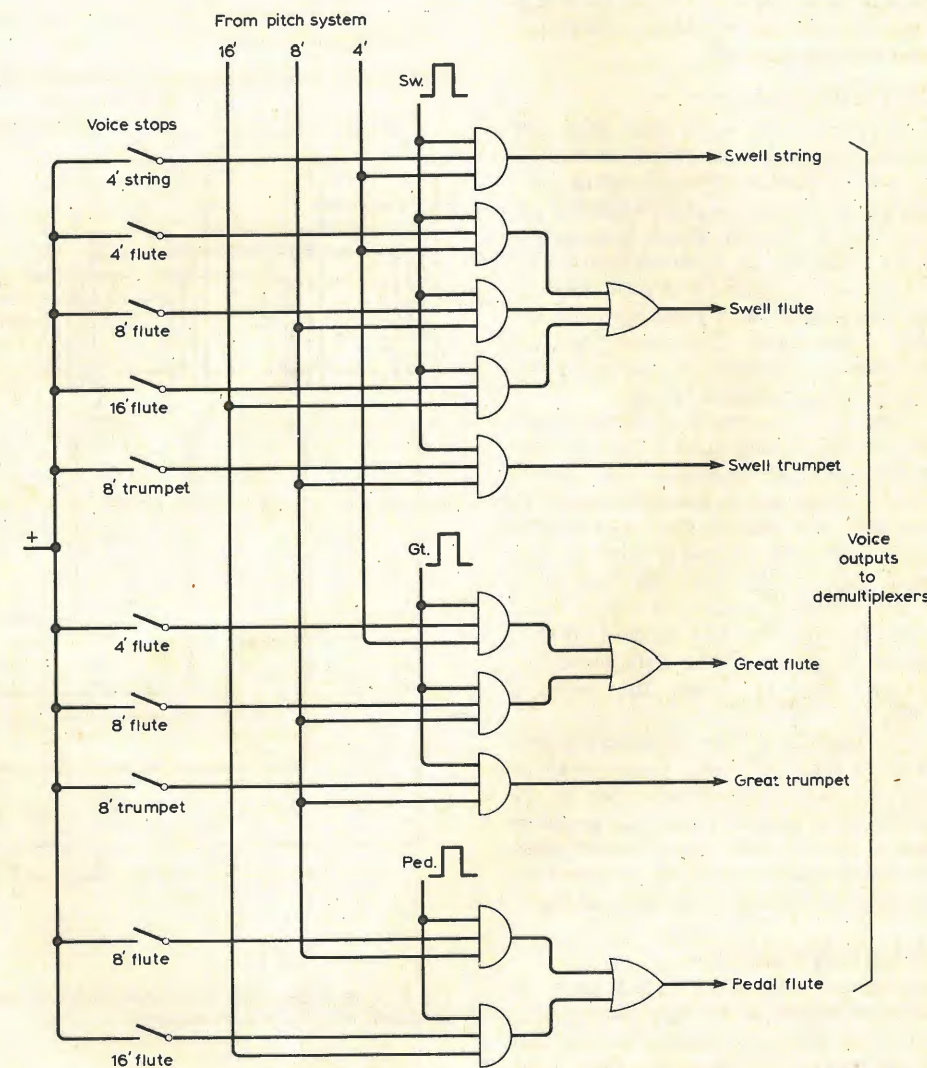


Fig. 7. Simplified pitch selection system for two-manual church organ, resulting in three demultiplexers instead of six.

any mixture is better than no mixture and it is simplicity to provide one with this system. The method is shown in Fig. 9 which shows how to generate a four-rank mixture stop as found on a large organ. This one is based on the one found on the choir manual of St Albans cathedral organ.

The range of notes played is from 45 to 92. The maximum pitch required from the generators is 1 1/3 ft but the maximum pitch relative to a key is 1/4 ft (for notes 1 to 12). The pitch shift register thus has to extend for five octaves beyond unison pitch in order to accommodate this mixture stop.

## Composition of a four-rank mixture

Played Ranks Notes played keys

		I				II				III				IV			
1-12	26	29	33	36	45-36	49-60	57-68	61-72									
13-20	22	26	29	33	49-56	57-64	61-68	69-76									
21-33	19	22	26	29	52-64	57-69	65-77	69-81									
34-44	15	19	22	26	58-68	65-75	70-80	78-80									
45-51	12	15	19	22	64-70	69-75	76-82	81-87									
52-61	8	12	15	19	64-73	71-80	76-85	83-92									

### Timing

The unison pitch delay due to sub-octave coupling and 32ft pitch generation amounts to three octaves. With the five octaves required to generate up to 1/4 ft pitch for mixtures, eight octaves have to be added to the six for each keyboard scan to give clearance between keyboards. This results in a total of 14 octave pulses. It would be reasonable to settle for the good binary number of sixteen which then allows for a super-octave coupler (2ft pitch) if desired. A further keyboard scan period could be added to cater for other contact data such as stops, pistons, etc.

Sixteen octaves contains 192 pulses (keys). This is convenient as a suitable c.m.o.s. shift register contains 64 bits so that three packages would give the correct delay between manuals.

### Demultiplexing

Conversion of the serial data back into parallel information to switch on and off the various pitches is performed in a demultiplexer consisting of a D-bistable per pitch and a decoder which sequentially clocks them, Fig. 10. The data inputs of all bistables are paralleled and each clock input receives one clock pulse per complete scan of the organ. The output data are therefore incremented in scan and faithfully follows the original keying.

There is unfortunately a practical problem with this arrangement in that the integrated circuits are packaged with separate data inputs and a common clock input. To overcome this, another shift register with taps at every stage is used to drive the data inputs sequentially whilst the clock input of the bistables receives a single clock pulse per scan. The clock input of the shift register is driven at the data pulse frequency. Fig. 11 shows the practical system.

The outputs of the bistables operate whatever form of keying circuit is to be used; a c.m.o.s. transmission gate is one possibility. A transistor interface would be used to drive a pipe organ magnet when the demultiplexer could be mounted on the pipe chest and thus save more wiring.

### Automatic pedal

Pianists are sometimes called upon to amaze onlookers at an organ but are not able to perform adequately with their feet for the bass part of the music. Here is the answer!

The pedal department can be played from the lowest note *only* of whatever is being played on the manuals, usually the great manual. Due to the scanning process, the first note obtained from the manual is also the one of lowest frequency. The simple circuit of Fig. 12 obtains this note and ignores the rest. The input data sets an R-S latch which can be set only once by the input data if enabled by the great gating pulse. The resulting pulse is then shortened to obtain only the leading edge. This signal, together with a pulse occurring just before the great scanning period, reset a counter clocked at note rate. Its period is sufficient to place the output transition in the right place for the

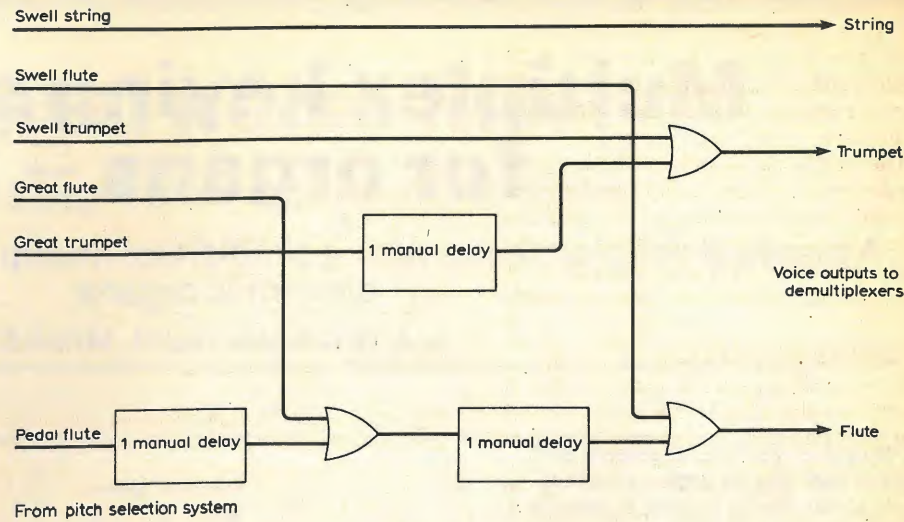


Fig. 8. Voice collection system for extension organs (simplified).

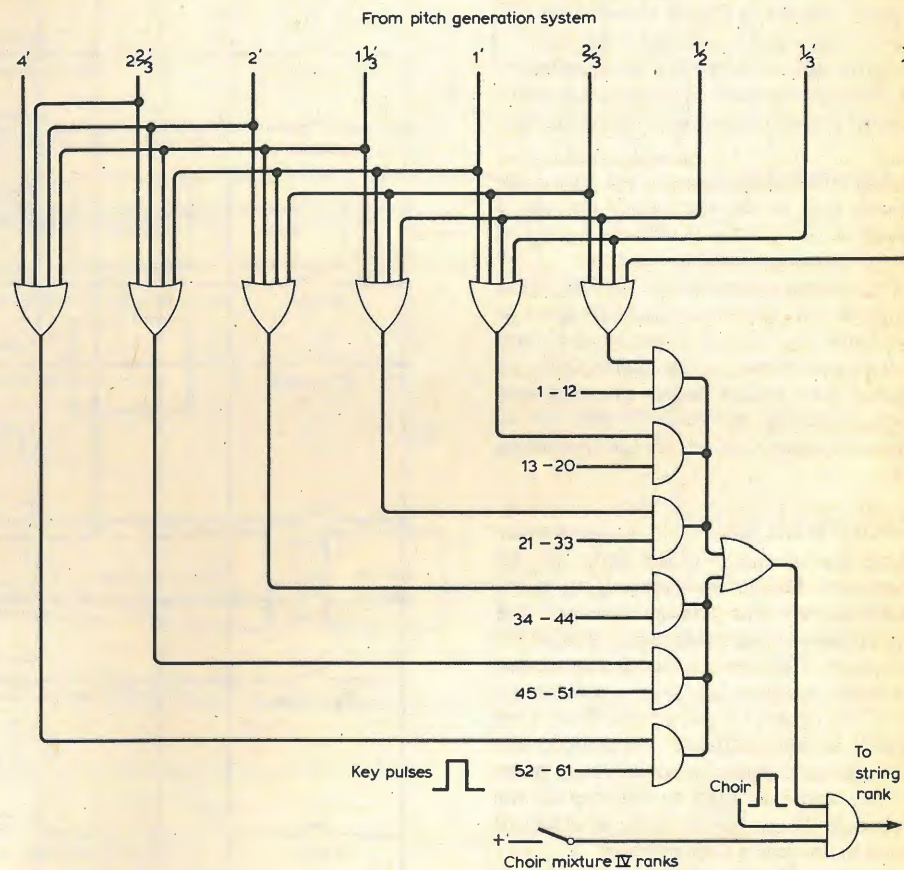


Fig. 9. How to generate a four-rank mixture stop as found on a large organ (based on St Albans Cathedral choir manual).

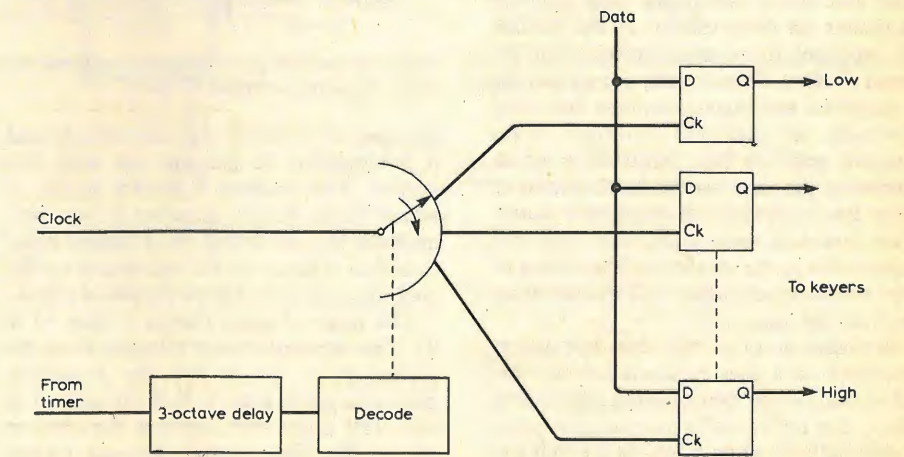


Fig. 10. Serial to parallel data conversion is achieved by a D-type bistable per pitch and a decoder to sequentially clock them.

note to be played in the pedal scan time – it must be less than one total scan. A D-bistable and nor-gate reduce the long pulse from the counter to a one-note wide pulse at this time.

The output signal could be further gated to prevent the pedals from being operated by high notes on the manual. It could also “break back” the pedal notes to the lowest octave whichever keys were being played if a variable shift register were also included.

### Automatic melody

With a small organ it would be useful to be able to solo and accompany on the same manual without the bother and expense of second-touch keys or splitting the keyboard. This can be done by extracting the last, or highest, note from the keyboard in use and using it to operate some other keyboard or voice. It is the reverse of the automatic pedal system.

A counter with a period at least equal to the delay between the played note and the note to be played is clocked at the note rate. It is continually being reset by the input data from the manual so that the counter produces an output change at the correct time to activate the note to be played as a solo. To prevent continuous action, the reset-pedal is fed with a pulse which disables the counter after the time required to produce the output. If no notes are played, the counter will not then give a false result. A D-bistable and AND-gate convert the counter output back to a single note-wide pulse. Fig. 13.

For soloing on the same manual with a different voice, a complication arises in that the counter has to be reset just before that manual can operate. So to get the information to the voice demultiplexer requires that the counter have a delay to one total scan less one manual scan and the manual scan is made up with a shift register to render it coincident with the original note.

### Percussive action

For bells, chimes and similar percussive effects, each note has only a short duration even though the key may be held on. It also has to operate whether or not other keys are held down on the same manual. This is achieved by digitally shortening each note in the serial data stream for a particular demultiplexer. One such circuit will work for all the notes on that demultiplexer. Each note has its own decay system as required for the voice effect which is part of the demultiplexer.

A suitable period for each note to operate is perhaps two scans of the organ (1/50 second, say) and the delay is provided by a shift register.

An AND gate cancels out any pulses after the two scan periods. The shift register must be clocked at note rate but the total delay has to be in increments of the total scan time to effect cancellation in the gate. This gives a long shift register, Fig. 14.

One of these circuits can handle all the percussive requirements of the entire organ if the output is routed and gated by appropriate manual gating pulses. With

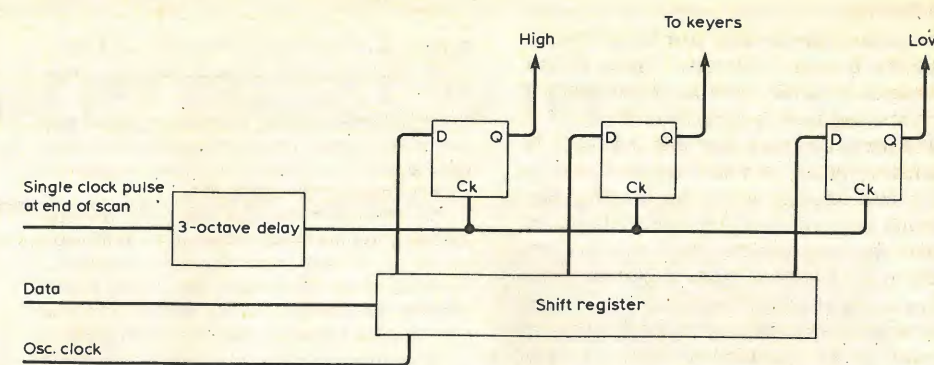


Fig. 11. Practical demultiplexer uses additional shift register to drive data inputs sequentially whilst the clock input of the bistables receives a single clock pulse per scan.

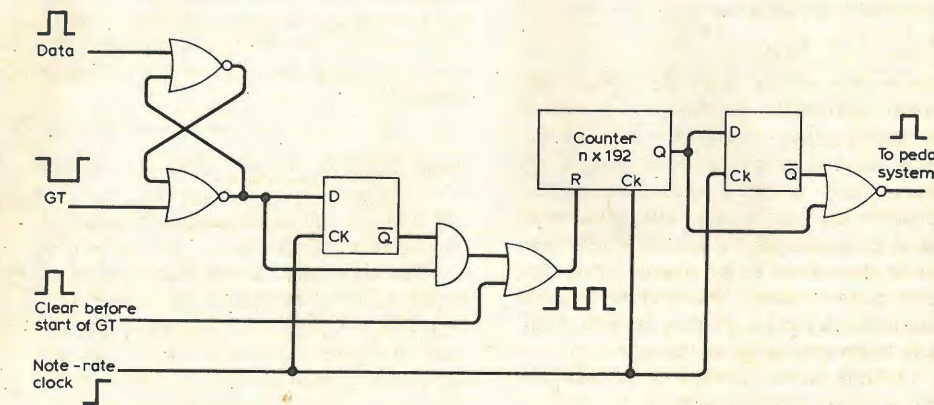


Fig. 12. Pedals can be played from the lowest note only of whatever is being played on the manuals.

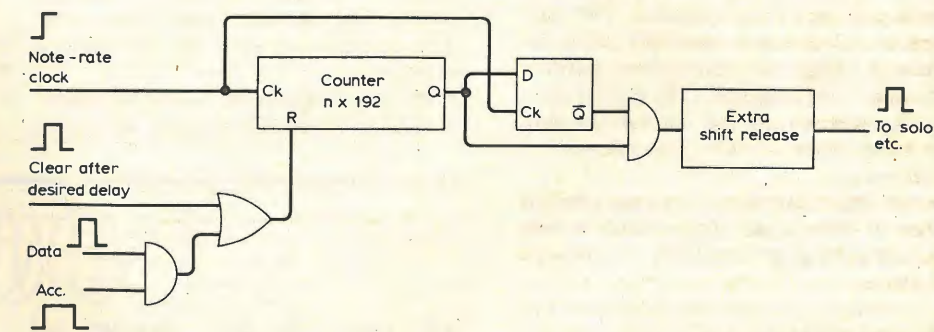


Fig. 13. Solo and accompaniment can be obtained from the same manual by extracting the highest note in use.

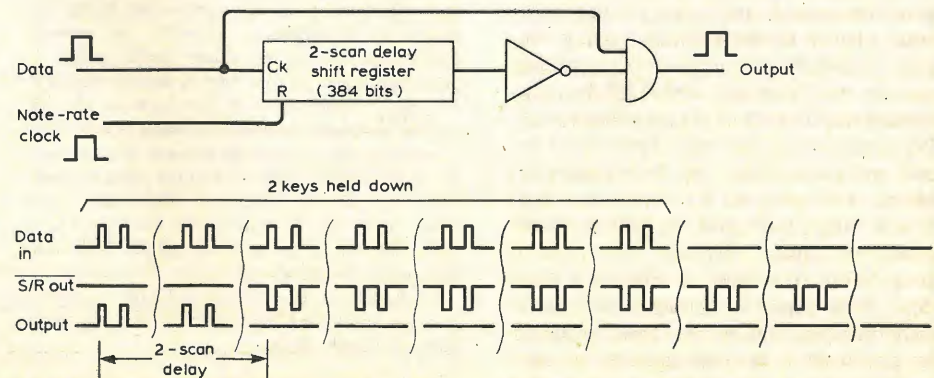


Fig. 14. For percussive effects each note has to be shortened to two scans of the organ. Delay is provided by a shift register.

further delays in increments of manual scan periods it can also provide pizzicato coupling between manuals. These delays already exist in the coupling system so that all that is required is some logic.

Pizzicato coupling can also be used to momentarily key in noise or harmonics in electronic organs in order to simulate starting tones or chuff in flute and diapason pipes.

As the percussion output ceases if the notes are held down, it follows that a pulse will occur every time any note is changed even if the rest are still down. This is very useful; it means that untuned percussion is possible merely by gating out each manual or pedal scan to a simple percussion effect generator without the need for a demultiplexer. This is not possible on theatre organs where the key contacts were simply paralleled to operate the "traps."

### Microprocessor control and other possibilities

The multiplexing system is an ideal application for a microprocessor. It could be implemented with a good deal less hardware than indicated, but at a great cost in programming. Basically, the organ can be considered to be a large programmable memory source which is continually being altered by the player. A sequential scan can be generated by the microprocessor in 8-bit format instead of 12 and the data stored in a holding store.

All stops, couplers, keys, switches and other controls can also be read into the store which then contains all the data available. The program then consists of manipulating the contents en route to another output store according to the presence or absence of stops and couplers. For instance, to add an octave needs the microprocessor to look for available notes and then add 12 to their addresses. The output store can be read out in serial form or the data can be transferred in 8-bit bytes directly to the keyers.

The same hardware can cater for all types of organ and the specific details stored in programmable read-only memories.

Combination pistons can be included in the scanning process. The bigger organs have the facility of being able to couple them together in much the same way as the keys, e.g. to couple great and pedal pistons. In any case it would further reduce the wiring.

Including a stitchable delay in the demultiplexer clock path, or in the data stream gives a method of transposing the pitch of the entire organ — something novel for a pipe organ. Extra pitches are desirable on the ends of the ranks though.

Synthetic stops are sometimes fitted to small extension organs and are intended to be used as solo voices. A typical one is the clarinet which is formed by keying three pitches of flute together — 8, 2 $\frac{2}{3}$ , 1 $\frac{3}{5}$  ft. This is a form of coupling and can easily be done by this system. Another synthetic stop is the oboe formed from 4, 2 $\frac{2}{3}$  and 1 $\frac{3}{5}$  ft pitches of flute. Acoustical bass, although not musically satisfactory, can be obtained by keying a

Arthur W. Critchley is President of Cross-point Video Limited of Scarborough, Ontario. He is a former committee member of the British Amateur Television Club and has contributed many articles to their magazine CQ-TV as well as to other magazines and *Wireless World* (Aug. 71).

His interest in organs is purely private, learning to play the church organ at the age of 14 in St Annes-on-Sea in Lancashire. Famous broadcasters on the cinema organ kindled his interest in this instrument and later on he became Minor's organist at a cinema in Uxbridge, playing for his own amusement. A life-long interest in the innards of organs led to several unfinished electronic organs — whoever finishes one of these projects! They must surely have the highest mortality rate of any home construction project. Presently he is building a three-manual entertainment type of organ with all the effects and second touch which embodies the principles outlined in this article.

pedal flute at 16 and 10 $\frac{2}{3}$  ft. Chimes are obtained by using 6 $\frac{2}{3}$ , 4, 2 $\frac{2}{3}$  and 2 ft pitches of flute with a decay. A two-octave range is usual.

The data stream can be displayed on an oscilloscope to represent the organ keyboard layout. The trace is triggered at the manual repetition rate and the manual gating pulses used to add different amounts of s.c. to the data to separate the traces. Each black key can be decoded to lift up the traces more than for a white key. This results in a fair representation of the keyboards.

It is possible to store the data in a memory — perhaps as a way of learning chords. The memory could even drive i.e.ds situated over each key for teaching purposes.

The scanning process could conceivably be used to generate automatic arpeggios.

## BOOKS

**Hi-Fi Choice No. 20 — Cartridges and Headphones**, by Martin Colloms, is the latest in this very useful series of guides to the choice of audio equipment. It follows the familiar form of a long introduction for both technical and non-technical readers, preceding a large number of test reports and data charts, buying recommendations and comparison charts on cartridges and accessories, the same procedure being followed for headphones. Clearly, the reviews themselves are an extremely useful guide to potential buyers of this type of device, which is not easily understood by the layman, the information otherwise being tediously culled from a large number of audio magazines, if it exists at all, but perhaps the most helpful parts of these books are the introductions. There have been many attempts to explain the finer points of audio devices to the general public, but these are models of clarity.

Hi-Fi Choice No. 20 costs £2.00 in paperback, is published by Sportscene and is available from booksellers.

**Communicating with Microcomputers**, by Ian H. Witten, is a layman's introduction to

Finally, the organ could be played automatically from the memory — shades of yesteryear with player pianos and organs. Sooner or later somebody reinvents a good idea! □

### Glossary

**Stops** are controls which select either the kind of sound or the manner in which keys may be coupled together. May be a form of rocker switch or drawstop types. Either kind might be electrically operated by solenoids for combination selections.

**Manuals** (keyboards) have various names according to the type or organ; accompaniment, choir, swell, great, solo, orchestral, echo are typical.

**Ranks**, complete scale of pipes or other generators.

**Magnets**, solenoids which control the air feed to each pipe.

**Couplers**, stops which enable keys to be joined so that one key can also do the job of another, but not in reverse.

**Unison**, normal pitch of the keys, also known as 8ft pitch.

**Mutation**, pitch which is not octavely related, e.g. 2 $\frac{2}{3}$ ft.

**Mixture**, stops play several high-pitched notes for every key to add brilliance.

**Second touch**, keying a second set of contacts by pressing a bit harder on the keys or stops, used in cinema organs to permit the playing of a melody and accompaniment on the same manual, usually by one hand!

**Octave**, twice the frequency, **Sub-octave** half of it.

**Tenor-C**, the C below middle C or the second C up from the bottom.

**Chiff**, splitting sound that some flutes make when they start up.

**Voice**, kind of sound a rank of pipes makes, e.g. a trumpet.

**Pitch**, frequency of a note. Refers to the length of an open-ended pipe for the lowest note on the keyboard which is 8ft long. An octave up would be half as long at 4ft, and so on.

**Diatonic scale**, doh, ray, me, etc., the white notes only if doh is C.

**Fifth**, five-note spacing in the diatonic scale e.g. G and C.

methods of relating humans and microcomputers. It begins with some general talk on the subject of what micros are and what they can do, establishing the level of subsequent treatment and explaining some of the terms to be used later in the book. Communication within the micro itself — buses and bus control — is then examined with a view to providing a sound base for the ensuing descriptions of input and output man/machine interface equipment — keyboards and v.d.us, for example.

Later sections of the book are concerned with the technology of graphics displays and their control, and with the ways in which a microcomputer can be induced to speak. Throughout, the processor is considered as a component in a system, and programming is not dealt with at all.

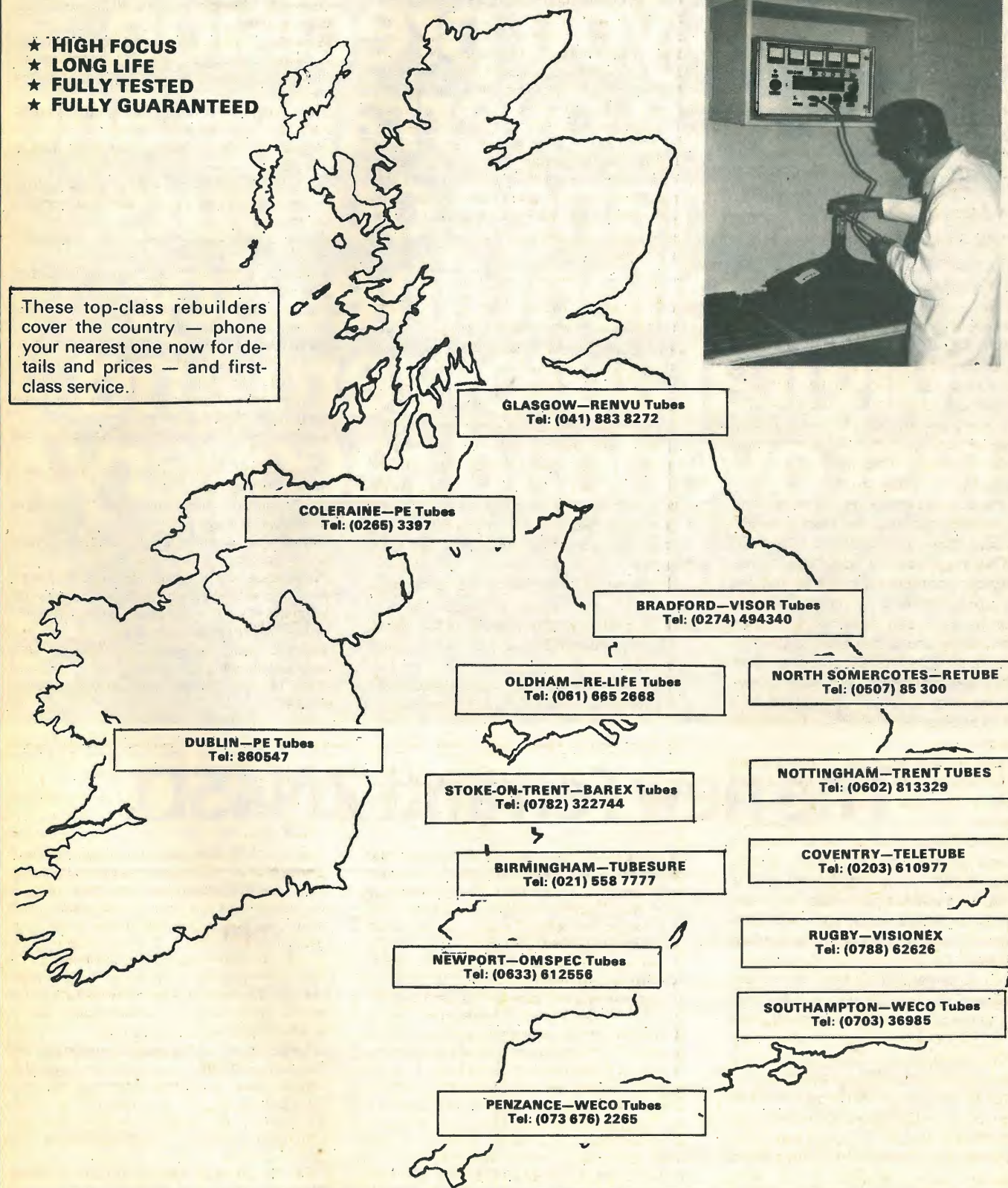
Dr. Witten was, until recently, at the Man/Machine Systems Laboratory of the University of Essex, and has contributed several articles to *Wireless World* on the subjects covered in this book. The publishers are Academic Press Inc (London) Ltd, 24-28 Oval Road, London NW1 7DX, and the book costs £8.80 in hardback (£4.95 in paperback).

## TOP QUALITY REBUILT TV TUBES

Rebuilt on the most modern equipment to original manufacturers' specifications

- ★ HIGH FOCUS
- ★ LONG LIFE
- ★ FULLY TESTED
- ★ FULLY GUARANTEED

These top-class rebuilders cover the country — phone your nearest one now for details and prices — and first-class service.



All these top-class rebuilders use plant and equipment manufactured by Western-Whybrow Engineering — acknowledged as the best available, and the product of more than twenty years' experience of rebuilding colour tubes in U.K. and U.S.A. There is a constant interchange of information to ensure the highest standard of rebuilt tube.



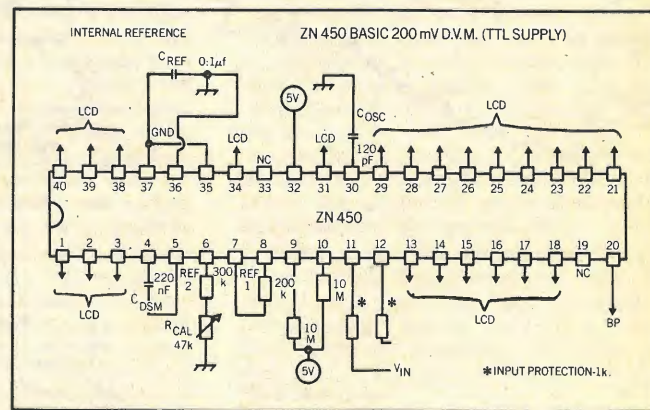
# What DVM chip gives you precision reference, overrange and underrange outputs, excellent linearity, digital auto-zero and fast overload recovery?

## The new Ferranti ZN450.

It also has all the usual features that you expect in a 3½ digit DVM IC—200 mV full-scale reading, direct drive of a liquid crystal display, differential inputs, on-chip clock, low power operation over a wide supply voltage range with no external active components.

The ZN450 is ideal for digital voltmeters, panel meters, thermometers, multimeters and many other applications.

Send for data sheet to:  
IC Marketing, Ferranti Electronics Limited,  
Fields New Road, Chadderton,  
Oldham, OL9 8NP.  
Telephone: 061-624 0515 Telex: 668038



**FERRANTI**  
Semiconductors



# Tellegen's theorem — some applications

Encounters with a powerful network tool

by Harry E. Stockman

Although Tellegen's theorem is a really basic network theorem, implying as it does a re-statement of the law of energy conservation in networks, it is not very well known to electronics engineers. This article first introduces the original formulation of the theorem in terms of energy and power, then discusses an immittance version of it, written for driven networks with storage elements, and finally gives some examples of its application to practical linear networks.

Tellegen's theorem is one of the most basic network theorems ever formulated, since it implies a re-statement of the law of energy conservation as applied to networks.<sup>1,2</sup> It offers a highly useful method for analysis of electrical systems. In mathematical shorthand, the fundamental message of the theorem may simply be stated as  $\sum ivt=0$ , where  $i$  is current,  $v$  voltage, and  $t$  time. The prerequisites for the use of the theorem are knowledge of the network topology, and Kirchhoff's laws. In some instances and special cases one need not even know the network topology so long as certain mathematical relations pertaining to the network are known. Typically, Kirchhoff's voltage-sum law and Tellegen's theorem together imply Kirchhoff's current-sum law, and the latter plus Tellegen's theorem imply Kirchhoff's voltage-sum law.

The very general nature of Tellegen's theorem is evident from the fact that it holds for non-linear as well as linear networks, whether time-variant or time-invariant. It holds for the periodic steady state as well as for transients, and for reciprocal as well as non-reciprocal networks. With reference to transients, we should not be surprised to find that among the many things that can be arbitrary belong also the initial conditions. The excitation of the system can be almost anything, with one or more driving sources, in any mixture of coherent, incoherent, and random sources. The system can be driven in the steady state, periodic steady state, or transient state, with exponential and sine-wave drive common cases. In spite of all these remarkable features the theorem is not well known, or rather, it has remained quite unknown to the practical engineer up towards the end of the 1970 decade. The reason for this is the stark simplicity of the theorem, its appearance of being self-evident. In numerous applications it is simply taken for granted.

In this short article we shall stay away from any and all proofs of Tellegen's theorem. The reader interested in such proofs may consult ref. 2, which proceeds to show how Tellegen's theorem may be used to derive or prove other theorems. Virtually, there is no end to the number of theorems derivable from Tellegen's theorem. The following quotation from ref. 2 is timely: "There is hardly a basic network theorem that cannot be proved by invoking Tellegen's theorem". A few typical cases are Heaviside's transient theorem, Van der Pol's transient theorem, the reciprocity theorem, and the reactance theorem. The last two are well known. Heaviside's transient theorem deals with energy supplied during transients in non-linear networks, and Van der Pol's transient theorem pertains to excess electric energy over magnetic energy in a CLR one-port, excited by direct voltage. Actually, when we are using Tellegen's theorem, we are inclined to automatically involve other theorems, and indeed we shall find this to be true in the following.

Tellegen's theorem implies that the energy entering the system equals that leaving it, some of the departing energy often being changed into other forms of energy. We may write a basic power relation for resistive networks in the simple form

$$P_{in} = P_{dissipation} + P_{out}$$

Here  $P_{in}$  includes the power contributed by existing dependent sources, if any, the sign of the term being decided by the relative direction of the current and voltage that applies to each dependent source. These sources, so common in today's transistor devices and i.c.s, are here of the simple kind  $ki(s)$  or  $kv(s)$ , in complex notation  $kI$  and  $kV$ . The proportionality constant  $k$  may also be complex. In the following application examples we shall limit ourselves to linear networks.

### Reducing to immittance

In his theorem formulation, Tellegen employs current-voltage products, thus dealing with power, readily extended to energy. Accordingly, he achieves an elegant treatment, independent of the precise form of the network, its number of meshes and nodes. In communications and electronics, however, many energized networks are inherently of single-mesh or single node-pair form, or can with a

reasonable amount of work be turned into one or the other of these two forms. Some interesting possibilities now evolve. If, in a given power relation such as equation (1), we divide out the common variable (current in a mesh, voltage in a node pair), one of Kirchhoff's laws results. If we carry out the same division a second time, an immittance (admittance or impedance) summation obtains, still governed by Tellegen's theorem. While our reduction from power to immittance scarcely requires a theorem of its own, such a theorem has nevertheless been published.<sup>3</sup> Written for driven networks with storage elements, the immittance theorem takes the general form

$$\sum [Y(s) \text{ or } Z(s)] = 0 \quad (2)$$

Note that this formula is restricted to single mesh and single node-pair networks. Like its parent theorem, the immittance theorem holds true whether the network is stable or brought to the point of instability. The summation always yields a zero with (2) providing an identity. This matter will be clarified in a following example. With reference to (2) it goes without saying that all sources must be converted to immittance by an application of the compensation theorem. Currents and voltages are automatically eliminated.

One important field of application for the original theorem as well as its immittance version is that of checking already obtained solutions to network problems. Such checking may involve considerable labour, however, particularly for algebraic solutions. On the other hand, since the Tellegen theorem solution may differ considerably from more common solution methods, the mathematical tool Tellegen has given us is highly useful for checking purposes.

As a first application example, consider the simple operational amplifier in Fig. 1, identified by the following formulas

$$A_s = \frac{V_2}{E} = \frac{aR_L}{r_o + (1+ab)R_L} \quad (3)$$

$$R_{OUT} = \frac{r_o}{1+ab} \quad (4)$$

Here  $A_s$  is the system amplification,  $R_{OUT}$  the system output resistance,  $r_o$  the inherent amplifier output resistance,  $R_L$  the load resistance, and  $a$  and  $b$  initially constants. The voltage  $aV_1$  marks a dependent source. Let us dwell for a moment on the derivation of (4). Perhaps the most basic

procedure for that purpose, when the network is given with or without dependent sources, is to make use of the applied source method. We apply the voltage  $V_0$  to the output port, determine the ensuing current  $I_0$  into the network, and then form the quotient  $V_0/I_0$ , which is  $R_{OUT}$ .

As another alternative, we may for a moment go back to the time when Thévenin's and Norton's theorems were combined into a single theorem.<sup>4</sup> This theorem formulation strongly brought out the idea, already in practical use, to write the output immittance as a consequence of the Thévenin and the Norton equivalents, existing simultaneously. The procedure is specifically described by the Thévenin-Norton dependent-source theorem, this being one of the names under which this theorem appears.<sup>5</sup> If the driving sources in the two network equivalents under discussion are  $E^*$  and  $I^*$ , the quotient  $E^*/I^*$  simply depicts the output impedance, and this is true whether or not the network contains dependent sources.

The starting point for the application of this theorem may be either the given network, or its transfer function, which in our example is (3). Thus (4) is actually included in (3). This entire procedure of deriving the Thévenin generator and the Norton generator from the transfer function is specifically spelled out in a highly time-saving theorem called the equivalent generator theorem.<sup>6,7,8,9</sup> Its time-saving feature stems from the fact that the output immittance is determined in quite a different manner, and if the output immittance is all we want, the parent theorem degenerates into the output immittance theorem.<sup>9</sup> This theorem clearly verifies that indeed (4) is contained in (3), and in such an obvious way that in most network problems the output immittance can be read off directly without the need for any calculations whatsoever.

With reference to our example, with (3) the proper transfer function, the theorem simply states that the output resistance is the denominator, less the term that describes the load resistance. Of the methods discussed above, this is by far the quickest one, and, like the other two methods, it holds whether or not the network contains dependent sources. But to use this theorem, we must have access to the transfer function in (3).

### Practical example

Above we have given particular consideration to output immittance because we wish to make this quantity a key issue in our application of Tellegen's theorem. The network in Fig. 1 is a stable system, in fact, a negative-feedback system, for which Tellegen's theorem, as given by (2), simply takes the form  $\Sigma r = 0$ . In summing up the resistance around the mesh we are using the immittance theorem, and as we find the sum to be zero, we obtain the identity  $0=0$ . However, the interested reader may instead use power, following the formulation of Tellegen's theorem, and certify that the net result is precisely the same identity  $0=0$ .

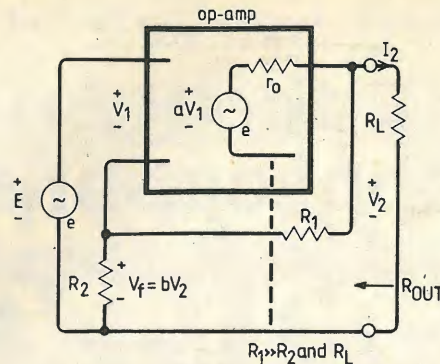


Fig. 1. Simple operational amplifier with negative-feedback voltage  $V_f = bV_2$  and dependent source  $aV_1$ .

The steps in using the immittance theorem are as follows. First we apply the compensation theorem to the source  $aV_1$  to turn it into resistance, then sum up all resistance, writing

$$-\frac{aV_1}{I_2} + r_o + R_L = 0$$

The first term here represents a negative resistance. Eliminating all variables with the aid of the relations  $V_1 = (E - bV_2)$  and  $V_2/I_2 = R_L$ , and using  $V_2/E$  from (3), we quickly find the identity  $0 = 0$ .

Knowing that Tellegen's theorem is extremely general, we have the right to expect that the mathematical reasoning above would remain the same if the network instead had positive feedback. The switch from degeneration to regeneration can be accomplished simply by a change of the sign for  $b$ . Specifically, then, we conclude that the identify is independent of the sign of  $b$ . The reader can easily verify that this is the case. If we keep increasing the regeneration in a practical amplifier system, a point will be reached where we must accept non-linearity, and thus give up the use of a linear network theory approach. In theoretical work, however, we have the right to assume that the system remains linear up to the "take-off" point, the point of instability. We cannot proceed beyond this point with linear network theory, but Tellegen's theorem is equally valid after surges and oscillations have commenced. This observation is an important one.

Returning to our application example, we shall now claim that the previous result of an obtained identity holds true even when the system becomes unstable. As the network attains self-excitation, it maintains currents and voltages although there is no applied signal voltage, and with  $V_1 = b_c V_2$ , our summation takes the form

$$-ab_c R_L + r_o + R_L = 0 \quad (6)$$

where  $b_c$  is the critical value of  $b$ . Solving for  $b_c$ , we obtain

$$b_c = \frac{r_o + R_L}{aR_L}$$

Turning this around and claiming that we have available the information of  $b_c$  in (7), we can quickly establish the significant identity  $0 = 0$  by inserting  $b_c$  in (6). In the

above examination of the network, we arrived at a summation that gave zero. The same result obtains if we instead work from the transfer function in (3) and insert  $-b_c$  from (7) in its denominator.

### Stability considerations

If our aim is to establish the stability conditions for a network in general, starting from the network, the above discussion shows that the summation of power, or, in the simplified case, immittance, will provide the answer. In the many cases where the pertinent information is given by formula similar to (3) and (4), with the network either known or unknown, Tellegen's theorem guides us, however, to a much more direct and time-saving procedure. We are already familiar with the determination of the stability conditions by setting the denominator in transfer functions like (3) equal to zero. We shall now find that in cases where the only available information is a port termination formula like (4), Tellegen's theorem again gives us the stability conditions, and in a most direct way.

While Tellegen did not present his theorem as a stability criterion, it nevertheless contributes this information, and indeed, in certain applications, it provides an excellent and time-saving stability criterion. In his original theorem formulation, employing power, Tellegen implies that, unless the power in a port load "sees" itself inside the port with the opposite sign in the power summation, the system is not lossless. In the simplified case of a single mesh or a single node pair, the corresponding statement is that unless the load immittance "sees" itself inside the port with the opposite sign in the immittance summation, the system is not lossless. In terms of the immittance theorem, and with reference to our example, the consequence of this reasoning is the simple stability criterion<sup>7</sup>

$$R_{OUT} = \frac{r_o}{1 - ab_c} = -R_L$$

which directly gives  $b_c$  in (7). On the other hand, (8) is the direct result when the transfer function denominator ( $R_{OUT} + R_L$ ) is set equal to zero. The point is that the transfer function may be unknown, but a formula for the port output immittance is known.

In passing, we shall make use of at least one other method for determination of the stability conditions in the given example, the popular Barkhausen criterion  $H_c A = 1$ . In our example, the feedback transfer function is  $H_c = b_c$ , and  $A$  is obtained from (3) with  $b = 0$ . We find that  $b_c A = 1$ , solved for  $b_c$ , yields (7).

