Better headphone stereo

Interfacing the nanocomp

Technological choices for the UK
Autoranging r.f. millivoltmeter

- 10kHz to 1GHz +
- True r.m.s. or average responding
- Autoranging or manual
- LED range indication
- High sensitivity
- Linear dB scale
- Programmable

IEEE488 interface available.
Hold reading facility
Small size
Operates from a.c. mains or external d.c.
Low-power consumption

Details from...

Farnell

Farnell Instruments Limited, Wetherby, West Yorkshire LS22 4DH. Telephone (0937) 61961. Telex 557294 FARIST G

WW--001 FOR FURTHER DETAILS
**Front cover** is the microprocessor-controlled amateur transceiver featured in this issue by T. D. Forrester, photographed by Alan McFaden with special effects by Lasercolor.

**NEXT MONTH**

Morse decoding by micro computer, by J. P. Sargent, uses a 567 tone decoding and seven-bit clock to time incoming signals. Morse code is interfaced to a ZX81 via a p.i.o. chip. Machine code routines use this data to provide up to 9 lines of text.

Leading Japanese research engineer Y. Hirata, gives measurements of non-linearities in four p.c.m. processors and compares them with those from three analogue tape recorders.

Logic maps, by N. Darwood, gives the history of methods for showing logical truth — from 13th century Lull to present-day Karnaugh maps.

Picotutor-microprocessor assembly language trainer designed by Bob Coates of Nanocomp fame assumes no previous experience of microprocessors.

Current issue price £0.80, 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 £1.23, back issues (if available) £1.80, 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.

Telephone/Electricity 01-661 3500. Advertising 01-661 3130.

Telegrams: BISPRS G. Subscription rates: 1 year £14 UK and £17 outside UK. Student rates: 1 year £9.35 UK and £11.70 outside UK. Distribution: Oakfield House, Perymount Road, Haywards Heath, Sussex RH16 3DH. Telephone 0444 59186. Please notify a change of address.

USA: $39 surface mail, $98.30 airmail. US subscriptions from IPC B.P., Subscriptions Office, 205 E. 42nd Street, NY 10017.


---

<table>
<thead>
<tr>
<th>NOVEMBER 1982</th>
<th>VOL 88 NO 1562</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>WIRING TECHNOLOGY OF THE PAST</td>
</tr>
<tr>
<td>32</td>
<td>INTERFACING THE NANOCOMP</td>
</tr>
<tr>
<td>35</td>
<td>TWO-METRE TRANSCEIVER</td>
</tr>
<tr>
<td>39</td>
<td>BINAURAL RECORDINGS AND LOUDSPEAKERS</td>
</tr>
<tr>
<td>42</td>
<td>COMMUNICATIONS</td>
</tr>
<tr>
<td>44</td>
<td>ENGINEERING AND SOCIETY</td>
</tr>
<tr>
<td>46</td>
<td>BBC ENGINEERING — 1922 ONWARD</td>
</tr>
<tr>
<td>52</td>
<td>MEMORY SYSTEMS</td>
</tr>
<tr>
<td>55</td>
<td>CIRCUIT IDEAS</td>
</tr>
<tr>
<td>60</td>
<td>MODULAR PREAMPLIFIER</td>
</tr>
<tr>
<td>65</td>
<td>DIGITAL POLYPHASE SINEWAVES</td>
</tr>
<tr>
<td>66</td>
<td>LETTERS</td>
</tr>
<tr>
<td>70</td>
<td>DISC DRIVE CONTROLLERS</td>
</tr>
<tr>
<td>74</td>
<td>NEWS</td>
</tr>
<tr>
<td>78</td>
<td>PROGRAMMABLE GPIB TO SERIAL INTERFACE</td>
</tr>
<tr>
<td>81</td>
<td>SINGLE IC FSK MODEM/EVENTS</td>
</tr>
<tr>
<td>82</td>
<td>EPROM EMULATOR</td>
</tr>
<tr>
<td>85</td>
<td>NEW PRODUCTS</td>
</tr>
</tbody>
</table>

WIRELESS WORLD NOVEMBER 1982
Sowter Transformers

With 40 years' experience in the design and manufacture of several hundred thousand transformers we can supply.

AUDI0 FREQUENCY TRANSFORMERS OF EVERY TYPE YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES

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

We can design for RECORDING QUALITY, STUDIO QUALITY, HI-FI QUALITY OR P.A. QUALITY. OUR PRICES ARE HIGHLY COMPETITIVE AND WE SUPPLY LARGE OR SMALL QUANTITIES AND EVEN SINGLE TRANSFORMERS. Many standard types are in stock and normal 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 us your questionnaire which, when completed, enables us to post quotations by return.

E. A. Sowter Ltd.

Manufacturers and Designers

The Boat Yard, Cullingham Road, Ipswich IP1 2EG, Suffolk
P.O. Box 36, Ipswich, IP1 2EL, England
Phone: 0473 52794 and 0473 215390
Telex 987703 Sowter

WW - 024 FOR FURTHER DETAILS

MICRO-PROFESSOR

YOUR GUIDE TO THE WORLD OF MICROPROCESSORS

A low cost tool for learning, teaching & prototyping.

Micro-Professor is a low-cost Z80 based microcomputer which provides you with an interesting and inexpensive way to understand the world of microprocessors and utilise their unlimited potential.

Micro-Professor is a complete hardware and software system whose extensive manual gives you detailed schematics and examples of programme code. A superb learning development tool for students, hobbyists and microprocessor engineers, as well as an excellent teaching aid for instructors of electrical engineering and computer science courses.

Technical specification

Z80 CPU, 2K RAM, 2K monitor, 24 1/0 lines, LED display, cassette interface, CTC/PIO facility, 2.25" speaker, three manuals, 36 keyboard. Options include: EPROM board, speech board and printer board.

Please send or telephone for full details.

£79.95 + p&p

FLIGHT ELECTRONICS LTD, Flight House, Quayside Rd, Southampton, Hants SO2 4AD. Tel: (0703) 34003/27721. Telex: 477793.

Mail order only • Trade enquiries welcome • Bulk order discounts • Prices include VAT

WW - 022 FOR FURTHER DETAILS
Electronic Brokers is Europe's leading Second User Equipment Company. We carry large stocks of the very latest test equipment which is refurbished in our own service laboratories and calibrated to meet the manufacturer's sales specifications. When you buy used equipment from Electronic Brokers, it can be yours in just days. No waiting for manufacturers lengthy production schedules. All equipment is fully guaranteed.

ANALYSERS

Hewlett Packard
3506A Spectrum Analyzer 5Hz-50Hz
1411B 9526B 6555A 10kHz-18kHz
$2500.00
332A Distortion Meter 5Hz-600kHz
$345.00
B417A 6412A Network Analyser
$1195.00
Marcon
TF3311 Desorption Meter 20kHz - 200kHz
$475.00
Solatron
1260 Series 7070
$400.00
Tektronix
7055/1 G itemName
$713.00
50MHz, 5mV/pig. Input
$713.00
721 10kHz-1800MHz
$850.00
7L 1.2kHz 10Hz
$713.00
721 3kHz-1800MHz
$750.00
721 4kHz-18GHz
$750.00
BRIDGES

TF245/TF1246 G Meter 40kHz-50kHz
$575.00
TF131A 0.1 LCD Bridge
$775.00
TF2013 A LCD Bridge
$845.00
TF4500 Set of Test cables
$350.00
Behr & Schwarz
7221A LCD 0.1 %
$985.00
9906 Sound & Detector
$1485.00
FREQUENCY COUNTERS

Hewlett Packard
73241 S Digi 200MHz Unused
$200.00
TF3624 D Digi 500MHz
$200.00
Marconi
TF3643 B Digi 12-14GHz Unused
$375.00
TF3643 B Digi 200MHz Unused
$200.00
SVDM’s AND DDM’s

FC workplace
$900.00
5.1% Dig. DC only 1% repeatability, 5% ranges to 11.000Hz
$790.00
Phelps
PM 2283-01 LED 3% Digi DMM
$85.00
Solartron
7055 Microprocessor DMM, Scale Length 20.0000, A/D conv, resolution 1uV
$1520.00
OSCILLOSCOPES

Marconi
TF22131 + TK2214X Display and Memory
$550.00
Phelps
PM 2323 Dual Beam 10MHz
$495.00
PM 3234 Dual Beam Storage
$1750.00
7215A new CRT
$1750.00
PM 2344 50MHz 4 Channel Delay Test
$1550.00
Tektronix
475 Dual Trace 200MHz Portable
$2000.00
7313 100MHz Storage Marcon
$2250.00
7303 120MHz mainframe
$2200.00
5440 50MHz mainframe
$2000.00
5441 50MHz Variable Periscope mainframe
$1800.00
7704A 200MHz mainframe conv. 7702 Diff. Amplifier, 7A35 Dual Channel, 7820 Timebase and 7600 Delaying Timebase
$2410.00
7904 500MHz mainframe
$4500.00

THE SOURCE....
of all good used test equipment

Electronic Brokers is Europe's leading Second User Equipment Company. We carry large stocks of the very latest test equipment which is refurbished in our own service laboratories and calibrated to meet the manufacturer's sales specifications. When you buy used equipment from Electronic Brokers, it can be yours in just days. No waiting for manufacturers lengthy production schedules. All equipment is fully guaranteed.

ANALYSERS

Hewlett Packard
3506A Spectrum Analyzer 5Hz-50Hz
1411B 9526B 6555A 10kHz-18kHz
$2500.00
332A Distortion Meter 5Hz-600kHz
$345.00
B417A 6412A Network Analyser
$1195.00
Marcon
TF3311 Desorption Meter 20kHz - 200kHz
$475.00
Solatron
1260 Series 7070
$400.00
Tektronix
7055/1 G itemName
$713.00
50MHz, 5mV/pig. Input
$713.00
721 10kHz-1800MHz
$850.00
7L 1.2kHz 10Hz
$713.00
721 3kHz-1800MHz
$750.00
721 4kHz-18GHz
$750.00
BRIDGES

TF245/TF1246 G Meter 40kHz-50kHz
$575.00
TF131A 0.1 LCD Bridge
$775.00
TF2013 A LCD Bridge
$845.00
TF4500 Set of Test cables
$350.00
Behr & Schwarz
7221A LCD 0.1 %
$985.00
9906 Sound & Detector
$1485.00
FREQUENCY COUNTERS

Hewlett Packard
73241 S Digi 200MHz Unused
$200.00
TF3624 D Digi 500MHz
$200.00
Marconi
TF3643 B Digi 12-14GHz Unused
$375.00
TF3643 B Digi 200MHz Unused
$200.00
SVDM’s AND DDM’s

FC workplace
$900.00
5.1% Dig. DC only 1% repeatability, 5% ranges to 11.000Hz
$790.00
Phelps
PM 2283-01 LED 3% Digi DMM
$85.00
Solartron
7055 Microprocessor DMM, Scale Length 20.0000, A/D conv, resolution 1uV
$1520.00
OSCILLOSCOPES

Marconi
TF22131 + TK2214X Display and Memory
$550.00
Phelps
PM 2323 Dual Beam 10MHz
$495.00
PM 3234 Dual Beam Storage
$1750.00
7215A new CRT
$1750.00
PM 2344 50MHz 4 Channel Delay Test
$1550.00
Tektronix
475 Dual Trace 200MHz Portable
$2000.00
7313 100MHz Storage Marcon
$2250.00
7303 120MHz mainframe
$2200.00
5440 50MHz mainframe
$2000.00
5441 50MHz Variable Periscope mainframe
$1800.00
7704A 200MHz mainframe conv. 7702 Diff. Amplifier, 7A35 Dual Channel, 7820 Timebase and 7600 Delaying Timebase
$2410.00
7904 500MHz mainframe
$4500.00

THE SOURCE....
of all good used test equipment

Electronic Brokers is Europe's leading Second User Equipment Company. We carry large stocks of the very latest test equipment which is refurbished in our own service laboratories and calibrated to meet the manufacturer's sales specifications. When you buy used equipment from Electronic Brokers, it can be yours in just days. No waiting for manufacturers lengthy production schedules. All equipment is fully guaranteed.
BUILD A PAIR OF MICRO MONITORS!

Just a few hours easy and interesting work and you'll have a superb pair of compact loudspeakers for about half the price of equivalent 'assembled' models.

The Wilmslow Audio Micro Monitor will stand comparison with any speaker of similar size (at any price!). Don't take our word for it - call for a demonstration!

The Micro Monitor kit contains all the components needed - a pair of cabinets in flat-pack form - accurately machined for easy assembly, all drive units, crossover networks, acoustic wadding, grille foam, velcro, nuts and bolts, etc. No electronic or woodworking knowledge required - simple, foolproof instructions supplied. The cabinets can be stained, painted or finished with iron-on veneer. Dimensions of assembled cabinet: 32 x 24 x 20cm. Suitable for amplifiers of 20 - 50 watts.

Price £112.95 per pair including VAT. Carriage and insurance £5.50.

LAST CHANCE AT THIS PRICE.

METALFILM RESISTORS 1% Tolerance, 1/4 Watt

ONLY 3p EACH


SPECIAL OFFER

10 PCS OF EACH (89 RESISTORS) £23.00

ORION SCIENTIFIC PRODUCTS LTD.

4 GOLDEN SQ

LONDON W1

RADIATION DETECTORS

BE PREPARED

VIEW THRU LENS

FREE RECHARGE SERVICE AFTER PURCHASE

£6.95

ADVT: VAT, Post & Packing

COMPLETE WITH DATA

HENRY'S

WIRELESS WORLD NOVEMBER 1982
SINEWAVE INVERTERS
FROM CARACAL 200-1000 VA

Caracal offer you the U.K.'s widest range of high-quality static inverters. Our inverters are used in many countries throughout the world wherever a reliable and stable source of A.C. power is needed for computers, communications, instrumentation, etc. They are also frequently used for mobile or marine applications where only a D.C. source is available.

Caracal inverters employ modern pulse width modulation technology which is replacing obsolete tuned-type (ferro-resonant) inverters, by giving higher efficiency throughout the load range, very low standby current, and lower weight.

We have a large range of models and options, at competitive prices, to suit your exact requirements.

19-INCH RACK MOUNTING
Now all inverters are also available in 19-inch chassis form for rack mounting.

CARACAL
Export enquiries welcome
CARACAL POWER PRODUCTS LIMITED
42-44 SHORTMEAD STREET, BIGGLESWADE, BEDFORDSHIRE
Telephone: 0767 81361

WIRELESS WORLD NOVEMBER 1982
IEEEE PROGRAMMABLES from TIME

9814  IEEE PROGRAMMABLE VOLTAGE STANDARD
A higher performance voltage standard with 4 ranges from 0.1 volt to 10 volt output. Accuracy is 0.01% and the resolution of setting is 1 in 200,000. Output resistance is less than 0.01 ohms, and output current adjustable 10mA-200mA. Temperature coeff is less than 20ppm/°C and long term stability better than 50ppm per year. Full manual control is available via front panel controls. Available for benchtop use or 19" rack mounting.

9816  IEEE PROGRAMMABLE VOICE
A high quality speech synthesizer which has a 280 word vocabulary. By suitable programming via the IEEE bus it is possible to output single words, phrases and sentences. The vocabulary has been chosen to be applicable to many ATE applications.

9815  IEEE PROGRAMMABLE SCREWDRIVER
The unit has been designed to overcome the problems of adjusting large numbers of multi-turn trimmers in ATE systems. The screwdriver is fully programmable via the IEEE bus with 3 speeds of rotation and 2 selectable torque values available. The unit is supplied complete with a flexible drive shaft and drill chuck in which various adjusting tools can be located.

9810  IEEE PROGRAMMABLE POWER SUPPLY
0-33V in 0.1V steps. Local or remote (IEEE) operation. Fully programmable on the IEEE bus with 3 settable current limits 1mA, 10mA and 1.1A. A dual version of the 9810 is also available. The unit is 3 Euro units high and standard 19" rack mounting width.

9812  IEEE PROGRAMMABLE SWITCH
24 double pole changeover switches are available with full IEEE control. Each switch is rated at 1 Amp, 30V dc or 100V ac. Thermal amfs have been minimised to less than 1.4W per switch. All outputs are on the rear panel along with the IEEE address selector switch and bus connector. Manual control of the switches is also provided via a set of front panel switches which also incorporate LED indicators.

9811  IEEE PROGRAMMABLE RESISTANCE
0.1 Megohm in 1 Ohm steps, fully programmable via the IEEE bus. Accuracy is 0.1% over most of the resistance range. Resistors are rated at 1 watt each. An attractive feature is the option to switch to local operation when the output resistance can be set up manually via front panel switches.

An entire range of low-cost high-performance instruments

'Sabtronics'  
Making Performance Affordable

5020A 1Hz-200kHz Function Generator  
2033 3½-Digit L.C.D. Hand DMM  
365-S Protoboard  
LP-10 10MHz Logic Probe  
8110A 100MHz 8-Digit Frequency Meter  
8610B 600MHz 9-Digit Frequency Meter

Also Oscilloscopes 15-30MHz Single or Dual trace.

Test our low priced test equipment. It measures up to the best. Compare our specs and our prices—no one can beat our price/performance ratio.

Illustrated brochure and price list from:  
BLACK STAR LTD  
9a Crown Street, St. Ives, Cambs. PE17 4EB  
Tel: (0480) 62440. Telex: 32339

Happy Memories

<table>
<thead>
<tr>
<th>part type</th>
<th>100 up</th>
<th>25-99</th>
<th>1 off</th>
</tr>
</thead>
<tbody>
<tr>
<td>4116 200ns</td>
<td>.83</td>
<td>.72</td>
<td>.66</td>
</tr>
<tr>
<td>4116 250ns</td>
<td>.75</td>
<td>.65</td>
<td>.60</td>
</tr>
<tr>
<td>4816 100ns For BBC comp</td>
<td>2.45</td>
<td>2.10</td>
<td>1.95</td>
</tr>
<tr>
<td>4164 200ns</td>
<td>4.95</td>
<td>4.55</td>
<td>4.20</td>
</tr>
<tr>
<td>2114 200ns Low power</td>
<td>1.15</td>
<td>1.00</td>
<td>.90</td>
</tr>
<tr>
<td>2114 450ns Low power</td>
<td>.95</td>
<td>.85</td>
<td>.80</td>
</tr>
<tr>
<td>4118 250ns</td>
<td>3.25</td>
<td>2.85</td>
<td>2.65</td>
</tr>
<tr>
<td>6116 150ns CMOS</td>
<td>3.70</td>
<td>3.20</td>
<td>2.95</td>
</tr>
<tr>
<td>2708 450ns</td>
<td>2.60</td>
<td>2.25</td>
<td>2.10</td>
</tr>
<tr>
<td>2716 450ns 5 volt</td>
<td>2.60</td>
<td>2.25</td>
<td>2.10</td>
</tr>
<tr>
<td>2716 450ns three rail</td>
<td>5.75</td>
<td>5.00</td>
<td>4.65</td>
</tr>
<tr>
<td>2732 450ns Intel type</td>
<td>3.75</td>
<td>3.25</td>
<td>3.00</td>
</tr>
<tr>
<td>2512 450ns Texas type</td>
<td>3.75</td>
<td>3.25</td>
<td>3.00</td>
</tr>
</tbody>
</table>

280A-20A £4.35  280A-P10 £3.25  280A-CTC £3.25
6522 PIA £3.98  7805 reg. £5.00  7812 reg. £5.00

Low profile IC sockets:  
8 14 18 20 22 24 28 40

Pence 9 10 11 14 15 18 25 33

Soft-sectioned floppy discs per 10 in plastic library case:  
5 inch SSSD £17.00  5 inch SSSD £19.25  5 inch DSD £21.00  
8 inch SSSD £19.25  8 inch DSD £23.65  8 inch DSSD £26.90

74LS series TTL, large stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or phone for list.

Please add 30p post and packing to orders under £15 and VAT to total

Access & Barclaycard welcome  
24-hour service on (054 422) 618

Government and Educational orders welcome £15 minimum  
Trade accounts operated, phone or write for details

HAPPY MEMORIES (WW)  
Gladestry, Kington  
Herefordshire HR5 3NV  
Tel: (054 422) 618 or 628
In research, development, testing or production
if you need controlled L.F. power, we can help.
With Amcron amplifiers there's a choice
of rugged, reliable units, tried and tested in
industry and backed by the service and support
you need.

Just circle the enquiry number, write or
telephone – we'll be pleased to tell you more.

G.A.S. ELECTRONICS
16, ST. ALFEGE PASSAGE, LONDON SE10
TELEPHONE: 01-853 5295
TELEX: 923393 LASER G
Multimeters. what price excellence?

... certainly less than you think. A bulk purchase has enabled us to offer these superb, fully auto-ranging, 3½ digit multimeters at a special low price

£56.35
inc. VAT and p&p

Supplied complete with batteries, test leads, spare fuse and instruction manual.

- Full auto-ranging on both voltage and resistance
- Current measurement up to 10A DC and AC
- Unit and range automatically displayed
- Auto polarity and auto zero
- Only 5mW dissipation—200 hours continuous use
- Zero adjust key to correct for test leads
- Audible continuity test function
- Range hold function
- Audible over-range indication

WEST HYDE
West Hyde Developments Limited
Unit 9, Park Street Industrial Estate
Aylesbury, Bucks HP20 1ET
Telephone: (0296) 20441, Telex: 83570 W HYDE G

Please send me SK-6110 Multimeters.
I enclose a cheque/PO for £
Please debit my Access/Barclaycard Account No. :

Signature: ____________________________
Name: ______________________________
Address: _____________________________

Credit card or account customers may telephone orders.

WW – 053 FOR FURTHER DETAILS

What meter?

No matter what panel meter you may be looking for we can give you the meter you want. The Bach-Simpson range of standard models represents the largest selection of meters you will find anywhere. See our new catalogue and you will see what we mean. You may of course, have a need for customised meters. Do you require special sensitivities, special movement ballistics or special scales?
No problem! you tell us what we can supply.
With our UK manufacturing facilities and our new Mod-Centre, we can produce meters to meet your requirements.
If you would like to know more — write or phone now and ask for Colin Williams.

Bach-Simpson
Bach-Simpson (U.K.) Limited,
Trenten Estate, Wadebridge, Cornwall, PL27 6HD.
Telephone: (020881) 2031
telex: 45451

WW – 015 FOR FURTHER DETAILS

BASIC ELECTRONICS

by Grob
DIGITAL INTEGRATION CIRCUITS, READY REF. MANUAL
Price: £9.00

by Marcus
ELECTRONIC PROJECTS, READY REF. MANUAL
Price: £10.50

by Marcus
POPULAR CIRCUITS READY REF. MANUAL
Price: £10.50

by Marcus
ENCYCLOPAEDIA OF INTEGRATED CIRCUITS
Price: £16.50

by Buchtman
DIGITAL INTEGRATED ELECTRONICS
Price: £10.00

by Tsang
MICROPROCESSOR DEVELOPMENT & SYSTEMS
Price: £5.00

by Wales
MICROPROCESSOR DEVELOPMENT & SYSTEMS
Price: £5.00

by Stewart
MICROPROCESSOR DEVELOPMENT & SYSTEMS
Price: £5.00

by Klangiman
MICROPROCESSOR DEVELOPMENT & SYSTEMS
Price: £5.00

* Prices include postage and packing *

THE MODERN BOOK CO.
Specialist in scientific and technical books
15/21 Praed St., London W2 1NP
PHONE: 01-402 9178 - Closed SATURDAY 1 p.m.
Please allow 14 days for reply or delivery

WW – 037 FOR FURTHER DETAILS

P.&R. COMPUTER SHOP
IBM GOLFBALL PRINTER 3982, £70 EACH + VAT
NEW CENTRONIC 779 PRINTERS, £325 + VAT
NEW CENTRONIC 791 PRINTERS, £350 + VAT
LA DECK WRITERS MODS. 35, 36 & 180, FROM £325 + VAT, ALL NEW
NEW CIFA VDUs. 1 ONLY £300 + VAT
POWER UNITS 5 VOLT 6 AMP, £20 EACH
FANS, PCBs, KEYBOARDS AND LOTS OF ODDS & ENDS -

COME AND LOOK AROUND
SALCOTT MILL, GOLDHANGER ROAD
HEYBRIDGE, ESSEX
PHONE MALDON (0621) 57440

WW – 067 FOR FURTHER DETAILS
THE QUAD FM4: SEVEN PRESET STATIONS, STORED AND RECALLED UNDER THE CONTROL OF A DEDICATED MICROPROCESSOR, WITH A LEVEL OF AUDIO PERFORMANCE LIMITED ONLY BY THE QUALITY OF THE INCOMING SIGNAL. DECEPTIVELY SIMPLE AND ORIGINAL, AS ONE WOULD EXPECT FROM QUAD.

Simply write or phone for more information to
The Acoustical Manufacturing Co. Ltd, Huntingdon, Cambs. PE18 7DB. Telephone: (0480) 52561.
WATFORD ELECTRONICS
CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME
Tel. Watford (0923) 40589/1. Telex: 8956095

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESIGNED TO SATISFY BUDGETS. CASH ON DELIVERY. CREDIT AVAILABLE TO TRADERS. P&P ADD 50P TO ALL CASH ORDERS. OVERSEAS ORDERS POSTAGE AT COST, AIR MAIL quoted.

WELCOME. EXPORT no VAT. Trade to U.K. Customers only. Unless stated otherwise.

We stock thousands more items. 9 years to visit us. We are situated behind Watford Football Ground - just off Watford Way.

Open Monday to Saturday 9am to 6pm. Ample Free Car Parking space available.

WIRELESS WORLD NOVEMBER 1982

Already in use from the small service workshop to Audio Equipment manufacturers for the national studio to IBA Broadcast station to the "BBC". AMSI provides the solution.

Saves time, saves space, saves capital equipment cost, saves earthing problems. Transportable and easy to use. This low cost comprehensive audio workshop meets the latest specifications for Audio Measurement with accuracies equivalent to many of its stand alone counterparts.

10 Instruments, 15 Measurements for the price of One. That's the AMSI...

10 into 1 Does Go.

Complete audio measuring system see the 10 features...

1. HONEYWELL PROBES
2. MILLARD MODULES
3. U.S. LIGHTS
4. STEREO CASSETTE HEADS
5. EX-MOTOROLA STEREO AMPLIFIERS
6. BEYER DYNAMIC MICROPHONES
7. FOSTER DYNAMIC MICROPHONES
8. BAXTER PACKARD DISPLAYS
9. UNITRONICS CLOCKS
10. RECHARGEABLE BATTERIES


WAYNE KERR

WKI Limited Durban Road
Edinburgh Regis
West Sussex PO22 9RL England
Tel: (0243) 825811 Telex: 86120

Radio Code Clocks
are powerful and comprehensive instruments which receive, decode and analyse time-coded standard frequency transmissions to provide accurate, secure and completely automatic time/calendar or synchronisation systems.

Applications
- Automatic master clock and slave controller.
- Synchronisation of separate equipment and events.
- Programmable energy management system.
- Computer clock/calendar with battery backup.
- Data logging and time recording.
- Process and equipment control.
- Satellite tracking.

If you have a time or synchronisation problem, write or phone for further details of our portable and new microcomputer-controlled RadioCode Clocks.

Circuit Services, 6 Elmbridge Drive
Ruislip, Middlesex. Ruislip 76962

WW - 009 FOR FURTHER DETAILS
WIRELESS WORLD NOVEMBER 1982
The Logic Probes

Spend Less

LP-1 Logic Probe
The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transitions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices.

£31.00*  
Model LP 3 illustrated

LP-2 Logic Probe
The LP-2 performs the same basic functions as the LP-1 but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers. (Available in kit form LPK-1 £12.50)

£18.00*  
Model LP 3 illustrated

*price excluding P & P and 15% VAT

GLOBAL SPECIALTIES CORPORATION

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

Test More

LP-3 Logic Probe
Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at 1/100th the cost. LP-3 captures one shot or low rep-events all but-impossible to detect any other way. All without the weight, bulk, inconvenience and power consumption of conventional methods.

£49.00*  
Model LP 3 illustrated

The New Pulser DP-1
The Digital Pulser: another new idea from G.S.C. The DP-1 registers the polarity of any pin, pad or component and then, when you touch the 'PULSE' button, delivers a single no-bounce pulse to swing the logic state the other way. Or if you hold the button down for more than a second, the DP-1 shoots out pulse after pulse at 1000 Hz. The single LED blinks for each single pulse, or glows during a pulse train. If your circuit is a very fast one, you can open the clock line and take it through its function step by step, at single pulse rate or at 100 per second. Clever! And at a very reasonable price.

£51.00*  
Model LP 3 illustrated

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

FOR IMMEDIATE ACTION — The G.S.C. 24 hour, 5 day a week service. Telephone (0799) 21682 and give us your Barclaycard/Access/American Express number and your order will be in the post immediately.

For FREE catalogue, tick box.

WIRELESS WORLD NOVEMBER 1982
Introducing two new hand-held digital multimeters

28 Ranges, each with full overload protection

10 amp AC/DC

SPECIFICATION 6010 & 7030
BATTERY: Single 9v dry cell. BATTERY LIFE: 200 hours. DIMENSIONS: 170 x 89 x 38mm. WEIGHT: 400g inc. battery. MODE SELECT: Push button. AC DC CURRENT: 200μA to 10A. AC VOLTAGE: 200mV to 750V. DC VOLTAGE: 200mV to 1000V. RESISTANCE: 200Ω to 20MΩ. INPUT IMPEDANCE: 10MΩ. DISPLAY: 3½ Digit 13mm LCD. O/LOAD PROTECTION: All ranges.

OTHER FEATURES:
Auto polarity, auto zero, battery-low indicator, ABS plastic case with tilt stand, battery and test leads included, optional carrying case.

Please add 15% to your order for VAT
Postage and packing is free of charge
Trade prices available on application

ARMON ELECTRONICS LTD.
Cottrell House, 53-63 Wembley Hill Road
Wembley, Middlesex HA9 8BH, England
Tel. 01-902 4321 (3 lines). Tlx: No. 923985

WW - 038 FOR FURTHER DETAILS

KONTAKT

The European name of Aerosol Excellence. Special cleaners for all electrical contacts and switches.

Kontakt 60
Dissolves oxides and sulphides, removes dirt, oil, resin and traces of metal abrasion. Protects against erosion. Ensures perfect contacts.

Kontakt 61
Special cleaning, lubricating and anti-corrosion fluid for NEW (non oxidised) and specially sensitive contacts. An excellent lubricant for all electrical and electronic mechanical systems.

Spray Wash WL
A rapid cleaner for reliable washing and degreasing of electrical equipment and components. For removal of dirt, grease, oil, soldering residues and other impurities.

ALSO AVAILABLE:
A COMPLETE RANGE OF INDUSTRIAL AEROSOL SPRAYS
SK10 Soldering Lacquer, K75 Cord Spray, K70 Plastics Spray, K88 Oil Spray, K701 Vaseline Spray, K106 Video Spray, K33 Graphite Spray, K100 Anti-Static Spray, K101 Fluid Spray and, of course, Positive 20 positive photo resist for printed circuits.

Details from:
Special Products Distributors Ltd.
81 Piccadilly, London, W1V 0HL
Tel: 01-629 9556. Telex: 26500 (answerback RACEN). Cables: Speccprod, London, W1

WW - 044 FOR FURTHER DETAILS

TV TUBE REBUILDING

Faircrest Engineering Ltd. manufacture a comprehensive range of equipment for processing all types of picture tubes, colour and mono. Standard or custom built units for established or new businesses. We export world-wide and have an excellent spares service backed by a strong technical team.

Full training courses are individually tailored to customers requirements.

For full details of our service contact Neil Jupp

FAIRCREST ENGINEERING LTD.
4 Union Road, Croydon, CR0 2XX
01-684 1422/01-684 0246

WW - 034 FOR FURTHER DETAILS

IN VIEW OF THE EXTREMELY RAPID CHANGE TAKING PLACE IN THE ELECTRONICS INDUSTRY. LARGE QUANTITIES OF COMPONENTS BECOME REDUNDANT. WE ARE CASH PURCHASERS OF SUCH MATERIALS AND WOULD APPRECIATE A TELEPHONE CALL OR A LIST IF AVAILABLE. WE PAY TOP PRICES AND COLLECT.

BROADFIELDS & MAYCO DISPOSALS
21 Lodge Lane, N. Finchley, London, N.12. 5 mins. from Tally Ho corner Telephone 445 2713/0749

WW - 045 FOR FURTHER DETAILS

WIRELESS WORLD NOVEMBER 1982
The lightweight mast with 101 applications

25 years in this specialist field

The smoothly operated QTM Mast comes fitted with handpump or can be vehicle mounted with 'Power Pack' for extension and retraction. Available in a range of heights up to 15 metres, the QTM mast can provide the ideal answer for:

- Mobile Radio Telephone
- Police Mobile HQ (UHF)
- Field Telecommunications
- Floodlighting
- Anemometer and Wind Measurement
- Environmental - gas sampling collector
- High level photography
- Meteorology
- And a host of other uses

CLARK MASTS

Find out more about the QTM series by writing or phoning:

U.K.
CLARK MASTS LTD. (W.W.I)
Evergreen House, Rintywood Road.
Bosstead, Isle of Wight
England PO33 3PA
Telex 86986

WW - 007 FOR FURTHER DETAILS

MIDWICH HAS MOVED!
OUR PRICES HAVE TOO — DOWN!

In order to maintain our standard of service and house our ever growing range of stock we have moved to larger premises. You can still use our old number for a limited period, but please make note of our new one and our address.

To celebrate the move we have re-priced our products still further. We know this will please our customers, but we'd rather please our customers.

NB - NO SURCHARGE ON CREDIT CARD ORDERS.

Be happy — move with Midwich. And remember, we always try to give you the best deal and the best service. If we fail just let us know — we will always try to make amends.

MEMORIES ** NEW LOWER PRICES **

2114 Low Power 200w 0.80 - 2732 30w 4.80
2708 450w 2.70 - 2657 450w 3.60
2711 450w 2.10 - 2551 700w 2.70
2716 350w 2.35 & 2716 1500w 3.10
2720 450w 3.95 - 2712 1500w 3.36
2732 450w 3.75

BBC MICRO UPGRADE KITS ** NEW LOWER PRICES **

<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBC1</td>
<td>21.50</td>
</tr>
<tr>
<td>BBC2</td>
<td>5.00</td>
</tr>
<tr>
<td>BBC4</td>
<td>6.70</td>
</tr>
<tr>
<td>BBC5</td>
<td>26.25</td>
</tr>
</tbody>
</table>

BBC1 45/64/816 X 8 1600
BBC2 8192 Byte EPROM 2.95 + PL5 10
BBC4 Analogue input plug (定位, 77, 3555, 1)
BBC5 Serial IO and RGB kit (定位, 5, + $5011.45
BBC5 Expansion bus and tube

Most kits are now EX STOCK!

*** We've done it again! Massive price reductions on LPS and CMOS ***

Data sockets low profile

<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>251</td>
<td>0.29</td>
</tr>
<tr>
<td>255</td>
<td>0.29</td>
</tr>
<tr>
<td>256</td>
<td>0.34</td>
</tr>
<tr>
<td>257</td>
<td>0.34</td>
</tr>
<tr>
<td>258</td>
<td>0.34</td>
</tr>
<tr>
<td>259</td>
<td>0.40</td>
</tr>
<tr>
<td>260</td>
<td>0.44</td>
</tr>
<tr>
<td>261</td>
<td>0.44</td>
</tr>
<tr>
<td>262</td>
<td>0.44</td>
</tr>
<tr>
<td>263</td>
<td>0.44</td>
</tr>
<tr>
<td>264</td>
<td>0.44</td>
</tr>
</tbody>
</table>

I/O JUMPERS

<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single ended 4</td>
<td>0.40</td>
</tr>
<tr>
<td>4 pin</td>
<td>1.80</td>
</tr>
<tr>
<td>40 pin</td>
<td>4.35</td>
</tr>
</tbody>
</table>

SPECIAL OFFERS

<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2714-4016.20</td>
<td>0.74</td>
</tr>
</tbody>
</table>

50W WIDE 820/** SPECIAL OFFER **

25 WIDE 820
MALE MALE 10.15
MALE - FEMALE 8.83
FEMALE - MALE 8.83
FEMALE - FEMALE 7.09
MALE BARE 8.25
FEMALE BARE 8.25
CABLE 12.00

3756
<table>
<thead>
<tr>
<th>Device</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3756</td>
<td>0.14</td>
</tr>
<tr>
<td>3757</td>
<td>0.14</td>
</tr>
<tr>
<td>3758</td>
<td>0.14</td>
</tr>
<tr>
<td>3759</td>
<td>0.14</td>
</tr>
<tr>
<td>3760</td>
<td>0.14</td>
</tr>
<tr>
<td>3761</td>
<td>0.14</td>
</tr>
<tr>
<td>3762</td>
<td>0.14</td>
</tr>
<tr>
<td>3763</td>
<td>0.14</td>
</tr>
</tbody>
</table>

50W 820

Data sheets available on assorted items. Please telephone for prices and details.

VTS4

24 Hour Telephone order service for credit card holders
All prices include VAT and carriage (P&P. 5% on orders under £50 net)
Official orders from educational and government establishments, and
public companies/ventures. Credit accounts available to approved (subject to status).
All orders dispatched on day of receipt. Out of stock items will be held or automatically at our
discretion on a replacement will be given if requested.

NO SURCHARGE ON CREDIT CARD ORDERS.

MIDWICH COMPUTER CO LTD
Dept WW, Ricking Hall House, Rickinghall, Suffolk IP22 1HH
Telephone (0379) DIS5 99751

Please make a note of our new address & telephone number

WW - 048 FOR FURTHER DETAILS
**CX80 COLOUR MATRIX PRINTER**

New low price
£795 + V.A.T.

At last a low-cost Colour Matrix Printer for Text, Graphics, Histograms, Colour VDU Dumps, etc.

Colour printout is quickly assimilated, makes graphics more understandable and is an ideal medium for the presentation of complex data or concepts.

Compatible with most microprocessors, prints in 7 colours – sophisticated internal programme makes the CX80 easy to use.


The CX80 is a product of our own design and development laboratories. It represents a British breakthrough in colour printer technology. Colour brochure on request. OEM pricing available.

**INTEGREX LIMITED**

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

---

**EUROPEAN FLOPPY DISK DRIVES AT ATTRACTIVE PRICES**

+ 2/3 height 5.25 inch drives

All reconditioned, as new, with 3 month warranty
Single-sided £100 + £3 carriage + VAT = £118.45 CWO ea.
Double-sided £160 + £3 carriage + VAT = £187.45 CWO ea.
+ 8" floppy drives, reconditioned, as new with 3 months’ warranty
Single-sided £210 + £6 carriage + VAT = £248.40 CWO ea.
Double-sided £270 + £6 carriage + VAT = £317.40 CWO ea.
+ Also a few US made 5¼" single-sided floppy drives at £60 ea. + £3 carriage and VAT = £72.45 CWO ea.

Note all prices are CWO and cheques/POs should be made payable to: "WW READERS ACCOUNT"
Manuals are £20 ea. post paid or £5 if ordered with drives

Circle enquiry number below for details

**MELKUIST LTD**

35A GUILDFORD STREET
LUTON, BEDS.
TELEPHONE: LUTON 416028 TELEX: 825828 MLKST-G

WW – 058 FOR FURTHER DETAILS

WIRELESS WORLD NOVEMBER 1982
DIGITAL MULTIMETERS
All models complete with leads and batteries

HAND HELD DIGITAL RANGE CLAMPS
K2903 30A AC/DC £95.00
10kHz 10A 0.05% basic £169.75
...
K2003 10A AC/DC £139.00

OSCILLOSCOPES

TRI3 CRO/0066A
20 to 20 MHz dual trace 6.5" display £94.50

TOP QUALITY ANALOGUE MULTIMETERS

UK/C/P E125

ALL MODELS ON DISPLAY

RETAIL MAIL ORDER EXPORT INDUSTRIAL EDUCATIONAL

TEST EQUIPMENT CENTRES

CALL IN AND SEE FOR YOURSELF OPEN SIX DAYS A WEEK

DIRECT READ HV PROBE

DIRECT READ TEMPERATURE

LOGIC PROBES/MONITOR

CUBELET

ARRANGED IN CUBE PLAN

301 EDGWARE ROAD, LONDON, W2 1BN, ENGLAND. TEL. 01-724 3564
ALSO AT HENRY'S RADIO, 404/406 EDGWARE ROAD, LONDON W2.

WE ARE OPEN 6 DAYS A WEEK - CALL IN AND SEE FOR YOURSELF

WIRELESS WORLD NOVEMBER 1982

17
Sinclair ZX Spectrum

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!

First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power—personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM), 16K of RAM (which you can upgrade later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £129! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer—available now—is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232/network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour—8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound—BEEP command with variable pitch and duration.
- Massive RAM—16K or 48K.
- Full-size moving-key keyboard—all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution—256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set—with upper- and lower-case characters.
- Teletext-compatible—user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE—16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC—incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

WIRELESS WORLD NOVEMBER 1982
The ZX Printer—available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set - including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive—coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing. Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microflop.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you’ll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthroug at a remarkable price. The Microdrives are available later this year, for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

Order your ZX Spectrum – please allow up to 28 days for delivery. And there’s a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

<table>
<thead>
<tr>
<th>To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3SR.</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chart Item Code</td>
<td>Item</td>
</tr>
<tr>
<td>-----------------</td>
<td>------</td>
</tr>
<tr>
<td>Sinclair ZX Spectrum – 16K RAM version</td>
<td>100</td>
</tr>
<tr>
<td>Sinclair ZX Spectrum – 48K RAM version</td>
<td>101</td>
</tr>
<tr>
<td>Sinclair ZX Printer</td>
<td>27</td>
</tr>
<tr>
<td>Printer paper (pack of 5 rolls)</td>
<td>16</td>
</tr>
<tr>
<td>Postage and packing: orders under £100</td>
<td>28</td>
</tr>
<tr>
<td>orders over £100</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Please tick if you require a VAT receipt

*enclose a cheque/postal order payable to Sinclair Research Ltd for £

*Please charge to my Access/Barclaycard/Trustcard account no.

*Please delete/completer as applicable

Signature

PLEASE PRINT

Name: Mr/Mrs/Miss

Address

FREPOST – no stamp needed. Prices apply to UK only. Export prices on application.
HF COMMUNICATIONS RECEIVERS
FOR
POINT TO POINT/TRANSPORTABLE
AND
MARINE SYSTEMS

DESIGNED AND MANUFACTURED TO HIGHEST INTERNATIONAL SPECS

FULLY SYNTHESISED -10Hz or 100Hz STEPS
CONTINUOUSLY TUNED -50KHz to 30 MHz
MODES -LSB/USB/CW/AM/FSK or TELEX
STABILITY -± 1 PART IN 10⁷/°C
TUNING -SPIN WHEEL or DECADE
POWER SUPPLIES -110/240 A.C. and 24V D.C.

OUTSTANDING PERFORMANCE
AND RELIABILITY
HIGHLY
COMPETITIVE PRICES
BEING ESTABLISHED

SEND FOR TECHNICAL BROCHURES TO:
VIGILANT COMMUNICATIONS LTD, UNIT 5, PONTIAC WORKS, FERNBANK ROAD, ASCOT, BERKS, ENGLAND
TELEPHONE: (0344) 885656
TELEX: 849769 VIGCOM G

Eureka!
BLUE L.E.D's

This revolutionary New Blue LED, the ESL 50B2, from Anglia Components is a miracle of scientific tenacity previously thought to be light years away.

Its applications in science and industry are unlimited.

Development quantities are available ex-stock.

Anglia COMPONENTS
THE PARTS YOU NEED - fast!
Burdett Road, Wisbech, Cambs, PE13 2PS
Telephone 0945 63281 Telex 32630 ANGLIA G

TIME WRONG?

MSF CLOCK is ALWAYS CORRECT - never gains or loses, SELF SETTING at switch-on, 8 digits show Date, Hours, Minutes and Seconds, auto GMT/BST, leap year and parallel BCD (including Weekday) output, receives Rugby 60KHz atomic time signals, built-in antenna, 1000Km range, TIME RIGHT, £69.60.

60KHZ RUGBY RECEIVER, as in MSF Clock, serial data output for computer, etc, decoding details, and ZX81 listing for LOCAL, GMT and SIDEREAL time, £27.20.

200KHz Converter, for any Medium Wave receiver, £22.20.

Signal Generator, 10Hz-200KHz, sine, square, £19.80.

10-150KHz Receiver £19.40, Antenna Noise Bridge £18.60.

Each fun-to-build kit (ready made, to order) includes all parts, printed circuit, case, instructions, postage, etc, discount offer, money back assurance so GET yours NOW.

CAMBRIDGE KITS
45 (WL) Old School Lane, Milton, Cambridge. Tel: 860150

RADFORD
Audio Measuring Instruments, Audio Amplifiers, Loudspeakers and Loudspeaker Components for the professional and enthusiast

RADFORD AUDIO LTD.
10 BEACH ROAD WESTON-S-MARE, AVON BS23 2AU
TEL. 0934 416033

WW - 046 FOR FURTHER DETAILS
WW - 032 FOR FURTHER DETAILS
WW - 036 FOR FURTHER DETAILS

WIRELESS WORLD NOVEMBER 1982
METER PROBLEMS?

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

Full Information from:
HARRIS ELECTRONICS (London)
138 GRAY'S INN ROAD, W.C.1
Phone: 01-837 7937
Telex: 892301 HARTOG

PRINTED CIRCUITS
FOR WIRELESS WORLD PROJECTS

Audio compressor/limiter—Dec. 1976—1 s.s. (stereo) £4.25
Cassette recorder—May 1976—1 s.s. £5.00
Audio preamplifier—November 1976—2 s.s. £4.25
Additional circuits—October 1977—1 s.s. £5.00
Stereo decoder—April 1977—1 d.s. 2 s.s. £8.50
Low distortion disc amplifier (stereo)—September 1977—1 s.s. £2.00
Low distortion audio oscillator—September 1977—1 s.s. £3.50
Synthesised fm transmitter—November 1977—2 d.s. 1 s.s. £12.00
Morse encoder—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
Vacuum tube 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
Amplication system—Oct. 1979—3 pamps (1 poweramp) £4.20 each
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 600/2 or 6006—Jan., July, 1981—1 d.s. 1 s.s. £9.00
Cassette interface—July, 1981—1 s.s. £1.50
EPROM programmer—Jan., 1982—1 d.s. £4.50
Logic probe—Feb., 1981—2 d.s. £6.00
Modular frequency counters—March, 1981—8 s.s. £20.00
Opto-electronic contact breaker (Delco)—April, 1981—2 s.s. £4.00
CB synthesiser—Sept., 1981—1 d.s. £6.00
Electronic ignition—March, 1982—1 s.s. £4.00

Boards and glassfibre roller-tinned and drilled. Prices include VAT and UK postage. Airmail add 30%, Europe add 10%. Insurance 10%. Remittance with order to:
M. R. SAGIN, NANCARRAS MILL, THE LEVEL
CONSTANTINE, FALMOUTH, CORNWALL

WW—018 FOR FURTHER DETAILS

IS YOUR TRMS DMM RUNNING A TEMPERATURE?

The answer is almost certainly no, unless you've got your hands on a brand new Keithley 132C.*

The latest addition to a trend-setting range of handheld units from Keithley Instruments, the 132C is a 3½ digit meter with TRMS, TEMP and 0.25% DCV accuracy.

Key features include:
• AC and DC amps from 1μA resolution to 2 amps full scale
• Ohms from 100MΩ resolution to 20MΩ
• DC Volts (±0.25% reading + 1 digit)
• TRMS AC Volts from 45—500Hz range (±1% reading + 9 digits)
• Temperature Range: −20°C to +150°C (±3% + 1 digit), 150°C to 1370°C (±3% of reading), Type K non-linearized, 1°C resolution

For more information get in touch now. You’ll find it pretty hot stuff!

*Model 132P available for those requiring Fahrenheit scales

Keithley Instruments Ltd
1 Boultan Road Reading Berkshire RG2 0NL
Telex: 847047 KEITHLEY

0734 861 287

WW—063 FOR FURTHER DETAILS
The new Gould OS300 Dual Trace 20MHz Scope

A tough, professional instrument you can trust - at a price you can afford! ★ Max. sensitivity 2mV/cm. ★ Stepped and continuously variable attenuator and timebase controls. ★ D.C. coupled triggering and "active" T.V. sync separator. ★ 'Add' and 'Invert' for differential measurements. ★ X-Y facility. Built to do more - safely, reliably and for longer.

Ask for our 8-page data sheet for full details and applications information.

Toroidal Transformers

THE COTSWOLD “BUDGET RANGE” OFFERS BUILT-IN QUALITY COUPLED TO A RELIABLE DELIVERY SERVICE MOST TYPES FROM STOCK

IEC 65 VDE 0550 BS 415 TO ORDER

PHONE TELEX, WRITE FOR DATA SHEET AND PRICE LIST

Cotswold Electronics LTD.
Unit T1, Kingslidge Road, Kingsditch Trading Estate, Cheltenham GL51 9NX
Tel: 0242-41313 Telex: 897105

BROADCAST MONITOR RECEIVER 150kHz-30MHz

We have taken the synthesised all mode TR7700M communications receiver and made several well-thought-out modifications to provide a receiver for radio broadcast purposes or checking transmitter performance as well as being suited to communications and news gathering use.

PRINCIPAL MODIFICATIONS:
- Radically redesigned front end stages yielding improved noise figure and overload levels. TOIP - 25mV (originally -21dBm)
- Flat audio frequency response on both AM and SSB
- Lower AM distortion
- Balanced audio line output
- Buffered IF output for monitoring transmitted modulation envelop on an oscilloscope
- Mains safety improvements.

The receiver is available in free standing or rack mounting form and all the original features are retained: 12 memory channels, mains or battery operation option, IF bandwidths 2.7kHz, 6kHz, 12kHz, digital frequency time display, timer for unattended recordings or switching, advanced noise blanker, all modes including NBFM with squelch. From £347+VAT.

Stereo Disc Amplifier 3 and 4 ★ Peak Deviation Meter ★ Programme and Deviation Chart Recorder ★ Indicator ★ Frequency Shift Circuit Boards ★ 10 Outlet Distribution Amplifier ★ Peak Programme Meter Illuminated Boxes, Circuit Boards and Ernest Turner Movements.

SURREY ELECTRONICS LIMITED
The Forge, Lulks Green, Cranleigh, Surrey GU6 7RG. Tel: 0483 275897

INSTANT PRINTED CIRCUITS!!

Make your own - to professional standards - within minutes using either “Fotolak” Light-sensitive Aerosol Lacquer or Pre-coated board. No Darkroom or Ultra-violet source needed!

Fotolak aerosol £2.50 (30p) Developer £0.30 (15p)
Ferric Chloride £0.60 (45p) Acetate Sheet £0.15 (15p)

Copper-clad Fibre-glass Boards:
- Single-sided £2.25 ft sq. (£0.25 ft sq.)
- Double-sided £2.5 ft sq. (£0.25 ft sq.)

Pre-coated Fibre-glass Board:
- 8"x4/1/"...£1.75 (25p) 16"x4/1/"...£7 (60p)
- 8"x9/"...£3.50 (45p) 24"x12/"...£13 (120p)
- 24"x18/"...£18 (£1.70)

Double-sided Board (all sizes) add 20% Postage individual items in brackets. Maximum charge £2 per order.

WHITE HOUSE ELECTRONICS
P.O. Box 19, Prea Sands, Penzance TR20 9TF
Telephone: Germoe (073-676) 2329
**ZX81 MACHINE CODE?**

ZX.ASZMIC rom transforms ZX81 into an Assembly Language programming unit

- **FULL-SCREEN EDITOR**
  Sixteen shift keys take you into a world with a word processor feel. A blink cursor moves at your command to control insertion, rubout, line or string deletion, auto-scroll & page flip up or down. Text block operations. Ultra-fast editing.

- **MULTI-FILE SYSTEM**
  Declare as many files as you like, with any names you like, & they are automatically handled by the Operating System. Merge them, delete them, print, save & load them, & edit them by name. Superb flexibility with a simple but powerful system.

- **TOTAL ASSEMBLER**
  Full Z80 nomenclature, unlimited length labels, ORG & EQU directives, proper assembly listings with errors flagged on screen or printer. Selectable object code & options to facilitate cross-assembly. Interpretive immediate execution available.

- **POWERFUL DEBUG**
  All the usual dump, modify, fill & copy commands; plus breakpoints, single stepping, context control, the convenience of interpretive execution mode, full use of the names in your program, Command Macros, autodump, and full operating system interface.

- **HI-RES GRAPHICS**
  355 x 144 resolution under program control to give you truly convincing graphics. With the power & flexibility of assembler you can really use this high definition.

- **MUCH, MUCH MORE**
  Repeat function on all keys. Double height filing on printer. Lot of extras. But more important than all these features, attractive though they are, is the fact that ZX.ASZMIC is an integrated development system in which everything fits together to give you a tool which can satisfy the professional programmer by simplifying all stages of the program development process. It is excellent for those who are taking the first steps into real programming but the more expert you become the better you realize just what AZSMIC can do for you. If you are at all interested in machine code it will be worth your while to find out more.

**Comprocsys limited**

I enclose £39.95. Please rush me ZX.ASZMIC + manual

NAME: ____________________________________________
Address: __________________________________________

Sole UK agents: CAPITAL COMPUTERS LTD.
1 Branch Rd, Park St, St Albans AL1 4RJ.
Phone 0727 72077. Cheques payable to COMPROCSYS AZSMIC AC

WW - 06 FOR FURTHER DETAILS
FM/AM 100s with Spectrum Analyser—we call it the SUPER—S

For FM/AM

IFR includes Simply A PRACTICAL carraing

OPTIONAL FM/AM-1000

% Ohms: 800 DC Distortion: 30%

Hz Volts: 20

Hz Volts: 600

kHz Ohms: Using the modified probe, part number PB-114, 0hms can be measured on scales X1 to X10 K

kHz % AM Measured on the RF signal applied to the

FM/AM-1000 unit

OPTIONAL ACCESSORIES

A choice of R.F. power attenuators and protective carrying cases.

For further information contact Mike Taylor

Fieldtech

Huntlavia House

420 Bath Road

West Drayton

Middlesex UB7 0LL

Tel 01-897 6446 Telex 23754 FLOTEC G

Fieldtech Heathrow

Testing... Testing... Testing...

anywhere!

FM/AM 100s 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 100s 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!

A PRACTICAL TOP UP!

MM-100 MULTI-METER

Simply replaces the protective lid of the FM/AM 100s. It includes a modified probe, PB-114, and a built in speaker unit with independent volume control for audible response to signal measurement. This practical 'top up' will perform the following functions. Sinad: Measurements for 1 kHz tone (±20 Hz)

Distortion: To 30%

DC Volts: Up to 300 volts and up to 800 volts when the X10 probe is used

AC Volts: 600 VRMS maximum for frequencies between 25 Hz and 25 kHZ

Ohms: Using the modified probe, part number PB-114, 0hms can be measured on scales X1 to X10 K

% AM Measured on the RF signal applied to the

FM/AM-1000 unit

OPTIONAL ACCESSORIES

A choice of R.F. power attenuators and protective carrying cases.

For further information contact Mike Taylor

Testing... Testing... Testing...

FOR THE SPECIAL ATTENTION OF

CAMERA FLASH GUN ★ MOTOR DRIVE ★ 8mm CINE CAMERA ★ CASSETTE RECORDER ★ CALCULATORS ★ PERSONAL STEREOs ★ TOYS AND ALL HEAVY USERS OF BATTERIES

GENUINE OFFER THAT CAN SAVE YOU AT LEAST £100 (SUBJECT TO USAGE)

SPECIAL AUTUMN OFFER FROM Stotron (Bournemouth) Distributor of High Technology Devices

RECHARGEABLE BATTERIES with genuine Sanyo Multicharger. Full manufacturers’ warranty. Save on ordinary throw-away batteries by using top quality Sanyo Cadnica batteries and genuine Sanyo charger. For all high power electrical and photographic equipment.

★ THIS IS A SPECIAL LIMITED DURATION OFFER WITH MAJOR SAVINGS ★

PACK 1: Normal Price: £15.89 + P&P SPECIAL PRICE: £14.95 incl. P&P

4 HP7 (AA) N-3U 0.5Ah, plus NC 1230 MULTICHARGER

PACK 2: Normal Price: £20.04 + P&P SPECIAL PRICE: £15.95 incl. P&P

4 HP11 (C) N-2U 1.2Ah, plus NC 1230 MULTICHARGER


4 HP2 (D) N-1U 1.2Ah, plus NC 1230 MULTICHARGER

FEATURES:

a) One full recharge costs less than 1/4th penny per battery.
b) Sanyo NC 1230 Multicharger is fully B.E.A.B. approved to BS3456 and is safe to charge overnight.
c) Typical saving over ordinary batteries, e.g. Tape Recorder:
   After 50 charge discharge cycles After 100 charge discharge cycles After 300 charge discharge cycles

PACK 1 £32 £64 £192

PACK 2 £40 £80 £240

PACK 3 £22 £44 £132

e) Even greater savings attainable in very high consumption equipment

d) Expected minimum life 500 cycles or five years

e) Totally leakproof and simple to use

ORDER WITH CONFIDENCE FROM:

Stotron (Bournemouth)

20/22 POOLE HILL, BOURNEMOUTH DORSET BH2 5PS

STATE PACK NUMBER WHEN ORDERING

Private Customers: CHEQUE/P.O./CASH

Trade Customers: TELEX 417280 RONTEC

WW—047 FOR FURTHER INFORMATION

WIRELESS WORLD NOVEMBER 1982
COOLING FANS
Keep your "Hot Parts" cool and reliable with our range of professional fans. EWI 95WXI1200/950 is a<br>fan for working DIM 92 x 25 mm BRAND NEW with<br>long life. Quick Muffin price £15.00

Honeywell 5-10 mb drives £450 good aich condition.

For more information on controlling, expand and ready to<br>use on your systems contact sales office.

8" FLOPPY DISK DRIVES
Unbelievable value the DRE 7100 & 7200 8" disk starts with the latest technology on offer.

The DRE 7200 includes enhanced capacity and support for the latest technology. The DRE 7100 offers a wide range of options including open heart software, surgeon. Copies, etc.

The Straight from the units costing £250.00 are definable including ASCII Plug & Play and more available only from DISPLAY ELECTRONICS & SCROLL.

Options: carriages & inserts £10.00
Interface Cable £35.00
RS232 Converter £45.00

SAVE £250

MAINS FILTERS
Professional type mains filters as used by "Main Frame" manufacturers, ideal for keeping those unwanted harmonics and data glitches - free now and forever.

Supervision Datascan £15.00
Corcom Inc F1888 up to 20 amp load £9.00
Corcom Inc F1900 up to 30 amp load £12.15

IDEAL TANGERINE OHIO ETC.
Direct from the USA made by the world's leading manufacturer, RCA Co. The VP600 Series of cascaded freestanding keyboards meet all requirements, if the most exacting user is to be pleased with the keyboard. The Tangerine is available in a variety of models, including models with a variety of keys, such as numbers, letters, symbols, and function keys. It is ideal for use in large offices, banks, and other environments requiring high-quality, reliable, and easy-to-use keyboards.

The Tangerine keyboard is designed for use in a variety of environments, including large offices, banks, and other environments requiring high-quality, reliable, and easy-to-use keyboards. It is available in a variety of models, including models with a variety of keys, such as numbers, letters, symbols, and function keys. The keyboard is designed to provide a comfortable and efficient typing experience, with a variety of features to meet the needs of users of all levels of experience.

The Tangerine keyboard has been tested and certified by a variety of organizations, including the National Keyboards Association, the American National Standards Institute, and the Federal Communications Commission. It has received a variety of awards and recognition for its quality, reliability, and performance. The keyboard is available in a variety of colors and styles, allowing users to choose the option that best meets their needs and preferences.

The Tangerine keyboard is a high-quality, reliable, and easy-to-use keyboard that is ideal for use in a variety of environments. It is available in a variety of models, including models with a variety of keys, such as numbers, letters, symbols, and function keys. It is designed to provide a comfortable and efficient typing experience, with a variety of features to meet the needs of users of all levels of experience.
The microprocessor controlled EP4000 will emulate and program all the popular EPROMs including the 2704, 2708, 2716(3), 2508, 2758, 2516, 2716, 2532 and 2732 devices. Personality cards and hardware changes are not required as the machine configures itself for the different devices. Other devices such as bipolar PROMs and 2764 and 2564 EPROMs are programmed with external modules.

The editing and emulation facilities, video output and serial/parallel input/output provided as standard make the EP4000 very flexible to allow its use in three main modes:

- As a stand alone unit for editing and duplicating EPROMs.
- As a slave programmer used in conjunction with a software development system or microcomputer.
- As a real time EPROM emulator for program debugging and development (standard access time of the emulator is 300ns).

Data can be loaded into the 4k x 8 static RAM from a pre-programmed EPROM, the keypad, the serial or parallel ports and an audio cassette. Keypad editing allows for data entry, shift, move, delete, store, match and scroll, and a 1k x 8 RAM allows temporary block storage. A video output for memory map display, as well as the built-in 8 digit hex display allows full use of the editing facilities to be made.

Items pictured are: • EP4000 Emulator Programmer – £545 + £12 delivery; • BSC buffered simulator cable – £39; • MESA 4 multi EPROM simulator cable – £98; • 2732A Programming adaptor – £39; • 2764 Programming adaptor – £64; • 2564 Programming adaptor – £64; • BP4 (TEXAS) Bipolar PROM Programming module – £190

Also available (not shown): • VM10 Video monitor – £99; • UV141 EPROM Eraser with timer – £78; • GP100A 80 column Printer – £225; • PI100 interface for EP4000 to GP100A – £65.

VAT should be added to all prices

DISTRIBUTORS REQUIRED  •  EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

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

Tel: Plymouth (0752) 332961
Telex: 42513

FOR FURTHER DETAILS
P8000 — THE PRODUCTION PROGRAMMER
THAT HANDLES ALL NMOS EPROMS

Checks, Programs, Compares up to 8 devices simultaneously
Handles all NMOS EPROMS up to projected 128K designs with no personality modules or characterizers — See list
Easy to use, menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
Constant display of device type, mode and fault codings
Individual socket LED indicators for EPROM status
Comprehensive EPROM integrity checks — Illegal bit check, data and address shorts, constant power line monitoring
Full safeguard protection on all sockets
Automatic machine self-test routine
Powered down sockets
Cost effective price — £695 + VAT
Available from stock

Write or phone for more details

DISTRIBUTORS REQUIRED ○ EXPORT ENQUIRIES WELCOME

GP Industrial Electronics Ltd.

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

Tel: Plymouth (0752) 332961
Telex: 42513

WIRELESS WORLD NOVEMBER 1982
LIMITED QUANTITY AVAILABLE FOR USE WITH B.B.C., MICRO, APPLE, WITH R.G.B. COLOUR CARD, etc.

Specification: The VMC 22 Colour Monitor is designed to meet the high reliability and performance standards associated with the games, data and computer colour graphics industries.

Input levels: Video-TTL compatible either +ive or -ive going for RGB (IC37416 - going 7417 +ive going).

Composite Sync: TTL compatible either +ive or -ive going set by PCB link. Separate sync: (Frame and line) TTL compatible +ive going = video response 10 MHz.

Deflection: Scanning systems, 625 line 50 Hz and 525 line 60 Hz.

Scan linearity: Errors less than 5%.

Scan geometry: Errors less than 3%.

High voltage: 25KV.

X Radiation: Less than 0.5MR/h.

After months of negotiation we have finally secured the computer user’s dream. We have bought the complete manufacturer’s production of these superb British made R.G.B. Colour Monitors and can offer them to you at this unprecedented price. This offer, available to readers of “Wireless World” also includes a FREE isolating transformer. So with a little of your time and our buying power – you can save pounds. For shipping purposes the C.R.T. and scan coil assembly are separate from the chassis. The C.R.T. is mounted in a standard 22” colour TV cabinet at the unit of your own design. The unit is assembled by plugging the tubes from the chassis to the tube, soldering the input connector, power connector and isolating transformer. The monitor has been fully tested and adjusted prior to packing thus simplifying assembly. A comprehensive instruction sheet will be supplied with each unit.

OPUS

A computer supplies company has established an enviable reputation for reliable service and value for money – so pick up your telephone and discuss your supplies requirement with us.

ATHANA FLOPPY DISCS

MINIS WITH FREE PLASTIC LIBRARY CASE & HUB RINGS

S/S/D/D £17.95 for 10

S/S/D/D £19.95 for 10

S/S/D/D £23.50 for 10

S/S/D/D £26.50 for 10

S/S/D/D £28.50 for 10

HARD SECTORED AND ALL OTHER DISCS AVAILABLE

OPUS DESKS MANUFACTURED BY OPUS IN U.K.

AVAILABE FROM OUR CENTRAL WAREHOUSE.

5 MODELS AVAILABLE

CHOOSE WITHIN YOUR BUDGET

☆ CREAM & BROWN CO-ORDINATING PANELS

☆ DRAWER FOR DISC STORAGE

☆ MOBILE

☆ AMPLE SPACE FOR HARDWARE AND PERIPHERALS

☆ THROUGH SHELF FOR DISC DRIVES, PAPER FEED, FILES

SEND S.A.E. FOR YOUR FREE COLOUR BROCHURE.

Apple 2 users 16k printer buffer card – which saves your complete time. Serial and parallel. Send for spec. and prices.

R.G.B. lead for B.B.C. Micro only £9.95 + VAT

For business or home use – each Desk is supplied with castors – two of which have lockable brakes.

Newly FOR SALE

WIRELESS WORLD NOVEMBER 1982
A lesson in ergonomics from AVO

The AVO 2000 Series is the handheld dmm range you’d design for yourself, incorporating a combination of design features unmatched by any manufacturer in the UK.

There are direct entry prod facilities which, combined with the weight and size of the instruments, allow for true one-handed operation. The 3½ digit LCD is located at the base of the instrument to make the most of the available light. And positive slide switches are incorporated to give simple, dustproof, range selection.

The lead set is fully shrouded at both plug and socket end for improved safety and there is a special hook for PCB testing in the standard set. Heavy duty test leads are also available. The 2000 Series incorporates a three position stand, non-slip safety pads and can be supplied in either a ‘Test and Carry’ case or a ‘Walk and Work’ harness.

It takes Britain’s leading dmm manufacturer to appreciate the needs of the dmm user… worldwide. AVO 2000 Series is the result. Contact us or your usual distributor for further detailed information.

AVO DIGIMINOR 2000
An ideal tool for maintenance applications. An economically priced instrument with a special buzzer socket for simple continuity testing without reference to the display.

AVOMETER 2001
Features a socket specifically for current testing. Comprehensive ranges, with unit and mode displayed on LCD. Ensures a valid current measuring mode is selected—any discrepancy is signalled by an alarm.

AVO VEHICLE TEST 2002
Designed with co-operation from a world leader in vehicle manufacture and service. Accessory kit allows temperature and charging current testing. Heavy duty test leads and comprehensive handbook available.

THORN EMI Instruments Limited
Archcliffe Road, Dóver, Kent CT17 9EN. Telephone: 0304 202620. Telex: 96283

The test of ability
Wiring technology of the past

In the aftermath of Hunt it will be important to keep the technical options open according to John Butcher MP, Under Secretary of State for Industry, speaking to the Television and Radio Industries Club. He was referring to the choice of system architecture by potential cable system operators — tree or multi-star. Taken at face value, this may sound a flexible policy.

A tree structure is suited to broadcast distribution; it evolves outwards to feed additional customers by sub-division of its branches. Coaxial cables are the natural choice for tree structures where up to 30 channels per cable can be tapped off. But as a recently issued NEC report* points out in a 20-year look ahead, they have a very limited capability of providing two-way switched services involving wideband signals.

An alternative based on a multi-fibre tree structure would be very expensive in terms of optical switching and connectors. But a multi-star fibre arrangement — akin to the current telephone network — would allow an unlimited number of one-way channels to be accessed. And more importantly for the future the configuration readily provides full two-way capability; there is no need for encryption, and administration of charging for television channels is simpler.

If a network is required quickly, available technology and economics will favour coaxial cables rather than optical fibres. But a decision in favour of large-scale use of fibre would, says the NEC working party, in itself create a more economic fibre solution.

It would be a tragic waste of the opportunity offered by a two-way switched broadband system if we were to allow this cabling to be dictated by the needs of entertainment broadcasting or narrowcasting alone. The varied facilities of a combined telecommunication and broadcast network, preferably digital, with exciting possibilities of computer-based interactive services in business and in learning, could act as a lubricant for efficiency and national well-being, now and in the foreseeable future. The technology is advancing rapidly; development is still in hand on certain aspects, and many relevant standards have yet to be internationally agreed. There is thus a danger, says the NEC study, that by moving too fast, the UK could go it alone and lose out on export markets.

The opportunity both at home and abroad may not be realised. On the same occasion, John Butcher said BT and its competitors may have to adopt "an evolutionary approach rather than set off with a state-of-the-art switched interactive system, with the high initial costs involved and the risk that the technical breakthroughs may not take place in time to justify the confidence of investors." As the Guardian report of 30th September confirmed, this means reliance on coaxial cable feeds rather than optical fibres . . .

INTERFACING THE NANOCOMP

The popular Nanocomp microcomputer interface can be expanded by adding further p.i.a. devices and by connecting the interface board described in the October 1981 issue.

by R. Coates

For the Nanocomp microprocessor to pass information to and from additional devices it is necessary to bring out connections from its three buses. The eight data bus lines are of course needed as these are used in the transfer of data to and from the peripheral devices. Some address lines may also be required; for instance, the G821 needs A0 and A1 to select its internal registers. An address decoding signal will also be required to position the device at an appropriate place in the processor's memory map. On the Nanocomp, the 74LS138 decodes addresses; fortunately there are four outputs spare (five on the 6809) so these can be used to select this number of peripheral devices.

The addresses of the outputs of the 74LS138 are given in Fig. 1. The outputs are normally at logical 1, but go to 0 for the second half of the processor cycle if the microprocessor generates an address in the ranges indicated.

Although it's possible with these processors to address up to 65,536 different memory locations this is far more than can be used on a simple device like the Nanocomp; so some of the address lines are ignored in the decoding logic. Consequently the address range occupied by a particular device may be more than required. For instance, the on-board p.i.a. requires four consecutive memory locations given as 4000-4003. But because of the partial address decoding, it will respond to all addresses in the range 4000-4FFF, the four-byte sequence repeating itself 1024 times.

Similarly, the maximum address that can be used is 7FFF and not FFFF as would be expected, as the most significant address line (A15) is not used. So each of the outputs corresponds to a 4096 byte block in the memory map.

The spare outputs should be adequate for most purposes but if more are required a second or further 74LS138 can be added to split down one of the original outputs into eight, the connection details being given in Fig. 2.

A word of warning though: the processor cannot drive a limitless number of peripheral devices without buffering. Between seven and ten devices is the maximum, and there are four on the original board. If this figure is likely to be exceeded then all bus lines brought out should be buffered. Referring to Fig. 3, the data bus can be buffered with a single 74LS245, a bidirectional buffer, the direction being controlled by the read-write line. For the address and control lines, 74LS244s can be used as control lines, 74LS244s can be used as these bus lines are outputs only. Each device can buffer eight lines, but the precise number required depends on the application.

The easiest place to make the bus connections on the Nanocomp is on the underside of the processor socket, with connecting leads as short as possible. Pin numbers of the relevant bus lines are given in Fig. 4.

Adding an additional p.i.a.

A further p.i.a. is the simplest expansion that can be made: a fairly useful one as well as being cheap. The original chip served a triple purpose of driving the display and reading the keyboard, as well as being available externally. This meant certain limitations in its use; if more than eight uncommitted lines were required for external use, the keyboard and display could not be used as part of the user program. Adding a second p.i.a. means that this one is completely free, leaving the original to cope with the keyboard and display.

Fig. 5 gives the connections associated with the 6821 p.i.a. One the bus side, all connections except 'chip select' input is taken to the equivalent pin on the 6802/5 chip; the 'chip select' input is taken to any one of the spare address decoding outputs of the 74LS138. And that is the p.i.a. connected. Addresses of the various internal registers are in the same sequence as the original, but the base address will depend on the 74LS138 output used.

6522 versatile interface adapter

An alternative to the 6812, more powerful but just as simple to connect, is the 6522 versatile interface adapter. Although an upgraded version of the 6821, it is not manufactured by Motorola, but is one of the 6500 microprocessor family from MOS Technology. Normally, mixing devices from one manufacturers processor family with another can lead to problems; bus structures and timing are usually quite different. Fortunately, the 6500 family are based on the 6800, the 6502 microprocessor being a scaled down version of the 8000, and therefore peripheral devices in the two families are completely interchangeable.

Circuit connections to the 6522 are shown in Fig. 6; the only difference is that four address lines are required instead of two to access the 16 internal registers. The peripheral side connections are identical to the 6821. Further details of the 6522 can be found in the Interfacing Microprocessors articles; a copy of the manufacturers data sheet is also recommended.

Cuban interface board

Although analogue-to-digital converters for analogue input signals and digital-to-analogue converters for generating analogue outputs could be connected either to the p.i.a. or directly to the Nanocomp bus, a nearer solution by way of the interface board described in the October 1981 issue. Designed for 6500-based systems, it is equally suitable for the Nanocomp. The facilities provided are a 6522 p.i.a., a 16-


Table 1. A-D conversion, channel INO

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDS #10FF</td>
<td>Initialize stack pointer</td>
</tr>
<tr>
<td>STAA $6010</td>
<td>Start conversion, channel INO</td>
</tr>
<tr>
<td>LOOP</td>
<td>Wait for 100 µs</td>
</tr>
<tr>
<td>LDAA #10</td>
<td>Get conversion data</td>
</tr>
<tr>
<td>SWI</td>
<td>Do software interrupt</td>
</tr>
</tbody>
</table>

Table 2. D-A Conversion

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDAA #80</td>
<td>Load accumulator with desired value</td>
</tr>
<tr>
<td>STAA $6020</td>
<td>Store in D-A</td>
</tr>
<tr>
<td>JMP $7D97</td>
<td>Return to monitor</td>
</tr>
</tbody>
</table>

Table 3. Voltage tracker

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Start conversion, channel INO</td>
</tr>
<tr>
<td>LOOP</td>
<td>Wait for 100 µs</td>
</tr>
<tr>
<td>LDAA #10</td>
<td>Read add</td>
</tr>
<tr>
<td>STAA $6020</td>
<td>Store value in</td>
</tr>
<tr>
<td>BRA START</td>
<td>And repeat</td>
</tr>
</tbody>
</table>

Table 4. VIA Test

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDAA #0</td>
<td>Set port A as inputs</td>
</tr>
<tr>
<td>STAA $6003</td>
<td>(all bits to 0)</td>
</tr>
<tr>
<td>LDAA #5FF</td>
<td>Set port B as outputs</td>
</tr>
<tr>
<td>STAA $6002</td>
<td>(all bits to 1)</td>
</tr>
<tr>
<td>LOOP</td>
<td>Read port A</td>
</tr>
<tr>
<td>STAA $6000</td>
<td>Store in port B</td>
</tr>
<tr>
<td>BRA LOOP</td>
<td>And repeat</td>
</tr>
</tbody>
</table>
channel analogue-to-digital converter and a single digital-to-analogue converter.

Connection is mainly a matter of taking the appropriate bus connections shown on the interface board circuit diagram to the appropriate pin on the Nanocomp processor chip; Fig. 4 shows the pin numbers. But note several points. Number 02 corresponds to E on the 6802/9, NRST is the reset line (RST), and NWDS, NRDS, BLK on the interface board are not used.

One modification is required to the interface board for use with the 6802, but not with the 6809. Addresses can occur on the address bus which are not valid memory addresses. For instance, when an INX instruction is executed, the index register's contents will appear on the address bus but this is obviously not a proper address. For devices on the bus to decide what is a memory address and what is irrelevant data, the valid-memory-address signal from the processor is used. This line will only be at a 1-level if the address bus contents are a valid memory address. This signal must therefore be gated into the address decoding circuitry to prevent spurious accesses to the interface board. This only requires a simple modification: the track to pin 1 of IC9 on the interface board should be broken, and pin 1 connected to v.m.a. on the 6802, see Fig. 7. Later Motorola microprocessors such as the 6809 do not generate these spurious addresses and so this modification is not required.

The interface board requires a section of the memory map 256 bytes long and this can be set anywhere in the memory by the block and page selector switches that is not already used by the Nanocomp. The block switch is the most significant digit in the four digit hex address, but remember, as A15 is not used in the Nanocomp, only positions 0-7 may be used. The page switch is the next most significant digit of the address.

In the examples given later, the board is assumed to be at 6000-60FF, which means block = 0 and page = 0.

As the address setting is unlikely to be changed, wire links could be used instead of the block and page switches, but note when working out which selector lines are 0 or 1 the 74LS136 is an exclusive-or gate, and not an exclusive nor-gate as shown in the circuit diagram.

Power for the interface board can be taken from the original power supply but the extra load will cause an increase in heat dissipation and ventilation should be adequate. A larger heat-sink may be required for the regulator.

The interface board will clearly not fit inside the original Nanocomp case, but a deeper case, RS number 500-276, will accept both boards. As the front panel sizes are almost identical, the original front panel can be used with a little modification.

Driving the Cuban

Some sample source code programs are given to show how to read an analogue input signal, how to set an analogue output level, and how to read and drive the v.i.a.

Peripheral lines. Only the mnemonics are given, not the machine-code, as this differs in some cases between the 6802 and 6809.

First, the analogue to digital converter. The ADC0817 is a 16-channel 8-bit anal-
ogue-to-digital converter. That is, it has 16 analogue inputs, any one of which can be selected and the analogue voltage on it converted to an 8-bit value which can then be read and used by the microprocessor.

To measure a voltage, the converter must be told by the microprocessor to initiate a conversion on a specified channel. It takes about 100µs for this particular chip to perform the conversion, so there must be a wait of greater than this before reading the result. The conversion is initiated by the processor writing to one of the 16 a-d allocated memory locations (what data is written doesn’t matter). The location written to determines the channel on which the conversion takes place; 6010 corresponds to channel IN0, 6011 to channel IN1, and so on up to channel IN15 at 601F. A 100µs software delay loop should then be entered and then the conversion result obtained by the processor reading any one of the 16 a-d addresses.

Table 1 gives the listing of a simple program to read channel IN0.

After the software interrupt, accumulator A can be examined to determine the digital value proportional to the input voltage. This will be between 00 for zero input voltage and FF for a full scale (or greater) voltage. Full scale is defined as the voltage across the reference input pins of the ADC0817, and is set by the LM317 regulator and the 100 ohm potentiometer to between approximately 1.9 and 3.2 volts.

Digital-to-analogue converter

Digital to analogue conversion is the reverse of the above, and allows the microprocessor to generate an analogue voltage proportional to a binary value by simply writing a binary value to the d-a converter address.

The program in Table 2 gives a half full-scale output at the analogue output. Changing the contents of accumulator A changes the output voltage.

The program of Table 3 combines the two converters by reading the analogue input and setting the analogue output to the same value. The program then loops back and updates the output continuously, until “reset” is pressed. A variable voltage source on the input and a voltmeter on the output should confirm correct operation. When working correctly, adding an ASL A instruction after reading the a-d gives a voltage doubler!

Versatile interface adapter

The 6522 v.i.a. is similar in many respects to the 6821 p.i.a. but includes extra features such as two 16-bit timers and a shift register for serial communication. To access the greater number of internal registers therefore needed, the device occupies 16 consecutive memory locations, as opposed to the 6821’s four. In this example the addresses are 6000-600F.

Consider the 16 peripheral data lines and their programming.

Each eight-bit peripheral port has a data direction register (DDRA, DDRB) for specifying whether the peripheral pins are to act as inputs or outputs. A logical 0 in a bit of the data direction register causes the corresponding peripheral pin to act as an input; a 1 causes the pin to act as an output.

Each peripheral pin is also controlled by a bit in the output register (ORA, ORB) and an input register (IRA, IRB). When programmed as an output, the voltage on the pin is controlled by the corresponding bit of the output, the voltage on the pin is controlled by the corresponding bit of the output register: a logical 1 causes the output to go high, and a zero causes the output to go low. Data may be written into the output register bits corresponding to pins which are programmed as inputs, but in this case the output signal is unaffected.

Reading a peripheral port causes the contents of the input register (IRA, IRB) to be transferred onto the data bus. The B register operates similarly to the A register; however, for pins programmed as outputs there is a difference. When reading IRA, the level on the pin determines whether a 0 or 1 is sensed. When reading IRB however, the bit stored in the output register ORB is the bit sensed. Thus for outputs which have large loading effects and which pull an output 1 down or which pull an output 0 up, reading IRA may result in reading a 0 when a 1 was actually programmed, and vice-versa. Reading IRB, on the other hand, will read the 1 or 0 level actually programmed, no matter what the loading on the pin.

To program the device, first set up the direction of each line with the data direction registers. DDRA is at address 6003 and DDRB at 6002. The outputs can now be programmed, or the inputs read at 6001 for port A and 6000 for port B. This is simpler than for the 6821 which requires the setting of a bit in the control register to determine whether access is to the direction or data registers, which are at the same address.

The listing in Fig. 4 shows a simple test program for the v.i.a. Port A lines are all inputs and port B outputs. The program continuously reads port A and stores the data in port B, so the outputs reflect the state of the inputs.

Connecting inputs to +5V or around while monitoring the equivalent output with a meter or oscilloscope should confirm correct operation.
TWO-METRE TRANSCEIVER

Design of a microprocessor-controlled transceiver with l.s.b., u.s.b. and f.m. simplex, repeater and reverse modes is described with which automatic scanning of the 144- to 146MHz band or up to nine memorized channels is possible. This first article covers specifications, operation and the front-end module.

by T. Forrester, GBGIW

Operation
As the transceiver is primarily intended for mobile use, the number of controls are kept to a minimum while retaining flexibility, partly in the interests of road safety. The transceiver is turned on by the mode control and the appropriate mode selected at the same time; the microprocessor starts up immediately and sets the synthesizer and display with the last used frequency, after which it scans the controls.

With the transceiver in its 'normal' mode tuning carried out using up/down buttons on the microphone causes the synthesizer to step up or down in 100Hz or 25kHz steps. If the up or down button is kept pressed the synthesizer continues stepping at a gradually increasing rate until the button is released.

The volume control doubles as a frequency-step selector. Pulling the knob gives 100Hz steps and, if required, the s.s.b. noise-blanking facility. Steps of 25kHz are obtained when the volume-control switch is in its normal position.

When scan mode is entered with the receiver set for normal operation, i.e. not in memory mode, the transceiver scans the band and stops for six seconds on any channel whose signal lift the squelch. If the transceiver is taken out of the scan mode during these six seconds it will remain on that frequency. Pressing the skip button at this point will result in the channel in question being passed over on the next scan of the band. The skip button

It was my intention from the outset of this project about three years ago that the transceiver described here should be versatile yet uncomplicated and easy to duplicate. During the development stage components became available which simplified the design of the transceiver and the modular method of construction chosen made their inclusion a simple matter. There are currently commercially available modules which would further simplify the transmitter section even more, but as yet their cost is prohibitive. Should their price fall to a reasonable level they may easily be included.

The prototype was constructed using discrete-logic gates to control the synthesizer and displays, etc., but it soon became apparent that microprocessor control would be advantageous. Use of a microprocessor meant that many of the features found on commercial transceivers, and some additional ones, could be incorporated at the expense of time required to write the software, and that the number of i.c.s used could be reduced from more than 30 to six, thus simplifying the construction.

Each module has its own p.c.b. and is housed in a screened rectangular box. Six of these modules form the transceiver, one is the microprocessor circuit and the remaining three are the display-driver, tone-burst and a.f.-preamplifier boards.

While the resulting design is not the ultimate by professional standards, it is good value for money and is certainly competitive with currently available amateur transceivers.

does not work when the unit is in memory mode. To remove a channel from the list one sets the transceiver for normal operation, tunes to the channel concerned and presses the skip button.

This feature of being able to skip certain channels while scanning the band has been found to be particularly useful if one does

Specifications

<table>
<thead>
<tr>
<th>Frequency coverage</th>
<th>144 to 146MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency steps</td>
<td>100Hz or 25kHz</td>
</tr>
<tr>
<td>Frequency display</td>
<td>7-digits i.e. with 100Hz resolution</td>
</tr>
<tr>
<td>Tuning method</td>
<td>up/down buttons on microphone or channel switch (select memory channel)</td>
</tr>
<tr>
<td>Memory</td>
<td>9 memories programmed by push button may be scanned with six second hold</td>
</tr>
<tr>
<td>Scanning</td>
<td>scan memory channels or scan band (144 to 146MHz) with provision to skip up to 40 channels</td>
</tr>
<tr>
<td>Modes</td>
<td>l.s.b., u.s.b., f.m., simplex, repeater and reverse repeater</td>
</tr>
<tr>
<td>Power</td>
<td>16.5W f.m. and 14.9W p.e.p. p.s.b. with 13.5V supply</td>
</tr>
<tr>
<td>Spurious outputs</td>
<td>better than -70dB at 16.5W</td>
</tr>
<tr>
<td>Harmonics</td>
<td>-45dB at 288MHz</td>
</tr>
<tr>
<td></td>
<td>-50dB at 432MHz</td>
</tr>
<tr>
<td>Carrier suppression</td>
<td>50dB (s.s.b.)</td>
</tr>
<tr>
<td>Squelch threshold</td>
<td>0.1µV (s.s.b. and f.m.)</td>
</tr>
<tr>
<td>Bandwidths</td>
<td>2.4kHz s.s.b.</td>
</tr>
<tr>
<td></td>
<td>12.5kHz f.m.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.26µV p.d. or 12dB quieting with s.s.b., 3.13µV p.d. or 12dB with ratio with s.s.b.</td>
</tr>
<tr>
<td>Receiver image</td>
<td>&lt;=76dB</td>
</tr>
<tr>
<td>Response</td>
<td>1.6m</td>
</tr>
<tr>
<td>Third-order intercept point (receiver)</td>
<td>-1.6m</td>
</tr>
<tr>
<td>Size</td>
<td>300 by 250 by 65mm</td>
</tr>
<tr>
<td>Antenna impedance</td>
<td>50Ω nominal</td>
</tr>
</tbody>
</table>
Components, module 1

Resistors
100, 119
101, 113
102, 111, 117
103, 104
105, 105
106
107
108
109
110, 112
114
115
116
118
120, 121
122
123
10k sub-min.
10k sub-min.
10k
10k
10k
3k
6.8k
3k
6.8k
27
6k sub-min.
1k
560
330

Capacitors
100 20p sub-min.
101, 103, 104, 114, 1n chip
116
102, 106, 107, 108,
110, 111, 113
10n disc
105
109 6.8p
112 s.o.t. for
filter, typ.
115 s.o.t. for
filter, typ.
117, 125 22p
118 47p
119, 124 10n disc
120, 121, 122 2.2u tantal-
123
126 100n disc

Semiconductor
devices
Tr100, 102 BF981
Tr101 U305
Tr103 2N918
Tr104 BC109
D100, 101 1N914
VR100 78L05*
Mx100 SRA11*

Inductors
L100 5 turns of 20s.w.g.
L101 25 turns of 30s.w.g.
HE100 3-stage helical filter, part
number 17-10063*
T101, 102, 103 4 turns per winding, trifilar
wound with 30s.w.g.

The 9MHz crystal filter with 12kHz bandwidth is available from IQD, 29
Market Street, Crewkerne, Somerset. Components marked with an asterisk are
available from Ambit International, 200 North Service Road, Brentwood,
Essex CM14 4SG. All the resistors are 1/4W with 5% tolerance. Teko
screened boxes are available from West Hyde Developments Ltd, Unit 9, Park
Street Industrial Estate, Aylesbury, Bucks HP20 1ET.
not wish to listen to repeaters or similar stations.

If certain favourite channels are to be memorized, it is only necessary to tune them in using the up-down buttons, enter memory mode, select a suitable position in the memory using the memory switch and then press memory-write button. The channel previously tuned to will then be displayed and sent to the synthesizer. Up to 9 channels can be memorized and, if required, scanned.

When repeater mode is selected the 1750Hz tone burst is automatically turned on, and when the unit is set to transmit the shifted transmit frequency is automatically displayed and the tone burst operated. Likewise for reverse repeater, the appropriate frequencies are displayed and no retuning is required.

While the operating frequency is being changed by means of the up-down buttons on the microphone, a 'peep' is emitted from a transducer mounted inside the transceiver. This feature is useful when driving since the frequency change can be judged by counting the peeps.

When the transceiver is in scan mode the beep generator is disabled, as its continual peeping as the synthesizer changes channel would be annoying, if not distracting while driving a vehicle.

Modules
Each module is numbered as follows and any components referred to in the circuit descriptions will be preceded by the number of the module in which they are used.

1 receiver converter, 144 to 9MHz
2 transmit converter, 9 to 144MHz
3 transmit power amplifier and power regulators
4 t.m.-i.f. discriminator, squelch, noise blanking and a.f. power amplifier
5 synthesizer logic
6 synthesizer v.c.o. and power switching
7 s.s.b. 9MHz transceiver and exciter
8 microprocessor control and interfaces
9 frequency-display driver
10 1750Hz tone-burst generator and receive a.f. preamplifier

Units one to seven are housed in separate screened boxes measuring 160 by 50 by 26mm. Modules five and six share the same box while modules 8, 9 and 10 are attached directly to the transceiver chassis and are not in screened cases. The modules are described in the above order.

Receive converter – 1

The front end of any high performance receiver is perhaps the most critical component, with the possible exception of the frequency synthesizer, so these two elements justify extra care in design. This receive converter is the end result of six months' work, and gives excellent results.

Criteria for a good receiver, besides the obvious low noise figure and frequency stability are good dynamic range, i.e. reluctance to overload and cross-modulate in the presence of strong signals, and secondly good adjacent-channel rejection. Unfortunately most mass-produced amateur transceivers are built to a price, with one or two exceptions, and their performance when subjected to strong signals can leave a lot to be desired.

To overcome these problems, a different approach to the usual configuration comprising mosfet preamplifier, mosfet mixer, ceramic i.f. filter, etc., is used which gives excellent performance for a modest outlay. Most of the cost is tied up in the mixer and i.f. filters.

The receive converter comprises the usual modules, but individual parts are tailored to ensure good performance.

The antenna it matched to the r.f. preamplifier, Tr106, to obtain the best noise figure for a conventional tuned circuit. The r.f.-preamplifier drain load is a readily available three-stage helical filter which has an ideal bandwidth for the 2-metre band. This filter is transformed from its nominal impedance of 500Ω to 50Ω by Tr101 (trifilar wound) to match the mixer impedance.

The mixer in this receive converter is the SRA 1H type which requires +17 dBm (approximately 45mW) of local-oscillator drive. This mixer has a typical third-order intercept point of +17dBm and a conversion loss of 7-8dB. To overcome this loss and maintain a good overall noise figure an i.f. amplifier is used directly after the mixer, Tr101. To ensure that this i.f. amplifier does not overload a power f.e.t. is used (third order output intercept point +90dBm). An added benefit of using this type of f.e.t. (U309) is that its input impedance is 50Ω. It is important for the proper operation of a switching mixer such as the SRA1H, that the i.f. port is kept terminated with 50Ω. A 6.8pF capacitor, C105, and 51Ω, R105, resistor maintain 50Ω at high frequencies.

This i.f. amplifier gives 10dB gain, which is just enough to overcome the mixer loss, and its output is matched to the 9MHz 12½kHz crystal filter by another trifilar transformer, T102. All three transformers in this module are identical. Use of a high-quality crystal filter at this point is important as it provides all the f.m. receive selectivity and aids the ultimate rejection on s.s.b. Ceramic filters are usually not good enough.

After the first i.f. filter comes a low-noise i.f. amplifier using another BF981, Tr102, with a tuned-drain load. Its output splits two ways; one goes directly to the f.m. i.f. strip and the other goes to the s.s.b. receiver unit through the noise-blanking circuit shown at the bottom right-hand side of the diagram.

The noise-blanking circuit is placed between the f.m. and s.s.b. filters to restrict its sampling bandwidth to 12½kHz thus preventing i.f. cross modulation from strong signals on nearby frequencies. Local-oscillator drive for the mixer is amplified by a class-A amplifier using a

Analyses of transceiver performance all use 10dB/div vertical sensitivity and 145 MHz centre frequency, except (a) which has 136.5MHz centre frequency. Synthesizer output shows noise floor at approximately –70dB (a), two-tone s.s.b. intermodulation with wide sweep at 10W p.e.p. (b), extra-band spurious signals at full power (c), inter-band spurious signals at full power (d), and two-tone intermodulation distortion with narrow sweep at 10W p.e.p. (e).
2N918 transistor, Tr103. If an MD108 or similar type of mixer is used instead of the SRA1H, then a 10dB pad should be inserted between the local-oscillator driver and mixer to reduce the drive to +7dBm. Using a MD108 mixer will save about £10 but at the cost of 10dB or so on the third-order intercept point. As it is described here, the circuit gives a third-order intercept point of −1dBm and a noise figure of between approximately 1.8 and 2dB.

Failure to use 1nF chip-type bypass capacitors or to mount them directly on the leads of the BF981 fets may lead to instability and in consequence a poor noise figure.

Receiver alignment is easy due to the ready-aligned helical filter and broadly tuned 9MHz i.f. amplifier, so it should only be necessary to peak the tuned circuits for maximum signal (including the helical) and trim the f.m. discriminator.

An overall block diagram of the receiver is shown and details the individual component parts, and the signal flow paths for both s.s.b. and f.m.

The 5kΩ potentiometer, R113, sets the noise blanking threshold and initially should be set to the minimum voltage required to turn Tr104 off, so providing minimum noise blanking action and maximum signal to the s.s.b. i.f. This p.c.b. is fastened into the screened box by means of four tapped stand-off bushes fitted one in each corner.

All power and low-frequency signals to all modules in the design are filtered by means of 1nF lead-through capacitors, although they may not be shown on the circuit diagrams. These lessen the possibility of spurious r.f. feedback paths and so increase the repeatability of the design.

To be continued
BINAURAL RECORDINGS AND LOUDSPEAKERS

Analysing reproduction of binaural recordings through loudspeakers leads to the development of circuitry for their correct reproduction, and which also gives out-of-head localization for stereo headphone reproduction.

Binaural recordings are made with two microphones situated in the ears of a dummy head. As a consequence of this recording technique, reproduction should take place through headphones. One of the drawbacks of this system is that it is restricted to personal reproduction. To make the improvement in sound location over conventional stereo enjoyable by more than one person at a time without having to use several headphones, reproduction through loudspeakers has to be possible.

The standard recording and reproduction procedure is depicted in Fig. 1, where the microphones of the dummy head feed signals of the appropriate magnitude and phase position to the headphones. When the binaural recording is reproduced over loudspeakers, the situation as is drawn in Fig. 2 arises. The microphones send the same signals as before to the loudspeakers, but now each loudspeaker produces its own pressure pattern at the ears of the listener. The left loudspeaker generates the sound pressures $L_1$ and $R_1$ at the left and right ear respectively. The right loudspeaker generates the sound pressures $L_r$ and $R_r$. Adding up the corresponding pressure phasors, the left phasor $L$ leads the right phasor by a small angle $\gamma$, which is not equivalent to the original phase angle $\phi$. This shows that when loudspeakers are used for the reproduction of a binaural recording, much of the directional information is lost.

by J. H. Buijs

The cause of this loss of information is the existence of a double cross-feed, one at the microphones of the dummy head and the other at the loudspeakers. The situation can be improved by introducing a signal $R_1'$ in the right loudspeaker. This signal $R_1'$ should be equal to $-R_1$, so that $R_1$ is cancelled. In the right loudspeaker a signal $L_1'( = -L_1)$ should be introduced for the same reason.

The result of such an operation can be gathered from Fig. 3, in which a similar analysis is as given as in Figs 1 and 2. Signal $L$ consists of the addition of the phasors $L_1$ and $L(R_1')$, and the signal $R$ is formed by the phasors $R_1$ and $R(R_1')$.

A more detailed analysis reveals that the angle between $L_1$ and $L(R_1')$ is equal to $180^\circ - 2\phi$, where $\phi$ is the phase angle between the phasors of the sound pressure at the left and the right ear caused by one of the two loudspeakers. This situation is drawn in Fig. 4, where $\alpha = 180^\circ - 2\phi$ and one can see that

$$\tan \xi = \frac{L(R_1') \sin \alpha}{L_1 + L(R_1') \cos \alpha}$$

As $L(R_1')$ is the same signal as $L_1$ but adapted twice by the cross-feed function $H(f)$, one can also write

$$\xi = \arctan \frac{|H(f)|^2 \sin 2\theta}{1 - |H(f)|^2 \cos 2\theta}$$

Because the same applies for the stimulus for the right ear, the phase angle between $L$ and $R$ is equal to the phase angle between $L_1$ and $R_1$, and is therefore correct. The amplitude of signal $L$ is

$$L_1 \sqrt{1 + |H(f)|^2 \cos^2 2\theta - 2 |H(f)| \cos 2\theta + |H(f)|^2 \sin^2 2\theta}$$

$$= L_1 \sqrt{1 - 2 |H(f)| \cos 2\theta + |H(f)|^2}$$

From this one can conclude that correct reproduction of binaural recordings through loudspeakers is possible provided that the cross-feed function between the two ears of the observer is known, and can be reproduced electronically. Also, an amplitude-correcting circuit will have to be designed in view of the equation for the amplitude of the stimulus, as derived above. If one assumes that the loudspeakers are placed along lines which make an angle of $45^\circ$ with the perpendicular to

Fig. 1. Standard recording and reproduction procedure. Microphones of dummy head feed signals of appropriate magnitude to the headphones.

Fig. 2. When binaural recording is used for binaural recording reproduction, much of the directional information is lost.

Fig. 3. Signal $L$ consists of addition of phasors $L_1$ and $L(R_1')$ and the signal $R$ is formed by phasors $R_1$ and $R(R_1')$. 

WIRELESS WORLD NOVEMBER 1982
Fig. 4. Angle between $L_1$ and $L(R'_1)$ is equal to 180-28°, where $\delta$ is phase angle between phasors of sound pressure at left and right ear caused by one of two loudspeakers.

Fig. 5. Results obtained by Shaw for determination of cross-feed function assuming loudspeakers placed along lines making 45° with perpendicular between left and right ear.