If we go the route of (8) to find the stability conditions, we must know the output immittance. Our entire problem may simply be to determine this immittance. We have already learned how to do this when the proper transfer function is known, but now let us instead assume that it is the network that is known. Equation (8) then hints a very direct method of determining output immittance from a given network. We must find the ratio of  $r_o$  to (1

$-ab$ ) whatever value  $b$  has up to the value  $b_c$ , but certainly  $R_L$  must not appear in our calculation although clearly  $R_L$  controls the mesh current. However, in the very specific case of  $R_L = -R_{OUT}$ , we don't mind that  $R_L$  appears in our derivation. This is the key to the procedure, Tellegen's lossless condition gives us the mathematical tool we must have. We simply terminate the port in  $-R_{OUT}$  instead of  $R_L$ , and employ the compensation theorem to turn the source into a resistance.  $R_{OUT}$  solved from the ensuing immittance equation is then our answer.

This method is described by a new theorem called the image output immittance theorem, and it gives the answer in shorter time than the application of the applied source method would. The procedure we follow to apply this new theorem to our network in Fig. 1 is first to replace  $R_L$  by  $-R_{OUT}$ , then to use the compensation theorem to turn the source  $aV_1$  into a resistance, and finally to make use of the relation  $V_2/I_2 = -R_{OUT}$ , so as to secure the all-resistance summation

$$-ab(-R_{OUT}) + r_o - R_{OUT} = 0 \quad (9)$$

Solving here for  $R_{OUT}$  we obtain (4) for the case of regeneration. If we instead enter  $V_1 = -bV_2$ , the result is (4) for degeneration; the case the formula represents.

### Second example

Some of our basic thinking in the above discussion will now be applied to the amplifier network in Fig. 2, which contains storage elements both inside the amplifier and in the load. The source  $\mu E$  is related to the driving voltage  $E$  while the dependent source  $\mu KV$  signifies positive feedback. Complex notation is used in the figure, and corresponding symbols in the text should be taken as complex quantities. The transfer function and the output impedance are known and are, with  $s = j\omega$  and  $(sL + R + R\omega + 1/sC) = Z$ ,

$$A_s = \frac{V}{E} = \frac{\mu Z_L}{(1 - \mu K)Z_L + Z}$$

$$Z_{OUT} = \frac{Z}{1 - \mu K}$$

Here  $R'$  is contributed by the  $Cg$ -combination as a series resistance, and  $C'$  is the ensuing series capacitance. From now on we shall consider the network as forming a single mesh. As in the previous example, (11) is instantly read off from (10) with the aid of the output immittance theorem. In accordance with Tellegen's theorem, the sum of all power around the mesh is zero. If the reader works this out as an exercise, he shall find that the identity  $0 = 0$  indeed obtains. We shall here limit ourselves to the use of the immittance theorem, writing

$$-\frac{\mu E}{I} - \frac{\mu KV}{I} + Z + Z_L = 0$$

With  $V/I = Z_L$  and  $E/V$  obtained from (10), we quickly find that the identity  $0 = 0$  obtains. Thus if (10) had been the result of some solution, the writing of (12) would have been the way we invoke Tellegen's theorem for checking purpose in this parti-

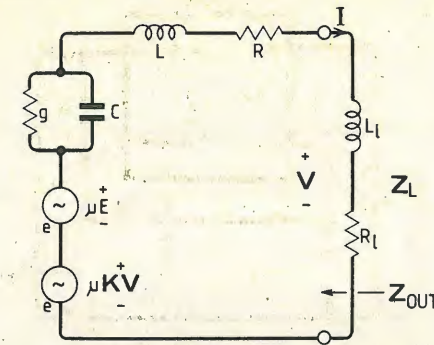


Fig. 2. Linear network to be turned into a single mesh. The calculation results are checked with Tellegen's theorem and the immittance theorem.

cular case. On the other hand, if instead the immittance theorem was used to secure an initial solution, then we simply leave  $V/E$  in, and, solving for this quantity in (12), obtain the answer in (10).

Guided by the above applications, we can now formulate the immittance theorem as follows:

For a linear single-node-pair or single-mesh energized network, Kirchhoff's current-sum law, respectively voltage-sum law, divided by the common variable, yields

$$\Sigma [Y(s) \text{ or } Z(s)] = 0$$

For  $K$  the feedback variable, we set the denominator of (10) equal to zero to find the stability conditions, or, we set (11) equal to  $-Z_L$ , obtaining

$$K_c = \frac{Z + Z_L}{\mu Z_L}$$

where  $K_c$  is the critical value of  $K$ . If instead (10) and (11) had been unknown, but the network given, a summation of all impedance around the mesh, with the sum equal to zero, would have given the same answer for  $K_c$ .

Using the image output immittance theorem to obtain  $Z_{OUT}$  from the network, we first replace  $Z_L$  by  $-Z_{OUT}$  and then sum up as follows, using the compensation theorem and reading off  $V/I$  as  $-R_{OUT}$ ,

$$\mu K Z_{OUT} + Z - Z_{OUT} = 0 \quad (14)$$

from which the answer in (11) obtains directly. Precisely the same procedure, with proper attention to signs, would give the correct answer for negative feedback. The image output immittance theorem is therefore general, and is often the quickest way available when we wish to determine the output immittance of a given network, not known by given formulas. The theorem may be formulated as follows:

For a linear active network with an output port at which the network forms a single node-pair or a single mesh, the output immittance is the locking-in immittance when the driving source is removed and the load immittance replaced by the image of the looking-in immittance with a negative sign.

In conclusion it should be mentioned that readers concerned with the checking of already obtained solutions might also

consider the superposition theorem since it gives solutions of a different kind. For this theorem to apply to networks with dependent sources, these sources must be entered with the values they have in the undisturbed network.

The above discussion confronts us with Tellegen's theorem from only a few avenues of approach, with examples chosen from among those which may be of common interest to people working with networks. Nevertheless, we have touched upon only a few possible exploitations. That the power of this theorem goes far beyond networks is perhaps evident if we realize that Kirchhoff's laws are merely approximations under specified conditions of two of Maxwell's equations. These two may be referred to as the curl- $H$  and curl- $E$  equations. Specifically, if we use the curl equations, invoking certain manipulations and writing a power equation that covers the total volume of the radiating system, the mathematical relation is in effect the same as that resulting from an application of Tellegen's theorem. In view of this tie-in with Maxwell's equations, we should not be surprised to find that if we have a charge flying by a conductor, inducing a current in it, the ensuing network analogue can be proven by means of Tellegen's theorem. If instead the charge stands still and the conductor flies by at arbitrary velocity, we become concerned with the message of Einstein's relativity theory. In the macroscopic world, then, Tellegen's theorem still holds, as properly modified by relativity theory. Dr Tellegen has given us an extremely powerful mathematical tool that deserves vastly increased use over what it enjoys presently.

### References

1. Tellegen B. D. H., "A general network theorem with applications", Philips Research Report No. 7, R 195, pp.259-269, August 1952.
2. Penfield P. Jr., Spence R., Duinker S., "Tellegen's theorem and electrical networks", Research Monograph No. 58, The M.I.T. Press, Cambridge, Mass. and London, England, 1970.
3. Stockman H. E., "The theorem Book, Sercolab 1977. By the same author:
4. "Output impedance theorem", *Wireless Engineer*, Vol. 31, No. 3, March 1954.
5. "Scientific models for experimenters", Sercolab, 1976.
6. "Thevenin and Norton", *Wireless World*, Vol. 70, No. 6, June 1964.
7. "Transistor and diode network problems and solutions", Hayden, 1967.
8. "Thevenin, Norton, and dependent sources", *Wireless World*, Vol. 82, No. 1490, October 1976.
9. "Time-saving network calculations", Sercolab, 1954.
10. "Stability and Tellegen's theorem", *IEEE Circuits and Systems Magazine*, Vol. 1, No. 3, 1979.

# NEW PRODUCTS

## 10MHz oscilloscope

The Scopex 14D10 is a 10MHz, dual-trace oscilloscope which supersedes the company's 4D10B. The 10 × 8cm display and associated controls have been moved to the left of the front panel and the two input channels to the middle. All the function switches are push-button and are in line across the lower half of the front panel. The trigger control has been replaced by a potentiometer and a ± push-button switch to give the ability to trigger positive and negative edges of pulse trains without re-adjustment.

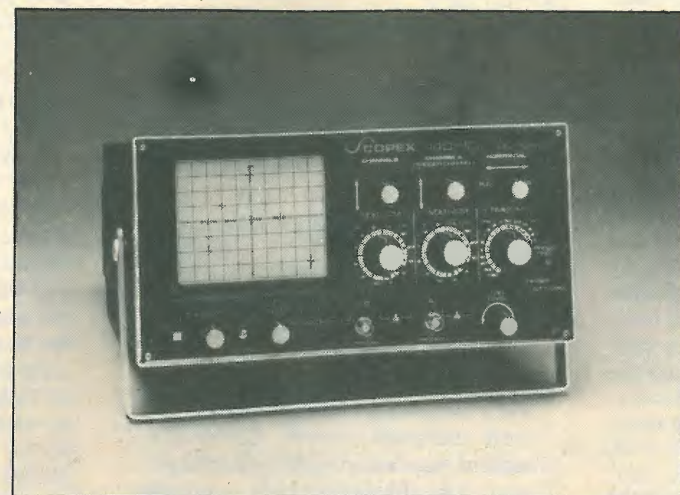
Sensitivity of both channels is 2mV/cm to 10V/cm in the internationally approved 1-2-5 sequence. Timebase speed ranges from 100ms/cm to 1µs/cm, with the option of ×5 expansion to give 200ns/cm. Add and invert facilities enable computer service engineers to align floppy disc drives and other computer peripheral devices.

The conventional power supply has been replaced by a switched-mode version and this has reduced the weight of the instrument to 5kg. The price of £230.00 plus v.a.t. includes two high-impedance probes, carriage (UK mainland) and the manufacturer's one-year guarantee. Scopex Instruments Ltd, Pixmore Avenue, Letchworth Herts SG6 1JJ.

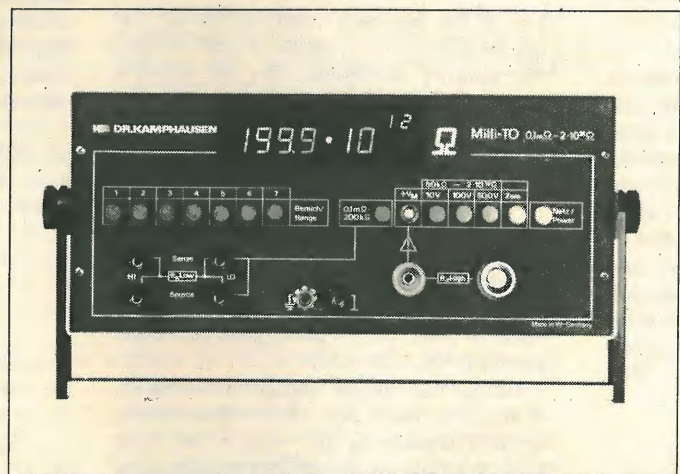
WW301

## Resistance meter

Digital readout of resistance in the range  $10^{-4}$  up to  $10^{14}$  ohms is the main feature of the Milli-TO resistance measuring instrument from Cropice Ltd. Low resistance measurements can be made in one of seven ranges from 0.1mΩ to 200kΩ. The d.c. test voltage across the sample reaches a maximum of 500mV at a reading of 2000 digits but is limited to 750mV if the wrong range is selected. For very low resistances, four-terminal measurements can be made (using the Kelvin principle) to avoid difficulties which may arise from test lead resistances. High-resistance measurements from 50kΩ to  $2 \times 10^{14}$ Ω are covered in seven ranges. The 10V, 100V or 500V test-voltage is selected by push buttons. Capacitor and cable dielectric measurements can be made accurately as the ripple of the test voltage is less than 200µV at 1Hz. The test voltage current is limited to 3mA for safety reasons. The Milli-TO is said to be easy to use



WW301



WW302



WW303

and an optional b.c.d. data output with digital adjustable limit control allows the instrument to be used for 'go/no-go' applications in production processes. A 3 1/2 digit 15mm l.e.d. and separate exponent display are used for the readout. Cropico Ltd, Hampton Rd, Croydon CR9 2RU.

WW302

## Printer/plotter

One of the first of a new generation of printers, the 'intelligent' printer/plotter, has recently been announced by Roxburgh Printers Ltd. The features of the X80SP needle printer include three character generators (one of which is fully programmable), bi-directional printing and paper feed, 8×8 matrix, horizontal and vertical tabs, selectable print direction in steps of 45 degrees, programmable line spacing, start/finish of print at any point and 80/96 chars. per line. For plotting, graphics and images, the X80SP has: X and Y, vector, rectangle and ellipse generators, single dot control, digitizer output, eight automatic centring symbols and recognizes pen up/down instructions. Various versions are available with interfaces for the PET, Apple II, Centronics parallel and RS232/20mA, 50 to 9600 baud. The plot accuracy is 0.1mm horizontal, 0.2mm vertical and the speed is 100ch/s. Measurements of the printer are 49.5×31×14.5cm and the cost per unit is £840 for the version with RS232 interface and £795 for other versions. Roxburgh Printers Ltd, 22 Winchelsea Rd, Rye, E. Sussex TN31 7BR.

WW303

## High-temperature regulator

Designed mainly with high-temperature environments in mind, the Teledyne Philbrick 2115 15V hybrid regulator will provide up to 50mA of current at temperatures of up to 275°C. Output voltage variation with temperature is 0.5V from +25 to +275°C and a line regulation of ±10mV is also specified for the 16V minimum and 25V maximum supply voltages. For loads of from 15 to 50mA the regulation is also specified as ±10mV and ±20mV for 5mA and upwards. The hermetically sealed package of the 2115 measures 1.15 × 0.75 × 0.23ins. Technical Selling Services, Unit 5, Brunel Gate, West Portway Ind. Est, Andover, Hants.

WW304

## Voltage standard

High-resolution d.v.ms, multimeters and a-to-d converters can be calibrated using the transportable Transcell-II d.c. reference calibrator made by Standard Reference Laboratories and marketed by Lyons Instruments. Two outputs are provided: the working voltage of 10.00000V with a source impedance of less than 100Ω and a stability error of 10p.p.m./year if untrimmed, and the prime reference output of 6.3V which is calibrated to 2p.p.m. and has a stability error of 10p.p.m./year. The 10V reference can supply currents of up to 2mA and can be corrected at any time using the 6.3V reference. Both outputs are said to be predictable to within 1p.p.m./1000hrs. Internal rechargeable batteries provide up to 75 operating hours. Lyons Instruments Ltd, Hoddeson, Herts.

WW305

## Fibre-optic dual cable

Dual channel fibre-optic cables with optional, factory-fitted connectors are available from Hewlett-Packard Ltd in lengths of from one to 1000 metres. The HFBR-3100 duplex optical cables consist of two single-fibre cables extruded together and surrounded by a common black polyurethane sheath. A tracer is provided along one of the two sections to enable identification and the cable can easily be split into two parts for convenience where the termination sockets are placed some distance from each other. These flame-retardant cables measure 6.35×3mm, weigh 17g/m and cost around £2.67 per metre, with an extra cost of £106.92 for factory fitting and testing of four connectors. HFBR-3100 cables are compatible with the HFBR-1001, HFBR-1002 and HFBR-2001 transmitter and receiver modules. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berks RG11 5AR.

WW306

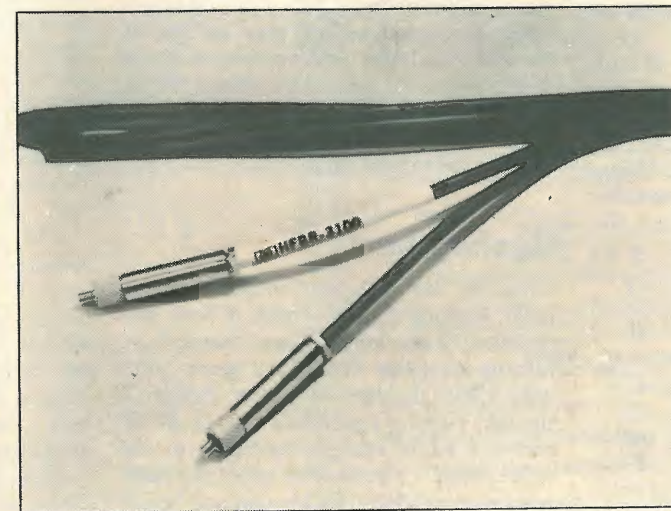
## S.a.w. delay line

When used in compressive receiver applications, 250MHz of bandwidth can be analysed in 0.25µs with a frequency resolution of 4MHz using the DS 1313 dispersive s.a.w. delay line from Signal Technology Ltd. A centre frequency of 750MHz, a dispersion time of 500MHz, a dispersion time of 0.5µs and a 1000MHz/µs 'down-chirp' sweep rate are some of the specifications quoted for the device. The DS1313 is manufactured on lithium-niobate substrate and housed in a four lead solid based TO-5 package for use in compressive receivers and spectrum analysers. Signal Technology Ltd, Cheney Manor, Swindon, Wiltshire SN2 2PJ.

WW307



WW305



WW306



WW308

## I.f. filters

Small i.f. filters for broadcast and communications receivers have been introduced to the market by Ambit International. Toko manufacture the filters, of which there are three basic types: the CFL ceramic a.m.-i.f. filter, the CFM low-profile mechanical filter with which a selectivity equivalent to three conventional single tuned i.f. transformers can be obtained in the range 450 to 530MHz, and the CFSKM

phanumeric keyboard can be supplied for an extra £50. Sockets are provided for connexion to a printer, to a tape-recorder for recording and re-displaying information, and to a tv monitor or a tv set with direct r.g.b. inputs. Dimensions of the 2000 are 408×214×89mm. The mains supply voltage requirement and r.f. modulator are adjustable internally as the unit has been designed with export in mind. Zycor Ltd, 33 Fortress Rd, London NW5 1AD.

WW309

## Wideband op-amp

An op-amp with a gain bandwidth product of 1.5GHz and a slew rate of ±800V/µs is made by Analog Systems and distributed by Pascall Electronics Ltd. Some of the applications for which this bipolar monolithic i.c., the MA-207, can be used are video, ultrasonic and pulse amplifiers and high speed cable drivers. Untrimmed, the input offset voltage of the device is 1mV and the input noise voltage 2nV/√Hz. The output current, based on a ±2V output swing, is 200mA maximum and power dissipation is 600mW maximum. The 207 is housed in a standard 14-pin d.i.l. package, costing £20.31 per unit and £13.53 in 100 up quantities. Pascall Electronics Ltd, Hawke House, Green St, Sunbury-on-Thames, Middx TW16 6RA.

WW310

## V.m.o.s.f.e.t.s

Plastic TO-273 packaged v.m.o.s. power f.e.t.s with a low-price have been developed by Siliconix. The VK1010 and VK1011 are capable of handling peak currents of up to 1A and have maximum blocking voltages of 100V and 30V respectively. Power dissipation is 1W in free air at 25°C. The devices feature five nanosecond switching times and will interface directly with t.t.l. or c.m.o.s. logic. For 100 up quantities the VK1010 costs 53p and the 1011 costs 43p. Siliconix Ltd, Morriston, Swansea SA6 6NE.

WW311

## 16K static r.a.m.

This 16K × 1 bit fully static r.a.m. features 50ns maximum address access and read cycle times and 660mW max. active state power consumption. The IMS1400 v.l.s.i. r.a.m., manufactured by Inmos, runs from a single 5V power supply and its i/os are all t.t.l. compatible. One of the 20 pins on the 0.3in d.i.l. package is a 'chip enable' input which can be used to place the device in standby mode to reduce consumption to 110mW. IMS1400 is at present only available in sample quantities but full availability is expected within the next three months. Inmos, Whitefriars, Levens Mead, Bristol BS1 2NP.

WW312

ceramic f.m.-i.f. filter which features a low temperature coefficient. Two bandwidth types are available in the CFSKM series — the CFSKM1 has 280kHz bandwidth and the CFSKM2 has 230kHz. The CFL filters are available for the range 450 to 470kHz with a nominal 8kHz bandwidth (-6dB). Ambit International, 200 North Service Rd, Brentwood, Essex CM14 4SG.

WW308

## Prestel adaptor

An adaptor costing under £200 that will turn a standard colour or monochrome tv set into a Prestel terminal is marketed by Zycor Ltd. The Teledak 2000 requires connexion to a tv set via the aerial socket, to a standard telephone network supply. Approval for the unit has been obtained from the Post Office, and it complies with issue six of the Prestel Terminal specifications. Information selection is via a 16-key infrared remote-control pad, supplied with the terminal, which can operate at distances of 9 metres from the terminal. A wired full al-

# SIDEBANDS

By Mixer

## Bourgeois ballistics

There has never been a better time for the d.i.y. enthusiast. Employing tradesmen to come and poke about in your house or on your car gets more ruinous by the day, and the results are very often little better than could be achieved by a troop of monkeys with a talent for social advancement. Run-of-the-mill joinery, bricklaying, plumbing and painting need hold no terrors for the averagely dextrous and even those of us with a full set of ten thumbs usually win through in the end. You can often obtain a lot of quiet pleasure, too, from a well-decorated sitting-room or a nicely finished set of bookshelves.

There has always been a feeling of cosiness, for me, in all these d.i.y. magazines. The same old subjects appear every year: loft insulation in November, swimming pools in May. It's astonishing the things some people will attempt, but I doubt that many folk would consider a project I've just seen on a press handout, here on my desk - a do-it-yourself bullet-proofing kit for vehicles. No experience necessary, it says here. There's one thing, though; it could give rise to some stimulating over-the-garden-fence conversation.

"Morning, George. Trouble?"  
"Morning, Harry. No, I'm just bullet-proofing the car. The wife keeps getting shot up on the way back from Sainsbury's, so I thought I'd beef the old bus up a bit. It's costing me a fortune, filling all these bullet holes in every weekend."

"Yes, see what you mean. Mind you, it's all right for your three-oh-three high-velocity stuff, but you'll be in trouble with those blasted bazooka rockets."

"Well, I haven't got time for more than heavy-calibre machine-gun protection. I said I'd put the new lino tiles down in the hall today, and you know what she's like if I don't do things straight away. She's out this morning, down at the hand-grenade class."

## Butter side down

Having just taken our library out of the orange plastic boxes it came from Dorset House in, I've had a unique opportunity to observe Murphy's Law in inexorable action. The library's former home was more a hole in the wall than a room, and everything was stacked up in unusable heaps of erudition. We've got stuff here going back to 1911 and the collection is growing all the time, what with the scores of magazines and books for review that come in. The library also used to be the place where all the office embarrassments were hurled, on the basis that so long as no-one found them until 2001 they wouldn't matter any more.

Packing it all up for the move, we decided to give the old heave-ho to a great

stack of papers and books that we didn't want and couldn't find space for. Some of it hadn't been seen, let alone used, since the BBC was a Company, not a Corporation. So, with a heavy heart and with moaning and wailing, we slung it. After all, you have to be sensible about this sort of thing - it's not a bit of good hoarding waste paper. We kept the useful stuff and the more important historical material and thought we'd done well.

I expect most of you are well ahead of me by now. Yes, of course, the very first thing I wanted from our new, streamlined, efficient library was in one of the old magazines I'd insisted, against good advice, on chucking out. And it isn't as easy as it was to nip across the road to the Patent Office library or the IEE.

I just hope they never have to move, or we'll be right in the soup.

## Cycling hertz

Since the day some unprincipled lout at RAF Stafford stole my bike, I have not pedalled. (I was going to say I haven't set foot on one, but that didn't seem quite right.) With the move to Sutton, though, I thought I'd have a go with a view to giving myself a bit of exercise by riding to the office, since it's only three miles. So I did my daughter's Moulton up a bit and began to work up to three miles in easy stages, starting with a short hop to the paper shop.

I'd been looking forward to riding the bike, and the feeling this tentative spin gave me of being in the wrong century was a bitter disappointment. The last time I rode a bike, the roads were uncrowded and I was thirty years younger. This time, I discovered what it is to be an unconsidered trifle; and, come to think of it, that is a good way of putting it, because I was quaking like a jelly when I got home again. Apart from the way the bike doubled its weight every hundred yards, the main worry was the sheer malevolence of the car drivers. I tell you, if I never ride a bike again, it will be much too soon. There was certainly no chance of thinking of anything but staying upright and in one piece, which is what makes me wonder about the latest marvel of modern science - a bike computer.

What is there to compute about bikes? Well, if you are of a statistical turn of mind, you can discover your speed, average speed, maximum speed achieved during a journey, distance travelled and journey time. And if that isn't enough to divert you, you can have a radio as well.

I can only suppose that your experienced cyclist is a lot more nonchalant about dicing with death than I am, because I'm pretty sure that knowing my average

speed would not be nearly enough inducement to get me to tear my eyes away from the monstrous regiment of car-borne werewolves intent on frightening the living day-lights out of me. Personally, I think I'd rather spend the money on a suit of armour.

## No sale

Now we are heading so surely towards the cashless, chequeless society you would think commercial transactions would have become simplicity itself. It only seems to be a mere mechanical process of transferring a few digits out of one computer into another in a matter of microseconds. Not so, unfortunately. The old Adam (which includes his rib, I hasten to add) still holds sway in such ignoble instincts as distrust of the other fellow and his computer.

The other day, for example, we had a despairing phone call from an engineer in a large public utility who was unsuccessfully trying to buy a kit of electronic parts from one of our mail-order advertisers. Could we help? Apparently the public utility wanted to place an order through its normal system, by which payment would be made after the delivery of the goods. The mail-order firm, however, was not playing. They insisted on cash with order, or no sale. It seems at least three wily accountants in the public utility had had a go at them at different times, no doubt trying to catch them off guard with a variety of siren voices; but no, they were adamant. Mind you, I can understand their reluctance. A friend who runs a small business tells me you can easily face ruin with a few of these large organizations as customers - they can take up to a year to pay their bills.

Anyway, the only help we could offer the engineer was: why not pay the required sum himself, out of his own pocket, and then recover it later from his employer, who surely must be honest enough to cough up? There was a sharp intake of breath at the other end of the telephone, followed by a long silence: "Oh, er . . . I don't think our organization could cope with anything like that . . ."

It's extraordinary that there can be such a stalemate between two parties who genuinely want to do business together. One is keen to buy, the other is willing to sell, but because each is a slave to his own method of transaction the result is no business at all. If human organizations have become so refractory it's surely time we got in some of those intelligent machines that our contributor Malcolm Peltu wrote about last month. *Machina sapiens* might be able to teach *homo sapiens* a thing or two about how he should be functioning.

# WILMSLOW AUDIO

The firm for Speakers

### HI-FI DRIVE UNITS

- Audax HD12.9D25 £8.25
- Audax HD11P25EBC £7.50
- Audax HD20B25H4 £14.95
- Audax HD13D34H £12.95
- Audax HD24S45C £21.95
- Baker Superb £25.00
- Castle Super 8 RS/DD £14.95
- Chartwell CEA205 £7.65
- Coles 4001 £7.65
- Coles 3000 £7.65
- Celestion HF1300 II £10.95
- Celestion HF2000 £10.95
- Dalesford ABR 10" £10.25
- Dalesford D30/110 £11.25
- Dalesford D50/153 £12.25
- Dalesford D50/200 £12.25
- Dalesford D70/250 £25.50
- Dalesford D100/310 £35.75
- Dalesford D10 tweeter £8.45
- Decca London Horn £61.95
- Eiac 6NC204 6 1/2" £7.50
- Eiac 6NC298 8" £7.95
- EMI type 350, 13" x 8", 4 ohm £9.45
- EMI 14A/770, 14" x 9", 8 ohm £19.50
- Isophon KK8/8 £8.15
- Isophon KK10/8 £8.45
- Jordan Watts Module £24.95
- Jordan Watts HF kit £10.50
- Jordan 50mm unit £24.50
- Jordan CB crossover £24.50 pair
- Jordan Mono crossover £9.45
- Kef T27 £12.25
- Kef B110 £13.50
- Kef B200 £13.50
- Kef B139 £27.75
- Kef DN13 £6.75
- Kef DN12 £9.40
- Kef DN22 £42.00 pair
- Lowther PM6 £59.00
- Lowther PM6 Mk I £62.00
- Lowther PM7 £94.50
- Peerless K0100T £10.95
- Peerless DT10HFC £10.50
- Peerless K040MRF £13.60
- Peerless K040MRF £36.95
- Radford BD25 Mk III £14.85
- Radford MD9 £25.50
- Radford MD6 £22.50
- Radford FNB/FN831 £13.50
- Richard Allan CG8T £29.50
- Richard Allan CG12T Super £20.75
- Richard Allan HP8B £14.50
- Richard Allan LP8B £33.50
- Richard Allan HP12B £9.95
- Richard Allan DT20 £10.75
- Richard Allan DT30 £8.95
- SEAS H107 £136.00 pair
- Shackman Electrostatic with polar network and crossover £118.00
- Tannoy DC296 10" £159.00
- Tannoy DC316 12" £199.00
- Tannoy DC386 15" £199.00

### PA GROUP & DISCO UNITS

- Celestion G12/50TC £19.50
- Celestion G12/80CE £24.50
- Celestion G12/80TC £23.75
- Celestion G12/125CE £42.00
- Celestion G15/100CE £37.95
- Celestion G15/100TC £38.50
- Celestion G18/200 £64.75
- Celestion HF1300 £12.50
- Celestion HF2000 £12.50
- Celestion Powercell 12/150 £86.00
- Celestion Powercell 15/250 £88.00
- Celestion MH1000 £21.75
- Fane Classic 45 12" £13.95
- Fane Classic 55 12" £15.50
- Fane Classic 80 12" £19.75
- Fane Classic 85 15" £26.00
- Fane Classic 150 15" £37.95
- Fane Classic 125 18" £43.95
- Fane Classic 175 18" £47.95
- Fane Guitar 80L 12" £26.25
- Fane Guitar 80B/2 12" £27.25
- Fane Disco 100 12" £28.75
- Fane PA85 12" £26.25
- Fane Bass 100 15" £39.00
- Fane Crescendo 12E £57.50
- Fane Crescendo 15E £74.50
- Fane Crescendo 18E £94.75
- Fane Colossus 15E £99.95
- Fane Colossus 18E £107.00
- Fane J44 £6.90
- Fane J104 £15.95
- Fane J73 £10.90
- Fane HPX1/HPX2 £3.45
- Fane HPX3A £5.60
- Fane HPX3B £4.55
- Goodmans 8PA £5.05
- Goodmans PP12 £22.50
- Goodmans D12 £25.50
- Goodmans GR12 £48.45
- Goodmans 18P £24.85
- Goodmans Hifax 50HX £24.45
- McKenzie C12100GP £24.45
- McKenzie C12100TC £24.45
- McKenzie C12100 bass £24.45
- McKenzie GP15 £35.10
- McKenzie TC15 £35.10
- McKenzie C15 bass £59.80
- Motorola Piezo horn 3 1/2" £8.50
- Richard Allan HD8T £12.25
- Richard Allan HD10T £20.25
- Richard Allan HD12T £21.75
- Richard Allan HD15T £29.75
- Richard Allan HD15P £52.75
- Richard Allan Atlas 15" £57.75
- Richard Allan Atlas 18" £96.00

### WILMSLOW AUDIO

- KITS FOR MAGAZINE DESIGNS, etc.  
KITS INCLUDE DRIVE UNITS, CROSSOVERS, BAF/LONG FIBRE WOOL, etc.  
FOR A PAIR OF SPEAKERS  
Carriage £3.95 unless otherwise stated
- Practical Hi Fi & Audio PRO9-TL (Rogers) £148.00
  - As above but including felt panels £152.75 + £5 carriage
  - Hi Fi Answers Monitor (Rogers) £148.00
  - Hi Fi News State of the Art (Atkinson) £185.00
  - Hi Fi News Miniline (Atkinson) £49.00 + £3 carriage
  - Hi Fi For Pleasure Compact Monitor (Colloms) £116.00 + £5 carriage
  - Popular Hi Fi Mini Monitor (Colloms) £74.00
  - Popular Hi Fi Round Sound (Stephens) including complete cabinet kit £71.00
  - Popular Hi Fi Jordan System 1 £96.00 + £3 carriage
  - Practical Hi Fi and Audio BSC3 (Rogers) £85.00
  - Practical Hi Fi and Audio Monitor (Giles) £180.00
  - Practical Hi Fi and Audio Triangle (Giles) £120.00
  - Hi Fi News Tabor (Jones) with J4 bass units £66.00
  - Hi Fi News Tabor (Jones) with H4 bass units £70.00
  - Wireless World Transmission Line KEF (Bailey) £125.00
  - Wireless World Transmission Line RAD-FORD (Bailey) £179.00
  - Everyday Electronics EE70 (Stephens) £150 + £5 carriage
  - Everyday Electronics EE20 (Stephens) £29.50 + £3 carriage

### SPEAKER KITS

- Prices per pair  
Carriage £3.75 pair
- Dalesford System 1 £54.00
  - Dalesford System 2 £57.00
  - Dalesford System 3 £104.00
  - Dalesford System 4 £110.00
  - Dalesford System 5 £142.00
  - Dalesford System 6 £95.00
  - KEF Reference 104aB kit £133.00 + £5 carriage
  - KEF Cantata kit £213.50 + £5 carriage
  - LS3 Micro Monitor kit £71.00 + £3.75 carriage
  - Lowther PM6 kit £116.00
  - Lowther PM6 Mk I kit £122.00
  - Lowther PM7 kit £195.00
  - Peerless 1070 £157.00
  - Peerless 1120 £169.90
  - Peerless 2050 £59.95
  - Peerless 2060 £79.95
  - Radford Studio 90 kit £181.00
  - Radford Studio 270 kit £309.00
  - Radford Monitor 180 kit £243.00
  - Radford Studio 360 kit £450.00
  - RAM 50 kit (makes RAM 100) £76.25
  - Richard Allan Tango Twin kit £55.50
  - Richard Allan Maramba kit £77.50
  - Richard Allan Charisma kit £111.00
  - Richard Allan Super Triple kit £102.50
  - Richard Allan Super Saraband II £159.95
  - Richard Allan RA8 kit £52.75
  - Richard Allan RA82 kit £98.75
  - Richard Allan RA82L kit £108.00
  - SEAS 223 £42.50
  - SEAS 253 £67.00
  - SEAS 403 £79.95
  - SEAS 603 £134.95
  - Wharfedale Denton XP2 kit £31.45
  - Wharfedale Shelton XP2 kit £40.40
  - Wharfedale Linton XP2 kit £56.20
  - Wharfedale Glendale XP2 kit £69.00

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

REPRINTS/CONSTRUCTION DETAILS OF ABOVE DESIGNS 10p EACH

CARRIAGE & INSURANCE  
TWEETERS/CROSSOVERS 60p each  
SPEAKERS 4" to 6 1/2" 80p each  
8" to 10" £1 each

12", 13" x 8", £1.95 each  
14" x 9" £2.95 each  
18" £4.50 each  
SPEAKER KITS £1.95 each  
£3.95 pair  
MAG DESIGN KITS £3.95 pair  
unless otherwise stated  
ALL PRICES CORRECT AT 1/2/80

WILMSLOW AUDIO BA1 sub bass amplifier/crossover kit £37.95 + £1 carriage

EVERYTHING IN STOCK FOR THE SPEAKER CONSTRUCTOR!

BAF, LONG FIBRE WOOL, FOAM, CROSSOVERS, FELT PANELS, COMPONENTS, ETC. LARGE SELECTION OF GRILLE FABRICS.

(Send 22p in stamps for grille fabric samples).

ALL PRICES INCLUDE VAT @ 15%

Send 50p for 56 page catalogue 'Choosing a Speaker' (or price list only free of charge)

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

Tel: 0625 529599 FOR MAIL ORDER & EXPORT OF DRIVE UNITS, KITS, ETC. Tel: 0625 526213 (SWIFT OF WILMSLOW) FOR HI-FI & COMPLETE SPEAKER SYSTEMS.

Lightning service on telephoned credit card orders!

WILMSLOW AUDIO The firm for Speakers

35/39 Church Street, Wilmslow, Cheshire



**SAVE**  
**£17.25**  
**ON A KEITHLEY**  
**130 DMM**

# SPECIAL OFFER

exclusive to Wireless World readers . . .  
Since it's recent introduction the Keithley 130 has established itself as one of the finest Handheld D.M.M.'s available.  
And through Wireless World it can be yours for only £73.60 including V.A.T. package and postage — a saving of £17.25 on the recommended retail price.

- Features include:
- ★ Full 10 amp range ★ Only one calibration adjustment required per annum
  - ★ 25 ranges and five functions; ohms DC and AC volts and amps
  - ★ 100µV, 1µA, 0.1Ω Sensitivity ★ 20,000 hour M.T.B.F.
  - ★ One year guarantee on specification

To take advantage of this unique offer, simply fill in the coupon, and send it to Wireless World with a cheque or Postal Order, allowing 21 days for delivery.  
Note: Offer closes on December 10th. This offer applies to readers in the U.K. only.

To: **Wireless World Offer**, Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks.  
Please send me a Keithley 130 at £73.60 including V.A.T., package and postage. I enclose a cheque/postal order made payable to Keithley Instruments Ltd.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
\_\_\_\_\_

WW — 073 FOR FURTHER DETAILS

## PRINTED CIRCUITS FOR WIRELESS WORLD PROJECTS

U.h.f. television tuner—Oct. 1975—1 d.s.	£8.50
Stripline r.f. power amp—Sept. 1975—1 d.s.	£5.00
Audio compressor/limiter—Dec. 1975—1 s.s. (stereo)	£4.25
F.m. tuner (advanced)—April 1976—1 s.s.	£5.00
Cassette recorder—May 1976—1 s.s.	£5.00
Audio compander—July 1976—1 s.s.	£4.25
Time code clock—August 1976—2 s.s. 3 d.s.	£15.00
Date, alarm, b.s.t. switch—June 1977—2 d.s. 1 s.s.	£9.50
Audio preamplifier—November 1976—2 s.s.	£8.50
Additional circuits—October 1977—1 s.s.	£4.00
Stereo coder—April 1977—1 d.s. 2 s.s.	£8.50
Morse keyboard and memory—January 1977—2 d.s.	
(logic board 10¼in. x 5in.) (keyboard and matrix 13in. x 10in.)	£14.00
Low distortion disc amplifier (stereo)—September 1977—1 s.s.	£2.00
Low distortion audio oscillator—September 1977—1 s.s.	£3.50
Synthesized f.m. transceiver—November 1977—2 d.s. 1 s.s.	£12.00
Morsemaker—June 1978—1 d.s.	£4.50
Metal detector—July 1978—1 d.s.	£3.75
Oscilloscope waveform store—October 1978—4 d.s.	£18.00
Regulator for car alternator—August 1978—1 s.s.	£2.00
Wideband noise reducer—November 1978—1 d.s.	£5.00
Versatile noise generator—January 1979—1 s.s.	£5.00
200MHz frequency meter—January 1979—1 d.s.	£7.00
High performance preamplifier—February 1979—1 s.s.	£5.50
Distortion meter and oscillator—July 1979—2 s.s.	£5.50
Moving coil preamplifier—August 1979—1 s.s.	£3.50
Multi-mode transceiver—October 1979—10 d.s.	£35.00
Amplification system—October 1979—3 preamp 1 poweramp	
(£4.20 each) £16.00	
Digital capacitance meter—April 1980—2 s.s.	£7.50
Colour graphics system—April 1980—1 d.s.	£18.50
Audio spectrum analyser—May 1980—3 s.s.	£10.50
Multi-section equalizer—June 1980—2 s.s.	£8.00
Floating-bridge power amp—Oct. 1980—1 s.s. (12V or 40V)	£4.00
Nanocomp—Jan. 1981—1 d.s. 1 s.s.	£9.00
Logic probe—Feb. 1981—2 d.s.	£6.00

Boards are glassfibre, roller-tinned and drilled. Prices include V.A.T. and U.K. postage.  
Airmail add 20%, Europe add 10%, Insurance 10%.  
Remittance with order to:  
**M. R. SAGIN, 23 KEYES ROAD, LONDON, N.W.2**

WW—031 FOR FURTHER DETAILS

## WHOLESALE ELECTRONIC COMPONENTS

	Stock	Price
AU113	120	.98
3k-Presets	2,000	.01
TBA800	500	.44
4700µF 16v Elec.	800	.14
7448 TTL	1,600	.20
16-Pin DIL Socket	5,000	.08
Z-80 P10 4MHz	30	6.50
2708 EPROM	500	4.39
2114 SRAM	800	3.51
4116 DRAM	800	4.50

And many more. Companies invited to send SAE for our up-to-date price list.

Please phone for availability before ordering. All our prices include 15% VAT. Postage extra.

**STRUTT**  
ELECTRICAL AND  
MECHANICAL ENGINEERING LTD.  
ELECTRICAL COMPONENT  
DISTRIBUTORS

3c BARLEY MARKET ST.  
TAVISTOCK  
DEVON PL19 05F  
Tel. TAVISTOCK (0822) 5439  
Telex: 45263

**“Tektronix understands”** Value for money.

# We sell the finest low cost oscilloscopes in the world.

The complete range of low-cost oscilloscopes available from Tektronix offers more choice and more value for money.

Because everyone needs a slightly different performance in either band-width/sensitivity or extra control functions, we offer a range with different specifications. There are 4 dual-trace oscilloscopes

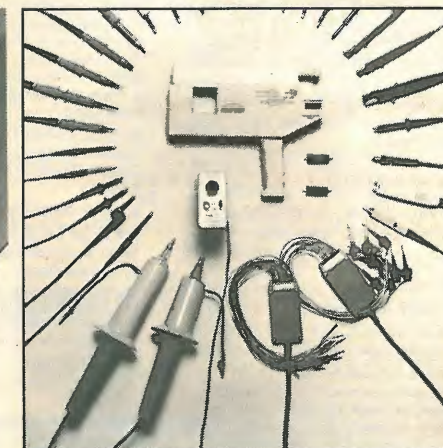
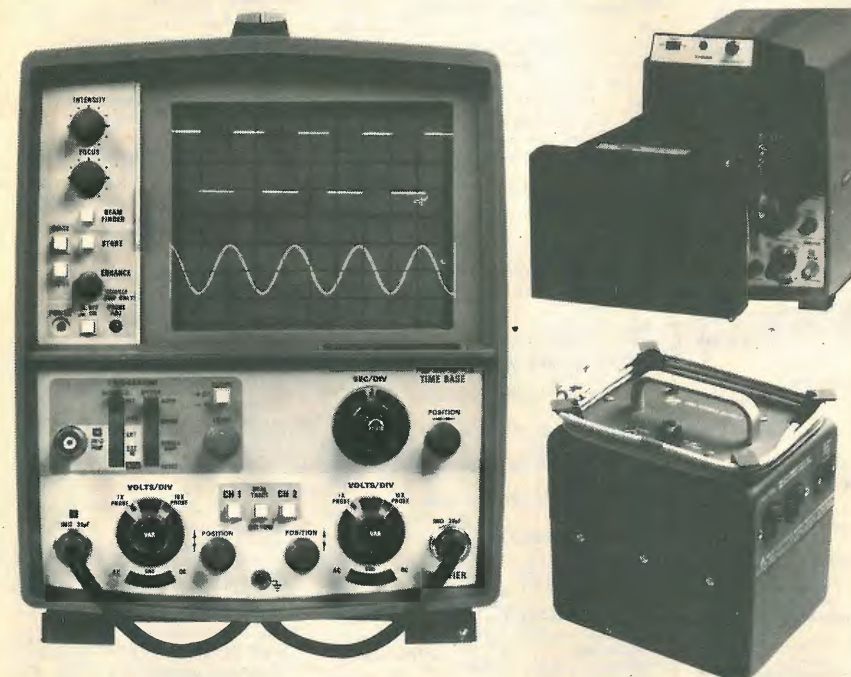
to choose from in the Telequipment D1000 Series family, with 10 or 20 MHz bandwidths.

And there are 5 different Tektronix T900 Series oscilloscopes ranging from a 15 MHz single trace oscilloscope to a 35 MHz dual-trace oscilloscope with Delayed Sweep.

All our oscilloscopes are thoroughly pre-tested to meet

the high standards that go with our name. The result is solidly built oscilloscopes which are not only easy to operate and maintain but also represent the most reliable buys on the market.

The T900 Series is supported by a full range of accessories including battery power packs, cameras & scope stands.