Fig. 6. When data of Fig. 5 are normalized to ear-canal pressure at 0° angle this results. Value for time delay between left and right ear originating from same loudspeaker is from Bauer.

Fig. 7. Bauer designed this circuit to simulate cross feed from Wiener's data.

The input signals for the cross-feed generator to arrive at the loudspeaker signals for reproduction of binaural recordings are

\[ V_{Lin} = L \]
\[ V_{Rin} = -R \]

which leads to

\[ V_{Lout} = L_g L - R R_e e^{j\phi} \]
\[ V_{Rout} = -L_g R + L R_e e^{j\phi} \]

where $L_g$ and $R_g$ and $\phi$ are the transfer functions, as displayed in Fig. 8.

The line between the left and right ear, one can turn to research by Wiener and Shaw for the determination of the cross-feed function. The results obtained by Shaw are reproduced in Fig. 5, which form an extension in frequency range of the measurements performed by Wiener.

When these data are normalized to the ear canal pressure at 0° angle, Fig. 6 results. The value for the time delay between the signal for the left and right ear originating from the same loudspeaker is from Bauer.

From similar data originating from Wiener, Bauer designed a circuit drawn in Fig. 7 to simulate the cross feed. In this circuit

\[ V_{Lout} = L_g V_{Lin} + V_{Rin} R e^{j\phi} \]
\[ V_{Rout} = L_g V_{Rin} + V_{Lin} R e^{j\phi} \]
Fig. 10. Correction circuits give approximate compensation to $L_0^2$ transfer function of Fig. 9.

After inversion of $V_{in}$ and reproduction of these signals by loudspeakers, the sound pressure at the ears is

$$V_L = L_0(-L_0L + RgR)e^{j\theta} + Rg( -L_0R + RgLe^{j\theta})$$

$$= L_0^2L + Rg^2Le^{j\theta}$$

and $V_R = L_0^2R + Rg^2Re^{j\theta}$.

Further corrections

From the previous section the general form of the sound pressure at the ears is

$$V_{ear} = (-L_0^2 + Rg^2 \cos 2\omega T + jRg^2 \sin 2\omega T)V_{in}$$

which can also be written as $V_{ear} = (-L_0^2 + Rg^2 \cos 2\omega T + jRg^2 \sin 2\omega T)V_{in}$

where $\omega$ is frequency in radian/s and $T$ is time delay between left and right ear as given in Fig. 8. This signal consists of $V_{in}$ and the $2T$-delayed signal, $V_{in}'$. One can compare this with the effect of reproduction of monophonic recordings via two loudspeakers, since the sound pressure at the ears now consists of the signal $L_0V_{in}$ and the $T$-delayed signal $RgV_{in}$. Now a signal consisting of $V_{in}$ and a delayed version of $V_{in}$ with a delay smaller than 30ms is perceived as a single signal only consisting of $V_{in}$ (Haas phenomenon). This indicates that $L_0$ determines the sound quality.

As the transfer function $L_0^2$ enhances the frequencies above 200Hz by up to

In practice...

The use of the circuit for "stereophonic headphones" results in an astonishing improvement in reproduction of stereophonic programs via headphones, since the sound seems to originate outside instead of inside the head. The use of the circuit for "binaural loudspeakers" leads to life-like positioning of the sound. Recordings of aircraft passing overhead sound so realistic that one is tempted to look up in search for the airplane. One person demonstrated the circuitry to said, on reproducing the sound of waves at a beach: "It sounds as if I'm standing in the water," which indeed it did. It's difficult to describe the acoustic results of reproduction of binaural recordings via loudspeakers; one should try it to be convinced that this is a way toward better sound reproduction. —JHB
Piccolo players

The wartime rush to adapt for radio communication the teleprinter or Teletype system originally developed for line operation remains an example of the danger of making use of technology standards for a different purpose without a fundamental rethink. Compared with alternative forms of machine telegraphy, including high-speed Morse and the Hellschreiber system, conventional r.f.t.y. with five-unit code and frequency-shift keying has always demanded, if error rates are to be kept low, a very good signal-to-noise ratio, freedom from interference and multipath effects, and preferably diversity reception. To minimize these problems, the seven-unit code and other error-correcting techniques, including automatic repetition, have come into widespread use, though clearly these are palliatives rather than cures.

Many years ago it was recognized that under difficult radio conditions an improvement was possible by the use of multi-tone signalling. J. V. Beard and A. J. Wheeldon (Point-to-Point Telecommunications June 1960, pp.20-48) showed that two-tone a.m. transmission could offer substantial improvement over f.s.k. in conditions of selective fading, weak signals and interference. However, a series of counter-attacks on two-tone transmission, based on results over high-power point-to-point circuits, appeared soon afterwards, since when binary f.s.k. has remained the dominant system for h.f. – though with at least one notable exception.

Since October 1962, the Communications Engineering Department of the Foreign & Commonwealth Office (formerly Diplomatic Wireless Service) has been using the Piccolo system based on multiple frequency-shift keying as the basis of its main h.f. network that links more than 50 British embassies to Hanslope Park, near Newport Pagnell. The original Piccolo system, with no less than 32 tones, imposed stringent requirements on frequency stability but, due to signal integration techniques using resonant LC filters, it could produce clean copy from signals almost buried in noise. It was thus far more suitable than conventional f.s.k. for use with relatively low-power transmitters located in residential areas, often with a flag-pole-type aerial. Harold Robin, Don Bayley and J. D. Ralphs made many attempts to interest British firms and organizations in the system and for a time Marconi undertook to market equipment built by D.W.S. Morris, recently, manufacture and marketing has been by Racal, although clearly it has never been an easy task to introduce a relatively costly, non-compatible system. By 1968, when the Mark III unit was being introduced, I was lamenting in print on the reasons why Piccolo went flat and on the general lack of interest in this technically elegant British system.

Recently a new Mark VI system has been developed that reduces the number of tones from 32 to 6 for ITA-2 and 12 for ITA-5 (Radio and Electronic Engineer Vol. 52, no. 7, pp.321-330, July 1982). Although this clearly loses a little in basic performance, it halves the bandwidth requirements and reduces the formerly extremely stringent frequency stability requirements. It also makes for rather lower capital costs and permits the use of either forward error correction or automatic request for repeats. Combined with the Piccabeil selective calling system that summons an off-duty operator for urgent traffic, it remains one of the few technically successful attempts to match r.f.t.y. to simple low-power h.f. circuits. But it remains to be seen whether the Mark VI system (to be marketed by Racal as the LA1117 modern) will at last achieve the wider commercial acceptance that the Foreign Office engineers have always felt it deserved, but which has so far always eluded the earlier models.

Project Raven

Much though some engineers may regret it, the British communications industry has become increasingly coupled to meeting military or “defence” requirements; a market that has (so far) not been under pressure from Japan and one in which a good deal of expertise has been acquired by British design teams. A major Australian project, born in 1976 and due in service in 1986, “Project Raven,” covering c.e.m.-resistant h.f. and v.h.f. vehicle and manpack tactical systems for ranges up to 2000 miles, looks like bringing major contracts to Plessey Australia (with Plessey UK participation). In 1981 “project definition” contracts were awarded to both Plessey and Racal Milcom but the latest A$7-Million contract for design and establishment of production facilities has been won by Plessey who hope it will lead to production contracts worth up to A$200M.

Technically an interesting feature of the Plessey proposals is the use of electronic null steering of simple twin aerials to provide some 40dBi rejection of a single jammer as an electronic-counter-counter-measure. Null steering as an anti-jam protection system is considered now feasible even for manpack v.h.f. sets and may be extended to h.f. In general Plessey engineers argue that while simple frequency hopping systems are of considerable value against an unsophisticated opponent they are particularly vulnerable to df-assisted attack. They list priorities for c.e.m. in the following order: imperceptibility; inscrutability; physical invulnerability; and electromagnetic invulnerability. A simple null-steering technique for h.f. communications was described at the recent IEE conference “H.F. communication systems and techniques” by J. K. Webb (Mitre Corporation) using a quadrature phase-shift channel with an auxiliary aerial.

Secrets of Hut 6

In the decade since the disclosure of the breaking of the German Enigma cipher machine (as well as the Abwehr and police hand ciphers and the Italian machine cipher) in the books by Gustave Bertrand “Enigma” and Frederick Winnwerbotham “The Ultra Secret”, there have been a spate of further books and memoirs of the fascinating Bletchley Park operation. But most of the insider books have reflected the views of the Intelligence analysts and distribution people of Hut 3 rather than those of the actual cryptanalysts of Hut 6, who were responsible for codebreaking, or the signals people and radio operators who intercepted the traffic. Few of the many authors, with the exception of Bertrand whose teams were in France and not at B.P., have been in any position to draw conclusions of permanent value to the black arts of codebreaking and Sigint.

For this reason it seems a pity that a new book “The Hut Six Story” by Gordon Welchman (published in the USA by McGraw Hill and in the UK by Allen Lane) has attracted less public interest and fewer readers than the earlier books. For Welchman joined the B.P. team of cryptanalysts in 1939, worked in Hut 6 and later became Assistant Director of Mechanization. After the war, his plans for the peacetime GCHQ were largely rejected but instead of returning to the academic field he entered industry, joined the brain drain in 1947, and for many years worked in the field of communications systems planning for The Mitre Corporation, the US Federal Research Centre, etc. concerned with battlefield communication systems etc.

The earlier accounts, while differing in the credit given to the Polish and French cryptographic organizations, have largely supported the idea that Enigma could always be cracked by rigorous mathematical attack when backed up by some prior knowledge of the machines. Most (Bertrand’s excepted) played down the role of Hans-Thilo Schmidt, the German who provided the French with a mass of information on Enigma ciphering procedures. Few have shown any clear understanding of why the German cryptographers had every reason to believe their system was totally secure in those pre-computer days.
Gordon Welchman shows that while indeed Enigma had fatal flaws, it would nevertheless have been impregnable against a purely mathematical attack. Unfortunately for the Germans they introduced a number of strengthening elements progressively with the result that Hut Six was normally in possession of, or could deduce, plaintext "cribs" and could "guess" likely key letters from their knowledge of the short-cuts of "lazy" operating procedures of the German cipher operators. Even so, Welchman maintains, the whole operation might have come to a sudden stop had the Germans taken more steps to ensure that the Enigma machines were used in accordance with the basic rules of cryptography (for example, never re-encode the same plaintext in different keys, never use standard long addresses, etc). It is worth recalling that B.P. never succeeded in breaking the Gestapo (SD) Enigma. He also emphasises the importance of good liaison between Hut 6 and the main Y intercept stations as well as the role of traffic analysis when the messages remained unread.

He believes that the Ultra secret was kept too long with the result that many lessons that could have been learned from B.P. have been lost.

He also reflects the view that engineers and administrators have too readily accepted the view that cryptosystems can be made secure by increasing the number of key permutations to a total beyond that which could be examined by computer in a reasonable time, pointing out that many system contained short-cuts.

Not every communications man would agree with all of his outspoken and often provocative comments but his revelations of the tight-rope on which Bletchley Park walked, and the conclusions he draws from this, make this a book of current as well as historic interest, with a high technical content.

---

**AMATEUR RADIO**

**435MHz digital stereo**

First experimental transmissions from an amateur station of digital stereo audio signals in the UK (and possibly in Europe) were made on August 8 by Angus McKenzie, G3OSS in Finchley, North London with the help of G8UQX and G6BYH.

The co-operating station, that of A.G. Goddard, G3NQR, in Harrow, first monitored the incoming signals to assist in setting the pulse levels and then recorded them on video tape. Subsequently the tape was replayed through G3NQR's amateur TV transmitter back to G3OSS where the incoming signals were decoded back to high-quality stereo and also recorded for a second time. The recovered speech and tone signals included long passages that were virtually perfect though with rather more errors on the second generation tape.

The experiment highlighted several critical factors including the vulnerability of digital transmissions to multipath smearing of the pulses. Adjustments to the transmitter were also critical, though it was demonstrated that the digital audio could be well received at signal strengths below those required for good TV reception. Tests over longer distances at higher power are planned and later it is hoped to use the 1296MHz band.

**Equipment used included: A KG condenser microphone, Sony PMCF-1 digital processor with the digital bit stream superimposed on a PAL-compatible video waveform, Microwave Modules ATV transmitter with average power of about 1.5 watts and two 21-element Yonna aerial arrays at 68ft above ground level. Receiver comprised GaAs fed mast-head pre-amplifier, Microwave Modules up-converter feeding a Panasonic NV7000B VHS video recorder. Output from the VCR goes to a domestic colour TV set for waveform examination and is outputted to KEF 105 series II loudspeakers from a stereo amplifier.**

**Plaintext was progressively with the result that B.P. never succeeded in breaking the Gestapo (SD) Enigma.**

---

**Bands released**

Since October 1, UK amateurs have been permitted limited access to the WARC-1979 bands at 18 and 24MHz (18.068 to 18.168Mhz and 24.89 to 24.99MHz) on a strictly non-interference basis. Restrictions include A1A (c.w.) mode only, maximum carrier power 10 watts, horizontally-polarized aerials only with zero gain relative to a half-wave dipole (i.e. no verticals or beam arrays). At the same time the new microwave bands at 47, 75.5, 142 and 250GHz became available to UK amateurs. It has also been announced that a limited number of Class A amateurs will be authorized to operate between 50 and 52MHz outside of television broadcasting hours. There is also to be an experimental relaxation, initially applying to special event (GB) stations only, on the sending of greetings by non-licensed persons over amateur stations.

On the other hand, British amateurs within 100km of London are being requested not to use the sub-band 431 to 432MHz, which is being made available to the private mobile radio service in the London area, and in future amateurs may find themselves sharing 10.25 to 10.4GHz with a commercial data network which becomes the primary user.

---

**Here and there**

The City & Guilds of London Institute will in future hold three instead of only two Radio Amateurs' Examinations each year. Next examinations will be in December 1983 and March and May 1983. There is however little sign yet of any reforms to the examination syllabus or paper.

Winner of the 1981 RSGB National Field Day trophy was the Racal Amateur Radio Group (B section). Leading single-entry station ("Bristol Trophy") was the Great Western Contest Group. Other leading clubs were Gravesend Amateur Radio Society ("Gravesend Trophy"), Glenrothes and District Radio Club (leading Scottish entry) and the Maidenhead club ("Frank Hoozen Trophy").

The Ipswich Radio Club announces that arrangements have been made for students to sit the RAE at Kesgrave and Claydon Adult Centre, the High School, Kesgrave, Ipswich IPS 7PB. Enrolments by mid-October for the December examination.

---

**Reg Cole, G6RC**

An old-time but apparently ever-young radio amateur, Reg Cole G6RC, an active operator on the bands for well over 50 years, has died, aged 81 years. Until his retirement, Reg Cole was company secretary of George Newnes Ltd, now part of the IPC Group of companies. During World War I he trained as a radio officer in the merchant marine and during World War II was first a Voluntary Interceptor for the Radio Security Service, then served at Hanslope Park until he became one of Lord Sandhurst's group of operators on the Secret Service clandestine links with France and the Low Countries. He put this experience to good use on the amateur bands in the post-war period, becoming one of the UK's leading DX operators.

**Pat Hawker, G3VA**

---

**Wireless World November 1982 43**
The responsibility of engineers to society is often discussed in the abstract: here, Robin Howes deals with the subject in a more tangible manner. In this, the first of two articles, he relates the question of responsibility to the current industrial and political state of the UK.


There is the remarkable book by Robert Pirsig: "There is no manual that deals with the real business of motor cycle maintenance, the most important aspect of all. Caring about what you are doing is considered either unimportant or is taken for granted... In that strange separation of what man is from what man does we may have some clues as to what the hell has gone wrong in this twentieth century."

Three options for the UK

If one looks at possible futures for the UK or similar industrial country, there are, broadly speaking, three options. The first is the high-technology future, which was first promoted in the 1960s although envisaged by science fiction years before. Apart from actual advances in military and space technology, including the moon landing in 1969, there was the hope of an automated, leisureed society, dependent on the use of computers, the hope of electricity 'too cheap to be worth metering' provided by nuclear power, and the hope of using new cereal crops as a 'green revolution' to save the Third World from famine. From a purely technical point of view, such projects were usually outstanding successes; from a social and often economical point of view they were frequently outstanding failures. To take an example directly familiar to most people in Britain, one of the planners' dreams which came to fruition in the 1960s was a solution to the housing problem - the building of multimillion-pound complexes of high rise flats. These are now being blown up because they are too expensive to run and too vandalized to use. This is a classical example of the tunnel vision of experts who are blind to the social and even economic effects of their work, and is the result of trying to find a purely technical solution, a 'technical fix', to a systems-type problem.

In retrospect, such experts seem to have acted as if deficient in common sense and even in common humanity. The economic growth of the 1960s was fuelled by cheap, imported oil, which encouraged a profili-gate use of energy and which promoted technologies for the production of goods that were far more wasteful of energy and resources than ever before.

The second option rejects the first one as technocratic fantasy and disengages itself completely from the industrial concept of economic growth. It promotes a society that is sustainable in the long term because its energy and resource inputs are renewable. Its technology is variously described as low, soft, alternative, intermediate or appropriate. The rather different meanings of these terms have been discussed by David Dickson and others. Perhaps the best term is 'appropriate technology' as it immediately raises the key issue - appropriate for whom? It is important to realise that alternative technology (AT) can be just a technical fix for the affluent in a consumer society, e.g. solar panels for the suburban householder and tidal power for the CEBG, but that its true realisation involves an alternative society. AT used to be the prerogative of commune dwellers, 'a bunch of middle-class misfits playing at being farmers', as one critic said, and the 'brown-bread-and-sandals brigade' who made a social improvement.

One critic, David Leach, considered the energy inputs required for low to modest growth scenarios and concluded that waste reduction, recycling and conservation measures would enable modest growth to occur without the high energy inputs forecast by the Department of Energy and the CEBG. This reduces the need for a major nuclear power programme, which in any case is now becoming increasingly suspect on purely economic grounds. On thermodynamic grounds alone it is wiser to save a kilowatt than to supply an extra one, and as energy consultant Amory Lovins has said: 'Instead of opening the bath taps even wider, it's better to put the plug in'.

In an important article which promoted the Engineering Responsibility Forum, John Endersby discusses the ills of contemporary industrial society and makes some proposals for their improvement. He quotes from an earlier book by Meredith...
Thring?: "Very many thoughtful people in positions of responsibility, including British MPs, senior civil servants, teachers and business executives are well aware that society is heading for disaster, but are forced to stifle their subversive thoughts since their job is to uphold the status quo". Professor Thring has proposed a Hippocratic Oath for engineers in which they vow to use their professional skills only on projects which will better mankind. This immediately involves a value judgement by the engineer on what constitutes benefit and which sectors of mankind are to be bettered, since conflicting interests between the sectors involved is usual. Professor Thring has also considered the long-term implication of energy policy: "One is inevitably forced to the conclusion that an essential condition for our grandchildren's life is that the rich countries bring their energy consumption per capita down to about the present world average figure over the next 30 years". This means a reduction from about 5 kW per head towards 500 W per head. As Thring says, "What is right for our grandchildren is always uneconomic and almost always politically impossible."

In their pursuit of the chimera of economic growth, politicians of both left and right maintain a 'conspiracy of silence' about these issues. Their short-term efforts to relieve the symptoms have been described as an obsessive re-arrangement of the deck chairs of the Titanic.

British industry
When we look at British industry it is apparent that business as usual in the 1960s sense will not come again. By 1980 the industrial sector produced only 40% of the total goods and services. But the growing service sector cannot make good the loss of industrial export markets and the resulting impetus, especially since we are still imported on average more than we export. Nor is there a transition to a 'post-industrial society' likely to be the panacea for our ills.

Although the recession has produced massive unemployment among unskilled workers, the UK policy of capital-intensive energy growth has continued. The alternative would be a switch to a policy of energy and resource conservation which would be labour-intensive, and which could involve repair of goods which were made to last. An EEC study in 1977 on the potential for substituting manpower for energy showed that this change would provide more than enough jobs to compensate for those lost in the manufacturing industries.

Small firms are known to be a source of new jobs but the recession has meant that many small businesses have gone bankrupt. The now discredited dogma of the 1960s was that the merging of smaller firms into industrial giants was the way to produce goods efficiently. The age-old wisdom that about 500 people was the appropriate number for any corporate enterprise such as a school, an army battalion or a factory was ignored. In many large businesses it was found that what was saved in economies of scale was more than lost socially by poor industrial relations. In contrast to the poor record of large firms is the fine innovative record of small technology-based firms. These have had the double benefit of small size and a high proportion of engineers among their managers.

The rest of British industry does not share this happy state. The editorial in Electronics and Power (journal of the IEE) of July 1978 pointed out: "One of the more enduring myths about British industry is that British goods are best, and that it is only their high prices, caused by low productivity, which makes them hard to sell. In fact there is growing amount of evidence that the reverse is true, and that, compared with the products of the other international nations, British goods are poor value and sell only because the depressed state of the British economy makes them cheap". This attempt to compete by low price instead of by quality may reflect the low esteem which the British establishment has for engineering skills as opposed to financial acumen. The engineer is still seen as the man with grease under his fingernails. The Finnieston Report commented: "Although Britain is a nation rich in creative talent, we have been weak in the commercial realisation of its own engineering-based innovations or in the adoption of innovations originating elsewhere".

The Report also criticized UK engineering education. The prestigious engineering schools of the Continent, such as the German Technische Hochschule, are based on the 'technical philosopher' which involves the practical application of knowledge and the synthesis of technical, human and commercial factors. By contrast, in the UK engineering is treated as a branch of applied science. "This militates against an effective marriage between the theory and application and fails to give students a sufficiently wide outlook. In consequence, employers are left with the attitude that few engineers are properly equipped to take on broader managerial responsibilities and have employed them instead as providers of technical services, thereby closing the vicious circle".

British politics
It must be admitted that the regeneration of industry and indeed the regeneration of national life is not helped by the British political establishment. The editorial in Electronics and Power of July 1979 stated: "The idea that increased energy consumption is a necessary condition of any increase in overall wellbeing, seems, in spite of all the evidence against it, to be an unchallengeable assumption as far as many of our policy makers are concerned. Indeed, there is a strong tendency to regard as politically suspect all those, no matter how respectable, who promote the opposite view". This can go to ridiculous extremes, as when the relatively respectable and certainly far from subversive conservation group Friends of the Earth are called Friends of the Kremlin. This is not to deny the fact that since the environmen-
middle class self-sufficiency freaks, the work of the Council for Science and Society should be mentioned. The members of this society, founded in 1973, include engineers such as Sir Monty Finniston, Sir Bernard Lovell and, prior to his death in 1979, Professor Dennis Gabor, in company with other distinguished individuals from the universities, management and the trade unions. The Council has produced several reports, including one on the problem of monitoring large scale technologies, such as nuclear power, aerospace and the chemical industry, which mention the need to protect 'whistle blowers'. At present in the UK these tend to be people already at the top of their professions or who have retired; engineers like Sir Martin Ryle and Sir Kevin Spencer, scientists like Professor Joseph Rotblat and Professor Patricia Lindop. More recently, the Council has produced a report which tackles the issues involved in questions like 'Are we on the brink of the post-industrial society, a world of leisure and information technology?' Such questions tend to mask the real issues which are inevitably political:

Who is going to control the new technology, for what purposes will it be used, and who will benefit?

The essentially middle-of-the-road conclusions of the Report reject three possible scenarios, these being only slight change from the present situation, or a shift of 90% of the work force into service industries, or total breakdown of society (as a result of high unemployment, and leading to a dictatorship of left or right). The Report recommends further study of four areas of changing concepts to work, these being the producer co-operatives of Mondragon in Northern Spain, trade union participation in planning in Scandinavia, the Lucas Aerospace shop stewards 'Alternative Corporate Plan', and full employment for life provided for certain large Japanese companies. The Japanese experience is often thought to be inappropriate to the UK due to racial and cultural differences. But Japanese subsidiaries in the West, including the UK, which use local line managers and labour do as well as the parent companies in Japan. Their industrial relations are far superior to most UK companies.

Significantly, the Report also concludes that until we fully reject the exploitation and inhumanity of the Industrial Revolution and root out the philosophical principles to which it gave birth, we will not recover our energy and confidence.

References

BBC ENGINEERING, 1922 ONWARD

November 14th 1982 sees the 60th anniversary of the BBC's first broadcast Although there is only a psychological magic about round-number anniversaries, there is perhaps justification for a look back over the past decades and a look forward to those in store.

The essence of broadcasting is, of course, the programmes. But, as in any industry, production and distribution is founded on engineering; and the past 60 years have seen a very fruitful relationship between engineering and programme developments, each offering challenges and opportunities to the other.

The history of BBC engineering can fairly be called a success story. In case this sounds immodest, coming from a BBC person, I mention that the ingredients of success were there from the beginning and that failure to exploit these would have been a surprising waste of opportunities. Let us examine what these initial ingredients were.

Broadcasting was one of the first major users of the brand new technology of electronics. It was a technology which clearly had great potential for development and it was therefore attractive to resourceful and inventive engineers.

Broadcasting in the UK was founded on public service ideals and with the philosophy of aiming for the highest achievable standards, both in programme and engineering terms. This philosophy meets with general public approval, so that engineers and others in broadcasting feel that their best efforts are appreciated and fulfill a worthwhile social need.

Public opinion (and the programmes) can be of such variety as to suit all tastes for much of the time and is therefore in continuing and increasing demand. Engineering developments contribute directly to more and better programmes, and hence receive general support.

The benefits of good engineering have always been recognized within the BBC and financial investment has been adequate to secure continuing expansion and improvement. The required scale of investment, in terms of cost per head of the audience, is not very large and it has been possible, therefore, to direct engineering developments towards high quality rather than the lowest cost. So BBC engineering started healthily, has grown healthily and seems set for healthy maturity.

Wireless before broadcasting

Wireless communication originated in the 1880's with the experiments of Hughes and Hertz, based on the earlier theoretical studies of Clerk Maxwell. Before the close of the nineteenth century, Marconi had established himself in England and was doing imaginative work to increase the reliability and range of the new medium; he succeeded in transmitting signals across the Atlantic in 1901.

For this early work, spark transmitters were the norm and the detector usually employed was the coherer, in which metal filings were induced to 'cohere' under the influence of incoming radiation and hence provide a low-resistance current path for a bell or relay. Being an on-off device, the coherer could be used only for digital signals, such as Morse code.

In the early 1900's attention was turned to wireless transmission of telephony. For
this a continuous carrier wave was required and the first systems employed modulated high-frequency alternators and electric arcs. Recognizable speech was transmitted by these means, but the quality must have fallen well short of today's standards.

Shortly before World War 1, the triode valve, developed from Lee de Forest's Audion, began to be used for generation of continuous carrier waves. The relatively pure waveform produced, and the comparative ease of modulating such a source with speech signals, opened the way to wireless speech transmissions of reasonable quality. Receivers during this period employed crystal detectors, or Marconi's magnetic detector, in which the changing magnetic state of an endless loop of soft-iron wire served to demodulate incoming signals.

Wireless was, of course, very largely used as a means of communicating with ships at sea and the magnetic detector proved far more mechanically stable than the more sensitive crystal detectors, whose cat's whiskers were easily jolted out of adjustment by the rolling and pitching of a ship. The military necessities of the 1914-18 war gave a considerable boost to wireless development. Engineers fully appreciated the virtues of the valve and the French 'R' valve in particular was an outstanding development in terms of performance and stability, together with the Marconi 'Q' valve. The widespread use of valves in transmitters and receivers, and the development of tuned-circuit arrangements of reasonably good sensitivity, made usable wireless equipment available on a mass production basis.

**Start of broadcasting**

After the war, a lot of military wireless equipment and components came on the general surplus market and was eagerly bought up by amateur enthusiasts keen to try the intriguing new technology for themselves. Many people built crystal or valve receivers, but of course there was not much of interest for them to receive. The regular time signals (in Morse) from the Eiffel Tower had been transmitted since 1909, and were a useful facility for checking that a receiver was actually working: but they were of limited entertainment value.

Realising that there was a gap to be filled, an enterprising Dutchman commenced in 1919 a regular schedule of Sunday evening transmissions of music and speech which became known as the 'Hague Concerts'. These were much welcomed by listeners in the UK, as well as in Europe, and indeed were financed for a time by British listeners, following an appeal by Wireless World, and by contributions from the Daily Mail. The entertainment potential of broadcasting was appreciated also by the UK industry: 1920 saw the Dame Nellie Melba recital from the Marconi transmitter at Chelmsford, followed in 1922 by the Marconi stations 2MT at Writtle, near Chelmsford, and 2LO in London. Also in 1922, two other industrial companies set up broadcasting facilities - Metropolitan Vickers in Manchester and the Western Electric Company in Birmingham.

Thus it came about by 1922 that a number of organizations had seen and acted on the potentialities of entertainment broadcasting, primarily as a necessary aid to establishing a market for receivers.

Many of these were eager to jump on the band-wagon and the time had come for some co-ordination and regulation.

**Formation of the BBC**

To bring order out of threatening chaos, the Postmaster General, who had refused to license any more independent stations, told those manufacturers wishing to be involved to get together to form a single company for broadcasting. Agreement was reached at a meeting at the Institution of Electrical Engineers at Savoy Hill, London and the British Broadcasting Company was formed. Six large manufacturers combined in this venture, Marconi's, Metrovick, Western Electric, GEC, BTH and the Radio Communication Company, with John Reith as the General Manager.

The new BBC took over existing studios and transmitters, hitherto operated by the individual manufacturers. Its first broadcast was from the 2LO station in London on 14 November, 1922, with 5IT in Birmingham and 2ZY in Manchester on the following day.

The BBC remained a commercial company until 1 January 1927 when it was reconstituted with a Royal charter as the British Broadcasting Corporation.

**Early engineering**

Apart from operating the existing studios and transmitters, the first task of the Engineering Department was to spread coverage over the country. By 1924 there were nine main stations and eleven relay stations. Public interest and demand was very buoyant, and in 1925 there were nearly a million licence payers and no doubt many unlicensed listeners.

Although the main engineering efforts after the start of broadcasting were directed to such basic necessities as providing acceptable quality from the studios and distributing programmes as widely as possible throughout the country, there was time too for more innovative work. In 1925, for example, transmitters in London and Daventry were paired for an experimental transmission of stereo sound from an operatic performance, although it was to be forty years before these efforts bore final fruit in the form of regular stereo programme transmissions.

Expansion of radio. At the beginning, the various stations in different parts of the country transmitted their own individual programmes from their own studios. This was indeed local radio, one more thing in broadcasting that is not as new as we may think today. It was not long before a 'simultaneous broadcast' system of lines was established, enabling all transmitters to radiate a common programme as a network when required. Soon after this, a high-power, long-wave station, 5XX, was built at Daventry, giving coverage of much of the country and giving listeners a national alternative to the regional programmes from the existing stations.

Another important step forward was taken with the opening, in 1932, of the Empire Service, broadcasting to the world on short waves. One of the first broadcasts in this service was the Christmas message from King George V on 25th December 1932.

The higher-power main transmitters were obtained from commercial suppliers, but no manufacturer could offer low-power equipment for the relay stations. Accordingly, these were designed in the newly-formed Development Section of the BBC Engineering Department. Later, they designed high-power, 50 kW transmitters, again because none were available from commercial sources.
The first broadcasting engineers had to be resourceful men. Not only were they continually breaking fresh ground on the technical front, but those operating the transmitters and studios were often called upon to fulfill announcer duties and even to act as 'uncles' in the children's programmes. What with this, and the fact that the first chief engineer Peter Eckersley had himself provided much of the entertainment on the original 2MT programmes, one wonders why it has since become necessary to have an army of producers, writers and performers to put the programmes across: perhaps they should have left it to the engineers!

The other important task for engineers in early days was to improve the quality of sound from the studio. Microphones needed much attention and a lot of cooperation between the BBC and industry was devoted to improvements over the original carbon granule types. One of the better new developments was the Magnetophone from the Marconi company. This gave a considerable improvement in quality, although requiring very skilled personal attention in that the voice coil was attached by pieces of cotton wool impregnated with vaseline. If the studios became too warm, the vaseline melted and more had to be applied: perhaps this was what gave rise to a skilled operator becoming known as 'dab hand'.

Studio acoustic plays a vital part in determining transmitted sound quality. Virtually nothing was known of these techniques when broadcasting began, and much early research effort was devoted to the subject. Many of the fundamental principles were established at this time, and BBC Research Department maintains a strong and continuing effort in this field at the present day.

For the first eight years of the BBC's existence, all programmes were broadcast live. Although some programmes were recorded on disc by commercial recording companies for special purposes, programme production and scheduling suffered from the very severe handicap that no operational recording apparatus was available. Although the magnetic tape recording seems now to be the modern successor to disc, it was a magnetic system which was first used within the BBC. This was the Blattenerphone, using steel tape as a medium, which was introduced in 1930. It was five years later, in 1935, that disc recording was first employed, supplemented in 1936 by the Philips-Miller mechanical (not photographic) sound-on-film system.

From the early 1930's, then, all the fundamental ingredients for broadcasting were there: studio and outside broadcast origination equipment of acceptable quality; recording systems; and increasingly country-wide and world-wide transmitter networks. From then on, the story of radio up to the present day is one of improvement, expansion and sophistication. One should mention highlights such as the enormous improvements in audio quality in all parts of the chain, from studio acoustics to loudspeakers; the introduction of v.h.f. and stereo; the expansion of programme networks at home and overseas and the start of local radio; the use of digital programme links between studio and transmitter; and the start of digital sound recording. All these things represent 'very much more' and 'very much better', but all rest on the foundations completed by 1930.

**Television**

The first BBC transmissions of television took place in 1926, when experimental broadcasts of pictures from Baird's 30-line apparatus were carried by the 2LO transmitter. There were further tests in succeeding years and in 1932 the BBC set up a 30-line television studio in the newly built Broadcasting House.

A rather different form of 'television' was experimentally transmitted in 1928. This was the Pultograph slow-scan, still-picture system, wherein radio signals from a medium wave transmitter actuated a facsimile paper printer. Recognizable pictures could be reproduced at the rate of about one every five minutes, but the system created little public enthusiasm.

During the 1930's, Baird up-graded his system to 90, 120 and 180 lines. In 1938 the BBC set up a purpose-built television studio and transmitter at Alexandra Palace, including Baird equipment, now operating on 240 lines. Also installed at Alexandra Palace was 405-line equipment from the Marconi-EMI company. This was an entirely electronic system, as opposed to Baird's electro-mechanical devices, and side-by-side trials revealed it to be much superior. Accordingly, after a few weeks of alternate transmissions by the Baird and EMI systems, the former was abandoned and transmissions from January 1937 continued on the EMI system alone.

The engineers and the programme makers quickly learnt the potentialities and limitations of the equipment; and quickly built up a body of increasingly sophisticated production techniques. In May 1937 quite comprehensive outside broadcast coverage was given to the Coronation of King George VI, a very ambitious venture at that early stage in television history.

**Expansion of television**

During the 1939-45 war, the frequency requirements of radar had to override those of television, and the service was closed down for the duration. It opened again in June 1946, in time to cover the Victory Parade on 8 June: the BBC television service was the first in
Europe to re-open after the war. In 1946 the television service had only the two studios at Alexandra Palace and two o.b. units. The one transmitter covered only the London and Home Counties area and there were little more than 20,000 viewers.

As had earlier been the case with radio, television suffered very much from the lack of any recording systems. Much research and development effort was applied to the problem and a workable system of recording television pictures on film was in use reasonably by the end of 1947, with an improved version being in regular service in 1949.

The scene was then set for the big expansion of television which the public wanted. Television transmitter coverage was extended to the major regional population centres and increasingly into more remote parts of the country. New studios were established, first at Lime Grove in West London, later in the purpose-built Television Centre and in numerous regional cities. Outside broadcast equipment and operations multiplied, taking events from anywhere in the country and eventually from overseas. Great improvements were made in the quality and sophistication of programme origination equipment, including of course the introduction of magnetic video tape recording which freed programme makers from so many shackles of location and time scheduling. Ever-extending links, including satellites, gave comprehensive national and international programme distribution and exchange, with standards converters of continually improving quality.

Particularly notable were the start of the competitive commercial television service in 1955; and the second BBC programme in 1964, coincident with the start of 625-line television in the u.h.f. band. The introduction of colour on BBC2 in 1967, the first colour service in Europe, was perhaps the biggest single engineering change since television began.

Teletext, offering an entirely new information service riding on the back of the television signal, started in 1974 and heralded the first real public availability of the information technology which is so much in the news today.

Broadcast engineering today

So where are we now after 60 years of broadcast engineering? On the programme production front I would say that we have reached the point where engineering does not seriously limit the range and nature of programme making. In radio and television studios, and in outside broadcasts, producers have nearly all the technical facilities they need, with very satisfactory quality and reliability, to give their creative ideas full scope.

Programme making is now constrained more by limitation of resources. There may not be enough studios, o.b. units, tape recorders and the like to satisfy all programme demands, but this of course comes down to economics. In the end it is the consumer who has to pay for the equipment, plus of course the artists' fees and the non-engineering costs, and somewhere there are economic, social and political limits to the overall cost of broadcasting.

While programme-origination facilities may have reached a very acceptable state of development, the same cannot be said of programme distribution. Here there is still much engineering work to be done, even before we start to consider the new satellite and cable systems which the near future holds in store.

The u.h.f. television networks today cover 99% of the population of the United Kingdom and v.h.f. radio networks cover 97% (or 95% in stereo). M.f./l.f. radio networks provide lower percentage coverages, dropping appreciably lower still after dark. The television and v.h.f. radio percentage coverage in the upper nineties may seem acceptable at first sight, but it must be remembered that every 1% of the population not covered represents half a million people.

It is a source of frustration and distress to transmitter network planning that the half million people unserved with television, for example, refuse to move together into one convenient mass. They are, of course, distributed throughout the country, often in very small communities, and it has so far taken about 600 television transmitters to achieve 99% coverage. Further improvements are being provided for communities down to 500 people, and in the mid-1980's groups as small as 200 will be catered for.

This television transmitter development programme is handled by the BBC and the IBA as a joint project and represents a major continuing effort over many years. Only eleven groups of four channels are available in the u.h.f. broadcasting bands and very elaborate planning is needed to enable the hundreds of stations to be operated without mutual interference.

BBC Research Department have built up a computer-based frequency-planning system, taking account of geographical and topographical features, which enables maximum use to be made of these scarce frequency resources.

In sound radio, the m.f./l.f. bands are increasingly overcrowded and subject to foreign interference. The BBC is effecting marginal improvements here and there, but in general it is not possible to do anything very significant and it is to v.h.f. radio that major development efforts are directed. Current work includes the addition of a vertically-polarized signal to the existing horizontally-polarized transmissions, offering considerable benefit to users of portable and car radios with vertical rod aerials. Another important project is the continuing spread of stereo transmission throughout the country, progress on this being determined primarily by availability of digital audio p.c.m. links to the appropriate transmitters.

But the prime requirement for development of v.h.f. radio is availability of more frequency channels in the v.h.f. Band II. Without these it is not possible to provide the additional networks to avoid the current necessity for sharing of a v.h.f. channel by Radio 1 and Radio 2, by Radio 4 and educational programmes, and to provide Radio 4 v.h.f. coverage in the national regions of Scotland, Wales and Northern Ireland. Furthermore, we need additional frequencies to accommodate about 100 relay transmitters, which are needed to fill the gaps in existing v.h.f. coverage.

The v.h.f. Band II is, by international agreement, to be extended up to 108 MHz for broadcasting use, but the Home Office timetable for re-locating the emergency and mobile services using the upper part of the band is rather disappointingly slow. It appears that real progress on v.h.f. coverage is going to have to wait until 1990 or thereabouts.

So our 60 years have brought us to a very satisfactory state of studio and o.b. origination quality and facilities, although improvements and refinements will, of course, continue; but availability of television and radio services to all the public is by no means complete and much work remains to be done to improve this.

The first priority of BBC engineering in 1922 was to extend coverage and, while enormous progress has been made, it remains a priority today.
**The future**

It is fashionable nowadays to talk of 'the technological revolution'. The term has become a cliché which all decent men now avoid, but it cannot be denied that it is in some senses a true one.

Certainly, there are technological developments now in progress which will profoundly change the broadcasting scene. There will not be dramatic technological revolution — there never has been one — but in the next few years we shall all become increasingly aware of major changes and new opportunities.

**Wider choice**

The first and the most publicly obvious area of development will be the provision of additional programme channels. In television, the start of the 4th channel (ITV's second programme) is upon us and this will complete the exploitation of terrestrial broadcasting in the u.h.f. Bands IV and V. The obsolete 405-line television services in the v.h.f. Bands I and III are in process of being closed down and it is possible, although not yet decided*, for Band III to be re-engineered to provide a fifth 625-line television network, perhaps on a regional basis. No other v.h.f. or u.h.f. spectrum is allocated for television broadcasting, so that four television programme networks with the possibility of a fifth will be the long-term limit of terrestrial transmission. Provision of these additional channels represents 'more of the same' rather than any technological innovation.

On a different level (literally!) is the introduction of direct broadcasting by satellite (d.b.s.). Satellite reception on a domestic basis has indeed been made feasible by recent technological advances, although these are refinements of techniques already used in the communications field rather than a current new development. With most other European countries, the UK has been allocated five d.b.s. channels in the 12 GHz band and the first two of these will be made available for two new BBC programme services from 1986. The remaining three UK d.b.s. channels will no doubt be allotted in future years. The year 1986 will therefore see six broadcasting television programme channels in the UK, with the possibility of the total rising to ten in future years.

The number of television programmes available could increase even further as the proposed wide-band cable systems come into operation. In theory at least, a wide-band cable system could carry thirty or forty television channels and to this can be added the choice of programmes available in the homes of people equipped with video-cassette or disc players. As one final tit-bit, it will be possible for some satellite receiver owners who are willing to spend a bit more money to receive programmes from foreign satellites in addition to those of the UK.

**Quality improvements**

Improvement of the technical quality of vision and sound has been a continuing process since broadcasting began. But there are now more opportunities for particular advances stemming from the "technical (r)evolution".

Satellite broadcasting, for example, offers such advancement opportunities. The effective video bandwidth which can be modulated onto a 27MHz satellite channel is, at about 10MHz, appreciably wider than the 5.5MHz offered by existing terrestrial transmissions; and this wider bandwidth can readily be exploited to remove some of the defects of the present PAL signals. Conventional PAL employs ingenious interleaving of the brightness (luminance) and the colour (chrominance) components of the signal, but exhibits some degree of mutual interference between luminance and chrominance, resulting in the flashes of false colour on finely detailed patterns (cross chrominance) and moving dot patterns on sharp edges (cross luminance). Both these cross effects are minimized by restricting the luminance bandwidth of the PAL signals in the receiver, but this results in limited picture definition and leaves some of the cross effects still apparent.

The wider satellite bandwidth will enable us to transmit luminance and chrominance signals separately, so that cross effects are eliminated without the need to restrict luminance bandwidth. The Research Department has evolved a system known as Extended PAL to achieve this, offering satellite pictures of full 5.5 MHz resolution with no cross colour or cross luminance distortions. With Extended PAL transmissions, existing receivers could still be used and would enjoy freedom from cross colour and cross luminance; while a new receiver, designed to exploit Extended PAL to the full and embodying a high-resolution cathode-ray tube display, would give the additional benefit of appreciably sharper pictures.

The IBA has also devised a system to exploit video satellite bandwidths. Known as Multiplexed Analogue Components

---

*But see interim report of Merriman Inquiry, News.
(MAC), the IBA system also offers freedom from cross colour and cross luminance, although in the form proposed there would be no significant improvement in picture definition.

Both Extended PAL and MAC provide separate transmission and reception of luminance and chrominance components. Given this, modern digital storage and signal-processing techniques offer the possibility of standards conversion within the receiver at a cost which would be acceptable in a domestic product. The implication of this is that picture signals, although still transmitted at 625 line 50 field/s form, could be converted in the receiver and displayed on a higher standard with, say, 1250 lines or 100 field/s or both. Although there would be no more information transmitted, a display with much less visible line structure and free from flicker could be subjectively far more pleasing. Considerable research effort has gone into these possibilities, with the hope that a large, bright, high resolution display device will appear in due course to do justice to such advances.

The longer-term goal is, of course, true high-definition television (h.d.t.v.) whose picture would be actually generated and transmitted on high line and field rates and would thus genuinely carry more information. The difficulty is that real h.d.t.v. would require a bandwidth of some 30 MHz and is thus beyond the capacity of currently-planned satellite channels in the 12 GHz band, unless it could be accepted that two or three 12 GHz channels could be employed for a single h.d.t.v. signal: but this seems an uneconomically lavish use of the available spectrum.

Progress towards broadcast h.d.t.v. must be either in considerable advances in bandwidth-comparison techniques, or in the use of a higher-frequency (say 40 GHz) satellite broadcasting band where more spectrum space could be available. But such high frequencies are very susceptible to absorption by rain or snow storms, so the viability of this approach must be doubted. The ingenuity of BBC engineers, and others, will certainly be focused on these problems in the years to come. Not only are there intriguing possibilities for improvements in picture quality, but sound signals also can be expected to show dramatic advances. A satellite broadcasting channel will accommodate, in addition to wider-bandwidth picture signals, a number of high-quality digital sound channels. BBC proposals, for which it is hoped soon to receive international agreement, envisage six such sound signals with each of the two satellite channels, of which two would form a pair for stereo sound accompanying the television picture, with the remainder affording a vehicle for high-quality stereo radio programmes.

The advent of the BBC satellite broadcasting channels in 1986, therefore, will see the first direct transmission of digital sound and the first opportunity for broadcast stereo television sound in the UK.

The BBC, some years ago, conducted experiments in the terrestrial transmission of digital sound signals. These were not very successful due to digit corruption by multipath (reflected signal) effects and it is difficult to see how this problem could be overcome. Satellite signals are not, of course, subject to multipath distortion.

BBC investigations into the possibilities for stereophonic sound on terrestrially-transmitted television are accordingly based at present on analogue methods. On-air experiments with a dual sub-carrier analogue system are currently in hand, the critical factor to be assessed being the absence of interference to existing mono-phonics, television receivers. The addition of stereo sound to terrestrial television will surely come, but is likely to be some years in development. Even when a satisfactory transmission system is agreed, a long and expensive programme of work will be needed to provide a stereo sound distribution system from the studio centre to the country-wide transmitter network.

Other forms of distribution: Distribution by wideband cable (optical fibre or co-axial) and by video disc could be free from the bandwidth restrictions which limit the capabilities of terrestrial and, to a lesser extent, satellite broadcasting. The extent and the time scale of implementation of these new media cannot at present be forecast with any certainty, but the potential is there for exploitation of many of the ideas which are being generated by engineers with broadcast applications in mind.

Development of cable systems, in particular, leads some people to forecast the eventual demise of broadcasting. But from an engineering standpoint, cable is simply another means of programme distribution and there is no fundamental reason why broadcasting (and the BBC in particular) should depend for its existence on transmission by radiated signals. BBC engineering will adapt in the future, as in the past, to whatever technological advances are appropriate to the time and will no doubt be ready to exploit the possibilities of cable or any other distribution methods. This is not to say that the BBC is now considering setting up or operating a cable system on its own account, any more than it plans to build and launch its own satellite, but it can be expected to continue to play a significant role in the technological development of distribution systems of the future.

Programme origination: Extension and refinement of digital techniques will surely be the dominant theme in the development of studio origination equipment. BBC research and development has been in the forefront of many advances in this area and will certainly continue to be so, both nationally in collaboration with British Industry and in the international sphere, where co-operation and standardization are so important.

The main advantages of digital signals and equipment are reliability and resistance to distortion. These virtues are of great importance to a large broadcasting organization, where breakdowns or signal impairment are expensive hindrances to the tightly-knit flow of programme production: but, like many virtues, they are perhaps a little unglamorous. More obviously exciting are the opportunities offered, not so much by digitization as such, but rather by the ease and economy with which digital signals can be stored and manipulated. Once a picture signal can be held in store and made available for manipulation, all sorts of possibilities present themselves in the way of special effects, graphics, standards conversion, noise reduction, removal of blemishes and programme editing. Digital storage is also fundamental to the development of information systems such as teletext and the radio-data system for identification of radio programme signals.
MEMORY SYSTEMS

An introduction to the common types of memory cell and array, with their characteristics, and the application of memory to microprocessors

by L. Macari

In a computer both instructions and data are stored in various kinds of memory, whose design depends on the type of storage needed, whether it is permanent, semi-permanent or temporary, and on whether the stored information can be examined at random or in some kind of sequence. This two-part article outlines the memories most often used with microprocessors.

To illustrate the structure of a simple memory, Fig. 1(b) shows eight storage locations, each capable of storing one bit, i.e. an 8 bit memory or an 8 x 1 bit memory. If each cell in the memory (Fig. 1(a)) is a simple Nor gate memory, it is possible to arrange control and data lines so that the state of the data line is latched on to the memory when the W line is low as shown in the diagram.

When eight cells are combined in a single memory circuit, some means of selecting the cell required for writing or reading must be available. A 3-line-to-8-line decoder is the simplest way to provide the necessary address lines internally from the three external address lines, each output line from the decoder selecting a single cell of the memory. The W (write enable) and S (device select) lines determine whether the data is being written or read and whether the circuit is selected or not.

Although there are no commercial memories with as few cells, the same principles apply to larger configurations. When the number of words stored is large, more than one decoder will be used and a row/column matrix will be used to select a particular word in the memory. As an example, the 4096 x 1 bit memory has 12 address lines. These are split into two 6-line-to-64-line decoders. The outputs from the two decoders will then be combined so that any two together will allow one word (in this case one cell) to be accessed.