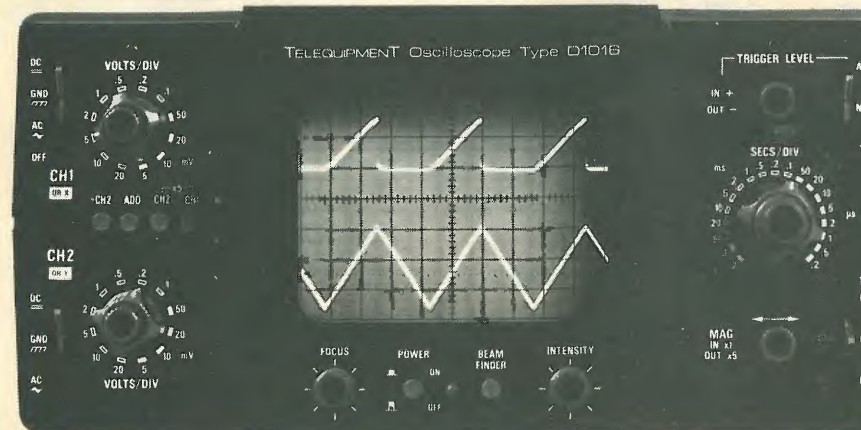
Telequipment oscilloscopes are sold & serviced worldwide by Tektronix.

Please send me more information on  
**Telequipment Oscilloscopes**  
**T-900 Series Oscilloscopes**

Name \_\_\_\_\_  
Position \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
Telephone \_\_\_\_\_

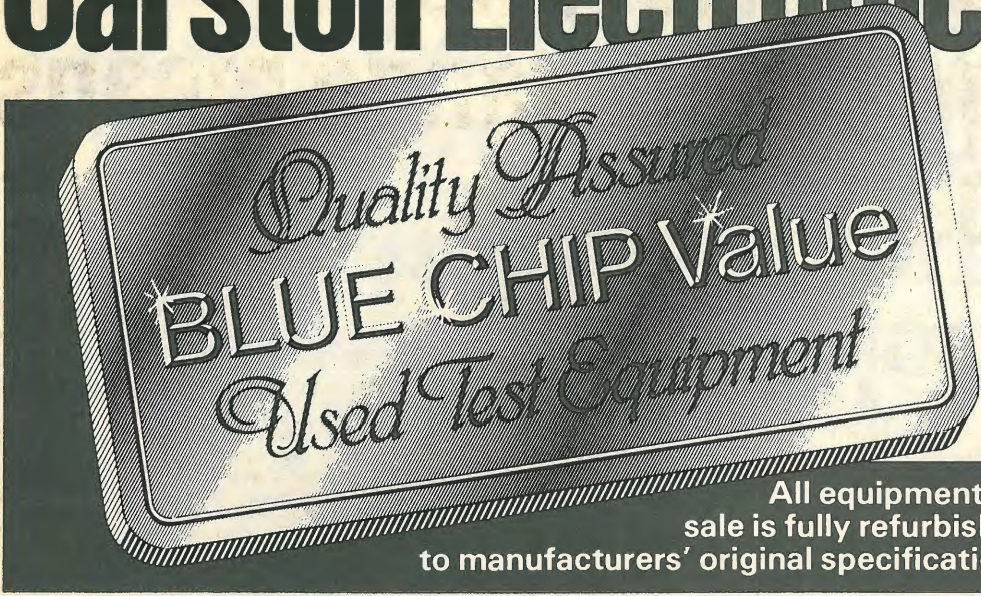
**Tektronix International Inc.**  
European Marketing Centre  
Postbus 827, 1180 AV Amstelveen  
The Netherlands

**Tektronix**  
COMMITTED TO EXCELLENCE



WW — 076 FOR FURTHER DETAILS

# Carston Electronics



Prices from £	Products	Prices from £
850	<b>Bridges</b> GENRAD GR1657 DigiBridge LCR, auto, LED display	850
130	CINTEL 277 Measures iron core inductances 0.01H-1000H (with a Q value not less than 2)	130
1250	HEWLETT PACKARD 4342A 'Q' Meter QLC complete	1250
250	MARCONI TF868A Universal Bridge	250
375	TF1313A Universal LCR Bridge 0.1%	375
475	WAYNE KERR B224 Wide range LCR Bridge	475
225	B500 Log LCR Bridge	225
125	B801 RF LCR Bridge (Detector and Oscillator not incl.)	125
450	B641, Measures L/C/R/G Accuracy of 0.1%	450
230	Q801, Y parameter test set. Plus transistor adaptor unit	230
575	<b>Cable Test Equipment</b> MARCONI TF2333 Transmission Test set	575
475	HEWLETT PACKARD 3556A For psophometric measurements from 20 Hz-20kHz. 0.1mV-30V input level	475
275	NEC TTS-37B, Noise, level and VU measurement. Sensitivity -80dBm up to +20dBm	275
240	STC 74216A Noise Generator CCITT	240
475	74261A Psophometer CCITT	475
2,725	TEKTRONIX 1502 Portable TDR Cable Tester	2,725
1,500	WANDEL u. GOLTERMANN DLM-1. Send/Receive system	1,500
3,250	LDS-2. 200Hz-600kHz sender for measuring group delay and attenuation variations	3,250
250	LDEF-2. Filters for DLM unit	250
90	<b>Counter Timers</b> HEWLETT PACKARD 5300A/5303B DC-520 MHz 6 digits	210
250	5300A Display Module. 6 Digits. 8 x 10 <sup>7</sup>	250
75	5302A DC-50 MHz, 100mV sens.-Time interval. Period. Ratio. Totalise.	75
120	5303B DC-520 MHz. (Plug-on) 125mV sens. 50 $\Omega$	120
100	5308A 0-75 MHz. Universal Module. 50mV sens. 1M $\Omega$	100
120	5267A Time Interval Plug-in 10ns	120
1,225	5345 DC-500 MHz Time Int. Ave. Burst Total Ratio	1,225
225	10590A Adaptor converts 5245 Plug-ins to 5345	225
250	RACAL 9024 10 Hz-600 MHz 7 + 1 digits	250
100	9835 6 Digit DC-20 MHz 10mV	100
130	9837 DC-80 MHz 6 digits	130
850	SYSTRON DONNER 6053-9 Digit 20 Hz-3 GHz BCD O/P	850

*As New Ex Stock delivery*

**OSCILLOSCOPES**

TEKTRONIX 465 DC-100 MHz Dual Trace 5mV-5V/Div 0.05 $\mu$ s-0.5s/Div Delayed T/B XY DC 4 MHz	£1250	TEKTRONIX 475A DC-250 MHz Dual Trace 5mV-5V/Div 0.01 $\mu$ s-0.5s/Div Delayed T/B XY DC 3 MHz	£1950
--	-------	---	-------

These instruments sold with **ONE YEAR FULL GUARANTEE**

Prices from £	Products	Prices from £
525	1825A Dual Timebase 50ns-1s/div.	525
550	1805A Dual Trace DC-100 MHz 5mV. 1M $\Omega$ /50 $\Omega$	550
100	TEKTRONIX Type R. Transistor R.T. tester. Pulse rate 120 pulses/sec. R.T. Less than 5 $\mu$ s	100
50	Type G. Differential amplifier. 100:1 CMR DC-20 MHz. 50 mV sensitivity Plug-ins for 500 series	50
225	1A1 dual trace Plug-in DC-50 MHz	225
180	1A2 dual trace Plug-in DC-50 MHz	180
375	1A4 four trace Plug-in DC-50 MHz	375
175	1A5 Differential Plug-in	175
140	Z Differential Plug-in	140
75	81 Adaptor Plug-in 1A Series to 580 Series	75
410	7A12 Dual Trace DC-105 MHz 5mV/div.	410
450	7A22 High gain diff. amp. 0.1 Hz-1 MHz 10 $\mu$ V	450
525	7A26 Dual Trace DC-150 MHz 5mV-5V/div.	525
550	7B53A Dual Timebase 5ns-5s/div.	550
675	<b>Oscilloscopes (storage)</b> TEKTRONIX 549/1A1. DC-30 MHz. 5mV sensitivity. Dual trace. Storage scope. Writing speed: 5cm/ $\mu$ s with enhancement. Includes trolley	675
750	564B/3A6/2B67. DC-10 MHz. Dual trace 10mV sensitivity, split screen storage oscilloscope	750
2,225	466 Storage 1350 cm/ $\mu$ s Variable Persist DC-100 MHz	2,225
1,650	7313 Split screen 4.9 cm/ $\mu$ s. DC-25 MHz (M/F for 3 Plug-ins)	1,650
200	<b>Phase Meter</b> ADVANCE OS1000A DC-20 MHz. dual trace 3300B Dual Trace DC-50 MHz 5mV/div. Dual Timebase	200
600	GOULD ADVANCE OS1000B DC-20 MHz Dual Trace X-Y TV Sync	600
400	HEWLETT PACKARD 1703A Storage 1000Div/ms. DC-35 MHz. Dual trace Mains/Ext DC	400
1,200	181A Storage 1000Div/ms DC-100 MHz Main frame only	1,200
650	182C DC-100 MHz Mainframe, large screen	650
525	MEDELEC M-scope 4 channel DC-100 kHz U/V Chart	525
1,650	PHILIPS PM 3211 DC-15 MHz Dual Trace 2mV	1,650
425	PM3233 Dual Beam DC-10 MHz 2mV/div.	425
400	TEKTRONIX 475 Dual Trace DC-200 MHz 2mV	400
1,125	485 Dual Trace DC-350 MHz 50 $\Omega$ 1 M $\Omega$ 250 MHz	1,125
2,100	545B/1A1. DC-30 MHz. dual trace. Delayed timebase	2,100
325	585A/82. DC-80 MHz. dual trace 10 mV sensitivity	325
525	547/1A1. DC-50 MHz. dual trace DTB	525
525	547/1A4. DC-50 MHz. four trace DTB	525
625	7403N DC-60 MHz 3 Plug-in Mainframe	625
450	7704A DC-200 MHz. CRT Readout. Mainframe for 4 Plug-in	450
1,200	SMITHS 4701 5-7V o/p Power Pack	1,200
32	SORENSEN DCR 300-2.5:0-300V 2.5A DC Stab.	32
375	Pulse Generators DB ELECTRONICS 150. I.C. pulse generator	375
50	EH RESEARCH 122. 1 kHz-200 MHz 5V/50 $\Omega$ RT 12ns	50
220	139(L). 10Hz-50 MHz 10V/50 $\Omega$ RT 5ns	220
175	1221. Timing Unit 6 Channel 0-10 MHz 5V/50 $\Omega$ RT 8ns	175
50	HEWLETT PACKARD 214A 100V/50 $\Omega$ . Double pulse O/P. W50ns-10ms. 10 Hz-1 MHz. 15ns RT	50
350	MARCONI TF2025 0.2 Hz-25 MHz $\pm$ 10V/50V RT 7ns	350
6500	<b>Recorders and Signal Conditioning Equipment</b> AMPEX PR2200 Instrumentation Recorder up to 16 channels. FM/DR. Record replay all speeds. 1" tape FM/DR I.R.I.G. DC-40 kHz FM. 100 Hz-300 kHz DR	6500
75	BRUNO WOELKE ME102B. Wow and flutter meter	75
90	ME102C. Wow and flutter meter	90

# Bigger stock investment greater equipment range means wider choice

Prices from £	Products	Prices from £
1,650	BRYANS SOUTHERN BS314 4 channel 1mV-10V 16 speeds	1,650
2,350	BS316 6 channel 1mV-10V 16 speeds	2,350
275	HEWLETT PACKARD 680M. 5 inch. Stripchart Single Pen 5mV-120V I/P 20cm/min 2.5 cm/Hr	275
995	7046A Two pen A3 0.25mV-5V/cm	995
1,215	KUDELSKI Nagra 4.2 LSP Professional Audio Recorder (Batt optd)	1,215
450	PHILIPS PM 8251 Single pen 10in chart 10mV-50V FS	450
1,675	RACAL Store 4. Uses D/4 inch magnetic tape. Will record 4 F.M. channels. Operates at 7 different speeds.	1,675
1,400	S E LABORATORIES 6150/6151 12 channel UV 1250 mm/s-25 mm/min 6 in chart 994 6 Channel Pre-Amp $\pm$ 1% $\pm$ 1V o/p	1,400
450	6008 25 Channel $\mu$ V 8 in 4m/sec to 25mm/min	450
895	DYMAR 2081/100 True RMS. DC-500 MHz. 30mV-100V	895
350	SMITHS INDUSTRIES RE541.20 Single Pen. 0.5mV-100V FSD. 3-60cm/min and hour	350
425	YOKOGAWA 3046. 10 inch Chart Single Pen. 0.5 mV-100V VI/P2.60cm/min and/hr	425
304.7	2 Pen Version of 3046	304.7
300	<b>Signal Sources and Generators</b> BOONTON 102B 4.3-520 MHz Int/Ext FM/AM 0.1 $\mu$ V-1V 50 $\Omega$	300
1725	74216 Noise Generator 20 Hz-4 kHz Flat/CCITT Wtg	1725

Prices from £	Products	Prices from £
525	DYMAR 1525 100 kHz-184 MHz Int/Ext AM/FM Batt/Mains	525
450	GENERAL RADIO 1362 UHF, 220-920 MHz	450
85	GOULD ADVANCE SG70 5 Hz-125 kHz 600 $\Omega$ 4w	85
1100	HEWLETT PACKARD 204D 5 Hz-1.2 MHz. 600 $\Omega$ . 80dB att. O/P 5V RMS	1100
1,950	620B 7-11 GHz 50 $\Omega$ FM/PM 1mw 8614A 800 MHz-2.4 GHz $\pm$ 10dBm to -127 dBm 50 $\Omega$ AM/FM	1,950
925	8616A 1.8-4.5 GHz Ext AM/FM/PM 10 mw	925
550	MARCONI TF144 H/4S HF Generator 10 kHz-72 MHz AM	550
95	TF791. FM Deviation Meter 4-1024 MHz	95
255	TF801/D1. 10-470 MHz AM. FM.	255
350	TF995A/2. 1.5-220 MHz AM. FM.	350
525	TF2171 Digital Synchroniser for TF2015	525
625	TF2002/AS 10 kHz-72 MHz FM/AM 0.1-1V o/p	625
650	TF2012 UHF. FM 400-520 MHz. 0.03 $\mu$ V. Counter o/p	650
550	TF2012 UHF. 400-520 MHz. FM	550
1,875	RACAL 9081 5-520 MHz LED Display O/P - 130dBm AM/FM	1,875
150	SCHAFFNER NSG300 Ignition Interference Attachment	150
250	NSG200B Mains Interference Simulator (Mainframe)	250
315	STC 74216 Noise Generator 20 Hz-4 kHz Flat/CCITT Wtg	315

Prices from £	Products	Prices from £
850	<b>Spectrum Analysers</b> HEWLETT PACKARD 8443A Tracking Gene/counter 100 kHz-110 MHz	850
1,300	8445A Automatic pre-selector 10 MHz-18 GHz	1,300
3,000	8555A RF Plug-in 10 MHz-18 GHz 1 kHz Res	3,000
1,350	851B/8515B Display & RF Section	1,350
350	NELSON ROSS 011. DC-20 kHz. 80dB dynamic range. Dispersion: 100 Hz-6 kHz	350
350	022. DC-100 kHz. Dynamic range 60dB fits into various 500 series CRO's	350
99	HEWLETT PACKARD 400E Millivoltmeter 10 Hz-10 MHz B/W 1mV FSS	99
275	427A. AC/DC/ $\Omega$ multimeter	275
345	3406A. 10 kHz-1.2 GHz	345
350	3400A 10 Hz-10 MHz 1mV-300V True RMS	350
99	KEITHLEY 610C Electrometer DC 1mV-100V. Amps 10 <sup>-11</sup> Recorder o/p	99
600	LEVELL TM3B 5 $\mu$ V-500VAC 1 Hz-3 MHz $\pm$ 50 to 100 dB	600
300	MARCONI TF2603. AC voltmeter to 1.5 GHz	300
525	PHILIPS PM2454B 1mV-300V. 10 Hz 12 MHz Z in 19MS $\Omega$ . DC O/P.	525
950	RACAL 9301 RMS Millivoltmeter 10 kHz-1.5 GHz with carry case	950
195	<b>Voltmeters-Digital</b> ADVANCE DM7A/01 1999 FSD AC/DC/ $\Omega$ /Current	195
115	FLUKE 8000A 1999 FSD. AC/DC/OHMS/Current	115
180	HEWLETT PACKARD 34740A/34702A 9999 FSD AC/DC/OHMS	180
75	SOLARTRON LM1420 2. 2300 FSD DC only 0.05% LM1420 2BA. 2300 FSD AC True RMS/DC	75
110	A200. 19999 FSD DC only	110
160	A203. 19999 FSD AC/DC/ $\Omega$ . Sensitivity: (1 $\mu$ V DC, 10 $\mu$ V AC, 100m $\Omega$ resistance)	160
300	A205. 19999 FSD AC/DC/ $\Omega$ . Sensitivity: (1 $\mu$ V DC, 10 $\mu$ V AC, 10m $\Omega$ resistance)	300
325	7050 99999 Auto AC/DC/ $\Omega$	325
350	<b>Voltmeters Vector/Phase</b> DRANETZ 305B 9999 FSD Mainframe for PA 3001 module	350
575	HEWLETT PACKARD 3490A 100000 FSD 1 $\mu$ V-1000V DC 0.01% 10 $\mu$ V-1000V AC $\pm$ $\Omega$	575

ALL PRICES LISTED ARE EXCLUSIVE OF VAT (Standard Rate).

## Prime Equipment

RACAL 9081 5-520 MHz Generator 130 dBm AM/FM	£1975
HEWLETT PACKARD 8640B Precision AM-FM Signal Generator	£3550
141T Spectrum Analyzer - Mainframe	£1300
8552B Spectrum Analyzer - IF Section	£2200
8553B Spectrum Analyzer - RF Section	£1650
8555A Spectrum Analyzer - RF Section	£4400
8556A Spectrum Analyzer - LF Section	£1650
8558B Spectrum Analyzer (for 180 Mainframe)	£2500
1600A 16 Channel Display Logic Analyzer	£2150
PHILIPS PM 3212 Dual Trace 25 MHz 2mV/Div Oscilloscope	£525
PM 3214 Dual Trace Dual Trace DC-25 MHz Oscilloscope	£625
TEKTRONIX 485 Dual Trace 350 MHz Oscilloscope	£2995
T912 Dual Trace Storage Oscilloscope	£699
DC-10 MHz 250 cm/ms writing speed	
7313 Storage Oscilloscope Mainframe	£1900
4.9 cm/ $\mu$ s writing speed DC-25 MHz	
7A22 Differential Plug-in. As new DC-1 MHz	£670
10 $\mu$ V-10V/Div (12 month guarantee)	
7A26 Dual Trace Plug-in. DC-150 MHz 5mV-5V/Div.	£780
7B53A Dual Timebase 5ns-5s/Div CRT Readout	£650

Carston Prime Equipment brings you recent "State-of-the-Art" instruments at competitive prices, with fast delivery (2-4 weeks). Every "Prime" instrument carries the Carston 90 Day Full Guarantee covering parts and labour.

# Carston Electronics

Contact Ed Cooper or Noel Jennings  
CARSTON ELECTRONICS LTD  
SHIRLEY HOUSE, 27 CAMDEN RD.,  
LONDON NW1 9NR Telex 23920

## 01-267 5311/2

WW-022 FOR FURTHER DETAILS

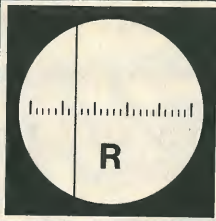
**PLEASE NOTE:**  
LISTED HERE IS ONLY A SELECTION OF OUR WIDE STOCK OF EQUIPMENT - FOR SPECIALIST NEEDS OR FOR DETAILS OF OUR FULL STANDARD RANGE OF EQUIPMENTS - RING US TODAY!  
**Redundant Test Equipment**  
Why not turn your under-utilized test equipment into cash? Ring us and we'll make you an offer.

VALVES				VALVES VAT IS INCLUDED					
Minimum Order £1.00									
A1065	1.40	KT66	6.30	X66	0.95	6H6	1.60	30PL14	2.45
A2293	8.80	KT88	9.20	X61M	1.70	6J4	1.35	35L6GT	1.40
A2900	12.80	ML6	13.80	XR1-6400A	82.90	6J4WA	2.00	35W4	0.80
ARB	0.75	MH4	2.50	Z759	9.00	6J5	2.30	35Z4GT	0.80
ARP3	0.70	N78	9.90	Z749	0.75	6J5GT	0.90	40B6	3.15
ATP4	0.50	N78	9.90	Z800U	3.45	6J6	0.85	50C5	2.15
B12H	3.90	OA2	0.70	Z800U	3.45	6J6W	0.90	50C6G	1.35
CY31	1.40	OB2	0.80	Z801U	3.75	6J7	1.20	75B1	1.25
DAF96	0.70	P8C80	0.80	Z801U	3.75	6JE6	2.95	75C1	1.70
DET22	21.85	PC84	0.75	Z900T	2.45	6J8C	2.35	76	0.95
DF96	0.70	PC86	0.95	1A3	0.85	6K7	0.80	78	0.95
DK96	1.20	PC88	0.95	114	0.50	6L6M	2.80	80	1.70
DH76	0.75	PC97	1.50	1R5	0.80	6L6G	2.50	85A2	1.40
DL92	0.80	PC900	1.15	1S4	0.45	6L6GC	2.10	85B2	2.55
DY86/87	0.85	PCC84	0.50	1S5	0.45	6L6GT	1.25	723A/B	11.00
DY802	0.70	PCC89	0.85	1T4	0.45	6L7G	0.85	805	20.70
E5SL	14.90	PC0189	1.05	1U4	0.80	6L8	0.70	807	1.25
EB8CC	1.60	PCF80	0.80	1X2B	1.40	6LQ6	2.95	813	13.30
EB8CC/01	1.60	PCF82	0.70	2021	1.10	6LQ6	0.70	829B	14.00
E92CC	3.10	PCF84	0.75	2K25	11.90	6K6A	2.70	832A	8.90
E180CC	2.80	PCF86	1.50	2K25	11.90	6Q7G	1.30	866A	3.80
E180F	6.30	PCF87	0.50	2X2	1.15	6SA7	1.00	866E	6.25
E182CC	4.95	PCF201	1.85	3A4	0.70	6SG7	1.15	931A	13.80
EA76	2.25	PCF800	0.50	3AT2	2.40	6SJ7	1.05	954	0.80
EABC80	0.60	PCF801	1.75	3D22	23.00	6SK7	0.95	955	0.70
EB91	0.80	PCF802	0.85	3E29	19.00	6SL7GT	0.85	956	0.80
EBC33	1.15	PCF805	2.45	3S4	0.80	6SN7GT	0.80	957	1.05
EB930	0.90	PCF806	1.85	4832	18.25	6SR7	1.10	1625	1.80
EBF80	0.60	PCF808	2.05	5B/254M	14.00	6SV6	0.95	1629	1.85
EBF83	0.60	PCH200	1.35	5B/255M	11.50	6V6GT	1.50	2051	14.00
EBF89	0.80	PCL81	0.75	5B/258M	8.80	6X4	0.75	5842	7.50
EC52	0.65	PCL82	0.95	5C22	29.90	6X4WA	2.10	5881	3.40
EC31	3.40	PCL84	0.90	5R4GY	1.30	6X5G	0.85	5933	6.90
EC92	0.85	PCL86	1.05	5U4G	0.75	6V6G	0.90	6057	2.20
ECC81	0.65	PCL805/85	0.85	5V3GT	0.80	6Z4	0.70	6060	1.95
ECC82	0.60	PD500/510	1.25	5Z4G	0.75	7B7	1.75	6064	2.30
ECC83	0.65	PFL200	1.10	5Z4G	0.75	7Y4	1.25	6065	3.20
ECC84	0.60	PL36	1.25	5Z4GT	1.05	9D2	0.70	6067	2.30
ECC85	0.60	PL82	0.70	6B7	0.70	9D6	2.90	6080	5.30
ECC86	1.70	PL84	0.95	6AC7	1.15	10C2	0.85	6146	4.95
ECC88	0.80	PL84	0.95	6AG5	0.80	10F18	0.70	6146B	5.20
ECC89	0.85	PL84	0.95	6AH6	1.15	10P13	1.50	6360	2.85
ECC90	0.85	PL84	0.95	6AK8	0.80	11E2	19.50	6320	6.80
ECC91	0.85	PL84	0.95	6AK8	0.80	12A6	0.70	6870	14.00
ECC92	0.85	PL84	0.95	6AL5	0.80	12A6	0.70	6870	14.00
ECC93	0.85	PL84	0.95	6AL5W	0.85	12A7	0.85	6973	3.30
ECC94	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC95	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC96	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC97	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC98	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC99	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC100	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC101	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC102	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC103	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC104	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC105	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC106	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC107	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC108	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC109	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC110	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC111	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC112	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC113	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC114	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC115	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC116	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC117	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC118	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC119	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC120	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC121	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC122	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC123	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC124	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC125	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC126	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC127	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC128	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC129	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC130	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC131	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC132	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC133	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC134	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC135	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC136	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC137	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC138	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC139	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC140	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC141	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC142	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC143	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC144	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC145	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC146	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC147	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC148	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC149	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC150	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC151	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC152	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC153	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC154	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC155	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC156	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC157	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC158	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC159	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC160	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC161	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC162	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC163	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC164	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC165	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC166	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC167	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC168	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC169	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC170	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC171	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC172	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC173	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC174	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC175	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC176	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC177	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	7199	2.85
ECC178	0.85	PL84	0.95	6AM5	4.20	12A7	0.85	719	

# RADIATION DETECTORS

**QUARTZ FIBRE DOSIMETER**

Recommended for  
**CIVIL DEFENCE • FIRE SERVICES • MEDICAL • HOSPITAL & General use.**



- RADIATION CANNOT BE HEARD, SEEN OR SMELT.
- THIS DOSIMETER WILL AUTOMATICALLY DETECT THE AMOUNT OF RADIATION IN THE AIR.
- UNIT IS SIZE OF FOUNTAIN PEN AND WILL CLIP IN TOP POCKET.
- PRECISION INSTRUMENT, METAL CASED, WEIGHT 40 GRAMS.
- CONTAINS 3 LENSES. ■ RUGGED CONSTRUCTION.
- MANUFACTURERS CURRENT PRICE OF A SIMILAR MODEL OVER £25 EACH.

COMPLETE WITH DATA

British design and manufacture. Tested, calibrated and guaranteed. Ex-stock delivery by return.

Be prepared, buy whilst available.

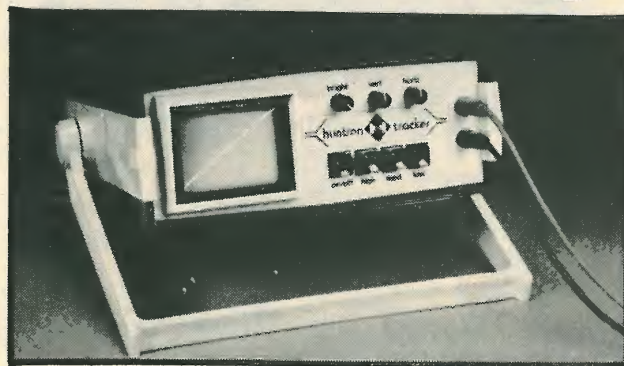
**HENRY'S**

Standard model  
**£6.95** inc. VAT  
Post & Packing 60p  
Industrial model O-150R  
**£10.95** incl. Post Paid

404 EDGWARE ROAD, LONDON W2 1ED  
Tel: 01-723 5095 Telex: 262284 Ref 1400



# Cut costs and speed trouble shooting



with the

## Huntron Tracker

This easy to use test instrument displays shorts, opens, and leakage in solid state components. Check diodes, unijunctions, bipolars, Darlingtons, J-FET's, MOS FET's, LED's, electrolytics and IC's... IN CIRCUIT!

Test pure digital or analogue hybrid boards... WITHOUT CIRCUIT POWER!

Current limited to protect delicate devices in the MOS-CMOS family. Save 20... 30... 40... even 50% of trouble shooting time and recover your investment fast! Exclusive 12 months warranty, available from—

MTL Microtesting Limited  
1-15 Butts Road, Alton, Hampshire  
Telephone: Alton (0420) 88022.



WW-059 FOR FURTHER DETAILS

**TELEPRINTER TYPE 7B:** Pageprinter 24v d.c. power supply. Speed 50 bauds per min. S/hand good cond. (no parts broken, £28.75. OR GPO MODEL, as above except motor, 110/230V d.c. £34.50. Carriage either type £9.50. Send SAE for list of Teleprinter spares available.  
**FRIDEN FLEXOWRITER** with Perforator. 230V a.c. Excellent cond. £86.25 ea. Carr. £10.  
**RADAR ECHO BOX TS.488A** X-band. £65. Carr. £5.  
**TS.147 RADAR TEST SET** Combination Sig. generator and frequency meter and power meter. Provides C.W. & F.M. signals. 115V a.c. £225. Carr. £7.  
**HEWLETT PACKARD Signal Generator HP608B.** Freq. 10-400MHz C.W. & A.M. Output 1microvolt to 8V, 50... Mod. 400-1000Hz. 230V a.c. £225. Carr. £10.  
**AUTO TRANSFORMER:** 230/115V 50 c/s 1000 watts. Mounted in strong steel case 5" x 6 1/2" x 7". Bitumen impregnated. £17.25 + carriage.  
**TRANSISTORISED 3cm RADAR AMPLIFIER SWITCH:** with 24v waveguide switch, 9 x 4cm ins. with crystal CV.2355 and spark gap VX.1046. £17.25 + £1 post.  
**INSULATION TEST SET 0** to 10KV, negative earth, with Ionisation Amplifier, 100/230 Volts AC. £48.87 + carr.  
**BC-221 FREQUENCY METER:** 125-20,000kc/s complete with original calibration charts £24.15 + carr.  
**ROTARY INVERTER TYPE PE-218E:** Input 24-28v. DC 80 amps, 4,800rpm. Output 110v AC 13 amp 400c/s, 1PH. P.F. 9. £23 + carr.  
**RESONATOR PERFORMANCE CTC 424** 8.5 to 9.0 kmc/s 3 cm £80.50 + post £2.  
**INVERTER 24v.** DC input 400 cycles 1pH 6600 r.p.m. 200v. peak. £8.05 + £2 post.  
**OXYGEN BOTTLE 1800lb.** w.p. £11.50 + carr.  
**NOISE SOURCE UNIT** with CV.1881 noise source mount. Produces thermal noise 15.5dB 200/250v. AC £80.50.  
**HS33 HEADSET.** Low imp. £5.35 + 75p post.  
**MUIRHEAD DECADE OSCILLATOR TYPE 890D:** £92 + carr. £5.  
**SIEMENS POWER METER REL3U/84/Alb:** 0-12kHz 1mw 500mw 6.ranges. 0.17dB 50 ohms. £92 + carr.  
**CV.1596 CATHODE RAY TUBE:** (09D, 09G), 4" screen, green electrostatic base B12B. HT1200 volts, heater 4 volts £11.50.  
**RADAR RECEIVING ANTENNA TYPE X443 Mk.D:** Suitable for detecting signals on X, K, J and Q bands, 9g Hz-60g Hz. Complete with waveguide horns, associated crystals. Transistorised amplifier and geared motor, etc. £143.75.  
**VACUUM & PRESSURE DEAL TEST EQUIPMENT:** complete with 2 x 4" gauges indicating 0.20lbs p.s.i. 0-30lbs vacuum. With stand, hand pump, etc. £34.50 + carr.

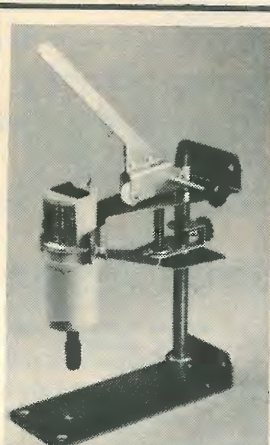
**BARGAIN MAPS**  
Large stocks of unused U.S.A.F. surplus maps, weather charts, etc. including:

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 75p (inc. P&P)  
25 x Maps (either same type OR assorted), £10 + £1.60 P&P.  
10 x Maps (either same type OR assorted), £6.50 (inc. P&P).

All prices include VAT at 15%  
Carriage quotes given are for 50-mile radius of Herts.

**W. MILLS**

The Maltings, Station Road  
SAWBRIDGEWORTH, Herts.  
Tel: Bishop's Stortford (0279) 725872



## LOW VOLTAGE POWER DRILLS AND ACCESSORIES

Illustration shows Titan Drill and Stand (Price £27 inc. VAT and Postage) which is one of the combinations which can be purchased from our comprehensive range of Drills and Accessories.

Prices from £8.34 (Reliant Drill only) inc. VAT and Postage.

Send 25p for Catalogue.

**A. D. BAYLISS & SON LTD.**

PFERA WORKS, REDMARLEY  
GLOUCESTER GL19 3JU

Barclaycard, Access Welcome  
Tel. Bromesbarrow (053 181) 364 or 273

WW-036 FOR FURTHER DETAILS

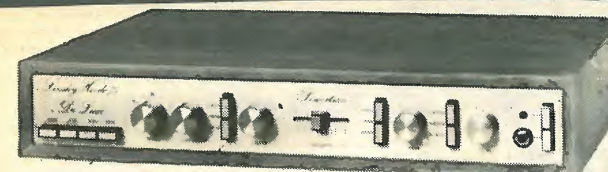
## ELECTRONIC VALVES WANTED

All Types Receiving, Transmitting, Industrial

PL504 — PL802 — PCL805 — CV131 — CV136 —  
CV138 — CV329 — CV345 — CV450 — 805 —  
807 — 813 — 2K25, Etc.

Phone/write to:  
**PYPE HAYES RADIO LTD.**  
606 Kingsbury Road  
Birmingham B24 9PJ  
021-373 4942

WW-026 FOR FURTHER DETAILS



**DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + VAT**

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring while distortion is less than 0.01%.



**T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT**

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30+30) is also available for £38.40 + VAT. MATCHING TUNERS — See our FREE CATALOGUE!

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc. and full instructions — in fact everything!

All kits also available as separate packs (e.g. PCB, component sets, hardware sets, etc.). Prices in our FREE CATALOGUE.

MANY MORE KITS ON NEXT PAGE!

# BLACK HOLE

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLDS), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

**COMPLETE KIT ONLY £49.80 + VAT** (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80 + VAT**

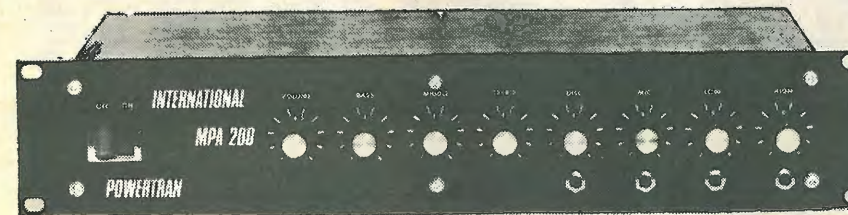
Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

**POWERTRAN ELECTRONICS**  
PORTWAY INDUSTRIAL ESTATE ANDOVER  
ANDOVER HANTS SP10 3NN (0264) 64455

## MPA 200 100 WATT (rms into 8Ω) MIXER / AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward. The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" x 3.5". Depth 7.3"

**COMPLETE KIT ONLY £49.90 + VAT!**  
MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

## 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 or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!



Panel size 19.0" x 3.5". Depth 7.3"

**COMPLETE KIT ONLY £49.50 + VAT!**



Think of KGM as your monitor production line...



See how big names pass their video display headaches to us!

Use CRT displays in your systems or equipment? Then it's well worth getting to know the KGM resources. We can take both design and production problems onto our own experienced shoulders.

For a quick scan of KGM capability, look through our new colour folder - featuring some of the units we have produced for major customers.

KGM Electronics Limited
Clock Tower Road, Isleworth, Middlesex TW7 6DU.
Tel: 01-568 0151. Telex: 934 120

WW-038 FOR FURTHER DETAILS

PM COMPONENTS LTD. VALVE & COMPONENTS SPECIALISTS
CONINGSBY HOUSE, WROTHAM ROAD, MEOPHAM, KENT. TEL. 0474 813225

Table of electronic components including Semiconductors, Diodes, Wirewound Resistors, and other parts with their respective prices.

WW-024 FOR FURTHER DETAILS

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper.



COMPLETE KIT ONLY
£168.50 + VAT!

Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)

NEW! TRANSCENDENT POLYSYNTH



EXPANDABLE POLYPHONIC SYNTHESIZER AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL
By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready-built equipment costing thousands of pounds.

Cabinet size 31.1" x 19.6" x 7.6" (rear) 3.4" (front)

TRANSCENDENT DPX MULTI-VOICE SYNTHESIZER



Another superb design by synthesizer expert Tim Orr published in Electronics Today International
COMPLETE KIT ONLY
£299 + VAT!

Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound—fully polyphonic, i.e. you can play chords with as many notes as you like.

There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors.

POWERTRAN MANY MORE KITS AND ORDERING INFORMATION ON PAGE 91
All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

# BI-AND SAVE SALE-81

**GERM. DIODES**  
200 Mixed Diodes - mainly Germ OA81-91-1N34/60 GC61/62 etc. Case DO-7. Coded and uncoded - You to test - Value all the way!  
O/No. SJ127. £1.00 per Pak.

**SIL DIODES**  
200 Mixed Diodes - mainly SILICON case DO-7 OA200/202 General purpose 200mA marked and uncoded - you to sort & test - Outstanding Value!  
O/No. SJ128. £1.00 per Pak.

**AUDIO AMPLIFIER**  
5 watt Audio Amplifier Module.  
Special Clearance Offer  
O/No. AL20. £2.50

**HEADPHONES**  
NEW Improved Lightweight Stereo Headphones including double headband and padded earcups - Impedance 8 ohms - Frequency 30-18000Hz ALL Black.  
O/No. 885. £4.00  
As above but with coiled lead and rotary volume controls.  
O/No. 884. £7.00

**HEADPHONE ACCESSORIES**  
7 metre Headphone Extension Lead.  
O/No. 136. £1.50

**ANTEX**  
Antex X25 Iron - 25 watt soldering iron. OUR SUPER SALE PRICE. Great reduction.  
O/No. 1931. £4.00  
ST3 Iron Stand - Suitable for above - OUR Sale Price  
O/No. 1939. £1.25 each

**POPULAR (CMOS)**  
CD4001 1 of each, normal price £1.80  
CD4007 for 5 - Our price £1.30 for 5  
CD4011  
CD4017  
CD4081  
O/No. SJ1245

**PLUGS & SOCKETS**  
Set of 4 1-metre Colour coiled leads with phono plug ends - ideal for audio and test use. Outstanding Value.  
O/No. SJ122. £1.00 per Pak  
1mm Plugs & Sockets in Red & Black.  
O/No. SJ123. 5 per £1.00

**CAPACITORS**  
SJ11 150 Caps. mixed types & values. £0.50  
SJ12 60 Electrolytics all sorts mixed. £0.50  
SJ13 40 Polyester/polystyrene capacitors mixed. £0.50  
SJ14 50 C280 type capacitors mixed. £1.00  
SJ15 Polystyrene Caps 1, 160v. £0.50  
SJ16 40 Low volts electrolytics mixed values up to 10v. £0.50

**TRANSFORMERS**  
MINIATURE MAINS Primary 240v  
No. Secondary  
2021 6v-0-6v 100mA £0.75  
2023 12v-0-12v 100mA £0.95  
2035 240v Primary 0-55v 2A Secondary £5.50

**BC108 FALLOUTS**  
50 NPN BC107/108 SJ124 £1  
Manufacturers out of spec on volts or gain or neither - Metal TO18 case - You test.  
50 PNP BC177/178 SJ1244 £1

**DIODES**  
300 1N4148 Type - uncoded Silicon Diodes Case DO-35 - you to test.  
O/No. SJ129. £1.00 per Pak  
Silicon Fast Switch  
NPN - like 2N706/2N2369  
You select by test!  
O/No. SJ125. 50 for £1.00

Special Introductory Offer  
**COMPUTER IC's**  
EPROM 2708 @ £3.00  
EPROM 2516/  
2716 @ £6.00  
D.RAMS 4116 @ £2.25

**SPECIAL OFFER LINEAR IC's**  
NE555 5 for £0.90  
741P 5 for £0.80  
NE556 5 for £2.50  
LM380 5 for £3.50  
72723 14 pin 5 for £1.75

**Semiconductors from Around the World**

100 A collection of Transistors, Diodes, Rectifiers, Bridges, IC's, SCR's, Triacs both Logic and Linear + Opto's all of which are current everyday usable devices. 100

Guaranteed Value over £10 at Normal Retail Price yours for only £4.00

Data etc in every pak. Order No. SJ220

**SILICON TRANS.**  
SJ25 100 Silicon NPN transistors all perfect & coded - mixed types with data - equivalent sheet - no rejects £2.50  
SJ26 100 Silicon PNP transistors all perfect & coded - mixed types and cases, data & equivalent sheet £2.50  
SJ27 50 Assorted pieces of SCR's, diodes & rectifiers incl. stud types, all perfect - no rejects, fully coded - data incl. £2.50

**TTL's**  
SJ28 20 TTL74 series gates - assorted 7401-7460 £1.00  
SJ53 Mammoth IC Pak. Approx 200 pcs assorted fall-out integrated circuits including logic 74 series - Linear audio and DTL. Many coded devices but some unmarked - you to identify £1.00

**RESISTORS**  
SJ1 200 Resistors mixed values. £0.50  
SJ2 200 Carbon resistors 1/2 watt preformed. £0.50  
SJ3 100 1/2 watt miniature resistors mixed values. £0.50  
SJ4 60 1/2 watt resistors mixed values. £0.50  
SJ5 50 1-2 watt resistors mixed pot values. £0.50  
SJ7 30 2-10 watt wirewound resistors mixed. £0.50

**CASSETTES**  
SUPER VALUE & A GREAT SAVING!!!  
C120 Dinky Cassettes - Low noise - astounding value and sound.  
O/No. SJ32. 10 for £3.50

**NPN**  
BD131 TO-126-NPN untested.  
O/No. SJ84. 25 for £1.00  
**SCR's**  
TO66 SCR's 5 Amp - ALL good - untested for volt - good yield 400.  
O/No. SJ130. 10 for £1.00

**AERIALS**  
FM Indoor Tape/Ribbon Aerial  
O/No. 107. 40p each  
HI-FI CAR AERIAL  
4-section fully retractable & locking SPECIAL PRICE.  
O/No. 109. £1.40 each

**BI-PAK'S OPTO BARGAIN!**  
Valued at over £10 - Normal Retail  
We offer you a pack of 25 Opto devices to include LED's large and small in Red, Green, Yellow and Clear. 7 segment Displays both Common Cathode and Common Anode PLUS bubble type displays - like DL-33. Photo Transistors - similar to OCP71 and Photo Detectors - like MEL11-12. This whole pack of 25 devices will cost you just...  
**£4.00!**  
and we guarantee your money back if you are not completely satisfied.  
Full data etc included  
O/No. SJ120.

**PRECISION VOM MULTIMETER**  
20,000 ohms/volts DC. Complete with test leads & instructions.  
**OUR SPECIAL OFFER PRICE £11.00 each.**  
O/No. 1323  
Use your Barclay or Access Card!