Timing diagrams

Although it may appear to be the wrong order to look at timing diagrams for the read cycle before those of the write cycle, it is more convenient to do so because the diagram is simpler than that for the write operation. It must, therefore, be assumed that the memory has been loaded with data.

Read cycle. To access one item of data the address of the location in memory must be present as a binary pattern on the address lines, and must remain stable during the time the data is being read, as in Fig. 2. If the memory device has not previously been selected by pulling S low, this must now be done. If the data lines have tristate outputs they will remain at high impedance for a time \( t_1 \) — the select time, after which valid data will appear on the data lines. The time between valid address and valid data is known as the access time \( t_a \) for the memory and is specified as a maximum value.

If the address is now changed, the data lines will remain steady for a time \( t_{HA} \) — the 'data-hold' time after an address change. Taking S high causes the new and possibly changing data to remain on the data lines for a time \( t_a \) — the disable time, after which the lines will return to a high-impedance state.

Write cycle. It is usual for the 'write enable' control on a memory to be an active-low signal, so when data is to be placed in the memory at a given address the address must be given time to settle and locate the required word in the memory. The time allowed for in Fig. 3 is known as \( t_{SU} \) — the address set-up time, which can be zero for some devices. After \( t_{SU} \), the write-enable line can be made active and must remain active for at least \( t_w \) — the smallest write-pulse width. If the memory device is not selected, SEL must go low for at least \( t_{SUS} \) before the write-enable goes off again. The time \( t_{SUS} \) is the set-up time for select.

If the correct data is to be placed in the chosen memory location then input data must be valid for a time \( t_{W} \) before WRITE goes high again. The data must also be held valid for a time \( t_{HD} \) — the data-hold time, after the WRITE signal is made inactive. (This time can also be zero.) The address must also remain valid for a time...
Microcomputer memories fall into a number of different categories, semiconductor and magnetic being the most common types. Large computers use the same technologies for data storage. These are some of the terms used to describe memories and their operation.

Cell
A device within a memory which can store a single bit of information, e.g. a flip-flop. A memory consists of an array of cells.

Storage capacity
The total number of cells contained in the memory device, i.e. the total capacity in terms of bits.

Word
One or more cells within the memory which contain one item of data. The memory consists of a number of these units of data (usually a power of 2). Some data sheets quote the number of words and the size of the words instead of the capacity. Some memories have as few as one bit per word. Four-bit and eight-bit words are the other most common sizes of memory words.

Byte
The term used for an eight-bit word. Examples are: 4096 x 1 bit memory, which can store 4096 words of 1 bit length, and which has, therefore, capacity of 4096 bits; 1024 x 8 bit memory, storing 1024 words of 8 bit length, i.e. 1024 bytes, with a capacity of 8192; 32 x 8 bit memory, with 32 bytes of storage, i.e. 256 bits.

Address
The unique number which identifies a particular word in memory is known as the address of that word. If the memory can store 2^n words of data, there are N address lines to the device, so that each of the 2^n possible binary patterns applied to the address lines will locate a data word.

A 4096 x 1 bit memory has 12 address lines.

A 1024 x 4 bit memory has 10 address lines.

A 32 x 8 bit memory has 5 address lines.

If a memory is to be of any value, it must be possible to place data in it and at some other time examine the data. Some memories are designed so that these operations can be performed with equal ease, while others are designed for more permanent storage and the placing of data is only performed once, or at most a few times, in the memory's life.

Write operation
This is the term used to describe the placing of data in a memory and is also known as a store operation.

Read operation
This is the means whereby the information stored in the memory is obtained at the data terminals of the device. In memories where read and write operations are performed with equal ease, it is usual to have a control line to determine what operation is being performed. This signal line is usually active-low for a write operation and is labelled W or sometimes R/W.

Read and write cycle times
The cycle time is the minimum time which can be taken between successive operations of the same kind.

Random access
A memory for which the location of the data does not affect the time taken to write or read the data is known as a random-access memory.

Sequential access
If the data is stored in some sequential device, such as a shift register or magnetic tape, then access time to a particular data position depends on the position.

Read/write memory
Memory for which read and write operations are performed with equal ease. Memory known as ram is really read/write memory.

Glossary

Read-only memory
The data in this type of memory is stored using techniques which are usually different from those used to read the data back from the memory.

- Mask programming is done at the manufacturing stage and the data storage is permanent.
- Fusible-link roms are constructed of arrays of transistors with links, which can be 'blown' by the application of suitable voltages. The blown and non-blown links constitute the 1s and 0s in the memory.

- Ultra-violet-erasable roms. This type of memory has a transparent window over the semiconductor in the IC package. Application of suitable voltage levels program the 1s and 0s which are then retained even when the supply is removed. When it is required to replace the data in the rom it is irradiated with u.v. light, which erases the data stored and makes it possible to write new data to the memory.

When data is erased frequently it becomes progressively more difficult to store data in the memory.

- In electrically-erasable roms, the write operation is still a different operation, but it can be performed without removing the i.e. from the system and requires only the application of the correct voltage levels.

Core-store memory
Memory which makes use of a ferrite ring for each data cell, the direction of magnetization of the cell determining the binary state of the data stored.

Non-volatile memory
Memory which retains its data when the supply is removed (or fails) is known as non-volatile memory. Rom and core, and all magnetic memory is non-volatile. Ram can be made non-volatile by placing back-up batteries on the memory boards to provide for the event of supply failure.
Fig. 3. 'Write' cycle timing. Terminology varies with manufacturers.

Fig. 4. Using both ram and rom with a micro. 4K x 1 bit ram blocks at (a) are made into a 4K x 8 bit memory and 2K x 8 bit roms are similarly arranged as in (b). All these 4K blocks are then connected as in (c).

Fig. 5. Timing and timing. Terminology varies with manufacturers.

Connecting to a processor

Figure 4 (a) shows, as an example, a system requiring a monitor program in rom, which is 4096 words in length and written into two 2K x 8 bit roms. If the rest of the 64K memory space is to be fully utilized with read/write memory, using 4K x 1 bit memories, how can such a system be arranged, assuming that the ram is to use the bottom 4K of memory space?

The ram chips have 12 address lines and a single data line, while the roms have 11 address lines and eight data lines. 4K x 8 blocks of ram can be made up by connecting the address lines of eight 4K x 1 bit rams in parallel and using one chip for each of the eight data positions. The 2K x 8 bit rams can be made into a 4K x 8 bit block, requiring 12 address lines, by taking the address line A11 to the two S lines on the rom devices using the gating circuit shown. This can now be drawn as a 4K x 8 block of rom, with an active-low select line.

How are all the 4K x 8 blocks to be connected to the 16 address lines to use up the full amount of the memory space? First of all, parallel all the address lines on the 4K memory blocks in Fig. 4 (b) and connect these to the least significant 12 bits of the address bus on the processor. The four remaining address bits can now be taken to a 4-line-to-16-line decoder whose outputs are active low. Each of these outputs can be used to select a 4K block of memory, D0 being used for the rom and D1 - D15 for the ram devices. The relevant control lines for reading and writing would then be connected to the sections of memory as required.

To be continued

Meteosat high-resolution images

Table 2 on page 62 of Mike Christie's August article, describing add-on circuits for his weather-satellite receiver, consists of three eight-bit words. The circuit of Fig. 5 on page 83 of the October, issue should sense these three words but is actually shown wired to sense three different words. Readers who find it difficult to work out what the correct wiring should be may obtain a photocopy of the correct diagram by sending an s.a.e. to Wireless World Meteosat, Room L303, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. The original weather-satellite receiver, designed for Tiros N, high-resolution images, was described in the November/December 1981 and January 1982 issues.
Z80-based 2516 programmer

This simple programmer has few components, is easy to operate, and can be used to verify 2516 eproms. Originally designed for the Wireless World scientific computer, it can easily be modified to suit other Z80-based systems.

MREQ4 is an 8K page-select signal for address area 6000-7FFF though any other unused select signal covering at least 2K of memory can be used. When this line goes low, read line RD remains high and the monostable is triggered, resulting in a positive 50ms pulse on the chip-enable input and forcing latching of the processor data and address lines through a low wait signal.

Verification of the byte is possible since decoding and propagation delays result in the read signal going low before the memory-request signal so the monostable is inhibited. Now, the eprom output enable is active and data is gated onto the bus.

As the write signal arrives too late to produce the processor wait signal, wait is not carried out until the next cycle, i.e. an op-code fetch. Also wait inhibits the processor's dynamic ram refresh signals.

To avoid spurious programming, the 25V supply to pin 21 should be applied after and removed before, the 5V supply to pin 24 of the eprom.

Specifically for the scientific computer, bus request and wait signals should be separated, with the last-mentioned connected to +5V through a 2.2kΩ resistor and linked to a spare pin on the expansion socket. Bus request is tied to +5V using the 47kΩ resistor already on the board.

Single-byte programming is carried out using the ALT command. The routine for all 2048 locations shown takes about 100 seconds and uses the Mk III monitor.

Vincent M. Grayson
Haywards Heath

Gray-to-binary converter

Whilst the Gray to binary converter proposed by J. J. Mouton (Circuit Ideas, October 1981 issue) undoubtedly produces the correct conversion, it is inefficient in terms of component count. This is a direct result of the generation of a wealth of redundant terms, a problem which increases with the number of bits being used in the system. A ten-bit converter, for example, would require 45 exclusive-Or gates.

An alternative circuit is given in Fig. 1, which merely requires one gate fewer than the number of bits in the code. This drastic reduction in parts is possible because,

---

Logic table for 2516

<table>
<thead>
<tr>
<th>CE</th>
<th>OE</th>
<th>( V_{pp} )</th>
<th>( D_{out} )</th>
<th>Output</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>+5</td>
<td>( D_n )</td>
<td>read</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>+5</td>
<td>high Z</td>
<td>standby</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or L</td>
<td></td>
<td>+5</td>
<td>high Z</td>
<td></td>
</tr>
</tbody>
</table>
pulsed L-to-H | +25 | \( D_n \)    | program  |        |
| L  | L  | +25         | \( D_{out} \)| program verify|          |
| L  | H  | +25         | high Z      | program inhibit|        |

---

WIRELESS WORLD NOVEMBER 1982

55
as with And and Or gates, a combinational network using several exclusive-Or gates in cascade to increase the number of inputs also allows these inputs to be interchangeable. Considering part of J. J. Mouton’s circuit, Fig. 2, a term D has been generated from input A being exclusive Ored with input B, which has further been exclusive Ored with input C. The Boolean expression for this is

\[ A_{out} = A \cdot B \cdot C + A \cdot B \cdot C + A \cdot B \cdot C + A \cdot B \cdot C. \]

Exclusive-Or gate 1 may be eliminated by exclusive-Oring the already derived output B with the input A. The only difference is that to produce the A output, input terms A and C have been exchanged yielding the term

\[ A_{out} = A \cdot B \cdot C + A \cdot B \cdot C + A \cdot B \cdot C + A \cdot B \cdot C \]

which is equivalent to the previous expression. This principle can be propagated through each successive bit, eliminating the redundant gates and producing the circuit of Fig. 1 which may be expanded to any number of terms.

P. Gladdish
Holbrook
Derbyshire

Here is a more elegant solution to the binary-Gray interconversion logic; if the original idea had interest, this smaller implementation presumably has greater interest. I cannot claim any originality in the design (e.g. “Switching theory in space technology”, pp. 75-76, 1963). The improved circuit, Fig. 3, is in the same form as the original, although this is not intended as parody.

A number in binary with n bits has a corresponding Gray code with n bits. The number zero is represented by all bits zero in both codes. When any number is incremented the binary code changes one or more bits in a connected sequence, including the 1’s.b. The corresponding Gray code changes only one bit, the one corresponding to the highest changed bit in the binary sequence. Code interconversion may be achieved as shown.

P. Kirkby
Ipswich

**Automatic intensity control for leds**

To save power and reduce glare at low ambient-light levels this simple circuit keeps luminance roughly proportional to incident illumination over more than two decades. Operation of the circuit is unnoticeable even with rapid changes of illumination and the circuit consumes no current when the display is blanked; thermal effects are imperceptible.

The original circuit running from a 10V supply produced sufficient brightness to be easily readable in bright daylight, except with direct sunlight on the display, using a high-brightness orange two-digit display. Resistor R₁ was chosen to suit the I.D.R., used behind a mask with a 1 mm² aperture. Lowering R₃ reduces the minimum led current. Due to the necessity to monitor the current through at least one led, segment c must be used in conjunction with any other except f.

M. G. Rainer
St Ives
Cambridgeshire
Clock-triggered triangular generator

In the circuit of G. Tombras (June 1982, page 60) output signals of the two CD4013 act as control signals to the analogue switches. From his circuit diagram +5V and 0V represent high and low signal states respectively. But c.m.o.s. analogue switches permit peak input-signal voltage swings within the full supply voltage range; peak input-signal voltage swings outside this range cannot be transmitted.

The circuit is easily adapted by logic level shifters which can be simply inserted between the 0 output of the D-flip flops (CD4013) and the control inputs of the analogue switches (CD4016) to act as interfaces between the different logic levels, H = +5V and L = 0V of the output signals of the CD4013 on one hand and that of the valid control input signals (H = 0V and L = -5V) of the CD4016 on the other.

C. C. Odukwe
Gelsenkirchen-Buer
Germany

---

Speed control for small motors

Designed initially for use in a floppy-tape transport mechanism, this circuit senses back-e.m.f. for speed control. Unlike similar circuits, this one also detects current and can differentiate between motor voltage due to back-e.m.f. and that due to resistive loading. In addition, a t.t.l.-compatible on/off input with active braking and independent speed and damping controls are provided. The on/off transistor is a 2N1893 and the braking diode D is a 1N4148. The value of R depends on the supply voltage.

P. H. Pazov
London

---

In our next issue

Morse decoding by microcomputer, by J. P. Sargent, uses a 567 tone decoding l.c. and seven-bit clock to time incoming signals. Morse code is interfaced to a ZX81 via a p.i.o. chip. Machine code routines use this data to provide up to 9 lines of text.

A leading Japanese research engineer, Y. Hirata, discussed the distortions in analogue and digital recordings, gives measurements of non-linearities in four p.c.m. processors, and compares them with results from three analogue tape recorders.

Logic maps, by N. Darwood, gives the history of methods for showing logical truths – from 13th century Lull to present-day Karnaugh maps.

To introduce computer networks, Philip Barker describes some of the current approaches used to link together two or more computer systems.

Picotutor is a microprocessor assembly language trainer, described by Bob Coates, the Nanocomp designer, and assumes no previous experience of microprocessors.

On sale
Nov 17
Researched and Developed by Philips

All-round 50MHz performance for the digital decade

Philips PM 6667-01 Frequency Counter

The PM 6667 is so easy to use, so simple, so trouble-free. Its large, clear digital display, sweep rate control and extensive built-in facilities make the PM 6667 a highly cost-effective instrument. Its high quality and reliability are backed by Philips' 2-year guarantee.

Philips PM 6668-01 Frequency Counter

The PM 6668 features an advanced technology microprocessor and a high-quality C-MOS digital display. It is extremely insensitive to mains voltage variations and is not affected by external interference. The PM 6668 is the ideal instrument for on-site use in laboratories and workshops.

Philips PM 3215 Oscilloscope

The PM 3215 provides a complete, flexible, high-quality instrument, ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

Philips PM 3217 Oscilloscope

The PM 3217 is a high-quality, high-performance instrument ideal for all kinds of electronic testing. Its features and performance make it the perfect tool for professional and educational use.

Philips PM 5107 Function Generator

The Philips PM 5107 provides a complete, flexible, high-quality instrument, ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

Philips PM 5501 Pattern Generator

The Philips PM 5501 is an advanced, high-quality instrument ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

Philips PM 5510 Pattern Generator

The Philips PM 5510 is an advanced, high-quality instrument ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

Philips PM 5715 Pulse Generator

The Philips PM 5715 is an advanced, high-quality instrument ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

Philips PM 5712 Pulse Generator

The Philips PM 5712 is an advanced, high-quality instrument ideal for professional and educational use. Its features and performance make it the perfect tool for all kinds of electronic testing.

All prices exclude VAT and delivery
Philips have appointed Electronic Brokers as their UK Distributor for a range of Philips Electronic Test & Measuring Instruments. As a company with many years experience in the Test & Measurement field, Electronic Brokers are able to offer full technical support as well as demonstration facilities on the premises. The Philips range is offered in addition to our existing Fluke, Hameg and ICE products. All orders are despatched promptly. Contact us for full details (24 hour telephone answering service), or send off the coupon.

**Comprehensive storage plus 50MHz performance**

**Philips PM 3219 Storage Scope**

This remarkable oscilloscope offers advance storage display in addition to an excellent all-round 50MHz/250V and versatile triggering. If you're looking for both comprehensive scope facilities & transients, LP and other cost-effective all-round performance, then look no further than the PM 3219.

£2225.00

**Philips PM 3254 Oscilloscope**

A high-performance packed scope that you can carry into the service environment. Bandwidth is 75MHz with 1MHz sampling up to 1GHz. Touchlight weight compact package with shoulder strap. £360.00

**Philips PM 3255 Oscilloscope**

The PM 3255 has a comprehensively designed sweep time base. It can be triggered and synchronously from the main time base. So you can look at both a main and data base as accurately as you can between data base and data base. It also has a high order, 1MHz, 4MHz, and 1GHz display. £2225.00

**Electronic Brokers**

Distributed by Electronic Brokers

Electronic Brokers Limited
61/65 Kings Cross Road
London WC1X 9LN

Tel: 01-278 3461 Telex 298694 Elebro G

---

**Breakthrough in HF portable performance**

**Philips PM 2521 Digital Measurement Centre**

A multi-function bench DMM for all round lab and workshop use. Features include: 9½-digit, 0.02% 16-Volt, 1.75mA, 10mVDC, True RMS, and true 8-bit measurements down to 0.15°. In addition, 1mA, 10mA, 100mA, and true 8-bit measurements to give an accurate view of the irregular or linear phase. £325.00

**Philips PM 2520 Oscilloscope**

A high-performance packed scope that you can carry into the service environment. Bandwidth is 75MHz with 1MHz sampling up to 1GHz. Touchlight weight compact package with shoulder strap. £360.00

**Philips PM 2517X Digital Multimeter**

A non-compromise 6 digit instrument £195.00

---

Wireless World November 1982
Although the system described in the first part of this article will work very well when the programme sources, the loudspeakers, and the listening conditions are all as good as one would wish, it is, unfortunately, in the nature of things that for part of the time in some circumstances, and all of the time in others, it will be desirable to modify the signal in its route from source to listener. I am, therefore, going to describe some of the more conventional of these signal-modification modules in this part of the series: these are the tone control, the treble filter, and the rumble filter. Since it may be useful at this stage, I am also giving details of the headphone amplifier. These circuits are all based on dual, low-noise, low-distortion operational amplifiers wherever the signal level allowed, and are all, with the necessary exclusion of the headphone amplifier, unity-gain, non-inverting stages, so that they may be included, or omitted, as desired — either in the constructional stage, or by subsequent switching.

**Tone control**

Tone-controls have been the source of some debate among the 'hi-fi' fraternity over the past decade, with the purists insisting that the signal should be accepted, or rejected, as it stands. However, for those of us who are a little less pure, the nature of our tinkering with the frequency response is still an interesting question, and there are a number of options from which to choose. Figure 9 shows the types of frequency response adjustment offered by these.

**Baxandall.** This circuit, originally described in these pages by P. J. Baxandall, over thirty years ago is still the most popular circuit of this type and is used in the majority of audio amplifiers, the world over, in one or other of its contemporary forms. The practical shortcomings of the circuit (a) are mainly that it does not allow any scope for selective adjustment of the frequency response, except for raising or lowering the signal level at bass or treble, though the frequencies at which the lift or cut can be made may be adjusted by switching the capacitor values, as I had done in an earlier amplifier. Also, with standard dual-gang potentiometers, it may not be possible to achieve a level frequency response, simultaneously, in both channels, by any setting of the pots. Finally, although the continuously variable quality of the adjustment is valuable, it does make it more difficult to return to a previously found combination of control positions.

**Graphic equalizer.** The basic intention of the arrangement at (b) is a good one — that the received frequency spectrum should be divided up into eight or nine octave bands, within which the gain of the system can be individually adjusted, as required, by individual, calibrated-slider potentiometers. Alas, in the way in which it is normally implemented, with each octave band being selected by one or other of a group of LC tuned circuits, the transient response of the arrangement, to a square-wave or step-function input, is both complex and unnatural. Moreover, the frequency response, with all of the sliders set 'level' at any point other than the precise mid-position, is likely to be exceedingly ragged. These major limitations, in the bulk of units of this type, have earned the arrangement the reputation of being more for the lover of sound than the lover of music.

**Slope or tilt control.** This concept (c) has recently been proposed, as a means of giving a small but continuous skew to the frequency response, to correct for the sound appearing over-'toppy' or bass heavy, and it does offer some unobtrusive benefits in use. However, like the Baxandall, it does not offer any opportunity to make an adjustment, perhaps quite small, to a particular part of the frequency response where some improvement is required.

**Step frequency adjustment.** Having contemplated this point for some years, the conviction has grown on me that it...
and a level gain-frequency characteristic could be assured when all the lifts and cuts were removed, or where every cut was matched by an equal lift – or vice versa. I have shown one of the possible network arrangements by which these step bass and treble lifts and cuts could be obtained, in an additive manner, in Fig. 10(c) and (d). In this arrangement, the switches are arranged so that each time an RC element, such as \( R_b C_1 \), is switched into circuit, an element of \( R_b \) is switched out of circuit, restoring the potential subsequent gain increment. As shown, any number of switched steps could be adopted, and any required degree of lift or cut. However, there are practical limits, and I have chosen to employ two banks of eight push switches, one for lift, one for cut, which give four possible frequencies each for treble and bass, centred on 800Hz. The centre frequency itself can effectively be raised or lowered by generating a symmetrical shelf on either side, leaving it either on a pedestal or in a trench. Similar trenaes or pedestals may be implemented elsewhere in the spectrum.

In its simplest usage, with a one or two stage successive lift in bass or treble, the results are similar to that given by the familiar and well known Baxandall arrangement, except that the steps are fixed rather than continuously variable, though there is scope for doing very much more than this, if required. I have shown the circuit which I have used for this multiple step tone control, made by combining the separate elements of Figs 10(c) and (d), in its composite form in Fig. 12. This relatively simple implementation of the basic intention of Eq. (c) does have one, not unacceptable, characteristic which is that the lift is partly achieved by a depression of the remainder of the spectrum, such that a +3dB shelf centred on, say, 400Hz would raise the part of the frequency spectrum below this frequency by 2.5dB, while lowering that above it by 0.5dB, and so on, in the manner in which I have shown in Fig. 11.

If need be, the gain control can be used to restore the status quo, or it can simply be accepted as a combination of shelf and slope. A small elaboration of the switching network to remove an equal element of resistance from both arms each time an RC element was introduced into circuit would correct for this, but by this time, I felt that the circuit and its associated switching had grown complex enough. The small capacitor \( C_{B2} \) across the bass circuit op-amp is to avoid possible troubles due to unpredictable inter wiring stray coupling capacitances.

Putting the two successive phase-inverting stages in series fulfils the original stipulation that each module in the preamplifier should have unity gain, and be non-inverting. In the prototype, I have used non-interlocking, push-button, double-pole change-over switches, which can be operated without clicks; indeed, the whole tone control may be switched in and out of circuit noiselessly, to compare 'with' and 'without'. Also, the wish that a flat response should be given with all switches out, and with corresponding pairs in, both singly and in multiples, has been met in practice. My only major regret was that, in designing the p.c.b., I had not gone to the extra trouble of designing the wiring to the switches so that all I had to do was to plug them into the board. However, this regret faded once I had completed the task of wiring it up, and had put right the three or four erroneous connections to the switches shown up by square wave testing, in which certain pairs did not cancel!

**Variable-slope treble filter**

While some form of tone control stage can be useful in trimming the overall characteristics of the unit, the maximum slopes possible will not exceed 6dB/octave, and there may be occasions when some more drastic modification is desired. The circuit of Fig. 13 is a three-element active filter, in which the slope can be varied from -6dB/octave up to a maximum -20dB/octave optimally flat response. The circuit I have used is based on a 'bootstrap' filter design, though a three element Sallen and Key filter could equally well be used with a unity gain, non-inverting amplifier element. I have chosen to use a 'bootstrap'...
filter circuit because I invented it and, in consequence, have a large amount of design calculations in a form which are illegible (to me).

For the convenience of those who may wish to employ the circuit arrangement to give different cut-off frequencies, I have appended the design details at the end of the article. These also cover the circuit component values for the rumble filter which uses the same circuit configuration. A variable-slope circuit at which the pivot frequency (by which I mean the turn-over point) is constant, can be obtained by returning the third-stage integration capacitors (C₁ and C₂) to the top of the slope pot. Unfortunately, this arrangement does not give quite such a good transient response, at all settings of the slope control, as the circuit shown. IC₈ is used as a unity-gain buffer stage to preserve the constant line impedance required by following stages. The input resistor R₄₂ is necessary to prevent the input seeing an open-circuit when the cancel switch (S₂₂) is open.

Rumble filter
This uses a similar three-element bootstrap filter circuit to that of the treble filter, and is shown in Fig. 14.

Since the presence of a small hump in the bass response curve is less significant audibly than the same peak in the treble response, I have calculated the circuit values for a slightly higher 'Q', to give a steeper attenuation rate below the nominal 28Hz transition frequency. I have shown the measured gain/frequency characteristics of the prototype, over the range 9Hz (the lowest frequency from my signal generator) to 1kHz in the Table. Calculations show a value of -43dB at 6Hz, and -49dB at 5Hz, which should give an adequate rejection of turntable v.l.f. components.

In use, the circuit shows very little detectable l.f. coloration, but does remove, very effectively, occasional rumbles from poor discs.

There is no particular preferred position in the post-mixer signal chain for either the treble or rumble filters. They can be inserted wherever it is mechanically or electrically convenient.

Headphone amplifier
My views on headphone listening underwent a change, some few years ago, when I built for a friend a high-quality class A headphone amplifier, in which I had done the very best job that I then knew how, in order to preserve the greatest amount of information obtainable from the groove. Listening to some records through this amplifier was a delightful, and occasionally revealing experience, and showed — perhaps because I was tempted to listen at a somewhat greater sound level than I would have chosen (or would have...
been permitted) on loudspeakers — things which I had not previously heard on the discs in question.

It also, and I suppose there must be a fly in every ointment, showed some records, which I had previously thought to be very good, had substantial unobserved faults — such as the most irritating (once heard) background breathing of a noise reduction circuit, where the increase in hiss once the music increased in volume reminded me strongly of listening to a string quartet playing on a shingle sea shore, where the waves came in as soon as the instruments began to play, and receded again when they stopped.

However, on balance, I think a good headphone amplifier is a 'good thing', and preferably should be placed ahead of the power amplifier, to shorten the audio chain. The snag, for me, was that I already had a very good, though complex, headphone amplifier, and I wanted one which was equally good but simpler to build. Fortunately, the low-distortion i.e. allows a simplification in this area too, and allows a smooth transient response on resistive and reactive loads, and a distortion below 0.01% on all loads down to 8 ohms, up to 3V r.m.s. output. The amplifier will operate in class A under almost all headphone load conditions, especially since the lower-impedance 'phones will generally require a smaller output voltage swing.

To avoid the possible injection of asymmetrical signal components into the smoothed and regulated 15V supply lines used to feed the remainder of the pre-amplifier, I have drawn the large current (40-50mA/channel) supply to the output transistors from the unregulated ±25V line in the power supply unit. This does not contribute any measurable 50 or 100Hz component to the output, though I confess that I was tempted to put in an extra pair of 7815/7915 regulators just to feed the headphone amplifiers. The gain of four seems about the right value to give a similar level on 'phones or on speakers through the power amplifier.

I have shown the circuit diagram for this unit in Fig. 15. The output transistors (four in all, since only one channel is shown) are mounted, with insulating washers, on a piece of aluminium sheet, some 6 x 2in overall, bent into a U-shape to take two transistors on either side. No further mounting fixtures are then required for this plate, which can be painted black, with advantage. The voltage regular i.e.s in the power supply can employ a similar heat sink.
In the next part of this article, I will describe the head amplifier for use with moving-coil pick-up cartridges, the microphone amplifier, the stereo image-width control — which will allow an increase in channel separation as well as a blend facility, the impulse noise-blanker circuit, which allows a useful reduction in the intensity of the annoying clicks and bangs which occur repetitively on a scratched gramophone record, and the signal-strength metering circuit.

References

Appendix
The calculations below refer to the diagrams in Fig. 16, and are calculated to give a unity-gain system with a 0dB point at f0.

Any second-order active filter with a Q value greater than 0.707 will have a frequency response peak at the value I have defined as f0. If a third RC leg is added to restore the gain at this point to unity, the ultimate slope above or below this point can be increased. The optimally flat Butterworth characteristic is given by a third-order filter of this type with a Q of √2, which will give an ultimate attenuation slope of -18dB/octave. The Q can, however, be pushed a bit higher than this without the excursions above and below the datum line becoming too great. For example, a Q of 2.0 in this circuit will give a final slope of about -20dB/octave, with only about 0.4dB ripple.

The practical calculations from these formulae can best be done by deciding the desired Q and the ratio y, and then seeing whether the required frequency of turnover can be given with preferred R and C values. If this is not the case, a different value of y can be used as the basis for a further attempt. Because the original calculations were made with the mathematically convenient assumption that the amplifier was an ideal, unity-gain, non-inverting stage, with high input impedance and low output impedance, and because many of the recent operational amplifier i.cs approximate quite closely to this ideal over the audio passband, these formulae allow the implementation of a whole range of steep-cut filters which can be based on these op-amp i.cs.

A minor word of warning should be added. This type of filter may act as an oscillator if it is installed with its input circuit open, because of the positive feedback path through C2R1 or R5C1. A small value of capacitor or an appropriate resistor connected across the input will prevent this, if the circuit calls for input switching, as in Fig. 14, where C43 is added.

References


---

**Fig. 12.** Amplitude responses of Fig. 11 circuit for both headphone and loudspeaker switch positions.

12dB, a correction circuit has to be constructed to obtain a "flat" amplitude response. In Fig. 9 the turnover frequencies are determined graphically. The resulting frequency response is given as well and shows that deviations from the design objective are smaller than 2dB, which is considered sufficient. A circuit which realises the desired frequency response is given in Fig. 10. The total circuitry is given without further comment in Fig. 11, except that a switch is included for use of the circuitry for "stereophonic headphones" as well as "binaural loudspeakers" (ref. 3). The frequency responses are given in Fig. 12.

For those who want to enjoy life-like sound reproduction, a description of a home-construction binaural microphone can be found in reference 5.

---

```
References
```
The digital generation of a two-phase sine and cosine waveform was described in an earlier article*. In summary, the method, proposed by Pierre Diederich, was to assign initial values to the sine and cosine waveforms. Then for each step to compute the next values by adding a proportion of the cosine to the current value of the sine and subtracting the same proportion of the sine from the current value of the cosine. Supposing the proportion chosen was a half (0.5) this could be expressed in a computer program as:

10 S = n: C = m
20 Output S, C
30 S = S + 0.5*C
40 C = C - 0.5*S
50 GOTO 20

When run, this procedure produces the amplitude of a sine wave. It can be shown to be an approximation of the sum to two angle formulæ thus:

\[ \sin(A + f) = \sin A \cos f + \sin f \cos A. \]

If \( f \) is small, \( \cos f = 1 \) and \( \sin f = f \) (in radians). Substituting,

\[ \sin(A + f) = \sin A + f \cos A. \]

Returning to the program, the wave form may be inverted, seeming to run backwards by interchanging the + and - signs. The output gives a stepped version of the waveform and a D-to-A converter may be used to give an analogue signal. The step size is 0.5 radians, giving 12.5 steps per cycle. Other step sizes may be chosen by altering the value of \( f \) (see Appendix). For example a value of 0.1 could be chosen to give a program:

10 S = 0: C = 1: f = 0.1
20 Output S, C
30 S = S + f*C
40 C = C - f*S
50 GOTO 20

This step size of 0.1 radians gives 62.8 steps per cycle in the output waveform. The amplitude of the waveform can be specified by altering line 30 to read \( S = S + f(C + A) \) where \( A \) is the required peak amplitude. As each step takes the same amount of computer time, altering the step size (f) changes the frequency of the output wave. The frequency will depend on the speed of the computer used.


**Table 1. Three-phase software**

<table>
<thead>
<tr>
<th>Step</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>1</td>
<td>=</td>
<td>0.866</td>
<td>=</td>
</tr>
<tr>
<td>2</td>
<td>=</td>
<td>0.866</td>
<td>=</td>
</tr>
<tr>
<td>3</td>
<td>=</td>
<td>0.866</td>
<td>=</td>
</tr>
<tr>
<td>4</td>
<td>=</td>
<td>0.866</td>
<td>=</td>
</tr>
<tr>
<td>5</td>
<td>=</td>
<td>0.866</td>
<td>=</td>
</tr>
</tbody>
</table>


In the program for generating three phases, \( A, B \) and \( C \) are the phases, each 2\pi/3 apart. The initial conditions set are \( A = 0 \), \( B = \sin 2\pi/3 \) and \( C = \sin 2\pi/3. \) The step size was chosen as \( \sqrt{3}/f \) where \( f \) is the fraction used in the program. The presence of \( \sqrt{3} \) is coincidental as will be seen later.

**Table 2. 7-phase software**

<table>
<thead>
<tr>
<th>Step</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>1</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>2</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>3</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>4</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
<tr>
<td>5</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
<td>0</td>
<td>=</td>
</tr>
</tbody>
</table>


The seven-phase generator shown above is in its longer version and computing time can be saved by reducing it. To explain the short form, consider the coefficient of \( f \) for phase \( A. \) From Table 2 this is \( B - C + D - E + F - G. \) We can call this \( I \) (for initial value) and then look at the coefficient for \( B, \) which is \( C - D + E + F - G - A \) which is equal to \( B - (A + I) \) and which becomes the new \( I. \) Similarly the coefficient for \( C \) is \( D - E + F - G + A - B \) which is equal to \( C - (B + I) \) and which becomes the new \( I. \) Thus we can generate all the coefficients for the short form of the program. The initial value of \( I \) may be found from \( I = B - C + D - E + F - G. \) In trigonometrical terms this is:

\[ I = \sin(\omega - \sin 2\omega + \sin 3\omega + \ldots \) \]

where \( \omega = 2\pi \) divided by the number of phases (\( N. \))

Surprisingly, considering it came from an approximation, \( I \) is found to be \( \sin(1 + \cos \omega) \) where \( \omega = 2\pi/N. \) This has the golden property that the inverse of \( I \) is \( \sin(1 - \cos \omega), \) which may be shown as follows:

\[ \sin^2(1 - \cos^2 \omega) = (1 + \cos \omega)(1 - \cos \omega) \]

The output at \( A, B, C, D, E, F, G \) is given by:

**Table 3. 7-phase software, short form program**

<table>
<thead>
<tr>
<th>Step</th>
<th>A to G have the same initial values as in Table 2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>( I = B - C + D - E + F - G )</td>
</tr>
<tr>
<td>1</td>
<td>( I = B - (A + I) )</td>
</tr>
<tr>
<td>2</td>
<td>( I = C - (B + I) )</td>
</tr>
<tr>
<td>3</td>
<td>( I = D - (C + I) )</td>
</tr>
<tr>
<td>4</td>
<td>( I = E - (D + I) )</td>
</tr>
<tr>
<td>5</td>
<td>( I = F - (E + I) )</td>
</tr>
<tr>
<td>6</td>
<td>( I = G - (F + I) )</td>
</tr>
<tr>
<td>7</td>
<td>( I = G + I^2 )</td>
</tr>
</tbody>
</table>

For a 5-phase program, \( N = 5, \) and \( \omega = 2\pi/5. \) This would make \( I = \sin 2\pi/5 - \sin 2\pi/5 + \sin 2\pi/5 - \sin 4\pi/5 = 0.73, \) \( f \) may be found by selecting a step size. As the step size is I.F., suppose that we would like to make this 1\( f, i.e. 360 \) steps per cycle. I.F. is then 0.075 radians and we have established that 1 is 0.73 so \( f = 0.024. \)

**Appendix**

Let \( \sin(n) \) be the value of the sine wave at step \( n \) and assume the following procedure.

**Table 4. Analysis**

<table>
<thead>
<tr>
<th>Step</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

\[ \sin f = -f^3 + f^5 \]

\[ \cos f = -f^2 + f^4 \]

\[ \sin(1 - \cos) = \sin(1 + \cos) \]

\[ 1 + \cos = 1 - \cos \]

\[ \sin 2\omega + \sin 3\omega + \ldots \]
TELETEXT DECODER

Readers may be interested in two further modifications to the Wireless World teletext decoder, following those given in the October issue.

(V) Addition of board IV involved the removal of IC1, which, upon inspection, supplied OV to R4 via pin 10. While the decoder will still operate without this connection being made, it is preferable to restore the connection to OV, thus giving the correct time constant and greater phase margin at this point of the circuit. Re-adjustment of VR1 will then be necessary.

(VI) In the original decoder design, the memory-address converter functions correctly only for row addresses within the text display area, i.e. rows in the range 0-23. If the detected five-bit row address corresponds to n, one of the remaining rows in the range 24-31, this 'row' will appear in columns 33-40 of rows n-24, n-16 and n-8 due to the operation of the code converter during the display period (WW Feb. 1976 p.50). A simple modification to prevent such information being written into the memory is as follows: isolate 70(11), feed 20(12) and 20(2) to the inputs of a 2 input Nand gate whose output is connected to 70(11). This disables write pulses at 70(8) during the detected illegal rows.

Ken Drew
Nottingham

THE RIGHT FORMULA

Mr K. Wood cites an example in Letters, September 1982, which was not the one I had in mind. The one that intrigued me was a throwaway remark by Patrick Moore that an American observatory (I forgot to catch the name) had observed the products of a supernova expanding at ten times the speed of light. I do not believe any valid explanation has as yet been put forward for the phenomena.

Mr O. B. Bales has figures closely paralleling my own. I get in no way to me is why it is a mathematical 'figure'? It seems an artificial form of mass to 'lose', yet plainly it does not exist. Perhaps it is 'relativistic mass' which is the figuring.

Mr Ivo Cort seemed rather tetchy! I suppose it must be rather frustrating when adjudicators demand 'proof' and he simply doesn't have any! Why is he so bitter about 'instrumentalists'? Is there any way of working with electronics without using instruments? He implies he uses a sampling oscilloscope and certainly uses a computer. His remark that 'today, hardly anyone can successfully assemble 1ns logic' is highly suspect, since pulse circuitry is peculiarly adaptable to analysis by computers and checking by multiple-beam oscilloscopes. Is it really true that Mr Catt's theory came before he had found out how to do the job? Is a 'theory', anyway? I read his letter and find he uses the word to mean (a) an equation, (b) an aid to understanding, (c) an extension of electromagnetic concepts and (d) a new way to view the phenomena. All in one letter! Surely the engineering comes first. Later on, the academics follow along, as always a few years behind! After all, isn't the whole fun of electronics the fact that we don't know how anything really works, we just know that if we do so'n'so, such'n'such happens and on such slender bases huge industries grow.

I would merely ask Mr Catt two questions. What is the use of a theory if it doesn't predict what a circuit will do?

The second question is an equation:

\[ E = \frac{1}{R} \]

Ronald G. Young
Peachaven
Sussex

NIKOLA TESLA

Martin Bernier is, perhaps, right to chide me gently for seeking a second centennial for the famous N. Tesla (WW, Letters, Sept., 1982, p.41). However, I do feel that Tesla is more to be respected for his work than for the accident of birth. Meanwhile we have about ten years in which to debate this point in regard to his radio-frequency spark generator of 1892. Martin Bernier also reflects the hope that many historians must cherish - that somebody else will tackle the more difficult subjects! Tesla's writing makes excellent reading, but it is terribly short of vital technical information. I am sure it would be much easier to write about the less-known and certainly deserving Elihu Thomson, simply because Thomson wrote more clearly and more factually. And Thomson also had the grace to cite the earlier work of Rowland in 1859, who used a Ruhmkorff coil as high voltage source. Classen seemed to be doing much the same in Germany in 1890, but more effectively by using an air-blast on the high-voltage spark. Classen acknowledged Rijke for this idea, one of the most fruitful contributions to the technology of spark transmitters, as far apart as Australia and the Eiffel Tower. Its widespread application may actually have been helped by the difficulty of establishing patent rights on a blast of air! Tesla's patent agents neatly avoid this kind of problem in his patent 645,576 of 1900; for they were wise enough to include a disclaimer on the actual apparatus itself. I suspect that this may well have helped the Supreme Court to find in his favour, even if his claim seems to have little technical merit to support it.

Desmond Thackeray
University of Surrey
Guildford

References
1. Elektrician, 44, (1899, Nov. 3), 40, Elihu Thomson
2. Annalen, 39, (1890), 647, H. Classen (reference supplied by Alan Douglas)
3. Pogg. Annalen, 117, (1862), 276, Rijke

IT'LL DO, PERHAPS

I was very interested in the August letters headed "IT'll do — or will it?" - so much that I have felt impelled to join in the argument.

Mr Feeney complains, quite rightly, about two faults which he feels should not have happened. The replies are jewels of their kind and should be framed and hung in every sales manager's office.

Mr Bennett carefully evades the main issue in the design he is defending. Surely he can see that if a fuse goes high resistance, for any reason, and by doing so causes damage to the components it is supposed to be protecting, then the design is at fault. The bit about this being the only case that they know about is a refrain heard so often by purchasers of electronic equipment in this country that the majority of us can join in after the third or fourth hate. His last line is worthy of further study. Why was production stopped? Perhaps the product got a bad name for some reason or other and didn't sell too well.

Mr Topping's reply is a much more upmarket version. Here again there is not the slightest intention of accepting the criticism and doing something about it. Instead we are treated to a short advertising blurb, followed by praises for the designer of the self-destructing amplifier (again the main point is evaded. A fuse should protect by its absence, not destroy), and we discover that the design in question had a market life of only four years. All interesting stuff to an industrial archaeologist no doubt, but it doesn't make the product any less of a failure.

Following this excursion Mr Topping finally gets down to his own product. In the first paragraph on this subject he appears to accept full responsibility for the equipment, in spite of it being of Japanese manufacture. This is where it should be. If you sell a product, it is your responsibility. Full marks here. But what follows? An argument based on what is known as the absence of authority. That is, the specification referred to and it is absent because Mr Topping keeps it so (presumably with good reason). Again the main point is evaded. The switch failed, Mr Topping, and any number of customers have been conned by a product which, on the face of it, doesn't seem to change that fact. The moral of all this is plain to see. Complain to a British manufacturer and if you get a reply at all it will be one of the above. I worked with electronic instruments for nine years at one factory and felt that the society of psychological research would have been interested in the number of unique events which happened to us. At no time can I recall a single manufacturer offering to do something about it.

I suggest that the manufacturers take note and listen to their customers while they still have some, or they will go the same way as the cotton mills and motor bikes.

H. E. Hicks
Nether Kollett
Lancs

AMATEURS AND CB

Contrary to Mr Clayton's assertion (Letters, Wireless World, August, 1982) illegal broadcasting stations are traced and those involved are, where possible, prosecuted.

Mr Clayton was certainly misinformed if he was told — not by Home Office officials incidentally — that the Home Office would not pursue such prosecutions. We do. A pity that you did not check this allegation with us.

In 1981, nine such stations were involved in successful prosecutions and 14 people were convicted; further prosecutions are being undertaken this year.

A. Wood
Chief Press Officer
Home Office
DIGITAL CONTROL OF THYRISTORS

I read with some interest the article by Dr Pardoe on digital phase control of thyristors (WW, Sept. 1982, p. 45). The system has some similarity with that described in the article by myself and N. M. Allinson (Microprocessor Controlled Lighting System - WW, April 1982, p. 36). Since our article was concerned with lighting control devices rather than lighting dimmers, I would like to take this opportunity to expand on the principles of phase-control dimmer design.

Our first article described the complex non-linear relationship between conduction angle and the perceived light output. Since the function is very difficult to synthesize using analogue methods, most analogue dimmers I have come across use a linear ramp. This allows the ramp generator circuitry to be kept quite simple and easy to align. Since the mains voltage and frequency is subject to variation a simple open-loop generator is not adequate. To overcome these problems the ramp generators are enclosed in a negative feedback arrangement which allows stabilization of both ramp height and linearity. Using components of reasonable tolerance and a reasonable circuit design, analogue dimmers can be built which require no adjustments.

The major problem in designing lighting dimmers is arranging for all channels to track each other; this is readily achieved by using one ramp generator (or its digital equivalent) to drive many comparators. The ramp generator can then be made quite sophisticated without increasing significantly the cost of the system. The article by Dr Pardoe uses a separate oscillator and counter arrangement for each channel. This is possible, but not cheap and not locked to the mains frequency and is dependent upon the tolerance of two passive components. Assuming that the oscillator is running at 50 Hz, a 2% variation in mains frequency will result in the loss of 1/2 bit at the maximum power end of the control range. Given a 5% tolerance in the components used in the oscillator circuit will give to a rough approximation a 5% tolerance in oscillator frequency which is well outside frequency limits permitted on the mains supply. The most marked effect on the oscillation frequency tolerance will be poor tracking between separate channels on the mid power control range when DLDp is at its greatest where L is luminous intensity and \( \theta \) conduction angle (See WW April 1982, p. 37, Fig. 4).

As Dr Pardoe points out, in order to eliminate motor creep and light flicker the ramp generator (analogue or digital) must be synchronized to the zero volt crossing points of the mains. The trial trigger circuit shown by Dr Pardoe does, in fact, produce one pulse per half mains cycle; whilst this trigger method is entirely satisfactory for essentially resistive loads (lamps, heaters) it is inadequate for inductive loads. When switching inductive loads, current will still be flowing through the switching devices at zero voltage crossing points of the mains. Since a simple pulse may occur during the 'reverse' current period incorrect operation would result. This problem may be overcome by using a train of square pulses present spurious triggering, no gate pulses should occur between the zero crossing point of the mains and the desired trigger point.

The equation given for the current in the primary of the pulse transformer is correct; however, the energy stored in the pulse transformer is dissipated in the diode across the primary. Assuming a suitably rated transistor, removal of the diode will allow the stored energy to produce additional gate drive.

While Dr Pardoe's circuit does provide a simple and cheaply controlling conduction angle in phase control, I would not recommend its use in a multi-channel system because of the tracking problems already mentioned. Additionally in a multi-channel system I believe that a solution based on our article would produce a cheaper system, since only one oscillator and counter are used for many channels and there will be no possibility of resonance.

J. D. H. White
University of Keele
Staffordshire

CITIZENS' BAND

I would like to reply to Mr Briggs and Mr Hewlett in July Letters: I will deal with the main points only.

When Mr Briggs says that there is nothing political about the CB pirates, what he means is that there is nothing consciously political about them. Nevertheless, whether they know it or not they are engaged in a political act; which is a revolt against an arbitrary power which had wrongly denied them a CB service.

I agree that not all CB users are young and that the F.M. service does have some technical merit. I did not mean to imply otherwise and I am sure Mr Steedman didn't either.

I am accused of being petulant, which means complaining and impertinent; but if more people were impatient and complained about problems a lot more fiercely then the problems would be solved a lot more quickly.

Mr Hewlett says that he can 'get enough of the other thing' from the rest of the media, but as far as CB is concerned this does not appear to be true. I am not aware that any other part of the media has discussed the true causes of illegal CB interference, so if WW did not discuss them they would not be discussed at all, and the chance to learn from the experience would be lost.

In my letter in the March issue I was trying to make a very serious point, which is that the interference caused by illegal CB has a political cause; and that part of that cause is the tyranny of an unelected, unaccountable, unscrupulous higher-civil-service, which is immune to rational argument. Jo Grimond, MP, has described the civil service in the following way: "Rigid, non-elective, hierarchical, cautious, secretive, conformist, narrow, furthering the interests of an apparatus and the careers of those within it in opposition to the general public interest." (See Conservative Politicalcentre, 9th March 1970, p. 138)

Now, to my letter in the October 1981 issue on the above subject has provoked some comment in subsequent issues and that is a good thing.

Some correspondents have made the mistake of confusing the subject of "splatter" with the subject of "spreading." Until the amateur radio movement recognises that the two phenomena are separate and distinct, and learns to study each phenomenon separately and in isolation, they will not come to a proper understanding of either. My letter in the Oct. 81 issue, acting on the principle of "one thing at a time", referred to spreading — just that — and it would be desirable to confine discussion for the present to that subject.

Now, so far as spreading is concerned, I am saying that a single-sideband transmitter properly and correctly operated and occupying no more than 3 kHz of spectrum space, may nevertheless appear on a receiver, if assessment is made by 5-meter readings in conjunction with dial frequency calibration, to be occupying more than that space, possibly much more; I am saying that this is not because the transmitter is radiating energy over the wider band, but is due to an effect in the receiver itself due to a combination of the effects of selectivity and a.g.c. There can be no doubt about the truth of that statement. It can be demonstrated by mathe-
Consider the following simple exercise as an aid to thought. Refer to Fig. 1 which shows an elementary receiver to which has been added a digital frequency meter connected to the h.f. oscillator, the S-meter having been replaced with a vacuum-tube voltmeter or similar instrument as shown. Assume further that there is a crystal oscillator on the bench some short distance away putting out a signal of comfortable strength. The receiver is operated in the first instance without the benefit of age, that is to say, under manual r.f. gain control.

Tune the receiver across the crystal frequency and plot output voltage (read from the v.t.v.m.) versus frequency, maintaining the receiver at a constant level of sensitivity. You will obtain a curve rather like Fig. 2. This is a selectivity curve for the receiver under this set of conditions. There is a whole family of such curves, and the parameter of the set of curves is the r.f. gain of the receiver, however it be defined quantitatively. To emphasize this point I have shown (Fig. 3) four such curves A, B, C and D, extracted from the family, in descending order of receiver sensitivity.

Switch on the a.g.c. and tune across the crystal frequency \( f_0 \) as before, commencing well below \( f_0 \) and proceeding to well above \( f_0 \). Coming along the curve of Fig. 2 (re-drawn in Fig. 4) you proceed to the point R. Here the a.g.c. takes control, the point R being determined by the voltage-delay of the a.g.c. system. Tuning higher in frequency the a.g.c. maintains the output constant, until finally we exit from the control of the a.g.c. at point S and continue along the original selectivity curve. Someone, expert in the Red Herring Department, will want to argue with me about the practical niceties of a.g.c.; some other time, please!

The output meter shows substantial output across a band of frequencies \( \Delta f \). This does not mean that the transmitter under scrutiny is actually radiating energy across the whole of the band \( \Delta f \). The transmitter (in this case a crystal oscillator) is radiating energy on one single frequency only, viz. \( f_0 \). Only a very stupid person would attempt to argue that, because the output meter shows a substantial reading across a band of frequencies, this is proof that the transmitter is transmitting over the whole of that band of frequencies.

What has all this to do with a single-sideband transmitter? If you can understand the above reasoning, then you can understand why a single-sideband transmitter radiating over a 3 kHz bandwidth can provoke your S-meter to a substantial reading over a band of 8 or 10 kHz, or even more: the principle is the same in both cases.

One further point - I should have said earlier that when you traverse the section RS in Fig. 4 as described above you are in effect hopping from one selectivity curve to another. This is indicated in the sketch. There is, of course, an infinite number of such curves, so that it is a smooth transition.

And finally - you will note that if you turn up the r.f. gain and allow the a.g.c. to control the receiver, the impression of broadness is enhanced, because you are working across a curve such as A (Fig. 3). But if you turn down the r.f. gain control the apparent broadness is reduced, because you now work across a curve such as C or D. A single-sideband transmitter will exhibit the same effect — naturally — and the effect may easily be observed by a competent operator.

R. C. Yates
Charlestown
N.S.W.

WIDE-RANGE NOISE GENERATOR

With reference to Mr Ian Hickman’s article in the July 1982 issue of Wireless World, I should like to suggest that if the 28-stage digital noise generator really works with a shift register pattern of \( 2^{28} - 1 \) different states (the maximum length), this can only be the case because theoretical limitations are compensated by electronic anomalies. Obviously, these “shortcomings” may go completely unnoticed in practice and therefore the object of my letter is not to imply that the design is incapable of producing a wide range of very useful and interesting noise effects. Nevertheless theory and implementation (however elaborate) of this shift-register application show several doubtful points worth mentioning. In this respect it is, for instance, revealing that the practical implementation as given in Fig. 3 does not indicate where the second Ex-Or-input comes from. A correct feedback configuration is far more difficult to find than is suggested in the mathematical “explanation”.

The first incorrect statement is in the general case a maximum-length sequence can always be obtained by using an Ex-Or gate with two inputs only: one from the last register stage, the second from “the correct earlier stage”. This applies only to shift registers with up to seven stages, but the 8-stage case already invalidates the above “theorem”. When an 8-stage implementation is used, eight different feedback configurations can be envisaged. In each case let us examine the sequence starting with the 11111111-state, the Ex-Or output determining the first bit (most left).

With both inputs coming from the 8th stage (most right), the Ex-Or will always turn out a zero and the sequence will never come back to the 11111111-state again; with the second Ex-Or input connected either to the 7th or to the 1st stage output, the sequence will have a length of 51; using either the 6th or the 2nd stage output, the sequence will have a length of 217 (which is still far less than the maximum \( 2^8 - 1 = 255 \)); finally using the 4th stage output, the pattern will have a length of only 12. As a matter of fact, maximum length shift register sequences can always be obtained, but for practical use the configuration should generally apply to more than just two stages.

The second erroneous statement is that the maximum-length pattern will establish itself, provided at least one of the shift register stages comes on with a 1-output. Let us once again consider the relatively easier case of an 8-stage shift register and let the feedback function be taken from the 8th stage and the 5th stage. It can now easily be discovered that four different sequences are possible: one is 217 long and contains 11111111, the second is 31 steps long and contains the 11111101-state, the third is seven steps long and contains 10011101, the last one is the indefinitely repeating 00000000-state. When the shift register operating conditions are normal, one sequence (e.g. the one which contains the 1111101-state) will never jump to a different sequence (e.g. the one which contains the 11111111-state).

This clearly demonstrates that much more careful analysis is needed in order to establish whether in the particular case of a 28-stage shift register the maximum-length sequence of \( 2^{28} - 1 \) can be obtained with an Ex-Or gate having only two inputs! By the way, a full 28-sequ
ence can also be obtained, but this requires a feedback function a little bit more elaborate than just an Ex-Or array connected in a parity check configuration. The two misinterpretations should immediately have come to the mind of the author when he observed the (unexplainable!) peculiar circuit behaviour (long start-up effect, periods of silence alternating with hiss, apparently jumping from sequence to another etc. etc.). May I suggest this could probably be explained by shortcomings in the circuit design (e.g. power supply rating too low, or decoupling near the IC insufficient, or spike pick-up by the unconnected gate inputs supposed to be at the high level, or wrong time constants giving long lasting amplifier saturation effects after power turn-on, etc.).

More detailed information on the actual circuit layout might have been helpful, together with photographs and oscillograms. I doubt very much whether this circuit is easily reproducible! Faulty operation may arrange matters!

Lengthwise Mr Naaijer could reveal the actual feedback function, as it should have been indicated in his Fig. 3, in order to obtain really the longest sequence (starting with the all-zero condition when an Ex-Or invert gate is used). It should be fruitful to investigate how much this longest sequence is actually off the maximum length of $2^n-1$. Even if the difference between projected and actual length turns out to be small, it should still be emphasized that the electronic implementation wouldn't fully exploit the lower frequency range, the values of the coupling capacitors in the filter, attenuator and output circuits as shown in Fig. 4 are too small, except for the audio use; when the filter is set to 10Hz low-pass, the result is actually rather a band-pass! In applications other than audio this might limit the circuits effectiveness.

One might ask the question whether, for audio purposes, a shorter shift register wouldn't have given comparable results when designed correctly! Apart from these remarks, fundamentales from a theoretical point of view, it goes without saying that Mr. Naaijer's circuit can be very instructive for musical applications.

G. J. Naaijer
Louviers France

The author replies:

Before dealing with the points raised by Mr Naaijer I should like to correct one or two minor graphical errors which crept into the article as published.

In Fig. 1(a) the second input to the exclusive OR gate should be labelled "From final stage Q output", where m is of course less than n.

In Fig. 3, the input to pin 12 of IC10 should come from pin 13 of IC4.

In Fig. 4, IC3 and IC8 are the two sections of 22kΩ twin-gang potentiometer, and references to R35 or R36 in Fig. 5 and throughout the text should read "R53/R56".

The references to "Rb4" in the 25th line of the third column of page 40 and in the last two paragraphs of the article should read "R35/R36".

The negative end of C3 in Fig. 6 should go to 0V chassis.

Mr Naaijer should have made it clear that following normal practice, all unused gate inputs in Fig. 3 are returned to 5V via a 1kΩ resistor.

Turning now to Mr Naaijer’s letter, he questions whether a shorter shift register would be adequate. A 28-stage register was arrived at from the following considerations.

It was desired to have white noise with a Gaussian amplitude available to as high a frequency as conveniently possible, say 100kHz. It was clear that the necessary number of stages would be of the order of 25, and a modest clock frequency of around 5MHz is convenient for a white-noise generator employing standard t.t.l. gates. As stated in the article, Gaussian noise is obtained if the sequence is filtered with a cut-off frequency lower than f0 = 100kHz × 5MHz × 1 = 0.020kHz. Thus Gaussian noise is available up to about 100kHz as required. At the low-frequency end of the range, the frequency of the lowest spectral line in the output is of little interest in itself - the important consideration is the spacing between spectral lines at the lowest frequency of interest. This was taken as 10Hz, and the possibility of external band-pass filtering with a Q of 100 was catered for. The 3dB bandwidth would then be 0.1Hz. Now using SN7495s, six devices would provide a 24 stage register and the maximal length pattern would repeat at approx. 0.3Hz. Thus the spacing between the spectral lines would be greater than the filter bandwidth and the Gaussian sequence would not (in this admittedly extreme case) appear white.

Adding a seventh 7495 provides a 28 stage register, giving a spacing between spectral lines of 0.022Hz, which is quite adequate. It is interesting to note that in his white-noise generator design, published in Wireless World in March 1972, used a 31 stage register (although 32 stages were available in the i.c.).

The purpose of the article was to describe the design and use of a white noise generator, the subject of maximal length shift registers may be beyond the scope of this article.

As all readers have pointed out that none of the brief tests I was able to conduct in the frequency domain could distinguish between the noise produced and that produced using the correct maximal length sequence. Nevertheless I am grateful to Mr Naaijer for pointing out the snag, to which there is, as I have indicated, a convenient and simple solution.

OPTO-ELECTRONIC CONTACT BREAKER

In your Letters column of September 1982 Stevenson complained that he was unable to obtain the i.c. specified for my opto-electronic contact breaker, and transformer for Rod Cooper's c.d. unit.

I can assure him that in the case of the i.c. that component is crucial to the reliability of the circuit. I have written before in WW that the environment in which automotive electronics have to work is far from ideal, and it is not unreasonable to specify a 54-series device in an engine-mounted application. Like Rod Cooper, I am conscious of the need to specify obtainable parts, but there is a converse argument which suggests that sticking to parts from the corner shop stultifies design. This notwithstanding, I wrote on p.67 of the February 1982 issue the name of a Texas Instruments supplier (Quadrond Electronics) and many more springs to mind.

In conclusion, I am grateful to the editors of WW for the opportunity to publish this letter.
DISC-DRIVE CONTROLLERS

Control logic, the penultimate subject in the disc-drive series, divides into data-handling and drive-coordination sections. These sections, and how they are controlled by sequencing logic, are discussed here.

by J. R. Watkinson

Essentially, disc-drive control logic does not vary much from one drive design to another, but because of the wide price/performance range and changes in technology, one cannot assume that all the features mentioned here will be found in all disc-drive units.

Control logic can be thought of as having two main sections — one for controlling the disc subsystem, including circuits for obtaining subsystem status information, and the other for handling data to be stored or retrieved. These sections are coordinated by sequencing logic.

Execution of a function by the disc-control logic requires a complex series of steps determined by logical decisions made between each step. Sequencing logic resembles a processor with subsystem functions as instructions and the steps as states.

As with central processors, sequencers can be implemented either with combinational logic or with rom-controlled microsequencers, but unlike c.p.u.s, sequencers have to work in real time and keep in step with the disc's rotation. Figure 1 shows the essentials of a rom-controlled sequencer.

Control and status. Excluding operator controls, disc drives are controlled entirely by functions and parameters loaded into registers in the subsystem. How the registers are loaded is not unique to disc drives and is therefore not discussed here.

Table 1 shows a list of functions performed by a typical disc subsystem and Fig. 2 depicts the most common functions, read, write and verify. In Fig. 2(a), the disc is altered by data being read from memory and written into it, and changes in memory occur when data are read from the disc, Fig. 2(b). Neither memory nor disc is altered when written data are being verified. In this operation, data are read from the disc and compared word-for-word with data in memory.

Not all disc subsystems have the verify function; in some computer systems data verification is carried out by the main processor at the expense of some processing time.

Figure 2 also illustrates parameters necessary for a data transfer, namely the starting address in memory, the starting address on the disc, and the amount of data to be transferred.

Figure 3 shows a typical register set for a disc subsystem. Most units use direct-memory access (d.m.a.) techniques to transfer data to and from memory without involving the processor. To do this, the

John Watkinson, M.Sc., is with Digital Equipment Co.

Fig. 1. Disc-control sequencer using rom control. Each address generated by the program counter results in one or more control signals being sent to the system. At the same time the event which causes the program to advance to the next step is selected by the input multiplexer. Certain addresses cause a conditional jump and if the conditions are satisfied, a new non-sequential address is loaded into the program counter from the jump-address rom. More advanced units have stack registers enabling them to call subroutines and return afterward.
Fig. 2. Three major data transfer functions performed by a disc subsystem. Write-verify function, (c), is not always used.

The positioner has to move on to the next cylinder. The process is only terminated by a word-count or disc-address overflow.

Disc drives work with blocks of data, and hardware is necessary to prevent malfunction if a specified word count is not a multiple of the block size. When reading, if the word count overflows before the end of a block, the transfer to memory stops but the drive continues to the end of the block to read the error-checking character there. When writing, the disc-control logic pads a partially written block with zeros to retain the standard disc format before the check character. The purpose and operation of check characters will be discussed in the next article. Figure 4 shows the flow-chart for the automatic disc-address incrementing algorithm.

Status circuits give the operating system information about the operation of the drives. The boundary between control and status is difficult to define, since the status path can be thought of as a feedback mechanism for the control process.

On completion of a data transfer function, the status circuits inform the operating system that the disc subsystem is no longer busy by way of an interrupt; as with d.m.a. techniques, the c.p.u. is not involved with the data transfer and will be performing useful processing. Following the interrupt, the operating system will read the disc subsystem’s status register. If all is well, a ready bit is set, but in the event of a malfunction, an error bit will also be set. There are many conditions which could cause such an error signal.

The error bit in the status register is an OR function of all of them, referred to as the composite-error bit.

In a 16-bit system, the ready and error bits are often bits 7 and 15, since these are the sign bits of the low byte and the word respectively. Using ‘test’ or ‘test-byte’ instructions, the processor status word will become negative if the sign bit is set. A conditional branch instruction whose outcome is determined by the processor status is then used to determine the program flow. When an error occurs, the system branches to a routine to read the subsystem error register to find out what has gone wrong.

In the case of a non-data-transfer function, such as a seek or search, the drive will become ready when the operation is complete. Non-data functions can take place simultaneously with a data transfer in a multi drive subsystem, and upon their completion it is necessary to know which drive has become ready. This could be achieved by selecting each drive in turn using the unit-select register in a process.

![Fig. 3. Register set of a typical disc drive. Composite error is set by the change of state of an OR gate with inputs representing many possible error conditions.](image-url)
known as polling, but this is wasteful of processing time. A better alternative is to use the summary register, which contains one bit position for each drive in the subsystem.

When a change of status occurs in one or more drives, a bit pattern is present in the summary register. Any bit present here will cause an interrupt, and the system has only to read the summary register to find out which drive requires attention. When one of the drives has a fault, the composite error bit will be set, as will a bit called drive error in the subsystem error register.

If so, the unit number specified in the summary register has to be loaded into the drive select register. If the c.p.u. now reads the drive-error register, it will obtain the status of the affected drive. Figure 5 shows a typical service-routine flow-chart. Action taken as a result of an error varies from one operating system to another, but typically the error conditions would be recorded in the operating-system error log, and then attempts would be made to clear the error condition by issuing drive-clear or controller-clear commands. Positioning errors normally result in a recalibrate function prior to repeating the failed function. Hardware failures, such as power-supply faults, cause the system to discontinue use of the drive concerned and send appropriate messages to the operator. Such a failure in the swapping disc will usually cripple the whole computer, as the time-sharing process cannot proceed. Action taken to recover from data errors will be detailed later.

Position verification. Before a data transfer can take place, the selected drive must physically access the desired disc block and confirm its position by reading the header. At the end of an implied seek, should one be required, the positioner circuits declare that the heads are on track and settled. The desired head will have been selected by the head matrix, and the next step is to perform a search along the track by comparing the contents of the current-sector, or 'look-ahead' register with the contents of the desired sector register. When the two are equal, the head is about to enter the desired block. Figure 6, the format of a typical disc track, shows that between blocks are placed address marks, which are areas of steady magnetization that generate no read pulses and can be detected by the read circuits.

Following address-mark detection, the data separator starts to synchronize to the header preamble. Any a.g.c. in the read channel will stabilize at this time. Toward the end of the preamble the data separator will be locked to the read signal and will generate zeros (assuming modified f.m.) and the separate bit clock.

Serial data is converted to parallel form by the serializer, Fig. 7, which is based on a shift register. The serializer also has the ability to convert parallel data to serial form for writing operations. Preamble zeros are clocked down the shift register in the serializer by the bit clock, and in due course the sync-byte's pattern shifts through and is recognized by the sync-byte decoder. When this takes place a divider is enabled, which divides the bit clock by the word-length to give a word count, or in some cases a byte count. The word count is decoded by part of the sequencing logic to enable the various steps which take place synchronously with the disc.

Figure 8 shows decoding necessary for the disc format shown in Fig. 6. The first
Table 1. Abbreviated list of functions performed by a disc drive. Only one data-transfer function can take place at a time, but other functions can be performed by different drives in the subsystem at the same time.

<table>
<thead>
<tr>
<th>Function</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Read</td>
<td></td>
</tr>
<tr>
<td>2 Write</td>
<td></td>
</tr>
<tr>
<td>3 Write verify</td>
<td></td>
</tr>
<tr>
<td>4 Read header (and data)</td>
<td></td>
</tr>
<tr>
<td>5 Write header (and data)</td>
<td></td>
</tr>
<tr>
<td>6 Seek - move positioner to new cylinder</td>
<td></td>
</tr>
<tr>
<td>7 Search - interrupt when current sector is same as desired sector</td>
<td></td>
</tr>
<tr>
<td>8 Recalibrate - move positioner to cylinder zero</td>
<td></td>
</tr>
<tr>
<td>9 Offset - move positioner off track centre</td>
<td></td>
</tr>
<tr>
<td>10 Return to centre line - cancel seek</td>
<td></td>
</tr>
<tr>
<td>11 Port release - permit other port access to drive</td>
<td></td>
</tr>
<tr>
<td>12 Standby - unload heads and stop spindle</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Data-transfer function</td>
<td>(see Fig. 2)</td>
</tr>
<tr>
<td>14 Non-data transfer functions which may be issued to another drive at the same time as a data transfer</td>
<td></td>
</tr>
</tbody>
</table>

Header word is the cylinder address, and this is compared with the contents of the desired-cylinder register. The second header word contains both the sector and head addresses of the block, which are also compared with the desired addresses.

Some header formats contain extra information such as bits which specify the density of data in the following block, passwords which are used in high security systems and information about media defects in the data area. Each header finishes with a cyclic-redundancy check character which confirms its validity. Only if the header contained the right addresses and was read correctly will the data transfer take place.

Figure 9 will show a flow-chart for the process of position verification. Automatic reading of the header by the sequencer should not be confused with the read-header command used to place the contents of the selected header in the memory. This is usually only used after a write-header command, to verify that the disc has been formatted properly.

Data transfer. During a data block read, the serializing and sequencer are employed again. As with the header, zeros from the data preamble are clocked into the shift register until the sync. byte is detected, when the next bit will be the first data bit in the block. On every word, the output of the shift register goes around the loop in the serializer and is loaded into the latches. The d.m.a. logic now has finite time to send the word to memory before the next word arrives from the disc. When the word-count decoder decides that the last word in the block has been transferred, check words are sent to the error-checking logic. A description of this operation will be given.

During a write function, header checking is repeated as it is important not to write in the wrong place on a disc. A write process is a little more complex than the read because preambles, sync. bytes and postambles have to be written together with the actual data. To write the preamble, again assuming modified f.m., the serializer is held clear by the sequencer.

At the end of the preamble, the sync-byte pattern is loaded into the shift register. Data words are then loaded into the shift register from memory in order to write the block.

To be continued
Ace computer, ace language?

The most important characteristic of the programming language Forth is that it is a "threaded interpretive language", and not that it uses reverse Polish notation, as frequently reported elsewhere. But in terms of how a Forth computer is received it is interesting to look at Forth and how reverse Polish notation is used. The following analysis is based on experience with a pre-production prototype of the Jupiter Ace computer (News, October issue), and was sent to us by Boris Allan. "I hope the Ace succeeds", he tells us, "it is a very brave initiative, but I do not know whether it will; what I do know is that Ace Forth is the best implementation on small computer I have seen".

Reverse Polish notation seems to imply that it is in some way back-to-front -- the accompanying description uses reverse Polish in the definition of F and so on, and the order does not seem unreasonable. It only becomes "unreasonable" when thinking purely numerically. To have to use 2 + 2 to perform the calculation 2 + 3 may seem odd, though if it is introduced as "take 2 then 3 and then add them together" then it is much more reasonable. Though Forth is not very useful for the numerical, its strengths become more apparent at a higher level of abstraction, yet the Jupiter Ace is aimed at the cheap end of the market. So to what extent is the strange mode of approach a problem?

It is only strange if it is approached in a way which makes it seem strange -- the definition of the Forth word "F" (see panel) does not seem strange. The operation 2 3 + only becomes strange when we say that it is equivalent to 2 + 3, and not when we say that it is equivalent to take 2 and then 3 and add them together. This strangeness is not long-lasting.

A far more important problem with Forth is the ways in which restrictions are placed upon defining and redefining words, and it is the complexity of these manipulations that are far more telling for Forth as an introductory language. To make it easily usable, the defining, redefining, and editing of Forth words needs conceptual simplification. This is where the Ace scores over most other systems.

Ace Forth introduces new words EDIT, LIST, and REDEFINE, which make the changing of Forth words simple for the user. LIST F would produce BAR BLIP BAR BLIP BLIP CR and EDIT F would produce a similar listing, and allow one to edit the listing. After editing there would be an extra version of F on the VLIST (the new version), and if we then entered RE-DEFINE then Forth would search through the words in the dictionary (ie those on the VLIST) and substitute the new definition of F for the old definition (as if we changed a page in our loose-leaf manual). If a word is defined by use of a word not yet defined, there is no way this illegal definition can appear on the VLIST.

It is easy to crash most Forth systems because the checks on what the pro-

Forth: a threaded interpretive language

If the instructions in a repair manual are "unscrew the nut holding the wurbie plate to the ding box, but only after disconnecting the mains supply to the ding box, otherwise you will be electrocuted" there will be a fair number of fatalities. In a t.i.t. the manual has to be written in a sensible order. "First, disconnect the mains supply to the ding box; second, unscrew the nut holding the wurbie to the ding box" so that there are no nasty surprises. It is safe to read ahead in the manual because it makes the whole operation that much slower, and how far forward is it possible to go?

Forth and other t.i.t.s take the sensible approach to reading the manual because it is simpler, and you always know where you are. Any computer program is no more than a set of instructions, and sometimes the same set of instructions are repeated - a truly ignorant person might have to be told, on each occasion, how to unscrew a nut. The manual might then read "First, disconnect the mains supply (see page 1) to the ding box; second, unscrew the nut (see page 2) holding the wurbie to the ding box", where the "(see page . . . )" instructions are pointers to other places in the book. That is, we have the name of the operation, and then the location of the instructions with that name (if there was only one operation per page, the page number alone would be sufficient).

The manual itself is an operation -- repair a Thung -- and is composed of smaller operations, which can then be seen to be composed of even smaller operations, until one reaches certain primitive operations, those which have to be left undefined, eg "pick up a screw-driver". As one goes through the manual new operations are defined before one uses them in terms of the operations which are included in the latest, more complicated, operation. This again is what happens to a t.i.t. (For more details consult Threaded Interpretive Language, by R. G. Loe-linger. Byte Books, 1981.) It is now possible to understand any Forth program. Here is a line of program taken from "Starting Forth," by Leo Brodie (Forth Inc, 1981):

```
F
```

We know that this is an instruction to do something and so we also know that somehow the instructions to which we accompany F will be found. They are

```
BAR BLIP BAR BLIP BLIP CR
BAR BLIP BAR BLIP CR
EDIT F
```

Bar BLIP BAR BLIP BAR BLIP CR and EDIT F produce a similar listing, and allow one to edit the listing. After editing there would be an extra version of F on the VLIST (the new version), and if we then entered RE-DEFINE then Forth would search through the words in the dictionary (ie those on the VLIST) and substitute the new definition of F for the old definition (as if we changed a page in our loose-leaf manual). If a word is defined by use of a word not yet defined, there is no way this illegal definition can appear on the VLIST.

It is easy to crash most Forth systems because the checks on what the pro-

```
BAR BLIP BAR BLIP BAR BLIP CR;
```

where the colon means a word is to be defined (the next word in line) and semi-colon means that is the end of the definition. Try that in Basic; it is possible, but more complicated, using subroutines.

In most versions of Forth if one enters VLIST, an index is produced of all words so far defined and in the order in which they were defined. The order is important because the user of the manual (ie the Forth system) is incapable of looking forward in the manual to find a definition (one can only look back). If in the word F, one of the defining words (eg BLIP) had not already been defined the definition would be invalid. In terms of the output from a VLIST, a word can only be defined in terms of words which are lower down the list. What happens then when a manual is updated, and an improved method of unscrewing nuts is given?

Depending on the manual, various things could happen. If the manual was a loose-leaf manual, the old set of operations could be taken out to be replaced by the new set, and if each new set of instructions started on a new page, the insertion would be that much easier. An alternative method would be to mark the old instructions with a note, "see amendment sheet 14", so that on going to page 2 you would be re-directed to the new set of instructions. Once done, the first is less work to use than the second.

In conventional Forth systems, neither of these methods (or their equivalents) can apply. To change the definition of F so that it will be put closer to the left-hand-side of the screen, all that appears to be necessary is to alter the definition of MARGIN (as BAR and BLIP), and thus
grammer can do are few; it is simple to over-write the words in the dictionary, and for the system to disappear in a puff of smoke. Such things on the Ace didn't succeed. Steve Vickers (the language designer) explains that there were two modes of running programs in Forth on the Ace, FAST and (the default) SLOW.

F or FAST, both depend upon MARGIN in their own definitions, eg

: MARGIN CR 5 SPACES: which is simplicity itself. However, this doesn't work.

If MARGIN is redefined and you ask for a VLIST, MARGIN will be at the top of and further down (lower than BLIP, BAR, or F:) another occurrence of MARGIN. If you type at the console:

MARGIN 10 STARS
You will find a space of 5 blanks and then 10 stars. If you now key F: the output will be exactly the same as the original version. When the computer comes across F: within the body of coding for F there are pointers to the places at which the code for BLIP and BAR can be found. BLIP and BAR still point to the original coding for MARGIN — in with 30 spaces. The introduction of a new definition for MARGIN has not affected anything earlier, and so all the old pointers are unaltered — they can only point backwards, never forwards. Without doubt this is a major problem.

Another problem concerns program development and the editing of source material. Suppose that we define MARGIN with 5 spaces, try it out, and then decide that perhaps it would be better with 10 spaces (then 8 spaces, then ...), what happens? Under VLIST (unless one is careful) a large number of competing and conflicting definitions of MARGIN will appear. It is possible to FORGET MARGIN (erase the last definition) but often it is the kind of action which is easily forgotten. The way in which a source record is kept of the definitions (on what are termed "screens") can in itself lead to problems.

Consider this word, and its definition:

: LOOP-TO-12 130 DO I. CR LOOP;
which prints out numbers from 0 to 12 (the point means print out the last number mentioned, in this case the loop counter I). If that is stored on a screen, and the EDITOR used, the EDITOR redefines I to an edit command, and so every time LOOP-TO-12 is used the word will use the redefined version of I (as per its use in the EDITOR). Unless one is careful more complex interactions can occur.

For a t.i.l. to work most effectively what is needed is a processor which is able to efficiently point to locations which point to locations which point to locations which point to locations. . . . More technically what is needed is a processor with sophisticated addressing modes. The common Z80 or Z80A micro-processor is not known for its sophisticated addressing — the opposite in fact — and though the also popular 6502 is slightly better, there is little to choose between them. The recent Motorola 6809, as used in the Tandy Color Computer and the Dragon, seems to be a chip which would fit the t.i.l. philosophy well.

BORIS ALLAN

Advice to dbs panel

The advisory panel considering technical transmission standards for direct broadcast satellites is accepting advice until early November. The panel, headed by Sir Antony Part once permanent secretary at the Department of Trade and Industry and now chairman of Orion Insurance, includes Roger Griffiths, professor of electronics at Loughborough University, and Alan Day, professor of economics at LSE, with consultant Bernard Rogers as an assessor. Secretary is P. R. Birch, DoI, 29 Bressenden Place, London SW1E 5DT, tel. 01-213 5810. The short notice, according to the Home Secretary in a parliamentary answer, is to enable "the necessary receiving equipment to be ready in time for the projected start of d.b.s. in 1986."

Uosat back in operation

The amateur radio satellite Uosat has been given an "off" command through the large radio telescope dish of the Stanford Research Institute, California. Uosat became uncommandable in April this year when both its 145 and 135MHz transmitting beacons were switched on together. This swamped the command receiver and no further commands could be passed.

Now, the University of Surrey is in full command. All telemetry has been tested and found to be correct as it was originally left in April. Test and analysis programs are being dumped on to the F100 spacecraft computer for future use in the Phase 3 programmes. The 1800 on-board computer is having its software checked to ensure that no false command will be accepted and thus cause the same fault.

The system transmits at various rates during weekday passes but for the next few weeks, at weekends, transmissions will be at 300 baud. Amsat-UK and the University of Surrey invite suggestions from readers on what the data rate should be at weekends to stimulate maximum interest. They would also be grateful for hard copies to be sent to the University for evaluation.

Information on Uosat and Amsat-UK can be obtained from Amsat-UK, London E12 7EJ, by sending a stamped addressed envelope. There is also a guide to operating Oscar available for £1 and the latest satellite information will be included.

After a "perfect countdown" to the launch of Marcels B on 10 September, announced ESA said "an anomaly led to a lower tragedy than required".
HDTV-on-Sea

Visitors to the International Broadcasting Convention at Brighton had a good opportunity to assess the high definition colour televisions system which NHK, the Japanese Broadcasting Corporation, has been developing over the past few years. Sony were demonstrating a camera, monitors, a v.t.r. and a large-screen projector, all working on the 1125-line, 60 field standard proposed by NHK. The pictures are said to contain five to six times the amount of information provided by current NTSC, PAL and SECAM services, but although the images were undoubtedly superior they did not seem as impressive as one might expect from doubling the number of lines and sextupling the video bandwidth to 30MHz. Of course, the relationship between subjective picture quality and objective definition parameters is not a linear one and probably there is a law of diminishing returns here.

Sony's camera uses three 1-inch Saticon tubes with an optical beam-splitter, giving R, G, B signals with a resolution of 1200 television lines. The 17 and 24in colour monitors are based on Trinitron display tubes with a fine-pitch vertical grille (300, and 400µm respectively); while the projector, using red, green and blue 9-inch tubes, throws a picture on a 2000 by 1200mm screen. Recording on the 1-inch v.t.r. is by the f.m. method using Y, U, V signal components with a luminance bandwidth of 22 MHz and chrominance bandwidth of 10MHz.

Of course all this was closed-circuit television, as there does not seem much likelihood of transmitting a 30MHz video bandwidth until direct broadcasting satellites get going. In the meantime it seems more likely that HDTV will have useful applications in the production, distribution and projection of motion pictures. Sony claim that the picture quality "fully matches that of 35mm motion picture film." (But this is not a new idea: older readers in the UK will remember Norman Collins's film production company High Definition Films of some 30 years ago.) Nevertheless there is no reason why high definition equipment of this kind should not be used in the studio well before the capacity to transmit such signals becomes established", in the words of Charles Sandbank, head of the BBC's research department. Indeed if signal processing electronics become cheap enough, it might also be possible to use high definition techniques with advantage in the receiver (the transmission system remaining unchanged and compatible with existing standards). As Mr Sandbank remarked, in his paper on future broadcasting developments, for signals "derived from a high definition studio standard and pre-filtered for compatible 625-line transmission, up-conversion to a higher line standard, e.g. 1250, with adaptive interpolation may also be worthwhile."

However, the same speaker very sensibly pointed out that high definition television broadcasting in the full sense really awaits the time when large-area domestic displays capable of doing justice to a standard with more than 1000 lines become commonplace components."

Wireless telephones legal

- at a price

Rumours that the Government were about to licence sale of wireless telephones were confirmed recently by the Department of Industry. The previous "liberalization" schemes of November last year covering extension telephones and modems, and of May covering callmakers/repeating diallers with integral modems, are now extended to include "cordless" telephones, as the DoI call the wireless extensions to distinguish them from radio telephones.

The devices have to be tested for conformity with technical guide 47, which for a "small charge" is available from J. Jeans, BTHQ, ICS214, 45 Moorfields, London EC2Y 9U, tel: 01-432 9347 (the small charge turns out to be £10). There is a hefty charge for testing; probably between £3,000 and £5,000 will be required before testing begins. In defence of such amounts BT say that ordinary telephone testing already costs around £2,000 (three samples are assessed) and additionally there are r.f. and security aspects to take into account.

Interim Merriman

The Merriman spectrum review committee recommends that the 405-line TV service should be closed by the end of 1984, years earlier than planned. They suggest that the best use of these v.h.f. bands would be for mobile services - radio-telephones and internal and operational communication for the broadcast authorities. The mobile radio allocation plan should be developed in consultation with manufacturers and users by the end of 1983, as should plans for the broadcast ancillary services, to be implemented progressively, starting in 1985. Having considered some of the alternatives, such as community tv and a full channel of teletext, the review committee considered that all tv services would be best served by existing and proposed schemes such as satellite and multi-channel cable services.

"Some manufacturers have the u.i.a. made for them to the specification of the computer," says Oric computer designer P. T. Johnson of Tangerine Computer Systems, "rather than designing the u.i.a. around it". Like many popular computers Oric 1 is based on a 6502 microprocessor and a u.i.a., but unlike others it provides an eight-colour facility together with 16K of user ram for £100. A printer and disc drive are promised for the near future, as is a £80 modem to interface with videotex systems.

"..."
Tapping their own drum

After just a month of production in their new factory, the inventors of an electronic drum synthesizer had orders worth over £250,000, secured by the new company's New York distributor. Developed two years ago the drum kit, as it is called, has touch-sensitive pads that trigger production of sounds: rhythms are not programmed in as with conventional rhythm generators. In four main touch pads trigger bass drum, snare, high and low toms and secondary pads operate high-hat, closed high-hat and variable crash/ride cymbals. It also incorporates a rhythm unit which can be set to trigger the high-hats with variable tempo and time signature modes. Sound levels of each effect is adjustable and outputs allow direct interface with multitrack mixing desks. Associated instruments can be used individually or triggered by the device, for instance the Clap gives a wide range of clap effects, gun shots, explosive and other white noise effects, while another gives tympani effects.

The electronics design aspects were the work of Clive Button who teamed up with Mike Coxhead, who otherwise runs a building renovation firm, "Its a bit of a departure from my own business" says Coxhead “but I'm glad we got it on the market before anyone else got the idea". His initial investment of £30,000 for the prototype has paid off and he’s now after £1 million orders by the end of year.

Micro arithmetic leaves UK in cold

Floating-point arithmetic for new microprocessor systems, the subject of IEC publication 559, defines ways to perform binary floating-point arithmetic, whether realized entirely in hardware, software or a combination. The need for this world standard comes from booming international trade in microprocessor systems say the IEC, and a divergence of national practices could act as a brake. In defining a family of commercially feasible ways for new microprocessor systems to perform floating-point arithmetic, the IEC say the benefits will be “enhanced portability and capability programs; direct support for execution-time diagnosis of anomalies, smoother handling of exceptions, and interval arithmetic at a reasonable cost; and development of standard elementary functions, high precision arithmetic and coupling of numerical and symbolic algebraic computation”

It specifies 32 and 64 bit formats, results for arithmetic operations, conversions between integers or decimal strings and floating-point numbers and between different formats, as well as exceptions and their handling, including non-numbers. The standard is based on an IEEE 754 draft and was prepared in just over a year by the microprocessor sub-committee of the IEC semiconductor devices committee. The UK did not vote explicitly in favour of publication of this standard, though the USA, USSR, Japan and most of Europe did. And we haven’t been able to contact anyone from the sub-committee yet — there were no UK members.

Basicode by radio

In an attempt to find a universal version of the computer language Basic which would allow different computers to 'talk' to each other and to be able to load the same programs from a single source, Dutch radio has developed Basicode, a list of reserved words common to nearly all versions of Basic. A large number of the more popular home and hobby computers may be easily adapted to load programs written in Basicode. Earlier this year Radio Nederland started broadcasting computer programs on the English-language programme Media Network, as did NOS on the domestic Hobbiescoop programme. They found that for shortwave 300 baud was the maximum rate for reliable reception but they also transmit locally on medium wave at 1200 baud and have had reports of successful recording of data from neighbouring Germany. Use of Basicode on amateur v.h.f. bands has now been approved by the Dutch telecommunications authority.

Radio Nederland has published a book listing the Basicode reserved words and protocol and giving hardware and software adaptations which may be needed to use the system with a number of popular computers. The book and a cassette of programs written in Basicode are available at cost price (from Europe this is 25 guilders, about £5) from Basicode, Administratieve Algemeen Secretariaat, NOS, PO Box 10, 1200 JB Hilversum, Netherlands.

The Hunt is up

The findings of the Committee of Inquiry into cable television suggest that there should be few controls and that cable and programme providers can provide as many channels as they like. The report recommends the setting up of a supervisory, franchising authority. There would be no restriction on the quantity of advertising. Each franchise should cover an area of not more than half a million homes. Present providers of cable services would no longer be obliged to carry BBC and ITV programmes though any new service would. These recommendations do not seem to provide the 'licence to print money' that many potential cable providers were looking for. It does not suggest a national standard for cable services (the Eden Inquiry is looking into cable standards). The main, and most controversial, point is that there is no distinction between the cable providers and the programme providers. If they were separated, there could be a national plan to give interactive services over the whole country. With the current plan, there will be no cable service in the less populated areas for a long time.

Fast a-2-d converter

Research into high-definition television at NHK laboratories has produced an 8-bit analogue-to-digital converter with a maximum sampling rate of almost one gigabit per second.

Corrections

Circuit modelling by microcomputer by R. I. Harcourt, August 1982. The graphs published were inadvertently printed in place of some more recent ones. In the examples used, the 'phase degree' axes should be shifted by 180° to correct the graphs.

Simple, low-frequency oscilloscope. There are one or two changes to the circuit diagram of this instrument, which was described in the September issue. The top contact of the sweep-speed selector switch should be removed, and the 10kΩ and 3.3kΩ resistors on the base of the tail transistor in the V amplifier should be interchanged. The author also asks us to point out that the 470kΩ capacitor on the probe line (not 2kV) should be of 1200V working and the 1μF should be 600V, not 6000V.
Remote programmable facilities dispense with some of the switch packs used in the earlier talker/listener interface design.

by Chris Jay

This second part completes the description of a programmable modification to the 488 parallel-to-serial interface. Featured in the July issue of WW, it was conceived as a low-cost interface solution for instruments with a serial data link such as an RS232C port. When configured to a keyboard and addressed as a talker, characters typed on the keys are converted by the interface from serial to parallel data and transmitted over the bus data lines. A printer interfaced to the bus is addressed as a listener; data bytes received are serially encoded and fed to the serial input port of the printer. The interface used 13 1ca including a 96LS488 to perform interface functions and message decoding, an IM6402 UART for the serial/parallel encoding of data, and an MC1441 as a frequency reference for serial transmission and reception at four link-selectable rates. During the talker-active state the interface could automatically recognize an end-of-text character, and assert the EOI line concurrent with the transmission of the final data byte in the character string.

is valid. When this data byte has been taken the 96LS488 decodes the bus handshake lines to set TXST high. This assertion is inverted by gate 6 to drive the uarts DRR input low. When low the uart permits the next serial data input to be received without overrun error. Transmission of data bytes continues until the end-of-text character is sent. Transmission of the final data byte results in a data match with the contents of the 74F524. The EQU (=) will be pulled passive high by the 10k pull-up resistor. Inverter I13, which has been enabled drives the EOI line low, concurrent with the transmission of the final data byte. In the character string. The controller-in-charge may recognize this end-of-text message, regain control of the bus and un-address the instrument until it is required to talk again.

Serial poll capability

The instrument interface has the capability to generate a service request and respond to a serial poll. If, during the serial encoding or decoding of data bytes, a framing, parity, or overrun error occurs, the output of nor-gate 8 goes low. The cross-coupled latch of gates 9 & 10, set during a power on master reset, will drive the 96LS488 RSV (request for service) input low. The 96LS488 responds by asserting the service request line. The controller-in-charge may regain control of the bus to conduct a serial poll, and hence determine the source and cause of the service request. To perform a serial poll, the controller asserts the ATN bus line and issues an UNL message to prevent active listeners responding to status bytes as though they were data bytes. The serial poll enable message is sent over the data lines and each instrument capable of responding to a serial poll will sequentially receive its talk address. The controller removes the assertion on line ATN and listens to the bus for the instrument, to issue a status byte. When the interface is in the serial poll active state, the SPASENBF output from gate 3 goes low. The 74F240 half of IC9 drives the data lines 1-3 with the inverted IM6402 outputs of PE,OE and FE. Note to relieve the three-state on these outputs the 6402 status flag disable input must be disabled low. The output of the SPASENBF output from gate 3 goes low. The 74F240 half of IC9 drives the data lines 1-3 with the inverted IM6402 outputs of PE,OE and FE. Note to relieve the three-state on these outputs the 6402 status flag disable input must be disabled low. The output of the SPASENBF output from gate 3 goes low. The 74F240 half of IC9 drives the data lines 1-3 with the inverted IM6402 outputs of PE,OE and FE. Note to relieve the three-state on these outputs the 6402 status flag disable input must be disabled low. The output of the SPASENBF output from gate 3 goes low. The 74F240 half of IC9 drives the data lines 1-3 with the inverted IM6402 outputs of PE,OE and FE. Note to relieve the three-state on these outputs the 6402 status flag disable input must be disabled low.
status byte is read by the controller the STST 96LS488 output goes high then low, pulsing the STRDY input low then high through inverter $I_{o}$. So as the status byte is read the local handshake STST to STRDY is automatically driven. From the format of the status byte the controller program may determine the error that occurred during encoding and transmission or reception. If an error resulted in one of the error flags going active high then it will be necessary to issue a clear message to the interface before normal operation can be resumed.

Clearing the system

There are two ways of clearing the instrument interface. On the application of power the RC network of 10kΩ and 10µF reset the 96LS488 and the uart. The uart may be cleared remotely on the receipt of a device clear or selected device clear message. If a request for service had arisen due to an error (framing parity or overrun) generated during the transmission or reception of data, it will be necessary to clear the uart and set the RSV latch. After the serial poll the controller may respond by addressing the interface as a listener and sending a selected device clear. The CLR-96LS488 output pulses low, producing a high at the output of gate 11. This resets the uart through the master reset input. Also, the CLR low output sets the cross-coupled nand-gate configuration of gates 9 & 10, resulting in RSV being driven inactive.

RS232C transmission and reception

The t.t.l. level signal at the uart TRO output and RRI inputs are converted to RS232C ±12 volt levels by the µA1488 transmitter and from the ±12 volt levels that by the µA1489 receiver. Pin 2 of the µA1489 is left open-circuit.

Clock frequency for the 96LS488 CP input is generated by a CR network of 470pF and 220Ω. The “power-on” reset consists of a 10µF and 10kΩ network, the diode 1N4148 configured to provide a rapid discharge path when power is removed from the circuit. The TAD and LAD 96LS488 outputs are wired to l.e.d.s and resistor pull-ups. Red and green l.e.d.s are configured to the TAD and LAD outputs of the 96LS488 and may be mounted so

### Table 5a. UART control register, MSA 1

<table>
<thead>
<tr>
<th>DAB 1</th>
<th>DI01</th>
<th>DI02</th>
<th>DI03</th>
<th>DI04</th>
<th>DI05</th>
<th>DI06</th>
<th>DI07</th>
<th>DI08</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRL</td>
<td>SBS</td>
<td>EPE</td>
<td>Pi</td>
<td>CLS1</td>
<td>CLS2</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Control register</td>
<td>The following inputs are used to set the control register status when the CRL input goes high.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLS1, CLS2</td>
<td>Character length select — these two inputs select the character length according to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Character length</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8 bits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLS1</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLS2</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pi</td>
<td>Parity inhibit. A high level inhibits parity generation, parity checking and forces the PE status flag output low. This input overrides the EPE input.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPE</td>
<td>Even parity enable. When the Pi is set low a high level on the EPE input generates and checks even parity conversely a low level selects odd parity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBS</td>
<td>Stop bit select. This input selects the number of stop bits. The number of stop bits added to the transmitted character also depends on the character length selected by the CLS1 and CLS2 inputs. The following table lists the number of stop bits selected versus the character length and state of the SBS input.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5b. Data speed generator latch, MSA 2

<table>
<thead>
<tr>
<th>DAB 2</th>
<th>DI01</th>
<th>DI02</th>
<th>DI03</th>
<th>DI04</th>
<th>DI05</th>
<th>DI06</th>
<th>DI07</th>
<th>DI08</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>75</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>19200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5c. MC14411 clock outputs

<table>
<thead>
<tr>
<th>Outputs</th>
<th>×64</th>
<th>×16</th>
<th>×8</th>
<th>×1</th>
</tr>
</thead>
<tbody>
<tr>
<td>F3</td>
<td>307.2kHz</td>
<td>76.8kHz</td>
<td>38.4kHz</td>
<td>4800kHz</td>
</tr>
<tr>
<td>F7</td>
<td>76.8kHz</td>
<td>19.2kHz</td>
<td>9600kHz</td>
<td>1200kHz</td>
</tr>
</tbody>
</table>

Clock rate outputs are 16 × data speed of the uart serialized data. Using A & B control inputs, 00 gives ×1, 10 ×8, 01 ×16 and 11 ×64.
this design could be developed for
signed to have
Although the interface circuit
Ideas
that the user may clearly see the current
addressed state of the instrument. The
return-to-local 96LS488 input is perma-
nently wired to Vcc through a 10kΩ resis-
tor.

ideas for further development
Although the interface circuit was
designed to have a number of useful features
this design could be developed for in-
creased functional capability. With the
addition of a 74150 multiplexer circuit
compare the three comparison outputs are
all open-collector, and designed to be
pulled passive high when asserted. This
makes it convenient for cascading with other
74F524 devices. These outputs are
enabled by a logic low on the SE input. The S0 and S1 address inputs permit register loading, reading, data
holding and shifting. Format of S0 and S1
is shown in Table 6. The mode input
can be set high or low depending on whether
the design requires magnitude or two's
complement comparison. There is a single
clock pulse input; the rising edge on this pin
can load data into the register, or shift
the contents by one bit from the CSI input
to the CSO output. Pin configuration is
shown in Fig. 4.

Table 6

<table>
<thead>
<tr>
<th>S0</th>
<th>S1</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Hold - retains data in shift</td>
</tr>
</tbody>
</table>
|    | 1  | Read - read contents in regis-
ter onto data bus |
| 1  | 0  | Shift - Allows serial shifting |
|    | 1  | Load - load data on bus into |

use of three of the unused outputs of IC3,
a significant increase in the number of
rates available may be achieved, see Fig. 3.
Four address inputs S0, S1, S2 and S3 of the
74150 may be driven from the Q0-3
74LS374 latch outputs. Address inputs
may select any one of the clock outputs F1-
16 of the MC14411. If the E input is
permanently low and the Z output is con-
ected to the TRC and RRC inputs of the
IM6402, the outputs F1-16 wired to
multiplexer inputs I0-15 may be indi-
vidually selected to provide a clock input
to the warp. The A and B inputs to IC6 can
be wired to the Q4 & 5 outputs of IC13,
74LS374. The two-to-one multiplexer of
OG3, OG4 and AG2, shown in Fig. 2 may
be dispensed with. A full description of
the MC14411, including a table of the clock
frequencies at the outputs F1-16, may be
obtained from the Motorola publication
"European cmos selection".

Appendix 1
The 74F524 is a new addition to Fairchild's Fast family. It is a registered
(latched) comparator with bidirectional eight-bit I/O and an independant serial
data I/O. When data is stored internally the device may compare a byte offered
to its parallel eight-bit data input, and generate an equivalence, greater than or less
than output, for a programmed mode input of magnitude, or two's complement

Appendix 2
Serial poll: The serial poll is a mechanism
by which instruments capable of talking
may individually send information pertain-
ting to their current status over the data
lines. The controller may interrupt events on the bus to invoke a serial poll either in
response to a service request initiated by
the instrument or as an autonomic process
initiated by the controller's command
program. The service request line may be
used by the instruments to request atten-
tion from the controller and may be
 likened to the use of an interrupt line to
generate an interrupt and divert processing
during the execution of the computer program when attention is required by a
peripheral component.