**NPN TRANSISTORS**  
SJ68 30 ZTX300 type transistors pre-formed for P/C Board colour coded Blue - all perfect. £1.00  
SJ70 25 BC107 NPN TO106 case perfect transistors code Green Spot. £1.00  
SJ71 25 BC177 PNP TO106 case perfect transistors code C1395. £1.00  
SJ72 4 2N3055 silicon power transistors TO3 £1.00

**POTENTIOMETERS**  
16173 15 Assorted Pots £0.50  
SJ54 20 Assorted Slider Pots £1.00  
SJ56 10 100 K Lin Slider Pots 40mm £0.50  
16186 25 Pre-sets Assorted £0.50  
SJ49 8 Dual ganged carbon pots log and lin mixed values £1.00  
SJ50 20 Assorted slider knobs - chrome/black £1.00

**TRIACS**  
4A 400v TO-202 non-isolated TAG136D £0.40  
8A 400v TO-220 isolated TAG425 £0.60  
Diag D32/BR100 £0.15  
SCR C106D plastic case £0.30

**KNOBBS**  
SJ62 5 15mm chrome knobs standard push fit. £0.50  
SJ63 Instrument knob - black winged (29x20mm) with pointer. 1/2" standard screw fit. £0.15  
SJ64 Instrument knob - black/silver aluminium top (17x15mm). £0.12

**IC SOCKET PACKS**  
SJ36 14 8 pin SJ41 6 22 pin  
SJ37 12 14 pin SJ42 5 24 pin  
SJ38 11 16 pin SJ43 4 28 pin  
SJ39 8 18 pin SJ44 3 40 pin  
SJ40 7 20 pin  
ALL AT ONLY £1.00 each

**VOLTAGE REGULATORS**  
Cast TO220  
Positive Negative  
uA7805 £0.65 uA7905 £0.70  
uA7812 £0.65 uA7912 £0.70  
uA7815 £0.65 uA7915 £0.70  
uA7818 £0.65 uA7918 £0.70  
uA7824 £0.65 uA7924 £0.70

**MICRO E**  
NPN silicon transistors, plastic case, perfect and coded C108 = BC108 TO-18 plastic.  
O/No. SJ29. 50 off £2.50  
100 off £4.00, 1,000 off £25.00

**AUDIO ACCESSORIES**  
SJ75 FM coax cable - plain copper conduction cellular polythene insulated & plain copper braided PVC sheath - impedance 75 ohms £0.10 per metre  
SJ76 1 Board containing 2x5 pin DIN sockets 180° 02-2 pin DIN loudspeaker sockets £0.30  
SJ77 A 5-pin DIN 180° chassis/normal socket incl. DPDT switch £0.20

**DISC CERAMIC CAP**  
100 Disc Ceramic Cap. Mixed values covering complete range 3PF-4,700PF.  
**SUPER VALUE**  
O/No. SJ121. £1.00

**SWITCHES**  
Push-to-make. 6mm panel mounting.  
O/No. SJ131. 5 for £0.50  
Push-to-break as above.  
O/No. SJ132. 4 for £0.50  
Silicon Heat Sink Compound  
3mL in syringe £0.25

**L.E.D.**  
2nd Quality Packs  
1507 10 Assorted colours & sizes £0.65  
S122 10 125 RED £0.50  
S123 10 2 RED £0.50  
LED CLIPS  
1508/125 .125 5 for £0.10  
1508/2 .2 5 for £0.12

**MISCELLANEOUS**  
SJ20 2 Large croc clips 25A rated - ideal for battery chargers etc. £0.30  
SJ21 Large 7/8" Mains Neon Tester - screw-driver chrome finish. £0.95  
SJ22 Small pocket size Mains Neon Tester screwdriver. £0.55  
SJ23 Siemens 220v AC relay DPDT contacts 10 amp rating - housed in plastic case. £1.00

**ODDMENTS**  
16170 50 metres asst. colours single strand wire. £0.50  
16187 30 metres stranded wire mixed colours. £0.50  
16178 5 Main slider switches assorted. £0.50  
SJ76 1 Board containing 2x5-pin DIN sockets 180° & 2x2-pin DIN loudspeaker sockets. £0.30

**COMMUNICATIONS RECEIVERS** made by Murphy Radio for Navy; high grade Rx covering 60 to 560Kc in two bands and 1.5 to 30Mc/s in 3 bands, uses 13 B7g type valves as 2 RF stages, 3x IF stages at 800Kc. Det. N. Lim. AVC 2x AF stages. BFO and 800Kc crystal Cal. the O/P stage matches to 100 ohm phones or 2 watts into 600 ohm. Controls, Main, Tune Band Sel. RF gain, LF gain. Phone gain, AVC On/off, Selectivity at 8, 3, 1Kc, or 200 c/s the 1Kc sel uses Bandpass Crystal filter, the 200c uses Crystal plus Audio Filter, the BFO can be swt to upper or lower beat i.e. 801 or 799Kc int set, also 800Kc for tune. There are two O/P jacks for phones and one for spk. on front panel, provision for 75 ohm Ae I/P or long wire. Complete in steel case, size 13" x 14" deep. Note these Rx require external power supply giving 250v 100Ma and 150v Stab DC 6.3v AC at 4 amps. There is room inside the case to build an internal P.U. Supplied tested with circ. and 40 page handbook. **£115.**  
**VIDEO RECORDERS.** Philips type LDL1000 portable monochrome 625 line reel to reel type 1/2" tape 75 ohm I/P and O/P 1v sig., .4v Vid ext. size 42 x 34 x 20 Cm weight 12Kg 240v 50c I/P supplied in good condition with 80-page handbook, untested with 2x tapes, fuller spec. on request **£185.**  
**TEST SET CT373** Audio bench set Osc 17c to 170Kc. AF VTVM Dist. meas. set, new cond., with book, full spec. on request, **£80.**  
Above prices include carr./postage & VAT. Goods ex-equipment unless stated new. 2 x 10p stamps for list 25/1.

## A.H. SUPPLIES

122 HANDSWORTH ROAD, SHEFFIELD S9 4AE  
TELEPHONE: 444278 (0742)  
WW-035 FOR FURTHER DETAILS

**QUICK ACTING & ANTI SURGE CARTRIDGE FUSES**

from £2.80 per 100

**Wirewound Power Resistors (Ceramic), 5w-17w OR5-39K from £9.35 100.**

**Cable Sleeves and Markers from £1.31 1000.**

**Cf. Resistors. 1/4w-2w from £4.00 1000.**

**Crimp Terminals, Elma Knobs and Dials, Audible Warning Devices from £1.14 each.**

Catalogue available (state interests)

**PBRA LTD.**  
Golden Green, Tonbridge Kent, TN11 0LH  
Hopfield (073274) 345  
Member Crystalate Group

WW-028 FOR FURTHER DETAILS

**OHIO SCIENTIFIC COMPUTERS.** New Series 2 Challenger C1P £259 + 15%. New Series 2 disc version Challenger C1PMF £689 + 15%. New Superboard 3 £159 + 15% VAT post free, with free power supply and modulator kit. Kits for use with old Superboard 2 (Add 15% VAT) Guard band kit £8. 4k extra ram £16.85. Display expansion kit approx. 30 lines x 54 characters £20. Case £27. Colour conversion board kit £45 or built £85. CEGMON improved monitor rom £29.50. Cassette recorder £16.

**SINCLAIR PRODUCTS SC110.** 10 MHz Scope £145. PFM200 £51.95.  
**TV GAMES.** AY-3-8600 + kit £12.98. Stunt cycle chip + kit £20.95.  
**IC AUDIO AMPS** with pcb. JIC12 6W £2.50. JC20 10W £3.64.  
**BATTERY ELIMINATORS.** 3-way type 6/7 1/2 / 9v 300ma £3.50. 100ma radio type with press-studs 9v £4.77. 9+9v £5.99. Car converter 12v input, output 4 1/2 / 6 7/8 / 9v 800ma £3.04.  
**BATTERY ELIMINATOR KITS.** 100ma radio types with press-studs 9v £1.84. 9+9v £2.30. Stabilized 8-way types 3 1/4 / 6 7/8 / 9 / 12 / 15 / 18v 100ma £3.12. 1 Amp £8.10. Stabilized power kits 2-18v 100ma £3.12. 1-30v 1A £8.30. 1-30v 2A £14.82. 12v car converter 6 7/8 / 9v 1A £1.62.  
**T-DEC AND CSC BREADBOARDS.** s-dec £3.78. t-dec £4.58. exp4b £2.84. exp300 £8.61.  
**TRANSFORMERS.** 5-0-6v 100ma 95p. 1 1/2 £3.32. 9-0-9v 75ma 95p. 1a £3.08. 2a £6.93. 12-0-12v 100ma £1.20. 1a £3.70.  
**SHARP COMPUTERS**

Add 15% VAT to these prices. Sharp M280K Computer with Basic tape and a free tape of approx. 50 programs: 20K version £438. 48K version £486. M280 I/O £83. M280P3 £499. M280FD £772. PC1211 £83. CE121 £12. PRINTERS Senkosha GP80 £290. Oki Microline 80 £348. Free interface and word processor for Superboard 2 included. Add 15% VAT.

**SWANLEY ELECTRONICS**  
Dept. WW, 32 Goldale Rd, Swanley, Kent  
Post 40p extra. Prices include VAT unless stated. Official and overseas orders welcome. Lists 27p post free.  
Telephone Swanley 64851

**Self Instruction Courses**

**CAMBRIDGE LEARNING**

Microcomputers are coming - ride the wave! Learn to program. Millions of jobs are threatened but millions will be created. Learn BASIC - the language of the small computer and the most easy-to-learn computer language in widespread use. Teach yourself with a course which takes you from complete ignorance step-by-step to real proficiency, with a unique style of graded hints. In 60 straightforward lessons you will learn the five essentials of programming: problem definition, flowcharting, coding the program, debugging, and clear documentation.

**Computer Programming in Basic (CPB) £10.00**

BOOK 1 Computers and what they do well; READ, DATA, PRINT, powers, brackets, variable names; LET; errors; coding simple programs. BOOK 2 High and low level languages; flowcharting; functions; REM and documentation; INPUT, IF...THEN, GO TO; limitations of computers, problem definition. BOOK 3 Compilers and interpreters; loops, FOR...NEXT, RESTORE; debugging; arrays; bubble sorting; TAB BOOK 4 Advanced BASIC; subroutines; strings; files; complex programming; examples; glossary.

Also THE BASIC HANDBOOK (BHB) £11.50 An encyclopaedic guide to the major BASIC dialects. A must if you are other peoples' programs

and: ALGORITHM WRITER'S GUIDE (AWG) £4.00 Communicate by flow chart! Learn to use Yes/No questions for: procedures, system design, safety, legislation etc.

**Understand Digital Electronics**

Written for the student or enthusiast, this course is 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 an understanding of the design and operation of calculators and computers

**BOOK 1 Decimal, Octal, hexadecimal, and binary number systems and conversion between number systems; negative numbers; complementary systems. BOOK 2 OR and AND functions; multiple-input gates; truth tables; De Morgan's Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic. BOOK 3 Half, full, serial, and parallel adders; subtraction; processors and ALU's; multiplication and division. BOOK 4 flip flops; shift registers; asynchronous, synchronous, ring, Johnson, and exclusive-OR feedback counters; ROMS and RAMS. BOOK 5 Structure of calculators; keyboard encoding; decoding display-data; register systems; control unit; PROM; address de-coding. BOOK 6 CPU; memory organisation character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming, assemblers; computers; executive programs; operating systems.**

**DIGITAL COMPUTER LOGIC & ELECTRONICS. (DCL) £7.50**  
A course covering the material in italics above, but at a slower pace. (4 vols)

**GUARANTEE - No risk to you.** If you are not completely satisfied your money will be refunded without question, on return of the books in good condition.

PLEASE SEND ME: Quantity

CPB (10.00)

BHB (£11.50)

AWG (£4.00)

DDS (£13.50)

DCL (£7.50)

FOUR WAYS TO PAY:

- 1) A U.K. cheque or a U.K. postal order (Not Euro or overseas)
- 2) A bank draft, in sterling on a London bank (available at any major bank)
- 3) Please charge my Access/M.Ch Barclay/TrustC/Visa Am. Exp. Diners
- 4) Or phone us with these credit card details - 0480 67446 (ansaphone) 24 hour service.

Card No. .... Signed .....

**THESE PRICES COVER THE COST OF SURFACE MAIL WORLDWIDE. AIRMAIL:**  
Eur, N.Af, Mid.E. add 1/2 to price of books; Jpn, Aus, N.Z. Pcf add 1/2; elsewhere add 1/2

Name .....

Address .....

U.K. Delivery: up to 21 days

Cambridge Learning Limited, Unit 39, Rivermill Site, FREEPOST, St. Ives, Huntingdon, Cambs. PE17 4BR, England  
Reg. in Eng. No. 1328762

# BI-PAK

Send your orders to: Dept. WW2, BI-PAK, PO BOX 6, WARE, HERTS.  
SHOP AT: 3 BALDOCK ST, WARE, HERTS.  
TERMS: CASH WITH ORDER, SAME DAY DESPATCH, ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL: (0920) 3182. GIRO 388 7006  
ADD 15% VAT AND 50p PER ORDER POSTAGE AND PACKING.

**SIMPLY AHEAD  
and staying there**

# The range grows bigger... better...

## New Profile Amplifiers - Two New Series

### MOSFET

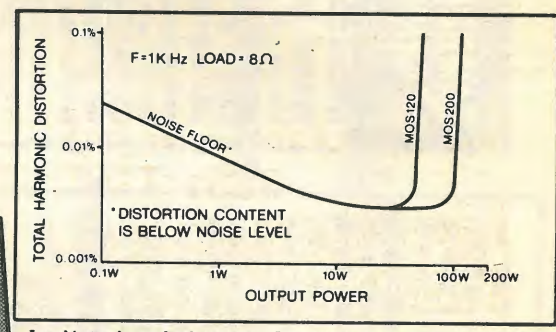
CHOOSE AN I.L.P. MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P.'s exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P. MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

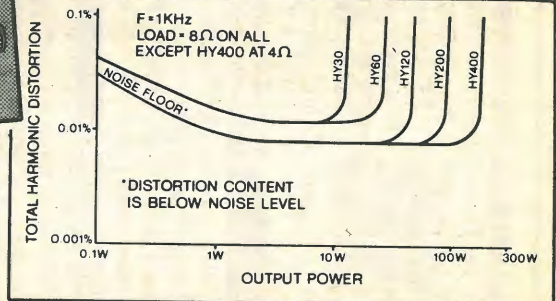
### BIPOLAR

CHOOSE AN I.L.P. BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P. Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77



Load impedance both models 4Ω-∞ Input impedance both models 100KΩ  
Input sensitivity both models 500mV Frequency response both models 15Hz-100KHz -3dB



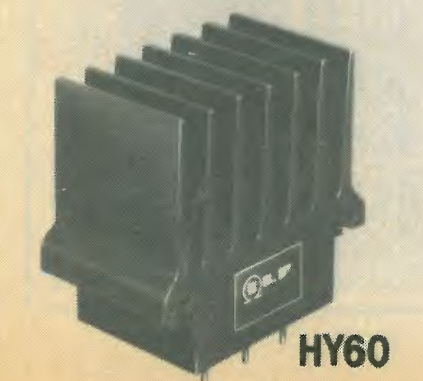
Load impedance all models 4Ω-∞ Input impedance all models 100KΩ  
Input sensitivity all models 500mV Frequency response all models 15Hz-50KHz -3dB

**I.L.P. POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE**

**THE NEW PROFILE EXTRUSIONS**  
The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages:— Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.



HY120



HY60

### NEW PRE-AMPS

**HY6 (mono) and HY66 (stereo)** are new to I.L.P.'s range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P. power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.  
Sizes - **HY6** - 45 x 20 x 40 mm. **HY66** - 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost.  
Inputs Sensitivity - Mag. P.U. - 3mV; Mic - selectable 1-12mV; All others 100mV. Tape O/P - 100mV; Main O/P - 500mV; Frequency response - D.C. to 100KHz - 3dB.

- HY6 mono £6.44 + 97p VAT Connectors included
- HY66 stereo £12.19 + £1.83 VAT Connectors included
- B6 Mounting Board for one HY6 78p + 12p VAT
- B66 Mounting Board for one HY66 99p + 15p VAT

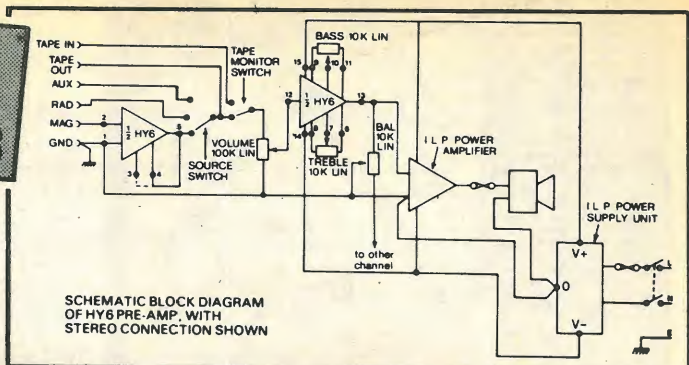
### NEW POWER SUPPLY UNITS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P. power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P. amps and pre-amps with types to match whatever I.L.P. power amps you choose.

- PSU30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 £4.50 + 0.68p VAT
- THE FOLLOWING WILL ALSO DRIVE I.L.P. PRE-AMPS
- PSU36 for use with 1 or 2 HY30's £8.10 + £1.22 VAT
- ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS
- PSU50 for use with 1 or 2 HY60's £10.94 + £1.64 VAT
- PSU60 for use with 1 HY120 £13.04 + £1.96 VAT
- PSU65 for use with 1 MOS120 £13.32 + £2.00 VAT
- PSU70 for use with 1 or 2 HY120's £15.92 + £2.39 VAT
- PSU75 for use with 1 or 2 MOS120 £16.20 + £2.43 VAT
- PSU90 for use with 1 HY200 £16.20 + £2.43 VAT
- PSU95 for use with 1 MOS200 £16.32 + £2.45 VAT
- PSU180 for use with 1 HY400 or 2 HY200 £21.34 + £3.20 VAT
- PSU185 for use with 1 or 2 MOS200 £21.46 + £3.22 VAT

- ★ **Freepost facility**  
When ordering or writing about I.L.P. products, you do not need to stamp the envelope. Mark it FREEPOST plus the code shown in the address below. We pay the postage for you.
- ★ **TO ORDER** Send cheque or money order payable to I.L.P. Electronics Ltd and crossed. Or pay by ACCESS or BARCLAYCARD. Cash payments must be in registered envelope; if C.O.D. payment is wanted, please add £1.00 to TOTAL value of order.

**COMPATIBLE WITH ALL I.L.P. MODULES**



- DISTORTION TYPICALLY 0.005%
- S/N RATIO - 90dB (Mag. P.U. - 68 dB)
- 38 dB overload margin on Mag. P.U.
- LATEST DESIGN HIGH QUALITY CONNECTORS
- ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING
- NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60V

**IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS**

### 1971-1980 TEN YEARS OF PLANNED PROGRESS

When, in 1971, Ian L. Potts founded his now world-famous company, he saw the need for a different and more rational approach to exploiting to the full, the potential that lay in modular construction. New thinking was badly needed. The result was a range of modules revolutionary in concept. The rightness of this new thinking is shown by the size of the company today, its vast exports, its acceptance by constructors as the modules to build with. The range grows bigger and better. Exciting new lines (in no way conflicting with existing ones) are well past drawing board stage. This is why I.L.P. are simply ahead and staying there.

### BRITAIN'S FOREMOST QUALITY MODULE SUPPLIERS

To: I.L.P. ELECTRONICS LTD. CANTERBURY CT2 7EP

Please supply ..... Total purchase price £.....

I enclose Cheque  Postal Orders  International Money Order

Please debit my Access/Barclaycard Account No. ....

NAME .....

ADDRESS .....

Signature .....

**NO QUIBBLE 5 YEAR GUARANTEE  
7-DAY DESPATCH ON ALL ORDERS  
BRITISH DESIGN AND MANUFACTURE  
FREEPOST SERVICE**

**ALL U.K. ORDERS  
DESPATCHED  
POST FREE**

# Now you can shop in Europe for Microwave Chip Capacitors.



## A European source for Microwave and Ceramic Chip Capacitors

is now available from Pascal who offer the full range from Eurofarad, one of Europe's leading capacitor manufacturers. Eurofarad's specifications meet all industrial, military and aerospace applications.

- 4 sizes
- E6 & E12 kits available
- UK stock of individual values
- Available with ribbon leads
- Tinned termination option
- High self-resonant frequency
- High power capability
- High stability

For further details send for the Eurofarad Shortform - now!



WW - 064 FOR FURTHER DETAILS

Pascal Electronics Limited  
Hawke House, Green Street,  
Sunbury-on-Thames, Middlesex TW16 6RA  
Telephone: (09327) 87418 Telex: 8814536



Def. Stan. 05-31/BS 9000/CECC Approved.

the best in electronics

# LANGREX SUPPLIES LTD

Climax House, Fallsbrook Rd., Streatham, Langton SW16 6ED  
RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS		VALVES		INTEGRATED CIRCUITS	
AA119 0.12	AA190 0.30	A134 10.35	E130L 18.39	PC97 1.38	QY5-3000A 23.91
AA213 0.17	AA214 0.17	A2087 13.58	E188CC 8.98	PC90 1.38	QY5-3000B 23.91
AA215 0.17	AA216 0.17	A2134 10.06	E188F 8.98	PC91 1.38	QY5-3000C 23.91
AA217 0.17	AA218 0.17	A2293 8.82	E188G 12.58	PC92 1.38	QY5-3000D 23.91
AA219 0.17	AA220 1.15	A2325 24.38	E188H 12.58	PC93 1.38	QY5-3000E 23.91
AA221 0.17	AA221 1.15	A2900 14.43	E188J 12.58	PC94 1.38	QY5-3000F 23.91
AA222 0.17	AA222 1.15	A3343 25.56	E188K 12.58	PC95 1.38	QY5-3000G 23.91
AA223 0.17	AA223 1.15	AZ1 1.26	E188L 12.58	PC96 1.38	QY5-3000H 23.91
AA224 0.17	AA224 1.15	AZ41 1.33	E188M 12.58	PC97 1.38	QY5-3000I 23.91
AA225 0.17	AA225 1.15	BK448 118.27	E188N 12.58	PC98 1.38	QY5-3000J 23.91
AA226 0.17	AA226 1.15	BK449 140.00	E188O 12.58	PC99 1.38	QY5-3000K 23.91
AA227 0.17	AA227 1.15	BS90 52.27	E188P 12.58	PC100 1.38	QY5-3000L 23.91
AA228 0.17	AA228 1.15	BT5 35.24	E188Q 12.58	PC101 1.38	QY5-3000M 23.91
AA229 0.17	AA229 1.15	BT17 100.71	E188R 12.58	PC102 1.38	QY5-3000N 23.91
AA230 0.17	AA230 1.15	BT19 34.11	E188S 12.58	PC103 1.38	QY5-3000O 23.91
AA231 0.17	AA231 1.15	BT29 306.57	E188T 12.58	PC104 1.38	QY5-3000P 23.91
AA232 0.17	AA232 1.15	BT59 314.47	E188U 12.58	PC105 1.38	QY5-3000Q 23.91
AA233 0.17	AA233 1.15	BT75 102.42	E188V 12.58	PC106 1.38	QY5-3000R 23.91
AA234 0.17	AA234 1.15	BT95 119.00	E188W 12.58	PC107 1.38	QY5-3000S 23.91
AA235 0.17	AA235 1.15	CB131 2.30	E188X 12.58	PC108 1.38	QY5-3000T 23.91
AA236 0.17	AA236 1.15	CL33 2.30	E188Y 12.58	PC109 1.38	QY5-3000U 23.91
AA237 0.17	AA237 1.15	CY31 1.15	E188Z 12.58	PC110 1.38	QY5-3000V 23.91
AA238 0.17	AA238 1.15	C1K 2.50	E188A 12.58	PC111 1.38	QY5-3000W 23.91
AA239 0.17	AA239 1.15	C3A 2.50	E188B 12.58	PC112 1.38	QY5-3000X 23.91
AA240 0.17	AA240 1.15	C4A 2.50	E188C 12.58	PC113 1.38	QY5-3000Y 23.91
AA241 0.17	AA241 1.15	DA41 21.50	E188D 12.58	PC114 1.38	QY5-3000Z 23.91
AA242 0.17	AA242 1.15	DA42 12.40	E188E 12.58	PC115 1.38	QY5-3000A 23.91
AA243 0.17	AA243 1.15	DA100 112.82	E188F 12.58	PC116 1.38	QY5-3000B 23.91
AA244 0.17	AA244 1.15	DAF91 0.40	E188G 12.58	PC117 1.38	QY5-3000C 23.91
AA245 0.17	AA245 1.15	DAF92 1.15	E188H 12.58	PC118 1.38	QY5-3000D 23.91
AA246 0.17	AA246 1.15	DET22 32.70	E188I 12.58	PC119 1.38	QY5-3000E 23.91
AA247 0.17	AA247 1.15	DF18 51.90	E188J 12.58	PC120 1.38	QY5-3000F 23.91
AA248 0.17	AA248 1.15	DF96 1.50	E188K 12.58	PC121 1.38	QY5-3000G 23.91
AA249 0.17	AA249 1.15	DK91 1.21	E188L 12.58	PC122 1.38	QY5-3000H 23.91
AA250 0.17	AA250 1.15	DK92 1.44	E188M 12.58	PC123 1.38	QY5-3000I 23.91
AA251 0.17	AA251 1.15	DK96 1.50	E188N 12.58	PC124 1.38	QY5-3000J 23.91
AA252 0.17	AA252 1.15	DI13 102.42	E188O 12.58	PC125 1.38	QY5-3000K 23.91
AA253 0.17	AA253 1.15	DI94 1.50	E188P 12.58	PC126 1.38	QY5-3000L 23.91
AA254 0.17	AA254 1.15	DL96 1.26	E188Q 12.58	PC127 1.38	QY5-3000M 23.91
AA255 0.17	AA255 1.15	DL510 9.48	E188R 12.58	PC128 1.38	QY5-3000N 23.91
AA256 0.17	AA256 1.15	DL515 12.87	E188S 12.58	PC129 1.38	QY5-3000O 23.91
AA257 0.17	AA257 1.15	DL519 12.87	E188T 12.58	PC130 1.38	QY5-3000P 23.91
AA258 0.17	AA258 1.15	DM71 1.44	E188U 12.58	PC131 1.38	QY5-3000Q 23.91
AA259 0.17	AA259 1.15	DM71 1.44	E188V 12.58	PC132 1.38	QY5-3000R 23.91
AA260 0.17	AA260 1.15	DM80 3.98	E188W 12.58	PC133 1.38	QY5-3000S 23.91
AA261 0.17	AA261 1.15	DY86 0.72	E188X 12.58	PC134 1.38	QY5-3000T 23.91
AA262 0.17	AA262 1.15	DY802 0.80	E188Y 12.58	PC135 1.38	QY5-3000U 23.91
AA263 0.17	AA263 1.15	ESGL 25.17	E188Z 12.58	PC136 1.38	QY5-3000V 23.91
AA264 0.17	AA264 1.15	EB80C 10.13	E188A 12.58	PC137 1.38	QY5-3000W 23.91
AA265 0.17	AA265 1.15	EB80E 14.19	E188B 12.58	PC138 1.38	QY5-3000X 23.91
AA266 0.17	AA266 1.15	EB80L 15.86	E188C 12.58	PC139 1.38	QY5-3000Y 23.91
AA267 0.17	AA267 1.15	EB80C 10.13	E188D 12.58	PC140 1.38	QY5-3000Z 23.91
AA268 0.17	AA268 1.15	EB80E 14.19	E188E 12.58	PC141 1.38	QY5-3000A 23.91
AA269 0.17	AA269 1.15	EB80L 15.86	E188F 12.58	PC142 1.38	QY5-3000B 23.91
AA270 0.17	AA270 1.15	EB80C 10.13	E188G 12.58	PC143 1.38	QY5-3000C 23.91
AA271 0.17	AA271 1.15	EB80E 14.19	E188H 12.58	PC144 1.38	QY5-3000D 23.91
AA272 0.17	AA272 1.15	EB80L 15.86	E188I 12.58	PC145 1.38	QY5-3000E 23.91
AA273 0.17	AA273 1.15	EB80C 10.13	E188J 12.58	PC146 1.38	QY5-3000F 23.91
AA274 0.17	AA274 1.15	EB80E 14.19	E188K 12.58	PC147 1.38	QY5-3000G 23.91
AA275 0.17	AA275 1.15	EB80L 15.86	E188L 12.58	PC148 1.38	QY5-3000H 23.91
AA276 0.17	AA276 1.15	EB80C 10.13	E188M 12.58	PC149 1.38	QY5-3000I 23.91
AA277 0.17	AA277 1.15	EB80E 14.19	E188N 12.58	PC150 1.38	QY5-3000J 23.91
AA278 0.17	AA278 1.15	EB80L 15.86	E188O 12.58	PC151 1.38	QY5-3000K 23.91
AA279 0.17	AA279 1.15	EB80C 10.13	E188P 12.58	PC152 1.38	QY5-3000L 23.91
AA280 0.17	AA280 1.15	EB80E 14.19	E188Q 12.58	PC153 1.38	QY5-3000M 23.91
AA281 0.17	AA281 1.15	EB80L 15.86	E188R 12.58	PC154 1.38	QY5-3000N 23.91
AA282 0.17	AA282 1.15	EB80C 10.13	E188S 12.58	PC155 1.38	QY5-3000O 23.91
AA283 0.17	AA283 1.15	EB80E 14.19	E188T 12.58	PC156 1.38	QY5-3000P 23.91
AA284 0.17	AA284 1.15	EB80L 15.86	E188U 12.58	PC157 1.38	QY5-3000Q 23.91
AA285 0.17	AA285 1.15	EB80C 10.13	E188V 12.58	PC158 1.38	QY5-3000R 23.91
AA286 0.17	AA286 1.15	EB80E 14.19	E188W 12.58	PC159 1.38	QY5-3000S 23.91
AA287 0.17	AA287 1.15	EB80L 15.86	E188X 12.58	PC160 1.38	QY5-3000T 23.91
AA288 0.17	AA288 1.15	EB80C 10.13	E188Y 12.58	PC161 1.38	QY5-3000U 23.91
AA289 0.17	AA289 1.15	EB80E 14.19	E188Z 12.58	PC162 1.38	QY5-3000V 23.91
AA290 0.17	AA290 1.15	EB80L 15.86	E188A 12.58	PC163 1.38	QY5-3000W 23.91
AA291 0.17	AA291 1.15	EB80C 10.13	E188B 12.58	PC164 1.38	QY5-3000X 23.91
AA292 0.17	AA292 1.15	EB80E 14.19	E188C 12.58	PC165 1.38	QY5-3000Y 23.91
AA293 0.17	AA293 1.15	EB80L 15.86	E188D 12.58	PC166 1.38	QY5-3000Z 23.91
AA294 0.17	AA294 1.15	EB80C 10.13	E188E 12.58	PC167 1.38	QY5-3000A 23.91
AA295 0.17	AA295 1.15	EB80E 14.19	E188F 12.58	PC168 1.38	QY5-3000B 23.91
AA296 0.17	AA296 1.15	EB80L 15.86	E188G 12.58	PC169 1.38	QY5-3000C 23.91
AA297 0.17	AA297 1.15	EB80C 10.13	E188H 12.58	PC170 1.38	QY5-3000D 23.91
AA298 0.17	AA298 1.15	EB80E 14.19	E188I 12.58	PC171 1.38	QY5-3000E 23.91
AA299 0.17	AA299 1.15	EB80L 15.86	E188J 12.58	PC172 1.38	QY5-3000F 23.91
AA300 0.17	AA300 1.15	EB80C 10.13	E188K 12.58	PC173 1.38	QY5-3000G 23.91
AA301 0.17	AA301 1.15	EB80E 14.19	E188L 12.58	PC174 1.38	QY5-3000H 23.91
AA302 0.17	AA302 1.15	EB80L 15.86	E188M 12.58	PC175 1.38	QY5-3000I 23.91
AA303 0.17	AA303 1.15	EB80C 10.13	E188N 12.58	PC176 1.38	QY5-3000J 23.91
AA304 0.17	AA304 1.15	EB80E 14.19	E188O 12.58	PC177 1.38	QY5-3000K 23.91
AA305 0.17	AA305 1.15	EB80L 15.86	E188P 12.58	PC178 1.38	QY5-3000L 23.91
AA306 0.17	AA306 1.15	EB80C 10.13	E188Q 12.58	PC179 1.38	QY5-3000M 23.91
AA307 0.17	AA307 1.15	EB80E 14.19	E188R 12.58	PC180 1.38	QY5-3000N 23.91
AA308 0.17	AA308 1.15	EB80L 15.86	E188S 12.58	PC181 1.38	QY5-3000O 23.91
AA309 0.17	AA309 1.15	EB80C 10.13	E188T 12.58	PC182 1.38	QY5-3000P 23.91
AA310 0.17	AA310 1.15	EB80E 14.19	E188U 12.58	PC183 1.38	QY5-3000Q 23.91
AA311 0.17	AA311 1.15	EB80L 15.86	E188V 12.58	PC184 1.38	QY5-3000R 23.91
AA312 0.17	AA312 1.15	EB80C 10.13	E188W 12.58	PC185 1.38	QY5-3000S 23.91
AA313 0.17	AA313 1.15	EB80E 14.19	E188X 12.58	PC186 1.38	QY5-3000T 23.91
AA314 0.17	AA314 1.15	EB80L 15.86	E188Y 12.58	PC187 1.38	QY5-3000U 23.91
AA315 0.17	AA315 1.15	EB80C 10.13	E188Z 12.58	PC188 1.38	QY5-3000V 23.91
AA316 0.17	AA316 1.15	EB80E 14.19	E188A 12.58	PC189 1.38	QY5-3000W 23.91
AA317 0.17	AA317 1.15	EB80L 15.86	E188B 12.58	PC190 1.38	QY5-3000X 23.91
AA318 0.17	AA318 1.15	EB80C 10.13	E188C 12.58	PC191 1.38	QY5-3000Y 23.91
AA319 0.17	AA319 1.15	EB80E 14.19	E188D 12.58	PC192 1.38	QY5-3000Z 23.91
AA320 0.17	AA320 1.15	EB80L 15.86	E188E 12.58	PC193 1.38	QY5-3000A 23.91
AA321 0.17	AA321 1.15	EB80C 10.13	E188F 12.58	PC194 1.38	QY5-3000B 23.91
AA322 0.17	AA322 1.15	EB80E 14.19	E188G 12.58	PC195 1.38	QY5-3000C 23.91
AA323 0.17	AA323 1.15	EB80L 15.86	E188H 12.58	PC196 1.38	QY5-3000D 23.91
AA324 0.17	AA324 1.15	EB80C 10.13	E188I 12.58	PC197 1.38	QY5-3000

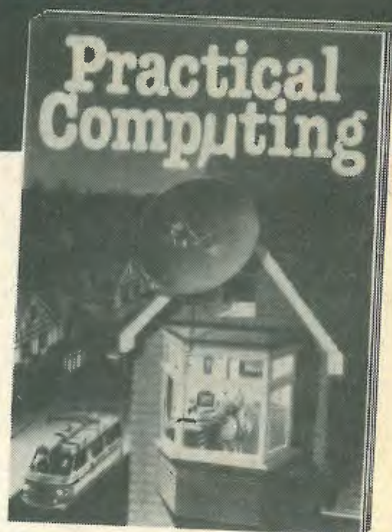
# Satellite communications and you...

## in Practical Computing

The February issue, available from leading newsagents, examines the feasibility of exchanging data between home computers, using satellites. In principle a small rooftop dish aerial would allow a home computer in the UK to communicate with other users in the USA and Europe. Just think what that could do to your telephone bills.

**Also in this issue:**

Reviews of MuPet, a multi user system for linking Pet computers, a new Pet colour monitor and the Data Applications personal computer. And on the software side, a review of OZZ - a powerful information-handling system which can be implemented on a Pet. In the applications area we see how a firm of stonemasons is making use of a micro - new technology coming to the aid of an old craft. All this, plus our regular advice columns for users of Pet, Apple and Tandy micros for only 60p. From your newsagents or post this coupon now.



Out January 21.

To: Marketing Services Department, Room 316, IPC Electrical Electronic Press Ltd., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Please post me a copy of Practical Computing every month for a year. I enclose cheque/p.o. for £8 (inc) payable to IPC Business Press Ltd.

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_

### 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	£2.00	Pre-coated 1/16" Fibre-glass board	
Developer	30p	204mm x 114mm	£1.50
Ferric Chloride	50p	204mm x 228mm	£3.00
		408mm x 228mm	£6.00
		467mm x 305mm	£9.00

Plain Copper-clad Fibre-glass.	Single-sided	Double-sided
Approx. 3.18mm thick sq. ft.		£1.50
Approx. 2.00mm thick sq. ft.	£2.00	
Approx. 1.00mm thick sq. ft.	£1.50	£1.75

Clear Acetate Sheet for making master, 260mm x 260mm 12p

Postage and packing 65p per order. VAT 15% on total

**G. F. MILWARD ELECTRONIC COMPONENTS LIMITED**  
369 Alum Rock Road, Birmingham B8 3DR. Telephone: 021-327 2339

### Memories 8085 Series

2716	1-24 25-99	5.50 4.50	8085A	1-24 25-99	6.80 4.10
2732	11.80 9.50	8085A-2	8.50 6.50		
2114L (200ns)	2.99 2.75	8155	9.45 7.47		
4116 (200ns)	2.62 2.50	8155-2	11.81 8.21		
2147 (70 ns)	5.90 4.99	8251A	5.60 4.70		
2112 (450ns)	3.00 2.80	8253-5	5.99 4.90		
All components guaranteed new full specification.		8255A-5	4.99 4.67		
		8257-5	10.40 8.40		
		8279-5	8.30 6.33		

Please add VAT to your order.

**BDS Microsystem Designs Ltd.**  
28 Pinewood Close, St Albans, Herts AL4 0DS  
Telephone St Albans (0727) 31831

WW-009 FOR FURTHER DETAILS

## NEW! Thurlby 1503 high resolution multimeter £139

Greater resolution, greater accuracy, and greater versatility + VAT

- 4 1/2 digits (±32,768 counts)
- 10uV, 10mΩ, 1nA resolution
- 0.05% basic DCV accuracy
- LCD, fully field portable
- 7 functions including Frequency
- Outstanding price/performance ratio

Thurlby 1503 digital multimeter

**Thurlby Electronics Ltd.**  
Coach Mews, St. Ives, Huntingdon, Cambs. PE17 4BN. ENGLAND. Tel: (0480) 63570

WW - 063 FOR FURTHER DETAILS

# Test Instruments

**MODEL 820 NEW PORTABLE DIGITAL CAPACITANCE METER**  
Measures capacitance from 0.1pF to 1 Farad in 10 ranges - Resolves to 0.1pF on lowest range - 4 digit easy-to-read LED display - 0.5% accuracy - Uses either rechargeable or disposable batteries. See also Autoranging Model 830.

**NEW 3 1/2 DIGIT AUTORANGING μC DMM**  
**MODEL 2845**

- Fully automatic
- 0.1% accuracy
- Fast reading, 1.5 sec. maximum
- 0.5" LCD display
- Autozeroing
- Autopolarity on all ranges
- Audible continuity indicator
- Varistor and fuse overload protection
- RF Shielded
- Range lock
- Meets U.K. 1244 safety standards

**MODEL 1850 520 MHz FREQUENCY COUNTER**  
Features: 5Hz to 520 MHz reading guaranteed - Gate times from 10ms to 10 seconds - Period measurement capability - 50 mV input sensitivity at 520MHz - 240 VAC, or 12 VDC - Well protected input circuitry - Temperature compensated crystal oscillator - LED readout.

**MODEL 3010 NEW LOW DISTORTION FUNCTION GENERATOR**  
Features: Generates sine, square and triangle waveforms - Variable amplitude and fixed TTL square-wave outputs - 0.1 Hz to 1 MHz in six ranges - Typical sine wave distortion under 0.5% from 0.1 Hz to 100 kHz - Variable DC offset for engineering applications - VCO external input for sweep-frequency tests.

**MODEL 510 PORTABLE TRANSISTOR TESTER**  
Features: Fast GO/NO-GO in-circuit testing - Fast and thorough GOOD/BAD out-of-circuit testing - Tests FET's and SCR's in-circuit or out-of-circuit - Gives positive emitter-base-collector identification in LO drive-positive base identification in H1 drive - Light-Emitting Diodes indicate NPN-OK or PNP-OK - Pocket-size-Over 100 hours of testing from single set of "AA" cells - Digital stability-no adjustments; nothing to go out of calibration.