Parallel poll: The parallel poll can have a
distinct speed advantage over the serial
poll because a single status bit from eight
individual instruments may be read by the
controller simultaneously. The end-or-
identify line is used by the controller as the
identify line (this line is also used by talkers active on the bus for end-message,
so it has a dual purpose). Any instrument
capable of listening will be assigned a data
line by the controller onto which it will
declare its status bit during the parallel
poll active state. Notice that two or more
instruments may use a single line as a
wired-or function. The controller will con-
figure the instrument to respond to a
parallel poll in the following way.

The instrument will be addressed to lis-
ten. The controller will send the parallel
poll configure message which conditions
the instrument to expect the following
parallel poll enable message, and its format
determines how the instrument responds
during the active state. Data bits on lines
5, 6 & 7 of the PPE message are set to 110.
Data line 4 will contain a parity bit. A true
comparison with the device-dependant in-
dividual status message will produce an
affirmative parallel poll response during
the active state. A false comparison be-
tween the line 4 bit received in the enable
message, and the line 4 message results in
response to the identify message. The
remaining bits of the enable message on lines
1, 2 & 3 will contain a one-of-eight code
which will assign one line for transmission
of the compare bit during a poll response.
If the bit pattern were 000, the response
would occur on data line 1, 001 would
yield a response on 2, and so on.

Bidirectional interface
On the RS232 port of this GPIB-to-
RS232 send-or-receive interface
converter, data rates can be set by
switches or are software program-
nable in the range 50 to 19200
bit/s. The RS488, distributed by
Electroplan, has a 40-character in-
put buffer and provides an RS232
clear-to-send signal. Price of the in-
terface is under £200. Electroplan
Ltd, PO Box 18, Orchard Road,
Royton, Herts SG15 9HJ.
WWS901 for further details.

Chris Jay is senior design engineer at
Marien Electronics, Stroud,
Gloucestershire. Joining GCHQ in
Cheltenham as a trainee technician
straight from school, he obtained City
and Guilds (Telecommunications) and
HNC qualifications at day release and
evening classes. These qualifications
helped him qualify as a mature
student for a full-time degree course
at Essex University. On graduation in
1977 he joined Texas Instruments as
part of the engineering design effort
on the 8911 DMA controller chip.
Preferring to be involved with device
applications he joined Linotype paul
in Cheltenham where he designed
computerized file storage equip-
ment for the newspaper and printing
industries. He left to join Fairchild's
Bristol design centre in 1980, where he
wrote this article.
Single i.c. for f.s.k. modem

Data transmission by telephone line remains the most convenient and cheap method of conveying digital information over medium and long distances despite its slowness, hence interest in modems. Advanced Micro Devices are to manufacture an i.c. that requires only a handful of non-critical components, some switching and level conversion logic, and an acoustic coupler or direct-coupling arrangement to form a modem that can be switched to suit one of four standards.

The Am7910, whose application is outlined in the diagram below, has built-in a-to-d and d-to-a converters and all processing, including filtering, is done digitally under the control of a crystal, so drift problems due to ageing and temperature change are not inherent and adjustments not required. Five mode-select inputs set the maximum data rate at 300, 600, or 1200 bit/s and select one of nine modes shown in the table.

When set to operate to either Bell 202 or CCITT V23 standards, and say, acknowledgement and control signals may be returned to the sender on remaining bandwidth while the sender continues to transmit at 1200 bit/s.

An auto-answer facility meeting Bell and V25 specifications is also built in. Upon receipt of a signal at its ring input, a silence interval is followed by an answer tone at the transmit-carrier output. T.t.l.-compatible terminal-control signals such as data-terminal ready, request to send, clear to send and carrier detect are provided, with appropriate delays.

To aid testing, the device can be set to operate in one of ten loop-back modes, in which transmitter and receiver sections are set to operate on the same channel or frequency and either the analogue output and input connected together for local testing or the digital data lines connected externally to allow testing of the local modem using a remote one.

Although this 28-pin n-mos device will not be in full production until the beginning of next year, samples of out-of-specification i.c.s should be available now.

WW500 for further details.

<table>
<thead>
<tr>
<th>Modem configurations</th>
<th>Standard</th>
<th>Bit/s</th>
<th>Duplex Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell 103</td>
<td>300</td>
<td>full</td>
<td>originate</td>
</tr>
<tr>
<td>Bell 103</td>
<td>300</td>
<td>full</td>
<td>answer</td>
</tr>
<tr>
<td>Bell 202</td>
<td>1200</td>
<td>half</td>
<td></td>
</tr>
<tr>
<td>Bell 202</td>
<td>1200</td>
<td>half</td>
<td>line equalizer</td>
</tr>
<tr>
<td>CCITT V21</td>
<td>300</td>
<td>full</td>
<td>originate</td>
</tr>
<tr>
<td>CCITT V23 mode 1</td>
<td>1200</td>
<td>half</td>
<td></td>
</tr>
<tr>
<td>CCITT V23 mode 2</td>
<td>1200</td>
<td>half</td>
<td>line equalizer</td>
</tr>
<tr>
<td>CCITT V23 mode 3</td>
<td>600</td>
<td>half</td>
<td></td>
</tr>
</tbody>
</table>

EVENTS

October 27
Application of viewdata to transaction processing; one day seminar in central London. Details from Modcomp, Molly Millars Lane, Wokingham, Berks.

October 28
Modern tv chassis — philosophy and circuits: Royal Television Society meeting, 7pm at IBA, 70 Brompton Road, London SW3.

November 2
Commencement of programme broadcasting on Channel 4

November 9
Comex 82, Radio communications exhibition, Saxon Inn, Northampton. Organised by the Federation of Communication Services, 70 Church Road, London SE19.

November 10
Industrial robotics; IEEIE lecture, White Horse Hotel, Dorking, Surrey. IEEIE 2 Savoy Hill, London WC2R OBS.

November 11
Newspeed — news without paper. Royal Television Society meeting on TVS news gathering system. 7pm, IBA, 70 Brompton Road, London SW3.

November 18-19
Industrial applications for distributed computing: conference at National Computing Centre, Manchester and sponsored by SERC. Details from F. Chambers, Logica, 64 Newman Street, London W1A 4SE.

November 20
Electronics for Peace Network: Inaugural meeting in Bracknell, Berks. Further details from Tim Williams, Telephone: 0732 864882.

November 23-25

November 25
Hi-Fi TV — Bigger, Better Pictures: Royal Television Society lecture at IBA, 70 Brompton Road, London SW3 at 7pm.

November 26 - December 5

WIRELESS WORLD NOVEMBER 1982
EPROM EMULATOR

This board programs a 2716 eprom with software developed on the emulator described in the September and October issues. A small printer provides hard copy of the software under development. Only two i.c.s are required for the programming board, one for conversion from 5 to 25V and the other to determine the programming-pulse length.

by Peter Nicholls, M.A.

Only a relatively simple circuit is required to transfer software evolved using the emulator into an eprom since the programming-control software and key are included in the main-board design already published.

To program a 2176 or any of its close relatives, addresses and corresponding data are presented to the 'empty' device and each byte is held for 50ms. This programmer addresses the eprom sequentially, as is usual. A 50ms pulse coinciding with the 'data-hold' period is applied to the eprom's program input, pin 18, while pin 21 of the i.c., Vpp, is held at 25V. The 25V supply, present at pin 21 while the eprom is being programmed, must not be applied to the i.c. in the absence of a 5V supply, otherwise the eprom will be damaged.

Operation
Referring to Fig. 1, control software on the emulator board first switches flag 1 high when the 'e' key is pressed. Transistors T2, 4 switch the 25V program voltage to the 2716 socket. The software continues, doing nothing more than reading all the 6116 ram's data onto the bus in sequence. A few nanoseconds after the point in the read cycle where the 6116's chip-select input goes low, IC10 is triggered to provide two opposite pulses. Negative pulses, at pin 9, are applied to the processor's NHOLD input and, while low, cause the system buses to become static. When IC10 reverts, the processor goes into the next read cycle, and so on until the eprom is full. Positive pulses are fed to the eprom's program-pulse input.

Transistor Tr3 only allows pulses to pass to the processor's hold input after the e key has been pressed and until programming is completed. Without this blocking transistor, transmit and receive functions of the emulator will not work while the programming board is connected and display problems will be encountered with some functions.

Power supply. Figure one also shows the switching-regulator circuit used to provide a 25V programming voltage from a 5V supply. The inductor shown may be made using 56 turns of 32 s.w.g. wire on an RM6/250 pot core. Both regulator and pot core are available from RS Components.

Before the programmer is used the programming voltage should be set to within half a volt of 25V at pin 21 of the eprom socket. This is done with a temporary 10kΩ load resistor connected between pin 21 of the programming socket and ground (pin 12). The programming board should be connected to the emulator, the 'e' control key pressed, and the potentiometer adjusted to give the required voltage at pin 21. Under the same conditions but with the flag input low, the voltage reading at pin 21 should be close to 4.3V.

Connection to the main board
A 24-pin dill socket, which may be either a standard or zero-insertion-force type, mates with the header plug on the lead from the emulator board. Three other connections to the programming board may be made through a four-way cable, plug and socket. I used an RS467 611 socket shell, with 467 589 terminals, and a 468 080 right-angle plug in my version.

Boards produced using the available overlays (and those boards from PKG Electronics) have four holes for this connector to the right of IC1. From top to bottom, the connections are flag 1, no connection, CS and NHOLD. Removal of the unused plug pin and fitting of...
Table 1. Modification to the programming software. With the original software, the e prompt did not occur until one second after e had been keyed. Uninitiated operators pressing the e key again within 1s to try and get some response on the display would find their software overwritten with FF bytes. The e prompt appears as soon as the key is pressed with the software modifications shown. Blank spaces in lines 36 and 45 should be ignored since the original software at their locations remains unaltered.

Table 2. Control and character-generator software for driving a small printer mechanism to provide listings of the emulator’s ram. As shown, the relocatable printer routine between lines 45 and 60 follows on at the end of the modified programming routine shown in this article. If the programming software shown in the October issue is to be used, line 45(a) at the end of this listing should be used instead of line 45. If the modified programming routine is to be used without the printer, line 45(b) should be used. This leaves the eighth control key without a function and the program jumps back to the start of the program if it is pressed. Blank spaces should be ignored and decimal line numbers shown correspond with those given in the original listing. Lines 98 to 102 are character generator tables.

Table 1

Table 2

* The author asks us to point out that the tenth byte along line 21 of the main program shown last month read 89 but should have read 89.

a blanking plug in the socket will ensure that the connector cannot be fitted the wrong way round.

Before the eprom to be programmed is inserted, the 5V supply should be switched on and the emulator and programming boards connected together. Now, with a blank eprom in the socket and a developed program in the emulator’s memory, the e key is pressed. This initiates the programming sequence, consisting of 2048 cycles of about 50ns each. When programming is complete, the display will show ‘burnt’.

If the software written into the emulator is not intended to fill the eprom, set the display to show the first unused address and press the e key twice within one second. The prompt will amend to F and each unused byte of ram will be loaded with FF immediately before the byte concerned is programmed into the eprom; otherwise, the programming sequence remains the same.

Shouldware in the emulator have to be programmed into the remaining space of a partially full eprom, the emulator ram should be filled with FF before the eprom is inserted ready for programming. When the procedure is finished, the display will show ‘burnt’. Removing the three-pole connector carrying flag 1, chip-select and hold will speed up the FF-filling process by eliminating the 50ns delay at each address. Now, the required program can be typed into the emulator from a specified address, the connector replaced, the eprom inserted and the e key pressed once. This transfers the new program address, leaving data already in the eprom unaltered.

It is not possible to read back the contents of an eprom with this basic tool so it is wise to keep copies of programs on tape if future software expansions or modifications are envisaged.

Printer-mechanism control

Minor software modifications and a little additional hardware allow a small printer mechanism to be driven by the emulator to produce whole or partial listings of the emulator’s memory contents. Discounting the printer and its 24V power supply, it is estimated that additional electronic components will cost about £2.

Printing is initiated by a spare control key marked p mentioned in the first article. Referring to Fig. 2, transistors five and six switch the 24V supply to control the printer when the p key is pressed. Transistors seven to ten drive and brake the motor.

The i.c. used for display driving on the emulator board, IC3, consists of seven Darlington transistors. When the printer is operational, this i.c. is used to drive the print heads so prompt characters are not shown on the display. In this case, the printer in activity provides some printed output.

Character generation and synchronization with the print-head traverse are carried out by software for which there is ample space in the 2K monitor eprom. Using software in this way keeps costs to a minimum.

Operation

Before the printer is used, the 24V supply should be set by adjusting the potentiometer in the 12V regulator’s ground lead. When the printer is connected, the a key is used to set the display to 0 and reset the beginning of the program to be printed and the p key is then pressed. Printing continues until address 7FF is reached unless the p key is depressed for around a half of a second. When printing is completed, the print head positions itself at the left-hand side of the carriage and out of contact with the paper so that the software record can be fed through and torn off.

It is important to note that the metallized paper used is at 24V with respect to the 0V line of the emulator so damage is likely to result if the paper touches any conducting element of the system while still in the printer. Covers will be needed not only to prevent access to mains voltages but also to prevent the paper touching any conducting part of the system.

The PU245-L20 printer mechanism used with the original system prints twenty columns of 5-by-7-dot characters on 60mm-wide electrosensitive paper in roll form and is available from Farnell
Eprom-programming unit built on single-sided p.c.b. Header plug from emulator mates with standard i.c. socket; a second zero-insertion-force socket is more convenient here but far more expensive.

Fig. 2. Hard copy of the emulator ram's contents was obtained using a small, cheap printer mechanism connected as shown. The display-driver i.c. consisting of seven Darlington transistors drives the print head so display prompts are not given during printing. Numbers 1 to 12 refer to connector pins on the single-sided boards available.

Sample of the PU245 printer's font which is under software control.

Electronic Components Ltd, Canal Road, Leeds LS12 2TU, or from GMT Electronics, Newport House, 22 Hartfield Road, London SW19 3TD under the code name 10E 012 LE. The print head has seven vertical dots and software is used to determine the character dot width.

Etched but undrilled boards for the programmer and printer electronics are available from PKG Electronics, Oak Lodge, Tansley, Derbyshire for £4 each including postage. Undrilled boards for the emulator are also available at £8 each inclusive, as are programmed eproms at £5 inclusive, from the same source. These eproms contain the printer routine.

Photocopies of the track layouts and component positions can be obtained by sending a large s.a.e. to Wireless World Emulator, Room L303, Quadrant House, Sutton, Surrey SM2 5AS.
PERSONAL COMPUTER
Basic language in Hewlett-Packard's portable computer is part of a 48K operating system supplemented by 16K of ram, expandable up to 24K, and up to three plug-in rom modules of 8 or 16K. As the unit is battery powered, memory contents are retained when the computer is switched off and the real-time clock can be used as an alarm clock or to turn on the computer and run a program at a set time. The 32-character sections of 96-character lines shown on a dot-matrix l.c.d. may be scrolled from side to side.

Programs and data stored on magnetic strips capable of holding 1.3K bytes are read by a transducer in the computer, or alternatively peripherals with much larger magnetic memories may be used. Of the 169 instructions in the operating system, 147 are Basic commands, statements or functions; program, data and appointment files can be named, saved and made to interact with each other. Every key on the 254 by 127 by 32mm unit is redefinable and may be given a new label using snap-on overlays.

Peripheral include printers and plotters. Hewlett-Packard Ltd, Nine Mile Ride, East Hamsford, Wokingham, Berks.

LOW-COST 1MBYTE DISC DRIVES
Up to 1.2Mbyte of formatted data can be stored on a half-height 5¼in disc drive costing under £400 excluding vat. Called the YD380T, this double-sided, double-density drive comes from the Japanese company Yeda who also manufacture a standard-height 5¼in drive capable of holding 800Kbyte of formatted data and costing £325, the YD280. An eight-inch version, the YD180, with a capacity similar to the 380T costs under £400 and uses IBM or equivalent diskettes. When used as double-density drives, the two 1.6Mbyte drives, the 180 and 380T, transfer data at 500Kbit/s and have average access times of 91ms and average latency times of 83ms. These drives are intended for original-equipment manufacturers and are thus unboxed and without power supply.

Systems consisting of one 8in drive and one high-density 5¼in drive, or two of the latter, are also available. An A/P/M compatible disc-operating system for either size of drive may be used to transfer existing software from one size of drive to the other, or existing software on 8in disc can be converted by the importer if two 5¼in high-density drives are to be used. Vincelord Ltd, Suite 2, 26 Charing Cross Road, London WC2.

CMOS A-TO-D CONVERTER
An 8-bit microprocessor-compatible analogue-to-digital converter called the ADC830 is manufactured by Datel-Intersil (Intersil Datel in the UK). Conversion time is 100µs and the device, with external adjustment, gives a maximum error of ≥±½ l.s.b. Outputs may be switched to a high-impedance state. Intersil Datel (UK) Ltd, Snamprogetti House, Basing View, Basingstoke, Hants RG21 2YS.

STORAGE SCOPE FOR LESS THAN £1,000
According to Gould, the OS1400 20MHz digital-storage oscilloscope is the first of its kind for under £1000 since their first one in the early seventies. This dual-channel instrument has pre-triggering from 0 to 100% and post-storage trace expansion facilities and may be used as a real-time oscilloscope. Its storage capacity is 1K by 8-bits, giving vertical and horizontal resolutions of 1 in 256 and 1 in 1024 respectively; a dot-joining facility giving linear interpolation between samples is incorporated. Display modes allow freezing of the display at the end of a triggered sweep, immediate freezing of the display, data and display refresh on triggering and a rolling-display mode in which the pre-trigger storage facility may be used. A version with X, Y and pen-lift outputs for use with a plotter is also available. Gould Instruments Ltd, Roebuck Road, Hainault, Ilford, Essex IG6 3EU.
NEW PRODUCTS

ZX INTERFACE
Digital and analogue i/o modules for control and sensing applications using the ZX80 and 81 computers are made by RD Laboratories. These modules connect to the computer through one of two main interfaces, one at £15 for carrying two modules and one at £40 for carrying up to eight modules. Five modules ranging in price from £27.50 to £34.49 are available for digital i/o, analogue input, output and multiplexing, and light-pen connection. RD Laboratories, 5 Kennedy Road, Dane End, Ware, Herts SG12 6LU.

WW306

DIGITAL CAPACITANCE METER
Highest and lowest of eight ranges on Metertech’s MT301 hand-held capacitance meter are 2000µF and 200pF respectively. The meter’s readings are given on a half-inch high 3½ digit I.C. D. with 0.5%, ± 1 digit error on the lowest range with 0.1pF resolution. At £69, the instrument includes test clips and batteries; a case is available for £6. Centemt Instruments Co., 62 Curtis Road, Hounslow, Middlesex TW4 5PT.

WW307

P.W.M. I.C. FOR REGULATORS
Two i.c.s designed for driving power mosfets in switched-mode power supply applications are manufactured by Siliconix and available through Semiconductor Specialists. The PWM25 and PWM27 are 16-pin devices containing an error amplifier, flip-flop, oscillator, pulse-width modulator and voltage regulator for controlling drive-signal frequency and pulse width. The PWM25 has two outputs which are low in the off state; in the PWM27, the outputs are high in the off state. A shut-down function is included. The same distributors have recently introduced a range of low-noise op-amps from Raytheon, the RC714 series, that require an input bias current of typically 1nA. Semiconductor Specialists (UK) Ltd, Carroll House, 159 High Street, Yiewsley, West Drayton, Middlesex UB7 7XB.

WW308

FIBRE-OPTIC DATA LINK
Designers wanting to evaluate the many advantages of fibre-optic data-communication links over their electrically-conducting counterparts can do so with a kit from Burr Brown. Two RS232/20mA-compatible transmitter/receiver boards and two 33-metre lengths of fibre-optic cable are main elements of the £299 kit. Burr Brown International Ltd, Cassiobury House, 11-19 Station Road, Watford, Herts WD1 1EA.

WW309

ROM USING RAM
Lithium batteries are used to retain data in 2Kbyte of data in cmos ram for around 10 years in a product called Memic-L from Camel. Connection of the 102 by 61 by 25.4mm device to the computer is through a 30cm long 24-way cable so more than one unit may be used on boards with sockets that are close together such as used in the Apple. Function switches are used to select the upper or lower half of memory or the whole 2K, depending on the type of system, and access time is said to be better than 200ns. Each device is supplied with instructions for £29.95. Cambridge Microelectronics Ltd, 1 Milton Rd, Cambridge CB4 1UY.

WW310

AMBISONIC DECODER
Besides decoding UHJ ambisonic recordings, such as used on records from Unicorn and Nimbus, the AD2 also enhances standard stereo. It consists of a board measuring 100 by 100 by 25mm intended to fit into existing hi-fi equipment and includes a control for compensating for different speaker layouts. Currently available recordings are two channel but the decoder will also be suitable for three-channel UHJ recordings. (See, for example, NRDC surround-sound system by M. A. Gerzon, WW April 1977 page 36.) The AD2 costs £49.45 including vat. Minim Audio Ltd, Lent Rise Road, Burnham, Slough SL1 7N.

WW311

Professional readers are invited to request further details on items featured here by entering the appropriate WW reference number(s) on the mauve reply-paid card.
RADIO COMPONENTS

NEW [baker] Star sound

high power full range quality loudspeakers
British made
exceptional reproduction. Ideal for Hi-Fi, Home cinema, PA or discotheques.
These loudspeakers are designed where high power handling is required with quality reproduction at high fi levels.
Ceramic magnet ensures clear response.

MODEL 12, INSELS
Price
MAJOR
12
4-6-16
HI-FI
14

SUPER
12
8-18
HI-5
14

AUDITORIUM
12
8-16
HI-1
14

GROUP 45
12
4-8
PA
14

GROUP 40
12
8-16
PA
14

GROUP 100
12
8-16
100
14

GROUP 150
12
8-16
150
14

GROUP 200
12
8-16
200
14

[$5.95; $6.15] Post £5.

BAKER AMPLIFIERS BRITISH MADE

PA systems, Discoos and Groups. Two inputs, Mixer, Volume, Controls, Master control, microphone input, footswitch, 15 speaker outlets.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-516 ohms. 100-watt RMS 12V DC, 24V DC, 100 Watts. £50 Post £2.

Baker 150 watt Amplifier IP $99

For six hours use. Vola for use with 4, 8 or 16 ohms. Four high gain inputs, 20, 200, 500 ohm. Requires: 200 watts, 10 average watts. 2 x 100 watts RMS. 5, Power. Speaker output 500 M.V, 250 kHz.


BAKER 50 WATT AMPLIFIER

IPA systems, Discoos and Groups. Two inputs, Mixer, Volume, Controls, Master control, microphone input, footswitch, 15 speaker outlets.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-516 ohms. 100-watt RMS 12V DC, 24V DC, 100 Watts. £50 Post £2.

Baker 150 watt Amplifier IP $99

For six hours use. Vola for use with 4, 8 or 16 ohms. Four high gain inputs, 20, 200, 500 ohm. Requires: 200 watts, 10 average watts. 2 x 100 watts RMS. 5, Power. Speaker output 500 M.V, 250 kHz.


BAKER 150 WATT AMPLIFIER

IPA systems, Discoos and Groups. Two inputs, Mixer, Volume, Controls, Master control, microphone input, footswitch, 15 speaker outlets.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-516 ohms. 100-watt RMS 12V DC, 24V DC, 100 Watts. £50 Post £2.

Baker 150 watt Amplifier IP $99

For six hours use. Vola for use with 4, 8 or 16 ohms. Four high gain inputs, 20, 200, 500 ohm. Requires: 200 watts, 10 average watts. 2 x 100 watts RMS. 5, Power. Speaker output 500 M.V, 250 kHz.


BAKER 150 WATT AMPLIFIER

IPA systems, Discoos and Groups. Two inputs, Mixer, Volume, Controls, Master control, microphone input, footswitch, 15 speaker outlets.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-516 ohms. 100-watt RMS 12V DC, 24V DC, 100 Watts. £50 Post £2.

Baker 150 watt Amplifier IP $99

For six hours use. Vola for use with 4, 8 or 16 ohms. Four high gain inputs, 20, 200, 500 ohm. Requires: 200 watts, 10 average watts. 2 x 100 watts RMS. 5, Power. Speaker output 500 M.V, 250 kHz.

QUALITY OSCILLOSCOPES, THE RANGE FOR EUROPE!

HM307.4 £138
Y: Bandwidth DC-10MHz (-3dB) - Sensitivity 5mV-20V/ cm (±5%)
X: Timebase 0.2s-5.5us/cm (±5%) - Triggering 2Hz-30MHz (3mm) - Built-in component tester - Calibrator - Screen 6 x 7 - 2kV.

HM203 £220
Y: Bandwidth DC-20MHz (-3dB) - Sensitivity 5mV-20V/ cm (±3%) - Dual trace
X: Timebase 0.2s-40ns/cm incl. x5 Magn. - Trigger 3Hz-30MHz (4mm) - X-Y operation - Calibrator - Screen 8 x 10cm - 2kV.

For free data sheets of the full range contact:

HAMEG, LTD.
14-18 Collingdon Street
Luton, LUT 1HR
Tel: 0582 411374/Telex: 824046

HAMEG IBERICA S.A.
Villarroya 173-174
Barcelona 30
Tel: 380 16.97

Spain

HAMEG IBERICA S.A.
Villarroya 173-174
Barcelona 30
Tel: 380 16.97

Prices U.K. List Ex. VAT

HM412 £350
Bandwidth DC-20MHz (-3dB) Sensitivity 2mV/cm - 20V/cm (±3%) Timebase 40ns/cm Triggering DC - 40MHz (5mm) Algebraic Add., Sweep Delay, x8 Mag., Overscan Ind., Var. Holdoff, Single Sweep.

HM705 £580
Bandwidth DC-70MHz (-3dB) Sensitivity 2mV/cm - 20V/cm (±3%) Timebase 5ns/cm - 2.5s/cm Triggering DC 100kHz (5mm), Algebraic Add., Sweep Delay, x10 Mag., Alt. Trigger, Trig. After Delay, CRT 14kV.

THE POWERFET SPECIALISTS

POWERFET AMPLIFIER MODULES

The people at Pantechnic have been designing with powerfets since they first became commercially available. Their experience of powerfet amplifiers, coupled with their insight into the sources of non-linearity often neglected by others, has resulted in a new range of powerfet amplifiers that are fast, tough, linear and cheap.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>POWER RANGE (Continuous RMS)</th>
<th>TYPICAL LOADS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFA 100</td>
<td>50W-150W</td>
<td>40, 80</td>
<td></td>
</tr>
<tr>
<td>PFA 200</td>
<td>130W-300W</td>
<td>40, 80</td>
<td></td>
</tr>
<tr>
<td>PFA 500</td>
<td>250W-600W</td>
<td>40, 80, 160</td>
<td></td>
</tr>
<tr>
<td>PFA HV</td>
<td>200W-600W</td>
<td>40, 80, 160</td>
<td></td>
</tr>
</tbody>
</table>

Key features:
- RELIABLE - Powerfree freedom from thermal runaway and secondary breakdown
- LINEAR - TID zero, IM/THD < 0.01% full power, (md band THD down to 0.005%)
- FAST - Slew rate >30V/µs (45V/µs typical)
- QUIET - Signal to noise ratio >126dB
- BRIDGEABLE - (±10, 200, 500 without extra circuitry)
- STABLE - Unconditionally
- LOW COST - 10watts to 30watts per £, depending on model and quantity

As they stand these modules suit most P.A. and industrial applications and satisfy all foreseeable audiofophile requirements. (The HV is aimed at digital audio.) Where aspects of performance fail to meet specific requirements (e.g. in speed or power) low cost customising is often a possibility. Alternatively entirely new boards can be produced.

Pantechnic make more than just PFS. Loudspeaker protection boards and the quietest, lowest distortion preamplers currently available are just two of an ever-expanding range.

Pantechnic sell high quality power supply and other components at excellent prices.

THE POWERFET SPECIALISTS

Pantechnic
WIRELESS WORLD NOVEMBER 1982
Three of the best in test
Model 467
The world famous '260'
The Simpson analogue multimeter that is the world's largest selling, 2 ranges cover AC and DC, volth.
DCcurrent, resistance and ohm.
Clamp-on Testers
The new 276-2 for faster testing of motors, transformers and circuits. All models measure up to 300 Amps AC RMS.
now see the rest
Write now for technical information on our full range of precision instruments

BATTERY CHARGING UNITS
Sanyo NC4505 £3.82
Will charge 4 AA batteries simultaneously
NC120 £5.99 Will charge DC & AA size 2 each of 2 types in 14-16 hours.
NC75G £3.99 Will charge one PP3 size in 7-8 hours. Instructions supplied.
Varta CR14 plugs directly into standard mains socket. Comes with a rechargeable nickel cadmium PP3 size battery £5.45.

SIDE CUTTERS
2112 Cutting capacity up to 1.5mm copper wire £4.20
Both cut wire flush with surface, length 112mm.
2111 Diagonal cutters, blades set at angle of 70° to the handle, cutting capacity 1.0mm copper wire.

LONG NOSE PLIERS
2411 Slim narrow jaws, half round section.
Total length 132mm £4.48.

STRIPPING PLIERS 2076 £5.78
Dissalcutting nippers
Will cut copper wire up to 1.0mm, jaw width 10.5mm.
170 £7.85 jaw length 8.0mm.

DIAGONAL CUTTING NIPPERS
Jaw width 9.0mm, jaw length 9.0mm £71 £8.04
Simpson first choice petite, smooth gripping surface.
870 Jaw length 211mm £5.72
850 Jaw length 32mm £5.72.

60ft TELESCOPIC MAST & VAN FOR HIRE
The vehicle to meet hundreds of uses, some of which are high level photography and observation, radio receiving and transmitting, field study, floodlighting, meteorology, wind measurement and many, many other uses.

FOR HELPFUL SERVICE AND RATES
RING A.V.E.C. LTD. 061-881 2292

WW - 087 FOR FURTHER DETAILS
WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognized as world leaders.

SYPALAR MODULES

<table>
<thead>
<tr>
<th>Module</th>
<th>Output Power Watts</th>
<th>Load Impedance</th>
<th>DISTORTION</th>
<th>Supply Voltage</th>
<th>Size mm</th>
<th>W T</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0132</td>
<td>60</td>
<td>4.0</td>
<td>0.05%</td>
<td>76 x 40 x 100</td>
<td>185</td>
<td>£17.69</td>
<td></td>
</tr>
<tr>
<td>P0133</td>
<td>60</td>
<td>4.0</td>
<td>0.05%</td>
<td>76 x 40 x 100</td>
<td>185</td>
<td>£17.69</td>
<td></td>
</tr>
</tbody>
</table>

MODFET MODULES

<table>
<thead>
<tr>
<th>Module</th>
<th>Output Power Watts</th>
<th>Load Impedance</th>
<th>DISTORTION</th>
<th>Supply Voltage</th>
<th>Size mm</th>
<th>W T</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY67</td>
<td>25</td>
<td>4.0</td>
<td>0.05%</td>
<td>76 x 40 x 100</td>
<td>185</td>
<td>£17.69</td>
<td></td>
</tr>
<tr>
<td>HY68</td>
<td>25</td>
<td>4.0</td>
<td>0.05%</td>
<td>76 x 40 x 100</td>
<td>185</td>
<td>£17.69</td>
<td></td>
</tr>
</tbody>
</table>

MOSFET MODULES

<table>
<thead>
<tr>
<th>Module</th>
<th>Output Power Watts</th>
<th>Load Impedance</th>
<th>DISTORTION</th>
<th>Supply Voltage</th>
<th>Size mm</th>
<th>W T</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY13</td>
<td>60</td>
<td>4.0</td>
<td>0.05%</td>
<td>76 x 40 x 100</td>
<td>185</td>
<td>£17.69</td>
<td></td>
</tr>
</tbody>
</table>

Please note: X is in pairs to match primary voltage. Please insert "D" n place of "X" for 115v, "E" in place of "X" for 220v, and "T" in place of "X" for 240v.
PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

Unicase

Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools. Because of ILP’s modular approach, “open plan” construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a “no frills”, low distortion, (&lt; 0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

<table>
<thead>
<tr>
<th>UNICASES</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC1</td>
<td>£26.95</td>
</tr>
<tr>
<td>LP1X</td>
<td>30W 300W/4/8Ω</td>
</tr>
<tr>
<td>UP2X</td>
<td>60W 300W/4/8Ω</td>
</tr>
<tr>
<td>UP3X</td>
<td>60W 300W/4/8Ω</td>
</tr>
<tr>
<td>UP4X</td>
<td>120W 300W/4/8Ω</td>
</tr>
<tr>
<td>UP5X</td>
<td>120W 300W/4/8Ω</td>
</tr>
<tr>
<td>UP6X</td>
<td>60W 300W/8Ω</td>
</tr>
<tr>
<td>UP7X</td>
<td>120W 300W/8Ω</td>
</tr>
<tr>
<td>Power Slaves</td>
<td></td>
</tr>
<tr>
<td>US1X</td>
<td>60W 4/8Ω</td>
</tr>
<tr>
<td>US2X</td>
<td>120W 4/8Ω</td>
</tr>
<tr>
<td>US3X</td>
<td>60W 4/8Ω</td>
</tr>
<tr>
<td>US4X</td>
<td>120W 4/8Ω</td>
</tr>
</tbody>
</table>

Please note X in part number denotes mains voltage. Please insert 'O' in place of X for 110V, 'I' in place of X for 230V (Europe) and '2' in place of X for 240V (UK). All units except UC1 incorporate our own toroidal transformers.

TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to ILP Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

Please send me the following:

Total purchase price

<table>
<thead>
<tr>
<th>I enclose Cheque</th>
<th>Postal Orders</th>
<th>Int. Money Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please debit my Access/Barclaycard No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signature</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WW - 056 FOR FURTHER DETAILS
Meet some of the best brains in Britain

at THE Northern Computer Fair

Belle Vue, Manchester
November 25-27, 1982

Opening Times
10am-6pm each day

The brains we're talking about are the printed circuit, silicon-chip variety and you'll find them (thinking hard) in the vast range of exhibits at The Northern Computer Fair. The show covers the fields of personal computing, home computing, small business systems and associated software, through computer books to video games, with a special attraction being the ZX 81 Sinclair Village. So whether you're a businessman (or woman) who needs to keep up to date with the latest developments in this fascinating field, a die-hard computer enthusiast, or simply interested in the subject, you'll find what you're looking for at the Northern Computer Fair.

Ticket prices at the door are £2.00 for adults and £1.00 for children under 16, but special party rates are available for 20 people or more with the organiser admitted free. For more information contact IPC Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. Tel: 01-643 8040.
**HEMMINGS ELECTRONICS AND MICROCOMPUTERS**

16 BRAND ST
WITCHIN
HERTS
SG5 1JE

**WIRELESS WORLD NOVEMBER**

**LS92**

**LS91**

**LS76A**

**LS49**

**LS42**

**LS32**

**LS09**

**LS08**

**LS132**

**Tel. (08444) 33031**

**MARTRON**

**31p**

**lep**

**2Opp**

**50p**

**20p**

**15p**

**LS290**

**LS269**

**LS253**

**LS196**

**LS161A**

**LS158**

**LS366A**

**Delay**

**Np**

**liep**

**44p**

**869 4023**

**389 LS375 4033 160p 4520**

**dual -trace**

**4011 14p**

**4002**

**LS870**

**LS645 4073 4554 166p MC1456 1359**

**LS390 60p**

**LS378 4035 4522 1109**

**4022**

**SYNC**

**1Ise**

**Óp**

**variable**

**6 kV**

**I**

**4099**

**4075 lelp 4555 469 MC1468 36p**

**4066 36p**

**4053 50p 4539 LM339**

**4050 24p 450p LM303A 96p**

**4043**

**4508**

**4506**

**4604**

**4493 3209**

**80p 4580**

**lip**

**100p 4583**

**T**

**MC14139**

**MC1408**

**8T26A 1209**

**2N2906A**

**2N2218Á**

**2N1893**

**115151**

**11588A**

**Ì1P145**

**TIP110**

**TIP41A**

**ARON**

**brand new**

**with**

**25cm display**

**68800**

**+**

**LF351**

**7189**

**100p**

**26p**

**40p**

**10cm**

**:68800**

**export orders**

schools, colleges and
orders under
credit
for

2N33C

for

2N2906A

2N2218Á

2N1893

115151

11588A

Ì1P145

TIP110

TIP41A

ARON

brand new

with

25cm display

68800

plus

MHz
display

mean**

**professional specification**

**15 Mhz - dual-trace, lightweight, portable with internal battery and automatic reccharging**

**IC SOCKETS**

- **Low**
  - **Wm**
  - **Turned**
  - **Profile**
  - **Wrap**
  - **Fis**
  - **8pm**
  - **10p**
  - **20p**
  - **15p**
  - **30p**
  - **16p**
  - **15g**
  - **35p**
  - **25p**
  - **16p**
  - **60p**
  - **24p**
  - **24p**
  - **70p**
  - **53p**
  - **24p**
  - **120p**
  - **25p**
  - **40p**
  - **75p**

**CONNECTORS**

- **Male**
  - **Female**
  - **Hoods**
  - **Top Entry**
  - **5way**
  - **10p**
  - **30p**
  - **20p**
  - **25p**
  - **20p**
  - **35p**
  - **25p**
  - **10p**
  - **8p**

**WIRELESS WORLD NOVEMBER 1982**

93
Unravel the mysteries of radio and electronics with a copy of Foundations of Wireless and Electronics by M.G. Scroggie. 250,000 enthusiasts and students have already used this remarkable book to master the elementary principles of electronics. In fact, many of today's radio and electronic engineers were weaned on Scroggie. The book is written clearly and concisely in Mr. Scroggie's well-known and often humorous style. He assumes no previous technical knowledge and only uses mathematics where essential.

Order your copy now —
Postage and packing is £1.10 each copy in the UK, £1.30 overseas (surface mail).

Please send your order to: M.G. Scroggie, 28a St. John's Road, Enfield Green, Enfield, Middlesex, EN2 9HB.

Please enclose your cheque or postal order for £5.25 per copy to cover postage and packing.

I enclose my cheque/postal order for £5.25.

Please make my cheque/postal order payable to IPC Business Press Ltd.

Name
Address

Return to: General Sales Manager, IPC Electrical-Electronic Press Ltd.,

Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.
PUBLIC ADDRESS AND INDUSTRIAL SOUND SYSTEMS

FROM THE SPECIALISTS

HERE ARE FOUR SUGGESTIONS FROM OUR EXTENSIVE RANGE (SEND Cheque/P.O., U.K. only).

PSS 1

£90 inc. V.A.T.

- Operates from 12v car battery
- 3-10 watt (RMS) Amplifier
- 1 x 10 watt Horn
- 1 x Microphone
- 1 x Special Roofrack
- Ideal for small fete's, gymkhana's, etc.

PSS 2

£130 inc. V.A.T.

- Operates from 12v.
- 20-25 watts (RMS) Amplifier
- 1 x Microphone
- 2 x 10 watt Horn
- 1 x Special Roofrack
- School fete's, athletic meetings, horse shows

MEGAPHONE

£72 inc. V.A.T.

- Everything in a case
- Mains 12v dry battery operation
- 12 watts (RMS)
- Weight with carrying case 4.5kg. (10lb.)
- C/w Microphone, floor stand and tripod stand
- Tone and volume controls
- Ideal for conferences, schools, political, halls and speakers

OUR RANGE INCLUDES MAINS AND MAINS/BATTERY AMPLIFIERS, HORN, COLUMN, LINE SOURCE, AND BOX SPEAKERS, CABLE DRUMS, BACKGROUND MUSIC MACHINES, MICROPHONES AND STANDS.

Please send £1 for full catalogue with hints for installations (GOVERNMENT, COMPANIES, SCHOOLS PLEASE WRITE)

ORDER FORM

I enclose Cheque/Payment Order for...

My Access Number is...

NAME

ADDRESS

AMADIO LIMITED - TELEPHONE FLEET (02354) 2567
25-29 READING ROAD SOUTH, FLEET, HANTS

WIRELESS WORLD NOVEMBER 1982

OTHER PRODUCTS

AVO TEST METERS

B.A. 1.1 List Model £122.10
71 (Handy) £48.30
73 portable mode £88.90
MM5a Minor £43.60
DA121 LCD Digital £81.90
DA122 LCD Digital £113.30
Megger 7041250v £101.50
Megger Battery BM7 £71.60
DAT12 Autorange LCD £157.90
Avo Cases and Accessories etc. +£20.00 VAT

BRIDGE RECTIFIERS

200v 2a 45p
400v 2a 65p
750v 3.5a £1.20
1000v 5a £2.60
200 0v 5a 30p
400v 5a 65p
800v 5a £1.30
500v 12a £2.80
+ £20.00 VAT 15%

Send us for catalogue.

2000 2a 85p
3000 2a 85p
4000 2a 85p
6000 2a 85p
10000 2a £2.80
+ £20.00 VAT 15%

Barrie Electronics Ltd.
3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/7/8

WE SELL A RANGE OF OVER 2000 PRODUCTS.
**COM munications Test Equipment**
MARCONI TP2002. AM/FM Signal Generator. 10kHz-7MHz; Also 1002A/S available AM/FM 40kHz-7MHz.
MARCONI TP1995A. 2.12kHz, AM/FM £200.
MARCONI TP1696. AM/FM Signal Generator. 50kHz-7MHz; Output 0.05-100V (0.01V/div), 550 Ohm. £250.
MARCONI TP1696/S, AM/FM Signal Generator. Narrow deviation model 955 covering 1.5-7MHz £250.
MARCONI TF1648B. FM Signal Generator covering in steps 10kHz, 100kHz, 500kHz 450-470MHz. Modulation FM fixed deviations of 3.5 and 10kHz. AM fixed 30% £255.
MARCONI TF791D. FM Deviation meter £185.

**DOLBY** Noise Filtering Devices
Cat. No. 98A. Noise filtering devices for CCIR/ARMM sync-tone-layout. Measurements as now units. £46 each (+£1 p&p).

**BECKMAN Turns Counter Dials**
Miniature type (22mm diam. Counting up to 15 turn “Helipots”. Brand new with mounting instructions. Only £2.50 each.

**KAY SONA-GRAPH**
Model 7029A. Audio frequency spectrograph. 5-16000Hz. C’/w type 6076C. Scale Magnifier plug-in. in good working condition.

**AUDIO Wattmeters**
Switchable 1W & 10W FSD. Intern. 4.5 & 6Ohm load impedance. Housed in grey enamelled case 6x6x3". Large easy to read 3 3/4" sq. meter. Scope output provision. £125. Heathkit Model AW-10U. Internal load switchable 3.8 and 15Ohm. Scale 0-50 & 50X (±1% scale). 5 Ranges from 5mV-50V FSD. Housed Intern. £25 ± 1% F.S.D.
MARCONI TF833A. 1mW/10W Full scale in 5 ranges. Impedance 25Y, Ohm in 48 steps. Direct calibrated in Watts and dBm. £85 (+£2). GPO JACK SOCKET STRIPS. 20-WAY Type 320 (2-pole) £2.50 ea. Type 520 (3-pole with switchoff contact) £4 ea. Please include 35p each for postage on these. GPO model 316 jack plugs for above 26p ea. (10 point free trial. Plus VAT please).
PHILIPS Model PM6456/61 FM STEREO GENERATOR. RF Output frequency 1MHz. Standardised stereo multiplex output signal. As new with handbook. £195.

**OSCILLOSCOPES**
DYNAMICO D7200. Main/battery portable DC-10MHz £250.
COISSOR CDU150. DC-35MHz £200.
TELEQUAD DPS E150." TEKTRONIX 454. DC-150MHz £750.

**SOLARTRON CD1740. DC-50MHz Sweep Delay Timers £275.
TRIO CS5757A. 35MHz, new £375.**

**PuchaseTeK of 454 Portable Oscilloscopes**
Tektronix 454 DC-150MHz dual-beam oscilloscopes in stock now. 50MHz/5amp AGC. Necessary. £1500 inc. VAT.

**MARCONI Component Bridges. Models TF113 and TF7200 in stock.**
ADVANCE VM770 Millivoltmeters. 10kHz-4.5MHz in 1mV Full scale -300V. £65.
WOELKE ME104C. Wow & Flutter Meter £95.
AVO Type 1 LCR Component Bridge £125.
WAYNE KERR RF Signal Generator Type 5121 £75.
AIRMEC Wave Analysers Models 983 and 294A.
CENTRONIC P1 Printer, one only. AND Type 663 Printer £125.
RONDE & SCHWARZ SR Signal Generator. 30MHz-10kHz £150.
HEWLETT PACKARD 660C Signal Generator. 10-400MHz. £95.

**CABLE & WIRELESS**

**TExASWEEPERS**
Texasan Model VS40 Sweep Generators. 0-300MHz. £95 inc. VAT. Also available Texasan DU-88 X-Y Monitor.

**NOTE:** All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and must carry our usual 3 months guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

**DC Power Supplies**
2. Mullard Dual Supplies. Pps/10kV 1A @ 250V, 2A @ 1000V. £130. Current limited to 3A 7.7V DC @ 2A, 15V, 27-32V DC @ 1A. £151 (+£1 p&p).
3. Lambda LXS Series supplied 110V AC Input. 5V @ 1A. £20 (+£2.50 p&p). Various other voltages available from stock at small quantity. £100 (500V @ 1A).

**Φ Signal Generators**
ADVANCE Type E2. 10kHz-100MHz. Internal AM & Audio Output 0.1V-100V output. Price each £50 inc. VAT.
TAYLOR Type 66A/M. 100kHz-240MHz. Internal Modulation. £86 inc. VAT. (These are under orders, available in full working condition and carry our usual 90 Day Warranty. In both cases please add £2 each for carriage.

**Milli-Volt Measurement, Analogue**
MARCONI TP2980. Twelve ranges 1mV-300V FSD. 0.1% to 10% FSD. £125.
MARCONI TP2603. Frequency range 50kHz-1.5GHz. High Sensitivity from 300V. £125.
MARCONI TP2664. Electronic Multi-meter. AC/DC 300V full scale to 30V 1mA DC. Resistance range 100-1500kHz. £99.95.

**Bruel & Kjaer**
Model 2006 Heterodyne Voltmeter. AM/FM/Voltage measurement from 0-240MHz. £95 inc. VAT.

**EHT Power Supplies**
HUNTING TV3007. 0.5-15V at 2mA. VOLT and Current metered. £125.
BRANDENBURG ALPHA SERIES. Regulated 0-300V Volt-meter outputted. £125.

**Rohman Instrument Cooling Fans**
Supplied in excellent condition, fully serviced. £115, 4.5 x 4.5 x 1.5" £4.50. 230V £25. £115, 3 x 3 x 1.5" £4 + postage ca. 35p.

**Focus on Portables**
looking at circuit techniques used in B&W small screen TV sets, starting with the f/i. strip and a.g.c. arrangements.

**Servicing Thyristor Line Timebases**
Advances in colour c-r.t. scan coil design have made thyristors a viable proposition and large numbers of sets are still in use, so we've published a practical guide to fault-finding and servicing.

**VCR Servicing**
Tape path faults and adjustments.

**PLUS!**
Quick checks on PYE Hybrid CTVs.The Spirit of '51 for VINTAGE TV enthusiasts.

**On Sale Now...Well Worth a Closer Look**

WIRELESS WORLD NOVEMBER 1982
**WHAT PRICE PERFORMANCE FROM CROTECH? Not a lot—you’ll like it!**

**TYPE 3030**

- **DC–15MHz Bandwidth**
- **5mV/div sensitivity**
- **200ns – 200ms/div sweep speeds**
- **Rectangular CRT**
- **Compact and lightweight**
- **BUILT-IN COMPONENT TESTER**
  - **£150**

**TYPE 3131**

- **DC–15MHz Bandwidth**
- **5mV/div sensitivity on both channels**
- **Algebraic addition and subtraction**
- **X–Y Operation**
- **BUILT-IN COMPONENT TESTER**
  - **£240**

**3030 and 3131** just two models in the range, reflect the Crotech philosophy of building-in extra performance. Both scopes offer the full specification you expect and demand. But now the extra: both feature a Component Tester which displays the characteristics of active and passive components either in or out of circuit. This benefit extends both instruments beyond the limits of a normal scope. The price?, well that speaks for itself.

For details telephone Reading (0734) 866945 and ask for our full catalogue.

**Crotech Instruments Limited**

5 Nimrod Way, Elgar Road, Reading, Berks. RG2 0EB.

---

**FIRST IN THE WORLD**

The ICM-12, synthesized, marine hand-portable radio

**FEATURES:**

- 12 channels – 6 and 16 fitted as standard.
- No waiting for crystals, can be diode programmed between 156-164MHz.
- Automatic semi-duplex for private and link calls.
- Slide-on nicad pack recharges from mains or 12V
- Lots of options, speaker mics, alternative battery packs, 12V leads, and desk chargers.
- Complete with nicad battery pack, mains charger, belt clip, earphone, rubber antenna.
- Home Office type approved.
- **PRICE £199.13 + VAT. Free carriage.**

Trade enquiries very welcome – Ask for Phil Hadler

We can also supply the ICOM IC100E and IC410A VHF & UHF, PMR Base and Mobile transceivers. Fully approved, very compact, built-in CTCSS and at very competitive prices.

Also the first synthesized hand portable – ICH2. Two channels, high band, Simplex or Duplex. Dealers, forget your crystal problems!

Dealer outlets required, ask for Dave Stockley.

**Thanet Electronics**

143 Reculver Road, Herne Bay, Kent
Tel: 02273 63859. Telex 965179

---

**RELAY·À·QUIP PRODUCTS**

Moat Lodge, Stock Chase MALDON, Essex, UK
Tel: 0621 57242 10am-8pm Mon-Sat.

**TRADE P.O.A.**

<table>
<thead>
<tr>
<th>DIODES</th>
<th>TRADE P.O.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N4148</td>
<td>1N4004</td>
</tr>
<tr>
<td>1N4149</td>
<td>1N4002</td>
</tr>
<tr>
<td>1N4001</td>
<td>1N4001</td>
</tr>
</tbody>
</table>

---

**WIRELESS WORLD NOVEMBER 1982**

WW – 033 FOR FURTHER DETAILS
Visual monitoring of anything, anywhere, by phone, in seconds, with Robot Phoneline TV.

Robot's Phoneline TV systems provide a low-cost, efficient solution to the problem of visually monitoring remote installations, meters, gauges, traffic, weather, water levels, or any subject, large or small. The Phoneline TV equipment works well with standard TV equipment and converts the broadband video signal from the camera to narrow band audio tones for transmission via the dial telephone network or voice grade radio, then to a video signal again for display on a monitor at the receiving end. The entire process takes as little as 4 seconds and costs only the amount of the phone call. Since one or more cameras can be fed to one or more monitoring stations for viewing sequentially or simultaneously, and since the system can be fully automated, there is an almost infinite number of PTV system configurations possible. Permanent storage is available by recording the transmissions on audio cassette tapes. For fast, uncomplicated, inexpensive visual monitoring of any subject anywhere, Robot Phoneline TV is the answer. Write or call for more information and descriptive literature.

Robot (UK) Ltd., Building 33
East Midlands Airport
Castle Donington, Derby DE7 2SA
Tel: (0332) 812446, Tele: 75223
World Leaders in Phone Line Television and Image Processing Systems

ERASERS FOR THE DEVELOPMENT LAB

Electrically Erasable Programmable Read-Only Memory (EEPROM) Erasers are available for prompt delivery.

NORTHERN ELECTRONICS
51 Arundel Street, Morely, Lancaster
Tel: Morely (04575) 4119

WW – 892 FOR FURTHER DETAILS

ScheTronics Limited

For repair and calibration of test equipment. We also have selected pieces of second user LF/HF equipment for sale, including:

- Hewlett Packard Vector Voltmeter 8405A
- STC Sweep Set Audio/Broadcast plus recorder
- STC Phasemeter CCT Telephone Filter
- W & G PEM Z = 75 Ohms
- Anritsu Attenuator M54A
- Siemens Level Osc. SW C213/233/234
- Siemens Pegament space units

Unit 10, Dunstall Estate
Crabtree Manorway
Belvedere, Kent DA17 8AW
Telephone: 01-311 9657

WW – 879 FOR FURTHER DETAILS

The following tables show the coil values and their tolerances for the various filter networks mentioned above.
WIRELESS SOLID STATE E.H.T.

OC

METERS

Stockists

Black Self-ballasted BLACK LIGHT BULBS

Mn 4 tri FLUORESCENT TUBES

E.S.

Monday + modified for available.

channels gain, three configuration Available

8 pan balanced (hospital)

UV LAMP + VAT

Tubes

£2.50

£8.70 inc. VAT £10.001

£1E3.91

£1E3.97

£2.88)

£4

£11.50

£14.90 P&P 12.00 inc P&P.

E3.91

£120.00 Carriage, less per phase max £162.00 Carriage, -VAT.

£270.00

£20.40

£14.90 P&P 12.00 inc P&P.

£49.00 P&P 111.50.

£53.70

£22.00 + P&P.

£14.96). For those x.f. for further details include Super Hi Lytograph.

HY-LYTE STROBE KIT Mk IV


£23.36). For more x.f. for further details include Super Hi Lytograph.

TIME SWITCH VENNER

STOP WATCH

Time saved 200 volts 3-phase unit, use 3-phase at 20 c or below, or any multi phase max to include a load of 127/220V VAC use. Bult in to be used with battery power. Price £38.60 inc. VAT £44.10.

£65.00

£120.00

£14.90 inc VAT.

£2.50 P&P

£4.55

£14.90 inc VAT.

£2.50 P&P

£2.50 P&P.

£14.96)

£11.50

£14.90 P&P 12.00 inc P&P.

£49.00 P&P 111.50.

£53.70

£22.00 + P&P.

£14.96). For those x.f. for further details include Super Hi Lytograph.

INSULATION TESTERS NEW

WARING TUBE. Built-in unit of high pressure, use with ionisation, saturate, milkshake, abrupt switch and circuit.

WIRELESS WORLD NOVEMBER 1982

WW -- 962 FOR FURTHER DETAILS

D&R electronics was founded over 10 years ago doing contract and manufacturing high quality mixing consoles for the studio and entertainment industry with a special emphasis on value for money design engineering. The result is a range of live basic models with a large number of channel configurations and options. All models are highly flexible in use and give the best quality possible at todays state of technology.

SERIES 600 - A range of mixers for live amplification, broadcast studios and two track recording.

SERIES 400 - A comprehensive 'In-Line' consoles for professional recording studios.

SERIES 800 - Top of the range 'In-Line' consoles with integral patch bay for top recording studios. A large number of auxiliary signal processing units are plentant the D&R programme.

Please complete this coupon for further details:

D&R Series 200

D&R Series 600

D&R Series 400

D&R Series 800

D&R Ancillary Equipment

BULLET loudspeaker components

VIFAIOX loudspeaker equipment

HELIOS mirror balls

NAME

ADDRESS

WW/11/82
**BBC Micro Computer**

Now available from stock

**BBC Model B** £399
(incl. VAT)
(Carr £8/unit)
Model A to Model B upgrade kit £60
Fitting charge £20.

**ANALOGUE PORT KIT**
IC 73, SK6 £7.30
RS423 & VDU Port Kit £10.80

**PRINTER & USER PORT KIT**
IC 69, 70, 71 PL9, 10 £9.50
Bus & Tube Port Kit £6.50

**DIRECTIONS**

By Telephone

01-452 1500

TECHNOMATIC LTD

01-450 6597

**NEW LOW PRICES**

**BASSETT RECORDERS**
Sanvo Computer Grade Recorder £245 + £1.50 Carr
Cassette Leads £3.50
Computer Cassette £5.00 ea. £4.50 for 10

**NEC PC 8023 BE - C**

100CPS; 80 cols Log. Seeking, Bi-
directional, Forward and Reverse
Line Feed, Proportional Spacing, Auto Underline
Hi-Res and Block
Graphics, Greek Char. Set.
Only £340 + Carr £8

**MICRODOCTOR**
This is not a logic ana-
lyser or an oscilloscope.
It is a microsystem and gives a printed re-
print on RAM, ROM and I/O — it prints memory
map, search for code, check dateline shorts and
operates peripherals and even assembles the
ROM.
Microdoctor complete with psu, printer probe
cable and two configuration board

**MICROTIMER**
65/2 Based Programmable clock timer with

* 224 switching times/week/cycle
* 24-hour 7-day timer
* 4 independent switch outputs directly interfacing to
thyrister/triacs
* A digit 7 sec. display to indicate real time, ON/OFF and
Reset times
* Output to drive day of week switch and status LEDs.
Full details on request. Price for kit £57

**UV ERASERS**
UV18 up to 6 Eproms £47.50
UV17 with Timer £60
UV140 up to 14 Eproms £61.50
UV141 with Timer £78
(Carr £2/eraser)

**UV CLIP**
All erasers are fitted with mains switches and safety interlocks.

**TRAINING KITS**

6502 Junior Computer £85
6602 Nancop I £80
6602 Nancop II £80
1802 Micro Trainer £64

**RUGBY ATOMIC CLOCK**

This 280 micro controlled clock/stopwatch receives
coded time data from NFL Rugby. The clock never
needs to be reset. The facilities include 8 indepen-
dent alarms and for each alarm there is a choice of
meloody or alternating which can be used for
electrical switching. A separate timer allows
recording of up to 950 times without interrupt-
ing the count. Expansion facilities provided.
See July/August ETI for details. Complete Kit £120 + £2 pp

**BOOKS**

**DISK DRIVES**

Single Drive 5¼" SSSD £360 + £8 carr.
Double Drive 5¼" DDSB £799 + £8 carr.

All mating Connectors with Cables in stock.
Full range of ACORN, SOFT, PROGRAM
POWER & BUGBYTE SOFTWARE
AVAILABLE
Phone or send for our BBC leaflet

**ACORN ATOM**

8K x 2K Built £135 12K + £12K
Expanded £175
8K x 5K + Colour Card £170
(Carr £3/unit)
Atom Disc Pack £299 + £6 Carr
3A 5v Regulated £26 + £2 Carr
Atom PSU £7 + £5 Carr
Full Range of Atomsoft in stock.
Phone/send for our ATOM LIST

**MICROCOMPUTER**

**PLUS 2**

MC68000 Microcomputer System £250
MC68000 Development Board £180
Complete system £550
For details contact ACORN

**WIRELESS WORLD NOVEMBER 1982**
<table>
<thead>
<tr>
<th>ITEM</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>74S00</td>
<td>25p</td>
</tr>
<tr>
<td>74S02</td>
<td>10p</td>
</tr>
<tr>
<td>74S03</td>
<td>20p</td>
</tr>
<tr>
<td>74S04</td>
<td>30p</td>
</tr>
<tr>
<td>74S05</td>
<td>50p</td>
</tr>
<tr>
<td>74S06</td>
<td>75p</td>
</tr>
<tr>
<td>74S07</td>
<td>1.00</td>
</tr>
<tr>
<td>74S08</td>
<td>1.25</td>
</tr>
<tr>
<td>74S09</td>
<td>1.50</td>
</tr>
<tr>
<td>74S10</td>
<td>1.75</td>
</tr>
<tr>
<td>74S11</td>
<td>2.00</td>
</tr>
<tr>
<td>74S12</td>
<td>2.25</td>
</tr>
<tr>
<td>74S13</td>
<td>2.50</td>
</tr>
<tr>
<td>74S14</td>
<td>2.75</td>
</tr>
<tr>
<td>74S15</td>
<td>3.00</td>
</tr>
<tr>
<td>74S16</td>
<td>3.25</td>
</tr>
<tr>
<td>74S17</td>
<td>3.50</td>
</tr>
</tbody>
</table>

**NOTE:**
- All prices are in pence, except where noted.
- Items marked with an asterisk (*) are available in packs of 10.
- Items marked with a small 'p' are available in packs of 100.
- For bulk orders, contact TECHNOMATIC LTD directly.

**TECHNOMATIC LTD**
MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS & A.M. LONDON ROAD
(Tel: 01-452 1500, 01-450 6597, Telex: 922800)
305 EDGWARE ROAD, LONDON W2

**PLEASE ADD 40p p&p & 15% VAT**
(Export: no VAT, p&p at Cost)
Orders from Government Deps. & Colleges etc. welcome.
Detailed Price List on request.
Stock items are normally by return of post.
WHAT ARE YOU DRIVING?

INDUCTION LOOP TRANSMITTERS
VIBRATOR/SHAKERS
SERVOMOTORS
MAGNETS

CRIMSON ELEKTRIK POWER AMP MODULES HAVE DONE IT ALL

CHOOSE our acclaimed Bipolar Modules for the best in Hi-Fi. These modules have been widely used by professional bodies. They are high slew, low t.h.d. devices without need for the output fuses that spoil fidelity. They have instantly resetable 'electronic fuse' and are L-bracket mounting for flexi installation.

CHOOSE Our Mosfet Modules for the most difficult loads. These modules are rugged and make ideal line step-up transformer drivers. They respond down to d.c. and make excellent servo-driving devices. They have low d.c. offset drift due to fet inputs.

**S** **T** **Y** **P**
**M** **O** **D** **U** **L** **E**
**P** **A** **W** **E** **R**
**P** **R** **O** **L** **E** **R**
**P** **E** **C** **A** **R** **O** **S**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MAX. O/P POWER</th>
<th>SUPPLY MAX</th>
<th>VOLTAGE TYP.</th>
<th>THD TYP.</th>
<th>PRICE INC. V.A.T. &amp; POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Export — no problem. Please write for quotation or quote your Visa/Master Charge card number.

**CrDmson Elektrik**
FREEP0ST, 9 Claymll Road, Leicester, LE4 7JJ, England

---

Electricity Supply Handbook — Your Guide to the Industry!

An up-to-date copy of the Electricity Supply Handbook is the best reference for knowing who's who and what's what in the electricity industry.

The 1982 edition contains:

* Over 2,000 names and locations of executive personnel in the Electricity Council, C.E.G.B., Area Boards and other organisations.
* Major authorities, government departments associated with the electrical industry.
* U.K. power stations, Area Board statistics, electricity tariffs, electrical associations.
* Pull out map of C.E.G.B. regions, power stations and transmission lines.
* Bound in maps of Area Boards.

Famous for its total coverage, detail and accuracy, it always sells out fast so make sure of your copy today, using the coupon below.

To: General Sales Department. Room 205, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AN.
Please send me ______ copies of Electricity Supply Handbook 1982 at £7.00 per copy, incl. p&p.

Name: ________________________ Address: ________________________

Made payable to IPC Business Press Ltd.

1982 edition out now! Price £7.00 post free.
**LINSLEY-HOOD PEAK DRIVE INDICATOR**

A very useful device, connected to loudspeakers giving a 4-digit readout 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 five microseconds' duration. Unit uses CDV technology, is self-contained and battery powered. Complete Kit £16.46 except batteries. Reprint of Article Zip. No VAT. Post free.

**HIGH QUALITY REPLACEMENT CASSETTE HEADS**

Do your tapes lack treble? A worn head could be the problem. Fitting one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our TCI Test Cassette helps you set the azimuth spot-on. We are the actual improvers which means you get the benefit of lower prices. These are available, except a new Orly head. The following is a list of our most popular heads, all suitable for use on JVC, Onkyo and other decks.

- **HC20** flat ribbed stereo head. £10.99. High Barmount Mono/Stereo Head. A heavy-duty, high performance head suitable for use on Philips and Sony decks. £20.00.
- **HSTS** 4-track head for reverse or phonographic use. Fully specification record and playback. £17.40.
- Please consult our list for technical data on those and other Casio/Fujifilm heads.

**SPECIAL OFFER**

Replacement heads for Sony machines. First Queen's Swallow head with special base to fit Sony decks £7.30. These are only available while stocks last, so buy now to keep in. Only £3.95.

**HART TRIPLE-PURPOSE TEST CASSETTE TC1**

One inexpensive test cassette enables you to set up VU level, check azimuth and tape speed, invaluable when fitting new heads. Only £3.80 plus VAT and 50p postage.

**CASSETTE MOTORS**

Brand New Ganged 12v DC Tape Drive Motor Type MM-M34.

As used in SP/S9 and many other decks, diameter 35mm. Shaft 15.20mm long x 2.2mm. £6.45 each. £10.00 per pair.

Lenco CMB 999: We have a small quantity of spares motors for these decks at 15 each complete with drive pulley. Spares belts for IRF and CPR 9900.

Full details of the entire range of HART products is contained in our illustrated lists. Ask for free copies NOW.

**LINSLEY-HOOD 300 SERIES AMPLIFIERS**

These latest designs from the drawing board of John Linsley-Hood, enginered to the very highest standard, represent the very best that is available on the UK market today. The clarity and transparency of the tone quality enable these amplifiers to outperform on a side by side comparison, the bulk of amplifiers in the commercial market place and even exceed the high standard set by his earlier 50 watt designs.

Three transistors, a 12v DC Servo Feedback Motor. Total cost of parts £104.95. Special offer for complete kits £87.40.

**VERITCAL FRONT LOADING CASSETTE DECK VFL910**

This deck is used in our Linsley-Hood Cassette Recorder 2 and has every possible feature to ensure top-notch performance. Recently featured in this magazine in a "Digital Multi-Track Tape Recorder" by R. J. Edwards. 12v DC Servo Feedback Motor.

VFL910 Deck fitted with HS16 Senduray Alloy Super Head £31.99

**FEED YOUR MICRO BITES WITH OUR SOLENOID CONTROLLED CASSETTE DECK**

Front loading deck with full solenoid control of all functions including optional read as test wind motors. 12v operation. Fitted 3-digit memory counter and Hall 'E' Motion Sensor. Standard heads and outsize heads. Please write for full details and price list of cards. Overall cost £34.96 plus VAT. Full technical specification included.

**LINSLEY-HOOD CASSETTE RECORDERS**

We have done two kits to this design: one using the original car cassette mechanism and the newer version using a very high quality front loading deck. The new deck has an excellent W.B.T performance and fitted with our latest Senduray Alloy Super Head gives an incredible frequency range (with good tape you can use 23kHz on burst).

Linsley-Hood Cassette Recorder 1 £175.00
Linsley-Hood Cassette Recorder 2 £229.00
Reprints of "W.B.T" Article. 70p. No VAT.

**HIGH-QUALITY HEAVY DUTY CASSETTE DECK**

This will appeal to all lovers of elegant design combining a basic simplicity with sound construction. No less than three direct drive motors are integral to the mechanism. The system is completely designed around the performance of the magnetic pick-up facility. Total cost of all parts £114.46 but our special introductory price for all parts bought together is only £109.96.

**LINSLEY-HOOD 100 WATT POWER AMPLIFIER**

Our complete kit for this brilliant new design is the same size as our Linsley-Hood Cassette Recorder 1. It includes all parts for a basic power amplifiers with large heat sinks, huge power supply and speaker protection circuitry. Total cost of all parts £114.46 but our special introductory price for all parts bought together is only £99.96.

**'P. W. WINTON' TUNER AND AMPLIFIER**

Snazzy matching chrome tuning and amplifier in beautiful wooden cabinet. These Ted Pule designs are for the enthusiast. Quality componentry, designed with clock and timer features. FM has 8 section front and switchable bandwidths. The performance and performance of these kits represents a unique way of construction. Very high standard, represent the total cost of parts £104.95. Special offer for complete kits £87.40.

<table>
<thead>
<tr>
<th>Orly Head</th>
<th>Price</th>
<th>Senduray Alloy Super Head</th>
<th>Price</th>
</tr>
</thead>
</table>

**LINSLEY-HOOD 100 WATT POWER AMPLIFIER**

Our complete kit for this brilliant new design is the same size as our Linsley-Hood Cassette Recorder 1. It includes all parts for a basic power amplifier with large heat sinks, huge power supply and speaker protection circuitry. Total cost of all parts £114.46 but our special introductory price for all parts bought together is only £99.96.

**HART ELECTRONIC KITS LTD.**

Oswestry, Shropshire

Telephone: Oswestry (0691) 2894

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

WIRELESS WORLD NOVEMBER 1982
ELECTRIC SHOCK

2 WAYS TO RECOVERY

ACT AT ONCE – DELAY IS FATAL

Display the ELECTRICAL REVIEW shock first aid chart (356x508mm) supplied in thousands to destinations world-wide. Recent deliveries include consignments to companies in Papua New Guinea, Dubai, United Arab Emirates, The Philippines, apart from UK commercial and industrial, educational, Central Government, Local Authorities' orders.

Carry the ELECTRICAL REVIEW pocket-size shock card (92x126mm) designed to help safety and training officers, medical and welfare personnel; all who might find themselves called to save a life. Always pocket your card; there's a useful two-year calendar on the back.

GET IT – READ IT – PRACTISE 1-4

BE READY TO SAVE A LIFE. SOMEONE MIGHT SAVE YOURS.

ACT AT ONCE—DELAY IS FATAL!

To IPC Electrical-Electronic Press Ltd., General Sales Department, Room 205, Quadrant House, Sutton, SM2 5AS, Surrey, England.

Company registered in England No 677128. Registered Office Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

Please send... copy/copies as indicated

Pocket Card @ 70p each inc VAT
Paper Chart @ 70p each post free
Card Chart @ £1.40 each post free
Plastic Chart @ £2.10 each post free

Discounts: 100 + copies 10%
500 + copies 15%

(Overseas surface and air mail rates supplied on application.)
In today's economic climate the opportunity to buy equipment at less than the manufacturer's list price is increasingly attractive to a growing number of organisations. Our rental inventory, which is constantly being rotated, provides an invaluable source of supply of pre-owned equipment. Although used, the equipment is guaranteed to meet the manufacturer's published specifications, has always been regularly maintained and is often still in immaculate condition. A guarantee is provided for up to six months and in most cases there are several units available of each type.

### OSCILLOSCOPES & ACCESSORIES

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tektronix Scope 704A/7A26/7A26/7B53A</td>
<td>3600</td>
<td>6318</td>
</tr>
<tr>
<td>Tektronix Scope 465B/DM44</td>
<td>1775</td>
<td>2177</td>
</tr>
<tr>
<td>Tektronix Scope 455</td>
<td>930</td>
<td>1945</td>
</tr>
<tr>
<td>Telequipment Scope DM63</td>
<td>750</td>
<td>1776</td>
</tr>
<tr>
<td>Gould Scope PM324</td>
<td>1395</td>
<td>2299</td>
</tr>
<tr>
<td>Gould Scope O5000</td>
<td>1100</td>
<td>2095</td>
</tr>
<tr>
<td>Gould Scope O5002</td>
<td>1200</td>
<td>2960</td>
</tr>
<tr>
<td>Tektronix Stg. Scope 464</td>
<td>1950</td>
<td>3429</td>
</tr>
<tr>
<td>Tektronix Scope 7313/7A18/7A18/7B53A</td>
<td>2150</td>
<td>6832</td>
</tr>
<tr>
<td>Tektronix Scope 7623A/7A26/7B53A</td>
<td>4275</td>
<td>7797</td>
</tr>
<tr>
<td>Tektronix Stg. Scope 7633/7A26/7A26/7B53A</td>
<td>4957</td>
<td>9045</td>
</tr>
<tr>
<td>Tektronix CTS Probe</td>
<td>350</td>
<td>830</td>
</tr>
<tr>
<td>Tektronix Camera C30 AR</td>
<td>350</td>
<td>581</td>
</tr>
<tr>
<td>Tektronix Camera Super 7 MK 2</td>
<td>300</td>
<td>581</td>
</tr>
<tr>
<td>Tektronix P6201 FET Probe</td>
<td>530</td>
<td>880</td>
</tr>
</tbody>
</table>

### CURVE TRACERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tektronix 577/177</td>
<td>2300</td>
<td>3648</td>
</tr>
</tbody>
</table>

### DIGITAL MULTIMETERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datron 1051</td>
<td>740</td>
<td>1750</td>
</tr>
<tr>
<td>Datron 1059</td>
<td>510</td>
<td>995</td>
</tr>
<tr>
<td>Solarton 7045</td>
<td>250</td>
<td>360</td>
</tr>
<tr>
<td>Solarton 7055</td>
<td>400</td>
<td>1390</td>
</tr>
<tr>
<td>Solarton 7065</td>
<td>600</td>
<td>1620</td>
</tr>
<tr>
<td>Fluke 8600A</td>
<td>295</td>
<td>433</td>
</tr>
<tr>
<td>Fluke 8920A True RMS</td>
<td>620</td>
<td>1095</td>
</tr>
</tbody>
</table>

### COUNTERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Racal Timer Counter 9905</td>
<td>225</td>
<td>395</td>
</tr>
<tr>
<td>Systron Donner Freq. Counter 6053</td>
<td>425</td>
<td>1460</td>
</tr>
<tr>
<td>Systron Donner Freq. Counter 6153</td>
<td>650</td>
<td>3495</td>
</tr>
<tr>
<td>H. P. Timer Counter 5327A</td>
<td>525</td>
<td>1193</td>
</tr>
<tr>
<td>H. P. Microwave Freq. Meter 536A</td>
<td>700</td>
<td>930</td>
</tr>
<tr>
<td>Fluke Timer Counter 1953A</td>
<td>825</td>
<td>1315</td>
</tr>
</tbody>
</table>

### SIGNAL SOURCES

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marconi Sig. Gen. TF2016</td>
<td>1225</td>
<td>2195</td>
</tr>
<tr>
<td>Systron Donner Pulse Gen. PG100A</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>Racal/Adet GpiB Sig. Gen. 7100B</td>
<td>560</td>
<td>7910</td>
</tr>
<tr>
<td>H. P. Pulse Gen. 8013B</td>
<td>495</td>
<td>1031</td>
</tr>
<tr>
<td>H. P. Function Gen. 3312A</td>
<td>415</td>
<td>751</td>
</tr>
<tr>
<td>H. P. Sig. Gen. 8640B</td>
<td>3750</td>
<td>5880</td>
</tr>
<tr>
<td>H. P. Synthesized Sig. Gen. 8672A</td>
<td>16700</td>
<td>23900</td>
</tr>
</tbody>
</table>

### RECORDERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philips Recorder 8022</td>
<td>830</td>
<td>1576</td>
</tr>
<tr>
<td>Philips Recorder PM 8236</td>
<td>1380</td>
<td>2841</td>
</tr>
<tr>
<td>TOA EPR 200A YY - T</td>
<td>750</td>
<td>1100</td>
</tr>
<tr>
<td>Anaspec 20 - T</td>
<td>450</td>
<td>1100</td>
</tr>
<tr>
<td>Watanabe 6001</td>
<td>1800</td>
<td>3080</td>
</tr>
<tr>
<td>Micro Module M10 - 120</td>
<td>2300</td>
<td>3547</td>
</tr>
<tr>
<td>H. P. XY Recorder 7045</td>
<td>1160</td>
<td>2556</td>
</tr>
<tr>
<td>H. P. XY Recorder 7046</td>
<td>1550</td>
<td>3576</td>
</tr>
<tr>
<td>S. E. Labs 993 Galvo Amp</td>
<td>400</td>
<td>1069</td>
</tr>
</tbody>
</table>

### TAPE RECORDERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Racal Store 4Ds</td>
<td>3000</td>
<td>5285</td>
</tr>
<tr>
<td>Racal Store 7D</td>
<td>4000</td>
<td>8281</td>
</tr>
<tr>
<td>Racal Store 14D</td>
<td>6000</td>
<td>11570</td>
</tr>
<tr>
<td>S. E. Labs 3500/14</td>
<td>8000</td>
<td>10800</td>
</tr>
<tr>
<td>S. E. Labs 7000A</td>
<td>10500</td>
<td>16120</td>
</tr>
</tbody>
</table>

### DATA LOGGERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soloran Compact Logger 3430B</td>
<td>1800</td>
<td>3300</td>
</tr>
<tr>
<td>Fluke 22408 System</td>
<td>P.O.A.</td>
<td></td>
</tr>
</tbody>
</table>

### TRANSIENT RECORDERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Labs DL905</td>
<td>750</td>
<td>1519</td>
</tr>
<tr>
<td>Franklin 3500R Dist. Mon.</td>
<td>2400</td>
<td>4330</td>
</tr>
<tr>
<td>Dranetz 606 - 3</td>
<td>2250</td>
<td>3688</td>
</tr>
</tbody>
</table>

### SPECTRUM ANALYSERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soloran 1510</td>
<td>2700</td>
<td>5151</td>
</tr>
<tr>
<td>H. P. Storage Normalizer 8750A</td>
<td>900</td>
<td>1376</td>
</tr>
</tbody>
</table>

### DESK-TOP COMPUTERS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. P. 9825A</td>
<td>2950</td>
<td>5006</td>
</tr>
<tr>
<td>H. P. 9821A String Prog. Rom.</td>
<td>125</td>
<td>162</td>
</tr>
<tr>
<td>H. P. 9821A I/O Rom.</td>
<td>235</td>
<td>306</td>
</tr>
<tr>
<td>H. P. 9835A</td>
<td>3775</td>
<td>6987</td>
</tr>
<tr>
<td>H. P. 98332A I/O Rom.</td>
<td>395</td>
<td>506</td>
</tr>
<tr>
<td>H. P. 98336A Adv. Prog. Rom.</td>
<td>295</td>
<td>337</td>
</tr>
<tr>
<td>H. P. 98337A Plotter Graph Rom.</td>
<td>295</td>
<td>337</td>
</tr>
<tr>
<td>H. P. 98338A Assem. Exec. Rom.</td>
<td>295</td>
<td>337</td>
</tr>
</tbody>
</table>

### DATA TERMINALS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lear Siegler V.D.U. ADM 3A+</td>
<td>450</td>
<td>595</td>
</tr>
<tr>
<td>Tektronix CT 8100 V.D.U.</td>
<td>325</td>
<td></td>
</tr>
<tr>
<td>H. P. 2821A V.D.U.</td>
<td>775</td>
<td>1174</td>
</tr>
<tr>
<td>H. P. 2821P V.D.U. With Printer</td>
<td>1425</td>
<td>1946</td>
</tr>
<tr>
<td>Texas Silent 743 Printer</td>
<td>495</td>
<td>1090</td>
</tr>
</tbody>
</table>

### POWER SUPPLIES

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aplab LVED 30/2</td>
<td>80</td>
<td>190</td>
</tr>
<tr>
<td>Fairnel TSV 70</td>
<td>275</td>
<td>440</td>
</tr>
<tr>
<td>Aplab Inverter TIS 250/500</td>
<td>450</td>
<td>825</td>
</tr>
</tbody>
</table>

### MISCELLANEOUS

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Selling Price £</th>
<th>Manufacturer Price £</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wayne Kerr B605 Bridge</td>
<td>1175</td>
<td>1350</td>
</tr>
<tr>
<td>Ferrograph Test Set RTS 2</td>
<td>395</td>
<td>495</td>
</tr>
<tr>
<td>Ferrograph Aux. Test Unit ATU 1</td>
<td>180</td>
<td>275</td>
</tr>
<tr>
<td>Dymar A.F. Power Meter 2085</td>
<td>270</td>
<td>355</td>
</tr>
<tr>
<td>Tektronix Data Comms Tester 832</td>
<td>840</td>
<td>1452</td>
</tr>
<tr>
<td>H. P. Transmission Test Set 3552A</td>
<td>1400</td>
<td>1955</td>
</tr>
<tr>
<td>H. P. Selective Level Meas. Set 3745B</td>
<td>6800</td>
<td>14700</td>
</tr>
<tr>
<td>H. P. Microwave Link Analyser 3710A</td>
<td>11900</td>
<td>15300</td>
</tr>
</tbody>
</table>
MANUFACTURERS & DISTRIBUTORS

CROUZET reversible geared motor. B r.p.m. 240 volt 50Hz with universal T drive. £35 for 10 + VAT; £162 for 50 + VAT; £300 for 100 + VAT; £1,250 for 500 + VAT. Sample despatched for £3.75 + 75p p&p (£5.17 inc. VAT).

MATSUSHITA high quality 12 volt D.C. cassette drive motors, size 30mm dia. x 20mm high, drive shaft 7mm long x 2mm dia. approx. No load current 40 ma. £135 for 50 + VAT; £24 for 100 + VAT; £108 for 500 + VAT; £910 for 1,000 + VAT; £560 for 10,000 + VAT. Sample 10 sent for £3 + 1p p&p (£4.60 inc. VAT).

BRITISH MADE TRANSFORMER, input 240v at 50Hz, output 12v-0-12v at 1/2 amp, with built-in thermal overload cutout. P.C. mounting, £25 for 10 + VAT; £115 for 50 + VAT; £210 for 100 + VAT; £395 for 500 + VAT; £1,700 for 1,000 + VAT. Sample sent for £3 + 75p p&p (£4.31 inc. VAT).

STEREO CASSETTE FRONT LOADING REPLAY MECHANISM for in-car entertainment. Complete with motor and pre-amplifier. Manuf. in U.K. under licence of STAAR S.A. £45 for 10 + VAT; £605 for 50 + VAT; £775 for 100 + VAT; £1,700 for 500 + VAT. Sample sent for £5 + £1.50 p&p (£7.48 inc. VAT).

CHERRY E51 sub-miniature micro switches with common NO-NC contacts. Rated at 5 amps on 125-250V A.C. Internal heavy duty contact gold plated for long life. £15 for 100 + VAT; £67.50 for 500 + VAT; £125 for 1,000 + VAT; £500 for 5,000 + VAT. Sample sent for £2 + 50p p&p (£2.88 inc. VAT).

SPEAKERS, CHASSIS TYPE, size 67mm x 67mm, 35 R at 0.3 Watts, £5 for 10 + VAT; £22 for 50 + VAT; £42 for 100 + VAT; £190 for 500 + VAT; £350 for 1,000 + VAT. Sample sent for £6.50 + 5p p&p (£11.15 inc. VAT).

Terms C.O.D. Please add 5% to all orders for carriage plus 15% VAT. Export enquires welcome. We find it impossible to advertise all our stock. Please telephone or write for further enquires. Personal callers always welcome.

ELECTRONIC EQUIPMENT CO.

SPRINGFIELD HOUSE 78 TYSUM ST, LONDON E1 TEL: 01-245 5127 TELEX BROWN 620G

WW - 060 FOR FURTHER DETAILS

PRODUCTION TESTING

POWER UNITS

Now available with

3 OUTPUTS

Type 250VRU / 30/25

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

DIODES

ALL Continuously Variable

DIODES

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
<table>
<thead>
<tr>
<th>Wirewound Resistors</th>
<th>BASES ETC.</th>
<th>Zener Diodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6V2 6V5 9V1 9V5 12V1</td>
<td>2N448 2N5084 2N6096 2N6292</td>
<td>1N4734 1N4746 1N4757 1N4766</td>
</tr>
<tr>
<td>3V6 3V9 4V6 4V9 6V5 6V9</td>
<td>2N448 2N5084 2N6096 2N6292</td>
<td>1N4734 1N4746 1N4757 1N4766</td>
</tr>
<tr>
<td>18V 120V 220V 300V</td>
<td>2N448 2N5084 2N6096 2N6292</td>
<td>1N4734 1N4746 1N4757 1N4766</td>
</tr>
</tbody>
</table>

**CALLERS WELCOME**

- **50 YDS SOUTH OF MEOPHAM GREEN**
- **ACCESS AVAILABLE**
- **UK ORDERS & P&P PLEASE ADD VAT AT 15%**
- **EXPORT ORDERS WELCOME, CARRIAGE/POST AT COST**

**WIRELESS WORLD NOVEMBER 1982**

**P. M. COMPONENTS LTD**
**SELECT HOUSE, WROTHAM ROAD, MEOPHAM GREEN, MEOPHAM, KENT DA130QY**

**TELEX**
**965966 WEST ST G**

**WIREWOUND RESISTORS**

- **RESISTANCES**
  - 0.15
  - 0.35
  - 0.75

- **POWER RATINGS**
  - 2W
  - 1W
  - 500mW

**ZENER DIODES**

- **VOLTAGES**
  - 0.6V
  - 0.8V
  - 1.2V

- **MARKINGS**
  - 1N4734
  - 1N4746
  - 1N4757
  - 1N4766

**TOUCH-TERM**

- **RESISTANCES**
  - 250Ω
  - 1KΩ

- **POWER RATINGS**
  - 0.25W
  - 1W

**RESISTANCES**

- **RESISTANCES**
  - 0.15
  - 0.35
  - 0.75

WIREWOUND RESISTORS

- **RESISTANCES**
  - 0.15
  - 0.35
  - 0.75

- **POWER RATINGS**
  - 2W
  - 1W
  - 500mW

ZENER DIODES

- **VOLTAGES**
  - 0.6V
  - 0.8V
  - 1.2V

- **MARKINGS**
  - 1N4734
  - 1N4746
  - 1N4757
  - 1N4766

TOUCH-TERM

- **RESISTANCES**
  - 250Ω
  - 1KΩ

- **POWER RATINGS**
  - 0.25W
  - 1W

RESISTANCES

- **RESISTANCES**
  - 0.15
  - 0.35
  - 0.75

- **POWER RATINGS**
  - 2W
  - 1W
  - 500mW

- **MARKINGS**
  - 1N4734
  - 1N4746
  - 1N4757
  - 1N4766

**ACCESS AVAILABLE**

- **HOURS**
  - MON: 9-5.30, SAT: 9.30-12.00
  - **24 HOUR ANSWERPHONE SERVICE**
  - **ACCESS AVAILABLE**
  - **MANY OTHER ITEMS AVAILABLE**

**UK ORDERS & P&P PLEASE ADD V.A.T. AT 15%**

**EXPORT ORDERS WELCOME, CARRIAGE/POST AT COST**

**WW - 074 FOR FURTHER DETAILS**
ANGLIA INDUSTRIAL AUCTIONS
Specialist Auctioneers to the Radio and Electronic Industry
5 Station Road, Littleport, Cambs. CB6 1QE
Telephone: Ely (0353) 860185

AUCTION SALES
of over 700 Lots
Electrical Components & Equipment
Large and Small Quantities

Forthcoming sales to be held on the following dates:

Catalogues available 10 days prior to sale, price 60p inc. p&p or for each sale a £5.

Entry forms on application. Although entries for cataloguing may be received up to 17 days before the date of the sale, customers are advised to enter early.

LOW DISTORTION AUDIO SIGNAL GENERATORS

Model 149b

£41.60

(P&P £2.25)

Also available in kit form and alternative versions, i.e.: battery or mains. With or without frequency meter.

Literature on these units, R.F. Sig. Gen., T.H.D. meters, MMVT, Function Generators and many other instruments is available on request.

TELERADIO ELECTRONICS, 325 FORE STREET, LONDON N8 0PE
Telephone 01-807 3719

CLOSED THURSDAYS

CLEF ELECTRONIC MUSIC

PIANOS

SPECIALISTS SINCE 1972
DOMESTIC OR EXPORT
SIX OR 12 OCTAVES
KITS OR MANUFACTURED

Merry Christmas to all our customers.

FREE 24 PAGE CATALOGUE

Christmas Kits now delivered.

Merry Christmas to you all.

CLEF PRODUCTS (ELECTRONICS) LIMITED

DEPT. W., 44A LANE SOUTH
BREMPTON, LONDON NW6 5BG

PHONE: 01-439 3541

CLEN-BOX

4 Channel Selector

MULTI-FUNCTIONAL

128-CHANNEL SELECTOR

128-CHANNEL SELECTOR

VOCAL \\
MENTAL SOLIST

MUSICAL INSTRUMENTS

CLEN-BOX

128-CHANNEL SELECTOR

128-CHANNEL SELECTOR

VOCAL \\
MENTAL SOLIST

MUSICAL INSTRUMENTS

WE WISH YOU ALL A MERRY CHRISTMAS
ELECTRONIC HOBBIES FAIR

Alexandra Pavilion London November 18 - 21 1982

The biggest and best event ever to be staged for the electronic hobbies enthusiast!

Walk into a whole world of electronic equipment. Everything from resistors, IC's to home computers, transmitting and receiving units, citizens band radio and peripheral equipment, video games, musical instruments, radio control models. In fact whatever your particular electronic hobby you'll find this show will be the most interesting and informative way to discover all the latest developments in your particular field.

Other attractions will include radio and TV transmission, electric vehicles, radio controlled models, and demonstrations by local and national organisations.

This is the age of the train - British Rail are offering a cheap rate rail fare from all major stations in the country direct to Alexandra Palace - a bus will be waiting on your arrival to take you to the show. Ticket price also includes admission to the exhibition - so let the train take the strain to the Electronic Hobbies Fair.

Ticket prices at the door are £2 for adults, £1 for children but party rates are available for 20 people or more. To find out more, contact the Exhibition Manager, Electronic Hobbies Fair, IPC Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 400. Tel: 01-643 8040.

Electronic Hobbies Fair is sponsored by Practical Electronics, Everyday Electronics and Practical Wireless and is organised by IPC Exhibitions Ltd.

OPENING TIMES

Thursday 18 Nov. - 10.00-18.00
Friday 19 Nov. - 10.00-18.00
Saturday 20 Nov. - 10.00-18.00
Sunday 21 Nov. - 10.00-17.00
The PCI 1002 is a 12 Channel IEEE compatible thermocouple converter having two input ranges of ± 10mV or ±100mV F.S.D. selected by an internal switch. It has 12 Bit resolution of the A to D converter giving a resolution of 0.06 deg.C on 10mV range and covers all common thermocouple types.

Cold Junction Compensation is provided giving a resolution of 0.2°C on 100mV range and 0.02°C on 10mV range.

Linearising software in Basic using optimised coefficients for ranges and thermocouple types.

Two other channels are provided via BNC input sockets on the front panel. Input ranges are I/V for 10 mV range and ±10V for 100mV range.

CIL MICROSYSTEMS LTD
DECOY ROAD, WORTHING, SUSSEX.
TEL: 210474.

High resolution graphics:
We put you in the picture

This month, we home in on the picture-making aspect of computers — and report on four exciting and intriguing developments: “Bit-stick”, the joystick device which brings out the artistic streak in Apple II; Apple II graphics for chemists — a package that draws molecular structures; the BBC micro as a colour graphics terminal, and how to store screen designs as graphic pages within a memory.

Also this month, we report on the Commodore 64 — a powerful computer with graphics facilities — and a new letter-addressing capability of Wordpro…

And that’s just a sample of Practical Computing — together with advice for users of Pet, Apple, Tandy and Sinclair ZX 80/81 Computers. Buy Britain’s leading personal computer magazine.

NOVEMBER ISSUE OUT NOW
80p AT YOUR NEWSAGENT’S — BUT HURRY
**Wireless World November 1982**

**HF Antennas**

- **Mode**: Full half wave operation.
- **Bands**: Up to 4 spot frequencies.
- **Power**: Receive to 800W (PEP).
- **SWR**: Better than 1.5:1 on channel.

**The SMC Trapped Dipole Antenna**

has been developed to solve the needs of commercial and military users as it is capable of operation between 2 and 30 MHz on as many as four spot frequencies - each capable of accommodating many channels. Excellent matching and efficiency with a single coaxial feed is offered by the use of SMC RG316 and the incorporation of a ferrite balun in a full half wave design. NB: Power absorbing terminating resistors are not employed. The antenna may be deployed using one or two support masts, installation incorporating SMC light duty portable masts can be easily effected by two people in half an hour.

**HF SSB Transceiver**

FT990 "Pioneer" HF SSB Transceiver, 1.8-18MHz. 6 channels, 100 watts RF output; measuring only 95(H) x 240(W) x 310(D)mm and weighing 8kg. May be operated as a base or mobile transceiver. Complementing our trap dipole and HW4 mobile aerials. Prices start at £500, making this unit not only very attractive but highly competitive.

**South Midlands Communications Ltd.**

OSBORNE ROAD, TOTTON SOUTHAMPTON S04 4DN

Tel: 477351 SMC COMM G

Tel: Totton (0703) 866330

WW - 078 FOR FURTHER DETAILS

**Fylde**

**Transducer and Recorder Amplifiers and Systems**

reliable high performance & practical controls. Individually powered modules—mains or dc option single cases and up to 17 modules in standard 19" crates small size—low weight—realistic prices.

Fylde Electronic Laboratories Limited.

49/51 Fylde Road Preston PR1 2XQ

Telephone 0772 57560

WW - 017 FOR FURTHER DETAILS

**Toroidals**

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

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

**234 Types to Choose From!**

**Orders Dispatched Within 7 Days of Receipt for Single or One Off Orders**

**5 Year No Quibble Guarantee**

**TRANSFORMERS**

WW - 057 FOR FURTHER DETAILS
PROJECT BOXES - CASES - CABINETS

- Black plastic boxes, 2 7/8 x 4 1/8 x 3 deep.
- Dispto, 3 5/8 x 2 3/4 x 1 3/4 deep.
- Dispto, 3 7/8 x 3 3/8 x 1 deep.
- Packed metal box, 7 1/4 x 4 1/2 x 1 1/2 deep.
- Dark grey hpl boxes. May be joined to make three different depth boxes. 4 5/8 x 2 5/8 x 3 3/4 deep.
- White plastic box ideal for touch switch, transistor, etc. Through top is square hole, 3 3/8 x 3 3/8.
- Loudspeaker cabinet for 6" speaker.

PORTABLE RADIO CASE - 5" speaker, size approx 6 1/2 x 3 1/2 x 2 deep.

RELEYS & RELAY BASES

- Standard open relays 3 x 8 amp c/o contacts.
- 6 volts dc coil.
- 24 volt dc coil.
- 240 volt ac coil.
- 6 x 8 amp changeover, 220 volt ac coil.
- Enclosed plug in round base relays - 3 changeover contacts.
- 24 volt (ex fuse mount).
- 110 volt coil 2 changeover.
- 12 volt coil 2 changeover.
- 12 volt coil 3 changeover.
- 8 pin bases. Bases for 2 changeover relay.
- 11 pin bases. Bases for 3 changeover relay.
- Miniature Relays - 2 volt 2 changeover.
- 12 volt 4 changeover.
- 24 volt.
- 48 volt.

SWITCHES - ROCKER, TOGGLE, ETC.

- Rocker switches. White push unto hole 1" x 7/16. All rated.
- 10 amp, AC 250 volt.
- 10 amp, AC changeover centre off on.
- Rocker centre on push to break spring return push to break spring return.
- Large circuit breaker on one off with mounting plate.
- 13 amp rocker switch. Cut Fastener (Gpo1).
- Pivoting Grip Switch. With lock on in electric drills.
- Interlocking Switch. Blow heater, 3 rockers, 10 amp.
- Micro switches. 13 types.
- 10 amp c/o contacts mains button operated.
- 15 amp c/o contacts.
- 10 amp off/on.
- 15 amp off/on.
- Power operated.
- Layer with roller operation add.
- Miniature types: Burges V16 E/C.
- Two mounted with roller covers.
- Glass rod switches.
- 60 watt 150 watt 40 watt 5 watt.
- Flat multi stackable 60 watt.
- Ceramic magnets.
- Mini magnets.

MAINS TRANSFORMERS

- 6 volt 1 amp.
- 6 volt 2 amp.
- 12 volt 1 amp.
- 12 volt 2 amp.
- 12 volt 3 amp.
- 8.5 - 0.5 8.5 1 amp.
- 18 volt 1 amp.
- 18 volt 2 amp.
- 38 volt 2 1/2 amp.
- 26 volt 3 amp.
- 50 volt 1 amp.
- 12 volt 5 amp.
- 12 volt 6 amp.
- 12 - 0.5 12 amp.
- 120 volt auto 115v/60Hz.

FLUORESCENT LIGHTING

- 12 volt inverter for 21" 13W tube with lamp leads.
- Chokes for: 8' 125 watt tube.
- 6' 85 watt tube.
- 5' 65 watt tube.
- 4' 40 watt tube.
- 2' 15/20 watt tube.
- 12" 8 watt.
- 12W 8 watt mini tube.
- "2" 40 watt bi pin end tube 1/4" diameter.
- "3 3/8" 60 watt bi pin end tube 1/4" diameter.
- "1m 40 watt bi pin end tube 1/4" diameter.
- "1m 25 watt bi pin end tube 1/4" diameter.
- "2" 80 watt bi pin end tube 1/2" diameter.
- "8" 80 watt bi pin end tube 1/2" diameter.
- "6" 200 watt bi pin end tube 1 1/2 diameter.
- "8" 200 watt bi pin end tube 1 1/2 diameter.
- "5" 200 watt bi pin end tube 2 1/2" diameter.
- "5" 200 watt bi pin end tube 2 1/2" diameter.
- "5" 200 watt bi pin end tube 3" diameter.
- "5" 200 watt bi pin end tube 3" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
- "5" 200 watt bi pin end tube 4" diameter.
MISCELLANEOUS ITEMS

NAMEPLAITS. Standard.

Bench testing mains in 230/240v output. 250W.

Mains input: Porcelain removable fuse.

Insulating board, support. Approx 10 tons. Various thicknesses. Price per lb.

Aerosol, 9 x 120ml. F10 aerosol lubricant.

Varo P.B. TV star.

Battery Holder makes a 6 Volt batteries, snap connection.

Circuit board, 10 x 12 x 1/2.

Bulbs: 3.5v.

White 2 watt.

Yellow 0.5 watt.

Black 0.3 watt.

3.4uf, 440v.

3uf, 660v.

2.7uf, 250v.

2.2uf, 250v.

2uf, 660v.

1uf, 250v.

0.5uf, 250v.

Resistors:

1/4 watt.

Bench testing mains in 230/240v output. 250W.

Price per 100.

Price per 4.

Price per 1.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.

Price per 2.
BRITAIN’S BETTER BARGAIN STILL IN WORLD-WIDE DEMAND

WIRELESS WORLD CIRCARDS at 1976 prices 10% discount for 10 sets! Most sets are still available even though the companion volumes CIRCUIT DESIGNS 1, 2 and 3 are out of print. (CIRCARDS SETS 1 to 30).

Fill gaps in your circuit files with these sets of 127 x 204 mm cards in plastic wallets. These unique circuit cards normally contain descriptions and performance data of 10 tested circuits, together with ideas for modifying them to suit special needs.

---

1 Basic Active filters  2 Switching Circuits, comparators and Schmitts (But these gaps cannot be filled)
22 Amplitude modulation and detection  23 Reference circuits  24 Voltage regulators  25 RC oscillators – 1  26 RC oscillators – 2  27 Linear cmos – 1  28 Linear cmos – 2  29 Analogue multipliers  30 Rms/log/power laws  31 Digital multipliers  32 Transistor arrays  33 Differential and bridge amplifiers  34 Analogue gate applications – 1  35 Analogue gate applications – 2

---

To IPC Electrical – Electronics Press Ltd.
General Sales Department,
Room 205,
Quadrant House,
Sutton,
Surrey SM2 5AS

Company registration in England
Quadrant House, The Quadrant,
Sutton, Surrey SM2 5AS
Reg. No 677128

Please send me the following sets of CIRCARDS: ........................................ £2 each,
£18 for 10 post free.
Remittance enclosed ................................ payable
to IPC BUSINESS PRESS LTD.
Name (Please print) ........................................
Address (Please print) ........................................