**MODEL 830 PORTABLE AUTORANGING DIGITAL CAPACITANCE METER**

- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
- No range switching
- 10 internal ranges for accuracy and resolution
- 0.2% basic accuracy
- Range Hold switch
- Zero control for test lead compensation
- 3 1/2 digit LCD display
- Banana jacks and special lead insertion jacks
- Battery or AC operation
- Fuse-protected

## 7 OF THE BEST FROM...

**BK PRECISION**

For details of the full range of Electronic Test Equipment: including Capacitance Meters DMM'S Frequency Counters Scopes Power Supplies and Semi-Conductor Testers

Please Contact

**BK PRECISION**  
**RADIO SUPPLIES (Components) LTD.**  
P.O. BOX 27-39 WHITBY STREET  
HARTLEPOOL CLEVELAND.  
TELEPHONE: 0429-75750/0429-68002

**40-CHANNEL CB SERVICEMASTER**

- Greatly simplifies all CB transceiver servicing
- Checks complete CB transceiver performance in minutes
- Checks AM and SSB transceivers, 23 or 40 channel
- No complex hookups or calculations required
- Test results displayed on direct reading meters
- Only one hookup required for all tests
- Eliminates need for special equipment
- Increases your CB service profit by saving you time

**MODEL 1040**

WW-072 FOR FURTHER DETAILS

**TEKTRONIX STORAGE OSCILLOSCOPE.** Type 434, as few 12 months' warranty £1,950.

**TEKTRONIX OSCILLOSCOPE.** Type 647, with 10A2 and 3B11. £500

**TEKTRONIX STORAGE OSCILLOSCOPE.** Type 564 with 3A6 and 3B4 £350.

**EQUIPMENT STORAGE OSCILLOSCOPE.** Type DM53A £285.

**TELETYPE OSCILLOSCOPE.** Type D32. Portable, mains/battery. £275.

**HAMEG OSCILLOSCOPE.** Type 512 DB. 50MHz. £350.

**TELETYPE OSCILLOSCOPE.** Type S54A SB 10MHz. £190.

**SE LABS OSCILLOSCOPE.** Type SM111 DB 20MHz. £325.

**ADVANCE OSCILLOSCOPE.** Type OS1000 DB 15MHz. £250.

**TEKTRONIX OSCILLOSCOPE 547** with 1A1 plug-in Dual TB. 50MHz. £375.

**TEKTRONIX OSCILLOSCOPE.** Type 561A with 3A1 and 2B67 10MHz. £300.

**TEKTRONIX OSCILLOSCOPE.** Type 533A with CA. DB 24MHz. £140.

**HEWLETT PACKARD AC CONVERTOR.** Type 3461A £120.

**MARCONI FM SIG. GEN.** Type TF1068B/BS. £295.

**G. & E. BRADLEY LTD. R.F. MILLIVOLTMETER.** Type 112 £75

**ADVANCE A.C. VOLTMETER.** Type VM77E £50

**MARCONI WAVE ANALYSER.** TF2330. Good condition. £150

**AVO R.F. SIG. GEN.** Model HF135. £75

**MARCONI WIDE RANGE R.C. OSCILLATOR.** TF1370. £95.

**MARCONI AM/FM SIG. GEN.** Type TF1068/1. £225

**MARCONI SENSITIVE VALVE VOLTMETER.** TF2600. £50.

**MARCONI SIG. GEN. MK2.** TF995A/3/S (CT402) £275.

**TEKTRONIX type 1L30 SPECTRUM ANALYSER PLUG-IN.** (works, slight corrosion) £225

**AIRMEC SIGNAL GENERATOR.** Type 204 AM/FM 320MHz £150

**WAYNE KERR UNIVERSAL BRIDGE.** Type B221 £50

**ADVANCE R.F. Signal Generator** £2100KHZ-100MHz £40

**ADVANCE VHF MILLIVOLTMETER VM79** (No probe) £50

**ADVANCE SIGNAL GENERATOR** Type B487 30KHZ-30MHz £25

**COBOR NOISE LEVEL METER** Type L11E £45 (Ministry) £18

**S.T.C. ATTENUATOR** 0-100DB 600ohm £9

**S.T.C. ATTENUATOR** 0-100DB 75 ohm £5

**AVO VALVE CHARACTERISTIC METER £20**

**E.H.T. UNIT** 230V 50cs 25VA 7.5V £22.50

**BRANDENBURG HIGH VOLTAGE GENERATORS 10KV £50**

**BRANDENBURG HIGH VOLTAGE GENERATORS 30KV £50**

**VARIACS** Ex-equipment. Good condition 8 amp £25

**VARIACS** Ex-equipment. Good condition 20 amp £35

**CRC GENERATOR TF80800.** Sine/square/Triangle. Very good £80

**B&K AUTOMATIC VIBRATION EXCITER CONTROL.** Type 101B £50

**B&K AUTOMATIC VIBRATION EXCITER CONTROL.** Type 1019 £50

**MARCONI UNIVERSAL BRIDGE.** Type TF868B £100

**SOLARTRON TRU RMS VOLTMETER.** Type VM1484 £75

**TAYLOR VALVE TESTER.** Type 450 £25

**ADVANCE LF OSCILLATOR.** Type H1E £45

**ADVANCE SIGNAL GENERATOR** 562B 150KHZ-220MHz £80

**MARCONI UNIVERSAL BRIDGE.** Type TF868A £50

**TAYLOR METER MODEL 126. £15**

**R.S. SELECTION TESTER BN 15221/2 £100**

**B&K LEVEL RECORDER.** Type 2304 £50

**RACAL HF SELECTIVE ANALYSER.** Type 9056. £375

**SCHLUMBERGER AUTO COUNTER.** Type FB2602. £150

**MARCONI F.E.T. MULTIMETER.** Type TF2650 (new) £95

**F.T. MULTIMETER.** Type TM11 £50

**ICE MULTIMETER SUPERTESTER 860R £15**

**MARCONI SIGNAL GENERATOR.** Type TF144H. £225

**MARCONI SIGNAL GENERATOR.** Type TF801D/1/S. £195

**MARCONI UNIVERSAL BRIDGE.** Type TF1313. £260

**RACAL SIGNAL GENERATOR.** Type G55A. 1 to 20MHz AM/FM. £175

**R&S 2-7 DIAGRAPH BN3562 300-2400MHz £25**

**R&S POLYSKOP 1 SWOB BN 4244/2/50 £350**

**WAYNE KERR COMPONENT BIDGE.** CT375 (B521) £75

**R&S UNBALANCED STANDARD ATTENUATOR** 500hm. BN18942/50 £45

**STODDART AIRCRAFT** Radio Interference and Field Intensity Meter, type NM-52A 375-1000MHz (2 pieces) £325

**MARCONI SIGNAL GENERATOR.** Type TF801B £85

**R&S DIRECT CAPACITANCE METER £50**

**B&K HETERODYNE VOLTMETER (RECEIVER)** Type 2005 £250

**MARCONI VARIABLE ATTENUATOR.** TF1073A/2S £40

**MARCONI PULSE GENERATOR.** Type TF1400/S £50

**RADIOMETER (COPENHAGEN) WAVE ANALYSER.** Type FRA 2CT3a £80

**SOLARTRON DIGITAL VOLTMETER.** Type LM1867 £75

**HEWLETT PACKARD DIGITAL RECORDER.** Type 5050B £80

**HATFIELD PHOTOMETER.** Type DRG 657167A £90

**ADVANCE DUAL BEAM D.C. SUPPLY PPS.** 0-30V 1A £25

**PICTURE MONITOR MODEL PM-82T** (5in screen) as new £85

**HEWLETT PACKARD POWER SUPPLY** 6214A. 0-12V. 0-1.2A. new, boxed. £85.

**H.P. DC POWER SUPPLY** 6209B. 0-320V. 0-0.1A. new boxed. £140

**T.O. ELECTRONICS LTD Electronic Pre-processor** EPR-2T. Mains £120

**THE JAMES KING COMPANY** FB-1100T FREQUENCY STANDARD £50

**MARCONI CARRIER DEVIATION METER.** Type TF891D £50

**SOLARTRON PULSE GENERATOR.** Type G01101.2 £40

**MJ SANDERS LEVELLING AMPLIFIER.** Type 6587 £175

**COPEX OSCILLOSCOPE.** Type 4D10 DB 10MHz £170

**ADVANCE OSCILLOSCOPE.** Type OS240 DB 10MHz £175

**COBOR OSCILLOSCOPE.** Type CDU150 DB 35MHz £225

**TELETYPE OSCILLOSCOPE.** Type D61 DB 10MHz £195

**HEWLETT PACKARD OSCILLOSCOPE.** Type 1208 X-Y. From £85

**FLUXES DIFFERENTIAL AC/DC VOLTMETER.** Model 632A £60

**ADVANCE AUDIO SIGNAL GENERATOR.** Type H1. Sine/Square £25

**R & S TUNABLE INDICATING AMP.** BN 12121/2/45-600MHz £100

**MUIRHEAD WAVE ANALYSER** 30-31Hz £60

**HEWLETT PACKARD DIGITAL VOLTMETER.** Type 3460B £75

**WAYNE KERR THERMOMETER.** Type 17100 £80

**HATFIELD RADIO FREQUENCY BRIDGE.** Type LE300A/1. £50

**SOLARTRON OSCILLOSCOPE.** Type CD1400. DB 15MHz. From £75

**HAMEG OSCILLOSCOPE.** Type HM412. £250

**KNIGHT RF SIG. GEN.** KG686 with Sweep Marker Gen. KG687. The Pair £100

**H.P. MEMORY DISPLAY** 5480B with 5486A Control TB and 5488A Y System. £275

**H.P. MEMORY DISPLAY** 5480A with 5486A Control TB and 5485A two channel input. £225.

**R&S UHF TEST RECEIVER** 0.9-2.7GHz. BN1524 £150

**EDDYSTONE RECEIVER.** Type 990S 250-850MHz. £450

**R&S UHF TEST RECEIVER.** BN1523 280-940 MHz. £120

**KEITHLEY REGULATED HIGH VOLTAGE SUPPLY.** Type 241. £250

**HEWLETT PACKARD D.C. CURRENT SOURCE.** Type 6181B £175

**MARCONI XY MEMORY** Type TK214. £115

**R&S UHF SIGNAL GENERATOR.** BN41022 300-1000MHz. £80

**GPO DATEL TESTER NO IC.** £100

**LEVEL BROADBAND VOLTMETER.** Type TM6B. £40.

**DAWTEC type 14611** £110

**R&S UHF/VHF FREQUENCY METER.** BN442 30-3000MHz. £80

**R&S UHF MILLIVOLTMETER.** BN1091. £70

**GERROLD SWEEP FREQUENCY GENERATOR.** Model 602. £40

**TELETYPE SWEEP GENERATOR.** Type SD-3 450-900 MHz. £75.

**H.P. VHF/VHF FREQUENCY METER.** BN442. Case damaged hence £50

**MARCONI VALVE VOLTMETER.** Type TF1300. £15

**SOLARTRON DIGITAL VOLTMETER.** Type LM1420.2. £30

**VOLDO CIRCUITS LTD TUBE TESTER.** Type V33. £30

**LARGE AREA COLOURMATCH 625 PATTERN GENERATOR.** Type CM6004. PG £100

**B & K BEAT FREQUENCY OSCILLATOR.** Type 1014. £175

**ADVANCE OSCILLOSCOPE.** Type OS1000A. DB 20MHz. £300

**FERRET A.T.E.**  
**£650**  
**Phone for details**

**EDDYSTONE RECEIVERS**  
Model 730-500KHZ to 30MHZ  
**£65 each**  
Model 770R-AM/FM  
**£95 each**  
Some models slight imperfections.  
Phone for Special Price

**INFRA RED IMAGE CONVERTER Type 9606 (CV 144)**  
1 3/4in diameter. Requires single low current 3KV to 6KV supply individually boxed. With data.  
**£12.50 each**  
Infra Red Lamps also advertised

**VARIAN RUBIDIUM STANDARD**  
Model R20  
5mhz, 1mhz, 0.1mhz  
**£600**

**EX-MINISTRY SOLID STATE 400 HZ INVERTOR**  
28 VDC input, 115V output. Size 7 x 2 1/2 x 1 1/2in approx. Connection details supplied.  
**£18 each. P&P £2**

**TRANSISTOR INVERTOR**  
115V AC 1.7 Amp Input. Switching is at 20KHz. Output windings from Pot Core. Can be rewound to suit own purpose or unit can be broken for host of components. Circuits supplied.  
**£1.25 each. P&P £2.**

**Integrated Circuits**

7453	5p	74H51	12p	75325	£1
7451	5p	74H52	7p	SN15862	4p
7407	12p	74502	10p	MC402B	8p
7476	20p	74502	12p	7411	14p
7495	35p	74C02	16p	74C86	50p
74122	12p	74C04	18p	74C181	24p
74C00	17p	74C74	18p		

**MOTOROLA DUAL** in Line 6 pin Opto Coupler 30p each. Gold plate tester version 50p each.

**EPROMS 2708** £5.50 each.

**SMITHS** encapsulated transistorised AUDIBLE WARNING DEVICES 4V-12V. Can be driven from TTL 85p each.

**ELECTROSTATIC VOLTMETER.** 7.5KV £5.00. P&P £1.50.

**Other ranges available - please enquire.**

**TRIMMERS.** Sub-min. 0.25 to 1.25 pf. 1 to 4.5 pf. 7 to 45 pf. All at 5p each.

**HONEYWELL** humidity controllers 50p each.

**THYRISTOR TIMER.** Solid State. 15 secs adjustable (reset) in plastic relay case. Standard 7-pin base. Series delay 80p each.

**MINIATURE PC MOUNT SLIDE SWITCH.** Single pole 3-way 10p each.

**4 DIGIT 7 SEGMENT** per digit plus a figure one to the left plus a centre minus sign to the left of the figure one with decimal places between digits. Good brilliance at 1.5V. 15 connections. £2.50 each. Some E.H.T. Transformers and Capacitors available. Please enquire.

**TELEPHONES** 706 style black, grey or blue £5.50 ea. 746 style black or grey £7.50. Older style black £2.90 each. Discoloured grey 706 £4 ea P&P £1.50 per telephone.

**DC SERVO MOTOR 110V** 2.5Amp continuous. Double shaft. Brand new. 4 wire. 4 brush £25 ea. Plus carriage.

**PC Mount POTS.** Wire wound with knob 200 ohm & 10ohm. 10p ea.

**MIN. RELAY 24V.** 2 pole c/o. Brand new. 75p each.

**TIME DELAY RELAY** 0.1 to 10 secs. 115V AC. DPDT. £5 each. Capacitors at 5p each. 0.1uf 400V. Small. ec. block PC Mount German class. 3300pf. 220mf/250V. 0.01mfd 160V.

**INSERT** can be used as Microphone/Earpiece (Like used as insert in telephone but superior quality) Ex-Min. Brand new wrapped 75p each, or 10 for £6.

**TOROIDAL TRANSFORMERS.** Input 0-120-240 Volts. Output 0-12V. 0-12V. 10VA per winding. Encapsulated - identical to R.S. Components at £9.90. OUR SPECIAL PRICE £5 ea. P&P £1.50.

**TANTALUM CAPACITORS** - All at 10p each - 100 off £7.50. 22mfd 6V. 39mfd 10V. 22mfd 35V. 1mfd 35V.

**MINIATURE SLIDE SWITCHES.** Single pole 2 way 10p each. 10 off 90p.

**HEAVY DUTY RHEOSTAT.** 7.5Ohm 5.5Amp. Diameter 5". Standard 1/4" shaft £2.50 each. P&P £1.50.

**LARGE EX-MINISTRY SPEAKERS.** OUTSIDE 15 ohm or 500 ohm. Tested £25 each or 5 for £100.

**CONVERT THIS UNIT TO A SUPER BATTERY CHARGER**  
Attractive green ministry quality case with removable top and bottom plates - heavy duty power switches, high powered resistors control current, good quality centre mounted am meter, strip of wiring nut terminals on front panel which can be used for connecting leads. All this for £3.50. P&P £2. Four units £12. Carriage £5.

**STEPPING MOTORS**  
6/12 position with additional where the rotor is coils. Device can be used as a tach. Diagram supplied. Will actually work on 5 volts. 12/24 recommended.  
**£1.50 each P&P 75p**  
or 5 for £5 P&P £1.50.

**STEPPING MOTORS**  
200 Steps. 20 oz/in. torque, 12/24 volt input 4-wire  
**£12 each. P&P £1.50**

**KEYBOARD PAD**  
Size 3x2 1/2 x 2 1/2 high with 12 Alma Reed Switches. Blue keys marked in green 0-9 and a star with one blank.  
**£4 each, P&P £1.** or 5 for £15 P&P £2.

**MINIATURE KEYBOARD**  
Push contacts, marked 0-9 and A-F and 3 optional function keys. **£1.75 each.**

**CRYSTALS** 50p each.  
Flat metal case - 19.2KHZ; 844.8KHZ; B7G - 10MHz.

**LOUDSPEAKERS.** Transistorised hand-held, no leads. Standard internal batteries supplied. Howl switch. £20 ea. P&P £2

**INFRA RED QUARTZ LAMPS.** 230V 620 Watts. Size 1 3/4" x 1/2" dia. £1.50 ea. 240V 1650 Watts. Size 2 3/4" x 1/2" dia. £3 ea.

**BRIDGE RECTIFIER.** 2 Amp 50p ea.

**PHOTODIODE DETECTOR** 4" fit tracks. 25p ea.

**AMPHENOL.** 17-way chassis mount edge connectors 0.1 spacing. 15p ea.

**I.E.C. Standard MAINS LEAD.** Moulded (3 vertical flat pins centre offset) 50p ea.

**FANS.** 115V 13 Watts. Size 3 1/4 x 3 1/4 x 1 1/2" BRAND NEW. £4.50 ea. Secondhand £2.50 ea.

**DELAY LINE.** 50 nanosecs. 3 connections - ground-in-out Size 2 x 7/16 x 5/16" New 25p ea.

**MOTOR.** 12V DC with pulley and integral semiconductor. Speed Control. New £1 ea.

**LEDEX ROTARY SOLENOIDS.** 115V DC. No switch assembly. 15p ea.

**DIAMOND H CONTROLS ROTARY SWITCH.** Single pole 10-way. Printed Circuit Mount. New 10p ea. 100 for £7.50

**SOME TEKTRONIX 500 range oscilloscopes**  
with Single Trace Plug-ins. Working.  
From £100. Phone for details

**DIODES**  
All new full spec. devices IN3063  
BAV 13. 1S44. 1N4148;  
1N3470; 1N4151.  
100 off £1.50, 1,000 off £10

**PULSE TRANSFORMER.** Sub min. Size 1/2 x 5/16 x 3/4". Secondary centre tapped. New 20p ea.

**REMO TYP TYPE MULTIPLIER.** Two high voltage outputs and focus. £1 each.

**DON'T TAKE CHANCES.** Use the proper EHT CABLE. 10p per metre or £7.50 per 100 metres (drum). P&P £2.

**PHOTOGRAPHIC LAMPS.** Pearl 230V 500 watt. Screw cap 75p ea. Box of 12 £5.50. P&P £1.50.

**RAPID DISCHARGE capacitors** 8mfd 4kV £5 each. P&P £2.

**MYSTERY IC PACK.** Some 40 pin - good mixture - all new devices. 25 ICs for £1. P&P 50p.

**DECOUPLING CAPACITORS.** 0.05mfd 10V. 0.01mfd. 0.047mfd 250V; 33K. 330pf. All values 100 for £1.50.

**E.H.T. Capacitor** 500pf 8KV 20p each.

**10-way MULTI COLOUR RIBBON CABLE.** New 40p per metre. 10 metres for £1.50.

**GEC UHF 4-button tuner** £1.50 each.

**CENTAUR 115V FANS** 1/2 x 4 x 1 1/2" £4.50 ea.

**EX-USED equipment.** tested. 80p each.

**CONTACTORS.** Heavy Duty 24V DC 5 make £1 each.

**GEC UHF VHF 6-button tuner** £2 each.

**931A PHOTO MULTIPLIER** £2 each. P&P £1.

**RANCO 250V 18A THERMOSTATS** with Control knobs calibrated 50-200 degree C. £2.50 each.

**SOLID STATE UHF TUNERS.** 30 acs £1 each.

**BRAND REX** blue wire wrap. 30 metres for £1. P&P 25p.

**SLIDER CONTROL 500K Log.** Single track. Complete with knob. Length 3 1/2". 25p each.

**TRANSFORMERS**  
**AUTO 240V input** 115V 1 Amp output £1.25 each. P&P £1.25.  
**240V input.** Soc. 6V. 1.86A. Size 2 1/2 x 2 x 2". Good quality. £1.50 ea. P&P £1.

**240V input** Soc. 12V 0.92A. Size 2 1/2 x 2 x 2". Good quality. £1.50 ea. P&P £1.

**240V input** 12V 100MA. Size 60 x 40 x 42mm. 80p each.

**240V input.** Soc. 12-0-12V 50MA. Size 52 x 45 x 40mm. £1 ea.

**115V input.** Soc. 5V 250MA. Size 1 1/16 x 1.5 x 1 1/4". 2 for 50p.

**115V input.** Soc. 10-0-10V1A. Size 2 1/2 x 2 x 2". 2 for £1.50.

**SEMICONDUCATORS**  
1N4005 - 5p; 1N4002 - 3p.  
At 5p each:  
BC147, BC148B, BC157, BC158, BC237, BF197, OA90, OA81, BA24, BA243.  
At 25p each:  
TIP31, TIP41A, 2N5696, AF139, 2TX341.  
BY127 10p, BF181 20p, BD239 40p, BD241 40p, MA343AT 40p, BD228 50p, BD233 & BD234 Comp Pair 25V - 80p per pr. at 50p each.

**REGULATOR** TBAG25 8to 20V in - 5V out 100MA TO5 Con. 50p each BF256C 20p.

**TV AMPLIFIER TBA 120** 20p each.

**MINIMUM ORDER £3 VALUE OF GOODS. MINIMUM P&P £1** - where P&P not stated please use own discretion - excess refunded.  
**E5 CARRIAGE ON ALL UNITS. P&P or CARRIAGE and VAT at 15%** on total MUST BE ADDED TO ALL ORDERS.  
**CALLERS VERY WELCOME STRICTLY BETWEEN 9am-1pm and 2-5pm Monday to Saturday inc.**  
**BARCLAYCARD (VISA) and ACCESS taken.** Official orders welcome.

**CHILTEARD LTD**  
**NORWOOD ROAD, READING** **TELEPHONE NO. READING 669656**  
(2nd turning left past Reading Technical College in King's Road then first right - look on right for door with "Spoked Wheel")

**POPULAR KITS AND PARTS**

**TRANSMITTER SURVEILLANCE**  
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox - all electronic parts and circuit £2.90.

**RADIO MIKE**  
Ideal for discos and garden parties, allows complete freedom of movement. Plug through FM radio or tuner amp £8.50.

**SAFE BLOCK**  
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1.95.

**LIGHT CHASER**  
Gives a brilliant display - a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. Price £18. Ready made up £4 extra.

**FISH BITE INDICATOR** enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. Price £5.99.

**8 WAVEBAND SHORTWAVE RADIO KIT**  
Bandspread covering 13.5 to 32 mhz. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit, includes case materials, fix transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price £11.95.

**SHORT WAVE CRYSTAL RADIO**  
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 99p. High resistance headphones (give best results) £3.75. Kit includes chassis and front but not case.

**RADIO STETHOSCOPE**  
Suits to fault find - start at the aerial and work towards the speaker - when signal stops you have found the fault. Complete kit £4.98.

**INTERRUPTED BEAM KIT**  
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components - relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2.30.

**OUR CAR STARTER AND CHARGER KIT** has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 230v mains transformer, two 10 amp bridge rectifiers, starting charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

**G.P.O HIGH GAIN AMP/SIGNAL TRACER.** In case measuring only 5 1/4in x 3 1/4in is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4.5v battery and has input sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. An absolute bargain at only £1.95. Suitable 80 ohm earpiece 89p.

**VU METER**  
Edgewise mounting through hole size 1 1/2" x 1/2" approx. These are 100 micro amps f.a.d. and fitted with internal 6 volt bulb for scale illumination, also have zero rest. The scale is not calibrated but has very modern appearance. Price £2.88.

**BALANCE METER.** Edgewise mounting 100 UA centre zero. Price £2.30.

**1 1/2in SQUARE PANEL METER.** Eagle full vision plastic front, 50 UA. Price £6.80. 1mA Price £4.03.

**WATERPROOF HEATING WIRE.** 60 ohms per yard. This is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses - around water pipes, under grow boxes, in gloves and socks. 2 1/2p metre.

**DIAL INDICATOR.** As used in toolmaking and other precision measuring operations, the famous John Bull accurately shows differences of 0.1mm. A beautifully made precision instrument, price in most toolshops would be £12-£15. We have a fair quantity. Price £8.20.

**COMPONENT BOARD Ref. W0085**  
This is a modern fibreglass board which contains a multitude of very useful parts, most important of which are: 35 assorted diodes and rectifiers including four 3 amp 400v types (made up in a bridge); 8 transistors, type BC107 and 2 type BFY51, electrolytic condensers, SCR net. 2N 5062 25 Out 100V DC and 100uf 25v DC and over 100 other parts including variable, fixed and wire wound resistors, electrolytic and other condensers. A real snip at £1.15.

**FRUIT MACHINE HEART.** 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". £9.95 + £6 carriage.

**BOLDERING PUMP**  
Ideal for removing components from computer boards as well as for service work generally. Price £8.35.

**4-CORE FLEX CABLE**  
White pvc for telephone extensions, discolors, etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

**MUGGER DETERRENT**  
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

**HUMIDITY SWITCH**  
Can be made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V ac. Only £1.15.

**HALF-PRICE CABLE OFFERS.** We have good stocks of:

Size	Type	Price per 100 metres	Carriage
1.5	Single	£4.00	£1.75
1.5	Flat twin	£8.50	£2.75
1.5	Flat 3-core & E	£9.75	£3.50
4	Single	£7.50	
4	Flat twin	£11.50	£4.00
6	Flat 3-core	£32.50	£5.00
16	Twin & E	£79.00	£10.00

**AC CONDENSERS**  
For motor starters, power factor correction voltage droppers. The voltage quoted is AC RMS, or for DC at 2 1/2 times the AC voltage.

1.5 mfd 440V	84p	6.25 mfd 250V	£1.00	12 mfd 440V	£2.75
2.5 mfd 440V	87p	8 mfd 250V	£1.27	13 mfd 275V	£1.65
3.4 mfd 440V	£1.00	8 mfd 440V	£1.89	15 mfd 325V	£1.77
3.5 mfd 250V	77p	11 mfd 275V	£1.82	20 mfd 275V	£1.77
5 mfd 570V	£1.12	12 mfd 250V	£1.52	32 mfd 250V	£2.80

**AC VOLTMETER**  
Complete kit of parts for a three-channel sound to light kit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.

This unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate as of connecting lamps. Special snip price is £14.95 in kit form or £18.95 assembled and tested.

**AC VOLTMETER**  
Complete kit of parts for a three-channel sound to light kit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.

This unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug

# From Newtronics

## THE NEW EXPLORER/85 SYSTEM

### EXPLORER/85 PROFESSIONAL COMPUTER KIT



An inexpensive 8085, S100 Based Computer System designed for maximum flexibility. Now available with 8" Floppies

The EXPLORER/85 offers you real design flexibility — you can build the exact system you require. EXPLORER/85 can be your Beginners System, OEM Controller or IBM formatted 8" Disc System. You don't buy more than you need. Prices start from £85. Here's the line up:

Intel 8085 microprocessor. 8355 as a really powerful 2K Monitor system. 8155 RAM I/O all on one single Mother board with room for RAM/ROM/PROM/EPROM and two S-100 pads (expands to six), plus plenty of prototype space. The 8085 is 100% compatible with the 8080 but 50% faster. The 8355 ROM 2K monitor system includes cassette interface with tape control. Two 8-bit programmable I/O ports, automatic baud rate selection, labelling of cassette files, etc. 8155 RAM I/O features 1/4K 'scratch pad'. Two programmable 8-bit and one programmable 6-bit I/O ports plus programmable 14-bit binary counter-timer. Plus many other features which cannot be included due to lack of space. You can purchase the EXPLORER/85 Mother board (level A) at this point for as little as £85 or we'll supply it with address decoding and data drives plus wait state generator and separate regulators (level B), 4K Workspace (level D), 8K Microsoft Basic in ROM for £233 in kit form of £293 assembled and tested. If you don't possess a VDU you can add our Keyboard Terminal (less monitor) which features a full ASCII keyboard with upper and lower case with cursor control, Video Display board which is microprocessor controlled giving 64 or 32 (on TV) Characters by 16 lines adding up to a full computer system having 4K workspace at a special price of £299 (less P.S.U. and monitor/TV).

Compare these prices carefully and you'll find you are actually getting more for your money. 4K space not enough? Then it's 'JAWS' for you (see below) and you can go up to 64K in 16K steps. We'll let you have a 16K EXPLORER/85 for only £399. Like a Floppy Disc system? We now have an 8" Drive system with CP/M. We will quote you for a complete system either in kit form or assembled ready to go.

### LET NEWTRONICS HELP YOU EXPAND YOUR SYSTEM

#### 8" FLOPPY DISC SYSTEM

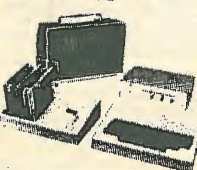
8" Control Data Corp Professional Drive  
 \* LSI Controller \* Write protect \* Single or Double density \* Capacity 400K Bytes (SD) 800K Bytes (DD) unf. matted \* Access time 25ms. Price £350.  
 DISC CONTROLLER I/O BOARD  
 Controls up to 4 Drives \* 1771 ALSI (SD) floppy disc controller \* On board data separator (IBM compatible) \* baud rate \* Two serial I/O ports \* Autoboot to disc system when system reset \* On board crystal controlled \* Price £180.  
 DOUBLE-SIDED PC BOARD (GLASS EPOXY). Price £150.  
 DISC DRIVE CABINET WITH POWER SUPPLY  
 De Luxe steel cabinet to house single drive with power supply unit to ensure maximum reliability and stability. Price £79.  
 DRIVE CABLE SET-UP FOR TWO DRIVES  
 Price £19.00.  
 SAVE £30 by purchasing complete single drive system. One 8" drive, F.D.C. board, cabinet/PS.U. and cables. Regular price £598, Special price £568.  
 CP/M 1.4 £75. CP/M 2.2 £98. Extended Microsoft Basic £213 (Includes CP/M 2.2).

### 64K 'JAWS' S100 DYNAMIC RAM BOARD

We offer you Hidden refresh 200ns 4116 RAM's on board crystal  
 fast performance 8K bank selectable  
 lower power consumption fully socketed  
 latched data outputs solder mask on both side of board  
 Designed for 8080, 8085 and Z80 bus signals works in Explorer/85, Tuscan, Horizon, Sol, as well as all other well-designed S100 computers.

KITS		WIRED & TESTED		KITS		WIRED & TESTED	
16K	£149	£169	48K	£239	£259		
32K	£194	£214	64K	£284	£304		
				16K expansion £45			

### ELF II



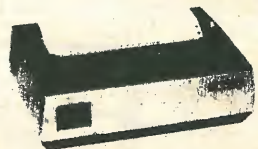
SPECIFICATION  
 \*RCA 1802 8-bit microprocessor with 256 byte RAM expandable to 64K bytes.  
 \*RCA 1861 video IC to display program on TV screen via the RF Modulator Single Board with Professional hex keyboard — fully decoded to eliminate the waste of memory for keyboard decoding circuits. Load, run and memory protect switches. 16 Registers. Interrupt, DMA and ALU Stable crystal clock. Built in power regulator 5-slot plug in expansion bus (less connectors).

### SPECIAL OFFER £59.95

STOP reading about computers and get your "hands on" an ELF II and Tom Pitman's short course. ELF II demonstrates all the 91 commands which an RCA 1802 can execute, and the short course speedily instructs you how to use them.  
 ELF II'S VIDEO OUTPUT makes it unique among computers selling at such a modest price. The expanded ELF II is perfect for engineers, business, industry, scientific and educational purposes.  
 ELF II EXPANSION KITS  
 Once you've mastered your ELF II you can then expand it to a full 64K microcomputer with our range of ELF II expansion kits. — Firmware — Software — Manuals.  
 NOW AVAILABLE BASIC LEVEL III with R.P.N. Maths package. Both cassette and EPROM versions.

SEND SAE FOR COMPREHENSIVE BROCHURE payable to NEWTRONICS or phone your order quoting BARCLAYCARD. ACCESS number. We are open for demonstrations and Sales Monday-Saturday. 9.30 a.m. - 6.30 p.m. Near Highgate Underground on main A1 into London.

### Oki Microline 80

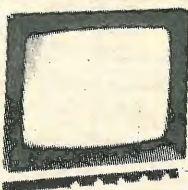


Small, light, quiet matrix printer.

40, 80 or 132 cols. 6 or 8 lines per inch. 96 ASC II + 64 graphics character set with Centronics compatible interface. £349

### Epson MX 80

— the worlds first printer with disposable print head  
 \*9x9 dot matrix \* Logic Seeking \* Bi-directional \* 96 ASCII Characters \* 64 Graphics and 8 International Characters \* Centronics I/P with optional RS232 and IEEE 488 \* Four print densities 40, 80, 66 or 132 columns \* Multiple type fonts \* Self Test \* Self Diagnostics \* Buzzer for end of paper and bell code error. ONLY £359



TVM 10" MONITOR

£99.50

NOW £79.95

IDEAL FOR APPLE NASCOM. U.K. 101, ETC.

- Designed for monitoring computers, closed circuit TV and Video Tape Recorders
- 10" black and white video monitor
- 10 MHz band width
- High-quality metallic cabinet
- Dimensions: 9" x 9" x 9 1/2"

Trade Enquiries Welcome



## Newtronics

255 ARCHWAY ROAD, LONDON, N.6  
 TEL. 01-348 3325

WW-023 FOR FURTHER DETAILS

# TUNE IN to the new-look Practical Wireless

## This month... 8 EXTRA PAGES OF PROJECTS & FEATURES...

### Morse Tutor:

Struggling to pass the Morse test? Build our Morse Tutor and master the c.w. This project fires random Morse at you for practice singly, or in groups of five characters, mixed or plain letters.

### Accented Metronome:

This device uses a distinct lowering of pitch to accentuate the pre-selected second, third or fourth beat. Using few components this is an ideal beginners project.

**Plus! New Series UNDERSTANDING RECEIVER PARAMETERS**

Get on the right frequency every month... order your copy NOW!!

# Practical Wireless

February issue on sale NOW 65p

### TRANSFORMERS CONTINUOUS RATINGS

Please add 15% VAT after P&P

12 or 24-VOLT			
Separate 12V windings Pri 220-240V			
Ref.	12v	24v	£ P&P
111	0.5	0.25	2.42 .52
213	1.0	0.5	2.90 .90
71	2.0	1.0	3.86 .90
85	4.0	2.0	4.46 1.10
50	5.0	2.5	6.16 1.10
70	6.0	3.0	6.99 1.10
108	8.0	4.0	8.16 1.31
72	10.0	5.0	8.93 1.31
116	12.0	6.0	9.59 1.52
17	16.0	8.0	11.79 1.52
115	20.0	10.0	15.87 2.39
187	30.0	15.0	19.72 2.39
226	60.0	30.0	40.41 OA

\* 115 or 240 sec only. State volts required. Pri 0.220-240V.

50 VOLT RANGE (Split Sec.)			
Pri 220-240V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V and 25V-0-25V			
Ref.	50v	25v	£ P&P
112	5	1	2.90 .90
79	1	2	3.93 1.10
3	2	4	6.35 1.10
20	3	6	7.39 1.31
21	4	8	8.79 1.31
51	5	10	10.86 1.52
117	6	12	12.29 1.67
88	8	16	16.45 1.89
89	10	20	18.98 2.24
90	12	24	21.09 2.39
91	15	30	24.18 2.39
92	20	40	32.40 OA

SCREENED MINIATURES Primary 240V			
Ref.	mA	Volts	£ P&P
238	200	3-0-3	2.83 .63
212	1A, 1A	0-6-0-6	3.14 .90
13	100	9-0-9	2.35 .44
235	330, 330	0-9-0-9	2.19 .44
207	500, 500	0-8-9-0-8-9	3.05 .85
208	1A, 1A	0-8-9-0-8-9	3.88 .90
236	200,200	0-15-0-15	2.19 .44
239	50MA	12-0-12	2.88 .37
214	300,300	0-20-2-20	3.08 .90
221	700 (DC)	20-12-0-12-20	3.75 .90
206	1A, 1A	0-15-20-0-15-20	5.09 1.10
203	500 (DC)	0-15-27-0-15-27	4.39 1.10
204	1A, 1A	0-15-27-0-15-27	6.64 1.10

HIGH VOLTAGE MAINS ISOLATING			
Pri 200/220 or 400/440 Sec 100/120 or 200/240			
VA	Ref.	£	P&P
60	243	7.37	1.58
350	247	18.07	2.12
1000	250	45.94	OA

BRIDGE RECTIFIERS			
Ref.	VA (Watts)	TAPS	£ P&P
113*	15 0-115-210-240V		2.73 .81
64	75 0-115-210-240V		4.41 1.10
4	150 0-115-200-220-240V		5.89 1.10
67	500		12.09 1.91
84	1000		20.64 2.39
93	1500		25.61 OA
95	2000		38.31 OA
73	3000		65.13 OA
80s	4000 0-10-115-200-220-240		84.55 OA
57s	5000		98.45 OA

CASED AUTO TRANSFORMERS			
240V cable input USA 115V Flat pin outlets P&P Ref.			
AV08 Mk 5	20VA	£6.55	1.03 56W
AV07	75VA	£8.50	1.31 64W
AV071	150VA	£11.00	1.31 4W
AV07M5 MINOR	AC/DC-1000V/V	200VA	£12.02 1.67 65W
WEE MEGGER	DC-100mA. Res-150K	250VA	£13.38 1.67 69W
DA211	Bargain at £7.20	500VA	£20.13 1.89 87W
DA116 Digital	VAT 15% P&P 71p	1000VA	£30.67 2.65 84W
Megger BM7 (Battery)		1500VA	£42.82 OA 93W
DA212		2000VA	£54.97 OA 95W

TEST METERS			
Ref.	Amp	Price	P&P
171	500MA	2.30	.52
172	1A	3.26	.90
173	2A	3.95	.90
174	3A	4.13	.99
175	4A	6.30	1.10

MINI MULTIMETER			
Ref.	VA	Price	P&P
171	500MA	2.30	.52
172	1A	3.26	.90
173	2A	3.95	.90
174	3A	4.13	.99
175	4A	6.30	1.10

Barrie Electronics Ltd. 3, THE MINORIES, LONDON EC3N 1BJ TELEPHONE: 01-488 3316/8 NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

**HERE IT IS! THE BRAND NEW 8022A HAND-HELD DMM**

Consider the following features:  
 6 resistance ranges from 200 ohm-20 ohms  
 8 current ranges from 2mA-2A AC/DC  
 10 voltage ranges from 200 mv-1000V DC-200 mc-750V AC  
 Pocket size — weighing only 370 grms.  
 Full overload protection — will withstand 6kv spikes  
 Rugged construction — virtually indestructible  
 Meets tough military specs — drop proof  
 In line, pushbutton operation for single-handed use  
 Incorporates low power CMOS chip for low power consumption  
 All this plus a 2-year full guarantee



**For only £75 + VAT** **SOFT CARRYING CASE £7 extra**  
 Carriage and Insurance E3

Even more sophisticated the Fluke 8020A identical in most respects to the 8022A but in addition incorporates a conductance range from 2mS-200nS.

**Price £125**

Carriage and Insurance E3.00

A handsome soft carrying case is included (this model only)

**OFF THE SHELF DELIVERY ON THESE**



**DIGITAL MULTIMETERS BRAND NEW FROM FLUKE!!! NOW AVAILABLE THE 8024A HAND HELD DMM**

This model incorporates all the features of the 8020A but in addition has:  
 A peak hold switch which can be used in AC or DC for volts and current functions.  
 Audible continuity testing and level detection for sensing logic levels.  
 A temperature (°C) range for use with a thermocouple. **£149**

Carriage and Insurance E3

The following accessories are in stock now

- Y8008 Touch and Hold Probe £18.00
- 80K-40 High Voltage Probe £45.00
- 81RF RF Probe Jc 100 MHz £52.00
- 80T-150C Temperature Probe (C) £35.00
- 801-600 Clamp-on AC Current Probe £55.00



**8010A AND 8012A BENCH MODEL D.M.M.s**

The 8010A is a general purpose, bench/portable digital multimeter with more functions and features than ever offered for such a low price. Its companion, the 8012A, has identical characteristics except that it has two additional low resistance ranges, 20 and 200 to replace the 8010A's 10 ampere current range.  
 The 8010A and 8012A feature:  
 10 voltage ranges from 200mv - 1000v dc, 200mv - 75v ac.  
 3 conductance ranges from 2mS - 200 nS.  
 6 resistance ranges from 2000 - 20mΩ - the 8012A has two additional resistance ranges 20 and 200.  
 10 current ranges from 200µA - 2A AC/DC — the 8010A has two additional current ranges 10A AC and 10A DC.

8010A £159 8012A £199

Carriage and Insurance E3  
 \*The 8010A is also available with two rechargeable Nicad size C batteries installed in piprot 01 at £179.00.

**LOW COST, AUTORANGING MULTI-FUNCTION COUNTER MODEL 1900A**

- Autoranging in both frequency and period measurement modes
- Wide Frequency range — 5 Hz to 80 MHz
- High sensitivity — 25 mV, typically 15 mV
- Six digit LED display with leading zero suppression, automatic annunciation and overflow
- Optional internal battery pack providing 4 hours continuous operation
- Autoreset on all gate times, all function switches
- Four manually selected gate times providing resolution to 0.1 Hz
- Event counting to 10<sup>6</sup> events with overflow indicator
- Signal input conditioning with switchable 1 MHz low pass filter and attenuator
- Rugged moulded case with convenient latching carrying handle
- Optional parallel data output with decimal point and annunciation
- Traditional high Fluke quality
- Self check

**£235** Carriage and Insurance E3

**PLEASE ADD 15% VAT TO ALL ORDERS EXCEPT WHERE ITEMS MARKED "VAT INCLUDED."**  
**CALLERS WELCOME**  
 We are open 9 a.m.-6 p.m. Monday-Saturday  
 We carry a very large selection of electronic components and electro-mechanical items.  
 Special quotations on quantities

**ROTARY STUD SWITCH**  
 PLESSEY 30-way, 2 bank. Single pole. Contacts 1 amp 240v. AC/DC. 0.05Ω res. Make before, break. Stop infinitely adjustable allowing for any desired arc of travel. Ideal for instrument and model switching. Size 2 1/4" dia. overall x 2 1/4" deep plus 1 1/4" x 1/4" dia. spindle. **£3.25** P&P 50p

**BENDIX MAGNETIC C. YTC**  
 Superb example of electro-mechanics. Main body in two sections, coil section fixed with 3/4" sleeve, drive section rotating on outer perimeter. Unting plate has 3/4" ID bearing concentric with main section and 18-tooth cog wheel. Extremely powerful transmission. 24V D.C. 240 m/a. **£4.75** P&P 75p

**Y7206 EN 20,000 OPV**  
 AC Volts: 0-10, 50, 250, 500, 1000  
 DC Volts: 0-0.5, 5, 25, 125, 250, 500, 1000  
 DC Current: 0-0.05, 5, 250 mA  
 Resistance: 0-3k ohms 300k ohms 3 meg ohms  
 Decibels -20 +63 db  
 Dims 127 x 90 x 32 mm  
**£10.95** P&P 75p

**TMK500**  
 30,000 OPV  
 A sturdy and reliable instrument. Has internal buzzer.  
 AC Volts: 0 to 2.5, 10, 25, 100, 250, 500, 1000  
 DC Volts: 0 to 0.25, 1, 2.5, 10, 25, 100, 250, 500, 1000  
 DC Current: 0 to 0.5, 5, 25, 100, 250, 500, 1000 mA, 12 amp.  
 Resistance: 0 to 6k, 60k, 6 meg, 60 meg.  
 Decibels: -20 to +56 db  
 Short test: Internal buzzer.  
 Size: 160 x 110 x 55 mm.  
**£20.50** P&P 75p

**ELECTRO-TECH COMPONENTS LTD.**

364 EDGWARE ROAD, LONDON, W.2. TEL: 01-723 5667

**PURE GOLD!**  
 Top-quality, low-profile, gold-plated contacts,  
**IC SOCKETS**  
 8 pin ..... 12p  
 14 pin ..... 15p  
 16 pin ..... 20p  
 18 pin ..... 22p  
 20 pin ..... 25p  
 22 pin ..... 28p  
 24 pin ..... 30p  
 28 pin ..... 35p  
 40 pin ..... 50p



**Unbeatable value!**

Any mix. Minimum order £10. Add £1 P & P

**Special Offer:** 10 x 14 pin, 10 x 16 pin, 5 x all others, total 55 sockets, only **£12.50 + £1 P & P.**

**ORION**

Orion Scientific Products Ltd., 10 Wardour St., London, W.1

WW-060 FOR FURTHER DETAILS

**COMPUTER APPRECIATION**  
 86 High Street, Bletchingley, Redhill, Surrey RH1 4PA. Tel: Godstone (0883) 843221

- PDP 11/23 SYSTEM.** Comprising 11/23 card with memory management chip; MXV 11-A multifunction card with 8K bytes, 2 serial interface channels and 2 x 2716 EPROMs; 64K byte MSV11 card; XYLOGICS Model CS10 disc controller with bootstrap; 2 x IOMEC disc drives with combined capacity of 20 Mbytes; VT52 VDU, 24 lines x 80 ch.; DEC BA 11-MF box with 4 spare slots; LEAR SIEGLER Series 200 bi-directional matrix printer. Apart from the terminal and printer the components of this system are NEW and dated 1980. Software includes RT11, BASIC, FORTRAN & PASCAL. **£6950.00**
- TELETYPE Model ASR 33** with 20mA current loop or RS232 interface, 110 Baud, remote reader control (which may be disabled by insertion of a jumper), paper tape reader/punch and stand (when available). From **£195.00**
- TELETYPE Model KSR 33.** As above, but without paper tape facility. **£180.00**
- DATA DYNAMICS Model ASR 390.** Mechanically identical to ASR 33 but with addition of 240v operation, motor cut-out feature, reader single stop, stand and silencing cover. RS232 interface. With low hours and in immaculate condition **£375.00**
- DATA DYNAMICS Model KSR 390.** As above, but without tape reader and punch. RS232/V24, 110 Baud 2,500 rpm. industry standard interface **£160.00**
- DI/AN Model 9030.** Desk-top terminal similar to DECwriter L436. Upper/lower case matrix printer, up to 300 Baud. Features switchable Baud rate, parity, keyboard and duplex options **£190.00**
- TEXAS SILENT 700 KBR terminal.** 30 cps dot matrix terminal using thermal paper. With 20 mA current loop interface **£275.00**
- ITEL Model 1061.** IBM SELECTRIC (Golfball) typewriter based terminal. With standard RS232/V24 serial interface and optical paper tape reader and punch. EBCDIC coded **£295.00**
- ITEL Model 1061P.** As above but tested only so far as typewriter operation. Ideal for those users who wish to substitute their own electronics **£195.00**
- SPERRY-REMINGTON Word Processor.** Incorporating IBM I/O typewriter with twin magnetic card stations. Operating stand-alone, or suitable for conversion to on-line use. Fully refurbished **£295.00**
- OLIVETTI Model 318 ASR Terminal.** 110 Baud printer with paper tape reader/punch and keyboard. One only available in excellent condition **£100.00**
- CREED 'ENVOY' Terminal.** ASR machine with keyboard and tape reader/punch. Features good quality upper/lower case character set **£175.00**
- CENTRONICS Model 101A 165 cps matrix printer.** With parallel and serial interface options **£275.00**
- POTTER Model LP-3000 High-speed (300 lpm) line printer.** **£175.00**
- BCL Matrix printer.** 120 cps with dual tractor and long platen (in excess of 300 c/s). Unused **£285.00**
- ODEC Model 4000 belt printer.** 65 lpm. Parallel TTL interface. Manufactured 1980 **£180.00**
- DIAMOND SERIES 30 DISC DRIVES.** These are offered fully refurbished and may be viewed operating on-line at our premises prior to purchase. 2.5 Mbyte removable cartridge version is directly compatible with the DEC RK05 drive for PDP/LS11. **£485.00**
- As above, but with cartridge removable by engineer rather than operator **£650.00**
- CDC Disc Drive.** Model BJ 58AB. BRAND NEW and with trolley if required but WITHOUT heads **£485.00**
- IOMEC Model 3404 disc drive.** 10 Mbyte capacity with one fixed and one top loading platter. 2,400 rpm, 200 tip and 2200 bpi. These drives are complete with documentation and have the industry standard interface. IOMEC are no longer in business, nevertheless, electronic components are standard and we can supply incomplete drives free of charge to buyers. Service is, in any case, apparently available for IOMEC drives. BRAND NEW in original boxes **£750.00**
- WANGCO Model T 1222 disc drives.** With one fixed and one top loading platter of 5 Mbyte capacity total. Schematics available **£380.00**
- DEC Model 6840-9-25 9-track PE and NRZ1 tape drives usually available from stock** **£475.00**
- PERTEC Model CR11 285 cps CARD Reader.** Without controller **£325.00**
- WANGCO Model 1025 9-track NRZ tape drives.** 2 drives mounted in cabinet. (Please enquire for one-off) **£1,100.00**
- PLESSEY Paper Tape Station.** With TALLY reader and TELETYPE BRPE 110 Punch. Operates either locally or on-line at up to 1200 Baud/V24. **£285.00**
- TREND Model HSR 350.** 350 cps optical reader with TTL interface **£225.00**
- DATA DYNAMICS Model 1114 high-speed tape punch.** With parallel TTL interface. With low hours and recently serviced by Data Dynamics. Price includes all documentation **£325.00**

**MAINS INTERCOM NEW IMPROVED**  
**NEW! AMERICAN TYPE CRADLE TELEPHONE AMPLIFIER**

**£37.99 + VAT £5.70 per pair**  
**£18.95 + VAT £2.88 + P&P £1.25**

**NO BATTERIES, NO WIRES.** Made to high safety and Telecommunications Standard. The modern way of instant 2-way communications. Just plug into power socket. Ready for use. Crystal clear communications from room to room. Range 1/4 mile on the same mains phase with call buzzer and light indicator. On-off switch. Volume control. Useful as inter-office intercom between office and warehouse, in surgery and in homes, between house and garage. Also useful as burglar alarm. 6 months' service guarantee. P&P £1.85. Also F.M. 2-channel model, £55.95 + VAT £8.40 + P&P £1.95 per pair.