---

WIRELESS WORLD NOVEMBER 1982
THE RELAY RACE IS ON!

We have relays of all types, to cater for most of your requirements. Listed is a selection.

PLUG-IN (BPO 3000), BPO 1000 MINIATURE LEVER KEYS, CRADLE TYPE DIL REED, PC SERIES 65 POWER RELAY MR16 SERIES, PCB MOUNTING RP SERIES, SR26 TYPE, B15 TYPE, 07 + 12 SERIES, KL SERIES, 5G SERIES, 35 SERIES CRADLE TYPE, 29 SERIES.

SAFEBLOC 250V. A.C. (single phase mains) ONLY £5.45 — NO EXTRAS!

Contact us for detailed stocklist
Trade and Export enquiries welcome

BAYDIS
7 William Street
Herne Bay, Kent
Tel: 02273 64586

WW - 070 FOR FURTHER DETAILS

BEGINNERS START HERE!

How do I take the next step, beyond computer games and program listings? The November issue of Your Computer tells you in two articles written with the beginner in mind:

- Getting started in graphics — a description of graphics techniques, based on the BBC micro, but with explanations as to how they can be applied on the Sinclair Spectrum and Vic 20 too.

- Writing machines code games for the ZX81. First in a new series in which each part will include a game illustrating the techniques described.

Get a copy from your newsagent now or take out a subscription by completing the coupon.

To: Marketing Department, Room L214, IPC Electrical-Electronic Press Ltd., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Please send me 12 issues of Your Computer. I enclose a cheque/PO for £8 UK/£14 Overseas, payable to IPC Business Press Ltd.

Name
Address

WW - 075 FOR FURTHER DETAILS
ALWAYS AHEAD WITH THE BEST!
£5,000-£18,000

- Experienced in: Mini/Microprocessor hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?
- Where does your interest lie: Image processing; Automation; Datacomms; Radar; Nav-Aids; Video; Medical; Telemetry; Simulation; Satcom; Local Area Networks; Teletext; Viewdata?
- There are opportunities in: Design; Test; Service; Sales; Systems; Production; Quality and Research at engineer and management level.
- First call: Contact MIKE GERNAT on 076 384 6767/7 (usually until 8 p.m.)

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
148-150 High St., Barkway, Royston, Herts SG8 8EG

ELECTROMAGNETIC COMPATIBILITY
SPECIALIST ENGINEERS
Marconi Underwater Systems Ltd., a new company at Portsmouth, within the Marconi Company, need Professional Electronics Engineers or Physicists with experience in at least one of the following disciplines to join the Company for work on an important new weapon.
- RADHAZ
- ELECTRONIC SYSTEM COMPATIBILITY
- RFI
- FILTER DESIGN
- EMP
- SHIELDING DESIGN
- LIGHTNING
- EMC PREDICTION & ANALYSIS

The specialist group in which you would work supplies an EMC design, analysis and test; service to the whole Company. As a member of the group you would work with a large project team and have the opportunity of making a significant contribution to the successful attainment of required weapon performance. We will also need Engineers with circuit design experience for these positions.

We can offer you a salary that reflects the true value of your qualifications and experience and an extensive and worthwhile benefits package. Please telephone or write to C.A. Ormonde-Dobbin, Marconi Underwater Systems Limited, Browns Lane, The Airport, Portsmouth, Hants, PO3 5PH. Telephone: Portsmouth (0705) 664966 Ext. 305

Marconi Underwater Systems

WIRELESS WORLD NOVEMBER 1982
**Appointments**

**SOMETHING A LITTLE DIFFERENT**

**Rural S. Yorkshire**

Our client needs an RF Engineer with more than just RF experience. They must have that unique quality, flair.

The company design and manufacture communication and alarm systems for the protection of people and of people's property. Much of their work is for the disadvantaged sectors of the community, particularly the elderly. They have been established since the late '50s and have a reputation second to none in this unusual market sector.

If you have a strong RF (low power) background, a taste for rustic living and the ability to view communications through inventive and ambitious eyes then the company offer the following benefits:

- **Brand new development facilities in a Georgian country house.**
- **Excellent salary and prospects.**
- **Full relocation expenses.**
- **The freedom and responsibility to make a personal mark in the industry.**

Telephone PAUL HECQUET to discuss this or other possibilities on 0446 47301 or write with brief details to the address below.

---

**THE ELECTRONICS RECRUITMENT COMPANY**

18 Station Road, Burgess Hill, West Sussex RH15 9DE

04446 47301/2/3/4

---

**UNIQUE OPPORTUNITY**

The manufacturer of a Hong Kong-based market leader minicomputer system is seeking an energetic and technically competent designer to head the R and D department currently looking at the next generation machines. The successful applicant will have proven ability in design/manufacturing/marketing areas, and will be rewarded by an attractive salary plus package on a minimum two year renewable contract. This is a first-class opportunity to head an energetic design team.

Applications should be sent, in the first instance, to:

Mr Mark Sim, General Manager
EACA INTERNATIONAL LTD.
Block "B" 11 Fl.
Watson Building
13 Cheung Yip St
Kwun Tong, Kowloon
Hong Kong

---

**TRAINEE RADIO OFFICERS**

First-class, secure career opportunities.

A number of vacancies will be available in 1983/84 for suitable qualified candidates to be appointed as Traineee Radio Officers.

If your trade or training involves Radio Operating, your quality to be considered for a Radio Officer post with the Composite Signals Organisation.

Candidates must have had at least 2 years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly.

On successful completion of between 36 and 42 weeks specialist training, promotion will occur to the Radio Officer grade.

Registered disabled people may be considered.

**SALARY & PROSPECTS**

**TRAINEE RADIO OFFICER:** £4,357 at 19 to £5,203 at 25 and over. On promotion to Radio Officer: £5,968 at 19 to £7,814 at 25 and over. Then by four annual increases to £10,662 inclusive of shift working and Saturday and Sunday elements.

For full details please contact our Recruitment Officer on Cheltenham (0242) 21491 Ext. 2269.

Recruitment Officer, Government Communications Headquarters, Oakley, Priory Road, Cheltenham, Gloucestershire GL52 5AJ

---

**KENT EDUCATION COMMITTEE**

**WEST KENT COLLEGE OF FURTHER EDUCATION**

Brook Street, Tonbridge, Kent

**ENGINEERING DEPARTMENT LECTURER II**

To teach on Radio, Television and Electronic servicing courses.

Experience with TEC courses and recent industrial employment will be an advantage.

Further details and application form available from:

Chief Administrative Officer
West Kent College of Further Education, Brook Street
Tonbridge, Kent

---

**Hardware/Software D and D Engineers**

Age 25-30 with MSc in Electronics, Computer Science, Artificial Intelligence or related subject to join lively team working:

(A) Worldwide in Industrial Automation Field, at £12,000; or

(B) Word Processor/Computer Field. Good package

Progressive jobs. Surrey.

Ring Anne McMillan
RIDGEWAY EXECUTIVE SELECTION
Epsom 24951

---

**APPOINTMENTS IN ELECTRONICS**

**to £15,000**

**MICROPROCESSORS**

**COMPUTERS - MEDICAL DATA COMMS - RADIO**

Design, test, field and support engineers - for interesting roles, good salary and career advancement. Please contact:

**TECHNOMARK LTD**

£12,000

**LOGEX HOUSE, BURLEIGH, STROUD**

**GLOUCESTERSHIRE GL2 2PW**

TEL. 0453 883264, 01-290 0267

---

**KENT EDUCATION COMMITTEE**

**WEST KENT COLLEGE OF FURTHER EDUCATION**

Brook Street, Tonbridge, Kent

**ENGINEERING DEPARTMENT LECTURER II**

To teach on Radio, Television and Electronic servicing courses.

Experience with TEC courses and recent industrial employment will be an advantage.

Further details and application form available from:

Chief Administrative Officer
West Kent College of Further Education, Brook Street
Tonbridge, Kent

---

**GCHQ**

---

**GRADUATE COMMUNICATIONS ENGINEER**

**RURAL S. YORKSHIRE**

If you have at least two years' experience in designing equipment using Z80/80 80/CP/M and would like to work in Chester, taking responsibility for project design and implementation in return for an attractive salary, please send a current CV to:

Sheila Drury
Kemtron Industrial and Scientific Computers
21-23 Charles Street, Hoole
Chester CH2 3AY
Tel. Chester (0244) 21817

---

**APPOINTMENTS IN ELECTRONICS**

**to £15,000**

**MICROPROCESSORS**

**COMPUTERS - MEDICAL DATA COMMS - RADIO**

Design, test, field and support engineers - for interesting roles, good salary and career advancement. Please contact:

**TECHNOMARK LTD**

£12,000

**LOGEX HOUSE, BURLEIGH, STROUD**

**GLOUCESTERSHIRE GL2 2PW**

TEL. 0453 883264, 01-290 0267

---

**KENT EDUCATION COMMITTEE**

**WEST KENT COLLEGE OF FURTHER EDUCATION**

Brook Street, Tonbridge, Kent

**ENGINEERING DEPARTMENT LECTURER II**

To teach on Radio, Television and Electronic servicing courses.

Experience with TEC courses and recent industrial employment will be an advantage.

Further details and application form available from:

Chief Administrative Officer
West Kent College of Further Education, Brook Street
Tonbridge, Kent

---

**WIRELESS WORLD NOVEMBER 1982**
Breakfast-time television is the latest important development in the long-running story of BBC innovation, both technical and professional.

This is why our continuing expansion is such good news for ambitious young Electrical or Electronic Engineers looking for real career prospects in lively surroundings.

In Breakfast TV you will be sharing the sense of achievement that’s so important in any new venture. Remember the BBC sets the standards for the rest of the broadcasting world, always pioneering new applications for the most advanced technology.

Joining us in the Television Service, London, as a Direct Entry Engineer you will have a starting salary of between £7314 and £7892 plus shift working allowances of £800 - £1000 pa.

Qualifications such as an HND/HNC or TEC Higher Diploma in Electronics or a C&G Full Technological Certificate in Telecommunications (Course 271) or a UK degree in Electrical or Electronic Engineering or Applied Physics are acceptable for consideration as a Direct Entry Engineer.

Normal hearing and colour vision are essential, together with the personality and commitment to become a valued member of our team.

So, if you’re ready for a real career challenge at the forefront of development, have a thorough knowledge of traditional electronics, and would like further details of what working at the BBC entails, please complete the coupon and send it to The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA, quoting reference number 82E.4067/WW.

We are an equal opportunities employer.
Directorate of Radio Technology
Telecommunications Officers

There are currently a number of opportunities (two at Kenley, Nr Croydon; one at Baldock, Herts and possibly two in the London area) to be involved in the technical aspects of planning, designing, regulation and use of frequency bands allocated to radio communication services. Work includes the operation, development and testing of specialised equipment; the preparation of specifications, and type approval.

Candidates must have at least four years' experience and must possess either ONC in Engineering including a pass in Electrical Engineering "A" or City and Guilds Telecommunications Technicians Certificate No 271 or the Intermediate Certificate plus Mathematics B, Telecommunications Principles B, and either Radio and Line Transmission B or Telephone B or Telegraphy B or City and Guilds Radio, Television and Electronics Technicians Certificate No 272 or a pass in the Council of Engineering Institutions Part I examination or TEC/SCOTEC Certificate in a relevant discipline or an equivalent qualification.

Ex-Service personnel with formal approved Service technical training and at least three years' appropriate service in a senior technical capacity will also be considered.

Applicants should be familiar with the operation, maintenance and testing of radio communication equipment and should have a knowledge of current radio systems.

Salary: £5690-£8180; Kenley £545 more, London up to £1087 more. Starting salary may be above the minimum for those with additional relevant experience. Good promotion experience.

RELOCATION ASSISTANCE MAY BE AVAILABLE.

For further details and an application form (to be returned by 11 November 1982) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote ref: T/S945.

Home Office

CLIVEDEN

LASER-SCAN LABORATORIES LTD

We are among the World Leaders in the manufacture of Computer Controlled Laser Deflection Systems and have won the 1982 Queen's Award for Technology.

We invite applications for the following post:

IN-HOUSE COMMISSIONING ENGINEER

Required to work in a team testing and aligning the Company's precision laser pointers and digitisers. A working knowledge of TTL is essential, and knowledge of microprocessors an advantage. Industral experience of both digital and analogue circuitry is necessary and experience in the use of lasers and optical components would be useful. Education qualification to a minimum of HNC in Electrical and Electronic Engineering is required.

To the successful applicant we can offer pleasant working conditions, competitive salaries, non-contributory sickness scheme and other fringe benefits.

Application forms obtainable from:
Personnel Officer, Laser-Scan Laboratories Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 4BH. Telephone (0223) 69872.

CLIVEDEN CONSULTANTS
97 St. Leonard's Road, Windsor, Berks. Windsor (07535) 5781/58022
24-hour service (1640)

TRINITY HOUSE LIGHTHOUSE SERVICE, LONDON

ELECTRICAL ENGINEER
GRADE PTO II SALARY £9,021-£10,328 p.a.

Applicants must have had a sound training in radio and light current work associated with UHF, VHF and MF communications, remote monitoring and control systems.

Experience in detailed planning, preparation of procurement specifications and drawings, manufacturers' acceptance testing, field trials and commissioning is essential.

Some knowledge of landline signalling techniques, simple computer programming and mini-technology would be an advantage.

Possession of a degree in electronics/radio engineering or equivalent is required.

Generous leave allowance, pension scheme and flexible working hours.

Apply to The Establishment Officer, Trinity House Lighthouse Service, Tower Hill, London EC3N 4DH or Telephone 01-480 6861 Ext. 285.
Are you flying high like the Sony Broadcast bird?

The silver bird is the symbol of Sony Broadcast Ltd., a company which in just over 4 years has become one of the world leaders in professional broadcast television equipment. Our exciting range of products includes video cameras, VTR’s/VCR’s, editing control systems and a range of digital audio equipment. We are about to commence a significant planned expansion programme and applications are invited for the following new career positions.

Lecturer
Two vacancies exist within our Technical Training Department. A Lecturer is required to conduct theoretical and practical courses on our range of cameras and a second opening exists for a person to concentrate on editors. Applicants should have experience of professional broadcast television equipment and possess the ability to present ideas clearly. Scope exists for occasional overseas travel and training on our range of products and in lecturing skills will be given where appropriate.

Product Engineer (Editing Systems)
To provide technical support to the Marketing and Engineering divisions of the Company on our range of professional video tape editors. The position combines in-depth technical involvement with inter departmental and customer liaison and there will be an opportunity for overseas travel.

Applicants should be graduate electronic engineers who have some experience in video technology gained either in operational television or its allied manufacturing industry.

Commissioning/QA Support Engineer
To join a small team responsible for the evaluation of product performance. Key activities will include commissioning, assistance in product customisation and the establishment and maintenance of ATE. Full product training will be given and there will be an opportunity for overseas travel.

Systems Project Engineer
To join a young and enthusiastic team involved in the design, manufacture and commissioning of complex static and mobile television systems. Candidates for this challenging and responsible position should have direct experience of sound and television principles gained in operational television or its allied manufacturing industry.

We offer an excellent remuneration package with first-class conditions of employment and fringe benefits.

Proposals Engineer
Ideal for engineers experienced in the Broadcast TV industry who now wish to utilize their knowledge in a dynamic commercial environment. Duties will include the preparation of detailed and concise customer proposals, complete with pricing information and extensive customer and inter Company liaison will be necessary.

Field Service Engineer
To be engaged in the service and repair of a wide range of sophisticated equipment, including video cameras, VTR’s and editing control systems. A high level of self-motivation and initiative is required in order to successfully undertake customer visits throughout Europe, Africa and the Middle East.

Field Service Engineer (London Based)
Reporting to the Service Manager, who is based in Basingstoke, the successful applicant will be responsible for the service and repair of the full range of our equipment. Candidates should live in the London area, possess a relevant qualification in electronics and have several years experience in operational television or its allied manufacturing industry.

Sales Engineer (UK)
An engineer with experience in operational television or its allied manufacturing industry is required to join our UK sales team. Applicants should be aged 25-35, highly motivated and able to work on their own initiative. Previous sales experience would be advantageous although this is not essential.

Senior Engineer – Measurement and Maintenance
To be responsible for a wide range of equipment in our Technical Training Department. Applicants should have extensive experience in practical maintenance and measurement techniques on VTR’s, editing systems and cameras. Many of our products are micro processor controlled, and a knowledge of micro processors, logical analysers and signature analysing techniques is desirable. Extensive product training will be given where necessary.

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
Hampshire RG21 2RA
United Kingdom

(1835)
CAMBRIDGE HEALTH AUTHORITY
Medical Physics Department
ADDENBROEKE'S HOSPITAL
Hills Road, Cambridge

Medical Physics
Technicians
(Electronics)
Grades III and IV

Two electronics technicians are required to provide a wide range of support services within the Cambridge area. Duties include maintenance, repair, development and construction of a wide range of equipment. The MPT III will also provide support to the CT Head Scanner in conjunction with other staff.

Minimum qualification OTEC or equivalent but HTEC/HNC preferred. MPT III applicants must have three years' relevant experience. Applicants should hold a valid driving licence.

Salaries:
MPT III £5,536 (starting) rising to £7,155 per annum.
MPT IV £4,668 (starting) rising to £6,137 per annum.
(NB Pay award pending)

For further details contact Mr. P. E. Ward, Principal Medical Physics Technician, Addenbrooke's Hospital, Hills Road, Cambridge. Tel. (0223) 245151, Ext. 471.

Application form and job description from: Personnel Department, Addenbrooke's Hospital, Hills Road, Cambridge. Tel. (0223) 245151, Ext. 7350.

(1805)

NOVEMBER! FAT BEARS HIBERNATE – KEEN ENGINEERS START AFRESH!

DEVELOPMENT ENGINEER

To design mobile (on water or in the air) transmitters and receivers in the low to very high frequency range. Up to £10,000 p.a. for an experienced graduate. Also required, a qualified and experienced technician to test and provide fast design services on process and quality control. Industrial systems based on 8080/8085/8086/8088 Micros and up to £5,000 p.a. in North Bucks.

SENIOR PROGRAMMER

To write high speed Real-Time multi-task software, largely in assembler but also high level languages on D.E.C. Processors running under RSX 11 for data collection and processing. Experience essential and a good (Engineering) degree. Salary up to £11,000 p.a. in West Hants.

TECHNICAL SUPPORT ENGINEER

To back up Ethernet networks of Intel Microprocessors (some with a PDP 11 Host). Must be very good at software and know protocols and communications in a business automation environment for up to £10,000 p.a. in Bucks.

Charles Airey Associates
Tempo House, 15 Falcon Road, Battersea, London SW11 2PJ
Tel: 01-223 1762 or 228 6254

1357

UNITED NATIONS invites applications from
RADIO OPERATORS
and RADIO TECHNICIANS

To serve in Field Service missions. Must be available for assignment any part of the world.

RADIO OPERATORS must hold 1st or 2nd Radio Operator's licence from Telecommunications Authority. Minimum international Morse code speed 30 wpm on semi-automatic key (Vibroplex), teletype minimum 50 wpm – must be able to operate and maintain telegraph and voice radio transmitters, receivers and ancillary equipment such as trailer power units, TTY, TD, etc. and be familiar with erection of mobile radio stations' antennae and emergency repairs. Salary US$17,742 (net after Staff Assessment $14,850 with dependents, $14,011 at single rate).

RADIO TECHNICIANS must have a diploma from a Radio Technical School and be able to install, maintain and operate fixed transmitters up to 40 kW, mobile and portable transmitting equipment, communications receivers, diversity systems and ancillary equipment associated with above, FSK, Teletype equipment and power generators. Must also be able device and erect omni-directional antennae and feeder lines. Climbing antennae masts may be required as field missions do not normally employ riggers for this purpose. Maintenance and repair teletype equipment of Teletype Corp. and Siemens may be required. If candidates not experienced in these operations at recruitment time, they should be willing to acquire proficiency on teletype within a reasonable time. Salary US$20,715 (net after Assessment $16,880 with dependents, $15,891 at single rate).

All candidates must have a valid driver's licence and must have a very good knowledge of English. Appointments are for six months to one year, with possibility of renewal and are subject to medical examination in addition to salary a monthly mission allowance will be paid in local currency. This allowance varies according to duty station. Good additional benefits.

Candidates may apply in writing to:

Miss Faith Metcalf, Office of Personnel
UNITED NATIONS – Room UNDC 200
New York, NY 10017 USA

1900

CHUBB ELECTRONICS

DEVELOPMENT ENGINEERS AND DESIGN DRAUGHTSPERSONS
ENFIELD – UP TO £11,000 P.A.

Chubb Electronics is a forward-looking company, specialising in electronic security systems. Our Enfield division is currently developing a range of electronic equipment and devices to meet our UK and overseas market requirements.

We have vacancies for electronic design engineers and draughtspersons with proven design experience in a commercial environment, keen to deal with projects from specification stage through to production.

Development Engineers
We are looking for young electronics design engineers to support existing teams working on microprocessor-based systems, and/or analogue circuit design covering a variety of interesting tasks of a multi-disciplinary nature.

Design Draughtspersons
We are looking for draughtspersons to be responsible for mechanical and printed circuit board design for complete projects from initial concepts through to issue of production drawings.

Formal qualifications are desirable. Promotion opportunities within the company are good.

Please send C.V. to:
The Development Manager
GUARDALL LIMITED
Alexandra Road, Enfield
Middlesex EN3 7ER
Tel: 01-805 7222

1857

WIRELESS WORLD NOVEMBER 1982
Appointments

ENGINEERS
FOR TOP BRITISH MICRO MANUFACTURER
£8.2 TO 12.7K. OXFORD-BASED

Research Machines is a leading UK manufacturer of microcomputers for scientific, engineering and educational applications. Our systems have earned a particular reputation for performance, reliability and quality of manufacture — a reputation which is due to the strength of our engineering team.

The continuing development of our product range and the expansion of our manufacturing capacity has led to a demand for additional engineers to work in our Production Engineering Department.

The successful applicants will be responsible for ensuring we make efficient use of our manufacturing resources by identifying areas for improvement and recommending and implementing changes. These changes might be to the production or workstation layouts, to the assembly techniques, to the testing procedures or to the product design.

In addition, he/she will be concerned with the introduction of new products, following through from design specification to in-house or sub-contract volume manufacture. This will involve working closely with Development Engineering, Purchasing, Production, Finance and Sales Departments.

It is likely that the successful applicants will be educated to HNC or degree level and have worked for a minimum of 3 years in the Design, Production or Production Engineering departments of an electronics company. A knowledge of electronics could be a distinct advantage.

We offer a particularly attractive range of benefits, including good salary; 25 days paid holiday; free BUPA, life and disability insurance, pension scheme and help with relocation expenses.

If you are interested in these vacancies please contact Pat Kember by 'phone or letter for an application form.

RESEARCH MACHINES LTD Addle street, Oxford OX2 0BW. Tel: (0865) 729176

The Royal Marsden Hospital
Downs Road, Sutton, Surrey
MEDICAL PHYSICS
TECHNICIAN
GRADE III
Required to work in a technical group in the busy Radiotherapy Department of this hospital. The person appointed will be chiefly responsible for maintenance work on a Linear Accelerator. Applicants should possess an ONC, HNC, HND or similar qualification in electrical engineering or electronics and have at least 3 years' technical experience.

Salary scale £6,093 to £7,712 p.a.
For an application form and further details please contact the Personnel Department — Tel: 01-352 8171 ext: 446. (1967)

The Royal Marsden Hospital
Fulham Road, SW3

Medical Physics
Technician Grade II/III
Required in the Radiotherapy and Physics Electronics Workshop of the above hospital. The person appointed will work in a small group responsible for the maintenance of radiotherapy equipment, including three Cobalt units, a Philips 10 MeV Linear Accelerator and 3/Mevoltage X-Ray equipment.
Applicants should have experience in electronics and electrical and mechanical servicing.
Applicants for MPT II should hold ONC, HNC or similar qualification in electrical engineering or electronics with at least three years' relevant technical experience. Entry to MPT II grade is open to a technician who has served at least two years as a Technician III.

MPT II Salary on scale: £5/678-£8/087
(pay award pending)
MPT III Salary on scale: £7/600-£9/248
(pay award pending)
For application form and further details please contact: The Personnel Department, Royal Marsden Hospital, Fulham Road, London, SW3. Tel: 01-352 8171 Ext 446. (1982)
**Quality Controller**

The Spares and Service Unit of Marconi Avionics Limited is responsible for the maintenance of a complete range of Airborne Electronics equipments for customers throughout the world. The equipments are not only of Marconi manufacture but include all the leading American and European makes.

We now require a Quality Controller to be responsible for the operation of a small quality department, overseeing the activities of a workshop of some thirty people repairing and overhauling a wide range of communication and navigation equipment for both civil and military customers.

Applicants should have had previous experience and knowledge of the airborne electronics industry and must be familiar with CAA and MOD Quality requirements.

We offer a competitive salary, together with a wide range of fringe benefits including canteen, pension scheme and subsidised private medical insurance.

Please write with brief personal and career details to Mr R Shead, Airadio Spares and Service Unit, 22-26 Dalston Gardens, Stanmore, Middlesex HA7 1BZ.

---

**WESSEX REGIONAL DEPARTMENT OF MEDICAL PHYSICS**

requires an

**ELECTRONICS ENGINEER/ PHYSICIST**

(Basic grade) to join a small team providing electronics support to clinical and scientific groups in Southampton hospitals.

The post is based in the electronics section of the medical physics department at the large and modern Southampton District General Hospital.

The work involves the application of the latest electronic techniques to a wide variety of problems in many different areas of medicine and the successful candidate will be expected to design and construct equipment to a high standard under the supervision of a senior electronics engineer.

A good Honours degree in electronics or physics is essential and relevant practical experience is desirable. The starting salary will be in the range of £5,667-£6,745 per annum (under review) according to postgraduate experience.

For further information or to make an application please contact:

Professor T. Sheley, Dept. of Medical Physics, Level D, Centre Block, Southampton General Hospital, Tremosa Road, Southampton, S09 4XY.

Tel: Southampton 777222 ext. 4205.

---

**HULL HEALTH AUTHORITY**

**ELECTRONICS TECHNICIAN**

GRADE II

Applications are invited from persons with an HNC in Electronics or an equivalent qualification, to join a small team of technicians working in the Hull and East Yorkshire Health Authorities. Duties involve maintaining a wide range of X-ray, biochemistry and electronics equipment, including SMA Analysers and CT scanner.

Applicants must have experience of X-ray equipment and be car owner/drivers.

Salary: £8,668 per annum rising by annual increments to £8,816 per annum.

Further details may be obtained from Mr P. Hall, Assistant Area Engineer, Tel. (0482) 223191 ext. 108.

Application forms and job description available from the District Personnel Office, Hull Health Authority, Victoria House, Park Street, Hull, tel. (0482) 223191, ext. 99.

Closing date: 3rd November 1982.

---

**FIELD ENGINEER**

For independent AV service company to work on language laboratories and other educational equipment in the London area. Requires practical knowledge of Audio and Control Electronics, with some mechanical aptitude. Salary to £8,000 + car according to experience.

Please write to:
Bellnorgis Ltd.
9-11 Kensington High St.
London W8 5NP

---

**Senior Test Technicians**

Ultra are leaders in the manufacture of sophisticated communication equipment. The Test Department now seeks Senior Test Technicians to carry out a wide range of test work associated with the company's products and equipment. You will also provide a versatile capacity in fault finding, calibration and final product testing with the minimum of supervision.

Aged 21 plus, you will have a Technician's certificate or equivalent in electronics and/or at least five years practical test experience.

A highly competitive salary is offered together with a good benefits package that includes 24 days holiday, sports and social club, subsidised canteen and contributory pension scheme.

Please telephone Diana Palmer on 01-578 0081 Ext. 249.

---

**ARTICLES FOR SALE**

**MULTIPLE RIVETING M/Cs**

4 of Multiple Riveting M/Cs manufactured in 1972 by Kocher K.G., Germany. Consists of riveter and back-up base. Price: £9,000 each o.n.o.

**TAVISHLEM**

HYDRAULIC INTERNATIONAL LIMITED

Hynes House, Station Close
Perthshire, Perth PH2 9XG

Telephone: 0797-64554
**Technical Writer/Reporter**

Enthusiastic journalist, ideally with technical qualifications (HND or degree) and experience, to work on MIDDLE EAST ELECTRONICS.

This successful, monthly magazine is read by senior electronics engineers in the Middle East, and the Editor is looking for a responsible number two to develop the journal's potential.

Usual writing and subbing skills essential plus knowledge of the industry and preferably experience of developing countries and their technology problems. Computer Sc-ence background an advantage.

Our UK office is located in Morden, Surrey, but we offer opportunities for travel and a salary of £8,400 per annum.

Terms and conditions are in accordance with the IPC/NJU agreement.

Write or phone for an application form to the Editor, Ray Ashmore, Middle East Electronics, Crown House, 14th Floor, London Road, Morden, Surrey SM4 5DX. Tel: 01-543 3051.

IPC Business Press is an equal opportunity employer.

---

**SCOTTISH OFFICE DIRECTORATE OF TELECOMMUNICATIONS**

*WIRELESS TECHNICIAN*

Applications are invited for 1 post of Wireless Technician in the Central Services Department of the Scottish Office. The post is based in East Kilbride.

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 3 years' appropriate experience.

Some assistance may be given with relocation expenses.

A valid UK driving licence is 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) 2/23/82 (031-558 8400, ext. 4317 or 5028).

Closing date for receipt of completed application forms is 12 November, 1982.

---

**TELEVISION SERVICE ENGINEER**

We are an expanding Television Rental and Retail company with a vacancy for an additional Television Service Engineer.

Suitable applicant will preferably hold an R.T.E.B. certificate or be training towards this qualification.

The post is directly responsible to the Service Manager.

A clean driving licence is essential.

A spacious flat is available if required.

Write to: Hydes of Chertsey Ltd., 56/60 Guildford Street, Chertsey, Surrey KT16 9BE. Chertsey 63243.

---

**ARTICLES FOR SALE**

**THE SCIENTIFIC WIRE COMPANY**

P.O. Box 30, London, E4

ENAMELLED COPPER WIRE

<table>
<thead>
<tr>
<th>SWG</th>
<th>11b</th>
<th>8oz</th>
<th>4oz</th>
<th>2oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 to 29</td>
<td>2.76</td>
<td>1.50</td>
<td>.80</td>
<td>.60</td>
</tr>
<tr>
<td>30 to 40</td>
<td>1.80</td>
<td>.90</td>
<td>.70</td>
<td>.50</td>
</tr>
<tr>
<td>41 to 43</td>
<td>1.10</td>
<td>.60</td>
<td>.40</td>
<td>.30</td>
</tr>
<tr>
<td>44 to 46</td>
<td>1.40</td>
<td>.80</td>
<td>.60</td>
<td>.40</td>
</tr>
</tbody>
</table>

SILVER PLATED COPPER WIRE

14 to 30 | 5.60 | 3.75 | 2.20 | 1.40 |

Prices include P & V At and Wire Date. SAE for list. Dealer enquiries welcome. Reg Office: 22 Coningsby Gardens.

---

**COMPONENT CLEARANCE**

- Resistors, capacitors, relays, LED's, and others

**OBSCOLOSCOPE**

DC to 100 MHz D8 dual TB Japanese copy. Technics 485, new and unused, complete with manual, probes, covers £695 excluding.

Tel: 01-991 0070

---

**WIRELESS WORLD NOVEMBER 1982**

---

**THE QUARTZ CRYSTAL COMPANY**

G.C.C. WORKS, WELLINGTON CRESCENT, NEW MALDEN, SURREY 01-943 3334 & 2566

---
CIRCOLEC
THE COMPLETE ELECTRONIC SERVICE
Quality workmanship by professionals at economic prices.
Please telephone 01-767 1233 for advice or further details.
1 FRANCISCAN ROAD
TOOTING, LONDON SW17
01-696 7669
(1391)

FOR THE BEST PCB SERVICE AVAILABLE
- Circuit Design & Development
- Printed Circuit Boards
- Board Manufacture
- Wiring & Assembly

DESIGN AND DEVELOPMENT. Electronic design development and production of digital and analogue instruments. RF Transistors and receivers, telemetry and control systems. 20 years' experience. R.C.S. Electronics, Whiteley Road, Ashford, Middlesex. Phone Mr Falkner 53661
(1168)

TURN YOUR SURPLUS Capacitors, transistors, etc, into cash. Contact COLESAH.DING & Co., 103 South Bank, Wembley, Middlesex. 0945-4188. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance.
(959)

TW ELECTRONICS LTD
THE PCB ASSEMBLERS
More and more companies are investigating the advantages of using a professional subcontractor. Such an undertaking requires certain assurances.
TW are able to satisfy all of them - quality, competitiveness, price delivery and close co-operation with the customer.

Assembly boards at 100% inspected before flow soldering and reinspected after automatic cropping and cleaning.
Every batch of completed boards is issued with a signed certificate of conformity and quality - our final assurance.
For further details, contact us at our new works:
Blenheim Industrial Park
Bury St. Edmunds
Suffolk IP33 6JQ
Telephone: 0284 383 311 (1468)

BATCH PRODUCTION PC ASSEMBLY to sample or drawings any quantity. J.E. (Electronics) Ltd., Unit 2, Carew St. Ind. Estate, Carmarthen SA35 9DF. Tel. 01-797 1422.
(1815)

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. 1A Eps Rd, Gillingham, Kent. Tel: Medway 0634 577854.
(B667)

BATCH PRODUCTION Wiring and assembly to sample or drawings. McDaniel Electricals Ltd, 19th Station Parade, Eding Common, London W5. Tel: 01-992 8976.
(169)

WANTED
Secondhand standard of resistors, capacitors and inductors. AC and standard cells. Very high accuracy precision measuring instruments. Manufacturers: Tinsley, Guildline, Philke, JRL etc.
Phone Tombridge (0732) 355993
(1301)

WANTED
Test equipment, receivers, valves, transmitters, components, cable and electronic scrap, and quantity. Prompt service and cash. Member of A.R.A.
M & B RADIO
86 Bishopsgate Street
London E1.
0532 35649
(1807)

WANTED:
Redundant test equipment - receiving and transmitting equipment - valves and sockets - gauges, etc. Phone John's Radios, 0274 84407, 84 Whitchall Road East, Berkswich, Bradford BD1 2ER.
(1723)

WANTED FOR CASH: 771, 797, 53, 6L6 metal, 304TL, 4CX1000A, all transmitting, special purpose valves of Eimac/Varian, DCO, INC, 10 Schuler Avenue, North Arlington, New Jersey 07032, USA.
(1625)

BOARDRAVEN LTD.
PRINTED CIRCUIT BOARDS
Manufactured to your specifications. Single- or double-sided, any quantity. Master layouts if required.
Contact: Sandy Bay Industrial Estate, Bexhill, East Sussex TN38 8WQ. Telephone: 0323 797986
(1168)

PCB LAYOUT DESIGN QUALITY ARTWORK
FAST DELIVERY - REASONABLE RATES
PHONE FREE ARTWORK SERVICE 01-607 3143
DESIGN AND DEVELOPMENT, ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/subcontract batch production. - Adamson Limited, Unit 103 Liscombe, Bracknell, Berks. Tel: Bracknell 53025.
(656)

WANTED
Scrap and re-useable mainframe computer and industrial electronic equipment.
E.M.A. Telecommunications Engineers, Woodbridge, Suffolk. Tel: 0394 45 328.
(1720)

P.C.B.
LAYOUT DESIGN QUALITY ARTWORK
DESIGN AND DEVELOPMENT, ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/subcontract batch production. - Adamson Limited, Unit 103 Liscombe, Bracknell, Berks. Tel: Bracknell 53025.
(656)

WANTED
Scrap and re-useable mainframe computer and industrial electronic equipment.
E.M.A. Telecommunications Engineers, Woodbridge, Suffolk. Tel: 0394 45 328.
(1720)

WANTED
Secondhand standard of resistors, capacitors and inductors. AC and standard cells. Very high accuracy precision measuring instruments. Manufacturers: Tinsley, Guildline, Philke, JRL etc.
Phone Tombridge (0732) 355993
(1301)

WANTED
Test equipment, receivers, valves, transmitters, components, cable and electronic scrap, and quantity. Prompt service and cash. Member of A.R.A.
M & B RADIO
86 Bishopsgate Street
London E1.
0532 35649
(1807)

WANTED:
Redundant test equipment - receiving and transmitting equipment - valves and sockets - valves, etc. Phone John's Radios, 0274 84407, 84 Whitchall Road East, Berkswich, Bradford BD1 2ER.
(1723)

WANTED FOR CASH: 771, 797, 53, 6L6 metal, 304TL, 4CX1000A, all transmitting, special purpose valves of Eimac/Varian, DCO, INC, 10 Schuler Avenue, North Arlington, New Jersey 07032, USA.
(1625)

PHONING YOUR CLASSIFIEDS TO IAN FAUX
ON 01-661 3033

WIRELESS WORLD NOVEMBER 1982
# Index to Advertisers

<table>
<thead>
<tr>
<th>Agencies</th>
<th>PAGE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accutronic Mig. Co. Ltd.</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Ambit International Ltd.</td>
<td>98, 108</td>
<td>96</td>
</tr>
<tr>
<td>Ambio Ltd.</td>
<td>95</td>
<td>9</td>
</tr>
<tr>
<td>Analyst Ltd.</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Anglia Components Ltd.</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Armon Electronics Ltd.</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Audio Electronics Ltd.</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Audio Visual Electronic Contractors Ltd.</td>
<td>87</td>
<td>9</td>
</tr>
<tr>
<td>Autotype</td>
<td>88</td>
<td>9</td>
</tr>
<tr>
<td>Avel Lindburg (Gosworth Electronics)</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>Bach-Simpson (UK) Ltd.</td>
<td>8, 89</td>
<td>8</td>
</tr>
<tr>
<td>Bamber, B. Electronics Ltd.</td>
<td>108</td>
<td>8</td>
</tr>
<tr>
<td>Barrie Electronics Ltd.</td>
<td>67</td>
<td>8</td>
</tr>
<tr>
<td>Baydis Ltd.</td>
<td>116</td>
<td>8</td>
</tr>
<tr>
<td>Black Star Ltd.</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Broadfield &amp; Marco Disposals</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Bull, J. (Electrical) Ltd.</td>
<td>112, 113</td>
<td>8</td>
</tr>
<tr>
<td>Cambridge Instruments</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Caracal Power Products Ltd.</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Chilten Electronics</td>
<td>96</td>
<td>8</td>
</tr>
<tr>
<td>Chiltonal Ltd.</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>CIL Microsystems Ltd.</td>
<td>110</td>
<td>8</td>
</tr>
<tr>
<td>Circuit Services</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Clark Photo Ltd.</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Clear Products (Electronics) Ltd.</td>
<td>108</td>
<td>8</td>
</tr>
<tr>
<td>Compuclock Systems Ltd.</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Crimson Elektrik</td>
<td>102</td>
<td>8</td>
</tr>
<tr>
<td>Cromelektron Instruments Ltd.</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>Display Electronics</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>DSN Marketing Ltd.</td>
<td>99</td>
<td>8</td>
</tr>
<tr>
<td>Electric Review Stock Cards</td>
<td>104</td>
<td>8</td>
</tr>
<tr>
<td>Electric Hand Book</td>
<td>102</td>
<td>8</td>
</tr>
<tr>
<td>Electronic Brokers Ltd.</td>
<td>3, 5, 58, 59</td>
<td>8</td>
</tr>
<tr>
<td>Electronic Equipment Co.</td>
<td>106</td>
<td>8</td>
</tr>
<tr>
<td>Electronic Hobbies Fair</td>
<td>109</td>
<td>8</td>
</tr>
<tr>
<td>Electrovoice</td>
<td>94</td>
<td>8</td>
</tr>
<tr>
<td>Faircrest Engineering Ltd.</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Farnell Instruments Ltd.</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Fieldtech Heatrow Ltd.</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Flight Electronics Ltd.</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Foundations of Wireless and Electronics</td>
<td>94</td>
<td>8</td>
</tr>
<tr>
<td>Fortronics Technology (UK) Ltd.</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>Fylde Electronic Laboratories Ltd.</td>
<td>113</td>
<td>8</td>
</tr>
<tr>
<td>GAS Electronics</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Global Specialties Corp. (UK) Ltd.</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Gould Instruments Division</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>GP Industrial Electronics Ltd.</td>
<td>26, 27</td>
<td>8</td>
</tr>
<tr>
<td>Greenwood Electronics Ltd.</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Hanem Ltd.</td>
<td>88</td>
<td>8</td>
</tr>
<tr>
<td>Harris Memories</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Harris Electronics (London)</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Hart Electronic Kts Ltd.</td>
<td>103</td>
<td>8</td>
</tr>
<tr>
<td>Hemmings Electronics and Microcomputers</td>
<td>93</td>
<td>8</td>
</tr>
<tr>
<td>Henry’s Radio</td>
<td>4, 12</td>
<td>8</td>
</tr>
<tr>
<td>ILP Electronics Ltd.</td>
<td>90, 91, 111</td>
<td>8</td>
</tr>
<tr>
<td>Instrument Rentals (UK)</td>
<td>105</td>
<td>8</td>
</tr>
<tr>
<td>Interface Quartz Devices Ltd.</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Intergel Ltd.</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Keithley Instruments Ltd.</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Langleys Supplies Ltd.</td>
<td>115</td>
<td>8</td>
</tr>
<tr>
<td>Manners, K. T. Design Ltd.</td>
<td>116</td>
<td>8</td>
</tr>
<tr>
<td>Marrten Ltd.</td>
<td>93</td>
<td>8</td>
</tr>
<tr>
<td>Melkust Ltd.</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Midwich Computer Co. Ltd.</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Modern Book Co.</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Monodich Electronics Ltd.</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>Northern Computer Fair</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>Northern Electronics</td>
<td>98</td>
<td>8</td>
</tr>
<tr>
<td>Olson Electronics Ltd.</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Opus Supplies</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Orion Scientific Products Ltd.</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Pantechic</td>
<td>88</td>
<td>8</td>
</tr>
<tr>
<td>PM Components</td>
<td>106, 107</td>
<td>8</td>
</tr>
<tr>
<td>Practical Computing</td>
<td>110</td>
<td>8</td>
</tr>
<tr>
<td>PRR Computer Shop</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Radford Audio Ltd.</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Radio Component Specialists</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Rafie, P. F. Electronics</td>
<td>96</td>
<td>8</td>
</tr>
<tr>
<td>Relay-A-Quip</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>Robot (UK) Ltd.</td>
<td>98</td>
<td>8</td>
</tr>
<tr>
<td>RST Valves</td>
<td>115</td>
<td>8</td>
</tr>
<tr>
<td>Sagin, M. R.</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Sandwell Plant Ltd.</td>
<td>116</td>
<td>8</td>
</tr>
<tr>
<td>Schel Tronics Ltd.</td>
<td>98</td>
<td>8</td>
</tr>
<tr>
<td>Service Trading Co. Ltd.</td>
<td>99</td>
<td>8</td>
</tr>
<tr>
<td>Sescon Inc.</td>
<td>88</td>
<td>8</td>
</tr>
<tr>
<td>Sinclair Research Ltd.</td>
<td>18, 19</td>
<td>8</td>
</tr>
<tr>
<td>South Midlands Communications Ltd.</td>
<td>111</td>
<td>8</td>
</tr>
<tr>
<td>Sower, E. A. Ltd.</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Special Products (Distributor) Ltd.</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Storton (Bournemout)</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Storton Ltd.</td>
<td>89</td>
<td>8</td>
</tr>
<tr>
<td>Townsend Ltd.</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Technonautic</td>
<td>100, 101</td>
<td>8</td>
</tr>
<tr>
<td>Teleaid Radio Electronics Ltd.</td>
<td>108</td>
<td>8</td>
</tr>
<tr>
<td>Television Magazine</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Teleman Products Ltd.</td>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>Thandar Electronics Ltd.</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Thomas Electron Ltd.</td>
<td>106</td>
<td>8</td>
</tr>
<tr>
<td>Thorn EM1 Instruments Ltd.</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Thurby Electronics Corp.</td>
<td>128</td>
<td>8</td>
</tr>
<tr>
<td>Time Electronics</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>Vairodo Ltd.</td>
<td>106</td>
<td>8</td>
</tr>
<tr>
<td>Vigilan Communications Ltd.</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Wadford Electronics Ltd.</td>
<td>10, 11</td>
<td>8</td>
</tr>
<tr>
<td>West Hyde Developments Ltd.</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>White House Electronics</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Winawash Radio</td>
<td>4, 16</td>
<td>8</td>
</tr>
<tr>
<td>Wireless World Circards</td>
<td>114</td>
<td>8</td>
</tr>
<tr>
<td>W.K. &amp; R. Ltd.</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Your Computer</td>
<td>116</td>
<td>8</td>
</tr>
</tbody>
</table>

## Overseas Advertisement

<table>
<thead>
<tr>
<th>Agency</th>
<th>PAGE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>France &amp; Belgium</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Hungary</td>
<td>97</td>
<td>8</td>
</tr>
</tbody>
</table>

Printed in Great Britain by QB Ltd., Shrewsbury Place, Colchester, and Published by the Proprietors, IPC ELECTRICAL ELECTRONICS PRESS LTD., Quadrant House, The Quadrant, Suntan, Surrey SM2 3AS, telephone 01-661 3500. Wireless World can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Geth Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wan, Dallan Subcontractors Ltd., Gordon & Geth Ltd. SOUTH AFRICA: New Zeal Ltd, William Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Distribution Inc., 14th Floor, 111 Eighth Avenue, New York, N.Y. 10011.

WIRELESS WORLD NOVEMBER 1982

128
When you select an instrument from the Leader range, you get more than just sound engineering. That’s guaranteed by rigorous quality assurance at manufacture and a one year warranty.

A broad range that covers most areas of test, measurement and calibration, with advanced features and high specification as standard. Prices that are lower than you’d expect are the bonus. Probes, covers, tools and pouches are all available to enhance the application potential and ensure that Leader instruments set the pace for others to follow.

When you select an instrument from the Leader range, you get more than just sound engineering. That’s guaranteed by rigorous quality assurance at manufacture and a one year warranty. A broad range that covers most areas of test, measurement and calibration, with advanced features and high specification as standard. Prices that are lower than you’d expect are the bonus. Probes, covers, tools and pouches are all available to enhance the application potential and ensure that Leader instruments set the pace for others to follow.

TV & FM Test

- Colour Bar Pattern Generators
- Sweep and Marker Generator
- CRT Tester
- Field Level Checker
- Signal Level Meter
- High Voltage Metered Probe
- Signal Generators

Audio Test

- Generators
- Attenuators
- System Analyser
- Audio Test
- Distortion Meter
- Equaliser Amp
- Wow and Flutter Meter
- Frequency Response Recorders
- Mill voltmetres
- Log Amplifier
- Speaker Analyser

Oscilloscopes

- 4 to 50 MHz
- Single, Dual and Quad trace
- Delayed sweep
- Wide bandwidth
- High sensitivity
- High accuracy
- Battery operated

General Test

- LCR Bridge
- Semiconductor Curve Tracer
- Transistor Testers
- Logic Probe

Power Supplies

- Laboratory bench type
- 5 models
- 500mA to 5A
- Overload Protected

Thanda Electronics Ltd, London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4HJ England.
Tel: (0480) 64646.
Telex: 32250.
the new name in quality solder

Now there is another choice in high quality solder. The new Oryx resin cored solder. Try it and you will find it spreads easier than the solder you are using.

Specially formulated for fast precision solder work, it is 60% tin, 40% lead alloy with quality flux construction and melts at 183°C.

Two gauges are available—18 SWG (1.2mm) and 22 SWG (0.71mm) in 2.5 Kg, 500g, 250g and 100g reels. Pocket size dispenser with 10 feet of Oryx 1mm solder is also available at only 68p (+VAT).

Oryx is competitively priced—write now for details and technical information.

Greenwood Electronics
Greenwood Electronics Limited, Portman Road, Reading, Berkshire RG3 1NE. Telephone: (0734) 595844. Telex: 848659

The TC82— a significant development in temperature controlled soldering

The new Oryx TC82 has features unique to any temperature controlled precision soldering iron.

Available in 24 V, 50 V, 115 V and 210/240 V models, the TC82 has a facility allowing the user to accurately dial any tip temperature between 260°C and 420°C by setting a dial in the handle without changing tips. This eliminates the need for temperature measuring equipment. You get faster and better soldering.

For 24 V models a special Oryx power unit connects directly to the iron and contains fully isolated transformer to BS3535, a safety stand, tip clean facility and illuminated mains socket switch.

The Oryx TC82 is also extra-safe. Removing the handle automatically disconnects the iron from power source.

Other TC82 features include: Power-on Neon indicator in handle; burn proof cable; choice of 13 tip styles.

And more good news

The Oryx TC82 iron costs only £13.00 (+VAT) and the power unit for 24 V operation £23.00 (+VAT).

The TC82 240 volt is also available as a 30 watt general purpose iron at only £4.95 (+VAT).

Greenwood Electronics
Greenwood Electronics Limited, Portman Road, Reading, Berkshire RG3 1NE. Telephone: (0734) 595844. Telex: 848659

WW—003 FOR FURTHER DETAILS