10 days' price refund guarantee. Barclaycard and Access welcome.  
**WEST LONDON DIRECT SUPPLIES (WWW)**  
 169 KENSINGTON HIGH STREET, LONDON W8 6SN

**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". 3 speeds. Above motor board 3 1/2". Below motor board 2 1/2". with Ceramic Stereo cartridge.  
**£20** Post E2  
 Ready cut Mounting Board £1 extra

**HEAVY METAL PLINTHS**  
 Cut out for most BSR or Garrard decks. Silver grey finish. Size 16 x 14 x 3in. **£4.50**  
**BSR DE LUXE TEAK VENEERED MODEL**  
 With hinged perspex cover. Size 17 1/2 x 15 x 6in. **£10.50**  
**J.V.C. TEAK VENEERED PLINTH**  
 19 x 14 1/2in. with Plastic Cover **£10.50** Post E2  
**TINTED PLASTIC COVERS**  
 Sizes: 14 1/2 x 12 1/2 x 3in. **£3.50**.  
 18 x 13 1/4 x 4in. **£6**.  
 17 1/4 x 9 1/2 x 3 1/2in. **£3**. 18 x 12 1/2 x 3in. **£6**.  
 18 x 13 1/4 x 3 1/2in. with standup hinges **£7**. Post E1.50

**BSR SINGLE PLAYER DECKS**  
 BSR P182 3 speeds flared aluminium turntable 'S' shape arm, cueing device, ceramic cartridge **£26** Post E2.00.  
 Ready cut mounting board. Only £1 extra.  
**BSR P172 RIM DRIVE QUALITY DECK**  
 Manual or automatic play. Three speeds. Precision ultra slim arm. Cueing device. Bargain price With stereo ceramic cartridge **£20** Post E2  
**BSR P207 BUDGET SINGLE PLAYER** ideal for disco or small two-speed Hi-Fi system with stereo cartridge cartridge and cueing device. **£15** Post E2

**GARRARD 6-200 SINGLE PLAYER DECK**  
 Brushed Aluminium arm with stereo ceramic cartridge and Diamond Stylus, 3-speeds. Manual and Auto Stop/Start. Large Metal Turntable. Cueing Device and Pause Control. Ready cut mounting board only **£1** extra. **£22** Post E2

**ELAC HI-FI SPEAKER 10in. TWIN CONE**  
 Large ceramic magnet. 50-16,000 c/s. bass response 40 c/s. 8 ohm impedance. **£7.95** Post 99p

**POTENTIOMETERS Carbon Track**  
 5K to 2MΩ. LOG or LIN. L/S 50p. DP 90p. Stereo L/S £1.10. DP £1.30. Edge Pot 5K. SP 45p. Sliders Mono 65p. Stereo 85p.

**EMI 13 1/2 x 8in. LOUDSPEAKERS**  
 With tweeter and crossover. 10 watt. 8 ohm. 15 watts, 3 or 8 ohm. **£9.95** Post 99p **£10.95** Post 99p

**SUITABLE BOOKSHELF CABINET** £9.50.  
 Bass woofer, EMI 15 ohm. 20 watt. **£10.95** Post 99p

**THE "INSTANT" BULK TAPE ERASER**  
 Suitable for cassettes, and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead. **£8**  
 Will also demagnetise small tools **£8**  
 Head Demagnetiser only **£5** Post 50p

**RELAYS.** 12V DC £1.25p. 6V DC 85p.  
**BLANK ALUMINIUM CHASSIS.** 6 x 4—£1.20; 8 x 6—£1.50; 10 x 7—£1.90; 12 x 8—£2.20; 14 x 9—£2.50; 16 x 6—£2.40; 16 x 10—£2.70.  
**ANGLE ALI.** 6 x 4 x 1/4in—25p.  
**ALUMINIUM PANELS.** 6 x 4—24p; 8 x 6—38p; 14 x 3—40p; 10 x 7—84p; 12 x 8—70p; 12 x 5—44p; 16 x 6—70p; 14 x 9—84p; 12 x 12—£1; 16 x 10—£1.16.  
**PLASTIC AND ALI BOXES IN STOCK. MANY SIZES**  
**ALUMINIUM BOXES.** 4 x 4 x 1 1/2. 4 x 2 x 2. 1. 3 x 2 x 1 1/2. 6 x 4 x 2. 2. 1. 30. 7 x 5 x 2. 1. 4. 8 x 6 x 3. 2. 2. 10 x 7 x 3. 2. 50. 12 x 5 x 3. 2. 2. 30. 12 x 8 x 3. 3.  
**BRIDGE RECTIFIER.** 200V PIV 4 amp £1.50. 8 amp £2.50.  
**TOGGLE SWITCHES.** SP 30p. DPST 40p. DPDT 50p.  
**RESISTORS.** 100 to 10M. 1/4W, 1/2W, 1W, 1 1/2W, 2W 10p.  
**HIGH STABILITY.** 1/2W 2% 10 ohms to 1 meg. 3p.  
 Ditto 5%. Preferred values, 10 ohms to 10 meg. 3p.  
**PICK-UP CARTRIDGES SONATONE 9TAC £2.50.**  
 BSR Stereo Ceramic SC7 Medium £2. SC8 High £2.  
**PHILIPS PLUG-IN HEAD.** ALL1020 (G306 - GP310 - GP233-AG3306 - AG3310) £2.  
**LOKITTIE SEALING KIT DECCA 118.** Complete £1.  
**SOLDERING IRON 240V 40W £2.75.**  
**VALVE OUTPUT Transformers (terminal) 90p.**  
**CAR SPEAKERS** on Baffles 7 x 4 1/2 x 1 1/2in. deep, 4 ohms. Twin Units Bass and Treble 10 watts, Door Mounting, Stereo pair £14.

**GRAPHIC EQUALISER.** Power Booster. Stereo 20 watts RMS per channel, 5 sliders Graphic Equalisation 5 1/2 wide x 7 1/2 deep x 2in. high. 12 volt D.C. suitable for Car Radio or Cassette £30.

**MINI-MULTI TESTER**  
 Deluxe pocket size precision moving coil instrument. jewelled bearings — 2000 o.p.v. Battery included.  
 11 instant ranges measure:  
 DC volts 10, 50, 250, 1000.  
 AC volts 10, 50, 250, 1000.  
 DC amps 0-100mA.  
 Continuity and resistance 0-1 meg ohms in two ranges.  
 Complete with Test Prods and instruction book showing how to measure capacity and inductance.  
**£6.50**

**PANEL METERS £4 each**  
 50µa 100µa 500µa, 1ma, 5ma, 50ma, 25 volt, 50 volt, VU Meter. Facia size 2 1/2 x 1 1/2in. Fixing hole 1 1/2in. dia. Lighting kit 6 or 12v 90p extra.

**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 or disco. **£18** Post 50p  
 Easy to build. Full instructions supplied. Cabinet **£4.50** extra. Will operate from 200MV to 100 watt signal. 200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights, Edison Screw. 6 for £4, or 12 for £7.50. Post 50p.

**"MINOR" 10 watt AMPLIFIER KIT £14.00**  
 This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£14.00**; Stereo, **£20**. Post 45p. Specification 10W per channel; input 100mV; size 9 1/2 x 3 x 2in. approx. SAE details. Full instructions supplied. AC mains powered. Input can be modified to suit guitar.

**RCS STEREO PRE-AMP KIT.** All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and PC Board **£2.95**  
 Can be ganged to make multi-way stereo mixers **Post 35p**

**MAINS TRANSFORMERS ALL POST 99p.**  
 250-0-250V 70mA, 6.5V, 2A £4.50  
 250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A £4.60  
 350-0-350V 250mA, 6.3V 4A, 4A CT, 5V 2A £12.50  
 300-0-300V 120mA, 2x6.3V 2A C.T. 5V 2A £16.00  
 220V 1 1/2 amp, 6.3V 2A £2.50

**GENERAL PURPOSE LOW VOLTAGE.**  
 Tapped outputs available  
 2 amp, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V £6.00  
 1 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6.00  
 2 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9.50  
 3 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £12.50  
 5 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £16.00

**CHARGER TRANSFORMERS**  
 6-12 volt 3 amp **£4.00**  
 6-12 volt 4 amp **£6.50**

**CHARGER RECTIFIERS**  
 6-12 volt 2 amp **£1.10**  
 6-12 volt 4 amp **£2.00**

**OPUS COMPACT SPEAKERS**  
 FLUTED WOOD FRONTS  
 TEAK VENEERED CABINET  
 11 x 8 x 7in.  
 50 to 14,000 cps/15 watts 8 ohm  
**£20** pair

**LOW VOLTAGE ELECTROLYTICS**  
 ALL 10p  
 1 mfd, 2 mfd, 4 mfd, 8 mfd, 10 mfd, 16 mfd, 25 mfd, 30 mfd, 50 mfd, 100 mfd, 200 mfd, 1000 mfd. All 15 volts. 22 mfd/6v/10v; 25 mfd/6v/10v; 47 mfd/10v; 50 mfd/6v; 68 mfd/6v/10v/16v/25v; 100 mfd/10v; 150 mfd/6v/10v; 200 mfd/10v/16v/25v; 220 mfd/10v/16v; 330 mfd/4v/10v; 500 mfd/6v; 680 mfd/10v/16v; 1000 mfd/2.5v/4v/7.10v; 1500 mfd/6v/10v/16v; 2200 mfd/6v/10v; 3300 mfd/6v; 4700 mfd/4v. ALL 10p.  
 500mF 12V 15p; 25V 20p; 50V 30p; 100V 70p.  
 2000mF 6V 25p; 25V 42p; 40V 60p; 1200V 76V 80p.  
 2500mF 50V 70p; 3000mF 50V 65p; 2000mF 100V £1.  
 4500mF 64V £2. 4700mF 63V £1.20. 2700mF/76V £1.  
 5000mF 35V 85p.

**HIGH VOLTAGE ELECTROLYTICS**  
 8/450V 45p 8+8/450V 75p 32+32+16/350V  
 16/350V 45p 8+16/450V 75p  
 32/500V 75p 20+20/450V 75p 100+100/275V 65p  
 50/500V £1.20 32+32/500V 50p 150+200/275V 50p  
 8/800V £1.20 50+50/500V £1.80 220/450V 95p  
 16/500V 65p 50+50/300V 50p 80+40/500V £2

**TRIMMERS** 10pF, 30pF, 50pF, 5p, 100pF, 150pF, 15p.  
**CERAMIC,** 1pF to 0.01mF, 5p. Polystyrene 2 to 5000pF, 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 CHANGEOVER 20p.**  
**SUB-MIN MICRO SWITCH, 25p.** Single pole change over.  
**TWIN GANG, 120P 50p; 500P £1.**  
**GEARED TWIN GANGS 25P 95p; 365P £1.** REARDED 365 + 365 + 25 + 25P £1  
**TRANSISTOR TWIN GANG.** Japanese Replacement 50p.  
**NEON PANEL INDICATORS 250V 30p.**  
**ILLUMINATED ROCKER SWITCH.** Single pole. Red 65p.  
**WIRE-WOUND RESISTORS** 5 watt, 10 watt, 15 watt 15p  
**CASSETTE MOTOR.** 6 volt £1  
**CASSETTE MECHANISM.** 12v Stereo Playback only £5  
**U.H.F. COAXIAL CABLE SUPER LOW LOSS.** 25p yd.  
**COAX PLUGS 20p. COAX SOCKETS 20p.**

**BAKER LOUDSPEAKERS "SPECIAL PRICES"**

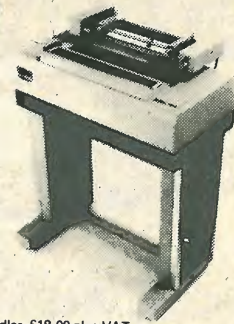
MODEL	INCHES	OHMS	WATTS	TYPE	PRICE
MAJOR	12	4-8	30	HI-FI	£12
DELUXE MK II	12	8-16	15	HI-FI	£14
SUPERB	12	8-16	30	HI-FI	£20
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	60	HI-FI	£35
GROUP 35	12	4-8-16	40	PA	£12
GROUP 40	12	4-8-16	45	PA	£15



<b>TTLs by TEXAS</b>	74290 150p	4020 100p	74291 150p	4021 110p	74292 150p	4022 100p	74293 150p	4023 100p	74294 150p	4024 60p	74295 150p	4025 20p	74296 150p	4026 130p	74297 150p	4027 50p	74298 150p	4028 60p	74299 150p	4029 100p	74300 150p	4030 55p	74301 150p	4031 200p	74302 150p	4032 200p	74303 150p	4033 110p	74304 150p	4034 295p	74305 150p	4035 295p	74306 150p	4036 295p	74307 150p	4037 295p	74308 150p	4038 295p	74309 150p	4039 295p	74310 150p	4040 100p	74311 150p	4041 80p	74312 150p	4042 80p	74313 150p	4043 80p	74314 150p	4044 80p	74315 150p	4045 80p	74316 150p	4046 110p	74317 150p	4047 100p	74318 150p	4048 100p	74319 150p	4049 45p	74320 150p	4050 45p	74321 150p	4051 80p	74322 150p	4052 80p	74323 150p	4053 80p	74324 150p	4054 150p	74325 150p	4055 125p	74326 150p	4056 135p	74327 150p	4057 135p	74328 150p	4058 115p	74329 150p	4059 120p	74330 150p	4060 120p	74331 150p	4061 120p	74332 150p	4062 45p	74333 150p	4063 45p	74334 150p	4064 45p	74335 150p	4065 45p	74336 150p	4066 45p	74337 150p	4067 45p	74338 150p	4068 45p	74339 150p	4069 45p	74340 150p	4070 25p	74341 150p	4071 25p	74342 150p	4072 25p	74343 150p	4073 25p	74344 150p	4074 25p	74345 150p	4075 25p	74346 150p	4076 107p	74347 150p	4077 107p	74348 150p	4078 107p	74349 150p	4079 107p	74350 150p	4080 107p	74351 150p	4081 27p	74352 150p	4082 27p	74353 150p	4083 27p	74354 150p	4084 27p	74355 150p	4085 27p	74356 150p	4086 27p	74357 150p	4087 27p	74358 150p	4088 27p	74359 150p	4089 150p	74360 150p	4090 150p	74361 150p	4091 150p	74362 150p	4092 70p	74363 150p	4093 70p	74364 150p	4094 25p	74365 150p	4095 95p	74366 150p	4096 95p	74367 150p	4097 340p	74368 150p	4098 340p	74369 150p	4099 120p	74370 150p	4100 120p	74371 150p	4101 200p	74372 150p	4102 200p	74373 150p	4103 130p	74374 150p	4104 130p	74375 150p	4105 130p	74376 150p	4106 130p	74377 150p	4107 130p	74378 150p	4108 130p	74379 150p	4109 130p	74380 150p	4110 130p	74381 150p	4111 130p	74382 150p	4112 130p	74383 150p	4113 130p	74384 150p	4114 130p	74385 150p	4115 130p	74386 150p	4116 130p	74387 150p	4117 130p	74388 150p	4118 130p	74389 150p	4119 130p	74390 150p	4120 130p	74391 150p	4121 130p	74392 150p	4122 130p	74393 150p	4123 130p	74394 150p	4124 130p	74395 150p	4125 130p	74396 150p	4126 130p	74397 150p	4127 130p	74398 150p	4128 130p	74399 150p	4129 130p	74400 150p	4130 130p																																																																																																			
<b>93 SERIES</b>	9301 160p	74500 60p	74511 120p	9302 175p	74501 60p	74512 300p	9303 175p	74502 60p	74513 160p	9304 175p	74503 60p	74514 75p	9305 175p	74504 60p	74515 225p	9306 175p	74505 60p	74516 225p	9307 175p	74506 60p	74517 225p	9308 175p	74507 60p	74518 225p	9309 175p	74508 60p	74519 225p	9310 175p	74509 60p	74520 225p	9311 175p	74510 60p	74521 225p	9312 175p	74511 60p	74522 225p	9313 175p	74512 60p	74523 225p	9314 175p	74513 60p	74524 225p	9315 175p	74514 60p	74525 225p	9316 175p	74515 60p	74526 225p	9317 175p	74516 60p	74527 225p	9318 175p	74517 60p	74528 225p	9319 175p	74518 60p	74529 225p	9320 175p	74519 60p	74530 225p	9321 175p	74520 60p	74531 225p	9322 175p	74521 60p	74532 225p	9323 175p	74522 60p	74533 225p	9324 175p	74523 60p	74534 225p	9325 175p	74524 60p	74535 225p	9326 175p	74525 60p	74536 225p	9327 175p	74526 60p	74537 225p	9328 175p	74527 60p	74538 225p	9329 175p	74528 60p	74539 225p	9330 175p	74529 60p	74540 225p	9331 175p	74530 60p	74541 225p	9332 175p	74531 60p	74542 225p	9333 175p	74532 60p	74543 225p	9334 175p	74533 60p	74544 225p	9335 175p	74534 60p	74545 225p	9336 175p	74535 60p	74546 225p	9337 175p	74536 60p	74547 225p	9338 175p	74537 60p	74548 225p	9339 175p	74538 60p	74549 225p	9340 175p	74539 60p	74550 225p																																																																																																																																																																																																									
<b>74S SERIES</b>	74S01 160p	74500 60p	74511 120p	74S02 175p	74501 60p	74512 300p	74S03 175p	74502 60p	74513 160p	74S04 175p	74503 60p	74514 75p	74S05 175p	74504 60p	74515 225p	74S06 175p	74505 60p	74516 225p	74S07 175p	74506 60p	74517 225p	74S08 175p	74507 60p	74518 225p	74S09 175p	74508 60p	74519 225p	74S10 175p	74509 60p	74520 225p	74S11 175p	74510 60p	74521 225p	74S12 175p	74511 60p	74522 225p	74S13 175p	74512 60p	74523 225p	74S14 175p	74513 60p	74524 225p	74S15 175p	74514 60p	74525 225p	74S16 175p	74515 60p	74526 225p	74S17 175p	74516 60p	74527 225p	74S18 175p	74517 60p	74528 225p	74S19 175p	74518 60p	74529 225p	74S20 175p	74519 60p	74530 225p	74S21 175p	74520 60p	74531 225p	74S22 175p	74521 60p	74532 225p	74S23 175p	74522 60p	74533 225p	74S24 175p	74523 60p	74534 225p	74S25 175p	74524 60p	74535 225p	74S26 175p	74525 60p	74536 225p	74S27 175p	74526 60p	74537 225p	74S28 175p	74527 60p	74538 225p	74S29 175p	74528 60p	74539 225p	74S30 175p	74529 60p	74540 225p	74S31 175p	74530 60p	74541 225p	74S32 175p	74531 60p	74542 225p	74S33 175p	74532 60p	74543 225p	74S34 175p	74533 60p	74544 225p	74S35 175p	74534 60p	74545 225p	74S36 175p	74535 60p	74546 225p	74S37 175p	74536 60p	74547 225p	74S38 175p	74537 60p	74548 225p	74S39 175p	74538 60p	74549 225p	74S40 175p	74539 60p	74550 225p																																																																																																																																																																																																									
<b>TRANSISTORS</b>	AC126 25p	BFR40 25p	TIP30A 48p	AC127 25p	BFR41 25p	TIP30C 60p	AC128 25p	BFR42 25p	TIP31A 58p	2N3055 48p	3N204 120p	6A 50V 80p	AC129 25p	BFR43 25p	TIP31B 58p	2N3056 48p	40290 250p	AC130 25p	BFR44 25p	TIP31C 58p	2N3057 48p	40360 40p	40291 250p	6A 100V 100p	AC131 25p	BFR45 25p	TIP31D 58p	2N3058 48p	40361 2 75p	40292 250p	6A 400V 120p	AC132 25p	BFR46 25p	TIP31E 58p	2N3059 48p	40362 2 75p	40293 250p	10A 400V 200p	AC133 25p	BFR47 25p	TIP31F 58p	2N3060 48p	40363 2 75p	40294 250p	25A 400V 400p	AC134 25p	BFR48 25p	TIP31G 58p	2N3061 48p	40364 2 75p	40295 250p	ZENERS	TIP31H 58p	2N3062 48p	40365 2 75p	40296 250p	2.7V-33V	TIP31I 58p	2N3063 48p	40366 2 75p	40297 250p	400mW	TIP31J 58p	2N3064 48p	40367 2 75p	40298 250p	1W	TIP31K 58p	2N3065 48p	40368 2 75p	40299 250p	15p	TIP31L 58p	2N3066 48p	40369 2 75p	40300 250p	TRIAES	TIP31M 58p	2N3067 48p	40370 2 75p	40301 250p	BY 127 12p	TIP31N 58p	2N3068 48p	40371 2 75p	40302 250p	6A 400V 80p	TIP31O 58p	2N3069 48p	40372 2 75p	40303 250p	6A 400V 70p	TIP31P 58p	2N3070 48p	40373 2 75p	40304 250p	6A 500V 88p	TIP31Q 58p	2N3071 48p	40374 2 75p	40305 250p	6A 500V 75p	TIP31R 58p	2N3072 48p	40375 2 75p	40306 250p	6A 500V 95p	TIP31S 58p	2N3073 48p	40376 2 75p	40307 250p	12A 400V 85p	TIP31T 58p	2N3074 48p	40377 2 75p	40308 250p	12A 500V 105p	TIP31U 58p	2N3075 48p	40378 2 75p	40309 250p	16A 400V 110p	TIP31V 58p	2N3076 48p	40379 2 75p	40310 250p	16A 500V 130p	TIP31W 58p	2N3077 48p	40380 2 75p	40311 250p	16A 500V 130p	TIP31X 58p	2N3078 48p	40381 2 75p	40312 250p	16A 500V 130p	TIP31Y 58p	2N3079 48p	40382 2 75p	40313 250p	16A 500V 130p	TIP31Z 58p	2N3080 48p	40383 2 75p	40314 250p	16A 500V 130p	DIODES	TIP320 58p	2N3081 48p	40384 2 75p	40315 250p	BY 336-300	TIP321 58p	2N3082 48p	40385 2 75p	40316 250p	0A47 20p	TIP322 58p	2N3083 48p	40386 2 75p	40317 250p	0A81 15p	TIP323 58p	2N3084 48p	40387 2 75p	40318 250p	0A85 15p	TIP324 58p	2N3085 48p	40388 2 75p	40319 250p	0A90 15p	TIP325 58p	2N3086 48p	40389 2 75p	40320 250p	0A91 9p	TIP326 58p	2N3087 48p	40390 2 75p	40321 250p	0A95 9p	TIP327 58p	2N3088 48p	40391 2 75p	40322 250p	0A200 9p	TIP328 58p	2N3089 48p	40392 2 75p	40323 250p	0A202 10p	TIP329 58p	2N3090 48p	40393 2 75p	40324 250p	1N914 4p	TIP330 58p	2N3091 48p	40394 2 75p	40325 250p	1N916 4p	TIP331 58p	2N3092 48p	40395 2 75p	40326 250p	1N4148 4p	TIP332 58p	2N3093 48p	40396 2 75p	40327 250p	1N4001/2 5p	TIP333 58p	2N3094 48p	40397 2 75p	40328 250p	1N4003/4 5p	TIP334 58p	2N3095 48p	40398 2 75p	40329 250p	1N4006/7 5p	TIP335 58p	2N3096 48p	40399 2 75p	40330 250p	1N4013/3 14p	TIP336 58p	2N3097 48p	40400 2 75p	40331 250p	1N5404/7 19p	TIP337 58p	2N3098 48p	40401 2 75p	40332 250p	1S920 9p	TIP338 58p	2N3099 48p	40402 2 75p	40333 250p	THYRISTORS	TIP339 58p	2N3100 48p	40403 2 75p	40334 250p	1A 50V 70p	TIP340 58p	2N3101 48p	40404 2 75p	40335 250p	1A 100V 90p	TIP341 58p	2N3102 48p	40405 2 75p	40336 250p	3A 400V 100p	TIP342 58p	2N3103 48p	40406 2 75p	40337 250p	8A 400V 180p	TIP343 58p	2N3104 48p	40407 2 75p	40338 250p	16A 400V 180p	TIP344 58p	2N3105 48p	40408 2 75p	40339 250p	16A 400V 180p	TIP345 58p	2N3106 48p	40409 2 75p	40340 250p	16A 400V 180p	TIP346 58p	2N3107 48p	40410 2 75p	40341 250p	16A 400V 180p	TIP347 58p	2N3108 48p	40411 2 75p	40342 250p	16A 400V 180p	TIP348 58p	2N3109 48p	40412 2 75p	40343 250p	16A 400V 180p	TIP349 58p	2N3110 48p	40413 2 75p	40344 250p	16A 400V 180p	TIP350 58p	2N3111 48p	40414 2 75p	40345 250p	16A 400V 180p	TIP351 58p	2N3112 48p	40415 2 75p	40346 250p	16A 400V 180p	TIP352 58p	2N3113 48p	40416 2 75p	40347 250p	16A 400V 180p	TIP353 58p	2N3114 48p	40417 2 75p	40348 250p	16A 400V 180p	TIP354 58p	2N3115 48p	40418 2 75p

Save Over £1200!!  
Logabax DZM180 High Speed  
Matrix Printers

This must be one of our greatest bulk saving deals this year. This fabulous printer is listed at over £1800 and judging by the quality workmanship we are not surprised. The Logabax DZM180 Matrix printer, capable of printing up to 132 characters per line on any size (via variable tractor unit) sprocket fed fanfold paper. A precision matrix head utilising ruby bearings gives exceptionally clear uniform legible characters via standard ribbon. Many other features include internal buffer, for high throughput, in excess of 180 characters per second, software controllable form and tab functions, standard TTL parallel centronics interface, etc, etc.



£499.00 plus VAT\*  
Optional extras  
Floor stand (as picture) £30.00 plus VAT Paper handler £18.00 plus VAT  
\*Carriage - please enquire for specific quote.

THE "MULTIVOLT" MULTI RAIL P.S.U.

This has got to be the power supply to end all your M.P.U./LAB supply requirements. Recently made by the famous "WIER" Co Ltd to the highest professional specifications. With an original cost of over £200 the supply features every possible form of protection, full regulation, over voltage and current limit and just look at these outputs, it may have been made to your specifications!

- + 5 V at 12 Amps
- + 30 V at 2 Amps
- + 5 V at 4.5 Amps
- + 5 V at 4 Amps
- 12 V at 2.5 Amps
- + 12 V at 2.5 Amps
- 9 V at 1 Amp

you agree then order now whilst stocks last.  
Supplied BRAND NEW at only complete with diagrams. £59.99 CARR. & INSUR. £6.75

Full range of T.T.L. ex-stock.



Dept. W.W. 64-86 Melfort Rd., Thornton Heath, Croydon, Surrey. Tel: 01-889 7702 or 01-889 6800

MAIL ORDER INFORMATION  
Unless otherwise stated all prices inclusive of V.A.T. Cash with order. Minimum order value £2.00. Prices and Postage quoted for UK only. Where post and packing not indicated please add 50p per order. Bona Fida account orders minimum £10.00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard Visa welcome.

WW — 077 FOR FURTHER DETAILS



The larger catalogue that means FREE POSTAGE IN U.K.  
• ADDITIONAL DISCOUNTS  
• KEEN PRICES  
• GUARANTEED SATISFACTION  
• GOOD STOCKS — GOOD DELIVERY  
• We pay postage

68 LARGER PAGES

Semi-Conductors • I.C.s • Opto-devices • Rs and Cs in great variety • Pots • Switches • Knobs • Accessories • Tools • Materials • Connectors

ELECTROVALUE LTD.

FREE FOR THE ASKING

(WW2), 28 St. Jude's Road, Englefield Green, Egham, Surrey (London 87) STD 0784. Phone: 33603 (London 87) STD 0784. Telex 264475  
NORTHERN BRANCH (Personal Shoppers Only): 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone (061) 432 4945

Happy Memories

4116	200ns	£2.95
2114	200ns	£3.45
2708	450ns	£4.75
2114	450ns	£2.95
2716	5 volt	£7.95

Memorex Soft-sectored mini-discs for PET, TRS-80 etc. Supplied in FREE LIBRARY CASE, £19.95 per 100

Low Profile I.C. Sockets by 'Texas'  
Pins 8 14 16 18 20 22 24 28 40  
Pence 10 11 12 16 17 20 21 28 37  
Memory Upgrade Kits for Apple, 2020, TRS-80 etc: from £30, please phone. Quantity prices available on request. Government and Educational Orders welcome  
Trade accounts opened

All prices include VAT. Postage FREE on orders over £10, otherwise add 30p.  
Access & Barclaycard welcome

HAPPY MEMORIES, DEPT. W.W.  
GLADESTRY, KINGTON  
HEREFORDSHIRE HR5 3NY  
Tel. (054422) 618

INFRA COMPUTER COMPONENTS LIMITED

Pendorrice House  
7 Westfield Road  
Great Shelford  
Cambridge CB2 5JW  
Telephone: (0223) 841728/843953

EPROMS		MEMORIES	
1702A	£4.50	2114 450 ns	£2.10
2708K	£3.80	2114 200 ns	£2.80
2716K (+5v) 450ns	£5.50	4416 200 ns	£2.40
2532K	£15.00	4116 150 ns	£3.75
2732 Intal	£18.50		

SPECIAL OFFERS

2732	£14.50 each
6845	£9.80 each
6809	£11.50 each
6802	£8.65 each
4116 2 ns x 16	£38.00

LS SERIES PRICES SLASHED:  
SOME AT A GLANCE  
LS 245 = £1.70 each. LS 242 = £1.20 each  
LS 240 = £1.40 each LS 241 = £1.20 each  
LS 244 = £1.15 each LS 157 = 50p each

A WHOLE RANGE MORE ON TRADE REQUEST

Please add 50p postage and 15% VAT

WW — 027 FOR FURTHER DETAILS

IMMEDIATE DELIVERY ON ALL THESE INSTRUMENTS

PM5519 - THE BEST PATTERN GENERATOR IN THE WORLD



PM 5519I CTV pattern generator

- \* Over 20 colour and b/w test patterns carefully selected for maximum versatility
- \* RF signals available in bands I, III, IV and V
- \* Variable video output (with 1 volt fixed position)
- \* External video and sound modulation facility
- \* Composite sync output for triggering - includes the line frame and blanking pulses to the local TV standard

\* Versions available for non-British TV systems  
Reader inquiry number 220

PHILIPS CHOICE FOR SERVICE

A selection from the range of Philips instruments with wide service applications.

PM 5326 RF signal generator

- \* 100 kHz - 125 MHz in nine overlapping ranges
- \* Built-in 5 digit counter
- \* 50 mV RF output at 75Ω can be attenuated to over 100 dB
- \* Electronically stabilized output level
- \* Wobbulator facility

Reader inquiry number 221

PM 2517 digital multimeter

- \* Full four digits
- \* Choice of LED or LCD display
- \* True RMS AC readings



- \* Triggering from either channel or external input
- \* Auto TV triggering
- \* Same sensitivity on X and Y channels
- \* B-invert facility
- \* Full 8 x 10 cm screen

Reader inquiry number 223

PM 6667 and 6668 high resolution counters

- \* 1 GHz (PM 6668) or 120 MHz (PM 6667)
- \* Microprocessor control with built-in intelligence
- \* Auto triggering on all waveforms and duty cycles
- \* 15 mV RMS sensitivity
- \* High stability X-tal oscillators: 10<sup>-7</sup>/month
- \* Self-diagnosis routine
- \* Battery option

Readers inquiry number 224



- \* Autoranging with manual override
- \* Current up to 10 A
- \* Options include temperature and data hold probes.

Reader inquiry number 222

PM 3207 dual trace oscilloscope

- \* Ideal for service and general purpose applications
- \* 15 MHz/5mV



Test & Measuring Instruments

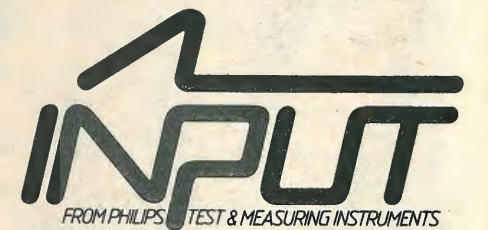
NEW PHILIPS CATALOGUE

The 300-page 1981 Philips Test and Measuring Instruments catalogue contains details of the company's full audio and video service equipment capability, as well as of its entire test and measuring range.

Send for your free copy by circling reader inquiry number 225.

WHERE TO BUY YOUR PHILIPS AUDIO AND VIDEO SERVICE EQUIPMENT

The entire range is available from the Philips Electronic Instruments Department (see address below) or from Philips Service Centres (phone 01-686 0505 for the address of your nearest branch). In addition, the PM 2517 and PM 3207 are available from Wessex Electronics Ltd, 114-116 North Street, Downend, Bristol BS16 5SE. Tel (0272) 571404.



Use the inquiry service to obtain information about the products which interest you. Alternatively, phone Cambridge (0223) 358866 and speak to our Commercial Office on extension 145 or 148.

Inquiry No	
PM 5519 CTV pattern generator	220
PM 5326 RF signal generator	221
PM 2517 digital multimeter	222
PM 3207 15 MHz oscilloscope	223
PM 6667/6668 frequency counters	224
1981 Test & Measuring catalogue	225

Pye Unicam Ltd  
Philips Electronic Instruments Dept  
York Street, Cambridge, CB1 2PX, England  
Tel: Cambridge (0223) 358866 Telex: 817331

PHILIPS



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.

WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW
WW	WW	WW

Name .....

Position in Company .....

Name of Company .....

Address .....

Telephone Number .....

Nature of Company/Business .....

No. of employees at this establishment .....

VALID FOR SIX MONTHS ONLY

Do not affix Postage Stamps if posted in Gt. Britain, Channel Islands or N. Ireland

Postage will be paid by Licensee

**BUSINESS REPLY SERVICE**  
Licence No. 12045

**WIRELESS WORLD,  
PRODUCT REPLY SERVICE,  
429 BRIGHTON ROAD,  
SOUTH CROYDON,  
SURREY  
CR2 9PS**

21

Wireless World Subscription Order Form Wireless World, February 1981 WW 162

<b>UK subscription rates</b>	<b>USA &amp; Canada subscription rates</b>
1 year: £10.00	1 year: \$33.80
Overseas 1 year: £13.00	

Please enter my subscription to Wireless World for 1 year

I enclose remittance value.....made payable to  
**IPC BUSINESS PRESS Ltd.**

Name.....

Address.....

CUT HERE

CUT HERE

CUT HERE

**OVERSEAS ADVERTISEMENT AGENTS**

**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), B212 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 Jr., The Farley Co., Suite 1548, 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 U.S.A. Telephone: (213) 821 8581 Telex: 18 - 1059.

Mr. Jack Mentel, The Farley Co., Suite 605, Ranna Building, Cleveland, Ohio 4415 - Telephone: (216) 621 1919

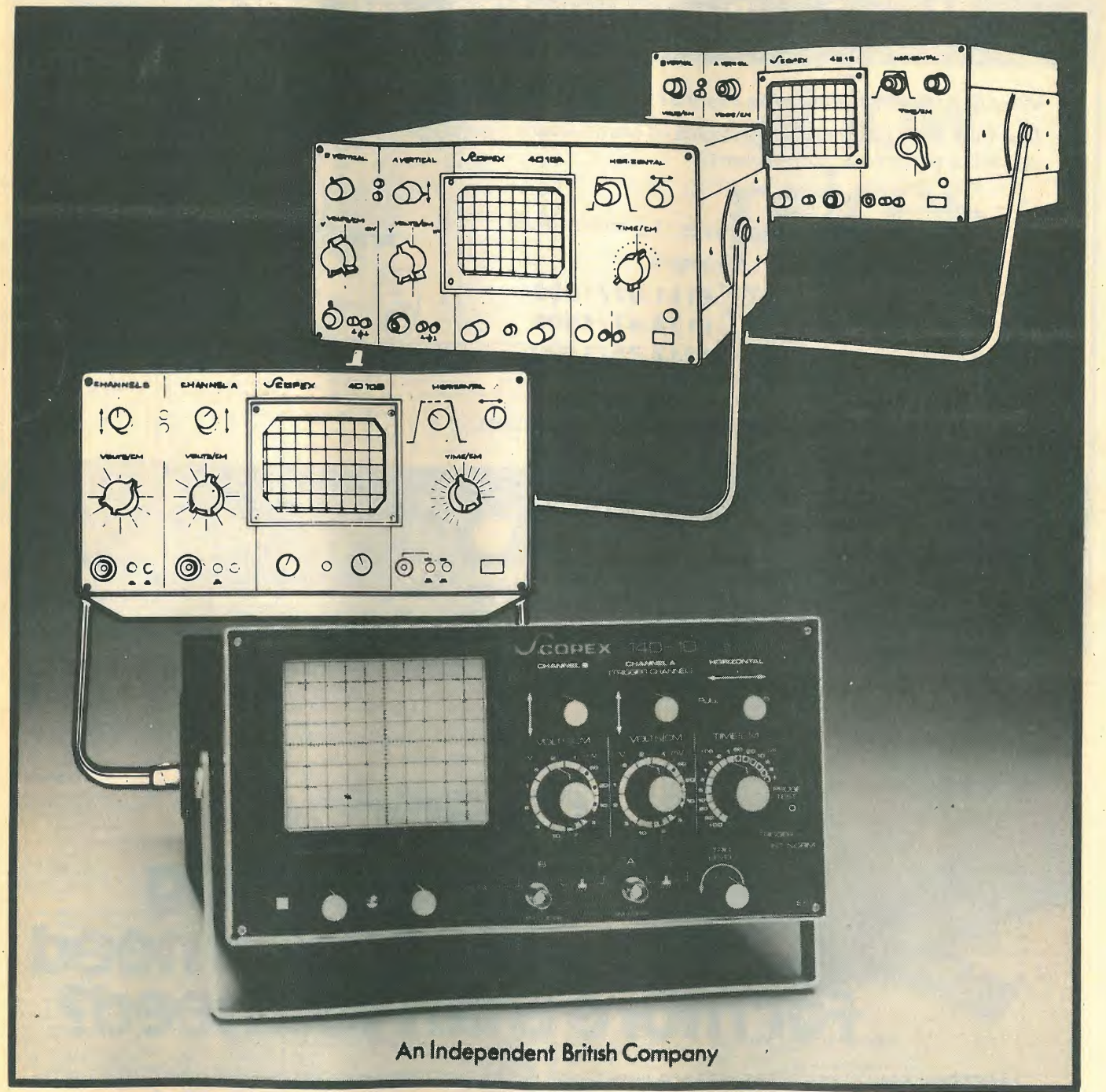
Mr. Ray Rickles, Ray Rickles & Co., P.O. Box 2008, Miami Beach, Florida 33140 - Telephone: (305) 532 7301

Mr. Jim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., Atlanta, Georgia 30305. Telephone: (404) 237 7432  
Mike Loughlin, IPC Business Press, 15055 Memorials, 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

# The New Scopex 14D-10



A dual trace 10MHz high sensitivity oscilloscope incorporating all the latest high technology developments to bring you all these outstanding features as standard. At a price of £230.00 + VAT. Ensures British leadership in the low cost high performance oscilloscope market.

- 10cm x 8cm display.
- 2mV sensitivity on both channels.
- Add and invert facility.
- Probe compensation.
- Push button X-Y.
- Trace locate.
- 10MHZ (-3dB) over full display.
- Complete with probes.

**SCOPEX**  
Pixmore Avenue, Letchworth,  
Herts SG6 1JJ. Tel: (04626) 72771.



I wish to pay by Barclaycard/Trust Card. Please charge to my account. My Barclaycard/Trust Card No. is

\_\_\_\_\_

Please send me full details of the 14D10.

Name.....

Company.....

Address.....

Tel:.....

WW - 058 FOR FURTHER DETAILS

# LOW COST — HIGH RESULTS

## Major Price Breakthrough on 6 MIL Pink Poly

Why pay more for the same results?

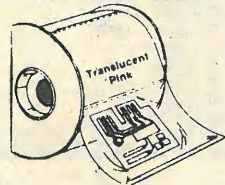
Our Pink Poly bags end the hazard of static spark discharge in handling and packaging of sensitive electronic components.

44 Standard sizes, 15 from Stock

Example:

8 x 8	£111.07/1000
10 x 12	£173.47/1000
13 x 16	£217.78/1000

VISIBLELY  
Anti-Static!



Other sizes and quantity prices available on request.

Send for full technical information to:

### CAVAC SYSTEMS LTD

Unit 15, Suttons Industrial Park London Road, Earley, Reading, RG6 1AZ

Tel: (0734) 669663 Telex: 849286



# LCR Bridges. Are you paying more than you need for more than you need?

For the vast majority of capacitance, resistance and inductance measurement applications, the Avo Measuring Bridge B151 is ideal. It can be used for production checking, fault finding, development engineering and much more.

True it may not be as elaborate as other measuring bridges, but it's not as pricey either.

The B151 offers accuracy at  $\pm 0.3\% \pm 1$  digit, a high level of sensitivity, a full range

of resistance measurement at dc and of R, L and C at 1kHz ac. There are also facilities for an external test frequency source and a polarizing voltage for capacitors.

Consider your requirements carefully. Match them against our data sheet. Call us today for your copy.



Avo Limited,  
Archcliffe Road, Dover, Kent CT17 9EN  
Telephone: 0304 202620. Telex: 96283

You'll never meet a better meter

A Member of the THORN EMI Group

WW — 080 FOR FURTHER DETAILS



**Freepost F**  
**Birmingham**  
**B19 1BR**  
**021-233-2400**

- FREEPOST ON ORDERS
- VAT INCLUSIVE PRICES
- ADD 30p P&P
- 24 HR PHONE ANSWERING SERVICE
- ACCESS
- VISA
- CASH
- CHEQUE

ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

C-MOS (BUFFERED)			LINEAR			SEMICONDUCTORS					
HEF4000	22	HEF4044	105	HEF4512	136	CA3046	84	IN914	5	BC182L	12
HEF4001	22	HEF4046	133	HEF4516	127	CA3080E	77	IN4001	5	BC184	11
HEF4002	22	HEF4047	109	HEF4517	478	CA3130E	99	IN4002	5	BC184L	12
HEF4006	119	HEF4049	57	HEF4518	118	CA3140E	48	IN4004	7	BC212	11
HEF4007	22	HEF4050	57	HEF4519	69	CA3188E	293	IN4007	9	BC212L	12
HEF4008	100	HEF4051	87	HEF4520	118	LM301AN	34	IN4148	4	BC214	11
HEF4011	22	HEF4052	90	HEF4521	235	LM339N	78	IN5402	15	BC214L	12
HEF4012	22	HEF4053	90	HEF4528	124	LM380N	104	2N2369	21	BC547	13
HEF4013	57	HEF4056	62	HEF4532	150	LM381AN	198	2N2646	46	BC548	11
HEF4014	105	HEF4067	475	HEF4534	638	LM3900N	75	2N2926G	13	BC549	12
HEF4015	100	HEF4068	22	HEF4539	138	MC3403P	156	2N3053	19	BC557	15
HEF4016	57	HEF4069	22	HEF4585	122	NE531	131	2N3054	55	BC558	15
HEF4017	100	HEF4070	22	HEF4724	214	NE53T	259	2N3055	55	BCY70	15
HEF4018	100	HEF4071	23	HEF40077	113	NE555N	28	2N3702	9	BCY71	15
HEF4019	58	HEF4072	23	HEF40098	92	NE556N	66	2N3704	9	BD131	39
HEF4020	112	HEF4073	23	HEF40106	78	NE566N	171	2N3705	10	BD132	39
HEF4021	107	HEF4075	23	HEF40160	149	NE570N	485	2N3773	297	BD139	39
HEF4022	103	HEF4076	130	HEF40192	149	NE571N	505	2N3819	22	BD140	39
HEF4023	22	HEF4077	22	PCA1326	146	2N3820	146	2N3820	39	BF190	333
HEF4024	76	HEF4078	23			2N3904	88	2N3904	9	BFX85	29
HEF4025	22	HEF4081	23			2N4557	39	8FY50	17	BSX20	21
HEF4026	244	HEF4082	23			2N5459	35	8FY51	17	CLB960	2850
HEF4027	57	HEF4083	80			40873	88	BFY90	33	TRP31	48
HEF4028	89	HEF4084	80	UA723CN	42	TL084CN	156	BC107	14	BSX20	21
HEF4029	113	HEF4093	63	UA7805CU	78	UA741CN	20	BC108	14	CLB960	2850
HEF4030	58	HEF4094	219	UA7812CU	78	UA741CT	47	BC109	14	TIP31	48
HEF4031	250	HEF4104	204	UA7815CU	78	Zener		BC109	14	TIP32	54
HEF4033	134	HEF4502	114	UA7912CU	97			BC109B	19	TIP41C	76
HEF4040	107	HEF4503	714	UA7915CU	97			BC109C	20	TIP42C	76
HEF4041	94	HEF4506	230	UA78180CS	38			BC148	10	TIP295S	75
HEF4042	83	HEF4510	135	UA78L12CS	38	8ZY88/BZx79		BC158	10	TIP305S	80
HEF4043	100	HEF4511	157	UA78L15CS	38	+ Voltage	9	BC177	17	TIS43	36

CAPACITORS			Polyester Radial Leads			Electrolytic Radial Leads		
Electrolytic Axial			Dipped Type, C280/352 Style			Cap 352		
-10% to +50% Tol.			Moulded Type, 10.2mm Pitch			Cap 380		
µF	V	16 26 40 63	µF	V	16 26 40 63	µF	V	16 26 36 40 50 63
1.0	1.6	9	0.001	7	9	0.01	7	9
2.2	2.7	9	0.0015	7	15	0.015	8	10
3.3	4.7	9	0.0022	6	22	0.022	8	11
4.7	6.8	9	0.0033	6	33	0.033	8	11
6.8	10	8	0.0047	6	47	0.047	8	11
10	15	8	0.0068	6	68	0.068	8	11
15	22	8	0.01	8	10	0.1	8	11
22	33	8	0.015	8	15	0.15	8	11
33	47	8	0.022	6	22	0.22	6	8
47	68	9	0.033	6	33	0.33	6	8
68	100	9	0.047	6	47	0.47	6	8
100	150	9	0.068	7	68	0.68	8	11
150	220	13				1.0	9	11
220	330	13				1.5	9	11
330	470	13				2.2	9	11
470	680	21				3.3	9	11
680	1000	26				4.7	9	11
1000	1500	35				6.8	9	11
1500	2200	42				10	9	11

RESISTORS		D.I.L. Sockets		Skeleton Presets, Miniature	
Carbon Film, Fixed		8 Pin Low Profile Socket Tin		0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	
0.25W, E24 Values 1R0-10M, 5% Tol. 2 each Res RD% + Value		14 Pin Low Profile Socket Tin		0.1W, E3 Values, 100R-1M, Lin. Horizontal Mount	
0.5W, E12 Values 1R0-4M7, 10% Tol. 3 each Res RD% + Value		16 Pin Low Profile Socket Tin		Skeleton Presets, Standard	
Metal Film, Fixed				0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	
0.5W, E24 Values, SRI-IM, 2% Tol. 8 each Res MR30 + Value				0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mount	
2.0W, E12 Values, 10R-27K, 5% Tol. 16 each Res PR52 + Value				Potentiometer, Rotary	
Metal Glaze, Fixed				0.5W, E3 Values, 1K-2M2 Lin. 39 Ro Pot Lin	
0.5W, E24 Values, IM-33M, 5% Tol. 16 each Res VR37 + Value				0.25W, E3 Values, 4K7-2M2 Log. 39 Ro Pot Log	
				Potentiometer, Slider	
				0.5W, E3 Values, 2K2-47K, Lin. 45 Si Pot Lin	
				0.25W, E3 Values, 1K0-1M0 Log. 45 Si Pot Log	

MAINS TRANSFORMERS		Plastic Boxes - Boss Industrial Mouldings	
6VA - Clamp Type Construction 235 each		Moulded Box and Close Fitting Flanged Lid	
Approx. 18% Regulation F.C. 54, H36, W35		ABS Box, C/W Brass Bushes, and Lid In Orange	
0.45V, 0.45V Secondaries Trans 6VA		L112 W82 D31 99	
0.5V, 0.6V		L150 W80 D50 131	
0.12V, 0.12V		L190 W110 D60 223	
0.15V, 0.15V		Plastic Boxes with Metal Lids	
0.20V, 0.20V		Recessed Top Box	
20VA - Clamp Type Construction 360 each		ABS Base, C/W Brass Bushes, In Orange	
Approx. 16% Regulation F.C. 70, H48, W46		1mm Aluminium Top Panel Finished Grey	
0.45V, 0.45V Secondaries Trans 20VA		L85 W56 D29 112	
0.6V, 0.6V		L111 W71 D42 150	
0.12V, 0.12V		L161 W96 D53 208	
0.15V, 0.15V		Diecast Boxes	
0.175V, 0.175V		Diecast Box and Flanged Lid	
0.20V, 0.20V		Aluminium Box and Lid in Natural Finish	
		L113 W83 D31 124	
		L152 W82 D50 215	
		L192 W113 D61 334	

VERO ELECTRONICS PRODUCTS		SWITCHES	
2.5" x 5", 1" pitch Veroboard 71		Miniature Toggle - Honeywell	
3.75" x 5", 1" pitch Veroboard 79		SPDT	
2.5" x 1", 1" pitch Veroboard (S) 85/Pack		SPDT C/OH	
3.75" x 5", 1" pitch Plain Board 68		SPDT Double Bias To Centre	
5.82" x 2.9", 1" pitch V-Q DIP Board 135		DPDT	
Spot Face Cutter 107		DPDT C/OH	
Pin Insertion Tool for .040 type pin 147		Miniature Push - C & K	
DS Pins .040 (100) 44/Pack		SP Push To Make, Momentary	
SS Pins .040 (100) 44/Pack		SP Push To Break, Momentary	
Verovire Kit (1-pan, 2-wire, 25-comb) 454/Kit			
Verovire Combs (25) 109/Pack			
Verovire Wire (2) 109/Pack			

GMT ELECTRONICS PROJECTS		KIT		BUILT UP	
FREE-STANDING COMPLETE TELETEXT UNIT - FULL SPEC		£199-90		£275-00	
TELETEXT DECODER BOARD + REMOTE HAND CONTROL		£135-90		£160-00	
TELETEXT COMPATIBLE TUNER AND P.S.U.		£ 46-90		£ 57-00	
TELETEXT COMPATIBLE PAL ENCODER + MODULATOR		£ 22-90		£ 35-00	
F. E. T. OUTPUT 100W MONO POWER AMPLIFIER MODULE		£ 27-50		£ 35-00	
X-BAND DOPPLER RADAR ALARM MODULE - MARK II		£ 35-90		£ 44-00	
ONE AMP P.S.U. MODULE (SPECIFY 5 OR 12 VOLTS)		£ 7-50		£ 10-00	
SIMULATED INERTIA MODEL TRAIN CONTROLLER		£ 22-50		£ 35-00	
SIMULATED INERTIA SLOT RACER CONTROLLER		£ 27-50		£ 40-00	
MODEL TRAIN STEAM SOUND SIMULATOR MODULE		£ N/A		£ 5-00	

WW — 078 FOR FURTHER DETAILS

# EPROM Erasure at low prices.

Chiptech ultraviolet erasers have been designed primarily for economy in situations that have a low throughput.

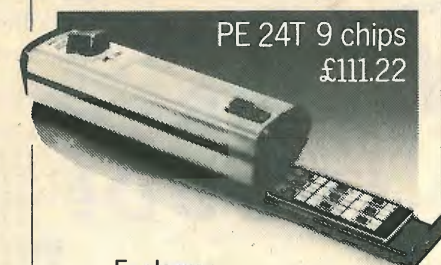
Although low cost, they are also the fastest and most efficient erasers of their size.

All models are fitted with 600-hour UV tubes, safety interlocks and housed in gold anodised aluminium casings.

PE 14 6 chips £56.00  
PE 14T 6 chips £76.58



prices exclude delivery and VAT



PE 24T 9 chips  
£111.22

For larger systems users, model PE 24T has a double tube construction and automatic shut-off with 60 minute timer.

## Chiptech Limited

Chiptech Limited,  
Tewin Court, Welwyn Garden City,  
Herts. AL7 1AU  
Tel (07073) 32140. Telex 8953451

WW — 081 FOR FURTHER DETAILS

**B. BAMBER ELECTRONICS** Dept. WW, 5 STATION ROAD, LITTLEPORT, CAMBS, CB6 1QE  
Telephone: ELY (0353) 860185 (2 lines) Tuesday to Saturday

Two new high-performance mobiles at very competitive prices. The C-7800 for 70cm operation, is fully synthesised with five memories, two-speed scan from mic etc, etc, and the C-8800 is the matching unit with the same features covering the 2m band in 5KHz or 25KHz steps

**C-7800 £275 inc VAT**  
**C-8800 £250 inc VAT**



**C-8800**



**PX402** 13.8V DC 3 amp continuous 4 amp max fully stabilised power supply with overload protection £19.95 plus VAT. P & P £2.00.

**RADIO TELEPHONE EQUIPMENT**

TRADE PRICE LIST

**PYE OLYMPIC M201** high band AM multi-channel sets complete but less loudspeakers and mikes. Few only  
**£100 each + VAT**

**PYE PFS U.H.F.** hand portable complete with leather case but less batteries  
**Only £40 each + VAT**

**PYE PF2 U8 T** band ideal for 70cm. These sets are in as new condition. Complete with mike, battery and aerial  
**£80 each + VAT**

**PYE U.H.F. PAGERS.** PG3U. Used condition less batteries, few only  
**£40 each + VAT**

**PYE MF5AM MOTOPHONES.** Low band, sets complete and in good condition  
**£45 each + VAT**

**PYE POCKETPHONE.** Base station F450, complete less mike  
**£45 each + VAT**

**PYE REPORTER MF8AM.** High band sets complete but less cradles, few only  
**£150 each + VAT**

**PYE RTC** Controller units for remotely controlling V.H.F. or U.H.F. fixed stations, radio telephones, overland lines  
**£20 each + VAT**

**PYE WESTMINSTER W15AM.** High band and low band available. Sets complete and in good condition but are less speakers, mikes, cradles, and L.T. leads (sets only)  
**£70 each + VAT**

**PYE BASE STATION F.27. LOW AND HIGH BAND.** Few only  
**£75 each + VAT**

**PYE BASE STATION F30AM.** Low and high band with and without T/T. Prices from  
**£220 each + VAT**

**PYE CAMBRIDGE AM108.** (boot mount) low band 12.5 KHz sets only no control gear. Good condition  
**£20 each + VAT**

**F30 AM** spares: Mod trans  
**£3.00 each**  
Mains trans **£5.00 each** 80 + 40 uf  
**PYE PC1** PC 906 A controllers  
**£150.00 + VAT**  
**PYE PC1** controllers from  
**£50.00 + VAT**  
**PYE F30 FM** low band. Local control, mint condition  
**£400.00 + VAT**

**PYE AC 15 PV** Mains power unit for W15AM good condition, only  
**£50.00 + VAT**

**PYE T412** U.H.F. base station, one only  
**£250 + VAT**

**PYE T150** High band FM transmitter  
**£100 + VAT**

**PYE F460/470** U.H.F. base stations from  
**£150 + VAT**

**PYE CAMBRIDGE AM 108** high band boot mount sets complete, less control gear  
**£20 each + VAT**

**PYE CAMBRIDGE AM10 D** low band dash mount, fair condition  
**£35.00 each + VAT**

**CARRIAGE ON R/T EQUIPMENT MOBILES** £2.00 EACH / S £15.00 EACH.

**XTALS** 10.7 MHz HC6U Type. Large range in stock  
**£2 each + VAT**

**IC AUDIO AMP P.C.B.** output 2 watts into 3 ohm speaker. 12 volts D.C. supply. Size approx 5 1/2" x 1 1/4" x 1" high with integral heat sink, complete with circuits  
**£2.00 + VAT**

**NICAD CHARGER CONVERTER P.C.B.** (Low power inverter). Size 4" x 1 1/4" x 1" high 12vdc supply, 60v dc output through pot on P.C.B. for charging portable batteries from mobile supply. Only needs an BFY50/51/52 or similar transistor which can be mounted direct on to P.C.B. pins on the board fitted with star-type heatsink (not supplied)  
**£2.00 + VAT**

**10.7 MHz x TAL FILTERS** (2.4 KHz Bandwidth). Low imp type carrier and unwanted sideband rejection min -40dB (needs 10.68835 and 10.70165 XTALS for USB/LSB not supplied). Size approx 2" x 1" x 1"  
**£10.00 + VAT**

**LOW PASS FILTERS** (low imp type). 2.9 Hz. Small metal encapsulation. Size 1 1/2" x 3/4" x 3/4"  
**75p each + VAT**

**XTALS FOR TV SYNC. GEN.** 20.25 KHz for 405 lines, B7G glass type  
**£2.00 + VAT**

**TV OFF AIR RECEIVER KIT.** Contains Mullard ELC 1043/05 tuner unit, aerial socket, I.F. amp module, detector module and sound coil. Supplied with circuit diagram. Ex-brand new equipment  
**£10.00 + VAT**

**WIRE WOUND RESISTORS** 330 ohm 5 watt 5% vertical mounting, flame proof, 100 for only  
**£1.00 + VAT**

**WIRE WOUND RESISTORS** 5K1 7 watt 5% vertical mounting, flame proof 150 for only  
**£1.50 + VAT**

**TWIN MAINS LEAD** 2 x 0.5mm white 100 metres  
**£6.00 + VAT**

**WIRE WOUND RESISTORS** 2R7 10 watt 10% horizontal mounting, flame proof, 80 for only  
**£1.00 + VAT**

**CARBON FILM RESISTORS.** 1/2 watt, 8% on bandolier 18 ohm and 330 ohm available only  
**£1.00 per 500 + VAT**

**SKELETON PRESETS,** standard type 10K  
**£5.00 per 1,000 + VAT**

**GOULD POWER SUPPLY** type MMG5-5 5v at 5A output, 110v and 240v ac input, brand new  
**£25 each + VAT**

**REDWING REFRIGERATED MILK CABINET** and dispenser takes 3 x 2p could be used for soft drinks  
**£25.00 + VAT Buyer collects**

**GEC PORTABLE TV** Featherlite LOPT and scan coils, large quantity available, any sensible offers, all brand new.

**BARRY MOUNT** shock absorbing machine mounts type GBC-2030-T6, brand new. Size 3" x 3" x 1 1/2" high  
**4 for £5 + VAT**

**TERMS OF BUSINESS:** Cheques or P.O. with order, made payable to B. Bamber Electronics, or phone your Access or Barclaycard No. Please add 15% VAT on all goods advertised after adding postage as applicable.

**CARRIAGE:** Orders under £5 nett invoice add 75p. Orders over £5 but less than £20 add 50p. Orders over £20 at cost. Callers welcome. Tues.-Sat. 9.30 a.m.-5.30 p.m.

WW - 079 FOR FURTHER DETAILS

**TELEVISION SOUND IS GOOD!**

Yes it's true — but you'll need to listen through a Minim Television Sound Tuner to be convinced. Music, wildlife, even the news suddenly comes to life when you can hear all the detail that you expect from High Fidelity equipment. Connect the Minim Television Sound Tuner to the amplifier or music centre or listen directly on headphones so as not to disturb others.

Further information will only cost you 12p — stamp out poor television sound!

Name .....

Address .....

Minim Audio Limited, Lent Rise Road, Burnham Slough SL1 7NY. Tel: Burnham 63724  
**MINIM AUDIO**  
make a note of our name!

**SWITCHCRAFT** **XLR CONNECTORS**

Line Female A3F .....	£1.07	Chassis Female D3F .....	£1.34
Line Male A3M .....	£0.93	Chassis Male D3M .....	£0.71

4, 5 and 6 pin versions and large selection audio adaptors available

**NEUTRIK** **XLR CONNECTORS**

Latchless Chassis Female NC3-FZ .....	£0.67	Latchless Chassis Male NC3-MZ .....	£0.59
PCB Mounting Chassis Female NC3-FD .....	£1.12	PCB Mounting Chassis Male NC3-MD .....	£0.95

Please specify horizontal or vertical mounting PCB format.

**BELCLERE AUDIO TRANSFORMERS**

EN6422 Ratio 1 + 1:2 + 2. Freq. 40Hz-35KHz. PCB Mount. PRI 150/6000, sec. 600/2.4K0  
**£2.90**

EN6423 Ratio 1 + 1:6.45 + 6.45. Freq. 40Hz-25KHz. PCB Mount. PRI 150/6000, sec. 6.25K/25K0  
**£2.90**

SKT-723 MuMetal Screening can, 39dB reduction 50Hz ext. field  
**£0.95**

Trade enquiries welcome; quantity discounts available. All prices subject to VAT. Call, write or phone. Min. order £10. Please add £1 postage. Access, Amex, Barclaycard.

**KELSEY ACOUSTICS LTD.**  
28 POWIS TERRACE, LONDON W11 1JH  
01-727 1046

WW-013 FOR FURTHER DETAILS

**Codespeed Electronics**

P.O. BOX 23, 34 SEAFIELD ROAD, COPNOR, PORTSMOUTH, HANTS. PO3 5BJ

New, full spec. devices

**SIMULATED LASER CANNON** for spaceman toy, LED on moulded 6in. lead with mini jack plug. Fits socket on Sound Effects Module. Only 18p each.

**SOUND EFFECTS MODULE.** Brand new, designed for "Spaceman" toy. Gives 5 audio/visual programs. Requires 8 ohm speaker (not supplied). 85p. Cat. No. 108.

**GIANT LED DISPLAY.** Common cathode, non-multiplexed super 4 digit LED clock display. Lots of other uses too. Only £3.95 each. Cat. No. 204.

**DIGITAL MULTIMETER CHIP.** Builds into high accuracy dvm or panel meter. Requires additional circuitry. With data and circuit. MMS330. Only £3.25. Cat. No. 404.

**DIGITAL ALARM CLOCK MODULE.** Complete with giant 0.7in. LED display. Add transformer and switches for complete clock. With data. Only £4.99. Cat. No. 205.

**MINI 8 DIGIT LED DISPLAY.** 8 digit, 7 segment calculator style display. Common cathode, multiplexed, with 0.1 in. high digits 80p each. Cat. No. 312.

**20 KEY KEYBOARDS.** Calculator keyboards, excellent key action. 20 keys per boards. 2 keyboards for 80p. Cat. No. 101.

**DIGITAL ALARM CLOCK CHIP.** MMS316 alarm clock chip. With data £2.35. Cat. No. 203.

Untested Items

**FLOURESCENT CALCULATORS.** Manufacturers rejects. Most repairable but no guarantees. 10 function with full memory. With repairing calculator info. £2.25. Cat. No. 107.

Post and Packing please add 40p. (Overseas orders add £1)

**VAT** Please add 15% to the total cost of your order (including post and packing).

Lots more goodies in our catalogue, send medium-sized s.a.s. for your FREE copy. Satisfaction guaranteed on all items or full cash refunded.

- ORDER BY POST OR TELEPHONE WITH BARCLAYCARD/ACCESS
- ELECTRONIC TEST EQUIPMENT SPECIALISTS
- ALL PRICES INCLUDE VAT

**AUDIO ELECTRONICS**

- ALL MODELS ON DISPLAY
- RETAIL - MAIL ORDER - EXPORT - INDUSTRIAL
- OPEN SIX DAYS A WEEK
- CALL IN AND SEE FOR YOURSELF

ALL PRICES INCLUDE VAT

**SCOPES** A range of Scopes in stock from 5mHZ Single Trace to 50mHZ Dualtrace. Mains and Battery/Mains portables. Many on demonstration.

**SINGLE TRACE** (UK c/p etc £2.50)

Hm 307-3 10mHZ, 5mV, 6 x 7 cm display plus component test  
**£170.00**

CO1303D 5mHZ, 10mHZ, 7 x 7 cm display  
**£109.25**

SC110 10mHZ Battery portable, 10mV 3.2 x 2.6cm display (Optional case £8.80, Nicads £7.95 Mains unit £4)  
**£156.00**

\*LBO12A 10mHZ 10mV, 5" display  
**£195.00**

CS1559A 10mHZ 10mV, 5" display  
**£232.00**

\*V151 15mHZ 1mV 5" display  
**£241.50**

\*Price includes free Probe(s)

**OPTIONAL PROBES (ALL MODELS)**  
X1 £3.50, X10 £3.50, X100 £12.95, X1-X10 £10.95  
HAMEG • TRIO • SINCLAIR • LEADER • HITACHI

**DUAL TRACE** (UK c/p etc £3.50)

CS156A 10mHZ, 10mV 5" display  
**£267.00**

CS1575 5mHZ 1mV 5" display  
**£284.00**

Hm 312-8 20mHZ, 5mV 10cm display  
**£253.00**

CS1566A 20mHZ, 5mV, 5" display  
**£339.00**

\*LBO3085 70mHZ, 2mV, 5 x 6.3cm display. Battery/mains. Portable built in Nicads  
**£482.00**

HM412-4 20mHZ, 5mV, 8 x 10cm display plus Sweep Delay  
**£399.50**

CS1577A 35mHZ, 2mV, 5" display  
**£478.00**

CS1830 30mHZ, 2mV, 5" display plus sweep delay and delay line - new model  
**£569.00**

Hm 512-8 50mHZ, 5mV, 10 x 8cm display. Delay Sweep  
**£667.00**

\*LBO514 10mHZ, 1mV, (5mV) 5" display  
**£294.00**

\*V152 15mHZ, 1mV, 5" display  
**£326.00**

\*V302 30mHZ, 1mV, 5" display  
**£447.35**

\*V550 50mHZ, 1mV, 10 x 8cm Delay sweep + 3 channel display  
**£799.25**

**GENERATORS**

A range of Signal Generators to cover Audio, RF and Pulsing. Mains operated (TG series Battery).

RF SG402 100 KHZ 30mHZ with AM modulation  
**£68.00**

LSG16 100KHZ (300mHZ on Harmonics)  
**£63.25**

LSG231 100m HZ 1mHZ (adjustable) FM stereo generator, pilot and mod  
**£195.00**

**PULSE**

2001 1HZ 100KHZ (function)  
**£86.00**

TG105 5HZ 5mHZ  
**£92.50**

4001 0.5HZ 5mHZ  
**£105.00**

200P 0.00 2HZ 5.5mHZ  
**£253.00**

200SPC as 200P plus built-in freq. display/100mHZ counter  
**£437.00**

**AUDIO** (All sine/square)

AG202A 20HZ—200KHZ  
**£69.00**

LAG26 20HZ—200KHZ  
**£73.60**

AG203 10HZ—1mHZ sine/sq  
**£126.50**

LAG120A 10HZ—1mHZ  
**£146.00**

Also in stock range of Proto-board kits and breadboards.

(UK c/p £1.75)

LEADER • TRIO • NEWTRONICS • LEVELL

**PRO' MULTIMETERS**

(UK c/p £1.20)

M1200 100K/Volt 30 ranges plus AC/DC 15 amp  
**£67.00**

K1400 20K/Volt 23 range large scale  
**£79.95**

M1500 20K/Volt 42 range plus AC/DC 10 amp  
**£53.50**

K200 38 range FET 10m OHM input 20HZ to 30mHZ multimeter  
**£95.00**

**LOGIC PROBES/ MONITORS**

Logic probes indicating high/low, etc., states that scopes can miss. All circuit powered for all ICs.

LP3 50 MHz logic probe  
**£55.95**

LP1 10 MHz logic probe  
**£35.50**

LP2 1 MHz logic probe  
**£19.95**

LM1 Logic monitor  
**£33.00**

LDP076 50 MHz logic probe with case  
**£51.00**

**SWR/FS AND POWER METERS**

Range in stock covering up to 150mHZ and up to 1K watt power PL259 sockets. Also 250 uHz Grid Dipmeter.

SWR50 SWR/FS 3-150mHZ £9.50

SWR5 SWR/FS 3-150mHZ 200 watts  
**£13.95**

110 SWR/Power 1 1/2-144mHZ 0/10/100 watts  
**£11.50**

171 As 110 Twin meter plus E/S  
**£14.50**

Plus large range of BNC/PL259/ etc leads plus adaptors/connectors always in stock.

178 SWR/Power/FS 1 1/2-144mHZ 5-50 watt plus 25-40mHZ ac match  
**£16.60**

KDM6 Gnd Dip 1 1/2-250mHZ  
**£38.50**

**DIGITAL MULTIMETERS**

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors - some with optional Nicads. All supplied with batteries and leads.

**HAND HELD** (UK post etc 85p)

TM352 3 1/2 Digit LCD plus 10 ADC and Hfe checker  
**£54.95**

PDM35 3 1/2 Digit 16 range LED (no AC current)  
**£32.95**

ME502 3 1/2 Digit LED plus 10A DC and Hfe checker  
**£43.95**

LM2001 3 1/2 Digit LCD 2 amp AC/DC 0.1%  
**£51.70**

6200 3 1/2 Digit LCD 0.2A AC/DC. Auto range  
**£39.95**

6220 As 6200 plus 10A AC/DC  
**£49.95**

6100 As 6200 plus Cont. test/range hold  
**£59.95**

6110 As 6100 plus 10A AC/DC  
**£74.95**

**BENCH PORTABLES** (UK c/p £1)

DM235 3 1/2 Digit LED 21 ranges, 0.5% AC/DC 2A  
**£56.50**

DM350 3 1/2 Digit LED 34 ranges AC/DC 10A  
**£78.50**

TM353 3 1/2 Digit LCD AC/DC 2 amp  
**£86.50**

TM351 3 1/2 Digit LCD AC/DC 10 amp  
**£107.95**

LM100 3 1/2 Digit LCD AC/DC 2 amp  
**£86.50**

DM450 4 1/2 Digit LED 34 ranges AC/DC 10 amp  
**£107.95**

(DM series options. Carry case £8.50 NI-cads £7.95 Mains adaptor £4)

1503 4 1/2 Digit LCD 28 range AC/DC 10 amp includes mains adaptor  
**£159.85**

**FREQUENCY COUNTERS**

Portable and Bench LCD and LED Counters up to 600mHZ. Prices include batteries and leads.

**HAND HELD** (UK post etc 85p)

PFM200 20HZ to 200mHZ 8 Digit LED  
**£54.50**

MAX50 100HZ to 50mHZ 6 Digit LED  
**£61.00**

MAX550 30KHZ to 550mHZ 6 Digit LED  
**£106.00**

**BENCH PORTABLES** (UK c/p £1)

MAX100 8 Digit LED 5HZ to 100mHZ  
**£89.00**

TF200 8 Digit LCD 10HZ to 200mHZ  
**£158.95**

7010A 9 Digit LED 10HZ to 600mHZ  
**£169.00**

TP800 600mHZ Pre-Scaler for TF200  
**£41.00**

200SPC 6 Digit 100MHz LED built into 0.002HZ to 5.5 MHz Pulse Generator  
**£437.00**

CSC • SINCLAIR • OPTOELECTRONICS • NEWTRONICS

**CLAMP METERS/ INSULATION TESTERS** (All multirange except K2303)

K2303 30 AMPS 500 VAC  
**£21.95**

3101 300 AMPS 600 VAC 1K OHM  
**£32.95**

K2903 300 AMPS 600VAC 2K OHM  
**£53.95**

K2903 900 AMPS 750 VAC 2K OHM  
**£77.95**

K3103 Transistorised insulation/continuity tester. 100 MEG. 600 VAC 0/2 1/2 K  
**£96.00**

M500 Insulation tester 100 MEG. 500 VOLT. 0/200 OHMS continuity  
**£67.50**

Also digital and DC types in stock

**MULTIMETERS** (UK c/p 75p)

KRT101 1K/Volt 10 range pocket  
**£4.50**

ATM1/LT1 1K/Volt 12 range pocket  
**£5.95**

NH55 2K/Volt 10 range pocket  
**£8.95**

ATI 2K/Volt 12 range pocket de luxe  
**£7.95**

NH56 20K/Volt 22 range pocket  
**£10.95**

YN360TR 20K/Volt 19 range pocket plus hfe test  
**£13.95**

AT1020 20K/Volt 19 range de luxe plus hfe test  
**£16.95**

7081 50K/Volt 36 range plus 10 amp DC  
**£19.85**

TMK500 30K/Volt 23 range plus 12A DC/Cont. test  
**£21.50**

AT20 20K/Volt 21 range de luxe plus 10A DC and 5KV DC  
**£21.95**

AT205 50K/Volt 21 range de luxe plus 10A DC  
**£24.95**

7080 20K/Volt 26 range large scale, 10A DC plus 5KV AC/DC  
**£26.95**

AT2050 50K/Volt 18 range de luxe plus hfe test  
**£28.50**

AT210 100K/Volt 21 range de luxe 12A AC/DC  
**£29.95**

360TR 100K/Volt 23 range plus hfe checker and AC/DC 10 amps  
**£34.95**

**CHOOSE FROM UK'S LARGEST SELECTION TV GENERATORS**

LCG-393V PAL 8VHF 6 patts  
**£137.00**

SCG-392U  
**£137.00**

PAL B UHF 15 patts  
**£217.00**

Stockists of electronic equipment, speakers/kits, PA equipment plus huge range of accessories • UK carriage/packing as indicated • Export - prices on request • All prices correct at 1.1.81 E & OE • All prices include VAT

**AUDIO ELECTRONICS** Cubegate Limited  
301 EDGWARE ROAD, LONDON, W2 1BN, ENGLAND. TELEPHONE 01-724 3564

OPEN SIX DAYS A WEEK

**FREE CATALOGUE!**

Send large SAE (17 1/2p UK) Schools, Companies, etc. free on request.

Barclaycard, Access, American Express logos.

WW-051 FOR FURTHER DETAILS

# Appointments

Advertisements accepted up to 12 noon Monday, 2nd February, for March issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £12.00 per single col. centimetre (min. 3cm).  
 LINE advertisements (run on): £2.00 per line, minimum three lines.  
 BOX NUMBERS: £1 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.  
 PHONE: Eddie Farrell, 01-661 3500, Ext. 8158.  
 Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.



## ELECTRONIC OPPORTUNITIES £5,000-£15,000

Microprocessors — Minicomputers — Digital —  
 Analogue — HF — VHF — UHF — Microwave

Where does your skill and interest lie?

Design? Test? Production? Sales? Service? Systems? or perhaps Software?

- \* Our clients are drawn from all sectors of industry: There are opportunities at all levels from Technician to Manager
- \* Most UK locations and some Overseas
- \* Make your first call count — Contact **MIKE GERNAT** on 076-384-676/7 (24 hours)

**ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LTD**  
 148-150 High Street, Barkway, Royston, Herts. SG8 8EG

(691)

## FIELD SERVICE ENGINEER

SOUTH-EAST



Instrumentation Laboratory (UK) Limited is a market leader in the design and manufacture of a range of sophisticated instruments used extensively in clinical and industrial laboratories.

We currently have a vacancy for a Field Service Engineer to cover the S.E. London, Kent, Surrey and Sussex area to install, maintain and repair our range of Biomedical instruments.

Applicants should have a sound background in electronics (C. & G. Final, H.N.C., etc.) and a flair for practical work. A knowledge of microprocessors or computer systems would be an advantage, although not essential. Comprehensive training will be given to the successful applicant on all aspects of the Company's products.

An attractive salary will be offered, together with considerable additional benefits, including Company car, pension scheme, and B.U.P.A. membership.

Applicants who reside within the area or are prepared to move should telephone or write to:

Miss S. M. Houghton  
**INSTRUMENTATION LABORATORY (UK) LIMITED**  
 Kelvin Close, Birchwood  
 Warrington, Cheshire, WA3 7PB  
 Tel: 0925 810141

(843)

## INSTRUCTORS

BROADCAST VTRs AND CAMERAS

The Group Training Department in Reading, England, need Instructors to specialise in training courses in broadcast television colour cameras and videotape recorders. Key requirements are:

- Experience as (or the personality to become) an expert instructor with the talent to impart technical information to engineers of many nationalities and varying depth of knowledge
- Practical experience of broadcast television or similar equipment
- Theoretical knowledge of advanced electronics (A knowledge of languages is an advantage)

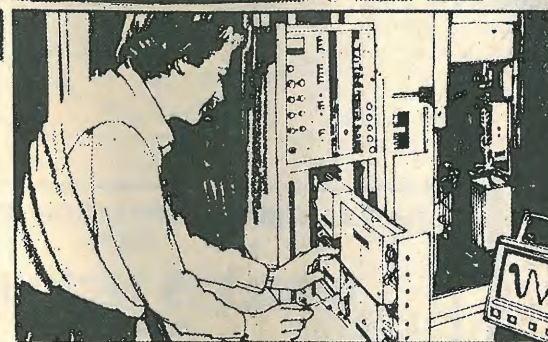
This is an opportunity to join a company in the forefront of technological innovation in a position offering overseas travel and contact with engineers of many countries. Attractive salary, pension, life assurance and permanent health schemes.

**AMPEX** Contact: Maureen Brake  
**AMPEX GREAT BRITAIN LTD.**  
 Acre Road, Reading, England  
 Tel: Reading (0734) 85200

## Broadcast Transmission Engineering

To ensure that broadcasting services are of consistently high quality provides far greater challenge than you may have realised. It is essential that viewers and listeners can rely on good television and radio reception and at the IBA we have a firm commitment to achieving these superior standards. We operate a

network of over 570 transmission stations nationwide, servicing Independent Television and Local Radio, services which we are steadily expanding. An increasing number of transmitting stations and the addition of the fourth channel all mean that ours is the environment to assure your future — we can offer both security and scope. We rely greatly on the skills of our highly trained engineers to maintain our Transmitting Stations so that they are reliable in operation and transmit services of the expected high standard.



## Trainee Broadcast Transmission Engineers

We have opportunities for Engineers (male or female) ideally at the HNC/HTC or equivalent level, to join us on our next training programme which commences this summer. Consideration will also be given to applicants at the City & Guilds Full Tech. to C.N.A.A. pass degree level. This comprehensive and carefully devised training, in collaboration with a leading Polytechnic, can result in a nationally recognised diploma, and is a step beyond traditional learning, combining theoretical and practical studies to give you a grounding in broadcast engineering that is second to none. During the course we will pay your fees, accommodation and meals and, if you do not already possess a full driving licence, we will arrange and pay for your instruction. Your salary, on satisfactory completion of the training, will be £6,752, and will then rise annually to £8,372 per

annum, with further progression to £9,433 per annum. Your initial salary while training will be in the range of £5,000/£5,400 per annum. Additionally we offer you a generous range of benefits, including free life assurance and personal accident schemes, a contributory pension scheme, generous relocation expenses and subsidised mortgage facilities. To receive our illustrated information package and application form please write to or telephone Mike Wright, Personnel Officer — Engineering Regions, IBA, Crawley Court, Winchester, Hants, SO21 2QA. Telephone Winchester 822574 or 822273.

**IBA** INDEPENDENT BROADCASTING AUTHORITY

(841)

## Electronics R&D

Join us in the forefront  
of technology

## Take your pick

HF-VHF-UHF-  
Microwave Optics & Acoustics

A challenging and full career in Government Service. Minimum qualification — HNC. Starting salary up to £6,737 (under review). Please apply for an application form to the Recruitment Officer (Dept. WW9) H.M. Government Communications Centre, Hanslope Park, Milton Keynes MK19 7BH.

(589)

### NATIONAL HEART AND CHEST HOSPITALS BROMPTON HOSPITAL

## Medical Physics Technician Grade IV or III (ELECTRONICS)

We require a technician to work in a small but busy department which provides a comprehensive medical electronics/physics service to this leading cardio-thoracic hospital.

Within the department the technician will be engaged mainly in electronics work but other scientific or engineering skills would be an advantage. In addition the technician will be required to work in clinical areas trouble shooting and advising staff in the use of equipment.

Salary within the range of £4931-£7277 inclusive depending on experience. For further information contact Chief Technician, Mr. P. Butler, ext. 4252.

For application forms and job description contact Personnel Manager, Miss J. A. Jenks, Brompton Hospital, Fulham Road, London, SW3. Tel. 01-352 8121, ext. 4357.

(900)

### CENTRAL SERVICES DEPARTMENT OF THE SCOTTISH OFFICE

## WIRELESS TECHNICIANS (£5,300-£7,060)

Applications are invited for three posts of Wireless Technician in the Central Services Department of the Scottish Office. The posts are based in Inverness, Edinburgh and Montreatmont, Forfar. Candidates must hold an Ordinary National Certificate in Electronic or Electrical Engineering or a City and Guilds of London Institute Certificate in an appropriate subject or a qualification of a higher or equivalent standard and have three years' appropriate experience.

A clean current driving licence and ability to drive private and commercial vehicles are essential.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref. PM(PTS) 2/13/80 (031-556 8400 Ext. 4317 or 5028).

Closing date for receipt of completed application forms is 11 February, 1981.

(897)

## APPOINTMENTS IN ELECTRONICS to £15,000

MICROPROCESSORS  
COMPUTERS - MEDICAL  
DATA COMMS - RADIO

Design, test, field and support engineers — for immediate action on salary and career advancement, please contact:

**Technomark**  
Engineering and Technical Recruitment  
11, Westbourne Grove  
London W2. 01-229 9239

(9257)

### PRESTON POLYTECHNIC School of Psychology

## SENIOR LABORATORY TECHNICIAN

required with an H.N.D. qualification in electronics or related discipline, and experience in the design and construction of novel pieces of apparatus would be useful.

Salary Scale: T3/4 £4581-£5784 (pay award pending).

36 1/4 hour week. Post superannuable. Application forms and further particulars are obtainable from the Personnel Officer, Preston Polytechnic, Corporation Street, Preston. Reference No. NT/80/81/49. Closing date: 14 days after appearance of advert.

(898)

### DIGITAL EXPERIENCE?

FIELD, SUPPORT AND PRODUCTION. VACANCIES IN COMPUTERS, NC, COMMS, MEDICAL, VIDEO, ETC.

Free registration ring 01-464 7714 ext. 502 24 HOURS

# LOGEX

ELECTRONICS RECRUITMENT SERVICE  
HIGH ROAD, LOUGHTON, ESSEX  
01-502 1589/01-464 7714. EXT. 502

(921)

### LOGIC ENGINEER

We wish to appoint a LOGIC ENGINEER to form a solid state repair department with practical experience of fault finding on microprocessor controlled logic and TV monitors.

The position offers interesting and varied work in the leisure field with good prospects for the right person, who would also enjoy the benefits of a good salary plus company car.

Please write or telephone for an application form to:

Miss D. Stith  
Tavern Automatics  
22-24 Bromell's Road  
Clapham, London, SW4  
Telephone: 01-720 1127

(885)

## Sony Broadcast success story means even more career opportunities!

Tremendous growth and success has created the need for even more first class staff for one of the world's leaders in professional television broadcast equipment.

During 1981 some 60 to 70 jobs must be filled, most of which are available now and based at our European Headquarters at Basingstoke, plus several more in other parts of our marketing territory.

*If you like the thought of enjoying the success of world leadership then write in strict confidence to Barry White, Personnel Manager, Sony Broadcast, now! And please don't forget the c.v.*

### Regional Sales Manager - Southern Europe

Reporting to the General Manager, Sales, the successful candidate for this substantial assignment will probably be a qualified television engineer with several years experience in Sales, Marketing and allied areas of commercial activity.

Working from the Basingstoke H.Q. the position offers extensive travel in the Southern European territory. A knowledge of at least one European language apart from English is desirable. This position offers the opportunity for significant career development as part of a talented and highly motivated team.

### Sales Manager - Africa

This is a challenging position for an experienced sales engineer or sales manager with a good knowledge of the radio and TV broadcast industry. Knowledge of the African market or other overseas sales territories is highly desirable. The successful candidate, who will be based in Basingstoke, will be expected to spend a substantial part of the time travelling in the territory. The high degree of initiative and self-motivation demanded by this job will be reflected in an above-average salary.

### Sales Engineer

We require competent engineers who are experienced in video cameras and/or VTR's to supplement our sales force. A number of vacancies exist in this area, some calling for extensive overseas travel. Successful candidates are likely to be in the age range 25-30 and should be highly motivated and able to work on their own initiative. Experience in selling or dealing with customers would be an advantage but the main requirements are a pleasant personality and ability to get along with people. The salaries will be above average and even better for those willing to travel frequently to West Africa and the Middle East.

### Senior Proposals Engineer

Reporting to the Sales Operations Manager. The successful applicant will have a technical background in television engineering preferably in the broadcast industry. He will be required to understand individual equipment as well as overall broadcast systems and will enjoy working with the minimum of supervision, often under pressure.

The work will include the assessment of customer's specifications and the preparation of the company's response to both the technical and commercial conditions. A knowledge of foreign languages would be useful although not essential.

### Assistant Product Managers and Product Engineers

We have vacancies for Assistant Product Managers and Product Engineers in each of our four equipment groups: TBC and Editing Systems, Cameras, 1 inch VTR's and U-matic VTR's.

Candidates for the Assistant Manager posts will ideally be graduate engineers with some years of experience in video technology, whereas applicants for the Product Engineers vacancies will probably be less experienced. However, at both levels we are willing to consider the right kind of experience in lieu of formal qualifications.

Successful candidates will receive suitable in-house training to enable them to provide technical product support both within Sony Broadcast and externally to customers.

### Lecturer

The successful candidate would conduct theoretical and practical training courses on our major products, be able to write circuit descriptions and produce training manuals with lucid block diagrams.



# SONY Broadcast

Ideally, candidates should have in-depth experience of video tape recorders, digital circuits and a practical up-to-date knowledge of the broadcast industry, especially measurement techniques. In addition it is essential that he or she can present ideas clearly and answer the most difficult and unexpected questions. Knowledge, or an ability to master the techniques of video cameras, digital audio equipment and the application of microprocessors to broadcast equipment will be an advantage, although we are prepared to provide the necessary additional training. Promising young graduates will be considered.

### R & D Engineers

Sony is now established as the world leader in digital video recording technology. Development is still in the formative stages but rapidly progressing to the new era of the 'All Digital Studio'. The R & D Section is involved in long term investigations into the application of high speed digital techniques to video processing, and in conventional product design. Being part of an international R & D team, the successful applicant may expect occasional opportunities for overseas travel. Applications are invited from engineers offering experience in high speed digital processing or video engineering. Alternatively, a well qualified recent graduate could be considered.

### Project Engineers

For our young and enthusiastic Special Projects Team. They will be involved in the design, manufacture and commissioning of static and mobile television systems, and in modifications and accessories. The successful applicant will have a thorough knowledge of sound and television principles. Ideally he or she should also have experience in operational television or its allied manufacturing industry.

### QA Technician

Candidates should be experienced in the repair of modern television equipment and also be familiar with digital circuitry. Activities will include the testing and commissioning of advanced broadcast television equipment. A relevant HNC level qualification is desirable.

### Service Engineers

Two openings exist, one at a more senior level, for qualified engineers with broadcast television engineering experience in operations and maintenance. The positions will entail responsibility for the repair and test of sophisticated broadcast television equipment, together with minor development work. Some travel within the UK and overseas is anticipated. Candidates for the senior appointment will have had several years experience working in a broadcast environment or for a television broadcast equipment manufacturer, during which time he or she will have worked on VTR and camera equipment. The second position should appeal to engineers with less experience who are now seeking a progressive environment.

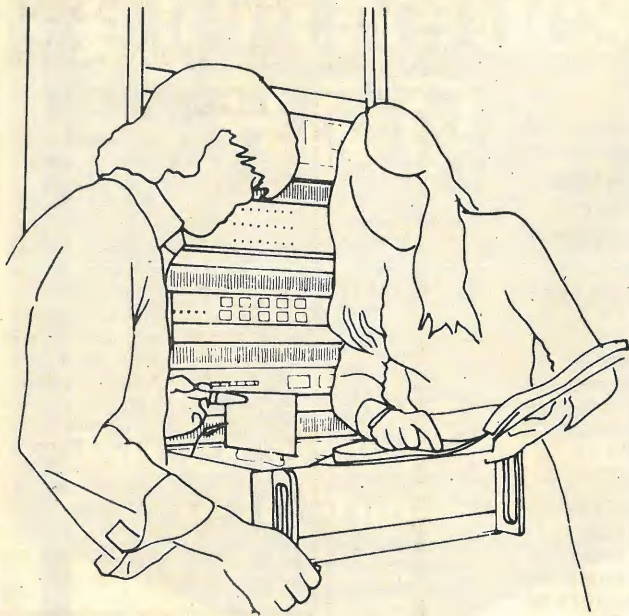
### Sony Broadcast Ltd.

City Wall House  
Basing View, Basingstoke  
Hampshire RG21 2LA  
United Kingdom

(844)



# 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 £3,500- £4,500- £5,500- over  
 £4,500 £5,500 £6,500 £6,500  
     
 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

**marconi instruments**

A GEC MARCONI ELECTRONICS COMPANY (9200)

Area Department of Medical Physics and Clinical Engineering have the following vacancies:

## Medical Physics Technician III/IV

(Clinical Measurements)  
Ref: MPT CM

Applications are invited from suitably qualified persons for the above post based at the Leicester Royal Infirmary.

Duties will consist of providing technical assistance throughout the full range of activities of this section of the department including

- i) Ophthalmic Electrodiagnosis
- ii) Audiometric Electrodiagnosis
- iii) Blood flow studies
- iv) Urodynamic measurements

For appointment at Grade III, 3 years' experience is required in at least two of the above categories, preferably i) and ii).

Further information may be obtained by telephone (Mr. S. Bentley) Leicester 541414, ext. 489.

## Medical Physics Technician III/IV

(Electronics Servicing)  
Ref: MPT ES

Applications are invited from suitably qualified persons for the above post. The successful applicant will join the servicing section of the Medical Physics Department and will complete a team of five technicians responsible for the repair and maintenance of a wide range of electro-medical equipment throughout the Leicestershire Area.

For further information contact Mr. R. V. Foxon on Leicester 541414, ext. 467.

Candidates for both posts should possess O.N.C./H.N.C. (or equivalent) in a relevant subject. For appointment at Grade IV experience, whilst desirable, is not essential as in post training will be provided.

Salary scales: IV £4404-£5790  
III £5223-£6750

New entrants to the N.H.S. will normally commence on the minimum point.

Application forms are available from the Personnel Department, The Leicester Royal Infirmary, Infirmary Square, Leicester, LE1 5WW. Telephone Leicester 541414, ext. 5137/8.

Please quote the relevant reference when applying.

Closing date for applications: February 4, 1981.



## Leicestershire Health Service

(899)

LEICESTERSHIRE AREA HEALTH AUTHORITY (TEACHING)

### ENGINEER FOR VIDEO COMPANY

We are a fast expanding professional video company dealing with a range of specialist products. Currently we require staff with electronics knowledge to act as service/installation engineers and sales engineers.

Previous knowledge of the video/TV industry is not essential but a good grounding in electronics is required plus a willingness to travel throughout Europe occasionally. Salary negotiable.

Contact: Peter Rowse at Polar Video Ltd., 38-38 Hanway Street, London W1P 9DE. Phone: 01-631 4080. (846)

**TEST AND COMMISSIONING ENGINEERS.** We urgently require engineers to work on our latest range of Numerically Controlled Machine Tools. Suitable applicants should be fully conversant with T.T.L. and CMOS Logic and have had some experience with Micro Processors. Salary, Attendance Bonus, Sick Pay and Subsidised Canteen. For details and application form, contact Brian Warner, Toolmasters Controls Ltd., Perimeter Road, Woodley, Reading, Berks. Telephone: 0734-691919. (857)

**TESTERS, TEST TECHNICIANS, TEST ENGINEERS.** Earn what you're really worth in London working for a World Leader in Radio & Telecommunications. Phone Len Porter on 01-874 7281, or write: REDIFON TELECOMMUNICATIONS Ltd., Broomhill Road, Wandsworth, London, SW18. (9856)

### RADIO SYSTEMS PLANNING ENGINEERS

Salary c £8,500

IAL, based near Heathrow, has a vacancy for a Systems Planning Engineer. Applicants must be suitably qualified and experienced in radio system planning, survey and customer liaison.

Salary dependent upon experience and qualifications. Benefits include relocation expenses, pension scheme and four weeks' leave, plus other amenities.

Phone or contact Harry Turner, IAL, Aeradio House, Hayes Road, Southall, Middlesex. Tel. 01-574 5134, quoting ref. K/001. (845)

### TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone: 01-906 0251 (8994)

SITUATIONS VACANT

# Telecommunications Manager Sudan

KENANA SUGAR COMPANY LIMITED, in which the Sudan Government is a major shareholder, is developing Africa's largest sugar estate, including a sugar factory and refinery, on the White Nile some 200 miles south of Khartoum. The company has recently installed a VHF radio system (RCA) with over 300 mobile sets, 18 base stations and 10 channels. Other equipment includes UHF systems and HF with FSK for teleprinter communications. A contract for a microwave and multiplex estate telephone system (1,000 line exchange and 8 PABXs) will be let shortly.

A Telecommunications Manager is required to control the Communications Division employing 40 people. He will be responsible for maintaining and servicing the equipment and will work closely with the company's consultants throughout the installation period.

An electrical/electronic engineering qualification at least to HNC level, management competence and a minimum of seven years' experience maintaining telecommunication/telephone equipment as specified are essential.

A highly competitive salary will be negotiated plus 15% end of contract gratuity, discretionary bonus and education allowances (where applicable). 60 days' annual leave, passages paid. Free air conditioned accommodation, services and medical attention. Sports and club facilities.

Please send relevant details - in confidence - to R. M. Cooper ref. ZH.60661. Further information will be sent.



United Kingdom Australasia Benelux  
Canada France Germany Ireland  
Italy Scandinavia South Africa  
Switzerland U.S.A.

**Management Selection Limited**  
International Management Consultants  
474 Royal Exchange Manchester M2 7EJ (842)

## LECTURER GRADE II/SENIOR LECTURER IN ELECTRICAL/ELECTRONIC ENGINEERING (6012-£10,539 (Bar)-£11,295)

Candidates will be concerned with the teaching of:

- a) Electrical/Electronic Engineering in Mechanical and Production Engineering diploma and degree courses or
- b) Electronics or
- c) General Electrical and Electronic Engineering

Relevant industrial experience with an appreciation and/or experience of computer engineering to some branch of electrical/electronic engineering, desirable.

Further details and form of application from The Assistant Director (Administration), Trent Polytechnic, Burton Street, Nottingham, NG1 4BU. Forms to be returned as soon as possible. (903)

**TRENT POLYTECHNIC NOTTINGHAM**

**UNIVERSITY OF BRISTOL**  
Applications are invited for a post as  
**ELECTRONICS TECHNICIAN**  
in the Electronics Laboratory of the Department of Physics at the University of Bristol. The person appointed will work as a member of a group which is responsible for the design, construction and maintenance of electronic equipment used by the research groups and the teaching laboratories in the department. The appointment will be made at a level up to, and including, Grade 5 with a starting salary in the range £4306 to £6129. Grading according to skills, qualifications and experience. Applications, giving full details, should be sent to Dr. R. R. Hillier, Department of Physics, University of Bristol, before 30th January, 1981. (895)

**COMPETENT PART-TIME HOME WORKERS** required for PCB assembly. Initially, work will be limited, but will expand. Good rates and confidentiality assured. Write, giving telephone number/experience, to Box No. 893. (893)

**TECHNICIAN**  
Grade 6  
(Salary scale £6020-£7191 increasing to £6532-£7802 on 1.7.81) required to provide wide-ranging electronic support; maintain and repair sophisticated and complex equipment; design, construct and commission equipment, etc. Applications stating qualifications, age and present salary, and giving the names and addresses of two referees to the Administrator, Department of Metallurgy and Science of Materials, Parks Road, Oxford OX1 3PH. (901)

**WARWICKSHIRE COUNTY COUNCIL COUNTY ENGINEER'S DEPARTMENT**

## SALE OF USED MOBILE RADIO EQUIPMENT

The following Used Mobile Radio equipment is for sale by tender:

- (1) Base station complete.
- (2) 42 transistorised mobile Trans/Receivers Lowband.
- (3) 36 Valved mobile Trans/Receivers Lowband.
- (4) Plus many other items.

Tender documents and appointment to view may be obtained from Mr. T. Inkester, County Engineer's Department, Warwickshire County Council, P.O. Box 50, Shire Hall, Warwick CV34 4RJ. (Telephone Warwick 43431, extension 2373) and tenders should be returned by not later than Monday, 16th March, 1981.

John W. M. Vallis, County Engineer, Shire Hall, Warwick. (902)

## ENJOY WORKING WITH PEOPLE? CRAFT INSTRUCTOR

Salary: £4437-£5808 p.a. incl. Michael Flanders Centre Church Road, Acton London, W3

A person with enthusiasm and initiative required to provide instruction and stimulation for physically handicapped and elderly people at this 75-place day centre. Knowledge of basic electronics and other forms of suitable arts/crafts/social activities would be useful. The initial appointment will be on a temporary basis until September, 1981.

For further information contact Neville Davenport on 01-993 1054.

Application form from the Personnel Office, Room A202, Town Hall Annex, Ealing W5 2BY. Tel. 01-599 2424 Ext. 3350.

Out of hours ansaphone 01-840 1995. Please quote reference No. 416SS. Closing date: 30.1.81. (896)

**ARTICLES FOR SALE**  
**CLEARANCE PARCELS:** Transistors, resistors, boards, hardware, 10lbs only £5.80; 1,000 Resistors £4.25, 500 Capacitors £3.75, BC 108, BC 171, BC 204, BC 230, 2N 5081, CV7497 Transistors, 10-70p, 100-£5.80, 2N 3055, 10 for £3.50. S.a.e. lists: W.V.E. (3), 15 High Street, Lydney, Glos. (444)

**PROFESSIONAL NAB tapes.** Scotch, Racal, etc. on 10 1/2 in spools. Ex local radio. Average of 2000ft of spliced SP tape. Metal spools: 1-9 £2.95 ea; 10+ £2.50 ea. Plastic spools: 1-9 £1.95 ea; 10+ £1.50 ea. P&P all orders £2. M. R. Gastern, 16 Elton Rd, Bishopston, Bristol. Tel. 0272 422532 evenings. (882)

SITUATIONS VACANT

DATA COMMUNICATIONS ENGINEERS RURAL OXON

c£8,000

Our client enjoys a reputation for innovative design in the field of Data Communications and has recently become the U.K. distributor for an International world leader in modems. With many excellent products "in the pipeline" an exciting expansion programme has been planned for the 1980's...

PRE-PRODUCTION ENGINEER

Aged 28-40 with an Electronics degree you will need to demonstrate a high level of practical expertise in new product development.

This key position requires a person with the ability to put theoretical ideas into practical, economical production and involves a great deal of liaison with management at all levels. Design or user know-how of modems, line drivers or data communications would be a distinct advantage...

For the successful applicants the rewards will be high, not only in the attractive package and relocation expenses, but also in the opportunities that exist for personal career development in a rapidly expanding company which is geared to extensive, controlled growth in a buoyant market.

Applicants, Male or Female, should telephone Ken Hoare on 021-643 5231 or write to: Gresham Executive Appointments, 5th Floor, New Street Chambers, 67a New Street, Birmingham.

Gresham Executive Appointments

TECHNICAL SUPPORT ENGINEER

This new position will ideally suit an experienced engineer used to acting as a technical co-ordinator between the customer and the company. The successful candidate will act as a link-up to all depts and will carry out a troubleshooting role with the end-user.

This diverse role calls for an engineer to co-ordinate the field service function, provide technical specifications and service manuals for company products, in-house and end-user technical troubleshooting as well as a back up to the marketing function. Hence appreciation of user problems in the data communications-computer data link field would be a great asset.

SITUATIONS VACANT

Electronic Engineers - What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES, 12 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 39388



Please send me a TJB Appointments Registration form:

Name .....

Address .....

(9238)

ARTICLES FOR SALE

EXCLUSIVE OFFER

Table with columns: Ref, Ht, width, Depth, Price. Lists rack mounting cabinets with various specifications and prices.

AUDIO AND INSTRUMENTATION TAPE RECORDER-REPRODUCERS

- List of audio and instrumentation tape recorder-reproducers including Ampex PR104, Ampex FR1300, etc.

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 MOD quality

- List of various electronic equipment including Racal RA 117, Lask Stereo 20 Amplifiers, etc.

ARTICLES FOR SALE

With 38 years' experience in the design and manufacturing of several hundred thousand transformers we can supply:

AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES

Microphone transformers (all types), Microphone Splitter/Combiner, transformers. Input and Output transformers. Direct Injection transformers for Guitars. Multi-Secondary output transformers. Bridging transformers. Line transformers. Line transformers to G.P.O. Isolating Test Specification Tapped impedance matching transformers. Gramophone Pickup transformers. Audio Mixing Desk transformers (all types). Miniature transformers. Microminiature transformers for PCB mounting. Experimental transformers. Ultra low frequency transformers. Ultra linear and other transformers for Valve Amplifiers up to 500 watts. Inductive Loop Transformers. Smoothing Chokes. Filter inductors. Amplifier to 100 volt line transformers (from a few watts up to 1000 watts). 100 volt line transformers to speakers. Speaker matching transformers (all powers). Column Loudspeaker transformers up to 300 watts or more.

We can design for RECORDING QUALITY, STUDIO QUALITY, HI-FI QUALITY, OR P.A. QUALITY. OUR PRICES ARE HIGHLY COMPETITIVE AND WE SUPPLY LARGE OR SMALL QUANTITIES AND EVEN SINGLE TRANSFORMERS. Many standard types are in stock and normal dispatch times are short and sensible.

OUR CLIENTS COVER A LARGE NUMBER OF BROADCASTING AUTHORITIES, MIXING DESK MANUFACTURERS, RECORDING STUDIOS, HI-FI ENTHUSIASTS, BAND GROUPS, AND PUBLIC ADDRESS FIRMS. Export is a speciality and we have overseas clients in the COMMONWEALTH E.E.C., USA, MIDDLE EAST etc.

Send for our questionnaire which, when completed, enables us to post quotation by return.

SOWTER TRANSFORMERS

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

(141)

ARTICLES FOR SALE

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, 1 Watt from 1 ohm to 10 meg. RESISTORS WIREWOUND. 1 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 (9461)

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)

BRAND NEW Ver0 packs 19in x 5.2in, complete with 5 "D" range cannon connectors on back panel, guides for 21 cards, and fully stabilised + 5 volt, 3 amp power supply. Complete unit £22, rack only £15, power supply only £10. VAT and 15 per cent extra. P&P £5 per unit. - Tel: (Rushmore Electronics Ltd) 0252 515373. (868)

THE SCIENTIFIC WIRE COMPANY

P.O. Box 30, London, E.4 01-531 1568

Table with columns: ENAMELLED COPPER WIRE, SWG, 1lb, 8oz, 4oz, 2oz. Lists prices for various wire gauges.

SILVER-PLATED COPPER WIRE 14 to 30 6.50 2.35 2.20 1.40

TINNED COPPER WIRE 14 to 30 3.85 2.36 1.34 0.90

Prices include P & P, VAT and Wire Data. Orders under £2 please add 20p. SAE for List. Dealer enquiries welcome.

GWM RADIO LTD, 40/42 Portland Road, Worthing, Sussex. Tel. 0903 34897. Surplus stocks bought and sold. Good selection of Pve, RT Equipment held. Communications receivers for callers. Many useful items in stock. No lists. 40ft masts £345. AV07 £32. (884)



CAPITAL APPOINTMENTS LTD.

THE UK'S No. 1 ELECTRONICS AGENCY

Design, Dev. and Test to £10,000 Ask for Brian Cornwell

SALES to £12,000 plus car Ask for Ken Sykes

FIELD SERVICE to £10,000 plus car Ask for Maurice Wayne

We have vacancies in ALL AREAS of the UK

Telephone: 01-637 5551 (3 lines)

CAPITAL HOUSE 29-30 WINDMILL STREET LONDON W1P 1HG TEL: 01-637 5551

COLOUR VIDEO AND ELECTRONICS ENGINEERS

Varied work in small experienced team operating broadcast quality studios/copying service, plus research and development.

SENIOR VIDEO ENGINEER

£7500-£8727

To run development/maintenance sub-section, supporting video player network, broadcast colour recorders, E.N.G. units, etc.

ELECTRONIC ENGINEER

£5952-£7212

Digital and analogue skills for new equipment development and some maintenance work.

Further details and application forms from the Personnel Officer, Brighton Polytechnic, Moulsecoombe, Brighton BN2 4AT. Tel. Brighton 693655 Ext. 2536. (847)

TOWERS' INTERNATIONAL MICROPROCESSOR SELECTOR

- List of microprocessor products including CP/M H/B with MP/M by R. Zaks, Optical Fibre Communication Systems by C. P. Sandbank, etc.

OPERATIONAL AMPLIFIERS

DESIGN OF TRANSISTOR CIRCUITS WITH EXPERIMENTS by Dr. K. A. Pullen Jr. Price: £9.15

DIGITAL ELECTRONICS FUNDAMENTAL CONCEPTS & APPL. by C. E. Strangio Price: £17.30

RADIO & TELEVISION SERVICING 1979/80 MODELS by R. N. Wainwright Price: £16.50

THE MODERN BOOK CO. Specialist in Scientific & Technical Books 19-21 PRAED STREET LONDON W2 1NP

Phone 402-9176 Closed Sat. 1 p.m. (8974)

MANUALS

We have a quantity of Technical Manuals and Periodicals of Electronic Equipment, not photostats, 1940 to 1960. British and American. No lists. Enquiries invited.

- List of manuals including Data Efficiency Resposloers 240v, Beiling Lee 100 Amp Interference Filter, etc.

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 (0202) 765051 (8981)

**ARTICLES FOR SALE**

**TELETEXT, TV SPARES & TEST EQUIPMENT.** TELETEXT. Latest MK2 external unit incl. Mullard Decoder 6101VML and infra-red remote control £258, p/p £2.50. Further details on request. Also MK1 external unit incl. Texas XM11 decoder, special offer price £168, p/p £2.50. Both kits incl. UHF modulator, and plug into TV set aerial socket. SPECIAL OFFER TEXAS XM11 Decoder, new and tested, limited quantity at 1/3 price, £85, p/p £1.40. Stab. power supply £50 for Teletext decoders, £5.80, p/p £1. For Teletext design XM11 inter-face unit, £1.80, p/p 80p. NEW SAW FILTER IF AMP PLUS TUNER complete & tested for sound & vision, £28.50, p/p £1. COLOUR BAR & CROSS HATCH GENERATOR KIT (MK4) PAL, UHF aerial input type 8 vertical colour bars. R-V, B-V, grey scale, etc. P/B control £35, Batt holders £1.50 or stab. mains power supply kit £4.80. De-luxe case £5.20 or alum. case £2.80, p/p £1.40. Built & tested in De-luxe case (battery) £50, p/p £1.50. CROSS HATCH KIT UHF aerial input type also gives peak white & black levels, batt. op. £11, p/p 45p. Add-on GREY SCALE KIT £2.90, p/p 35p. De-luxe case £5.20. UHF SIGNAL STRENGTH METER KIT £17.50. Alum. case £1.80. De-luxe case £5.20, p/p £1.40. CRT TEST & REACTIVATOR KIT for colour & mono £22.80, p/p £1.70. THORN 9000 Touch Tune Remote control receiver unit plus transmitter handset £16, p/p £1.40. THORN 9000 Fascia incl. channel select. indicator, set controls, speaker, £5.80, p/p £1.60. TV SOUND IF TRANSD. Tested, £6.80, p/p 85p. BUSH SURPLUS IF PANELS. A816 £1.80, TV312 (single I.C.) £5, Z718/BC6100 £5, A823 (Exp) £2.80, p/p 85p. BUSH Z718/BC6100 Line Time Base Panel Z904, incl. LOPT, EHT stick, Focus, etc., 18in or 22in, £15, p/p £1.60. BUSH 161 series TB panel A634 £3.80, p/p £1.20. DECCA colour TV Thyristor Power supply £3.80, p/p £1.40. GEC 2010 series TB panel £1, p/p 90p. GEC 2040 CDA panel £4.50, p/p £1.20. PHILIPS G6 S/S conv. panel £2.50, p/p £1.20. G8 Decoder panels for spares £1.80, p/p £1.20. G9 Signal panels for small spares £3.80, p/p £1.20. THORN 3500 Line TB panel £5, p/p £1.3000 ex-rental panels IF, VIDEO, DECODER, £5, p/p £1.20. 8300/8500 TB salv/spares £4.80, p/p £1. 9000 Line TB (incl. LOPT) salv/spares £7.50, p/p £1.60. COLOUR SCAN COILS (Mullard or Plessey) £6, p/p £1.80. Yoke £2.50, p/p £1. Blue Lat 75p, p/p 35p. Mono Scan Coils (Thorn, Philips, Pye) £2.80, p/p £1. VARICAP UHF TUNERS. Mullard U321 £7.80, ELC1043/05 £5.50. G.I. £3.50. Salv. (asstd) £1.50, p/p 45p. Varicap UHF/VHF ELC2000S £8.50. Bush (dual) £7.50, p/p 70p. TOUCH TUNE CONTROL units. Bush (6 pos) £4.50, p/p 80p. VARICAP CONTROL UNITS 3 pos. £1.20, 4 pos. £1.50, 5 pos. £1.80, 6 pos. £1.80, 8 pos. special offer £1, p/p 45p. UHF transd. Tuners (rotary) incl. s/m drive £2.50, 4 pos. P/B £2.50, 6 pos. P/B £4.20, p/p £1.20. (Special types available, details on request). DL50 Delay Line £2.50, p/p 50p. Large selection of LOPTs, Triplers, Mains Droppers, and other spares for popular makes of colour & mono receivers. PLEASE ADD 15% VAT TO ALL PRICES. — MANOR SUPPLIES, 172 WEST END LANE, WEST HAMPSTEAD, LONDON, N.W.6. SHOP PREMISES. Tel: 01-794 8751. Easily accessible W. Hampstead Jubilee Tube & Brit Rail N. London (Richmond-Broad St.) and St. Pancras-Bedford. Buses 28, 159, 2, 13. Callers welcome. Thousands of additional items not normally advertised available at shop premises. Open daily all week incl. Saturday (Thursday half day). MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON NW11 9HT. PLEASE ADD 15% VAT to all prices. (60)

**EURO CIRCUITS**  
Printed Circuit Boards — Master layouts — Photography — Legend printing — Roller tinning — Gold plating — Flexible films — Conventional fibre glass — No order too large or too small — Fast turnaround on prototypes. All or part service available NOW! (9630)

**EURO CIRCUITS TD.**  
Highfield House  
West Kingsdown  
Nr. Sevenoaks, Kent. WK2344

**PCB ASSEMBLY**  
Any quantity  
Wave soldering  
PCB manufacture  
Design service available  
Competitive Prices

**ENDEAN COMMUNICATIONS SERVICES**  
Bailys Mill, The Cliff  
Matlock, Derbyshire. Tel. 0629 4929 (849)

**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)

**TURN YOUR SURPLUS** Capacitors, transistors, etc. into cash. Contact COLES-HARDING & Co., 103 South Brink, Wisbech, Cambs. 0945-4188. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance. (9509)

**ELECTRONIC DESIGN SERVICES.** MICROPROCESSOR HARDWARE and SOFTWARE design facilities have now been added to our established expertise and comprehensive test facilities previously available to you for ANALOGUE and COMMUNICATIONS designs. — For fastest results please phone Mr. Anderson, Andertronics Ltd, Ridgeway, Hog's Back, Seale (nr. Farnham), Surrey. 02518-2639. (275)

**SHEET METAL WORK,** fine or general front panels chassis, covers, boxes, prototypes. 1 off or batch work, fast turnaround, 01-449 2695. M. Gear Ltd., 179A Victoria Road, New Barnet, Herts. (812)

**P.C.B. PROTOTYPE** and small batch production. Design layout, assembly and testing. Fast, reliable service. Wye Valley Electronics, 15 High St, Lydney, Glos. Tel: Dean (0594) 41267. (365)

**EPROM PROGRAMMING,** fastest, cheapest service. Single/triple rail: 2708/16/58/04; 2516/32/08. 1-5 off £3/1K or write for quotation. Petron Electronics, Courtlands Road, Newton Abbot, Devon. (854)

**ARTICLES FOR SALE**

**CRYSTAL for Scanner and Receiver**

10.7 MHz IF HC25/u  
£3.50/pcs. from stock or special order.  
We stock over 10,000 pieces.

Derungs ag  
Dübendorfstr. 335  
CH-8051 Zürich

Write for free documentation. (795)

**ENCAPSULATING,** coils, transformers, components, degassing, silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment low cost, used and new. Also for CRT regunning metalising. Research & Development. Barratts, Mayo Road, Croydon, CR0 2QP. 01-684 9917. (9678)

**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)

**SERVICES**

**Mayland Printed Circuit Board Co. Ltd.**  
4 The Drive, Mayland, Essex, CM3 6AB. Tel: 0621 741560

**PRICE LIST FOR CONVENTIONAL PCBs**  
Total cost = AxB or (AxB) + C or ((AxB) + C) x E or ((AxB) + C) x E + D, etc.

A) Area Charge	per sq. cm	Single sided	Double sided
Drilling charge	per sq. in.	£0.004	£0.008
Gold charge	per hole	£0.028	£0.082
Profile charge	per contact	£0.005	£0.005
	rectangle	£0.04	£0.06
	cuts out	Free	Free
		Costed individually	

(If no drilling required area charge doubled)

B) Number of PCBs	1	2-5	6-10	11-20	21-50	51-100
1 working day	6.6	3.57	3-4	N.A.	N.A.	N.A.
2 working days	3.03	1.79	1.70	1.61	N.A.	N.A.
3 working days	2.32	1.86	1.82	1.47	1.43	N.A.
4 working days	1.77	1.26	1.23	1.20	1.18	1.16
5 working days	1.61	1.18	1.18	1.18	1.07	1.12
2 weeks	1.58	1.18	1.18	1.13	1.06	1.03
4 weeks	1.58	1.14	1.12	1.10	1.03	1.00
8 weeks	1.44	1.06	1.06	1.02	1.00	1.00

N.B. Quantities greater than 100 are negotiated. N.A. = Not available

C) Silk screen £8 standing charge + 15p per print also add one working day.

D) Photographic charges Reductions film 1:1 per film £10.00 £5.00

E) Prototype add on 50% of the total cost. (Very fast turn around).

No quantities too small or too big. All boards are roller tinned. All prices exclude VAT (15%).  
Example of order: Eurocard size (100 x 160) mm, 100 holes, no legend, 20 off in two weeks.

Total cost	= £1.14 x 1.13	= £1.29 each
" "	= £1.29 x 20	= £25.76 for 20 off
" "	= £25.76 + £3.86	= £29.62 including VAT
" "	= £29.62 + Postage	

WE ARE ON CALL 24 HOURS A DAY AND 7 DAYS A WEEK  
IF WE ARE NOT AVAILABLE LEAVE YOUR NAME AND NUMBER (ANSWERPHONE) (852)

**CIRCOLEC**  
THE COMPLETE ELECTRONIC MANUFACTURING SERVICE

Let us realise all or any part of your project from prototypes to production, from artwork design and component sourcing, through assembly and test to final quality assurance, packing and delivery.

We also provide a test, repair and modification service to suit your individual requirement.

For competitive prices and fast turnaround contact:

**CIRCOLEC, 1 Franciscan Road, Tooting, S.W.17**  
Telephone: 01-767 1233 (544)

**SMALL BATCH PCBs** produced from your artwork. Also **DIALS, PANELS, LABELS.** Camera work undertaken. **FAST TURNAROUND.** — Details: Winston Promotions, 9 Hatton Place, London EC1N 8RV. Tel. 01-405 4127/0960. (9794)

**EQUIPMENT WANTED**

**TO ALL MANUFACTURERS AND WHOLESALERS 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 (9123)

**ARTICLES FOR SALE**

**FOR SALE**

**HP175A Scope 1750A dual trace plug-in, not working, but tube o.k. £99.**  
The following 175A plug-ins are offered in good working condition: 1715A 1-trace £19, 1754A 4-trace £75, 1781B Sweep Delay Gen. £39.

**MR TAYLOR**  
01-446 1381 Ext. 63 (894)

**RACAL SA505** frequency counter and manual Muirhead D890A decade oscillator and manual £110 pair. Thanet 0843 62952 evenings. (883)

**DESIGN AND DEVELOPMENT.** ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/small batch production. — **Adenmore Limited, Unit 103 Liscombe, Bracknell, Berks. Tel: Bracknell 52023. (856)**

**MISCELLANEOUS**

**RACAL COMMUNICATIONS RECEIVERS.** 5 — 30mc/s in 30 bands 1MHz wide. RA17 £150, RA17L £200. Or a few as new £250. RA117E £300, all air tested, supplied with full manual, dust covers, in fair condition, new metal housed case for sets £25. **RABA** SSB-LSB adaptors, new and boxed with manual, £75. **RAMD** used with manual, £75. **RA218** SSB-LSB adaptors and fine tune units for RA17 £85. **RA1217** transistor receiver and remote control unit (RTA2000). Can tune set over a long distance G.P.O. Phone wire, £250. Without A.T.U. or £450 with full manual.

**TEKTRONIX OSCILLOSCOPE, MAIN FRAMES.** 531 840, 535 645, 538 650, 534A 555, 545 650, 545B 655, 551 and power unit 655, 551 no P.U. £30, 555 and power unit £70, 585 plus 81 adaptor £90, 549 storage £325. **PLUG-IN UNITS.** B-D-E-G-H-K, all at £15 each; L £20; CA £25; M-R-Z £50 each. 1A1 £120, 1A2 £100, 1A4 £140. All above scopes and plug-ins have been tested, in fair working order and condition.

**MARCONI TF2333.** M.F. transmission measuring set, as new, £250.

**MARCONI TF801D/88.** £150.

**MARCONI R.F. RADIATION & POWER METER.** OA1430 (CT477), as new, in grey metal case with full manual, power meter FX range, 10mc/s to 10gc/s, complete with X-S-L band aerials, £50.

**COBSON CDU 160 OSCILLOSCOPE.** 25mc/s £150.

**MUIRHEAD FACSIMILE EQPT.** TX D 901 D/S £50. RX D900 D/S or P/D £75 each.

**WEATHER SATELLITE.** RX D900 S/1A or S/2A £125 each with manual.

**REDIFON TY11.** Transistor teleprinter terminal unit: 8000 ohms audio input. AC supply 100-240 AC, any speed from 0 to 100 + bauds, internal P.U. for teleprinter magnet coils, with circuit, tested, £25.

All items are bought direct from H.M. Government, being surplus expt. Price is ex-works. S.A.E. all enquiries. Phone for appointment for demonstration of any item. **JOHNS RADIO, 424 BRADFORD ROAD, BATLEY, YORKS. TEL: 0924 478169 (9.30 a.m.-1 p.m.). (848)**

**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)

**SMALL BATCH** productions wiring assembly to sample or drawings. Specialist in printed circuits assembly. Rock Electronics, 42 Bishopstield, Harlow, Essex 0279 33018. (9094)

**PRINTED CIRCUIT BOARDS.** Quick deliveries, competitive prices. Quotation on request, roller tinning, drilling, etc. Speciality small batches. Larger quantities available. Boardriven Ltd, Lancaster Road, Carnaby Industrial Estate, Bridlington, North Humberside, YO15 3QY. For the attention of Mr J. Harrison. Tel: (0262) 78788. (443)

**ELECTRONIC DESIGN SERVICE.** Immediate capacity available for circuit design and development work, PC artwork, etc. Small batch and prototype production welcome. — **E.P.D.S. Ltd., 93b King Street, MAIDSTONE, Kent. 0622-677916. (9667)**

**PCB ARTWORK DESIGN SERVICE** with component notation masters and assembly drawings. **PADS Electrical Ltd, 01-850 6516, 45 Southwood Road, New Eltham SE9. (7905)**

**PCB ASSEMBLY CAPACITY AVAILABLE**

Low or high volume, single or double sided, we specialise in flow line assembly.

Using the Zevatron flow soldering system and on line 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-contract assemblers and wirers to the Electronics Industry (9058)

**P.C.B. DESIGNS** on circuit diagrams, etc. Competitive hourly rates, quotes free, cheaper hourly rates for solder resists and legends. — Helstead Designs Ltd, Helstead. Tel: 0787-477408. (869)

**COMPARE** our charges, quality and turnaround for printed board artwork, assembly, test and prototype manufacture. Please phone Sharon Halfhide on Chelmsford 357935 or write to H.C.R. Artwork Designs, 1 Bankside, off New Street, Chelmsford, Essex. (557)

**TV LINE** output transformers. We manufacture most types. Return of post service. Barclaycard/Access. SAE all enquiries. Rewind service available. Papworth Transformers, 80 Merton High Street, London SW19 1BE. 01-540 3955. (892)

**BATCH PRODUCTION** wiring and assembly to sample or drawings. **McDeane Electricals, 19b Station Parade, Ealing Common, London, W5. Tel. 01-992 8976. (169)**

**MICROPROCESSOR DESIGN SERVICE**

Dept. of Industry Approval. Digital/ Analogue Circuitry and Software Instrumentation, Control, Data Logging: INTEL Specialisation. Prototypes, small batch and PCB layout facilities included.

**RED CLIFF MICROSYSTEMS**  
Sandown, I.W.  
Tel. (0983) 402856 (850)

**PRODUCT OR SYSTEM DEVELOPMENT.** Market survey, design, development, organisation of super cheap production, after sale service, one offs undertaken. Contact: The Park Electronics Co., Park View, Hayters Way, Alderholt, Fordingbridge, Hants SP6 3AX. Tel. (0425) 54282. (890)

**TAIWAN OFFER** PCBs design, manufacture, assembly and electronic components. Specialist in micro-processor boards, quick deliveries, lowest prices, reliable services, easy purchasing, small to large batches. Hu Mou Enterprises Co., Ltd., Room 3, 6th Floor, 306 Kuang Fu S. Rd., Taipei, Taiwan. Cable: Humou Taipei. Telex: 28564 Humou. (851)

**ARTICLES FOR SALE**

**PRINTED CIRCUITS.** Make your own simply, cheaply and quickly! Golden Fotolok Light Sensitive Lacquer — now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibre-glass Board approx. 1mm thick £1.75 sq. ft. Post/Packing 60. — White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall. (714)

**BATCH PRODUCTION**  
Wiring and assembly to sample or drawings.

**McDEANE ELECTRICALS LTD.**  
19b Station Parade  
Ealing Common, London, W.5  
Tel. 01-992 8976

**ARTICLES WANTED**

**WANTED**  
Test equipment, receivers, valves, transmitters, components, cable and electronic scrap, any quantity. Prompt service and cash. Member of A.R.R.A.

**M & B RADIO**  
86 Bishopsgate Street  
Leeds LS1 4BB  
0532-35649

**SPOT CASH**  
paid for all forms of electronics equipment and components.

**F.R.G. General Supplies**  
550 Kingston Road  
London SW20 8DR  
Tel: 01-404 5011  
Telex: 24224. Quote Ref. 3165 (8742)

**STORAGE SPACE** is expensive, why store redundant and obsolete equipment? For fast and efficient clearance of all test gear, power supplies, PC boards, components, etc., regardless of condition or quantities. Call 01-771 9413. (8209)

**WANTED** Tektronix 5000 series dual-beam mainframe oscilloscope, with or without 5A24N, 5B24N plug-ins. Details to Dr G. Duncan, 0603-56161 ext 2262. (853)

**CLASSIFIED ADVERTISEMENTS**  
**Use this Form for your Sales and Wants**

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

To "Wireless World" Classified Advertisement Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

NAME.....

ADDRESS.....

- Rate £2 PER LINE. Average six words per line. Minimum THREE lines.
- Name and address to be included in charge if used in advertisement.
- Box No. Allow two words plus £1.
- Cheques etc., payable to "Wireless World" and cross "& Co."


REMITTANCE VALUE..... ENCLOSED

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION..... NUMBER OF INSERTIONS.....

DT-400s are designed and manufactured by SAFGAN in UK

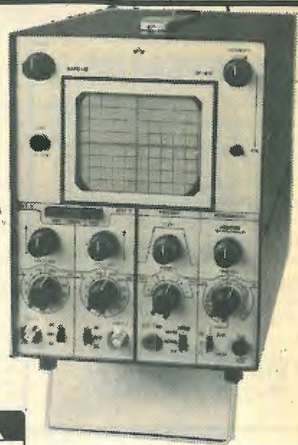
SAFGAN presents DT-400 series from £159 + V.A.T.

HIGH-QUALITY DUAL TRACE OSCILLOSCOPES A BRITISH PRODUCT EVERYONE CAN AFFORD

Model DT-410 DUAL TRACE 5mv/div 10MHz @ £159 + VAT
Model DT-412 DUAL TRACE 5mv/div 12MHz @ £172 + VAT
Model DT-415 DUAL TRACE 5mv/div 15MHz @ £185 + VAT

SPECIFICATION FOR ALL MODELS

- \* CH1, CH2; 5mv/div - 20v/div in 12 col 1-2-5-steps. Input impedance 1MΩ + 22pF
\* BANDWIDTH: 10MHz (DT-410), 12MHz (DT-412) 15MHz (DT-415)
\* TIME BASE: 0.5µs/div - 200ms/div in 18 cal steps
\* XY FACILITY: Matched Inputs X = CH1, Y = CH2



DT-400 Series



Orders to: SAFGAN ELECTRONICS LTD. (Goods + 15% + £3 p. & p.)
56 Bishop's Wood, St. John's, Woking, Surrey, GU21 3QB Tel: Woking 69560 or Woking 66836

WW-030 FOR FURTHER DETAILS

INDEX TO ADVERTISERS FEBRUARY

Appointments Vacant Advertisements appear on pages 118-127

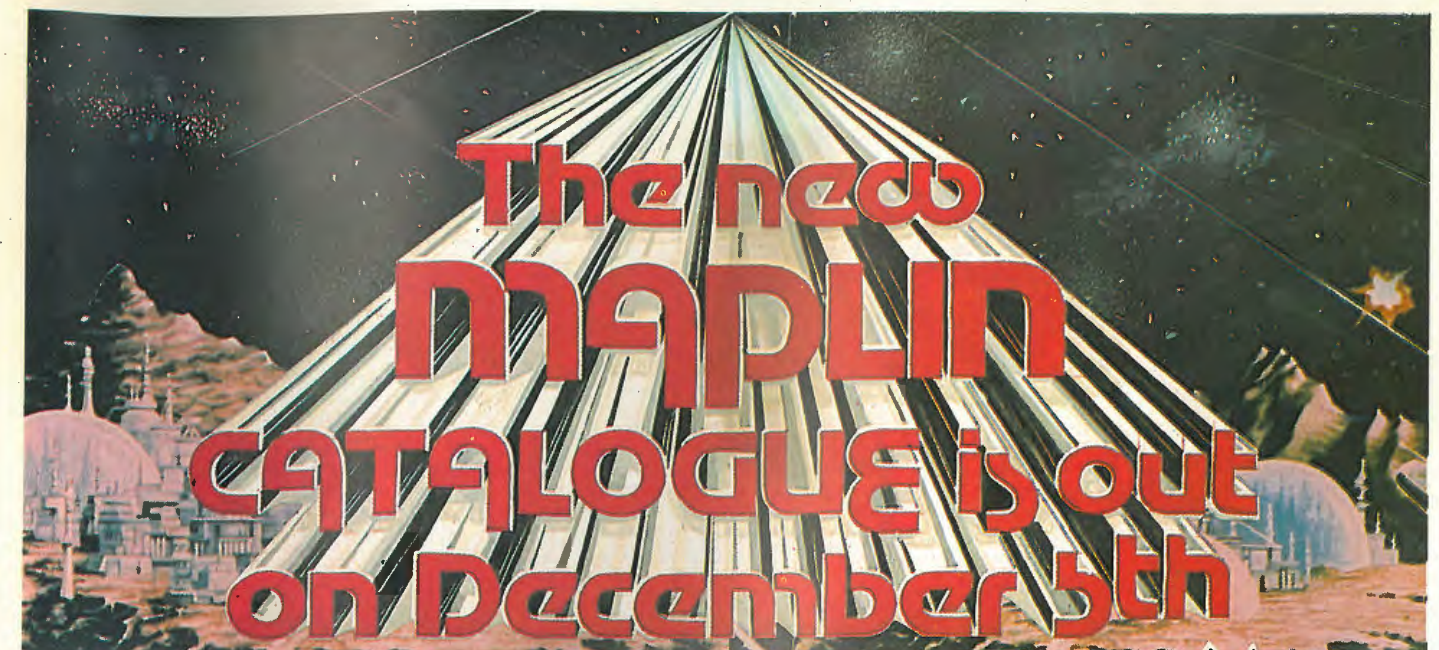
Table listing advertisers and their corresponding page numbers in the February issue.

OVERSEAS ADVERTISEMENT AGENTS:
Japan: Mr. Inatsuki, Trade Media - IBPA (Japan), B.212, Azabu Heights, 1-5-10 Roppongi, Minato-ku, Tokyo 106.
France & Belgium: Norbert Hellin, 50 Rue de Chemin Veat, F-9100, Boulogne, Paris.
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.

United States of America: Ray Barnes, IPC Business Press, 205 East 42nd Street, New York, NY 10017 - Telephone: (212) 867-2080. Telex: 238327.
Mr Jack Farley Jr., The Farley Co., Suite 1584, 35 East Wacker Drive, Chicago, Illinois 60601 - Telephone: (312) 63074.
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 2028, Miami Beach, Florida 33140 - Telephone (305) 532 7301.
Mr Tim Parks, Ray Rickles & Co., 3118 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.

Printed in Great Britain by QB Ltd., Sheepen Place, Colchester, and Published by the Proprietors IPC ELECTRICAL-ELECTRONIC PRESS LTD., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS, telephone 01-661 3500. Wireless World can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd, Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th floor, 111 Eighth Avenue, New York, N.Y. 10011.



The new MAPLIN CATALOGUE is out on December 5th

A massive new catalogue from Maplin that's bigger and better than ever before. If you ever buy electronic components this is the one catalogue you must not be without. Over 300 pages, it's a comprehensive guide to electronic components with thousands of photographs and illustrations and page after page of invaluable data. We stock just about every useful component you can think of. In fact, well over 5000 different lines, many of them hard to get from anywhere else. Hundreds and hundreds of fascinating new lines, more data, more pictures and a new layout to help you find things more quickly.



Maplin Electronic Supplies Ltd. All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR. Telephone: Southend (0702) 554155. Sales (0702) 552911. Shops: 159-161 King Street, Hammersmith, London W6. Telephone: (01) 748 0926. 284 London Road, Westcliff-on-Sea, Essex. Telephone: Southend (0702) 554000. Both shops closed Mondays.

On sale in all branches of W H Smith from Dec 5th price £1



PLUS LOW PRICES such as Resistors from 1p Multimeters from £4.25 Ni-Cads from £1.15 Stereo Headphones from £3.49 Radios from £2.95 Over 300 Books 21 Different ranges of capacitors, etc., etc., etc.

Post this coupon now for your copy of our 1981 catalogue price £1. Please send me a copy of your 320 page catalogue. I enclose £1 (Plus 25p p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the UK send £1.68 or 12 International Reply Coupons.

I enclose £1.25
Name \_\_\_\_\_
Address \_\_\_\_\_

WW-002 FOR FURTHER DETAILS



# Afterthought...or after thought?

When you think about the adverse effects of your tape head becoming magnetized, as it inevitably will – loss of high frequency response and undue background noise – the solution becomes obvious. Demagnetization.

The Bib Tape Head Demagnetizer is BSI approved, simple to use and suitable for both reel to reel and cassette machines. A probe is merely brought to within a few millimetres of the tape head and held there for about 3 seconds – so there is no risk of damaging the head itself. And, if

used regularly, you can be sure of getting the best possible reproduction from your tape machine.

Don't wait until you can actually hear the problem. Think about preventing it now with a Bib Tape Head Demagnetizer – part of the Bib Audiophile range of quality audio maintenance products. Displayed in leading department stores and specialist audio dealers, the Bib Audiophile Centre contains all you need to keep your audio equipment in peak condition. Ref. 90-AE. RRP £8.74 inc. VAT.



**Bib**<sup>®</sup>

*Audiophile Edition*

Bib Hi-Fi Accessories Ltd.,

Kelsey House, Wood Lane End, Hemel Hempstead, Hertfordshire. HP2 4RQ. Telephone: (0442) 61291 Telex: 826437

Bib Hi-Fi Accessories Inc. 1751 Jay Ell Drive, Richardson, Texas 75081 USA. Telephone (214) 238 1224 Telex 792451.

Bib Hi-Fi Accessories, 43 Birmingham Street, Alexandria, New South Wales, Australia 2015. Telephone 67 2750 Telex 20779.

WW-004 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)